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# IEEE Standard for Information Technology—
# Telecommunications and Information Exchange between Systems
# Local and Metropolitan Area Networks—
# Specific Requirements

# Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

# Amendment 2:
# Enhanced Throughput for Operations in License-exempt Bands above 45 GHz

IEEE Computer Society

STANDARDS

Developed by the
LAN/MAN Standards Committee

**IEEE Std 802.11ay™-2021**
(Amendment to IEEE Std 802.11™-2020
as amended by IEEE Std 802.11ax™-2021)

IEEE

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**LAN/MAN Standards Committee**
of the
**IEEE Computer Society**

Approved 25 March 2021

**IEEE SA Standards Board**

**Abstract**: In this amendment to IEEE Std 802.11-2020, standardized modifications to both the IEEE 802.11 physical layer (PHY) and the IEEE 802.11 medium access control (MAC) sublayer are defined to enable at least one mode of operation capable of supporting a maximum throughput of at least 20 gigabits per second (measured at the MAC data service access point), while maintaining or improving the power efficiency per station.

**Keywords:** 60 GHz, beamforming, directional multi-gigabit, EDMG, Extended DMG, IEEE 802.11™, IEEE 802.11ay™, millimeter-wave, MIMO, multiple input multiple output, variable channel widths

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# Introduction

This introduction is not part of IEEE Std 802.11ay-2021, IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications—Amendment 2: Enhanced Throughput for Operation in License-exempt Bands above 45 GHz.

This amendment defines modifications to both the IEEE 802.11 physical layer (PHY) and the IEEE 802.11 medium access control (MAC) sublayer for enhanced throughput operation in license-exempt bands above 45 GHz.

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# Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

# Amendment 2: Enhanced Throughput for Operation in License-exempt Bands above 45 GHz

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editorial instructions, change markings and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

## 3. Definitions, acronyms, and abbreviations

### 3.1 Definitions

***Insert the following definitions into 3.1 in alphabetic order:***

**reassembly:** The process of combining a set of segmented medium access control (MAC) protocol data units (MPDUs) into a larger medium access control (MAC) service data unit (MSDU).

**segmentation:** The process of partitioning a large medium access control (MAC) service data unit (MSDU) into a sequence of MAC protocol data units (MPDUs), each carrying an MSDU segment. The inverse process of combining a set of segmented MPDUs into an MSDU is known as reassembly.

**single input, single output (SISO):** A physical layer (PHY) configuration in which both transmitter and receiver use a single antenna.

## 3.2 Definitions specific to IEEE 802.11

***Change the following definitions in 3.2 as shown:***

**destination directional multi-gigabit (DMG) station (STA):** A DMG STA that is expected to receive during a time division duplex (TDD) slot, or a ~~A~~ DMG STA identified by the destination association identifier (AID) field contained in a Grant frame or Extended Schedule element that caused the allocation of a service period (SP) or a contention based access period (CBAP).

**directional multi-gigabit (DMG) frame:** A frame transmitted or received within a DMG physical layer (PHY) protocol data unit (PPDU) or within an enhanced directional multi-gigabit (EDMG) PPDU.

**non-high-throughput (non-HT):** A modifier meaning neither high throughput (HT) nor very high throughput (VHT) nor directional multi-gigabit (DMG).

**secondary channel:** A 20 MHz channel associated with a primary channel used by high-throughput (HT) stations (STAs) for the purpose of creating a 40 MHz channel or used by very high throughput (VHT) STAs for the purpose of creating the primary 40 MHz channel. A 2.16 GHz channel associated with a primary channel used by enhanced directional multi-gigabit (EDMG) STAs for the purpose of creating a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel.

**source directional multi-gigabit (DMG) station (STA):** A DMG STA that is expected to transmit during a time division duplex (TDD) slot, or a DMG STA identified by the source association identifier (AID) field contained in a Grant frame or Extended Schedule element that caused the allocation of a service period (SP) or contention based access period (CBAP).

***Insert the following definitions into 3.2 in alphanumeric order:***

**2.16 GHz mask physical layer (PHY) protocol data unit (PPDU)**: One of the following PPDUs transmitted using the transmit spectral mask defined in Clause 20: a) A directional multi-gigabit (DMG) PPDU; b) A 2.16 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 2.16 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**2.16 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 20 directional multi-gigabit (DMG) 17 PPDU or a Clause 28 2.16-GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter 18 FORMAT equal to EDMG) or a Clause 28 2.16-GHz non-enhanced directional multi-gigabit (non-EDMG) 19 PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**2.16+2.16 GHz mask physical layer (PHY) protocol data unit (PPDU)**: A PPDU that is transmitted using the 2.16+2.16 GHz transmit spectral mask defined in Clause 28 and that is one of the following: a) A 2.16+2.16 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG); b) A 2.16+2.16 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**2.16+2.16 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 2.16+2.16 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a Clause 28 2.16+2.16 GHz non-enhanced directional multi-gigabit (non-EDMG) PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**4.32 GHz mask physical layer (PHY) protocol data unit (PPDU)**: A PPDU that is transmitted using the 4.32 GHz transmit spectral mask defined in Clause 28 and that is one of the following: a) A 4.32 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 4.32 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); b) A 2.16 GHz EDMG PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 2.16 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**4.32 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 4.32-GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a Clause 28 4.32-GHz non-enhanced directional multi-gigabit (non-EDMG) PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**4.32+4.32 GHz mask physical layer (PHY) protocol data unit (PPDU)**: A PPDU that is transmitted using the 4.32+4.32 GHz transmit spectral mask defined in Clause 28 and that is one of the following: a) A 4.32+4.32 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG); b) A 4.32+4.32 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**4.32+4.32 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 4.32+4.32 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a Clause 28 4.32+4.32 GHz non-enhanced directional multi-gigabit (non-EDMG) PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**6.48 GHz mask physical layer (PHY) protocol data unit (PPDU)**: A PPDU that is transmitted using the 6.48 GHz transmit spectral mask defined in Clause 28 and that is one of the following: a) A 6.48 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 6.48 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); b) A 4.32 GHz EDMG PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 4.32 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); c) A 2.16 GHz EDMG PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 2.16 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**6.48 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 6.48-GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a Clause 28 6.48-GHz non-enhanced directional multi-gigabit (non-EDMG) PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**8.64 GHz mask physical layer (PHY) protocol data unit (PPDU)**: A PPDU that is transmitted using the 8.64 GHz transmit spectral mask defined in Clause 28 and that is one of the following: a) An 8.64 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or an 8.64 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); b) A 6.48 GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 6.48 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); c) A 4.32 GHz EDMG PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 4.32 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG); d) A 2.16 GHz EDMG PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a 2.16 GHz non-EDMG PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**8.64 GHz physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 8.64-GHz enhanced directional multi-gigabit (EDMG) PPDU (TXVECTOR parameter FORMAT equal to EDMG) or a Clause 28 8.64-GHz non-enhanced directional multi-gigabit (non-EDMG) PPDU (TXVECTOR parameter FORMAT equal to NON_EDMG).

**aggregate physical layer (PHY) protocol data unit (A-PPDU)**: A sequence of two or more PPDUs transmitted without an interframe space (IFS). The PPDU(s) transmitted following the first PPDU in the sequence do not contain PHY preamble(s), only PHY header(s) and PHY service data unit(s) (PSDU(s)).

**directional multi-gigabit (DMG) aggregate physical layer (PHY) protocol data unit (A-PPDU)**: An A-PPDU where all constituent PPDUs are DMG PPDUs.

**enhanced directional multi-gigabit (EDMG)**: Pertaining to an enhanced feature operation in directional multi-gigabit (DMG).

**enhanced directional multi-gigabit (EDMG) aggregate physical layer (PHY) protocol data unit (A-PPDU)**: An A-PPDU where all constituent PPDUs are EDMG PPDUs.

**enhanced directional multi-gigabit (EDMG) basic service set (BSS)**: A directional multi-gigabit (DMG) BSS in which a DMG Beacon frame transmitted by an EDMG station (STA) has the EDMG Supported field equal to 1.

**enhanced directional multi-gigabit (EDMG) physical layer (PHY) protocol data unit (PPDU)**: A Clause 28 PPDU transmitted with the TXVECTOR parameter FORMAT equal to EDMG.

**non-directional multi-gigabit (non-DMG)**: A modifier meaning not directional multi-gigabit (DMG), not enhanced directional multi-gigabit (EDMG), and not China directional multi-gigabit (CDMG).

**non-enhanced directional multi-gigabit (non-EDMG)**: A modifier meaning directional multi-gigabit (DMG) and that includes neither EDMG enhancement nor CDMG enhancements.

**non-enhanced directional multi-gigabit (non-EDMG) duplicate transmission format**: A transmission format of the physical layer (PHY) that duplicates a 2.16 GHz non-EDMG transmission in two or more 2.16 GHz channels and allows a station (STA) in a DMG basic service set (BSS) on any one of the 2.16 GHz channels to receive the transmission. A non-EDMG duplicate format is one of the following:

— 4.32 GHz non-EDMG duplicate transmission format: A transmission format of the PHY that replicates a 2.16 GHz non-EDMG transmission in two adjacent 2.16 GHz channels.
— 6.48 GHz non-EDMG duplicate transmission format: A transmission format of the PHY that replicates a 2.16 GHz non-EDMG transmission in three adjacent 2.16 GHz channels.
— 8.64 GHz non-EDMG duplicate transmission format: A transmission format of the PHY that replicates a 2.16 GHz non-EDMG transmission in four adjacent 2.16 GHz channels.
— 2.16+2.16 GHz non-EDMG duplicate transmission format: A transmission format of the PHY that replicates a 2.16 GHz non-EDMG transmission in two, not necessarily adjacent, 2.16 GHz channels.
— 4.32+4.32 GHz non-EDMG duplicate transmission format: A transmission format of the PHY that replicates a 2.16 GHz non-EDMG transmission in two frequency segments of two adjacent 2.16 GHz channels where the two frequency segments of channels are not necessarily adjacent.

**secondary1 channel**: A 2.16 GHz channel associated with a primary channel and a secondary channel used by enhanced directional multi-gigabit (EDMG) stations (STAs) for the purpose of creating a 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel.

**secondary2 channel**: A 2.16 GHz channel associated with a primary channel, a secondary channel, and a secondary1 channel used by enhanced directional multi-gigabit (EDMG) stations (STAs) for the purpose of creating an 8.64 GHz channel, 2.16+2.16 GHz, or 4.32+4.32 GHz channel.

NOTE—For the assignment and relationship of EDMG primary, secondary, secondary1, and secondary2 channels, refer to Table 8-5a and Figure 8-6.

**short sector sweep (SSW) PPDU**: A directional multi-gigabit (DMG) control mode physical layer (PHY) protocol data unit (PPDU) that has the Length field in the PHY header equal to 6 and the PPDU Type subfield within the Short SSW Payload field equal to 0.

**single input, single output (SISO) identifier (ID) subset**: A tuple comprising the values of the AWV feedback ID, TX antenna ID, RX antenna ID and BRP CDOWN subfields.

**time division duplex (TDD) service period (SP)**: An SP that uses the TDD channel access within the SP.

NOTE—TDD channel access is defined in 10.39.6.2.2.

## 3.4 Acronyms and abbreviations

***Insert the following abbreviations into 3.4 in alphabetic order:***

| | |
|---|---|
| A-PPDU | aggregate physical layer protocol data unit |
| DCM | dual carrier modulation |
| EDMG | enhanced directional multi-gigabit |
| NUC | nonuniform constellation |
| SAR | segmentation and reassembly |
| SISO | single input, single output |
| SMBT | single user multiple input, multiple output beamforming training |
| TDD | time division duplex |

# 4. General description

## 4.3 Components of the IEEE Std 802.11 architecture

### 4.3.22 DMG STA

***Change the third paragraph of 4.3.22 as follows:***

A DMG STA supports MAC features that provide channel access in an environment in which transmissions use a directional antenna pattern. The MAC entity of a ~~A~~ DMG STA provides ~~has MAC features that include~~ frame aggregation, block acknowledgment~~ features~~, service periods, contention based access periods, DMG protected period, AP or PCP clustering, dynamic channel time management (see 10.39.7, 10.39.8, and 10.39.9), reverse direction, spatial sharing, beamforming, discovery assistance, TDD channel access, and ~~operation (~~fast session transfer~~)~~ in a multi-band device. A DMG STA is not a mesh STA. A DMG STA does not use any of the following: HCCA, power save multi-poll (PSMP), TDLS, GCR.

***Insert the following subclause (4.3.30) after 4.3.29:***

### 4.3.30 EDMG STA

The IEEE 802.11 enhanced directional multi-gigabit (EDMG) STA is a DMG STA that provides PHY and MAC features that can support a throughput of at least 20 Gb/s, as measured at the MAC data service access point (SAP). An EDMG STA supports DMG and EDMG features as identified in Clause 10, Clause 11, Clause 12, Clause 20, and Clause 28. An EDMG STA supports transmission and reception of frames that are compliant with PHY specifications as defined in Clause 20 and Clause 28.

The main features in an EDMG STA that are not present in a DMG STA are the following:

- Mandatory support of the EDMG format (transmit and receive) using SC modulation.
- Mandatory support of 4.32 GHz channel width.
- Mandatory support of single spatial stream (transmit and receive) in all supported channel widths.
- Mandatory support of non-EDMG duplicate format transmission of non-EDMG portion of EDMG format preamble.
- Mandatory support of the BRP transmit sector sweep.
- Mandatory support of the Short SSW PPDUs.
- Mandatory support of the EDMG power save enhancements.
- Optional support of EDMG SU PPDUs (transmit and receive) using OFDM modulation.
- Optional support of two or more spatial streams (transmit and receive) using SC or OFDM modulations.
- Optional support of EDMG MU PPDUs (transmit and receive) using SC or OFDM modulations.
- Optional support of 2.16+2.16 GHz channel width.
- Optional support of 4.32+4.32 GHz channel width.
- Optional support of 6.48 GHz channel width.
- Optional support of 8.64 GHz channel width.
- Optional support of a 64-point nonuniform constellation.
- Optional support for 8-PSK using SC modulation.
- Optional support of the beamforming for asymmetric links.

— Optional support of the first path beamforming.
— Optional support of the EDMG multi-TID aggregation.

An EDMG STA is equipped with one or more DMG antennas. When the STA is equipped with more than one DMG antenna, each DMG antenna can be configured to cover overlapping or nonoverlapping spatial sectors (i.e., DMG antennas can be sectorized). Therefore, transmissions from different DMG antennas can reach different sets of STAs. Under the control of the MAC sublayer, transmissions from each DMG antenna can be synchronized to, for example, achieve MIMO communication (see 10.39.12.4).

## 4.9 Reference model

### 4.9.4 Reference model for multi-band operation

***Insert the following paragraph into 4.9.4 after the seventh paragraph ("By using the ...."):***

By using the discovery assistance feature described in 11.31.7, the SME of a multi-band capable device can trigger one of its MLMEs to start the discovery assistance procedure for its operating band upon reception of a multi-band discovery assistance request from another MLME of the same multi-band capable device. The multi-band discovery assistance request is an FST Setup Request frame including the DMG Discovery Assistance element. The SME of a multi-band capable device can trigger one of its MLMEs to start scanning its operating band upon reception of a multi-band discovery assistance response from another MLME of the same multi-band capable device. The multi-band discovery assistance response is an FST Setup Response frame including the DMG Discovery Assistance element. This enables multi-band capable devices to trigger the discovery assistance and scanning procedure on one band upon receiving the DMG Discovery Assistance element on another band. The multi-band discovery assistance procedure can be used to expedite the scanning procedure of a multi-band capable device that includes a DMG STA (see 11.31.1).

***Insert the following subclause (4.9.5, including Figure 4-29a) after 4.9.4:***

### 4.9.5 Reference model for co-channel coordinated management operation

The reference model for a device that uses the co-channel coordinated management operation is shown in Figure 4-29a. The reference model for co-channel coordinated management operation allows a device to operate on the same channel with more than one STA, where each STA is associated with a different antenna or DMG antenna configuration. Each STA can have its own PHY and MAC sublayer for channel access and MPDU processing.

The co-channel coordinated management operation reference model can be used by a device to provide TDD channel access as defined in 11.54 and in 10.39.6.2.2.

The SME of a device that uses the co-channel coordinated management operation contains a coordinated management entity that is responsible for coordinating the setup, configuration, time synchronization and scheduling of STAs belonging to the device.

Different MAC SAPs are presented to higher layers if different MAC addresses are used by each STA. Each MAC SAP is controlled by a separate and independent RSNA key management entity. The coordinated management entity is responsible for coordinating with each of the SMEs if a single IEEE 802.1X entity of the IEEE 802.1X Authenticator/Supplicant is shared among the MACs.

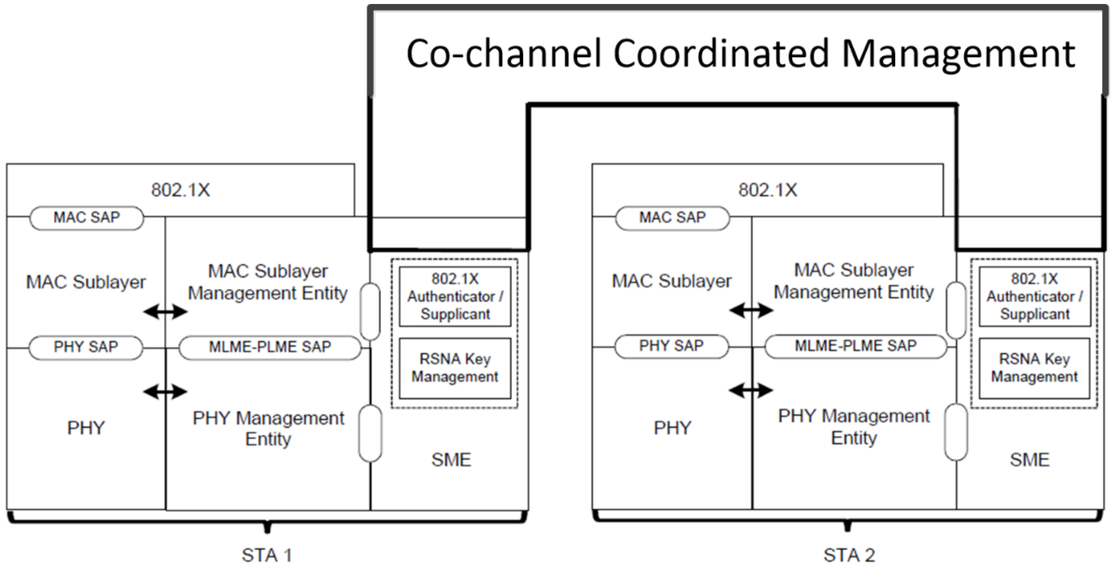


**Figure 4-29a—Reference model for co-channel coordinated management operation**

# 5. MAC service definition

## 5.1 Overview of MAC services

### 5.1.5 MAC data service architecture

#### 5.1.5.1 General

***Replace Figure 5-1 and Figure 5-2 with the following figures, which have been modified to integrate the "Segmentation (TX)/Reassembly (RX)" module introduced in 10.69:***

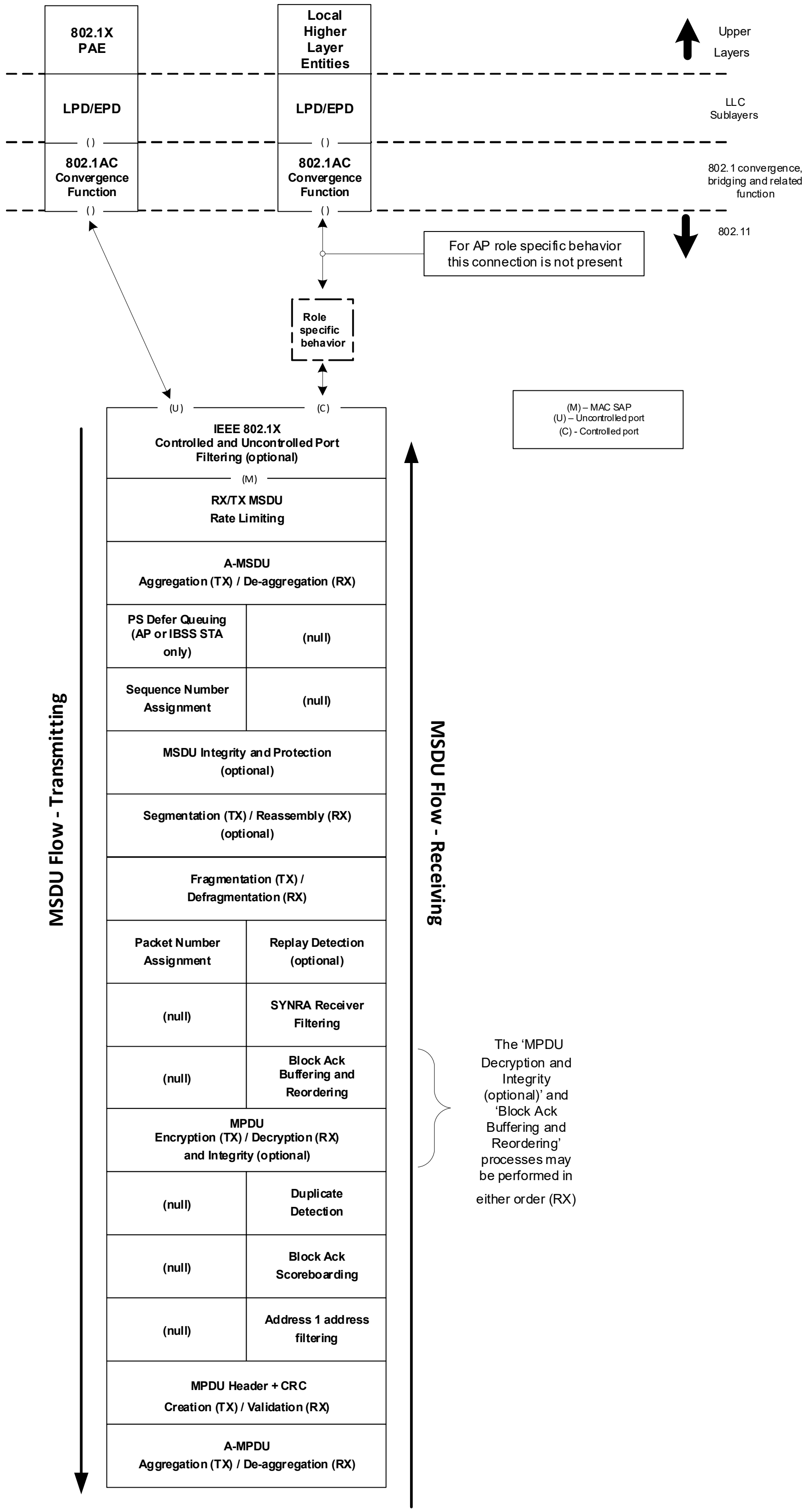


**Figure 5-1—MAC data plane architecture**

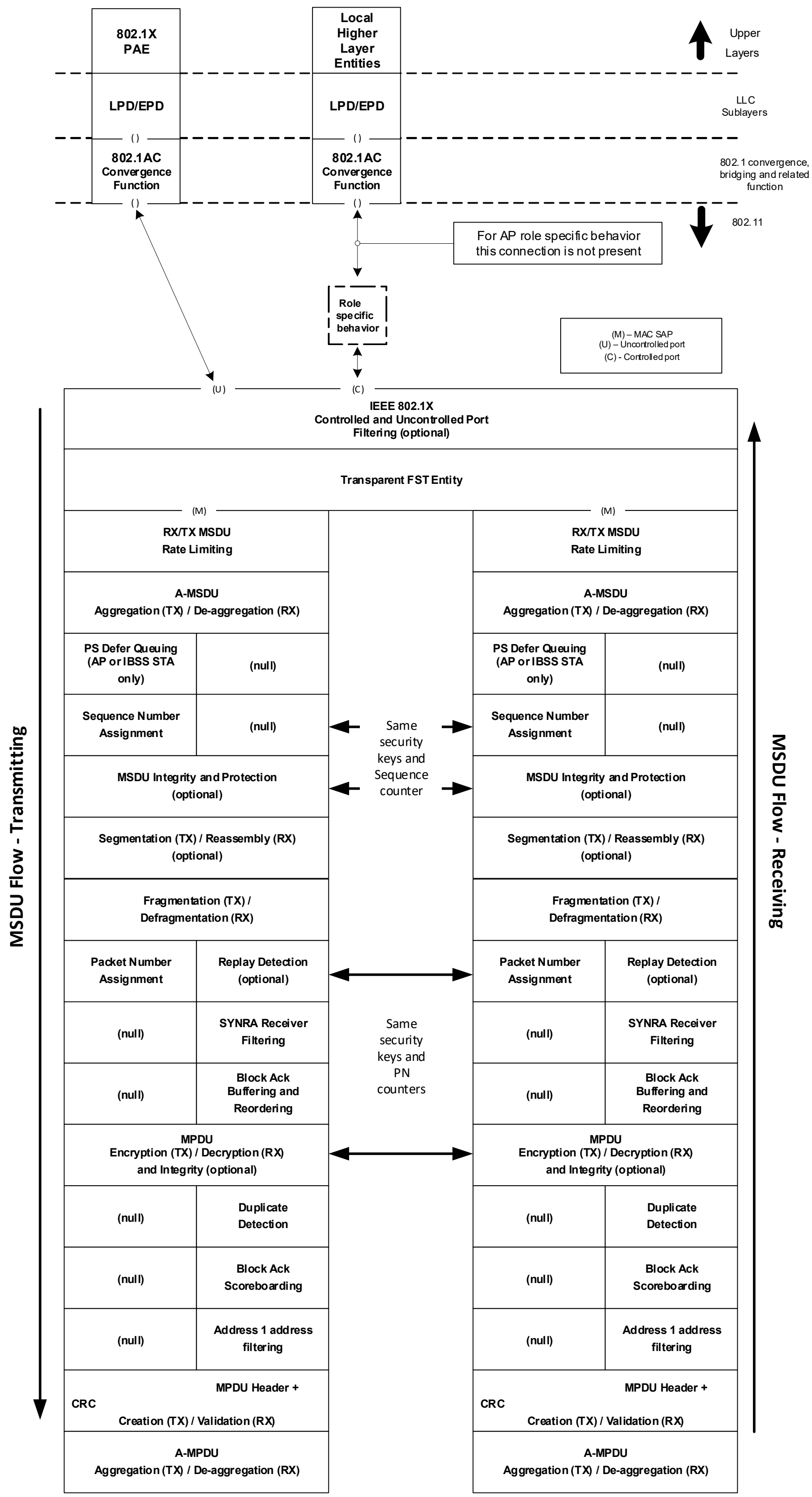


**Figure 5-2—MAC data plane architecture (transparent FST)**

# 6. Layer management

## 6.3 MLME SAP interface

### 6.3.3 Scan

#### 6.3.3.2 MLME-SCAN.request

##### 6.3.3.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.3.2.2 as follows:***

The primitive parameters are as follows:

MLME-SCAN.request(
…,
ScanAntennaSectorList,
SectorDwellTime,
EDMG Capabilities,
Unsolicited Block Ack Extension,
VendorSpecificInfo
)

***Change the following row in the untitled table in 6.3.3.3.2 as follows:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| ScanType | Enumeration | ACTIVE, PASSIVE, TDD PASSIVE | Indicates ~~either~~ active, ~~or~~ passive, or TDD passive scanning. |

***Insert the following rows into the untitled table in 6.3.3.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| ScanAntennaSectorID List | List of DMG antenna and sector configurations | Each DMG antenna and sector configuration is a valid configuration for the scanning STA. | Present if dot11TDDOptionImplemented is true and absent otherwise. Contains an ordered list of DMG antennas and sector configurations to be used during the scan using TDD beamforming (see 11.36.2). |
| SectorDwellTime | Integer | N/A | Present if dot11TDDOptionImplemented is true and absent otherwise. The time (in microseconds) to dwell on each sector during TDD beamforming (see 11.36.2). |
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |

| Name | Type | Valid range | Description |
|---|---|---|---|
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |

### 6.3.4 Synchronization

#### 6.3.4.2 MLME-JOIN.request

##### 6.3.4.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.4.2.2 as follows:***

The primitive parameters are as follows:

MLME-JOIN.request(
…,
<u>EDMG Capabilities,</u>
VendorSpecificInfo
)

***Insert the following row into the untitled table in 6.3.4.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |

## 6.3.7 Associate

### 6.3.7.2 MLME-ASSOCIATE.request

#### 6.3.7.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.7.2.2 as follows:***

The primitive parameters are as follows:

MLME-ASSOCIATE.request(
…,
EDMG Capabilities,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.7.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot availability of the STA. |

### 6.3.7.3 MLME-ASSOCIATE.confirm

#### 6.3.7.3.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.7.3.2 as follows:***

The primitive parameters are as follows:

MLME-ASSOCIATE.confirm(
…,
EDMG Capabilities,
EDMG Operation,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDD Slot Structure,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.7.3.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| EDMG Operation | EDMG Operation element | As defined in 9.4.2.266 | Specifies the parameters within the EDMG Operation element that are used in the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Structure | TDD Slot Structure element | As defined in 9.4.2.281 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Structure element corresponding to a target STA. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

#### 6.3.7.4 MLME-ASSOCIATE.indication

##### 6.3.7.4.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.7.4.2 as follows:***

The primitive parameters are as follows:

MLME-ASSOCIATE.indication(
…,
EDMG Capabilities,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.7.4.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

#### 6.3.7.5 MLME-ASSOCIATE.response

##### 6.3.7.5.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.7.5.2 as follows:***

The primitive parameters are as follows:

MLME-ASSOCIATE.response(
…,
EDMG Capabilities,
EDMG Operation,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDDSlotStructure,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.7.5.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| EDMG Operation | EDMG Operation element | As defined in 9.4.2.266 | Specifies the parameters within the EDMG Operation element that are used in the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDDSlotStructure | TDD Slot Structure element | As defined in 9.4.2.281 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Structure element corresponding to a target STA. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

### 6.3.8 Reassociate

#### 6.3.8.2 MLME-REASSOCIATE.request

##### 6.3.8.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.8.2.2 as follows:***

The primitive parameters are as follows:

MLME-REASSOCIATE.request(
…,
<u>EDMG Capabilities,</u>
<u>QoS Triggered Unscheduled,</u>
<u>Unsolicited Block Ack Extension,</u>
<u>TDD Slot Schedule,</u>
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.8.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot availability of the STA. |

### 6.3.8.3 MLME-REASSOCIATE.confirm

#### 6.3.8.3.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.8.3.2 as follows:***

The primitive parameters are as follows:
MLME-REASSOCIATE.confirm(
…,
EDMG Capabilities,
EDMG Operation,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDD Slot Structure,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.8.3.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| EDMG Operation | EDMG Operation element | As defined in 9.4.2.266 | Specifies the parameters within the EDMG Operation element that are used in the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Structure | TDD Slot Structure element | As defined in 9.4.2.281 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Structure element corresponding to a target STA. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

#### 6.3.8.4 MLME-REASSOCIATE.indication

##### 6.3.8.4.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.8.4.2 as follows:***

The primitive parameters are as follows:

MLME-REASSOCIATE.indication(
…,
EDMG Capabilities,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.8.4.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

#### 6.3.8.5 MLME-REASSOCIATE.response

##### 6.3.8.5.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.8.5.2 as follows:***

The primitive parameters are as follows:

MLME-REASSOCIATE.response(
…,
EDMG Capabilities,
EDMG Operation,
QoS Triggered Unscheduled,
Unsolicited Block Ack Extension,
TDDSlotStructure,
TDD Slot Schedule,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.8.5.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| EDMG Operation | EDMG Operation element | As defined in 9.4.2.266 | Specifies the parameters within the EDMG Operation element that are used in the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| QoS Triggered Unscheduled | QoS Triggered Unscheduled element | As defined in 9.4.2.278 | Specifies the parameters within the QoS Triggered Unscheduled element that are supported by the MAC entity. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDDSlotStructure | TDD Slot Structure element | As defined in 9.4.2.281 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Structure element corresponding to a target STA. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the TDD slot schedule of the STA. |

### 6.3.11 Start

#### 6.3.11.2 MLME-START.request

##### 6.3.11.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.11.2.2 as follows:***

The primitive parameters are as follows:

MLME-START.request(
…,
<u>EDMG Capabilities,</u>
<u>EDMG Operation,</u>
<u>Unsolicited Block Ack Extension,</u>
<u>TDDSlotStructure,</u>
<u>TDD Slot Schedule,</u>
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.11.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Capabilities | EDMG Capabilities element | As defined in 9.4.2.265 | Specifies the parameters within the EDMG Capabilities element to be advertised for the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| EDMG Operation | EDMG Operation element | As defined in 9.4.2.266 | Provides additional information for operating the BSS. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| Unsolicited Block Ack Extension | Unsolicited Block Ack Extension element | As defined in 9.4.2.279 | Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. _Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| TDDSlotStructure | TDD Slot Structure element | As defined in 9.4.2.281 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Structure element. |
| TDD Slot Schedule | TDD Slot Schedule element | As defined in 9.4.2.282 | Present if dot11TDDOptionImplemented is true and absent otherwise. Specifies the parameters within the TDD Slot Schedule element. |

### 6.3.27 Block Ack

#### 6.3.27.2 MLME-ADDBA.request

##### 6.3.27.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.27.2.2 as follows:***

The primitive parameters are as follows:

MLME-ADDBA.request(
…,
EDMG Flow Control Extension Configuration,
SAR Configuration,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.27.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Flow Control Extension Configuration | EDMG Flow Control Extension Configuration element | As defined in 9.4.2.277 | Specifies the EDMG flow control parameters. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| SAR Configuration | SAR Configuration element | As defined in 9.4.2.280 | Specifies the segmentation and reassembly parameters. The parameter is present if dot11SAROptionImplemented is true and is absent otherwise. |

#### 6.3.27.3 MLME-ADDBA.confirm

##### 6.3.27.3.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.27.3.2 as follows:***

The primitive parameters are as follows:

MLME-ADDBA.confirm(
...,
EDMG Flow Control Extension Configuration,
SAR Configuration,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.27.3.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Flow Control Extension Configuration | EDMG Flow Control Extension Configuration element | As defined in 9.4.2.277 | Specifies the EDMG flow control parameters. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| SAR Configuration | SAR Configuration element | As defined in 9.4.2.280 | Specifies the segmentation and reassembly parameters. The parameter is present if dot11SAROptionImplemented is true and is absent otherwise. |

### 6.3.27.4 MLME-ADDBA.indication

#### 6.3.27.4.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.27.4.2 as follows:***

The primitive parameters are as follows:

MLME-ADDBA.indication(
...,
EDMG Flow Control Extension Configuration,
SAR Configuration,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.27.4.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Flow Control Extension Configuration | EDMG Flow Control Extension Configuration element | As defined in 9.4.2.277 | Specifies the EDMG flow control parameters. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| SAR Configuration | SAR Configuration element | As defined in 9.4.2.280 | Specifies the segmentation and reassembly parameters. The parameter is present if dot11SAROptionImplemented is true and is absent otherwise. |

### 6.3.27.5 MLME-ADDBA.response

#### 6.3.27.5.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.27.5.2 as follows:***

The primitive parameters are as follows:

MLME-ADDBA.response(
...,
EDMG Flow Control Extension Configuration,
SAR Configuration,
VendorSpecificInfo
)

***Insert the following rows into the untitled table in 6.3.27.5.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMG Flow Control Extension Configuration | EDMG Flow Control Extension Configuration element | As defined in 9.4.2.277 | Specifies the EDMG flow control parameters. The parameter is present if dot11EDMGOptionImplemented is true and is absent otherwise. |
| SAR Configuration | SAR Configuration element | As defined in 9.4.2.280 | Specifies the segmentation and reassembly parameters. The parameter is present if dot11SAROptionImplemented is true and is absent otherwise. |

### 6.3.32 Link Measure Request

#### 6.3.32.1 General

***Change 6.3.32.1 as follows:***

The following primitives support the measurement of link path loss, ~~and~~ the estimation of link margin, and extended TPC (see 10.43.6) between peer entities.

#### 6.3.32.2 MLME-LINKMEASURE.request

##### 6.3.32.2.1 Function

***Change the paragraph in 6.3.32.1 as follows:***

This primitive supports the measurement of link path loss, ~~and~~ the estimation of link margin, and extended TPC (see 10.43.6) between peer entities.

##### 6.3.32.2.2 Semantics of the service primitive

***Change the primitive parameter list in 6.3.32.2.2 as follows:***

The primitive parameters are as follows:

```
MLME-LINKMEASURE.request(
                    ...,
                    Periodic Report Request,
                    Extended TPC Configuration,
                    EDMG Transmit Power,
                    VendorSpecificInfo
                    )
```

***Insert the following rows into the untitled table in 6.3.32.2.2 before the "VendorSpecificInfo" row:***

| Name | Type | Valid range | Description |
|---|---|---|---|
| Periodic Report Request | As defined in 9.4.2.289.2 | As defined in 9.4.2.289.2 | Optional subelement included to request periodic report. |
| Extended TPC Configuration | As defined in 9.4.2.289.3 | As defined in 9.4.2.289.3 | Optional subelement included for transmit power control. |
| EDMG Transmit Power | As defined in 9.4.2.289.4 | As defined in 9.4.2.289.4 | Optional subelement included for transmit power information in link measurement. |

### 6.3.91 DMG beamforming

***Insert the following subclause heading for 6.3.91.1 immediately after the heading for 6.3.91:***

#### 6.3.91.1 SISO beamforming

***Change the following subclauses (now 6.3.91.1.1 through 6.3.91.1.4.4) as shown:***

##### 6.3.91.1.1 ~~6.3.91.1~~ General

This subclause describes the management procedures associated with DMG beamforming.

##### 6.3.91.1.2 ~~6.3.91.2~~ MLME-BF-TRAINING.request

##### 6.3.91.1.2.1 ~~6.3.91.2.1~~ Function

This primitive requests that beamforming training occur with a peer STA.

##### 6.3.91.1.2.2 ~~6.3.91.2.2~~ Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-BF-TRAINING.request(
                                PeerSTAAddress,
                                RequestBRP,
                                BRPRequest,
                                DMGBeamRefinement,
                                EDMGPartialSLS,
                                EDMGBRPRequest
                                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform beamforming training. |
| RequestBRP | Boolean | true, false | If true, the beam refinement protocol (BRP) is performed as part of the beamforming training.<br>If false, only sector-level sweep (SLS) is performed. |
| BRPRequest | A set of information subfields | As defined in 9.5.4 | Specifies the parameters of a BRP request |
| DMGBeamRefinement | A set of elements | As defined in 9.4.2.129 | Zero or more elements |
| EDMGBRPRequest | A set of elements | As defined in 9.4.2.270 | Zero or more elements |
| EDMGPartialSLS | A set of elements | As defined in 9.4.2.272 | Zero or more elements |

##### 6.3.91.1.2.3 ~~6.3.91.2.3~~ When generated

This primitive is generated by the SME to request that beamforming training be performed with a peer STA.

#### 6.3.91.1.2.4 ~~6.3.91.2.4~~ Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer beamforming training procedures defined in 10.42.

### 6.3.91.1.3 ~~6.3.91.3~~ MLME-BF-TRAINING.confirm

#### 6.3.91.1.3.1 ~~6.3.91.3.1~~ Function

This primitive reports the outcome of a requested beamforming training procedure.

#### 6.3.91.1.3.2 ~~6.3.91.3.2~~ Semantics of the service primitive

The primitive parameters are as follows:

MLME-BF-TRAINING.confirm(
PeerSTAAddress,
ResultCode,
DMGBeamRefinement,
MeasFeedback,
EDMGMeasFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which beamforming training was performed or attempted. |
| ResultCode | Enumeration | SUCCESS, BF_TIMEOUT | Indicates the result of the beamforming procedure. |
| DMGBeamRefinement | A set of elements | As defined in 9.4.2.129 | Zero or more elements |
| MeasFeedback | A set of elements | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | A set of elements | As defined in 9.4.2.268 | Zero or more elements |

#### 6.3.91.1.3.3 ~~6.3.91.3.3~~ When generated

This primitive is generated by the MLME to report the result of beamforming training with a peer STA.

#### 6.3.91.1.3.4 ~~6.3.91.3.4~~ Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.1.4 ~~6.3.91.4~~ MLME-BF-TRAINING.indication

##### 6.3.91.1.4.1 ~~6.3.91.4.1~~ Function

This primitive indicates that beamforming training with a peer STA, and at the request of that peer, has completed.

##### 6.3.91.1.4.2 ~~6.3.91.4.2~~ Semantics of the service primitive

The primitive parameters are as follows:

MLME-BF-TRAINING.indication(
PeerSTAAddress,
ResultCode,
DMGBeamRefinement,
MeasFeedback,
EDMGMeasFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which beamforming training was performed. |
| ResultCode | Enumeration | SUCCESS, BF_TIMEOUT | Indicates the result of the beamforming procedure. |
| DMGBeamRefinement | A set of elements | As defined in 9.4.2.129 | Zero or more elements |
| MeasFeedback | A set of elements | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | A set of elements | As defined in 9.4.2.268 | Zero or more elements |

##### 6.3.91.1.4.3 ~~6.3.91.4.3~~ When generated

This primitive is generated by the MLME to indicate successful completion of a beamforming training procedure requested by a peer STA.

##### 6.3.91.1.4.4 ~~6.3.91.4.4~~ Effect on receipt

The SME is notified of the result of the procedure.

***Insert the following subclauses (6.3.91.2 through 6.3.91.5.4.4) after 6.3.91.1.4.4:***

### 6.3.91.2 SU-MIMO beamforming

#### 6.3.91.2.1 General

This subclause describes the management procedures associated with SU-MIMO beamforming.

#### 6.3.91.2.2 MLME-SU-MIMO-BF-TRAINING.request

##### 6.3.91.2.2.1 Function

This primitive requests that SU-MIMO beamforming training occurs with a peer STA.

##### 6.3.91.2.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-SU-MIMO-BF-TRAINING.request(
                                    PeerSTAAddress,
                                    RequestMIMOBRP,
                                    MIMOSetupControl
                                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform SU-MIMO beamforming training. |
| RequestMIMOBRP | Boolean | True, False | If true, the MIMO BRP procedure is performed as part of the SU-MIMO beamforming training.<br>If false, the SISO feedback procedure is performed as part of the SU-MIMO beamforming training. |
| MIMOSetupControl | A set of information fields | As defined in 9.4.2.273 | Specifies the parameters of the SU-MIMO BF setup |

##### 6.3.91.2.2.3 When generated

This primitive is generated by the SME to request that SU-MIMO beamforming training be performed with a peer STA.

##### 6.3.91.2.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer SU-MIMO beamforming training procedures defined in 10.42.10.2.2.

#### 6.3.91.2.3 MLME-SU-MIMO-BF-TRAINING.confirm

##### 6.3.91.2.3.1 Function

This primitive reports the outcome of a requested SU-MIMO beamforming training procedure.

##### 6.3.91.2.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-SU-MIMO-BF-TRAINING.confirm(
PeerSTAAddress,
ResultCode,
MIMOFeedbackControl,
MeasFeedback,
EDMGMeasFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform SU-MIMO beamforming training. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback element | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback element | As defined in 9.4.2.268 | Zero or more elements |

##### 6.3.91.2.3.3 When generated

This primitive is generated by the MLME to report the result of SU-MIMO beamforming training with a peer STA.

##### 6.3.91.2.3.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.2.4 MLME-SU-MIMO-BF-TRAINING.indication

##### 6.3.91.2.4.1 Function

This primitive indicates that SU-MIMO beamforming training with a peer STA, and at the request of that peer, has completed.

##### 6.3.91.2.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-SU-MIMO-BF-TRAINING.indication(
                                   PeerSTAAddress,
                                   ResultCode,
                                   MIMOFeedbackControl,
                                   MeasFeedback,
                                   EDMGMeasFeedback
                                   )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform SU-MIMO beamforming training. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback element | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback element | As defined in 9.4.2.268 | Zero or more elements |

##### 6.3.91.2.4.3 When generated

This primitive is generated by the MLME to indicate successful completion of a SU-MIMO beamforming training procedure requested by a peer STA.

##### 6.3.91.2.4.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.3 MU-MIMO beamforming

##### 6.3.91.3.1 General

This subclause describes the management procedures associated with MU-MIMO beamforming.

##### 6.3.91.3.2 MLME-MU-MIMO-BF-TRAINING.request

###### 6.3.91.3.2.1 Function

This primitive requests that MU-MIMO beamforming training occurs with a group of peer STAs.

###### 6.3.91.3.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-MU-MIMO-BF-TRAINING.request(
                                    EDMGGroupID,
                                    RequestInitiatorTXSS,
                                    MIMOSetupControl
                                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMGGroupID | Integer | As defined in 9.4.2.269 | Specifies the group of peer MAC entities with which to perform MU-MIMO beamforming training. |
| RequestMIMOBRP | Boolean | True, False | If true, the initiator TXSS procedure is performed as part of the MU-MIMO beamforming training.<br>If false, the TXSS procedure is performed as part of the MU-MIMO beamforming training. |
| MIMOSetupControl | A set of information fields | As defined in 9.4.2.273 | Specifies the parameters of the MU-MIMO BF setup |

###### 6.3.91.3.2.3 When generated

This primitive is generated by the SME to request that MU-MIMO beamforming training be performed with a group of peer STAs.

###### 6.3.91.3.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer MU-MIMO beamforming training procedures defined in 10.42.10.2.3.

#### 6.3.91.3.3 MLME-MU-MIMO-BF-TRAINING.confirm

##### 6.3.91.3.3.1 Function

This primitive reports the outcome of a requested MU-MIMO beamforming training procedure.

##### 6.3.91.3.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MU-MIMO-BF-TRAINING.confirm(
EDMGGroupID,
ResultCode,
DMGBeamRefinement,
MIMOFeedbackControl,
MeasFeedback,
EDMGMeasFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMGGroupID | Integer | As defined in 9.4.2.269 | Specifies the group of peer MAC entities with which to perform MU-MIMO beamforming training. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the MU-MIMO beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| DMGBeamRefinement | DMG Beam Refinement element | As defined in 9.4.2.129 | Zero or more elements |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback elements | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback elements | As defined in 9.4.2.268 | Zero or more elements |

##### 6.3.91.3.3.3 When generated

This primitive is generated by the MLME to report the result of MU-MIMO beamforming training with a group of peer STAs.

##### 6.3.91.3.3.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.3.4 MLME-MU-MIMO-BF-TRAINING.indication

##### 6.3.91.3.4.1 Function

This primitive indicates that MU-MIMO beamforming training with a peer STA, and at the request of that peer, has completed.

##### 6.3.91.3.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MU-MIMO-BF-TRAINING.indication(
PeerSTAAddress,
ResultCode,
MIMOSelectionControl,
EDMGGroupIDSet
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform MU-MIMO beamforming training. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the MU-MIMO beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| EDMGGroupIDSet | EDMG Group ID Set element | As defined in 9.4.2.269 | Zero or more elements |

##### 6.3.91.3.4.3 When generated

This primitive is generated by the MLME to indicate successful completion of an MU-MIMO beamforming training procedure requested by a peer STA.

##### 6.3.91.3.4.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.91.4 SU-MIMO hybrid beamforming

#### 6.3.91.4.1 General

This subclause describes the management procedures associated with SU-MIMO hybrid beamforming.

#### 6.3.91.4.2 MLME-SU-MIMO-HYBRID-BF-PROTOCOL.request

##### 6.3.91.4.2.1 Function

This primitive requests that the SU-MIMO hybrid beamforming protocol occurs with a peer STA.

##### 6.3.91.4.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-SU-MIMO-HYBRID-BF-PROTOCOL.request(
                                        PeerSTAAddress,
                                        SoundingType,
                                        ControlTrailer
                                        )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform the SU-MIMO hybrid beamforming protocol. |
| SoundingType | Boolean | true, false | If true, the BRP frames are used for the hybrid beamforming protocol. If false, tracking is used for the SU-MIMO hybrid beamforming protocol. |
| ControlTrailer | A set of information fields | As defined in 28.3.7 | Specifies the parameters of an SU-MIMO hybrid beamforming announcement in the SU-MIMO hybrid beamforming protocol |

##### 6.3.91.4.2.3 When generated

This primitive is generated by the SME to request that the SU-MIMO hybrid beamforming protocol be performed with a peer STA.

##### 6.3.91.4.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer SU-MIMO hybrid beamforming protocol procedures defined in 10.42.10.2.4.

### 6.3.91.4.3 MLME-SU-MIMO-HYBRID-BF-PROTOCOL.confirm

#### 6.3.91.4.3.1 Function

This primitive reports the outcome of a requested SU-MIMO hybrid beamforming protocol procedure.

#### 6.3.91.4.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-SU-MIMO-HYBRID-BF-PROTOCOL.confirm(
                              PeerSTAAddress,
                              ResultCode,
                              MIMOFeedbackControl,
                              MeasFeedback,
                              EDMGMeasFeedback,
                              DigitalBFFeedback
                              )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform the SU-MIMO hybrid beamforming protocol. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the SU-MIMO hybrid beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback element | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback element | As defined in 9.4.2.268 | Zero or more elements |
| DigitalBFFeedback | Digital BF Feedback elements | As defined in 9.4.2.284 | Zero or more elements |

#### 6.3.91.4.3.3 When generated

This primitive is generated by the MLME to report the result of the SU-MIMO hybrid beamforming protocol with a peer STA.

#### 6.3.91.4.3.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.4.4 MLME-SU-MIMO-HYBRID-BF-PROTOCOL.indication

##### 6.3.91.4.4.1 Function

This primitive indicates that the SU-MIMO hybrid beamforming protocol with a peer STA, and at the request of that peer, has completed.

##### 6.3.91.4.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-SU-MIMO-HYBRID-BF-PROTOCOL.indication(
PeerSTAAddress,
ResultCode,
MIMOFeedbackControl,
MeasFeedback,
EDMGMeasFeedback,
DigitalBFFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform the SU-MIMO hybrid beamforming protocol. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the SU-MIMO hybrid beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback element | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback element | As defined in 9.4.2.268 | Zero or more elements |
| DigitalBFFeedback | Digital BF Feedback elements | As defined in 9.4.2.284 | Zero or more elements |

##### 6.3.91.4.4.3 When generated

This primitive is generated by the MLME to indicate successful completion of an SU-MIMO hybrid beamforming protocol procedure requested by a peer STA.

##### 6.3.91.4.4.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.5 MU-MIMO hybrid beamforming

##### 6.3.91.5.1 General

This subclause describes the management procedures associated with MU-MIMO hybrid beamforming.

##### 6.3.91.5.2 MLME-MU-MIMO-HYBRID-BF-PROTOCOL.request

###### 6.3.91.5.2.1 Function

This primitive requests that the MU-MIMO hybrid beamforming protocol occurs with a peer STA.

###### 6.3.91.5.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-MU-MIMO-HYBRID-BF-PROTOCOL.request(
                                        EDMGGroupID,
                                        ControlTrailer
                                        )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMGGroupID | Integer | As defined in 9.4.2.269 | Specifies the group of peer MAC entities with which to perform the MU-MIMO hybrid beamforming protocol. |
| ControlTrailer | A set of information fields | As defined in 28.3.7 | Specifies the parameters of an SU-MIMO hybrid beamforming announcement in the SU-MIMO hybrid beamforming protocol |

###### 6.3.91.5.2.3 When generated

This primitive is generated by the SME to request that the MU-MIMO hybrid beamforming protocol be performed with a group of STAs.

###### 6.3.91.5.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer MU-MIMO hybrid beamforming protocol procedures defined in 10.42.10.2.4.

#### 6.3.91.5.3 MLME-MU-MIMO-HYBRID-BF-PROTOCOL.confirm

##### 6.3.91.5.3.1 Function

This primitive reports the outcome of a requested MU-MIMO hybrid beamforming protocol procedure.

##### 6.3.91.5.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MU-MIMO-HYBRID-BF-PROTOCOL.confirm(
EDMGGroupID,
ResultCode,
MIMOFeedbackControl,
MeasFeedback,
EDMGMeasFeedback,
DigitalBFFeedback
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| EDMGGroupID | Integer | As defined in 9.4.2.269 | Specifies the group of peer MAC entities with which to perform the MU-MIMO hybrid beamforming protocol. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the MU-MIMO hybrid beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOFeedbackControl | MIMO Feedback Control element | As defined in 9.4.2.275 | Zero or more elements |
| MeasFeedback | Channel Measurement Feedback element | As defined in 9.4.2.136 | Zero or more elements |
| EDMGMeasFeedback | EDMG Channel Measurement Feedback element | As defined in 9.4.2.268 | Zero or more elements |
| DigitalBFFeedback | Digital BF Feedback elements | As defined in 9.4.2.284 | Zero or more elements |

##### 6.3.91.5.3.3 When generated

This primitive is generated by the MLME to report the result of the MU-MIMO hybrid beamforming protocol with a group of STAs.

##### 6.3.91.5.3.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.91.5.4 MLME-MU-MIMO-HYBRID-BF-PROTOCOL.indication

##### 6.3.91.5.4.1 Function

This primitive indicates that the MU-MIMO hybrid beamforming protocol with a peer STA, and at the request of that peer, has completed.

##### 6.3.91.5.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-MU-MIMO-HYBRID-BF-PROTOCOL.indication(
                              PeerSTAAddress,
                              ResultCode,
                              MIMOSelectionControl,
                              EDMGGroupIDSet,
                              DigitalBFFeedback
                              )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform the SU-MIMO hybrid beamforming protocol. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the SU MIMO hybrid beamforming procedure, i.e., SUCCESS in case BF was successfully performed and FAILURE otherwise. |
| MIMOSelectionControl | MIMO Selection Control element | As defined in 9.4.2.276 | Zero or more elements |
| EDMGGroupIDSet | EDMG Group ID Set element | As defined in 9.4.2.269 | Zero or more elements |
| DigitalBFFeedback | Digital BF Feedback elements | As defined in 9.4.2.284 | Zero or more elements |

##### 6.3.91.5.4.3 When generated

This primitive is generated by the MLME to indicate successful completion of an MU-MIMO hybrid beamforming protocol procedure requested by a peer STA.

##### 6.3.91.5.4.4 Effect on receipt

The SME is notified of the result of the procedure.

***Insert the following subclauses (6.3.119 through 6.3.122.11.4) after 6.3.118.5.4:***

### 6.3.119 TDD beamforming

#### 6.3.119.1 General

This subclause describes the management procedures associated with TDD beamforming.

#### 6.3.119.2 MLME-TDD-BF-TRAINING.request

##### 6.3.119.2.1 Function

This primitive requests that TDD beamforming training, as defined in 11.36.2, occurs with one or more peer STAs.

##### 6.3.119.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BF-TRAINING.request (
        BFType,
        SchedulingMethod,
        PeerSTAAddressList,
        BeamformingStartTimestamp,
        TXAntennaSectorIDList,
        NumOfTDDSlotPerTXSector,
        NumOfSSWPerTDDSlot,
        NumOfAckPerTDDSlot,
        NumOfFeedbackPerTDDSlot,
        TDDSlotScheduleList
        )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| BFType | Enumeration | TDD individual BF, TDD group BF | Indicates TDD individual BF or TDD group BF. |
| SchedulingMethod | Enumeration | Unscheduled, Scheduled | Unscheduled in case transmission offset is indicated in TDD SSW frames. Scheduled in case the TDD Slot Schedule element is used. |
| PeerSTAAddressList | MAC address | Any valid individual MAC address or a list of MAC addresses | For TDD individual BF, specifies the address of the peer MAC entity with which to perform TDD beamforming training or none if the address of the peer MAC entity is unknown. For TDD group BF, specifies the address list of the peer MAC entities with which to perform TDD beamforming training. |
| BeamformingStartTimestamp | Integer | N/A | Timestamp that indicates when the TDD beamforming procedure should be started by the STA. |
| TXAntennaSectorIDList | List of DMG antenna and sector configurations | Each DMG antenna and sector tuple is a valid configuration for the transmitting STA. | Ordered list of DMG antenna and sector configurations to be used during the TDD beamforming transmission. |

| Name | Type | Valid range | Description |
|---|---|---|---|
| NumOfTDDSlotPerTXSector | Integer | 1–1024 | Indicates the number of TDD slot repetitions for each TX sector ID being utilized. |
| NumOfSSWPerTDDSlot | Integer | 1–7 | Indicates the number of TDD SSW frame transmissions using a DMG antenna configuration during a TDD slot.<br>The sum of NumOfSSWPerTDDSlot and NumOfAckPerTDDSlot is limited to 8. |
| NumOfAckPerTDDSlot | Integer | 1–7 | Indicates the number of TDD SSW Ack frame transmissions using a DMG antenna configuration during a TDD slot.<br>The sum of NumOfSSWPerTDDSlot and NumOfAckPerTDDSlot is limited to 8. |
| NumOfFeedbackPerTDDSlot | Integer | 1–4 | Indicates the number of TDD SSW Feedback frame transmissions using a DMG antenna configuration during a TDD slot. |
| TDDSlotScheduleList | A set of TDD Slot Schedule elements | As defined in 9.4.2.282 | Indicates the TDD slots to be used for transmitting TDD SSW frames, or the TDD slots used for TDD beamforming. |

### 6.3.119.2.3 When generated

This primitive is generated by the SME to request that TDD beamforming training be performed with one or more peer STAs.

### 6.3.119.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer TDD beamforming training procedures defined in 10.42.

### 6.3.119.3 MLME-TDD-BF-TRAINING.confirm

### 6.3.119.3.1 Function

This primitive reports the outcome of a requested TDD beamforming training procedure.

### 6.3.119.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BF-TRAINING.confirm (
                    BFType,
                    PeerSTAAddress,
                    NumberOfTDDFeedbackPeers,
                    TDDFeedbackResults,
                    ResultCode
                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| BFType | Enumeration | TDD individual BF, TDD group BF | Indicates TDD individual BF or TDD group BF |
| PeerSTAAddress | MAC address | Any valid individual MAC address or a list of MAC addresses | For TDD individual BF, specifies the address of the peer MAC entity with which TDD beamforming training was performed or attempted. For TDD group BF, specifies the address list of the peer MAC entities with which TDD beamforming training was performed or attempted. |
| NumberOfTDDFeed backPeers | Integer | 1, if BFType = TDD individual BF<br><br>2–1024, if BFType = TDD group BF | Indicates the number of peer MAC entities for which a TDD Feedback is available. |
| TDDFeedbackResult s | Tuples in the form of (MAC address, TDD Sector Feedback subelement) | As defined in 9.4.2.283 | Zero or more tuples, one for each of the peer MAC entities counted in NumberOf TDDFeedbackPeers, together with the address of that MAC entity. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD beamforming procedure, i.e., SUCCESS in case feedback result were successfully received and FAILURE otherwise. |

#### 6.3.119.3.3 When generated

This primitive is generated by the MLME to report the result of the TDD beamforming training procedure with one or more peer STAs.

#### 6.3.119.3.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.119.4 MLME-TDD-BF-TRAINING.indication

#### 6.3.119.4.1 Function

This primitive indicates that TDD beamforming training with a peer STA, and at the request of that peer STA, has completed.

#### 6.3.119.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-BF-TRAINING.indication (
                              BFType,
                              PeerSTAAddress,
                              NumberOfTDDFeedbackPeers,
                              TxBeamFeedback,
                              ResultCode
                              )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| BFType | Enumeration | TDD individual BF, TDD group BF | Indicates TDD individual BF or TDD group BF |
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which TDD beamforming training was performed or attempted. |
| NumberOfTDDFeedbackPeers | Integer | 0–1024 | Indicates the number of TDD Feedbacks included. |
| TxBeamFeedback | A set of Tx Beam Feedback fields | As defined in 9.4.2.283 | One or more Tx Beam Feedback fields are present. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD beamforming procedure, i.e., SUCCESS in case feedback result were successfully received and FAILURE otherwise. |

#### 6.3.119.4.3 When generated

This primitive is generated by the MLME to report the results of the TDD beamforming training procedure that was initiated by a peer STA.

#### 6.3.119.4.4 Effect on receipt

The SME is notified of the result of the procedure.

## 6.3.120 TDD sector switch

### 6.3.120.1 General

This subclause describes the management procedures associated with TDD sector switch.

### 6.3.120.2 MLME-TDD-SECTOR-SWITCH.request

#### 6.3.120.2.1 Function

This primitive requests that a sector switch be performed with a peer STA.

#### 6.3.120.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SECTOR-SWITCH.request (
                    PeerSTAAddress,
                    SectorSwitchTimestamp,
                    SectorRevertTimestamp,
                    InitiatorTXAntennaID,
                    InitiatorRXAntennaID,
                    ResponderTXAntennaID,
                    ResponderRXAntennaID,
                    InitiatorTXSectorID,
                    InitiatorRXSectorID,
                    ResponderTXSectorID,
                    ResponderRXSectorID
                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which to perform TDD sector switch procedure. |
| SectorSwitchTimestamp | Integer | N/A | Timestamp that indicates when the sector switch should take effect. |
| SectorRevertTimestamp | Integer | N/A | Timestamp that indicates when the sector revert should take effect in case of failure. The timestamp indicated by SectorRevertTimestamp is always later than the timestamp indicated by SectorSwitchTimestamp. |
| InitiatorTXAntennaID | Integer | 0–7 | Indicates the TX Antenna ID to be utilized by the initiator STA. |
| InitiatorRXAntennaID | Integer | 0–7 | Indicates the RX Antenna ID to be utilized by the initiator STA. |
| ResponderTXAntennaID | Integer | 0–7 | Indicates the TX Antenna ID to be utilized by the responder STA. |
| ResponderRXAntennaID | Integer | 0–7 | Indicates the RX Antenna ID to be utilized by the responder STA. |
| InitiatorTXSectorID | Integer | 0–511 | Indicates the TX sector ID to be utilized by the initiator STA. |
| InitiatorRXSectorID | Integer | 0–511 | Indicates the RX sector ID to be utilized by the initiator STA. |
| ResponderTXSectorID | Integer | 0–511 | Indicates the TX sector ID to be utilized by the responder STA. |
| ResponderRXSectorID | Integer | 0–511 | Indicates the RX sector ID to be utilized by the responder STA. |

#### 6.3.120.2.3 When generated

This primitive is generated by the SME to request that a sector switch be performed with a peer STA.

#### 6.3.120.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer sector switch procedure defined in 11.36.3.

### 6.3.120.3 MLME-TDD-SECTOR-SWITCH.confirm

#### 6.3.120.3.1 Function

This primitive reports the outcome of a TDD sector switch procedure.

#### 6.3.120.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SECTOR-SWITCH.confirm (
                PerSTAAddress,
                TXAntennaID,
                RXAntennaID,
                TXSectorID,
```

RXSectorID,
ResultCode
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which the TDD sector switch procedure was performed or attempted. |
| TXAntennaID | Integer | 0–7 | Indicates the TX Antenna ID to be utilized by the STA. |
| RXAntennaID | Integer | 0–7 | Indicates the RX Antenna ID to be utilized by the STA. |
| TXSectorID | Integer | 0–511 | Indicates the TX sector ID to be utilized by the STA. |
| RXSectorID | Integer | 0–511 | Indicates the RX sector ID to be utilized by the STA. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD sector switch procedure, i.e., SUCCESS in case new sectors were adopted successfuly and FAILURE otherwise. |

#### 6.3.120.3.3 When generated

This primitive is generated by the MLME to report the result of TDD sector switch with a peer STA.

#### 6.3.120.3.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.120.4 MLME-TDD-SECTOR-SWITCH.indication

#### 6.3.120.4.1 Function

This primitive indicates that a TDD sector switch request has been successfully received.

#### 6.3.120.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME- SECTOR-SWITCH.indication (
PeerSTAAddress,
SectorSwitchTimestamp,
SectorRevertTimestamp,
InitiatorTXAntennaID,
InitiatorRXAntennaID,
ResponderTXAntennaID,
ResponderRXAntennaID,
InitiatorTXSectorID,
InitiatorRXSectorID,
ResponderTXSectorID,
ResponderRXSectorID
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with the indication was received. |
| SectorSwitchTimestamp | Integer | N/A | Timestamp which indicates when the sector switch should take effect as described in 11.36.3. |
| SectorRevertTimestamp | Integer | N/A | Timestamp that indicates when the sector revert should take effect in case of failure as described in 11.36.3. The timestamp indicated by SectorRevertTimestamp is always later than the timestamp indicated by SectorSwitchTimestamp. |
| InitiatorTXAntennaID | Integer | 0–7 | Indicates the TX Antenna ID to be utilized by the initiator STA. |
| InitiatorRXAntennaID | Integer | 0–7 | Indicates the RX Antenna ID to be utilized by the initiator STA. |
| ResponderTXAntennaID | Integer | 0–7 | Indicates the TX Antenna ID to be utilized by the responder STA. |
| ResponderRXAntennaID | Integer | 0–7 | Indicates the RX Antenna ID to be utilized by the responder STA. |
| InitiatorTXSectorID | Integer | 0–511 | Indicates the TX sector ID to be utilized by the initiator STA. |
| InitiatorRXSectorID | Integer | 0–511 | Indicates the RX sector ID to be utilized by the initiator STA. |
| ResponderTXSectorID | Integer | 0–511 | Indicates the TX sector ID to be utilized by the responder STA. |
| ResponderRXSectorID | Integer | 0–511 | Indicates the RX sector ID to be utilized by the responder STA. |

#### 6.3.120.4.3 When generated

This primitive is generated by the MLME to indicate successful reception of a TDD sector switch request by a STA.

#### 6.3.120.4.4 Effect on receipt

The SME is notified of the result of the reception.

### 6.3.121 TDD beam measurement

#### 6.3.121.1 General

This subclause describes the management procedures associated with TDD beam measurement.

#### 6.3.121.2 MLME-TDD-BEAM-MEASUREMENT.request

##### 6.3.121.2.1 Function

This primitive requests that TDD beam measurement occurs with one or more peer STAs.

#### 6.3.121.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BEAM-MEASUREMENT.request (
        BFRole,
        SchedulingMethod,
        PeerSTAAddress,
        BeamMeasurementStartTime,
        InitiatorAntennaSectorIDList,
        ResponderAntennaSectorIDList,
        NumOfTDDSlotPerTXSector,
        NumOfSSWperTDDSlot,
        TDDSlotScheduleList
        )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| BFRole | Enumeration | Initiator or Responder | Set to Initiator or Responder. |
| PeerSTAAddress | MAC address | Any valid individual MAC address, or the broadcast addresses | Specifies the individual address of the peer MAC entity with which to perform TDD beam measurement, or the broadcast address if all MAC entities within reach are targeted. |
| SchedulingMethod | Enumeration | Unscheduled, Scheduled | Unscheduled in case the transmission offset is indicated in TDD SSW frames. Scheduled in case the TDD Slot Schedule element is used. |
| BeamMeasurementStartTime | Integer | N/A | TDD beam measurement procedure start time. |
| InitiatorAntennaSectorIDList | A set of TDD Sector Config subelement | As defined in 9.4.2.283 | Ordered list of DMG antenna and sector configurations to be used by the Initiator during TDD beam measurement. |
| ResponderAntennaSectorIDList | Multiple sets of TDD Sector Config subelement | As defined in 9.4.2.283 | Ordered list of DMG antenna and sector configurations to be used by the responders during TDD beam measurement. |
| NumOfTDDSlotPerTXSector | Integer | 1–1024 | Indicates the number of TDD slot repetitions for each TX sector ID being utilized. Applicable if BFRole is set to Initiator. |
| NumOfSSWperTDDSlot | Integer | 1–7 | Indicates the number of TDD SSW frame transmissions using a DMG antenna configuration during a TDD slot.<br>Valid if BFRole is set to Initiator. |
| TDDSlotScheduleList | A set of TDD Slot Schedule elements | As defined in 9.4.2.282 | Indicates the TDD slots to be used for transmitting TDD SSW frames, or the TDD slots used for TDD beam measurement. |

#### 6.3.121.2.3 When generated

This primitive is generated by the SME to request that TDD beam measurement be performed with one or more peer STAs.

#### 6.3.121.2.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer TDD beam measurement procedures defined in 10.42.11 and 11.36.4.

### 6.3.121.3 MLME-TDD-BEAM-MEASUREMENT.confirm

#### 6.3.121.3.1 Function

This primitive reports the outcome of a requested TDD beam measurement procedure.

#### 6.3.121.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BEAM-MEASUREMENT.confirm (
                BFRole,
                PeerSTAAddress,
                NumberOfTDDFeedbacks,
                TxBeamFeedback,
                ResultCode
                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| BFRole | Enumeration | Initiator or Responder | Set to Initiator or Responder. |
| PeerSTAAddress | MAC address | Any valid individual MAC address, or the broadcast address | Set to the address of the peer MAC entity specified in request. |
| NumberOfTDDFeedbacks | Integer | 0–1024 | Indicates the number of TDD Feedbacks included. |
| TxBeamFeedback | A set of Tx Beam Feedback fields | As defined in 9.4.2.283 | One or more Tx Beam Feedback fields are present. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD beam measurement procedure, i.e., SUCCESS in case TxBeamFeedback were requested by the initiator and successfully received, and FAILURE otherwise. |

#### 6.3.121.3.3 When generated

This primitive is generated by the MLME to report the result of the TDD beam measurement with one or more peer STAs.

#### 6.3.121.3.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.121.4 MLME-TDD-BEAM-MEASUREMENT.indication

##### 6.3.121.4.1 Function

This primitive indicates that TDD beam measurement with a peer STA, and at the request of that peer STA, has completed.

##### 6.3.121.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BEAM-MEASUREMENT.indication (
                                PeerSTAAddress,
                                NumberOfTDDFeedbacks,
                                TxBeamFeedback,
                                ResultCode
                                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the address of the peer MAC entity with which TDD beam measurement was performed or attempted. |
| NumberOfTDDFeedbacks | Integer | 0–1024 | Indicates the number of TDD Feedbacks included. |
| TxBeamFeedback | A set of Tx Beam Feedback fields | As defined in 9.4.2.283 | One or more Tx Beam Feedback fields are present. |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD beam measurement procedure, i.e., SUCCESS in case feedback result were successfully received and FAILURE otherwise. |

##### 6.3.121.4.3 When generated

This primitive is generated by the MLME to report the result of TDD beam measurement procedure that was initiated by the peer STA.

##### 6.3.121.4.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.122 TDD structure and schedule

#### 6.3.122.1 General

This set of primitives supports the TDD scheduled access as described in 10.39.6.2.2 and 11.54.

#### 6.3.122.2 MLME-TDD-SLOT-STRUCTURE.request

##### 6.3.122.2.1 Function

This primitive requests TDD slot structure establishment in the MAC entity within a STA.

##### 6.3.122.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SLOT-STRUCTURE.request(
                STAAddress,
                TDDSlotStructureList,
                VendorSpecificInfo
                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| STAAddress | MAC address | Any valid individual MAC address | Specifies the MAC address of the STA. |
| TDDSlotStructureList | A set of TDD Slot Structure elements | As defined in 9.4.2.281 | Specifies the parameters within one or more TDD Slot Structure elements corresponding to a target STA. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

##### 6.3.122.2.3 When generated

This primitive is generated by the SME any time a TDD slot structure is to be set in the MAC entity.

##### 6.3.122.2.4 Effect on receipt

If the content of the TDD Slot Structure element remains unchanged compared to the TDD Slot Structure element set in the MAC entity, receipt of this primitive shall have no effect. Otherwise, receipt of this primitive causes the MAC to apply the parameters of the primitive as defined in 10.39.6.2.2.

#### 6.3.122.3 MLME-TDD-SLOT-STRUCTURE.confirm

##### 6.3.122.3.1 Function

This primitive report the outcome of a TDD slot structure establishment according to procedures defined in 10.39.6.2.2.

##### 6.3.122.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SLOT-STRUCTURE.confirm(
                ResultCode,
                VendorSpecificInfo
                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD Slot Structure request received. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.3.3 When generated

This primitive is generated by the MLME to report that the TDD slot structure takes effect in the MAC entity of the AP or PCP.

#### 6.3.122.3.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.122.4 MLME-TDD-SLOT-SCHEDULE.request

#### 6.3.122.4.1 Function

This primitive requests TDD slot schedule establishment in the MAC entity within a STA.

#### 6.3.122.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SLOT-SCHEDULE.request(
                        STAAddress,
                        TDDSlotScheduleList,
                        VendorSpecificInfo
                        )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| STAAddress | MAC address | Any valid individual MAC address | Specifies MAC address of the STA. |
| TDDSlotScheduleList | A set of TDD Slot Schedule elements | As defined in 9.4.2.282 | Specifies the parameters within one or more TDD Slot Schedule elements corresponding to the target STA. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.4.3 When generated

This primitive is generated by the SME any time the TDD slot schedule is to be set in the MAC entity.

#### 6.3.122.4.4 Effect on receipt

If the content of the TDD Slot Structure element remains unchanged compared to the TDD Slot Structure element set in the MAC entity, receipt of this primitive shall have no effect. Otherwise, receipt of this primitive causes the MAC to apply the parameters of the primitive as defined in 10.39.6.2.2.

### 6.3.122.5 MLME-TDD-SLOT-SCHEDULE.confirm

#### 6.3.122.5.1 Function

This primitive report the outcome of a TDD slot schedule establishment according to procedures defined in 10.39.6.2.2.

#### 6.3.122.5.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-TDD-SLOT-SCHEDULE.confirm(
ResultCode,
VendorSpecificInfo
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD slot schedule request received. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.5.3 When generated

This primitive is generated by the MLME to report that the TDD slot schedule takes effect in the MAC entity.

#### 6.3.122.5.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.122.6 MLME-TDD-SLOT-ANNOUNCE.request

#### 6.3.122.6.1 Function

This primitive request transmission of an Announce frame to the peer STA to convey the TDD Slot Structure element and/or the TDD Slot Schedule element.

#### 6.3.122.6.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-TDD-SLOT-ANNOUNCE.request(
PeerSTAAddress,
TDDSlotStructureList,
TDDSlotScheduleList,
VendorSpecificInfo
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specific MAC address of the STA that is intended recipient of the TDD Slot Schedule and the TDD Slot Structure elements. |
| TDDSlotStructureList | A set of TDD Slot Structure elements | As defined in 9.4.2.281 | Optionally present. Specifies the parameters within one or more TDD Slot Structure elements corresponding to a target STA. |
| TDDSlotScheduleList | A set of TDD Slot Schedule elements | As defined in 9.4.2.282 | Specifies the parameters within one or more TDD Slot Schedule elements corresponding to the peer STA. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.6.3 When generated

This primitive is generated by the SME to initiate transmission of an Announce frame to the peer STA to convey the TDD Slot Structure element and/or the TDD Slot Schedule element.

#### 6.3.122.6.4 Effect on receipt

The Announce frame that conveys the TDD Slot Structure element and/or the TDD Slot Schedule element is transmitted to the peer STA.

### 6.3.122.7 MLME-TDD-SLOT-ANNOUNCE.confirm

#### 6.3.122.7.1 Function

This primitive reports the outcome of a TDD slot structure and a TDD slot schedule establishment according to procedures defined in 10.39.6.2.2 and 11.54.

#### 6.3.122.7.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-SLOT-ANNOUNCE.confirm(
                                ResultCode,
                                VendorSpecificInfo
                                )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the TDD slot structure and the TDD slot schedule establishment. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.7.3 When generated

This primitive is generated by the MLME to report the result of a TDD slot structure and a TDD slot schedule establishment in the peer STA.

#### 6.3.122.7.4 Effect on receipt

The SME is notified of the result of the procedure.

### 6.3.122.8 MLME-TDD-SLOT-ANNOUNCE.indication

#### 6.3.122.8.1 Function

This primitive indicates that a specific peer MAC entity is requesting a TDD slot structure and a TDD slot schedule with the local MAC entity.

#### 6.3.122.8.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-TDD-SLOT-ANNOUNCE.indication(
PeerSTAAddress,
TDDSlotStructureList,
TDDSlotScheduleList,
VendorSpecificInfo
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies MAC address of the peer STA from which the TDD Slot Schedule and the TDD Slot Structure elements are received. |
| TDDSlotStructureList | A set of TDD Slot Structure elements | As defined in 9.4.2.281 | Optionally present. Specifies the parameters within one or more TDD Slot Structure elements received from a peer STA. |
| TDDSlotScheduleList | A set of TDD Slot Schedule elements | As defined in 9.4.2.282 | Specifies the parameters within one or more TDD Slot Schedule elements received from a peer STA. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.8.3 When generated

This primitive is generated by the MLME as a result of the receipt of a TDD slot structure and a TDD slot schedule from a specific peer MAC entity.

#### 6.3.122.8.4 Effect on receipt

The SME is notified of the receipt of a TDD slot structure and a TDD slot schedule.

### 6.3.122.9 MLME-TDD-BANDWIDTH.request

#### 6.3.122.9.1 Function

This primitive requests the transmission of an Announce frame to the AP or PCP to convey the TDD Bandwidth Request element.

#### 6.3.122.9.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-TDD-BANDWIDTH.request(
PeerSTAAddress,
TDDBandwidthRequest,
VendorSpecificInfo
)

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specific the MAC address of the AP or PCP STA that is intended recipient of the TDD Bandwidth Request element. |
| TDDBandwidthRequest | A TDD Bandwidth Request element | As defined in 9.4.2.285 | Specifies the parameters within a TDD Bandwidth Request element. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.9.3 When generated

This primitive is generated by the SME of a non-AP and non-PCP STA to initiate transmission of an Announce frame to the AP or PCP to convey a TDD Bandwidth Request element.

#### 6.3.122.9.4 Effect on receipt

The Announce frame that conveys the TDD Bandwidth Request element is transmitted to the AP or PCP.

### 6.3.122.10 MLME-TDD-BANDWIDTH.confirm

#### 6.3.122.10.1 Function

This primitive reports the outcome of a TDD Bandwidth Request according to procedures defined in 10.39.6.2.2 and 11.54.

#### 6.3.122.10.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BANDWIDTH.confirm(
                    ResultCode,
                    VendorSpecificInfo
                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of a TDD Bandwidth Request element delivery. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

#### 6.3.122.10.3 When generated

This primitive is generated by the MLME to report the result of a TDD Bandwidth Request element transmission to the AP or PCP.

#### 6.3.122.10.4 Effect on receipt

The SME is notified of the result of the procedure.

#### 6.3.122.11 MLME-TDD-BANDWIDTH.indication

##### 6.3.122.11.1 Function

This primitive indicates that a specific non-AP and non-PCP MAC entity is requesting a TDD bandwidth request with the local MAC entity.

##### 6.3.122.11.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-TDD-BANDWIDTH.indication(
                                    PeerSTAAddress,
                                    TDDBandwidthRequest,
                                    VendorSpecificInfo
                                    )
```

| Name | Type | Valid range | Description |
|---|---|---|---|
| PeerSTAAddress | MAC address | Any valid individual MAC address | Specifies the MAC address of the non-AP and non-PCP STA from which the TDD Bandwidth Request element is received. |
| TDDBandwidthRequest | A TDD Bandwidth Request element | As defined in 9.4.2.285 | Specifies the parameters within a TDD Bandwidth Request element received from the peer STA. |
| VendorSpecificInfo | A set of elements | As defined in 9.4.2.25 | Zero or more elements. |

##### 6.3.122.11.3 When generated

This primitive is generated by the MLME as a result of the receipt of TDD bandwidth request from a specific non-AP and non-PCP MAC entity.

##### 6.3.122.11.4 Effect on receipt

The SME is notified of the receipt of a TDD bandwidth request.

## 6.5 PLME SAP interface

### 6.5.6 PLME-TXTIME.confirm

#### 6.5.6.2 Semantics of the service primitive

***Change the second paragraph of 6.5.6.2 as follows:***

The TXTIME represents the time, in microseconds, required to transmit the PPDU described in the corresponding PLME-TXTIME.request primitive. If the calculated time includes a fractional microsecond and the TXVECTOR parameter FORMAT in the corresponding PLME-TXTIME.request primitive is not HE_SU, HE_MU, HE_TB, or HE_ER_SU, a non-DMG STA rounds the TXTIME value to the next higher integer. A non-DMG STA does not round the TXTIME value up or down if the TXVECTOR parameter FORMAT in the corresponding PLME-TXTIME.request primitive is HE_SU, HE_MU, HE_TB, or HE_ER_SU. A DMG STA does not round the TXTIME value up or down ~~(see 20.11.3)~~.

***Insert the following subclauses (6.5.7 through 6.5.10.4) after 6.5.6.4:***

### 6.5.7 TDD beamforming

#### 6.5.7.1 Function

This primitive is a request for the PHY to start measuring the signal power of received PPDUs and compute metrics such as EVM, SNR and LDPC over iterations of PPDUs that exceed the prescribed PSDU length (see 10.43.5).

#### 6.5.7.2 Semantics of the service primitive

This primitive provides the following parameter:

```
PLME-MINPAYLOADSTAT.request(
                              PSDU_MIN_LENGTH
                              )
```

The PSDU_MIN_LENGTH parameter represents the smallest PSDU length, in octets, that PPDUs are required to have for the PHY to compute the required metrics.

#### 6.5.7.3 When generated

This primitive is issued by the SME to the PHY entity to require the PHY to proceed with parameters measurement of received PPDUs that have a PSDU length no less than PSDU_MIN_LENGTH. The SME also issues the primitive to change the value of PSDU_MIN_LENGTH.

#### 6.5.7.4 Effect on receipt

The effect of receipt of this primitive by the PHY entity is to start measuring signal power and to compute the metrics measured over PPDUs with a PSDU length no less than PSDU_MIN_LENGTH.

### 6.5.8 PLME-MINPAYLOADSTAT.confirm

#### 6.5.8.1 Function

This primitive indicates that the PHY is ready to proceed with the measurement over received PPDUs and that the threshold has been set to PSDU_MIN_LENGTH.

#### 6.5.8.2 Semantics of the service primitive

This primitive provides the following parameter:

```
PLME-MINPAYLOADSTAT.confirm(
                              PSDU_MIN_LENGTH
                              )
```

The PSDU_MIN_LENGTH parameter represents the smallest PSDU length, in octets, that PPDUs are required to have for the PHY to compute the required metrics.

#### 6.5.8.3 When generated

This primitive is issued by the local PHY entity in response to a PLME-MINPAYLOADSTAT.request primitive.

#### 6.5.8.4 Effect on receipt

The receipt of this primitive indicates to the SME that the PHY is ready to proceed with the measurement over received PPDUs that have a PSDU length no less than PSDU_MIN_LENGTH.

### 6.5.9 PLME- MINPAYLOADSTATRESET.request

#### 6.5.9.1 Function

This primitive is a request by the SME to reset the PHY counters corresponding to the PLME-MINPAYLOADSTAT primitive. No other PHY functionality is impacted by the primitive.

#### 6.5.9.2 Semantics of the service primitive

This primitive has no parameters.

#### 6.5.9.3 When generated

This primitive is generated to reset the PHY measurements initiated by the PLME-MINPAYLOADSTAT.

#### 6.5.9.4 Effect on receipt

Receipt of this primitive by the PHY causes it to reset the PHY counters of received PPDUs.

### 6.5.10 PLME- MINPAYLOADSTATSTOP.request

#### 6.5.10.1 Function

This primitive is a request by the SME for the PHY to stop all measurements corresponding to the PLME-MINPAYLOADSTAT primitive. No other PHY functionality is impacted by the primitive.

#### 6.5.10.2 Semantics of the service primitive

This primitive has no parameters.

#### 6.5.10.3 When generated

This primitive is generated to stop the PHY measurements initiated by the PLME-MINPAYLOADSTAT.

#### 6.5.10.4 Effect on receipt

Receipt of this primitive by the PHY causes it to stop the PHY measurements of received PPDUs.

# 8. PHY service specification

## 8.3 Detailed PHY service specifications

### 8.3.4 Basic service and options

#### 8.3.4.3 PHY SAP service primitives parameters

***Change Table 8-3 as follows:***

**Table 8-3—PHY SAP service primitive parameters**

| Parameter | Associated primitive | Value |
|---|---|---|
| DATA | PHY-DATA.request<br>PHY-DATA.indication | Octet value X'00'–X'FF' |
| TXVECTOR | PHY-TXSTART.request | A set of parameters |
| STATE | PHY-CCA.indication | (BUSY[, channel-list[, per20bitmap[, antenna-list]]])<br>(IDLE[, per20bitmap]) |
| RXVECTOR | PHY-RXSTART.indication | A set of parameters |
| RCPI | PHY-RXEND.indication | Clauses 15–19 and 21–23: 0–255;<br>Clauses 20, 24, and 25: not present |
| RXERROR | PHY-RXEND.indication | NoError, FormatViolation, CarrierLost, UnsupportedRate, Filtered |
| IPI-STATE | PHY-CCARESET.request<br>PHY-CCARESET.confirm | IPI-ON, IPI-OFF |
| IPI-REPORT | PHY-CCA.indication<br>PHY-CCARESET.confirm | A set of IPI values for the preceding time interval |
| PHYCONFIG_VECTOR | PHY-CONFIG | A set of parameters |
| TXSTATUS | PHY-TXSTART.confirm | A set of parameters |
| USER_INDEX | PHY-DATA.request | 0 to TXVECTOR parameter NUM_USERS – 1 |
| TRIGVECTOR | PHY-TRIGGER.request | A set of parameters |

### 8.3.5 PHY SAP detailed service specification

#### 8.3.5.12 PHY-CCA.indication

##### 8.3.5.12.2 Semantics of the service primitive

***Change the primitive parameter list in 8.3.5.12.2 as follows:***

The primitive provides the following parameters:

PHY-CCA.indication(
STATE,
IPI-REPORT,
channel-list,
per20bitmap,
RX-antenna-ID
)

***Change the fourth paragraph and Table 8-5 in 8.3.5.12.2 as follows:***

When STATE is IDLE or when, for the type of PHY in operation, CCA is determined by a single channel, the channel-list parameter is absent. Otherwise, it carries a set indicating which channels are busy. The channel-list parameter in a PHY-CCA.indication primitive generated by a VHT or S1G STA contains at most a single element. Table 8-5 defines the members of this set. For an EDMG STA, the channel-list parameter contains the primary and secondary channels and may contain the secondary1 and secondary2 channels, while the RX-antenna-ID parameter indicates a set of IDs of the DMG antennas in which the channel indication is provided.

**Table 8-5—The channel-list parameter entries**

| Channel-list parameter entry | Meaning |
|---|---|
| primary | In an HT STA that is neither a VHT STA nor an HE STA, indicates that the primary channel is busy according to the rules specified in 19.3.19.5.2.<br>In a VHT STA that is not an HE STA, indicates that the primary 20 MHz channel is busy according to the rules specified in 21.3.18.5.3.<br>In a TVHT STA, indicates that the primary channel is busy according to the rules specified in 22.3.18.6.3.<br>In an HE STA, indicates that the primary 20 MHz channel is busy according to the rules specified in 27.3.20.6.3.<br>In an EDMG STA, indicates that the primary 2.16 GHz channel is busy according to the rules specified in 28.3.8. |
| secondary | In an HT STA that is neither a VHT STA nor an HE STA, indicates that the secondary channel is busy according to the rules specified in 19.3.19.5.5.<br>In a VHT STA that is not an HE STA, indicates that the secondary 20 MHz channel is busy according to the rules specified in 21.3.18.5.4.<br>In a TVHT STA, indicates that the secondary channel is busy according to the rules specified in 22.3.18.6.4.<br>In an HE STA, indicates that the secondary 20 MHz channel is busy according to the rules specified in 27.3.20.6.4.<br>In an EDMG STA, indicates that the secondary 2.16 GHz channel is busy according to the rules specified in 28.3.8. |

**Table 8-5—The channel-list parameter entries *(continued)***

| Channel-list parameter entry | Meaning |
|---|---|
| secondary40 | In a VHT STA that is not an HE STA, indicates that the secondary 40 MHz channel is busy according to the rules specified in 21.3.18.5.4.<br>In a TVHT STA, indicates that the secondary TVHT_2W channel is busy according to the rules specified in 22.3.18.6.4.<br>In an HE STA, indicates that the secondary 40 MHz channel is busy according to the rules specified in 27.3.20.6.4. |
| secondary80 | In a VHT STA that is not an HE STA, indicates that the secondary 80 MHz channel is busy according to the rules specified in 21.3.18.5.4.<br>In an HE STA, indicates that the secondary 80 MHz channel is busy according to the rules specified in 27.3.20.6.4. |
| primary1 | In an S1G STA, indicates that the primary 1 MHz channel is busy according to the rules specified in 23.3.18.5.4 |
| primary2 | In an S1G STA, indicates that the primary 2 MHz channel is busy according to the rules specified in 23.3.18.5.4. |
| secondary1 | In an EDMG STA, indicates that the second secondary 2.16 GHz channel is busy according to the rules specified in 28.3.8. |
| secondary2 | In an S1G STA, indicates that the secondary 2 MHz channel is busy according to the rules specified in 23.3.18.5.5.<br>In an EDMG STA, indicates that the third secondary 2.16 GHz channel is busy according to the rules specified in 28.3.8. |
| secondary4 | In an S1G STA, indicates that the secondary 4 MHz channel is busy according to the rules specified in 23.3.18.5.5. |
| secondary8 | In an S1G STA, indicates that the secondary 8 MHz channel is busy according to the rules specified in 23.3.18.5.5. |

***Insert the following text, Table 8-5a, and Figure 8-6 at the end of 8.3.5.12.2:***

Table 8-5a defines the assignment of secondary, secondary1 and secondary2 channels in relation to the BSS Operating Channels field and Primary Channel field within the EDMG Operation element transmitted by an EDMG AP or an EDMG PCP. In Table 8-5a, the following conventions are used:

— The BSS Operating Channels field is indicated as *Ch*(*i*), *Ch*(*k*), *Ch*(*l*), and *Ch*(*m*), where $Ch(i) < Ch(k) < Ch(l) < Ch(m)$.

— The function *Ch*(*param*) returns a channel number, where *param* indicates a bit position (B0-B7), $0 \le param \le 7$, within the BSS Operating Channels field of the EDMG Operation element.

**Table 8-5a—Definition of EDMG secondary, secondary1, and secondary2 channels**

| Configuration indicated in the Primary Channel field and in the BSS Operating Channels field | | Channel definition | | | |
|---|---|---|---|---|---|
| **Number of channels** | **Channels set** | **Primary** | **Secondary** | **Secondary1** | **Secondary2** |
| 1 | *Ch*(*i*)<br><br>*i*=(0), (1), (2), (3), (4), (5), (6), (7) | *Ch*(*i*) | N/A | N/A | N/A |

**Table 8-5a—Definition of EDMG secondary, secondary1, and secondary2 channels *(continued)***

| Configuration indicated in the Primary Channel field and in the BSS Operating Channels field | | Channel definition | | | |
|---|---|---|---|---|---|
| **Number of channels** | **Channels set** | **Primary** | **Secondary** | **Secondary1** | **Secondary2** |
| 2 | *Ch*(*i*), *Ch*(*k*) | *Ch*(*i*) | *Ch*(*k*) | N/A | N/A |
| | (*i*,*k*) = (0,1),(0,2), (0,3), (0,4), (0,5), (0,6), (0,7), (1,2), (1,3), (1,4), (1,5), (1,6), (1,7), (2,3), (2,4), (2,5), (2,6), (2,7), (3,4), (3,5), (3,6), (3,7), (4,5), (4,6), (4,7), (5,6), (5,7), (6,7) | *Ch*(*k*) | *Ch*(*i*) | N/A | N/A |
| 3 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | N/A |
| | (*i*,*k*,*l*) = (0,1,2), (1,2,3), (2,3,4), (3,4,5), (4,5,6), (5,6,7), (0,1,3), (0,1,4), (0,1,5), (0,1,6), (0,1,7), (1,2,4), (1,2,5), (1,2,6), (1,2,7), (2,3,5), (2,3,6), (2,3,7), (3,4,6), (3,4,7), (4,5,7) | *Ch*(*k*) | *Ch*(*i*) | *Ch*(*l*) | N/A |
| | | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) | N/A |
| 3 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | N/A |
| | (*i*,*k*,*l*) = (0,2,3), (0,3,4), (0,4,5), (0,5,6), (0,6,7), (1,3,4), (1,4,5), (1,5,6), (1,6,7), (2,4,5), (2,5,6), (2,6,7), (3,5,6), (3,6,7), (4,6,7), (0,2,4), (0,2,5), (0,2,6), (0,2,7), (0,3,5), (0,3,6), (0,3,7), (0,4,6), (0,4,7), (0,5,7), (1,3,5), (1,3,6), (1,3,7), (1,4,6), (1,4,7), (1,5,7), (2,4,6), (2,4,7), (2,5,7), (3,5,7) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*i*) | N/A |
| | | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) | N/A |
| 4 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*), *Ch*(*m*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*m*) |
| | (*i*,*k*,*l*.*m*) = (0,1,2,3), (1,2,3,4), (2,3,4,5), (3,4,5,6), (4,5,6,7), (0,1,3,4), (0,1,4,5), (0,1,5,6), (0,1,6,7), (1,2,4,5), (1,2,5,6), (1,2,6,7), (2,3,5,6), (2,3,6,7), (3,4,6,7), (0,1,3,5), (0,1,3,6), (0,1,3,7), (0,1,4,6), (0,1,4,7), (0,1,5,7), (1,2,4,6), (1,2,4,7), (1,2,5,7), (2,3,5,7) | *Ch*(*k*) | *Ch*(*i*) | *Ch*(*l*) | *Ch*(*m*) |
| | | *Ch*(*l*) | *Ch*(*m*) | *Ch*(*k*) | *Ch*(*i*) |
| | | *Ch*(*m*) | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) |
| 4 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*), *Ch*(*m*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*m*) |
| | (*i*,*k*,*l*.*m*) = (0,1,2,4), (0,1,2,5), (0,1,2,6), (0,1,2,7), (1,2,3,5), (1,2,3,6), (1,2,3,7), (2,3,4,6), (2,3,4,7), (3,4,5,7) | *Ch*(*k*) | *Ch*(*i*) | *Ch*(*l*) | *Ch*(*m*) |
| | | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) | *Ch*(*m*) |
| | | *Ch*(*m*) | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) |
| 4 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*), *Ch*(*m*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*m*) |
| | (*i*,*k*,*l*.*m*) = (0,2,3,4), (0,3,4,5), (0,4,5,6), (0,5,6,7), (1,3,4,5), (1,4,5,6), (1,5,6,7), (2,4,5,6), (2,5,6,7), (3,5,6,7), (0,2,4,5), (0,2,5,6), (0,2,6,7), (0,3,5,6), (0,3,6,7), (0,4,6,7), (1,3,5,6), (1,3,6,7), (1,4,6,7), (2,4,6,7), (0,2,4,6), (0,2,4,7), (0,2,5,7), (0,3,5,7), (1,3,5,7) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*m*) | *Ch*(*i*) |
| | | *Ch*(*l*) | *Ch*(*m*) | *Ch*(*k*) | *Ch*(*i*) |
| | | *Ch*(*m*) | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) |

**Table 8-5a—Definition of EDMG secondary, secondary1, and secondary2 channels *(continued)***

| Configuration indicated in the Primary Channel field and in the BSS Operating Channels field | | Channel definition | | | |
|---|---|---|---|---|---|
| **Number of channels** | **Channels set** | **Primary** | **Secondary** | **Secondary1** | **Secondary2** |
| 4 | *Ch*(*i*), *Ch*(*k*), *Ch*(*l*), *Ch*(*m*) | *Ch*(*i*) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*m*) |
| | (*i*,*k*,*l*.*m*) = (0,2,3,5), (0,2,3,6), (0,2,3,7), (0,3,4,6), (0,3,4,7), (0,4,5,7), (1,3,4,6), (1,3,4,7), (1,4,5,7), (2,4,5,7) | *Ch*(*k*) | *Ch*(*l*) | *Ch*(*i*) | *Ch*(*m*) |
| | | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) | *Ch*(*m*) |
| | | *Ch*(*m*) | *Ch*(*l*) | *Ch*(*k*) | *Ch*(*i*) |

For an EDMG STA, the relationship of the channel-list parameter elements to the 4.32 GHz, 6.48 GHz, and 8.64 GHz BSS operating channel is illustrated by example in Figure 8-6.

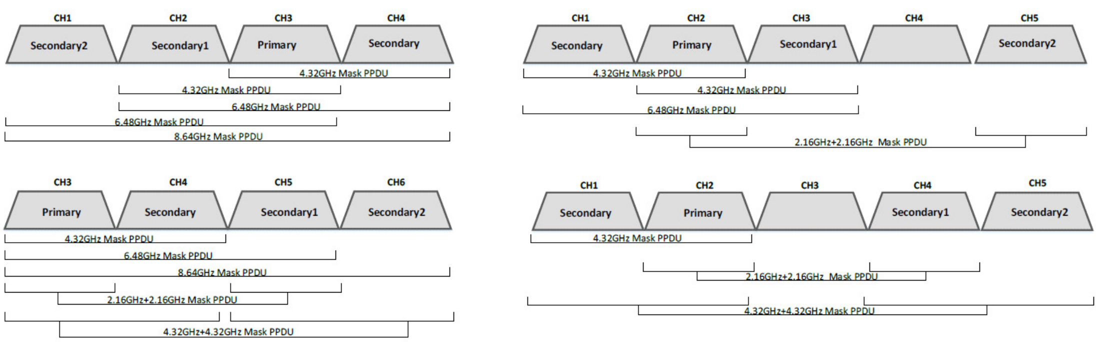


**Figure 8-6—Example channel-list parameter element for various BSS operating channels**

***Insert the following subclauses (8.3.5.17 through 8.3.5.17.4) after 8.3.5.16.4:***

### 8.3.5.17 PHY-ABORT.request

#### 8.3.5.17.1 Function

This primitive is a request by the MAC to reset the PHY. The PHY is always reset to the receive state.

#### 8.3.5.17.2 Semantics of the service primitive

This primitive has no parameters.

#### 8.3.5.17.3 When generated

This primitive is generated at any time to reset the PHY.

#### 8.3.5.17.4 Effect of receipt

Receipt of this primitive by the PHY causes the PHY entity to reset both the transmit and the receive state machines and places the PHY into the receive state.

# 9. Frame formats

## 9.2 MAC frame formats

### 9.2.4 Frame fields

#### 9.2.4.1 Frame Control field

##### 9.2.4.1.3 Type and Subtype subfields

***Change Table 9-2 as follows:***

**Table 9-2—Control Frame Extension**

| Type value B3 B2 | Subtype value B7 B6 B5 B4 | Control Frame Extension value B11 B10 B9 B8 | Description |
|---|---|---|---|
| 01 | 0110 | 0000 | Sector Ack ~~Reserved~~ |
| 01 | 0110 | 0001 | Block Ack Schedule ~~Reserved~~ |
| 01 | 0110 | 0010 | Poll |
| 01 | 0110 | 0011 | SPR |
| 01 | 0110 | 0100 | Grant |
| 01 | 0110 | 0101 | DMG CTS |
| 01 | 0110 | 0110 | DMG DTS |
| 01 | 0110 | 0111 | Grant Ack |
| 01 | 0110 | 1000 | SSW |
| 01 | 0110 | 1001 | SSW-Feedback |
| 01 | 0110 | 1010 | SSW-Ack |
| 01 | 0110 | 1011 | TDD Beamforming |
| 01 | 0110 | ~~1011~~ 1100–1111 | Reserved |

#### 9.2.4.4 Sequence Control field

***Change the subclause title for 9.2.4.4.1 as follows:***

##### 9.2.4.4.1 Sequence Control field structure <u>when SAR is not used</u>

***Insert the following subclause (9.2.4.4.1a, including Figure 9-7a) after 9.2.4.4.1:***

##### 9.2.4.4.1a Sequence Control field structure when SAR is used

If segmentation and reassembly (see 10.69) is established between the transmitting and receiving STA, the Sequence Control field has the format illustrated in Figure 9-7a. The Sequence Control field is not present in Control frames.

| | B0 | B1 | B2 B(MSDU Modulo + 1) | B(MSDU Modulo + 2) B15 |
|---|---|---|---|---|
| | Start of MSDU | End of MSDU | MSDU Sequence Number | MPDU Sequence Number |
| Bits: | 1 | 1 | MSDU Modulo | MPDU Modulo |

**Figure 9-7a—Sequence Control field format**

The Start of MSDU subfield is set to 1 to indicate that the MPDU contains the first segment of an MSDU or A-MSDU. It is set to 0 otherwise.

The End of MSDU subfield is set to 1 to indicate that the MPDU contains the last segment of an MSDU or A-MSDU. It is set to 0 otherwise.

The MSDU Sequence Number subfield indicates the sequence number value associated with the respective MSDU or A-MSDU segment. The length of the MSDU Sequence Number subfield is equal to the value of the MSDU Modulo subfield within the SAR Configuration element contained in the intended recipient's ADDBA Response frame (see 10.25.2).

The MPDU Sequence Number subfield indicates the MPDU sequence number that carries the MSDU or A-MSDU segment. The length of the MPDU Sequence Number subfield is equal to the value of the MPDU Modulo subfield within the SAR Configuration element contained in the intended recipient's ADDBA Response frame (see 10.25.2).

### 9.2.4.5 QoS Control field

#### 9.2.4.5.4 Ack Policy Indicator subfield

***Change Table 9-13 as shown:***

**Table 9-13—Ack policy**

| Ack policy | Ack Policy Indicator subfield | | Other conditions | Meaning |
|---|---|---|---|---|
| | Bit 0 | Bit 1 | | |
| Normal Ack | 0 | 0 | MPDU is a non-A-MPDU frame | Where the frame contains a fragment and both the originator and the addressed recipient support fragment BA:<br>The addressed recipient returns an NDP BlockAck or BAT frame after a SIFS, according to the procedures defined in 10.3.2.12 and 10.47.2.<br><br>The addressed recipient that is a DMG STA operating in an SP with TDD channel access (see 10.39.6.2.2) returns an Ack frame according to the procedures defined in 10.3.2.11.<br><br>Otherwise:<br>The addressed recipient returns an Ack, STACK, or QoS +CF-Ack frame after a short interframe space (SIFS) period, according to the procedures defined in 10.3.2.11, 10.47.2, and 10.23.3.5. A non-DMG STA uses this ack policy for individually addressed QoS Null frames. |
| Implicit BAR | 0 | 0 | MPDU is not a non-A-MPDU frame<br>NOTE—This MPDU is sent under a block ack agreement. | The addressed recipient returns a BlockAck, TACK or BAT frame, either individually or as part of an A-MPDU starting a SIFS after the PPDU carrying the frame, according to the procedures defined in 10.3.2.11, 10.25.6.5, 10.29.3, 10.29.4, 10.47.2, and 10.34.3.<br><br>The addressed recipient that is a DMG STA operating in an SP with TDD channel access (see 10.39.6.2.2) returns an BlockAck frame, either individually or as part of an A-MPDU according to the procedures defined in 10.25.6.5. |
| No Ack | 1 | 0 | None | The addressed recipient takes no action upon receipt of the frame. More details are provided in 10.26.<br><br>This ack policy is used in all individually addressed frames in which the sender does not require immediate acknowledgment. It is also used in all group addressed frames that use the QoS frame format except QoS Data frames with a TID for which a block ack agreement exists.<br>It is not used for QoS Data frames with a TID for which a block ack agreement exists. |

**Table 9-13—Ack policy *(continued)***

| Ack policy | Ack Policy Indicator subfield | | Other conditions | Meaning |
|---|---|---|---|---|
| | Bit 0 | Bit 1 | | |
| No Explicit Acknowledgment | 0 | 1 | Bit 6 of the Frame Control field (see 9.2.4.1.3) is equal to 1 and the frame is not carried in an HE MU PPDU, HE SU PPDU, or HE ER SU PPDU that contains a frame that solicits a response in an HE TB PPDU | There might be a response frame to the frame that is received, but it is neither the Ack frame nor any Data frame of subtype +CF-Ack.<br>This ack policy is used for QoS CF-Poll and QoS CF-Ack +CF-Poll Data frames.<br><br>NOTE—Bit 6 of the Frame Control field (see 9.2.4.1.3) indicates the absence of a Frame Body field in a QoS Data frame. If equal to 1, the QoS Data frame contains no Frame Body field, and any response is generated in response to a QoS CF-Poll or QoS CF-Ack +CF-Poll frame, but does not signify an acknowledgment of data. |
| PSMP Ack | 0 | 1 | Bit 6 of the Frame Control field (see 9.2.4.1.3) is equal to 0 and the frame is not carried in an HE MU PPDU, HE SU PPDU, or HE ER SU PPDU that contains a frame that solicits a response in an HE TB PPDU | The acknowledgment for a frame indicating PSMP Ack when it appears in a PSMP downlink transmission time (PSMP-DTT) is to be received in a later PSMP uplink transmission time (PSMP-UTT).<br>The acknowledgment for a frame indicating PSMP Ack when it appears in a PSMP-UTT is to be received in a later PSMP-DTT.<br>See 10.30.2.7. |
| HETP Ack | 0 | 1 | The frame is carried in an HE MU PPDU, HE SU PPDU, or HE ER SU PPDU that contains a frame that solicits a response in an HE TB PPDU | The addressed recipient returns an Ack, Compressed BlockAck, or Multi-STA BlockAck frame carried in an HE TB PPDU a SIFS after the PPDU, subject to reception of a triggering frame in the PPDU, as defined in 10.3.2.13.2 and 26.5.2. |
| Block Ack | 1 | 1 | None | The addressed recipient takes no action upon the receipt of the frame except for recording the state. The recipient can expect a BlockAckReq frame or implicit block ack request in the future to which it responds using the procedure described in 10.25. |
| <u>Scheduled Ack</u> | <u>0</u> | <u>1</u> | <u>Bit 6 of the Frame Control field (see 9.2.4.1.3) is equal to 0</u> | <u>The acknowledgment for a frame indicating Scheduled Ack when it appears in an EDMG PPDU is to be received in a scheduled time slot as described in 10.3.2.13, 10.29.4, and 10.29.5.</u> |

#### 9.2.4.7 Frame Body field

##### 9.2.4.7.1 General

***Change as Table 9-25 follows:***

**Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds)**

| | Non-HT non-VHT non-HE non-S1G non-DMG PPDU and non-HT duplicate PPDU | HT PPDU | VHT PPDU | HE PPDU | S1G PPDU | DMG PPDU | EDMG PPDU |
|---|---|---|---|---|---|---|---|
| MMPDU size | 2304 | 2304 | See NOTE 1 | See NOTE 1 | See NOTE 1 | 2304 | 2304 |
| MSDU size | 2304 | 2304 | 2304 | 2304 | 2304 | ~~7920~~<br>Without SAR agreement: for the basic A-MSDU format, it is equal to the value of A-MSDU size minus 14, or minus 2 for the short A-MSDU format, if the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element is valid; otherwise, it is equal to 7920.<br>With SAR agreement: see NOTE 8. | Without SAR agreement: for the basic A-MSDU format, it is equal to the value of A-MSDU size minus 14, or minus 2 for the short A-MSDU format, if the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element is valid; otherwise, it is equal to 7920.<br>With SAR agreement: see NOTE 8. |

**Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds) *(continued)***

| | Non-HT non-VHT non-HE non-S1G non-DMG PPDU and non-HT duplicate PPDU | HT PPDU | VHT PPDU | HE PPDU | S1G PPDU | DMG PPDU | EDMG PPDU |
|---|---|---|---|---|---|---|---|
| A-MSDU size | 3839 or 4065 (see NOTE 2) (HT STA, see also Table 9-184), or<br>N/A (non-HT STA, see also 10.11) | 3839 or 7935 (see also Table 9-184) | See NOTE 3 | 2.4 GHz band: 3839 or 7935 (see also Table 9-184)<br>Otherwise: see NOTE 3 | See NOTE 3 | ~~7935~~ Without SAR agreement: indirectly limited by the value of the MPDU Limit subfield in the Extended MPDU Capability field of the DMG Capabilities element, if the subfield is valid; otherwise, it is equal to 7935. With SAR agreement: see NOTE 8. | Without SAR agreement: indirectly limited by the value of the MPDU Limit subfield in the Extended MPDU Capability field of the DMG Capabilities element, if the subfield is valid; otherwise, it is equal to 7935. With SAR agreement: see NOTE 8. |
| MPDU size | See NOTE 4 | See NOTE 5 | 3895 or 7991 or 11 454 (see also Table 9-271) | 2.4 GHz band: see NOTE 5<br>Otherwise: 3895 or 7991 or 11 454 (see also Table 9-271)<br>See NOTE 7 | 3895 or 7991 (see also Table 9-300) | The value indicated in the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element if the subfield is valid; otherwise, as in ~~See~~ NOTE 5. | The value indicated in the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element if the subfield is valid; otherwise, as in NOTE 5. |
| PSDU size | $2^{12}$–1 (see Table 15-5, Table 16-4, Table 17-21, Table 18-5) | $2^{16}$–1 (see Table 19-25) | 4 692 480 ($\sim 2^{22.16}$) (see Table 21-28) | 6 500 631 ($\sim 2^{22.63}$) (see Table 27-54) | 797 160 ($\sim 2^{19.60}$) (see Table 23-40) | $2^{18}$–1 (see Table 20-30) | $2^{22}$–1 (see Table 28-12 and Table 28-19) |

**Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds) *(continued)***

| | **Non-HT non-VHT non-HE non-S1G non-DMG PPDU and non-HT duplicate PPDU** | **HT PPDU** | **VHT PPDU** | **HE PPDU** | **S1G PPDU** | **DMG PPDU** | **EDMG PPDU** |
|---|---|---|---|---|---|---|---|
| PPDU duration | See NOTE 6 | 5484 (HT_MF, see 10.27.4) or 10 000 (HT_GF, see Table 19-25) | 5484 (see Table 21-28) | 5484 (see Table 27-54) | 27 840 (see Table 23-40) | 2000 (see Table 20-30) | 2000 (see Table 20-30) |

NOTE 1—No direct constraint on the maximum MMPDU size; indirectly constrained by the maximum MPDU size (see 9.3.3.1).

NOTE 2—Indirect constraint from the maximum PSDU size: $2^{12}$–1 octets minus the minimum QoS Data frame overhead (26 octets for the MAC header and 4 octets for the FCS).

NOTE 3—No direct constraint on the maximum A-MSDU size; indirectly constrained by the maximum MPDU size.

NOTE 4—No direct constraint on the maximum MPDU size; indirectly constrained by the maximum MSDU/MMPDU or (for HT STAs only) A-MSDU size.

NOTE 5—No direct constraint on the maximum MPDU size; indirectly constrained by the maximum A-MSDU size.

NOTE 6—No direct constraint on the maximum duration, but an L_LENGTH value above 2332 might not be supported by some receivers (see NOTE 2 in 10.27.4).

NOTE 7—The maximum MPDU size might be greater than the size declared as supported by the recipient if the MPDU is an HE Compressed Beamforming/CQI frame.

NOTE 8—No direct constraint on the maximum MSDU or A-MSDU size; indirectly constrained by the maximum PSDU size. Each MPDU in an A-MPDU of the PSDU that contains the MSDU or A-MSDU generates an overhead of MPDU Header (26 bytes), FCS (4 bytes), GCMP Header (8 bytes), MIC (16 bytes), and MPDU delimiter (4 bytes).

## 9.3 Format of individual frame types

### 9.3.1 Control frames

#### 9.3.1.8 BlockAck frame format

##### 9.3.1.8.1 Overview

*Change Figure 9-42 as follows:*

| | B0 | B1 B4 | B5 B8~~11~~ | B9 | B10 | B11 | B12 B15 |
|---|---|---|---|---|---|---|---|
| | Reserved | BA Type | Reserved | No Memory Kept | Memory Configuration Tag | Management Ack | TID_INFO |
| Bits: | 1 | 4 | 7 | 1 | 1 | 7 | 4 |

**Figure 9-42—BA Control field format**

*Change Table 9-28 as follows:*

**Table 9-28—BlockAck frame variant encoding**

| BA Type | BlockAck frame variant |
|---|---|
| 0 | Reserved |
| 1 | Extended Compressed |
| 2 | Compressed |
| 3 | Multi-TID |
| 4–5 | Reserved |
| 6 | GCR |
| 7 | EDMG Multi-TID |
| 8 | EDMG Compressed |
| ~~7~~– 9 | Reserved |
| 10 | GLK-GCR |
| 11 | Multi-STA |
| 12–15 | Reserved |

***Insert the following paragraphs into 9.3.1.8.1 after the seventh paragraph ("The GCR BlockAck ...."):***

An EDMG STA sets the No Memory Kept subfield to 1 to indicate that the free memory space indicated in the last RBUFCAP subfield might not be kept at the start of the next frame exchange sequence; otherwise, if set to 0, free memory space indicated by the RBUFCAP subfield is kept by the receiver for the next frame exchange sequence for the corresponding TID(s). The No Memory Kept subfield is reserved if transmitted by a STA that is not an EDMG STA.

For an EDMG STA, the Memory Configuration Tag subfield indicates one out of two memory configurations as indicated in Memory Configuration Tag field in the recipient's EDMG Flow Control Extension Configuration element (9.4.2.277). For other types of STAs, this subfield is reserved.

The Management Ack subfield is set to 1 to indicate that a frame of type Management and subtype that is not Action No Ack is acknowledged. This subfield is reserved if the BlockAck variant used is not the EDMG Multi-TID BlockAck variant.

***Insert the following subclauses (9.3.1.8.8 and 9.3.1.8.9, including Figure 9-47e through Figure 9-47g, Table 9-28d, and Table 9-28e) after 9.3.1.8.7:***

#### 9.3.1.8.8 EDMG Compressed BlockAck variant

The TID_INFO subfield of the BA Control field of the EDMG Compressed BlockAck frame contains the TID for which a BlockAck frame is requested.

The BA Information field of the EDMG Compressed BlockAck frame variant is formatted as indicated in Figure 9-47e.

| | Block Ack Starting Sequence Control | Block Ack Bitmap | RBUFCAP |
|---|---|---|---|
| Octets: | 2 | variable | 1 |

**Figure 9-47e—BA Information field format (EDMG Compressed BlockAck)**

For a block ack agreement that does not use segmentation and reassembly (see 10.69), the Starting Sequence Number subfield of the Block Ack Starting Sequence Control subfield contains the sequence number of the first MSDU or A-MSDU for which this BlockAck frame is sent. The value of this subfield is defined in 10.25.6.5. The Fragment Number subfield of the Block Ack Starting Sequence Control subfield is reserved.

The Block Ack Bitmap subfield of the BA Information field is used to indicate the received status of MSDUs, where each entry represents an MSDU or an A-MSDU. The size of the Block Ack Bitmap subfield is negotiated during the block ack establishment (see 10.25). Each bit that is set to 1 in the Block Ack Bitmap subfield acknowledges the successful reception of a single MSDU or A-MSDU in the order of sequence number. The first bit of the Block Ack Bitmap subfield corresponds to the MSDU or A-MSDU with the sequence number that matches the value of the Starting Sequence Number subfield of the Block Ack Starting Sequence Control subfield.

The RBUFCAP subfield is defined in Table 9-28d.

**Table 9-28d—RBUFCAP subfield encoding for the EDMG Compressed BlockAck variant**

| RBUFCAP value | RBUFCAP value name | Definition |
|---|---|---|
| 0 | Receiver Buffer Empty | Indicates that the recipient's memory is not less than the length indicated by the Maximum A-MPDU Length Exponent subfield (Table 9-322i). |
| 255 | Receiver Buffer Full | Indicates no space in the recipient's memory. |
| 1–254 | Receiver Buffer Available | Indicates the size of recipient's current memory that the originator can use to transmit MPDUs to the recipient; measured in units indicated by the Buffer Unit Size field (9.4.2.277). |

#### 9.3.1.8.9 EDMG Multi-TID BlockAck variant

The TID_INFO subfield of the BA Control field of the EDMG Multi-TID BlockAck frame contains the number of TIDs minus one for which information is reported in the BA Information field. For example, a value of two in the TID_INFO subfield means that information for three TIDs is present in the frame.

The BA Information field of the EDMG Multi-TID BlockAck frame comprises one or more instances of the Per TID Info, Block Ack Starting Sequence Control, Block Ack Bitmap subfields and RBUFCAP subfield. The BA Information field is formatted as indicated in Figure 9-47f.

| Octets: | 2 | 2 | 8, 16, 32, 64, or 128 | 1 |
|---|---|---|---|---|
| | Per-TID Info | Block Ack Starting Sequence Control | Block Ack Bitmap | RBUFCAP |

Repeat for each TID

**Figure 9-47f—Information field format**

The Per-TID Info subfield is defined in Figure 9-47g.

| | B0 B6 | B7 B8 | B9 B11 | B12 B15 |
|---|---|---|---|---|
| | Reserved | Ack Type | Block Ack Bitmap Subfield Length | TID |
| Bits: | 7 | 2 | 3 | 4 |

**Figure 9-47g—Per-TID Info subfield format**

If the Ack Type subfield is not 0, the Block Ack Bitmap Subfield Length field is reserved. The Ack Type subfield is defined in Table 9-28e.

**Table 9-28e—Ack Type subfield definition**

| Ack Type subfield value | TID subfield value | Presence of Block Ack Starting Sequence Control subfield and Block Ack Bitmap subfields | Context of a Per TID Info subfield in a Multi-STA BlockAck frame |
|---|---|---|---|
| 0 | 0–15 | Present | Block acknowledgment context is sent in response:<br>— To MPDUs in an A-MPDU that solicits an immediate block acknowledgment or<br>— To a BlockAckReq frame or to A-MPDU with ack policy set to Scheduled Ack. |
| 1 | 0–15 | Not present | Ack context:<br>Sent as a response to an MPDU that has a TID that does not have BA agreement and with ack policy set to Scheduled Ack |

**Table 9-28e—Ack Type subfield definition** ***(continued)***

| Ack Type subfield value | TID subfield value | Presence of Block Ack Starting Sequence Control subfield and Block Ack Bitmap subfields | Context of a Per TID Info subfield in a Multi-STA BlockAck frame |
|---|---|---|---|
| 2 | 0–15 | Not present | All-ack context:<br>Sent as a response to an A-MPDU that contains an MPDU with Ack Policy set to Normal Ack or Scheduled Ack, and all MPDUs for a given TID contained in the A-MPDU are received successfully. |
| 3 | N/A | N/A | Reserved |

The Block Ack Bitmap Subfield Length subfield is an integer in the range 0 to 4 that is used to calculate the number of octets of the bitmap represented by the Block Ack Bitmap subfield in the BA Information field. The bitmap length is equal to 2(3+ Block Ack Bitmap Subfield Length) octets, as negotiated during the Block Ack establishment (10.25) for the TID indicated in the TID subfield of the Per-TID Info subfield.

The TID subfield contains the value of the TID to which the value of the Block Ack Bitmap subfield carried in this BA Information field relates.

The Block Ack Starting Sequence Control subfield is shown in Figure 9-37. The Starting Sequence Number subfield of the Block Ack Starting Sequence Control subfield is the sequence number of the first MSDU or A-MSDU for which this BlockAck frame is sent. The value of this subfield is defined in 10.24.7.5. The Fragment Number subfield of the Block Ack Starting Sequence Control subfield is reserved and set to 0.

The Block Ack Bitmap subfield of the BA Information field is used to indicate the received status of MSDUs, where each entry represents an MSDU or an A-MSDU. The size of the Block Ack Bitmap subfield is negotiated during the block ack establishment (see 10.25) and can contain 8, 16, 32, 64, or 128 octets. Each bit that is set to 1 in the Block Ack Bitmap subfield acknowledges the successful reception of a single MSDU or A-MSDU in the order of sequence number. The first bit of the Block Ack Bitmap subfield corresponds to the MSDU or A-MSDU with the sequence number that matches the value of the Starting Sequence Number subfield of the Block Ack Starting Sequence Control subfield. The maximum size of all Block Ack Bitmap subfields appended for all TIDs in one EDMG Multi-TID BlockAck is 256 octets.

The RBUFCAP subfield is defined in 9.3.1.8.8.

***Insert the following subclauses (9.3.1.23 through 9.3.1.25.4, including Figure 9-64m through Figure 9-64x and Table 9-29l through Table 9-29n) after 9.3.1.22.9:***

### 9.3.1.23 Sector Ack frame format

The frame format for the Sector Ack frame is defined in in Figure 9-64m.

| | Frame Control | Duration | RA | TA | Number of Sector Feedback | Sector Feedback List | FCS |
|---|---|---|---|---|---|---|---|
| Octets: | 2 | 2 | 6 | 6 | 1 | $N$×14 | 4 |

**Figure 9-64m—Sector Ack frame format**

The Duration field is set to the time until the end of the current beamforming training allocation (see 10.42.10.3.3).

If the value of the Number of Sector Feedback field is 1, the RA field contains the MAC address of the STA that is the intended destination of the Sector Ack frame. If the value of the Number of Sector Feedback field is greater than 1, the RA field is set to the broadcast address.

The TA field contains the MAC address of the STA transmitting the Sector Ack frame.

The Number of Sector Feedback field indicates the number, $N$, of Sector Feedback fields within the Sector Feedback List field.

The Sector Feedback List field contains $N$ Sector Feedback fields as defined in 9.5.9.

### 9.3.1.24 Block Ack Schedule frame format

The frame format for the Block Ack Schedule frame is defined in Figure 9-64n.

| | Frame Control | Duration | RA | TA | Block Ack Schedule Information | FCS |
|---|---|---|---|---|---|---|
| Octets: | 2 | 2 | 6 | 6 | 8 | 4 |

**Figure 9-64n—Block Ack Schedule frame format**

The Duration field is set to the time until the end of the TXOP or SP.

The RA field contains the MAC address of the STA that is the intended receiver of the Block Ack Schedule frame.

The TA field contains the MAC address of the STA transmitting the Block Ack Schedule frame.

The Block Ack Schedule Information field is defined in Figure 9-64o.

| | B0 B15 | B16 B31 | B32 B47 | B48 B51 | B52 B53 | B54 B63 |
|---|---|---|---|---|---|---|
| | Response Offset | Response Duration | Next PPDU Start offset | TID Aggregation Limit | Preferred AC | Reserved |
| Bits: | 16 | 16 | 16 | 4 | 2 | 10 |

**Figure 9-64o—Block Ack Schedule Information field format**

The Response Offset subfield indicates the offset, in units of 1 µs, from the end of transmitted PPDU to the time when the response is expected to be transmitted by the intended responder.

The Response Duration subfield indicates the maximum duration of the responder transmission in units of 1 us.

The Next PPDU Start Offset subfield indicates the offset, in units of 1 µs, from the end of the transmitted PPDU to when the initiator is expected to start transmitting its next PPDU. If the transmitter does not intend to transmit its next PPDU to a responder, the Next PPDU Start Offset field is set to 0.

If the EDMG Multi-TID Aggregation Support subfield is greater than 0 in the STA’s EDMG Capabilities element, the TID Aggregation Limit subfield indicates the maximum number of TIDs that can be aggregated in an A-MPDU by the RD responder as part of an RDG. Otherwise, the TID Aggregation Limit subfield is reserved.

If the EDMG Multi-TID Aggregation Support subfield is greater than 0 in the EDMG Capabilities element of the STA that is transmitting this element, the Preferred AC subfield indicates the lowest priority AC for aggregation of MPDUs in an A-MPDU sent as part of an RDG. Otherwise, the Preferred AC subfield is reserved. The Preferred AC subfield is reserved if the AC Constraint subfield is equal to 0. The Preferred AC subfield is encoded as the AC index (ACI) defined in Table 9-154.

### 9.3.1.25 TDD Beamforming frame format

#### 9.3.1.25.1 Overview

The frame format for the TDD Beamforming frame is defined in Figure 9-64p.

| | Frame Control | Duration | RA | TA | TDD Beamforming Control | TDD Beamforming Information | FCS |
|---|---|---|---|---|---|---|---|
| Octets: | 2 | 2 | 6 | 6 | 1 | variable | 4 |

**Figure 9-64p—TDD Beamforming frame format**

The Duration field is set to the time until the end of the current TDD slot.

The RA field is set to the MAC address of the intended receiver of the TDD Beamforming frame, or to the broadcast address when the intended receiver MAC address is unknown or there is more than one intended receiver.

The TA field is set to the MAC address of the transmitter STA of the TDD Beamforming frame.

The TDD Beamforming Control field is defined as shown in Figure 9-64q.

| | B0 | B1 | B2 B3 | B4 | B5 B7 |
|---|---|---|---|---|---|
| | TDD Group Beamforming | TDD Beam Measurement | TDD Beamforming Frame Type | End of Training | Reserved |
| Bits: | 1 | 1 | 2 | 1 | 3 |

**Figure 9-64q—TDD Beamforming Control field format**

Collectively, the TDD Group Beamforming, TDD Beam Measurement, and RA field values indicate a TDD Beamforming frame usage, as listed in Table 9-29l.

**Table 9-29l—TDD Beamforming frame usage**

| TDD Group Beamforming field value | TDD Beam Measurement field value | RA field value | Beamforming procedure |
|---|---|---|---|
| 0 | 0 | Individual address | TDD individual BF with a known STA |
| 0 | 0 | Broadcast address | TDD individual BF with an unknown STA |

### Table 9-29l—TDD Beamforming frame usage *(continued)*

| TDD Group Beamforming field value | TDD Beam Measurement field value | RA field value | Beamforming procedure |
|---|---|---|---|
| 0 | 1 | Individual address | TDD beam measurement with a known STA |
| 0 | 1 | Broadcast address | TDD beam measurement with all neighboring STAs |
| 1 | 0 | Individual address | Reserved |
| 1 | 0 | Broadcast address | TDD group BF with two or more STAs |
| 1 | 1 | Individual address | Reserved |
| 1 | 1 | Broadcast address | Reserved |

The TDD Beamforming Frame Type subfield is defined as shown in Table 9-29m.

### Table 9-29m—TDD Beamforming Frame Type subfield definition

| Value | Meaning |
|---|---|
| 0 | TDD SSW (Sector Sweep).<br><br>The TDD Beamforming Frame Type subfield is set to this value to indicate a TDD SSW frame (see 10.42.11). |
| 1 | TDD SSW Feedback.<br><br>The TDD Beamforming Frame Type subfield is set to this value to indicate a TDD SSW Feedback frame (see 10.42.11). |
| 2 | TDD SSW Ack.<br><br>The TDD Beamforming Frame Type subfield is set to this value to indicate a TDD SSW Ack frame (see 10.42.11). |
| 3 | Reserved |

The End of Training subfield is set as follows:

— The End of Training subfield is set to 1 in a TDD SSW frame to indicate that the initiator intends to end the TDD individual beamforming training or the TDD beam measurement after the transmission of the remaining TDD SSW frames with the current Sector ID; this subfield is set to 0 otherwise.

— The End of Training subfield is set to 1 in a TDD SSW Feedback frame sent as part of a TDD individual beamforming training if the TDD SSW Feedback frame is sent in response to a TDD SSW frame in which its End of Training subfield was set to 1; this subfield is set to 0 otherwise.

— The End of Training subfield is set to 1 in a TDD SSW Ack frame to indicate that the TDD individual beamforming training has completed; otherwise, this subfield is set to 0.

For TDD group BF, the End of Training subfield is reserved.

The definition of the TDD Beamforming Information field depends on the type of frame indicated by the TDD Beamforming Frame Type subfield and is specified in 9.3.1.25.2, 9.3.1.25.3, and 9.3.1.25.4.

The length of the TDD Beamforming Information field is 6 octets when the TDD Group Beamforming subfield is 0 and is $5 + 4 \times R$ octets otherwise, where $R$ is the number of target responders. The length of the TDD Beamforming Information field does not change during TDD group BF, even after beamforming training with one or more of target responders has completed. For the target responder that has completed beamforming training, the corresponding Responder Info subfield that has the Responder Info Valid subfield equal to 0 is reserved.

### 9.3.1.25.2 TDD SSW frame

The TDD Beamforming Information field of a TDD SSW frame when TDD individual BF is used is shown in Figure 9-64r. The TDD Beamforming Information field of a TDD SSW frame when TDD group BF is used is shown in Figure 9-64s. The TDD Beamforming Information field of a TDD SSW frame when TDD beam measurement is used is shown in Figure 9-64t.

| | B0 B8 | B9 B11 | B12 B14 | B15 B17 | B18 B25 | B26 B35 | B36 B45 | B46 B47 |
|---|---|---|---|---|---|---|---|---|
| | TX Sector ID | TX Antenna ID | Count Index | Beamforming Time Unit | Transmit Period | Responder Feedback Offset | Initiator Ack Offset | Number Of Requested Feedback |
| Bits: | 9 | 3 | 3 | 3 | 8 | 10 | 10 | 2 |

**Figure 9-64r—TDD Beamforming Information field format (TDD individual BF)**

| | B0 B8 | B9 B11 | B12 B14 | B15 B17 | B18 B25 | B26 B28 | B29 B36 | B37 B(37 + $N$×32 – 1) | B(37 + $N$×32) B(37 + $N$×32 + 2) |
|---|---|---|---|---|---|---|---|---|---|
| | TX Sector ID | TX Antenna ID | Count Index | Beamforming Time Unit | Transmit Period | Ack Count Index | Number of Responders | Responder Info List | Reserved |
| Bits: | 9 | 3 | 3 | 3 | 8 | 3 | 8 | $N$×32 | 3 |

**Figure 9-64s—TDD Beamforming Information field format (TDD group BF)**

| | B0 B8 | B9 B11 | B12 B14 | B15 B17 | B18 B25 | B26 B35 | B36 | B37 B47 |
|---|---|---|---|---|---|---|---|---|
| | TX Sector ID | TX Antenna ID | Count Index | Beamforming Time Unit | Transmit Period | TDD Slot CDOWN | Feedback Requested | Reserved |
| Bits: | 9 | 3 | 3 | 3 | 8 | 10 | 1 | 11 |

**Figure 9-64t—TDD Beamforming Information field format (TDD beam measurement)**

The TX Sector ID subfield is set to indicate the antenna sector through which the TDD SSW frame is transmitted.

NOTE—The size of sector ID fields in TDD beamforming frames are smaller than EDMG beamforming frames.

The TX Antenna ID subfield indicates the DMG antenna ID through which the TDD SSW frame is transmitted.

The Count Index subfield indicates the index of TDD Beamforming frames transmitted by the initiator within a TDD slot, with the subfield set to 0 for the first transmission and increased by one for each successive transmission within a TDD slot.

The Beamforming Time Unit (BTU) subfield is defined in Table 9-29n. The BTU subfield indicates the beamforming time unit for the Transmit Period, Responder Feedback Offset and Initiator Ack Offset subfields in the TDD Beamforming Information field of TDD SSW frames. The BTU subfield also defines the time unit for the Transmit Period, Initiator Transmit Offset and Responder Transmit Offset subfields in the TDD Beamforming Information field of TDD SSW Ack frames.

**Table 9-29n—Beamforming Time Unit subfield**

| Value | Time unit |
|---|---|
| 0 | 1 µsec |
| 1 | 100 µsec |
| 2 | 400 µsec |
| 3–7 | Reserved |

The Transmit Period subfield indicates the time interval, in units of BTUs, between TDD SSW transmissions with the same Count Index subfield value in different TDD slots. If the Transmit Period Offset subfield is 0, the transmission periodicity is unknown.

The Responder Feedback Offset subfield indicates the offset, in units of BTUs, from the beginning of the first TDD SSW frame in a TDD slot to when the first TDD SSW Feedback frame is to be transmitted by the responder. This subfield is reserved when the TDD SSW frame is transmitted exclusively for TDD beam measurement.

The Initiator Ack Offset subfield indicates the offset, in units of BTUs, from the beginning of the first TDD SSW frame in a TDD slot to when the first TDD SSW Ack frame is to be transmitted by the initiator. This subfield is reserved when the TDD SSW frame is transmitted exclusively for TDD beam measurement.

The Number Of Requested Feedback subfield indicates the number of TDD SSW Feedback frames the responder is required to transmit in response. Value of 0 indicates one frame to be sent, value of 1 indicates two frames and so on.

The Ack Count Index subfield indicates the number of the TDD SSW Ack frames that have been sent before the current TDD SSW frame within the same TDD slot. The Ack Count Index subfield is set to 0 if no TDD SSW Ack frame is transmitted before the current TDD SSW frame in the same TDD slot, and increases by one for each transmission of a TDD SSW Ack frame within the same TDD slot.

The Number of Responders subfield indicates the number of responders, *N*, with which the initiator intends to do TDD beamforming.

The Responder Info List subfield contains *N* Responder Info subfields. Each Responder Info subfield is defined in Figure 9-64u.

| | B0 B9 | B10 B19 | B20 B29 | B30 | B31 |
|---|---|---|---|---|---|
| | Responder ID | Responder Feedback Offset | Initiator Ack Offset | End of Training | Responder Info Valid |
| Bits: | 10 | 10 | 10 | 1 | 1 |

**Figure 9-64u—Responder Info subfield format**

The Responder ID subfield indicates the ID of the responder. The content of this subfield is derived from the responder's MAC address, based on the scheme in 10.42.11.4.

The Responder Feedback Offset subfield and the Initiator Ack Offset subfield are as defined above in this subclause.

The End of Training subfield set to 1 in the Responder Info subfield of a TDD SSW frame for TDD Group beamforming training indicates that the initiator intends to end the TDD beamforming training with the corresponding responder after the transmission of the remaining TDD SSW frames with the current Sector ID; this subfield is set to 0 otherwise.

The Responder Info Valid subfield is set to 1 to indicate that the Responder Info subfield values are valid and is set to 0 otherwise.

The TDD Slot CDOWN subfield is a down counter indicating the number of remaining TDD SP slots to the end of the TDD beam measurement. This subfield is set to 0 in the last TDD SSW frame transmission.

The Feedback Requested subfield set to 1 requests that the responder(s) send a TDD Route element to the initiator as a feedback to the TDD beam measurement.

### 9.3.1.25.3 TDD SSW Feedback frame

The TDD Beamforming Information field of a TDD SSW Feedback frame is shown in Figure 9-64v.

| | B0 B8 | B9 B11 | B12 B20 | B21 B23 | B24 B31 | B32 B33 | B34 B47 |
|---|---|---|---|---|---|---|---|
| | TX Sector ID | TX Antenna ID | Decoded TX Sector ID | Decoded TX Antenna ID | SNR Report | Feedback Count Index | Reserved |
| Bits: | 9 | 3 | 9 | 3 | 8 | 2 | 14 |

**Figure 9-64v—TDD Beamforming Information field format**

The TX Sector ID subfield is set to indicate the sector through which the TDD SSW Feedback frame is transmitted.

The TX Antenna ID subfield indicates the DMG antenna ID through which the TDD SSW Feedback frame is transmitted.

The Decoded TX Sector ID subfield contains the value of the TX Sector ID subfield from the TDD SSW frame that the feedback frame is sent in response to and that the TDD SSW frame was received from the initiator with the best quality.

The Decoded TX Antenna ID subfield contains the value of the TX Antenna ID subfield from the TDD SSW frame that the feedback frame is sent in response to and that was received with the best quality.

The SNR Report subfield is set to the value of the SNR achieved while decoding the TDD SSW frame received with the best quality and which is indicated in the Decoded TX Sector ID subfield. The value of the SNR Report subfield is an unsigned integer referenced to a level of –8 dB. Each step is 0.25 dB. SNR values less than or equal to –8 dB are represented as 0. SNR values greater than or equal to 55.75 dB are represented as 0xFF.

The Feedback Count Index subfield is counter indicating the index of the TDD SSW Feedback frame transmission during a TDD slot. Value 0 is used in the first transmitted TDD SSW Feedback frame and this subfield value is increased by 1 for each subsequent transmitted frame.

#### 9.3.1.25.4 TDD SSW Ack frame

The TDD Beamforming Information field of a TDD SSW Ack frame when TDD individual BF is used is shown in Figure 9-64w. The TDD Beamforming Information field of a TDD SSW Ack frame when TDD group BF is used is shown in Figure 9-64x.

| | B0 B8 | B9 B11 | B12 B14 | B15 B22 | B23 B30 | B31 B38 | B39 B46 | B47 |
|---|---|---|---|---|---|---|---|---|
| | Decoded TX Sector ID | Decoded TX Antenna ID | Count Index | Transmit Period | SNR Report | Initiator Transmit Offset | Responder Transmit Offset | Reserved |
| Bits: | 9 | 3 | 3 | 8 | 8 | 8 | 8 | 1 |

**Figure 9-64w—TDD Beamforming Information field format (TDD individual BF)**

| | B0 B8 | B9 B11 | B12 B14 | B15 B22 | B23 B30 | B31 B38 | B39 B46 | B47 B49 | B50 B55 |
|---|---|---|---|---|---|---|---|---|---|
| | Decoded TX Sector ID | Decoded TX Antenna ID | Count Index | Transmit Period | SNR Report | Initiator Transmit Offset | Responder Transmit Offset | Ack Count Index | Reserved |
| Bits: | 9 | 3 | 3 | 8 | 8 | 8 | 8 | 3 | 6 |

**Figure 9-64x—TDD Beamforming Information field format (TDD group BF)**

The Decoded TX Sector ID subfield contains the value of the TX Sector ID subfield from the TDD SSW Feedback frame that was received from the responder.

The Decoded TX Antenna ID subfield contains the value of the TX Antenna ID subfield from the TDD SSW Feedback frame that was received from the responder.

The Count Index subfield indicates the index of the TDD Beamforming frame transmitted by the initiator within a TDD slot, with the subfield set to 0 for the first frame transmission and increased by one for each successive frame transmission within a TDD slot.

The Transmit Period subfield is reserved when the End of Training subfield in the TDD SSW Ack frame is 0. Otherwise, it indicates the interval, in units of BTUs, between successive transmit opportunities for the initiator to transmit frames other than TDD Beamforming frames to the responder, and also between successive transmit opportunities for the responder to transmit frames other than TDD Beamforming frames to the initiator, after completion of the unscheduled beamforming procedure, as defined in 10.42.11.

The SNR Report subfield is set to the value of the SNR achieved while decoding the TDD SSW Feedback frame. The value of the SNR Report subfield is an unsigned integer referenced to a level of –8 dB. Each step is 0.25 dB. SNR values less than or equal to –8 dB are represented as 0. SNR values greater than or equal to 55.75 dB are represented as 0xFF.

The Initiator Transmit Offset subfield is reserved when the End of Training subfield in the TDD SSW Ack frame is 0. Otherwise, it indicates the offset, in units of BTUs, from the beginning of the first TDD Beamforming frame that is sent in the same TDD slot as the TDD SSW Ack frame (which can be the TDD SSW Ack frame itself), to the first transmit opportunity for the initiator to transmit a frame other than a TDD beamforming frame (i.e., a non-beamforming frame) to the responder. The Initiator Transmit Offset subfield is set to 0 to indicate that the initiator will transmit non-beamforming frames to the responder according to a TDD slot schedule available to the initiator and the responder.

The Responder Transmit Offset subfield is reserved when the End of Training subfield in the TDD SSW Ack frame is 0. Otherwise, it indicates the offset, in units of BTUs, from the beginning of the first TDD Beamforming frame that is sent in the same TDD slot as the TDD SSW Ack frame (which can be the TDD SSW Ack frame itself), to the first transmit opportunity for the responder to transmit a frame other than a TDD beamforming frame (i.e., a non-beamforming frame) to the initiator. The Responder Transmit Offset subfield is set to 0 to indicate that the responder will transmit non-beamforming frames to the initiator according to a TDD slot schedule available to the responder and the initiator.

The Ack Count Index subfield indicates the number of the TDD SSW Ack frames that have been sent before the current TDD SSW Ack frame within the same TDD slot. The Ack Count Index subfield is set to 0 if no TDD SSW Ack frame is transmitted before the current TDD SSW Ack frame in the same TDD slot, and increases by one for each transmission of a TDD SSW Ack frame within the same TDD slot.

### 9.3.3 (PV0) Management frames

#### 9.3.3.5 Association Request frame format

***Insert the following rows into Table 9-34 in numeric order:***

**Table 9-34—Association Request frame body**

| Order | Information | Notes |
|---|---|---|
| 51 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 52 | QoS Triggered Unscheduled | The QoS Triggered Unscheduled element is optionally present if dot11EDMGOptionImplemented is true. |
| 53 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 54 | TDD Slot Schedule | The TDD Slot Schedule element is optionally present if dot11DMGOptionImplemented is true. |
| 55 | TDD Route | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD beamforming results. |

#### 9.3.3.6 Association Response frame format

***Insert the following rows into Table 9-35 in numeric order:***

**Table 9-35—Association Response frame body**

| Order | Information | Notes |
|---|---|---|
| 67 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 68 | EDMG Operation | The EDMG Operation element is present if dot11EDMGOptionImplemented is true. |
| 69 | QoS Triggered Unscheduled | The QoS Triggered Unscheduled element is optionally present if dot11EDMGOptionImplemented is true. |
| 70 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 71 | TDD Slot Structure | The TDD Slot Structure element is optionally present if dot11DMGOptionImplemented is true. |
| 72 | TDD Slot Schedule | The TDD Slot Schedule element is optionally present if dot11DMGOptionImplemented is true. |
| 73 | TDD Route | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD sector switch configuration. |

#### 9.3.3.7 Reassociation Request frame format

***Insert the following rows into Table 9-36 in numeric order:***

**Table 9-36—Reassociation Request frame body**

| Order | Information | Notes |
|---|---|---|
| 55 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 56 | QoS Triggered Unscheduled | The QoS Triggered Unscheduled element is optionally present if dot11EDMGOptionImplemented is true. |
| 57 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 58 | TDD Slot Schedule | The TDD Slot Schedule element is optionally present if dot11DMGOptionImplemented is true. |
| 59 | TDD Route | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD beamforming results. |

### 9.3.3.8 Reassociation Response frame format

***Insert the following rows into Table 9-37 in numeric order:***

**Table 9-37—Reassociation Response frame body**

| Order | Information | Notes |
|---|---|---|
| 70 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 71 | EDMG Operation | The EDMG Operation element is present if dot11EDMGOptionImplemented is true. |
| 72 | QoS Triggered Unscheduled | The QoS Triggered Unscheduled element is optionally present if dot11EDMGOptionImplemented is true. |
| 73 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 74 | TDD Slot Structure | The TDD Slot Structure element is optionally present if dot11DMGOptionImplemented is true. |
| 75 | TDD Slot Schedule | The TDD Slot Schedule element is optionally present if dot11DMGOptionImplemented is true. |
| 76 | TDD Route | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD sector switch configuration. |

### 9.3.3.9 Probe Request frame format

***Insert the following rows into Table 9-38 in numeric order:***

**Table 9-38—Probe Request frame body**

| Order | Information | Notes |
|---|---|---|
| 39 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 40 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |

#### 9.3.3.10 Probe Response frame format

***Insert the following rows into Table 9-39 in numeric order:***

**Table 9-39—Probe Response frame body**

| Order | Information | Notes |
|---|---|---|
| 106 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 107 | EDMG Operation | The EDMG Operation element is present if dot11EDMGOptionImplemented is true. |
| 108 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |

### 9.3.4 Extension frames

#### 9.3.4.2 DMG Beacon

***Insert the following row into Table 9-45 in numeric order:***

**Table 9-45—DMG Beacon frame body**

| Order | Information | Notes |
|---|---|---|
| 56 | TDD Slot Structure | This element is optionally present if dot11TDDOptionImplemented is true. |
| 57 | TDD Slot Schedule | This element is optionally present if dot11TDDOptionImplemented is true. |
| 58 | EDMG Capabilities | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 59 | EDMG Operation | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 60 | EDMG Extended Schedule | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 61 | EDMG Group ID Set | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 62 | EDMG Training Field Schedule | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 63 | Time Advertisement | This element is optionally present if dot11UTCTSFOffsetActivated is true. |

***Change the sixth paragraph and Figure 9-77 in 9.3.4.2 as follows:***

The format of the Beacon Interval Control field when the Next A-BFT subfield is 0 is shown in Figure 9-77. The format of the Beacon Interval Control field when the Next A-BFT subfield is nonzero is shown in Figure 9-77a. The difference between the two formats is in the definition of the field occupying B14.

| | B0 | B1 | B2 B5 | B6 | B7 B9 | B10 B13 | B14 | B15 B18 |
|---|---|---|---|---|---|---|---|---|
| | CC Present | Discovery Mode | Next Beacon | ATI Present | A-BFT Length | FSS | IsResponderTXSS | Next A-BFT |
| Bits: | 1 | 1 | 4 | 1 | 3 | 4 | 1 | 4 |

| | B19 | B20 B26 | B27 B30 | B31 B36 | B37 B42 | B43 | B44 B45 | B46 B47 | ~~B44 B47~~ |
|---|---|---|---|---|---|---|---|---|---|
| | Fragmented TXSS | TXSS Span | N BIs A-BFT | A-BFT Count | N A-BFT in Ant | PCP Association Ready | A-BFT Multiplier | A-BFT in Secondary Channel | ~~Reserved~~ |
| Bits: | 1 | 7 | 4 | 6 | 6 | 1 | 2 | 2 | ~~4~~ |

**Figure 9-77—Beacon Interval Control field format when Next A-BFT subfield is 0**

***Insert Figure 9-77a into 9.3.4.2 after Figure 9-77:***

| | B0 | B1 | B2 B5 | B6 | B7 B9 | B10 B13 | B14 | B15 B18 |
|---|---|---|---|---|---|---|---|---|
| | CC Present | Discovery Mode | Next Beacon | ATI Present | A-BFT Length | FSS | Unsolicited RSS Enabled | Next A-BFT |
| Bits: | 1 | 1 | 4 | 1 | 3 | 4 | 1 | 4 |

| | B19 | B20 B26 | B27 B30 | B31 B36 | B37 B42 | B43 | B44 B45 | B46 B47 |
|---|---|---|---|---|---|---|---|---|
| | Fragmented TXSS | TXSS Span | N BIs A-BFT | A-BFT Count | N A-BFT in Ant | PCP Association Ready | A-BFT Multiplier | A-BFT in Secondary Channel |
| Bits: | 1 | 7 | 4 | 6 | 6 | 1 | 2 | 2 |

**Figure 9-77a—Beacon Interval Control field format when the Next A-BFT subfield is nonzero**

***Change the 12th and 13th paragraphs in 9.3.4.2 as follows:***

The FSS subfield indicates the number of SSW frames or Short SSW PPDUs allowed per sector sweep slot (10.38.5). The subfield contains the number of SSW frames allowed minus one. The range of this subfield is 0 to 15.

The IsResponderTXSS subfield is present when the Next A-BFT subfield is 0. The IsResponderTXSS is set to 1 to indicate the A-BFT following the BTI is used for responder transmit sector sweep (TXSS). This field is set to 0 to indicate responder receive sector sweep (RXSS). When this subfield is set to 0, the FSS subfield specifies the length of a complete receive sector sweep by the STA sending the DMG Beacon frame.

***Insert the following paragraph into 9.3.4.2 after the 13th paragraph:***

The Unsolicited RSS Enabled subfield is present when the Next A-BFT subfield is nonzero. The Unsolicited RSS Enabled subfield is set to 1 to indicate that the STA is capable of receiving an unsolicited RSS in response to its BTI. This subfield is set to 0 otherwise. This subfield is ignored when received by a non-EDMG STA or when received from a non-EDMG STA.

***Insert the following paragraphs into 9.3.4.2 after the now 21st paragraph ("The PCP Association Ready subfield ....")***

The A-BFT Multiplier subfield allows expanding the total length of the A-BFT. The total length of the A-BFT is equal to the value of the A-BFT Length subfield plus the multiplication of the value of the A-BFT Multiplier subfield and the value of the A-BFT Length subfield. This subfield is reserved if the value of the Next A-BFT subfield is nonzero.

The A-BFT in Secondary Channel subfield indicates that the A-BFT is allocated on an adjacent secondary channel, in addition to being allocated on the primary channel. If set to 0, the A-BFT is not allocated on any secondary channel. If set to a nonzero value, the A-BFT is allocated on an adjacent secondary channel as follows:

— If set to 1, the A-BFT is also present on the lower secondary channel adjacent to the primary channel.
— If set to 2, the A-BFT is also present on the upper secondary channel adjacent to the primary channel.
— If set to 3, the A-BFT is also present on both the lower and upper secondary channels adjacent to the primary channel.

The A-BFT in Secondary Channel subfield is reserved if the value of the Next A-BFT subfield is nonzero.

## 9.4 Management and Extension frame body components

### 9.4.1 Fields that are not elements

#### 9.4.1.4 Capability Information field

***Change the third paragraph in 9.4.1.4 as follows:***

A DMG STA sets the Triggered Unscheduled PS subfield to 1 within the Capability Information field when it transmits a Capability Information field in which the Reverse Direction subfield is equal to 1 and is capable of delivering a BU as an RD responder on receipt of a PPDU containing an RDG MPDU with the Power Management subfield set to 1 and sets it to 0 otherwise. An EDMG AP always sets the Triggered Unscheduled PS subfield to 1.

#### 9.4.1.7 Reason Code field

***Insert the following row into Table 9-49 in numeric order, and change the related Reserved row accordingly:***

**Table 9-49—Reason codes**

| Reason code | Name | Meaning |
|---|---|---|
| 69 | TIME_SYNC_LOST | The STA is not able to maintain TSF. |

### 9.4.1.14 Block Ack Timeout Value field

***Change the first paragraph in 9.4.1.14 as follows:***

The Block Ack Timeout Value field is used in the ADDBA Request and Response frames and the Unsolicited Block Ack Extension element to indicate the timeout value for Block Ack. The length of the Block Ack Timeout Value field is 2 octets. The Block Ack Timeout Value field is illustrated in Figure 9-97.

### 9.4.1.46 DMG Parameters field

***Change Figure 9-133 as follows:***

| | B0 B1 | B2 | B3 | B4 | B5 | B6 | ~~B6~~ B7 |
|---|---|---|---|---|---|---|---|
| | BSS Type | CBAP Only | CBAP Source | DMG Privacy | ECAPC Policy Enforced | EDMG Supported | Reserved |
| Bits: | 2 | 1 | 1 | 1 | 1 | 1 | 1 ~~2~~ |

**Figure 9-133—DMG Parameters field format**

***Insert the following paragraph at the end of 9.4.1.46:***

The EDMG Supported subfield is set to 1 when transmitted by an EDMG STA. Otherwise, it is set to 0.

### 9.4.2 Elements

### 9.4.2.1 General

***Insert the following rows into Table 9-92 in numeric order, and change the related Reserved row accordingly:***

**Table 9-92—Element IDs**

| Element | Element ID | Element ID Extension | Extensible | Fragmentable |
|---|---|---|---|---|
| EDMG Capabilities (see 9.4.2.265) | 255 | 61 | Yes | No |
| EDMG Operation (see 9.4.2.266) | 255 | 62 | Yes | No |
| EDMG Extended Schedule (see 9.4.2.267) | 255 | 63 | Yes | No |
| EDMG Channel Measurement Feedback (see 9.4.2.268) | 255 | 64 | Yes | No |
| EDMG Group ID Set (see 9.4.2.269) | 255 | 65 | Yes | No |
| EDMG BRP Request (see 9.4.2.270) | 255 | 66 | Yes | No |
| EDMG Training Field Schedule (see 9.4.2.271) | 255 | 67 | Yes | No |
| EDMG Partial Sector Level Sweep (see 9.4.2.272) | 255 | 68 | Yes | No |
| MIMO Setup Control (see 9.4.2.273) | 255 | 69 | Yes | No |
| MIMO Poll Control (see 9.4.2.274) | 255 | 70 | Yes | No |

**Table 9-92—Element IDs *(continued)***

| Element | Element ID | Element ID Extension | Extensible | Fragmentable |
|---|---|---|---|---|
| MIMO Feedback Control (see 9.4.2.275) | 255 | 71 | Yes | No |
| MIMO Selection Control (see 9.4.2.276) | 255 | 72 | Yes | No |
| EDMG Flow Control Extension Configuration (see 9.4.2.277) | 255 | 73 | Yes | No |
| QoS Triggered Unscheduled (see 9.4.2.278) | 255 | 74 | Yes | No |
| Unsolicited Block Ack Extension (see 9.4.2.279) | 255 | 75 | Yes | No |
| SAR Configuration (see 9.4.2.280) | 255 | 76 | Yes | No |
| TDD Slot Structure (see 9.4.2.281) | 255 | 77 | Yes | No |
| TDD Slot Schedule (see 9.4.2.282) | 255 | 78 | Yes | No |
| TDD Route (see 9.4.2.283) | 255 | 79 | Yes | No |
| Digital BF Feedback (see 9.4.2.284) | 255 | 80 | Yes | No |
| TDD Bandwidth Request (see 9.4.2.285) | 255 | 81 | Yes | No |
| TDD Synchronization (see 9.4.2.286) | 255 | 82 | Yes | No |
| EDMG Wide Bandwidth Channel Switch (see 9.4.2.287) | 255 | 83 | Yes | No |
| DMG Discovery Assistance (see 9.4.2.288) | 255 | 84 | Yes | No |
| Extended Link Measurement (see 9.4.2.289) | 255 | 85 | Yes | No |
| DMG STA Directional Transmit Activity Report (see 9.4.2.290) | 255 | 86 | Yes | No |

### 9.4.2.20 Measurement Request element

#### 9.4.2.20.16 Directional Channel Quality request

***Change the first paragraph in 9.4.2.20.16 as follows (Figure 9-216 remains unchanged):***

The Measurement Request field corresponding to a Directional Channel Quality request is shown in Figure 9-216. This Measurement Request is transmitted from a Requesting STA to a Requested STA to perform measurements toward a Target STA (see 11.30).

***Change the fifth paragraph in 9.4.2.20.16 as follows:***

The Measurement Method field indicates the method that is to be used by the Requested STA to carry out this measurement request and report back in the measurement report. If this field is set to 0, it indicates ANIPI. If this field is set to 1, it indicates RSNI. If this field is set to 2, it indicates ANIPI during the duration of the requested measurement, in units of 1 µs. If this field is set to 3, it indicates RSNI during the duration of the requested measurement, in units of 1 µs. Other values are reserved.

***Change the seventh paragraph in 9.4.2.20.16 as follows:***

If the Measurement Method field is not 2 or 3, t~~T~~he Measurement Duration field is set to the preferred or mandatory duration of the requested measurement, in units of TUs. See 11.10.4. If the Measurement Method field is 2 or 3, the Measurement Duration field is set to the duration of the requested measurement, in units of 1 µs (TU/1024).

***Change Table 9-120 as follows:***

**Table 9-120—Optional subelement IDs for Directional Channel Quality request**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Reserved | |
| 1 | Directional Channel Quality Reporting | Yes |
| 2 | Measurement Configuration | Yes |
| 3 | Extended Measurement Configuration | Yes |
| ~~2~~ 4–220 | Reserved | |
| 221 | Vendor Specific | Vendor defined |
| 222–255 | Reserved | |

***Insert the following paragraphs and Figure 9-217a through Figure 9-217d into 9.4.2.20.16 before the last paragraph ("The Vendor Specific subelements ...."):***

The Measurement Configuration subelement indicates measurement configuration information for which the measurement request applies and is used between a pair of EDMG STAs. The Data field of the Measurement Configuration subelement is formatted as shown in Figure 9-217a.

| | B0 B7 | B8 | B9 | B10 | B11 B15 |
|---|---|---|---|---|---|
| | Measurement Channel Bitmap | Channel Measurement Report Method | Antenna Measurement Report Method | RX Antenna Configuration Type | Reserved |
| Bits: | 8 | 1 | 1 | 1 | 5 |

**Figure 9-217a—Data field of the Measurement Configuration subelement format**

The Measurement Channel Bitmap subfield is a bitmap that indicates the 2.16 GHz channel(s) to which the measurement request applies and is formatted as shown in Figure 9-217b. In Figure 9-217b, Ch1 subfield corresponds to channel 1, Ch2 subfield corresponds to channel 2 and so on (channels are defined in Annex E). If a subfield is set to 1, the measurement request applies to the indicated channel; otherwise, if the subfield is set to 0, the measurement request does not apply to the indicated channel.

| | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|---|---|---|
| | Ch1 | Ch2 | Ch3 | Ch4 | Ch5 | Ch6 | Ch7 | Ch8 |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-217b—Measurement Channel Bitmap subfield format**

The Channel Measurement Report Method subfield indicates the method that is to be used by the Requested STA to report the results of measurements over multiple 2.16 GHz channels in the measurement report. The Channel Measurement Report Method subfield sets to 0 to indicate the results of measurements over all the requested 2.16 GHz channels during each measurement time block are reported per 2.16 GHz channel. The Channel Measurement Report Method subfield sets to 1 to indicate the averaged results of concurrent measurements over all the requested 2.16 GHz channels during each measurement time block are reported. The Channel Measurement Report Method subfield is set to 0 when the Extended Measurement Configuration subelement is present.

The Antenna Measurement Report Method subfield indicates the method that is to be used by the Requested STA to report the results of concurrent measurements using multiple RX DMG antennas in the measurement report. The Antenna Measurement Report Method subfield is set to 0 to indicate the results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported per DMG antenna. The Antenna Measurement Report Method subfield is set to 1 to indicate the averaged results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported.

The RX Antenna Configuration Type subfield is set to 0 to request that the RX antenna configuration used for SISO reception be used for measurements, and is set to 1 to request that the RX antenna configuration used for SU-MIMO reception be used for measurements.

The Extended Measurement Configuration subelement is present if the Measurement Configuration subelement is present. The Extended Measurement Configuration subelement contains measurement timing information for the channels indicated in the Measurement Configuration subelement. If the Extended Measurement Configuration subelement is not present, the measurement timing information indicated in the Measurement Request field applies to all requested channels. If the Extended Measurement Configuration subelement is present, the measurement timing information indicated in the Measurement Request field applies to the first requested channel (i.e., the requested channel with the lowest channel number) and measurement timing information indicated in the Extended Measurement Configuration subelement applies to the remaining requested channels in ascending order in terms of channel number. The Data field of the Extended Measurement Configuration subelement is formatted as shown in Figure 9-217c.

| | Measurement Request Info List |
|---|---|
| Octets: | $(N_{ch} - 1) \times 11$ |

**Figure 9-217c—Data field of the Extended Measurement Configuration subelement format**

The Measurement Request Info List field contains $(N_{ch} - 1)$ Measurement Request Info subfields, where $N_{ch}$ is the total number of the requested channels. Each Measurement Request Info subfield is defined in Figure 9-217d.

| | Measurement Start Time for $i^{th}$ Requested Channel | Measurement Duration for $i^{th}$ Requested Channel | Number of Time Blocks for $i^{th}$ Requested Channel |
|---|---|---|---|
| Octets: | 8 | 2 | 1 |

**Figure 9-217d—Measurement Request Info subfield format**

The measurement timing information for the $i^{th}$ requested channel is indicated in the Measurement Start Time for $i^{th}$ Requested Channel subfield, the Measurement Duration subfield for $i^{th}$ Requested Channel and Number of Time Blocks for $i^{th}$ Requested Channel subfield, where $i = 2, 3, \ldots, N_{ch}$. The definition of these subfields is the same as the corresponding subfields in the Measurement Request field (Figure 9-216).

### 9.4.2.20.17 Directional Measurement request

*Change Figure 9-218 as follows:*

| | Operating Class | Channel Number | Measurement Start Time | Measurement Duration per Direction | Measurement Method And Antenna Configuration | Optional Subelements |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 8 | 2 | 1 | Variable |

**Figure 9-218—Measurement Request field format for Directional Measurement request**

***Insert the following paragraph and Figure 9-218a into 9.4.2.20.17 after the fifth paragraph ("The Measurement Duration per Direction field ...."):***

The Measurement Method And Antenna Configuration field is defined in Figure 9-218a.

| | B0 B2 | B3 B4 | B5 B7 |
|---|---|---|---|
| | Measurement Method | Antenna Configuration | Reserved |
| Bits: | 3 | 2 | 3 |

**Figure 9-218a—Measurement Method And Antenna Configuration field format**

***Change the now seventh paragraph in 9.4.2.20.17 as follows:***

The Measurement Method subfield indicates the method that is to be used by the Requested STA to carry out this measurement request and report back in the measurement report. If this subfield is set to 0, it indicates ANIPI. If this subfield is set to 1, it indicates RCPI. If the subfield is set to 2, it indicates Channel Load. Other values are reserved.

***Insert the following paragraph into 9.4.2.20.17 after the now seventh paragraph:***

The Antenna Configuration subfield indicates the configuration of the DMG antenna(s) used by the STA to carry out the measurement. If this subfield is set to 1, it indicates a quasi-omni antenna pattern. If this subfield is set to 2, it indicates directional antenna pattern. Other values are reserved.

### 9.4.2.21 Measurement Report element

### 9.4.2.21.15 Directional Channel Quality report

***Change the fifth paragraph in 9.4.2.21.15 as follows:***

The Measurement Method field indicates the method used by the STA to carry out this measurement request and the format of the Measurement for Time Block field(s). If this field is set to 0, it indicates that the Measurement for Time Block fields are expressed in ANIPI. If this field is set to 1, it indicates that the Measurement for Time Block fields are expressed in RSNI. If this field is set to 2, it indicates that the Measurement for Time Block fields are expressed in ANIPI during the duration of the requested measurement, in units of 1 µs. If this field is set to 3, it indicates that the Measurement for Time Block fields are expressed in RSNI during the duration of the requested measurement, in units of 1 µs. Other values are reserved.

***Change the seventh paragraph in 9.4.2.21.15 as follows:***

If the Measurement Method field is not 2 or 3, t~~T~~he Measurement Duration field is set to the duration of the measurement, in units of TUs. If the Measurement Method field is 2 or 3, the Measurement Duration field is set to the duration of the requested measurement, in units of 1 µs (TU/1024).

***Change Table 9-144 as follows:***

**Table 9-144—Optional subelement IDs for Directional Channel Quality report**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Measurement Configuration | Yes |
| 1 | Extended Measurement Configuration | Yes |
| 2 | Extended Measurement Report | Yes |
| ~~0~~ 3–220 | Reserved | |
| 221 | Vendor Specific | Vendor defined |
| 222–255 | Reserved | |

***Insert the following paragraphs and Figure 9-277a through Figure 9-277g into 9.4.2.21.15 before the last paragraph ("The Vendor Specific subelements ...."):***

The Measurement Configuration subelement indicates measurement configuration information for which the measurement report applies and is used between a pair of EDMG STAs. The Data field of the Measurement Configuration subelement is formatted as shown in Figure 9-277a.

| | B0 B7 | B8 | B9 | B10 | B11 B15 |
|---|---|---|---|---|---|
| | Measurement Channel Bitmap | Channel Measurement Report Method | Antenna Measurement Report Method | RX Antenna Configuration Type | Reserved |
| Bits: | 8 | 1 | 1 | 1 | 5 |

**Figure 9-277a—Data field of the Measurement Configuration subelement format**

The Measurement Channel Bitmap subfield is a bitmap that indicates the 2.16 GHz channel(s) to which the measurement report applies and is formatted as shown in Figure 9-277b. In Figure 9-277b, Ch1 subfield corresponds to channel 1, Ch2 subfield corresponds to channel 2 and so on (channels are defined in Annex E). If a subfield is set to 1, the measurement report applies to the indicated channel; otherwise, if the subfield is set to 0, the measurement report does not apply to the indicated channel.

| | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|---|---|---|
| | Ch1 | Ch2 | Ch3 | Ch4 | Ch5 | Ch6 | Ch7 | Ch8 |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-277b—Measurement Channel Bitmap subfield format**

The Channel Measurement Report Method subfield indicates the method that is to be used by the Reporting STA to report the results of measurements over multiple 2.16 GHz channels in the measurement report. The

Channel Measurement Report Method subfield sets to 0 to indicate the results of measurements over all the requested 2.16 GHz channels during each measurement time block are reported per 2.16 GHz channel. The Channel Measurement Report Method subfield sets to 1 to indicate the averaged results of concurrent measurements over all the requested 2.16 GHz channels during each measurement time block are reported. The Channel Measurement Report Method subfield is set to 0 when the Extended Measurement Configuration subelement is present.

The Antenna Measurement Report Method subfield indicates the method that is to be used by the Reporting STA to report the results of concurrent measurements using multiple RX DMG antennas in the measurement report. The Antenna Measurement Report Method subfield is set to 0 to indicate the results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported per DMG antenna. The Antenna Measurement Report Method subfield is set to 1 to indicate the averaged results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported.

The RX Antenna Configuration Type subfield is set to 0 to indicate that the RX antenna configuration used for SISO reception is used for measurements, and is set to 1 to indicate that the RX antenna configuration used for SU-MIMO reception is used for measurements.

The Extended Measurement Configuration subelement is present if the Measurement Configuration subelement is present. The Extended Measurement Configuration subelement contains measurement timing information for the channels indicated in the Measurement Configuration subelement. If the Extended Measurement Configuration subelement is not present, the measurement timing information indicated in the Measurement Report field applies to all reported channels. If the Extended Measurement Configuration subelement is present, the measurement timing information indicated in the Measurement Report field applies to the first reported channel (i.e., the reported channel with the lowest channel number) and measurement timing information indicated in the Extended Measurement Configuration subelement applies to the remaining reported channels in ascending order in terms of channel number. The Data field of the Extended Measurement Configuration subelement is formatted as shown in Figure 9-277c.

| | Measurement Report Info List |
|---|---|
| Octets: | $(N_{ch} - 1)\times 11$ |

**Figure 9-277c—Data field of the Extended Measurement Configuration subelement format**

The Measurement Report Info List field contains $(N_{ch} - 1)$ Measurement Report Info subfields, where $N_{ch}$ is the total number of reported channels. Each Measurement Report Info subfield is defined in Figure 9-277d.

| | Measurement Start Time for $i^{th}$ Reported Channel | Measurement Duration for $i^{th}$ Reported Channel | Number of Time Blocks for $i^{th}$ Reported Channel |
|---|---|---|---|
| Octets: | 8 | 2 | 1 |

**Figure 9-277d—Measurement Report Info subfield format**

The measurement timing information for the $i^{th}$ reported channels is indicated in the Measurement Start Time for $i^{th}$ Reported Channel subfield, the Measurement Duration for $i^{th}$ Reported Channel subfield and Number of Time Blocks for $i^{th}$ Reported Channel subfield, where $i = 2, 3, \ldots, N_{ch}$. The definition of these subfields is the same as the corresponding subfields in Measurement Report field (Figure 9-277).

The Extended Measurement Report subelement contains supplementary results of measurements performed by an EDMG STA over multiple 2.16 GHz channels using multiple RX DMG antennas. The format of the

Extended Measurement Report data field depends on the values of the Channel Measurement Report Method subfield and the Antenna Measurement Report Method subfield. When both the Channel Measurement Report Method subfield and the Antenna Measurement Report Method subfield are 0, the results of measurements over the first 2.16 GHz channel using the first RX DMG antenna are carried in the Measurement for Time Blocks fields and the remaining results of measurements are carried in the Extended Measurement Report subelement. The Extended Measurement Report subelement data field format when both the Channel Measurement Report Method subfield and the Antenna Measurement Report Method subfield are 0 is shown in Figure 9-277e. The Number of RX Antennas for the $j^{th}$ Reported Channel field ($j = 1, 2, \ldots, N_{ch}$) indicates the number of RX DMG antennas used by the reporting EDMG STA to perform measurements on the $j^{th}$ reported channel. The Measurement Results for 1st Reported Channel field consists of N1 Measurement for Time Block subfields for each of $N_{RX}$,1 RX DMG antennas excluding the first RX DMG antenna. The Measurement Results for $j^{th}$ Reported Channel field ($j = 2, 3, \ldots, N_{ch}$) consists of Nj Measurement for Time Block subfields for each of $N_{RX,j}$ RX DMG antenna.

| | Number of RX Antennas for 1st Reported Channel ($N_{RX,1}$) | Measurement Results for 1st Reported Channel | Number of RX Antennas for 2nd Reported Channel ($N_{RX,2}$) | Measurement Results for 2nd Reported channel | … | Number of RX Antennas for $N_{ch}^{th}$ Reported Channel ($N_{RX,Nch}$) | Measurement Results for $N_{ch}^{th}$ Reported channel |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | $N_1 \times (N_{RX,1}-1)$ | 1 | $N_2 \times N_{RX,2}$ | | 1 | $N_{Nch} \times N_{RX,Nch}$ |

**Figure 9-277e—Extended Measurement Report data field format when both the Channel Measurement Report Method subfield and the Antenna Measurement Report Method subfield are set to 0**

When the Channel Measurement Report Method subfield is 0 and the Antenna Measurement Report Method subfield is 1, the results of measurements over the first 2.16 GHz channel using multiple RX DMG antennas are carried in the Measurement for Time Blocks fields and the remaining results of measurements are carried in the Extended Measurement Report subelement. The Extended Measurement Report subelement data field format when the Channel Measurement Report Method subfield is 0 and the Antenna Measurement Report Method subfield is 1 is shown in Figure 9-277f. The Measurement Results for $j^{th}$ Requested Channel field ($j = 2, 3, \ldots, N_{ch}$) consists of Nj Measurement for Time Block subfields.

| | Measurement Results for 2nd Reported Channel | Measurement Results for 3rd Reported Channel | … | Measurement Results for $N_{ch}^{th}$ Reported Channel |
|---|---|---|---|---|
| Octets: | $N2$ | $N3$ | | $N_{Nch}$ |

**Figure 9-277f—Extended Measurement Report data field format when the Channel Measurement Report Method subfield is set to 0 and the Antenna Measurement Report Method subfield is set to 1**

When the Channel Measurement Report Method subfield is 1 and the Antenna Measurement Report Method subfield is 0, the results of measurements over multiple 2.16 GHz channels using the first RX DMG antenna are carried in the Measurement for Time Blocks fields and the remaining results of measurements are carried in the Extended Measurement Report subelement. The Extended Measurement Report subelement data field format when the Channel Measurement Report Method subfield is 1 and the Antenna Measurement Report Method subfield is 0 as shown in Figure 9-277g.

When the Channel Measurement Report Method subfield is 1 and the Antenna Measurement Report Method subfield is 1, the results of measurements over multiple 2.16 GHz channels using multiple RX DMG antennas are completely carried in the Measurement for Time Blocks fields.

| | Number of Rx Antennas (NRX) | Measurement Results for 2nd RX DMG Antenna | Measurement Results for 3rd RX DMG Antenna | … | Measurement Results for NRX RX DMG Antenna |
|---|---|---|---|---|---|
| Octets: | 1 | *N* | *N* | | *N* |

**Figure 9-277g—Extended Measurement Report data field format when the Channel Measurement Report Method subfield is set to 1 and the Antenna Measurement Report Method subfield is set to 0**

### 9.4.2.21.16 Directional Measurement report

***Change Figure 9-278 as follows:***

| | Operating Class | Channel Number | Measurement Start Time | Measurement Duration per Direction | Measurement Method <u>And Antenna Configuration</u> | Measurement Results | Optional Subelements |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 8 | 2 | 1 | Variable | Variable |

**Figure 9-278—Measurement Report field format for Directional Measurement report**

***Insert the following paragraph and Figure 9-278a into 9.4.2.21.16 after the fifth paragraph ("The Measurement Duration per Direction field ...."):***

The Measurement Method And Antenna Configuration field is defined in Figure 9-278a.

| | B0 B2 | B3 B4 | B5 B7 |
|---|---|---|---|
| | Measurement Method | Antenna Configuration | Reserved |
| Bits: | 3 | 2 | 3 |

**Figure 9-278a—Measurement Method And Antenna Configuration field format**

***Change the now seventh paragraph in 9.4.2.21.16 as follows:***

The Measurement Method <u>sub</u>field indicates the method used by the STA to carry out the measurement request and the format of values in the Measurement for Direction fields. <u>The Measurement Method subfield is defined in Table 9-144a.</u> ~~If this field is set to 0, it indicates that the values in the Measurement for Direction fields are expressed in ANIPI. If this field is set to 1, it indicates that the values in the Measurement for Direction fields are expressed in RCPI. If this field is set to 2, it indicates that the values in the Measurement for Direction fields are expressed in Channel Load. Other values are reserved.~~

***Insert Table 9-144a and the subsequent paragraph into 9.4.2.21.16 after the now seventh paragraph:***

**Table 9-144a—Measurement Method subfield definition**

| Measurement Method subfield value | Definition |
|---|---|
| 0 | Values in the Measurement for Direction fields are expressed in ANIPI as defined in 9.4.2.21.15. |
| 1 | Values in the Measurement for Direction fields are expressed in RCPI as defined in 9.4.2.37. |
| 2 | Values in the Measurement for Direction fields are expressed in Channel Load as defined in 11.11.9.3. |
| 3–7 | Reserved. |

The Antenna Configuration subfield indicates the configuration of the DMG antenna(s) used by the STA to carry out the measurement. If this subfield is set to 1, it indicates a quasi-omni antenna pattern. If this subfield is set to 2, it indicates a directional antenna pattern. Other values are reserved.

***Change the now 12th paragraph in 9.4.2.21.16 as follows:***

Each Measurement for Direction field is set to the format of values specified in the Measurement Method subfield.

***Insert the following paragraph into 9.4.2.21.16 after the now 12th paragraph:***

If the Antenna Configuration subfield is equal to 2, the Measurement for Direction 1 subfield contains the measurement results corresponding to the direction the reporting STA uses to receive frames from the requesting STA.

### 9.4.2.52 Extended Capabilities element

***Change the fifth paragraph in 9.4.2.52 as follows:***

If transmitted by a STA that is not an EDMG STA, t~~T~~he New Channel Number field is set to the number of the channel after the channel switch. The channel number is a channel from the STA's new operating class as defined in Annex E. If transmitted by an EDMG STA, the New Channel Number field is set to the channel number of the primary channel after the channel switch. The channel number is a channel from the STA's new operating class as defined in Annex E.

### 9.4.2.127 DMG Capabilities element

### 9.4.2.127.1 General

***Change Figure 9-549 as follows:***

| | Element ID | Length | STA Address | AID | DMG STA Capability Information | DMG AP Or PCP Capability Information | DMG STA Beam Tracking Time Limit |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 6 | 1 | 8 | 2 | 2 |

| | Extended SC MCS Capabilities | Maximum Number Of Basic A-MSDU Subframes In A-MSDU | Maximum Number Of Short A-MSDU Subframes In A-MSDU | TDD Capability Information | SAR Capability Information | Extended MPDU Capability |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 1 | 2 |

**Figure 9-549—DMG Capabilities element format**

### 9.4.2.127.2 DMG STA Capability Information field

***Change Figure 9-550 as follows:***

| | B0 | B1 | B2 | B3 | B4 B5 | B6 | B7 B13 |
|---|---|---|---|---|---|---|---|
| | Reverse Direction | Higher Layer Timer Synchronization | TPC | SPSH and Interference Mitigation | Number of RX DMG Antennas | Fast Link Adaptation | Total Number of Sectors |
| Bits: | 1 | 1 | 1 | 1 | 2 | 1 | 7 |

| | B14 B19 | B20 | B21 B26 | B27 | B28 B51 | B52 | B53 |
|---|---|---|---|---|---|---|---|
| | RXSS Length | DMG Antenna Reciprocity | A-MPDU Parameters | BA with Flow Control | Supported MCS Set | Reserved | A-PPDU Supported |
| Bits: | 6 | 1 | 6 | 1 | 24 | 1 | 1 |

| | B54 | B55 | B56 | B57 B59 | B60 | B61 | B62 | B63 |
|---|---|---|---|---|---|---|---|---|
| | Heartbeat | Supports Other_AID | Antenna Pattern Reciprocity | Heartbeat Elapsed Indication | Grant Ack Supported | RXSSTxRate Supported | EPD | Extended TPC Rx Supported ~~Reserved~~ |
| Bits: | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 |

**Figure 9-550—DMG STA Capability Information field format**

***Insert the following paragraph at the end of 9.4.2.127.2:***

The Extended TPC Rx Supported subfield is set to 1 to indicate that the STA supports extended TPC Rx on the receiver side described in 10.43.6. This subfield is set to 0 otherwise.

***Insert the following subclauses (9.4.2.127.7, 9.4.2.127.8, and 9.4.2.127.9, including Figure 9-544a through Figure 9-544d) after 9.4.2.127.6:***

### 9.4.2.127.7 TDD Capability Information field

The TDD Capability Information field, shown in Figure 9-554a, indicates the transmitting STA capabilities in supporting TDD features.

| | B0 | B1 B4 | B5 | B6 B15 |
|---|---|---|---|---|
| | TDD Channel Access Supported | TDD Link Maintenance Statistics | TDD Synchronization Mode | Reserved |
| Bits: | 1 | 4 | 1 | 10 |

**Figure 9-554a—TDD Capability Information field format**

The TDD Channel Access Supported subfield is set to 1 if dot11TDDOptionImplemented is true and indicates that the STA supports the TDD channel access described in 10.39.6.2.2. The subfield is set to 0 otherwise.

The TDD Link Maintenance Statistics subfield indicates the capabilities of reporting TDD rate adaptation statistics and is shown in Figure 9-554b.

| | B0 | B1 | B2 | B3 |
|---|---|---|---|---|
| | RX Chain Statistics Supported | PPDU Statistics Supported | LDPC Statistics Supported | SC/OFDM Statistics Supported |
| Bits: | 1 | 1 | 1 | 1 |

**Figure 9-554b—TDD Link Maintenance Statistics subfield format**

The RX Chain Statistics Supported subfield is set to 1 to indicate the STA supports reporting the RX chain statistics in the DMG Link Margin element (see 9.4.2.142). Otherwise, this field is set to 0.

The PPDU Statistics Supported subfield is set to 1 to indicate the STA supports reporting the PPDU statistics in the DMG Link Margin element (see 9.4.2.142). Otherwise, this field is set to 0.

The LDPC Statistics Supported subfield is set to 1 to indicate the STA supports reporting the LDPC statistics in the DMG Link Margin element (see 9.4.2.142). Otherwise, this field is set to 0.

The SC/OFDM Statistics Supported subfield is set to 1 to indicate the STA supports reporting the parameters across SC blocks or OFDM symbols in the DMG Link Margin element (see 9.4.2.142). Otherwise, this field is set to 0.

The TDD Synchronization Mode subfield is set to 1 to indicate that the STA supports the TDD time synchronization described in 11.1.7. This subfield is set to 0 otherwise.

#### 9.4.2.127.8 SAR Capability Information field

The SAR Capability Information field is defined in Figure 9-554c.

| | B0 B6 | B7 |
|---|---|---|
| | Reserved | Segmentation and Reassembly Support |
| Bits: | 7 | 1 |

**Figure 9-554c—SAR Capability Information field format**

The Segmentation and Reassembly Support subfield indicates whether the STA supports the segmentation and reassembly mechanism as specified in 10.69. A value of 0 indicates that segmentation and reassembly is not supported, indicated by dot11SAROptionImplemented equal to false. A value of 1 indicates that segmentation and reassembly is supported, indicated by dot11SAROptionImplemented equal to true.

#### 9.4.2.127.9 Extended MPDU Capability field

The Extended MPDU Capability is defined in Figure 9-554d.

| | B0 B13 | B14 | B15 |
|---|---|---|---|
| | MPDU Limit | Reserved | Extended MPDU Support |
| Bits: | 14 | 1 | 1 |

**Figure 9-554d—Extended MPDU Capability field format**

The MPDU Limit subfield indicates the maximum MPDU size, in octets, that the STA can receive when this subfield is valid. The subfield contains an integer between 7990 and 16383.

The Extended MPDU Support subfield indicates whether the MPDU Limit subfield is valid. When dot11DMGExtendedMPDULimitValid is true, the Extended MPDU Support subfield is set to 1 to indicate that the MPDU Limit subfield is valid. When dot11DMGExtendedMPDULimitValid is false, the Extended MPDU Support subfield is set to 0 to indicate that the MPDU Limit subfield is invalid.

### 9.4.2.129 DMG Beam Refinement element

***Change Figure 9-558 as follows:***

| | B0 B7 | B8 B15 | B16 | B17 | B18 | B19 | B20 | B21 B26 | B27 B28 |
|---|---|---|---|---|---|---|---|---|---|
| | Element ID | Length | Initiator | TX-train-response | RX-train-response | TX-TRN-OK | TXSS-FBCK-REQ | BS-FBCK | BS-FBCK DMG Antenna ID |
| Bits: | 8 | 8 | 1 | 1 | 1 | 1 | 1 | 6 | 2 |

| | B29 B33 | B34 B51 | B52 | B53 | B54 B55 | B56 B60 | B61 | B62 B65 |
|---|---|---|---|---|---|---|---|---|
| | FBCK-REQ | FBCK-TYPE | MID Extension | Capability Request | Reserved | BS-FBCK MSB | BS-FBCK Antenna ID MSB | Number of Measurements MSB |
| Bits: | 5 | 18 | 1 | 1 | 2 | 5 | 1 | 4 |

| | B66 | B67 | B68 B69 | B70 | B71 |
|---|---|---|---|---|---|
| | EDMG Extension Flag | EDMG Channel Measurement Present | Sector Sweep Frame Type | DBF FBCK REQ | Channel Aggregation Requested |
| Bits: | 1 | 1 | 2 | 1 | 1 |

| | B72 | B73 B74 | B75 | B76 B79 |
|---|---|---|---|---|
| | Channel Aggregation Present | BF Training Type | EDMG Dual Polarization TRN Channel Measurement Present | Reserved |
| Bits: | 1 | 2 | 1 | 4 |

**Figure 9-558—DMG Beam Refinement element format**

***Insert the following paragraph into 9.4.2.129 after the seventh paragraph ("A TXSS-FBCK-REQ field ...."):***

The size in bits of the BS-FBCK field depends on the value of the EDMG Extension Flag field. If the EDMG Extension Flag field is set to 1, the BS-FBCK MSB field is prepended to the BS-FBCK field to form a single BS-FBCK field of size equal to 11 bits. Otherwise, the BS-FBCK MSB field is reserved and the BS-FBCK field remains with 6 bits in length.

***Change the now ninth paragraph in 9.4.2.129 as follows:***

If the EDMG Extension Flag field is set to 0, t~~T~~he BS-FBCK field indicates the index of the TRN-T subfield that was received with the best quality in the last received BRP-TX PPDU, where the first TRN-T subfield in the PPDU is defined as having an index equal to 1. ~~If the last received PPDU was not a BRP-TX PPDU, this field is set to 0.~~ If the EDMG Extension Flag field is set to 1, the BS-FBCK field indicates the AWV feedback ID of the TRN subfields transmitted with the same AWV that were received with the best quality in the last received EDMG BRP-TX PPDU or EDMG BRP-RX/TX PPDU as defined in 28.9.2.2. If the EDMG Extension Flag field is set to 1 and the last received EDMG BRP-TX PPDU or EDMG BRP-RX/TX PPDU was transmitted using channel aggregation, the BS-FBCK field indicates the AWV feedback ID of the TRN subfields transmitted with the same AWV that were received with the best quality in the channel that includes the primary channel. If the last received PPDU from the same STA was not a BRP-TX PPDU, an EDMG BRP-TX PPDU or an EDMG BRP-RX/TX PPDU, this field is set to 0. The determination of best quality is implementation dependent.

***Insert the following paragraph into 9.4.2.129 after the now ninth paragraph:***

The size in bits of the BS-FBCK Antenna ID field depends on the value of the EDMG Extension Flag field. If the EDMG Extension Flag field is set to 1, the BS-FBCK Antenna ID MSB field is prepended to the BS-FBCK Antenna ID field to form a single BS-FBCK Antenna ID field of size equal to 3 bits. Otherwise, the BS-FBCK Antenna ID MSB field is reserved and the BS-FBCK Antenna ID field remains at 2 bits in length.

***Change Table 9-255 as follows:***

### Table 9-255—FBCK-REQ field description

| Subfield | Meaning |
|---|---|
| SNR Requested | If set to 1, the SNR subfield is requested as part of the returned Channel Measurement element(s). Otherwise, set to 0. |
| Channel Measurement Requested | If set to 1, the Channel Measurement subfield is requested as part of the returned Channel Measurement element(s). Otherwise, set to 0. |
| Number of Taps Requested | Number of taps in each channel measurement:<br>0 x 0 – 1 tap<br>0 x 1 – ~~5~~ $4 \times N_{CB} + 1$ taps<br>0 x 2 – ~~15~~ $14 \times N_{CB} + 1$ taps<br>0 x 3 – ~~63~~ $62 \times N_{CB} + 1$ taps<br>where $N_{CB}$ is the integer number of contiguous 2.16 GHz channels over which the measurement is requested to be taken. |
| Sector ID Order Requested | If this subfield is set to 1 and the EDMG Extension Flag field is set to 0, the Sector ID Order subfield is requested as part of the returned Channel Measurement element(s).<br>If this subfield is set to 1 and the EDMG Extension Flag field is set to 1, the EDMG Sector ID Order field is requested as part of the returned EDMG Channel Measurement Feedback element(s).<br>Otherwise, this subfield is set to 0. |

***Change Table 9-256 as follows:***

### Table 9-256—FBCK-TYPE field description

| Subfield | Meaning |
|---|---|
| SNR Present | Set to 1 to indicate that the SNR subfield is present as part of the channel measurement feedback. Set to 0 otherwise. |
| Channel Measurement Present | Set to 1 to indicate that the Channel Measurement subfield is present as part of the channel measurement feedback. Set to 0 otherwise. |
| Tap Delay Present | If the EDMG Extension Flag field is set to 0, this subfield is s~~S~~et to 1 to indicate that the Tap Delay subfield is present as part of the channel measurement feedback. If the EDMG Extension Flag field is set to 1, this subfield is set to 1 to indicate that the Tap Delay subfield is present as part of the EDMG channel measurement feedback. This subfield is s~~S~~et to 0 in all other cases ~~otherwise~~. |

**Table 9-256—FBCK-TYPE field description *(continued)***

| Subfield | Meaning |
|---|---|
| Number of Taps Present | Number of taps in each channel measurement:<br>0 x 0 – 1 tap<br>0 x 1 – ~~5~~ $4\times N_{CB}+1$ taps<br>0 x 2 – ~~15~~ $14\times N_{CB}+1$ taps<br>0 x 3 – ~~63~~ $62\times N_{CB}+1$ taps<br>where $N_{CB}$ is the integer number of contiguous 2.16 GHz channels over which the measurement was taken. |
| Number of Measurements | The size in bits of the Number of Measurements subfield depends on the value of the EDMG Extension Flag field. If the EDMG Extension Flag field is set to 1, the Number of Measurements MSB field is prepended to the Number of Measurements subfield to form a single Number of Measurements field of size 11 bits. Otherwise, the Number of Measurements MSB field is reserved.<br><br>The Number of Measurements subfield indicates the n~~N~~umber of measurements in the SNR subfield and the Channel Measurement subfield. If the EDMG Extension Flag field is set to 0, the number of measurements ~~It~~ is equal to the number of TRN-T subfields in the BRP-TX PPDU on which the measurement is based, or the number of received sectors if TXSS result is reported by setting the TXSS-FBCK-REQ subfield to 1. If the EDMG Extension Flag field is set to 1, the number of measurements is equal to the number of TX-RX AWV configurations trained with the EDMG BRP-TX or EDMG BRP-RX/TX PPDUs on which the measurement is based (see EDMG Channel Measurement Feedback element), or is equal to the number of received sectors if a TXSS result is reported by setting the TXSS-FBCK-REQ subfield to 1. |
| Sector ID Order Present | Set to 1 to indicate<br>— That the Sector ID Order subfield is present as part of the channel measurement feedback when the EDMG Extension Flag field is set to 0; or<br>— That the EDMG Sector ID Order field is present as part of the EDMG Channel Measurement Feedback element when the EDMG Extension Flag field is set to 1.<br>Set to 0 otherwise. |
| Link Type | Set to 0 for the initiator link and to 1 for the responder link. |
| Antenna Type | Set to 0 for the transmitter antenna and to 1 for the receiver antenna. |
| Number of Beams | Indicates the number of beams in the Sector ID Order subfield for the MIDC subphase. |

***Insert the following paragraphs at the end of 9.4.2.129:***

The EDMG Channel Measurement Present field is set to 1 to indicate that at least one EDMG Channel Measurement Feedback element is present in the frame. Otherwise, this field is set to 0.

The Sector Sweep Frame Type field is set to 0 to indicate that DMG Beacon frames or SSW frames are used in the last sector sweep. This field is set to 1 to indicate that Short SSW PPDUs are used in the last sector sweep. This field is set to 2 to indicate that BRP frames are used in the last sector sweep. The field is set to 3 to indicate that the BRP frame that contains this DMG Beam Refinement element carries a feedback for beam tracking.

The definition of the DBF FBCK REQ field depends on the value of the Digital BF Request field within the EDMG BRP Request element contained in the same frame. If the Digital BF Request field is 1 and the DBF FBCK REQ is set to 1, digital beamforming matrix information is requested as part of a following MIMO BF Feedback frame. If the Digital BF Request field is 1 and the DBF FBCK REQ field is set to 0, MIMO channel measurement is present as part of a following MIMO BF Feedback frame. If the Digital BF Request field is 0, the DBF FBCK REQ field is reserved.

The Channel Aggregation Requested field is set to 1 to indicate that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel and to request the channel measurement feedback per channel in case of channel aggregation. Otherwise, it is set to 0. This field is reserved when the EDMG Extension Flag field is 0.

The Channel Aggregation Present field is set to 1 to indicate, in case of channel aggregation, that channel measurement feedback per channel is present. Otherwise, it is set to 0. This field is reserved when the EDMG Extension Flag field is 0.

The BF Training Type field is set to 0 to indicate SISO BF training, is set to 1 to indicate SU-MIMO BF training and is set to 2 to indicate MU-MIMO BF training. Other values are reserved.

The EDMG Dual Polarization TRN Channel Measurement Present field is set to 1 to indicate that the EDMG Channel Measurement Feedback element contains the Dual Polarization TRN Measurement field. If the EDMG Dual Polarization TRN Channel Measurement Present field is set to 0, the EDMG Channel Measurement Feedback element does not contain the Dual Polarization TRN Measurement field.

### 9.4.2.131 Extended Schedule element

***Change Figure 9-564 as follows:***

| | B0 B3 | B4 B6 | B7 | B8 | B9 | B10 | B11 | B12 | B13 B15 |
|---|---|---|---|---|---|---|---|---|---|
| | Allocation ID | Allocation Type | Pseudo-static | Truncatable | Extendable | PCP Active | LP SC Used | TDD Applicable SP | Reserved |
| Bits: | 4 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 4 3 |

**Figure 9-564—Allocation Control subfield format (DMG)**

***Insert the following paragraph at the end of 9.4.2.131:***

If the Allocation Type subfield indicates an SP allocation, the TDD Applicable SP subfield set to 1 indicates that the SP allocation is using TDD channel access as described in 10.39.6.2.2; otherwise, it is set to 0. For other values of the Allocation Type subfield, the TDD Applicable SP subfield is reserved.

### 9.4.2.133 DMG TSPEC element

***Change Figure 9-568 as follows:***

| | Element ID | Length | DMG Allocation Info | BF Control | Allocation Period | Minimum Allocation | Maximum Allocation |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 4 | 2 | 2 | 2 |

| | Minimum Duration | Number of Constraints | Traffic Scheduling Constraint Set | BW Control | BW |
|---|---|---|---|---|---|
| Octets: | 2 | 1 | Variable | 1 | 1 |

**Figure 9-568—DMG TSPEC element format**

***Insert the following paragraphs and Figure 9-571a at the end of 9.4.2.133:***

The BW Control field is defined in Figure 9-571a.

| | B0 | B1 | B2 B7 |
|---|---|---|---|
| | Is Channel Number | Channel Aggregation | Reserved |
| Bits: | 1 | 1 | 6 |

**Figure 9-571a—BW Control field format**

The Is Channel Number subfield indicates whether the value in the BW field represents a channel width or channel number.

The Channel Aggregation subfield is defined in Table 28-12.

The BW field indicates the requested channel width or channel number of the allocation. If the Is Channel Number subfield is set to 1, the BW field uses the bitmap format of the BW field defined in Table 28-12 and, together with the Channel Aggregation subfield, are collectively used to derive a requested channel number for the allocation per the channel numbers defined in 9.4.2.265.5. If the Is Channel Number subfield is set to 0, the BW field indicates a channel width using the bitmap format of the BW field defined in Table 28-12. In this case, the channel width can be allocated on any channel number. When transmitted in an ADDTS Response frame, the BW field indicates the allocated channel for the allocation using the bitmap format of the BW field defined in Table 28-12.

### 9.4.2.136 Channel Measurement Feedback element

*Change Table 9-263 as follows:*

**Table 9-263—Channel Measurement Feedback element format**

| Field | Size | | Meaning |
|---|---|---|---|
| Element ID | 8 bits | | |
| Length | 8 bits | | |
| SNR | $SNR_1$ | 8 bits | SNR as measured in the first TRN-T subfield or at the first sector from which SSW frame or Short SSW PPDU is received, or at the channel indicated by the first SISO ID subset. |
| | $SNR_2$ | 8 bits | SNR as measured in the second TRN-T subfield or at the second sector from which SSW frame or Short SSW PPDU is received, or at the channel indicated by the second SISO ID subset. |
| | .<br>.<br>. | | |
| | $SNR_{Nmeas}$ | 8 bits | SNR as measured in the $N_{meas}$ TRN-T subfield or at sector $N_{meas}$ from which SSW frame or Short SSW PPDU is received, or at the channel indicated by the $N_{meas}$ SISO ID subset. |
| Channel Measurement | Channel Measurement 1 | $N_{taps}$×16 bits | Channel measurement for the first TRN-T subfield or for the channel indicated by the first SISO ID subset. |
| | Channel Measurement 2 | $N_{taps}$×16 bits | Channel measurement for the second TRN-T subfield or for the channel indicated by the second SISO ID subset. |
| | .<br>.<br>. | | |
| | Channel Measurement $N_{meas}$ | $N_{taps}$×16 bits | Channel measurement for the $N_{meas}$ TRN-T subfield or for the channel indicated by the $N_{meas}$ SISO ID subset. |
| Tap Delay | Relative Delay Tap #1 | 8 bits | The delay of Tap #1 in units of $T_c$ relative to the path with the shortest delay detected. |
| | Relative Delay Tap #2 | 8 bits | The delay of Tap #2 in units of $T_c$ relative to the path with the shortest delay detected. |
| | .<br>.<br>. | | |
| | Relative Delay Tap #$N_{taps}$ | 8 bits | The delay of Tap #$N_{taps}$ in units of $T_c$ relative to the path with the shortest delay detected. |

**Table 9-263—Channel Measurement Feedback element format *(continued)***

| Field | Size | | Meaning |
|---|---|---|---|
| Sector ID Order | Sector $ID_1$ | 6 bits | Sector ID for $SNR_1$ being obtained, or sector ID of the first detected beam. |
| | DMG Antenna $ID_1$ | 2 bits | DMG Antenna ID corresponding to sector $ID_1$. |
| | Sector $ID_1$ | 6 bits | Sector ID for $SNR_2$ being obtained, or sector ID of the second detected beam. |
| | DMG Antenna $ID_1$ | 2 bits | DMG Antenna ID corresponding to sector $ID_2$. |
| | .<br>.<br>. | | |
| | Sector $ID_{Nmeas}$ or sector $ID_{Nbeam}$ | 6 bits | Sector ID for $SNR_{Nmeas}$ being obtained, or sector ID of the detected beam $N_{beam}$. |
| | DMG Antenna $ID_{Nmeas}$ or DMG Antenna $ID_{Nbeam}$ | 2 bits | DMG Antenna ID corresponding to sector $ID_{Nmeas}$ or sector $ID_{Nbeam}$. |
| Additional SNR | $SNR_1$ | 8 bits | SNR as measured in the first TRN-T field or at the channel indicated by the first SISO ID subset. |
| | $SNR_2$ | 8 bits | SNR as measured in the second TRN-T field or at the channel indicated by the second SISO ID subset. |
| | .<br>.<br>. | | |
| | $SNR_{Nmeas}$ | 8 bits | SNR as measured in the $N_{meas}$ TRN-T field or at the channel indicated by the $N_{meas}$ SISO ID subset. |
| Additional Channel Measurement | Channel Measurement 1 | $N_{taps}$×16 bits | Channel measurement for the first TRN-T field or for the channel indicated by the first SISO ID subset. |
| | Channel Measurement 2 | $N_{taps}$×16 bits | Channel measurement for the second TRN-T field or for the channel indicated by the second SISO ID subset. |
| | .<br>.<br>. | | |
| | Channel Measurement $N_{meas}$ | $N_{taps}$×16 bits | Channel measurement for the $N_{meas}$ TRN-T field or for the channel indicated by the $N_{meas}$ SISO ID subset. |

***Insert the following paragraphs at the end of 9.4.2.136:***

If both the Channel Aggregation Present field and the EDMG Extension Flag field in the accompanying DMG Beam Refinement element are 1 or if the Channel Aggregation Present field in the accompanying MIMO Feedback Control element is 1, the following apply:

- The SNR and Channel Measurement fields are for the channel that includes the primary channel in case of channel aggregation. Otherwise, the SNR and Channel Measurement fields are for the channel in which the measurement is taken.
- The Additional SNR and Additional Channel Measurement fields are for the channel that does not include the primary channel in case of channel aggregation. Otherwise, the Additional SNR and Additional Channel Measurement fields are not present.

If an EDMG Channel Measurement Feedback element is present in the same frame as a Channel Measurement Feedback element, the interpretation of each $\mathrm{SNR}_i$, Channel $\mathrm{Measurement}_i$, Tap $\mathrm{Delay}_i$, Additional $\mathrm{SNR}_i$ and Additional Channel $\mathrm{Measurement}_i$ fields, $1 \le i \le N_{meas}$, is associated to the $i^{\mathrm{th}}$ entry within the EDMG Sector ID Order field of the EDMG Channel Measurement Feedback element.

### 9.4.2.137 Awake Window element

***Change Figure 9-575 as follows:***

| | Element ID | Length | Awake Window Duration | EDMG Awake Window Duration |
|---|---|---|---|---|
| Octets: | 1 | 1 | 2 | 2 |

**Figure 9-575—Awake Window element format**

***Insert the following paragraph at the end of 9.4.2.137:***

The EDMG Awake Window Duration field contains the duration, in microseconds, of the awake window for the CBAP allocations scheduled through the EDMG Extended Schedule element.

### 9.4.2.138 Multi-band element

***Change Figure 9-577 as follows:***

| | B0 B2 | B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|---|
| | STA Role | STA MAC Address Present | Pairwise Cipher Suite Present | FST Not Supported | OCT Not Supported | Discovery Assistance Enabled ~~Reserved~~ |
| Bits: | 3 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-577—Multi-band Control field format**

***Insert the following paragraph into 9.4.2.138 after the eighth paragraph ("The OCT Not Supported subfield ...."):***

The Discovery Assistance Enabled subfield indicates whether the STA supports the multi-band discovery assistance procedure for the BSS defined by the BSSID field on the channel defined by the Band ID field, the Operating Class field, and the Channel Number field. The Discovery Assistance Enabled subfield is set to 1 if the BSS specified in the element is a DMG BSS and if dot11DiscoveryAssistanceActivated is true. The subfield is set to 0 otherwise.

### 9.4.2.142 DMG Link Margin element

#### 9.4.2.142.1 General

***Change Figure 9-583 as follows:***

| | Element ID | Length | Activity | MCS | Link Margin | SNR | Reference Timestamp |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 | 1 | 4 |

| | Rate Adaptation Control/Extended TPC | RX Chain Statistics | PPDU Statistics | LDPC Statistics | SC/OFDM Statistics | Extended TPC |
|---|---|---|---|---|---|---|
| Octets: | 5 | 0 or $N_{RX}$ | 0 or 3×$N_{STS}$ | 0 or 8 | 0 or 4×$N_{STS}$ | 0 or 2×$N_{STS}$ |

**Figure 9-583—DMG Link Margin element format**

***Change the fourth, fifth and sixth paragraphs in 9.4.2.142.1 as follows:***

The MCS field is set to an integer representation of the MCS that the STA sending this element recommends that the peer STA indicated in the RA field of the Link Measurement Report frame use to transmit frames to this STA. The reference PER for selection of the MCS is 10-2 for an MPDU length of 4096 octets. The method by which the sending STA determines a suitable MCS for the peer STA is implementation specific. Values 0-12 and values 25-31 indicate MCS 0 to MCS 12 and MCS 25 to MCS 31, respectively. Values 133, 134, 135, 136, 137, 138, 140 indicate MCSs 12.1, 9.1, 12.3, 12.4, 12.5, 12.2, and 12.6, respectively. The MCS field is reserved when the value of the Number of Space-Time Streams Reported (NSTS) subfield within the Rate Adaptation Control/Extended TPC field is greater than 1.

The Link Margin field contains the measured link margin of Data frames received from the peer STA indicated in the RA field of the Link Measurement Report frame and is coded as a 2s complement signed integer in units of decibels. A value of –128 indicates that no link margin is provided. The method used to ~~measure~~ estimate the link margin is beyond the scope of this standard. The Link Margin field is reserved when the value of the Number of Space-Time Streams Reported (NSTS) subfield within the Rate Adaptation Control/Extended TPC field is greater than 1.

The SNR field indicates the SNR measured during the reception of a PPDU. Values are from –13 dB to 50.75 dB in 0.25 dB steps. The SNR field is reserved when the value of the Number of Space-Time Streams Reported (NSTS) subfield within the Rate Adaptation Control/Extended TPC field is greater than 1.

***Insert the following paragraphs at the end of 9.4.2.142.1:***

The Rate Adaptation Control/Extended TPC field contains the number of space-time streams reported and indications of whether the element includes optional fields used for rate adaptation and TPC. The Rate Adaptation Control/Extended TPC field is defined in 9.4.2.142.3.

The RX Chain Statistics field is optionally present and is defined in 9.4.2.142.4.

The PPDU Statistics field is optionally present and is defined in 9.4.2.142.5.

The LDPC Statistics field is optionally present and is defined in 9.4.2.142.6.

The SC/OFDM Statistics field is optionally present and is defined in 9.4.2.142.7.

The Extended TPC field is optionally present and is defined in 9.4.2.142.8.

***Insert the following subclauses (9.4.2.142.3 through 9.4.2.142.8, including Figure 9-583a through Figure 9-583f and Table 9-266a) after 9.4.2.142.2:***

### 9.4.2.142.3 Rate Adaptation Control/Extended TPC field

The Rate Adaptation Control/Extended TPC field format is defined in Figure 9-583a.

| | B0 B3 | B4 B7 | B8 | B9 |
|---|---|---|---|---|
| | Number of RX Chains Reported (NRX) | Number of Space-Time Streams Reported (NSTS) | PPDU Statistics Present | LDPC Statistics Present |
| Bits: | 4 | 4 | 1 | 1 |

| | B10 | B11 | B12 | B13 B28 | B29 | B30 B39 |
|---|---|---|---|---|---|---|
| | SC/OFDM Statistics Present | IsEDMG | IsSC | Number of PPDUs | Extended TPC Present | Reserved |
| Bits: | 1 | 1 | 1 | 16 | 1 | 10 |

**Figure 9-583a—Rate Adaptation Control/Extended TPC field format**

The Number of RX Chains Reported (NRX) subfield indicates the number of RX chain entries being reported. Each entry, *i*, corresponds to an RX chain *i*.

The Number of Space-Time Streams Reported (NSTS) subfield indicates the number of space-time streams being reported. Each entry, *i*, corresponds to a space-time stream. If the value of this subfield is greater than 0, the MCS, Link Margin and SNR fields in the DMG Link Margin element are reserved. For a non-EDMG STA, the value of this subfield does not exceed 1.

The PPDU Statistics Present subfield is set to 1 if the DMG Link Margin element contains the PPDU Statistics field. It is set to 0 otherwise.

The LDPC Statistics Present subfield is set to 1 if the DMG Link Margin element contains the LDPC Statistics field. It is set to 0 otherwise.

The SC/OFDM Statistics Present subfield is set to 1 if the DMG Link Margin element contains the SC/OFDM Statistics field. It is set to 0 otherwise.

The IsEDMG subfield is used to indicate whether the value in the MCS field in the DMG Link Margin element corresponds to the DMG PHY (Clause 20) or the EDMG PHY (Clause 28). It is set to 1 for the EDMG PHY and to 0 for the DMG PHY.

The IsSC subfield is used to indicate whether the value in the MCS field corresponds to SC modulation or OFDM modulation. It is set to 1 for SC and to 0 for OFDM.

The Number of PPDUs subfield contains the number of PPDUs over which the reported statistics were measured.

The Extended TPC Present subfield is set to 1 if the DMG Link Margin element contains the Extended TPC field. It is set to 0 otherwise.

### 9.4.2.142.4 RX Chain Statistics field

The RX Chain Statistics field is defined in Figure 9-583b. This field is present in the DMG Link Margin element when the Number of RX Chains Reported (NRX) subfield within the Rate Adaptation Control field is nonzero.

| | $RCPI_1$ | … | $RCPI_{NRX}$ |
|---|---|---|---|
| Octets: | 1 | | 1 |

**Figure 9-583b—RX Chain Statistics field format**

Each $RCPI_i$ subfield, $1 \le i \le N_{RX}$, where $N_{RX}$ is the value of the Number of RX Chains Reported subfield within the Rate Adaptation Control/Extended TPC field, contains the RCPI (see 20.3.10 and 28.3.9.2) for the $i^{th}$ RF chain averaged across all PSDUs received within a report interval intended for the STA, and where the PSDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0. The value of the subfield is found by computing the arithmetic mean of the RF power measurements in mW, converting the result to dBm, and encoding the dBm value as defined in 9.4.2.37.

### 9.4.2.142.5 PPDU Statistics field

The PPDU Statistics field is defined in Figure 9-583c.

| | $SNR_1$ | $MCS_1$ | Link $Margin_1$ | … | $SNR_{NSTS}$ | $MCS_{NSTS}$ | Link $Margin_{NSTS}$ |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | | 1 | 1 | 1 |

**Figure 9-583c—PPDU Statistics field format**

Each $SNR_i$ subfield, $1 \le i \le N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, contains the SNR of space-time stream $i$ averaged across all PSDUs received within a report interval intended for the STA, and where the PSDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0. The value of the subfield is found by computing the arithmetic mean of the PPDU signal-to-noise ratios with signal and noise power in mW, converting the result to dB, and encoding the dB value in the same way as the SNR field in the Channel Measurement Feedback element. If the Number of PPDUs subfield within the Rate Adaptation Control/Extended TPC field is 0 and the PPDU Statistics field is present, the $SNR_i$ subfield is set to 0xFF.

Each MCS$i$ subfield, $1 \le i \le N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, contains the MCS of space-time stream $i$. This subfield is used to indicate the MCS that was used to collect the values within the LDPC Statistics field or SC/OFDM Statistics field. If the Number of PPDUs subfield within the Rate Adaptation Control/Extended TPC field is 0 and the PPDU Statistics field is present, the $MCS_i$ subfield is set to 0xFF.

Each Link Margin$_i$ subfield, $1 \leq i \leq N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, contains the link margin measured on space-time stream *i* and averaged across all PPDUs received within a report interval intended for the STA, and where all the PPDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0. The value of the subfield is found by computing the arithmetic mean of link margin values in decibels, and encoding the result as a 2s complement signed integer in units of decibels. A value of –128 indicates that no link margin is provided. The method used to estimate the link margin is beyond the scope of this standard. If the Number of PPDUs subfield within the Rate Adaptation Control/Extended TPC field is 0 and the PPDU Statistics field is present, the Link Margin$_i$ subfield is set to –128.

### 9.4.2.142.6 LDPC Statistics field

The LDPC Statistics field is defined in Figure 9-583d.

| | Average Iterations | Max Iterations | Nonzero Syndromes | Number of LDPC Codewords |
|---|---|---|---|---|
| Octets: | 1 | 1 | 3 | 3 |

**Figure 9-583d—LDPC Statistics field format**

The Average Iterations subfield indicates the average number of iterations used by the LDPC decoder on PSDUs received within a report interval intended for the STA, and where all PSDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0. One iteration includes processing of all rows. The value of the subfield is found by computing the arithmetic mean of number of iterations across all LDPC codewords in each PSDU, and across all PSDUs in the measurement set, and encoding as an 8 bit unsigned integer with 0 to 255 representing 0.0 to +25.5 iterations in 0.1 steps.

The Max Iteration subfield indicates the maximum number of iterations used by the LDPC decoder on PSDUs received with an MCS different from MCS 0 or EDMG MCS 0. One iteration includes processing of all rows. The value of the subfield is the maximum number of iterations across all LDPC codewords in each PSDU, and across all PSDUs in the measurement set, encoded as an 8 bit unsigned integer with 0 to 255 representing 0.0 to +25.5 iterations in 0.1 steps.

NOTE—The fractional part of the Max Iteration subfield represents the ratio of processed rows to total number of rows.

The Nonzero Syndromes subfield indicates the number of LDPC codewords with nonzero syndrome, summed across all PSDUs received within a report interval intended for the STA, and where the PSDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0.

The Number of LDPC Codewords subfield indicates the number of processed LDPC codewords using an MCS different from MCS 0 and included in the Average Iterations, Max Iterations and Nonzero Syndromes subfield statistics. The value is saturated to $2^{24} – 1$ if it overflows.

### 9.4.2.142.7 SC/OFDM Statistics field

The SC/OFDM Statistics field is defined in Figure 9-583e.

| | $EVM_1$ | Number of SC Blocks/OFDM $Symbols_1$ | … | $EVM_{NSTS}$ | Number of SC Blocks/OFDM $Symbols_{NSTS}$ |
|---|---|---|---|---|---|
| Octets: | 1 | 3 | | 1 | 3 |

**Figure 9-583e—SC/OFDM Statistics field format**

Each $EVM_i$ subfield, $1 \le i \le N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, indicates the EVM of the SC data symbols or OFDM data subcarriers for PSDUs of space-time stream *i* received within a report interval intended for the STA, and where the PSDUs are transmitted using an MCS other than MCS 0 or EDMG MCS 0. The value of the subfield is found by computing the arithmetic mean of EVM values in dB, across all SC data symbols or OFDM data subcarriers in each PSDU, and across all PSDUs in the measurement set, and encoding the result as an 8 bit unsigned integer with 0 to 255 representing –5.0 dB to +46.0 dB in 0.2 dB steps.

Each Number of SC Blocks/OFDM $Symbols_i$ subfield, $1 \le i \le N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, indicates the count of the SC blocks or OFDM symbols of space-time stream *i* included in the average EVM value. The value is saturated to $2^{24} – 1$ if it overflows.

### 9.4.2.142.8 Extended TPC

The Extended TPC field is defined in Figure 9-583f.

| | Extended $Activity_1$ | Extended Activity $Parameter_1$ | … | Extended $Activity_{NSTS}$ | Extended Activity $Parameter_{NSTS}$ |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | | 1 | 1 |

**Figure 9-583f—Extended TPC field format**

The Extended $Activity_i$ subfield, $1 \le i \le N_{STS}$, where $N_{STS}$ is the value of the Number of Space-Time Streams Reported subfield within the Rate Adaptation Control/Extended TPC field, indicates the following:

- An action that the sending STA recommends that the peer STA performs for space-time stream *i*.
- Information about space-time stream *i* that is helpful to the peer STA when performing TPC.

The method by which the sending STA determines a suitable action for the peer STA is implementation specific.

Each Extended Activity subfield is followed by an Extended Activity Parameter subfield. The Extended Activity and Extended Activity Parameter subfields are defined in Table 9-266a.

**Table 9-266a—Extended Activity and Extended Activity Parameter subfields definition**

| Extended Activity subfield value | Definition | Extended Activity Parameter subfield definition |
|---|---|---|
| 0 | No action | Reserved |
| 1 | Change MCS | Requested MCS for space-time stream *i*. |
| 2 | Increase/decrease transmit power | Change in transmit power for space-time stream *i* in units of 0.25 dB, and encoded as an 8-bit 2s complement signed integer. The encoding covers the range from –32 dB to 31.75 dB in 0.25 dB steps. |
| 3 | Link margin | Link margin for space-time stream *i* in units of dB, and encoded as 2s complement signed integer. The method used to estimate the link margin is beyond the scope of this standard. |
| 4–255 | Reserved | Reserved |

The sending STA should report link margin values through the PPDU Statistics field (see 9.4.2.142.5) if the field is present, and through the Extended TPC field otherwise.

NOTE—The link margin values in the PPDU Statistics field are calculated across PPDUs in a report interval and combined as described in 9.4.2.142.5. The link margin values in the Extended TPC field are implementation dependent.

### 9.4.2.143 DMG Link Adaptation Acknowledgment element

***Change Figure 9-584 as follows:***

| | Element ID | Length | Activity | Reference Timestamp | Extended TPC Control | Extended TPC Link Adaptation Acknowledgment |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 4 | 1 | $2 \times N_{STS}$ |

**Figure 9-584—DMG Link Adaptation Acknowledgment element format**

***Insert the following paragraphs, Figure 9-584a, and Figure 9-584b at the end of 9.4.2.143:***

The format of the Extended TPC Control field is shown in Figure 9-584a.

| | B0 B2 | B3 B7 |
|---|---|---|
| | Number of STS Reported (NSTS) | Reserved |
| Bits: | 3 | 5 |

**Figure 9-584a—Extended TPC Control field format**

The Number of STS Reported (NSTS) subfield is optionally present. If present, it indicates the number of STS being reported in the Extended TPC Link Adaptation Acknowledgment field. If the value of this field is greater than 0, the Activity field in the DMG Link Adaptation Acknowledgment element is reserved.

The Extended TPC Link Adaptation Acknowledgment field is present if the value of the Number of STS Reported (NSTS) subfield is greater than 0, and its format is shown in Figure 9-584b.

| | Extended Activity Acknowledgment$_1$ | Extended Activity Acknowledgment Parameter$_1$ | … | Extended Activity Acknowledgment$_{NSTS}$ | Extended Activity Acknowledgment Parameter$_{NSTS}$ |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | | 1 | 1 |

**Figure 9-584b—Extended TPC Link Adaptation Acknowledgment field format**

Each Extended Activity Acknowledgment$_i$ subfield, $1 \leq i \leq N_{STS}$, is set to the action that the STA sending this element has taken for the STS $i$ following the reception of the extended activity in a Link Measurement Report frame. The method by which the sending STA determines the action is described in 10.43.

Each Extended Activity Acknowledgment Parameter$_i$ subfield, $1 \leq i \leq N_{STS}$, contains the parameter associated with the Extended Activity Acknowledgment$_i$ subfield for space-time stream $i$. If the Extended Activity Acknowledgment$_i$ subfield is 1, the Extended Activity Acknowledgment Parameter$_i$ subfield contains the transmit power change that was done for space-time stream $i$, in units of 0.25 dB and encoded as an 8-bit 2s complement signed integer. The encoding covers the range from –32 dB to 31.75 dB in 0.25 dB steps. If the Extended Activity Acknowledgment$_i$ subfield is 0, no change is indicated. All other values for Extended Activity Acknowledgment$_i$ subfield are reserved.

#### 9.4.2.241 RSN Extension element (RSNXE)

***Change Table 9-321 as follows:***

**Table 9-321—Extended RSN Capabilities field**

| Bit | Information | Notes |
|---|---|---|
| 0–3 | Field length | The length of the Extended RSN Capabilities field, in octets, minus 1, i.e., $n - 1$. |
| 4 | Protected TWT Operations Support | The STA sets the Protected TWT Operations Support field to 1 when dot11ProtectedTWTOperationsImplemented is true, and sets it to 0 otherwise. See 10.47.1. |
| 5 | SAE hash-to-element | The AP supports directly hashing to obtain the PWE instead of looping. See 12.4.4.2.3 and 12.4.4.3.3. |
| 6 | Protected Announce Support | The non-EDMG STA sets the Protected Announce Support field to 1 when dot11ProtectedAnnounceImplemented is true, and sets it to 0 otherwise. See 12.6.20. |
| ~~6~~ 7 – (8×$n$ – 1) | Reserved | |

***Insert the following subclauses [9.4.2.265 through 9.4.2.290, including Figure 9-788al through Figure 9-788dl, Table 9-322i through Table 9-322ae, Equation (9-3d), and Equation (9-3e)] after 9.4.2.247:***

#### 9.4.2.265 EDMG Capabilities element

##### 9.4.2.265.1 General

A non-AP EDMG STA or a non-PCP EDMG STA declares that it is an EDMG STA by transmitting the EDMG Capabilities element.

The format of the EDMG Capabilities element is shown in Figure 9-788al. The EDMG Capabilities element contains a fixed length Core Capabilities field, which is followed by a variable length Optional Subelements fields.

| | Element ID | Length | Element ID Extension | Core Capabilities | Optional Subelements |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 6 | Variable |

**Figure 9-788al—EDMG Capabilities element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Core Capabilities field is defined in Figure 9-788am.

| | B0 B6 | B7 B18 | B19 B42 | B43 B47 |
|---|---|---|---|---|
| | A-MPDU Parameters | TRN Parameters | Supported MCS | Reserved |
| Bits: | 7 | 12 | 24 | 5 |

**Figure 9-788am—Core Capabilities field format**

The A-MPDU Parameters field is defined in Figure 9-788an. The definition of the subfields of the A-MPDU Parameters field is shown in Table 9-322i.

| | B0 B3 | B4 B6 |
|---|---|---|
| | Maximum A-MPDU Length Exponent | Minimum MPDU Start Spacing |
| Bits: | 4 | 3 |

**Figure 9-788an—A-MPDU Parameters field format**

**Table 9-322i—A-MPDU Parameters field definition**

| Subfield | Definition | Encoding |
|---|---|---|
| Maximum A-MPDU Length Exponent | Indicates the maximum length of A-MPDU that the STA can receive. | This subfield is an integer in the range 0 to 9.<br>The length defined by this subfield is equal to:<br>$2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1$ octets. |
| Minimum MPDU Start Spacing | Determines the minimum time between the start of adjacent MPDUs within an A-MPDU that the STA can receive, measured at the PHY SAP. | Set to 0 for no restriction.<br>Set to 1 for 8 ns.<br>Set to 2 for 16 ns.<br>Set to 3 for 32 ns.<br>Set to 4 for 64 ns.<br>Set to 5 for 128 ns.<br>Set to 6 for 256 ns.<br>Set to 7 for 512 ns. |

The TRN Parameters field is defined in Figure 9-788ao.

| | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 | B10 | B11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TP1 | TP4 | TN2 | TN4 | TN8 | RP1 | RP4 | RN2 | RN4 | RN8 | Short TRN | Long TRN |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-788ao—TRN Parameters field format**

The TP1 subfield indicates that the STA is capable of transmitting an EDMG PPDU with TXVECTOR parameter EDMG_TRN_P equal to 1.

The TP4 subfield indicates that the STA is capable of transmitting an EDMG PPDU with TXVECTOR parameter EDMG_TRN_P equal to 4.

The TN2 subfield indicates that the STA is capable of transmitting an EDMG PPDU with TXVECTOR parameter EDMG_TRN_N equal to 2.

The TN4 subfield indicates that the STA is capable of transmitting an EDMG PPDU with TXVECTOR parameter EDMG_TRN_N equal to 4.

The TN8 subfield indicates that the STA is capable of transmitting an EDMG PPDU with TXVECTOR parameter EDMG_TRN_N equal to 8.

The RP1 subfield indicates that the STA is capable of receiving an EDMG PPDU with RXVECTOR parameter EDMG_TRN_P equal to 1.

The RP4 subfield indicates that the STA is capable of receiving an EDMG PPDU with RXVECTOR parameter EDMG_TRN_P equal to 4.

The RN2 subfield indicates that the STA is capable of receiving an EDMG PPDU with RXVECTOR parameter EDMG_TRN_N equal to 2.

The RN4 subfield indicates that the STA is capable of receiving an EDMG PPDU with RXVECTOR parameter EDMG_TRN_N equal to 4.

The RN8 subfield indicates that the STA is capable of receiving an EDMG PPDU with RXVECTOR parameter EDMG_TRN_N equal to 8.

The Short TRN subfield is set to 1 to indicate that the STA is capable of receiving TRN subfields based on short Golay sequences (see 28.9.2.2.6) in SC mode or short TRN subfields (see 28.9.2.2.7) in OFDM mode; otherwise, it is set to 0.

The Long TRN subfield is set to 1 to indicate that the STA is capable of receiving TRN subfields based on long Golay sequences (see 28.9.2.2.6) in SC mode or long TRN subfields (see 28.9.2.2.7) in OFDM mode; otherwise, it is set to 0.

The Supported MCS field is defined in Figure 9-788ap.

| | B0 B4 | B5 B9 | B10 B21 | B22 | B23 |
|---|---|---|---|---|---|
| | Maximum SC MCS | Maximum OFDM MCS | Maximum PHY Rate | SC MCS6 OFDM MCS5 Support | Reserved |
| Bits: | 5 | 5 | 12 | 1 | 1 |

**Figure 9-788ap—Supported MCS field format**

The Maximum SC MCS subfield contains the index of the highest supported receive EDMG SC mode MCS. The mandatory EDMG SC mode MCSs are not impacted by the value of this subfield.

The Maximum OFDM MCS subfield contains the index of the highest supported receive EDMG OFDM mode MCS. A value of zero indicates that the EDMG OFDM mode is not supported.

The Maximum PHY Rate subfield contains the maximum PHY data rate, in units of 100 Mb/s, that the STA supports in receive mode, over all supported channel bandwidths and number of spatial streams. This PHY data rate can be lower than the data rate provided by the maximum supported MCS when used with a combination of the largest supported channel bandwidth and the maximum number of supported spatial streams.

The SC MCS6 OFDM MCS5 Support subfield is set to 1 to indicate that MCS 6 of the EDMG SC mode and MCS 5 of the EDMG OFDM mode are supported in SISO. Otherwise, this subfield is set to 0.

The Optional Subelements field contains zero or more subelements. The subelement format and ordering of subelements are defined in 9.4.3.

The Subelement ID field values for the defined subelements are shown in Table 9-322j. A subelement does not appear more than once in the EDMG Capabilities element. If a subelement corresponding to a Subelement ID is not present in a transmitted EDMG Capabilities element, the transmitting STA does not support any of the mechanisms defined within this subelement.

**Table 9-322j—Optional subelement IDs**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Beamforming Capability | Yes |
| 1 | Antenna Polarization Capability | Yes |
| 2 | PHY Capabilities | Yes |
| 3 | Supported Channels | Yes |
| 4 | MAC Capabilities | Yes |
| 5–255 | Reserved | |

### 9.4.2.265.2 Beamforming Capability subelement

The Data field of the Beamforming Capability subelement is defined in Figure 9-788aq.

| | B0 B4 | B5 | B6 | B7 | B8 | B9 |
|---|---|---|---|---|---|---|
| | Requested BRP SC Blocks | MU-MIMO Supported | Reciprocal MU-MIMO Supported | SU-MIMO Supported | Grant Required | DMG TRN RX Only Capable |
| Bits: | 5 | 1 | 1 | 1 | 1 | 1 |

| | B10 | B11 B14 | B15 | B16 | B17 B18 | B19 | B20 B31 |
|---|---|---|---|---|---|---|---|
| | First Path Training Supported | Dual Polarization TRN Capability | Hybrid Beamforming and MU-MIMO Supported | Hybrid Beamforming and SU-MIMO Supported | Largest Ng Supported | Dynamic Grouping Supported | Reserved |
| Bits: | 1 | 4 | 1 | 1 | 2 | 1 | 12 |

**Figure 9-788aq—Data field of the Beamforming Capability subelement format**

The Requested BRP SC Blocks subfield indicates the minimum number of data SC blocks that the STA requests be included in a PPDU carrying a TRN field and transmitted to the STA. The value of this subfield is set to dot11RequestedBRPMinDataLength. If the PPDU is an OFDM mode PPDU, the minimum number of OFDM symbols is calculated as described in 28.9.2.2.4.

The MU-MIMO Supported subfield indicates if the STA supports the DL MU-MIMO protocol including the MU-MIMO beamforming protocol described in 10.42.10.2.3. This subfield is set to 1 if dot11EDMGMIMOSupport is either muAndSuMimo (2) or reciprocalMuMimoAndSuMimo (3), and is set to 0 otherwise.

The Reciprocal MU-MIMO Supported subfield indicates if the STA supports the reciprocal MU-MIMO protocol specified in 10.42.10.2.3.5. This subfield is set to 1 if dot11EDMGMIMOSupport is reciprocalMuMimoAndSuMimo (3), and is set to 0 otherwise. This subfield is reserved if the MU-MIMO Supported field is 0.

The SU-MIMO Supported subfield indicates if the STA supports the SU-MIMO protocol including the SU-MIMO beamforming protocol described in 10.42.10.2.2. This subfield is set to 1 if dot11EDMGMIMOSupport is suMimoOnly (1), and is set to 0 otherwise.

The Grant Required subfield indicates if the STA requires reception of a Grant frame to set up a MIMO configuration. This subfield is set to 1 if dot11EDMGBFGrantRequired is true, and is set to 0 otherwise. The Grant Required subfield is reserved if both the MU-MIMO Supported subfield and the SU-MIMO Supported subfield are set to 0.

The DMG TRN RX Only Capable subfield indicates if the STA is capable of receiving only DMG TRNs as defined in 20.9.2.2.2, even when such TRNs are appended to an EDMG PPDU (see 28.9.2.2.3). This subfield is set to 1 if dot11EDMGBFDMGTRNRXOnlyImplemented is true. Otherwise, this subfield is set to 0.

The First Path Training Supported subfield indicates if the STA supports the first path beamforming training procedure defined in 10.42.10.6. This subfield is set to 1 if dot11FirstPathTrainingImplemented is true, and is set to 0 otherwise.

The Dual Polarization TRN Capability subfield is formatted as shown in Figure 9-788ar.

| | B0 | B1 B3 |
|---|---|---|
| | Dual Polarization TRN Supported | TRN Power Difference |
| Bits: | 1 | 3 |

**Figure 9-788ar—Dual Polarization TRN Capability subfield format**

The Dual Polarization TRN Supported subfield is set to 1 to indicate that the repetition of the same TRN subfield with different polarizations, as specified in 10.42.10.7, is supported by the STA both for transmit and receive. Otherwise, it is set to 0.

The TRN Power Difference subfield indicates the difference, in dB, between the radiated power of consecutive TRN subfields transmitted with the same AWV but with different polarizations. The encoding of the radiated power difference is shown in Table 9-322k.

The MU-MIMO Supported subfield and the Hybrid Beamforming and MU-MIMO Supported subfield indicates if the STA supports the hybrid beamforming protocol during MU-MIMO transmission, including the hybrid beamforming protocol described in 10.42.10.2.4. This subfield is set to 1 if dot11EDMGHybridMUMIMOImplemented is true, and is set to 0 otherwise. The Hybrid Beamforming and MU-MIMO Supported subfield is reserved if the MU-MIMO Supported subfield is 0.

**Table 9-322k—Encoding of TRN Power Difference subfield**

| TRN Power Difference subfield encoding | TRN power difference between the first TRN polarization and the second TRN polarization (dB) |
|---|---|
| 000 | 0 |
| 001 | 1 |
| 010 | 2 |
| 011 | 3 or higher |
| 101 | –1 |
| 110 | –2 |
| 111 | –3 |
| 100 | –4 or lower |

The SU-MIMO Supported subfield and Hybrid Beamforming and SU-MIMO Supported subfield indicates if the STA supports hybrid beamforming protocol during SU-MIMO transmission, including the hybrid beamforming protocol described in 10.42.10.2.4. This subfield is set to 1 if dot11EDMGHybridSUMIMOImplemented is true, and is set to 0 otherwise. The Hybrid Beamforming and SU-MIMO Supported subfield is reserved if the SU-MIMO Supported subfield is 0.

The Largest Ng Supported subfield indicates largest value of $N_g$ that the EDMG STA supports for the beamforming feedback matrix (see 9.4.2.284). This subfield is set to the value of dot11EDMGBFGrantLargestNgSupported, i.e., 0 for $N_g = 2$, set to 1 for $N_g = 4$, and set to 2 for $N_g = 8$. Value of 3 is reserved.

The Dynamic Grouping Supported subfield indicates if the EDMG STA supports dynamic grouping. The field is set to 1 if dot11EDMGBFDynamicGroupingImplemented is true, and is set to 0 otherwise.

### 9.4.2.265.3 Antenna Polarization Capability subelement

The Data field of the Antenna Polarization Capability subelement allows a STA to share its antenna polarization characteristics with other stations. The Antenna Polarization Capability field is defined in Figure 9-788as.

| | Number of DMG Antennas | Polarization Capability List |
|---|---|---|
| Octets: | 1 | $N$×2 |

**Figure 9-788as—Data field of the Antenna Polarization Capability subelement format**

The value of the Number of DMG Antennas subfield plus one defines the combined total number, $N$, of RX and TX antennas of an EDMG STA.

The Polarization Capability List subfield contains *N* Polarization Capability subfields. Each Polarization Capability *i* subfield, $1 \leq i \leq N$, describes the polarization characteristics of the DMG antenna that is identified by index *i*. Each Polarization Capability *i* subfield is defined in Figure 9-788at.

| | B0 B1 | B2 B3 | B4 B10 | B11 B15 |
|---|---|---|---|---|
| | TX/RX | Polarization Configuration | Polarization Description | Reserved |
| Bits: | 2 | 2 | 7 | 5 |

**Figure 9-788at—Polarization Capability subfield format**

The TX/RX subfield is set to 1 to indicate that the antenna is for both transmission and reception, is set to 2 to indicate that the antenna is for transmission only, and is set to 3 to indicate that the antenna is for reception only. Value 0 is reserved.

The Polarization Configuration subfield is set to 0 to indicate single polarization, is set to 1 to indicate polarization switch, is set to 2 to indicate synthesizable polarization, and is set to 3 to indicate MIMO dual polarization.

The definition of the Polarization Description subfield depends on the setting of the Polarization Configuration subfield.

If the value of the Polarization Configuration subfield is equal to single polarization or MIMO dual polarization, the Polarization Description subfield is set to 0 to indicate linear polarization, is set to 1 to indicate circular polarization and is set to 2 for mixed polarization. Other values are reserved.

If the value of the Polarization Configuration subfield is equal to synthesizable polarization, the Polarization Description subfield is set to 0 to indicate linear polarization, is set to 1 to indicate circular polarization, is set to 2 for mixed polarization, and is set to 3 to indicate support for both linear and circular polarization. Other values are reserved.

If the value of the Polarization Configuration subfield is equal to polarization switch, the Polarization Description subfield is defined as shown in Figure 9-788au.

| | B0 | B1 B2 | B3 B4 | B5 B6 |
|---|---|---|---|---|
| | Number of Throws | Polarization for Throw 1 | Polarization for Throw 2 | Polarization for Throw 3 |
| Bits: | 1 | 2 | 2 | 2 |

**Figure 9-788au—Polarization Description subfield format**

The Number of Throws subfield is set to 0 to indicate 2 throws and is set to 1 to indicate 3 throws. If the Number of Throws subfield is set to indicate 2 throws, the Polarization for Throw 3 subfield is reserved.

Each of Polarization for Throw 1 subfield, Polarization for Throw 2 subfield and Polarization for Throw 3 subfield is set to set to 0 to indicate linear polarization, is set to 1 to indicate circular polarization and is set to 2 for mixed polarization. Value of 3 is reserved.

#### 9.4.2.265.4 PHY Capabilities subelement

The Data field of the PHY Capabilities subelement is defined in Figure 9-788av.

| | B0 | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|---|
| | Phase Hopping Supported | Open Loop Precoding Supported | DCM π/2-BPSK Supported | Rate 7/8 Short CW Punctured Supported | Rate 7/8 Short CW Superimposed Supported | Rate 7/8 Long CW Punctured Supported |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 |

| | B6 | B7 B9 | B10 B12 | B13 | B14 |
|---|---|---|---|---|---|
| | Rate 7/8 Long CW Superimposed Supported | SC Maximum Number of SU-MIMO Spatial Streams Supported | OFDM Maximum Number of SU-MIMO Spatial Streams Supported | NUC TX Supported | NUC RX Supported |
| Bits: | 1 | 3 | 3 | 1 | 1 |

| | B15 | B16 B18 | B19 B20 | B21 | B22 | B23 |
|---|---|---|---|---|---|---|
| | π/2-8-PSK Supported | Number of Concurrent RF Chains | STBC Type | EDMG A-PPDU | Long CW Supported | Reserved |
| Bits: | 1 | 3 | 2 | 1 | 1 | 1 |

**Figure 9-788av—Data field of the PHY Capabilities subelement format**

The Phase Hopping Supported subfield indicates if the STA supports phase hopping as specified in 28.6.9.3. The subfield is set to 1 if dot11EDMGPhaseHoppingImplemented is true, and is set to 0 otherwise.

The Open Loop Precoding Supported subfield indicates if the STA supports open loop precoding as specified in 28.6.9.3. The subfield is set to 1 if dot11EDMGOpenLoopPrecodingImplemented is true, and is set to 1 otherwise.

The DCM π/2-BPSK Supported subfield indicates if the STA supports DCM π/2-BPSK as specified in 28.5.9.5.3. The subfield is set to 1 if dot11EDMGDCMBPSKImplemented is true, and is set to 0 otherwise.

The Rate 7/8 Short CW Punctured Supported, Rate 7/8 Short CW Superimposed Supported, Rate 7/8 Long CW Punctured Supported and Rate 7/8 Long CW Superimposed Supported subfields indicate the support by an EDMG STA for LDPC code rate 7/8 with codeword length equal to 624, 672, 1248, and 1344 bits as follows:

— The Rate 7/8 Short CW Punctured Supported subfield is set to 1 if dot11EDMGShortCWPuncturedImplemented is true, and is set to 0 otherwise. The subfield indicates support for transmission and reception of LDPC code with short codeword length equal to 624 bits and code rate 7/8. The encoding procedure for short codeword length equal to 624 bits is defined in 20.5.3.2.3.3.

— The Rate 7/8 Short CW Superimposed Supported subfield is set to 1 if dot11EDMGShortCWSuperimposedImplemented is true, and is set to 0 otherwise. The subfield indicates support for transmission and reception of LDPC code with short codeword length equal to 672 bits and code rate 7/8. The encoding procedure for short codeword length equal to 672 bits is defined in 28.5.9.4, and parity check matrix is defined in 28.3.6.2. This field is reserved if the Rate 7/8 Short CW Punctured Supported subfield is 0.

— The Rate 7/8 Long CW Punctured Supported subfield is set to 1 if dot11EDMGLongCWPuncturedImplemented is true, and is set to 0 otherwise. The subfield indicates support for transmission and reception of LDPC code with long codeword length equal to 1248 bits and code rate 7/8. The encoding procedure for long codeword length equal to 1248 bits is defined in 28.5.9.4.
— The Rate 7/8 Long CW Superimposed Supported subfield is set to 1 if dot11EDMGLongCWSuperimposedImplemented is true, and is set to 0 otherwise. The subfield indicates support for transmission and reception of LDPC code with long codeword length equal to 1344 bits and code rate 7/8. The encoding procedure for long codeword length equal to 1344 bits is defined in 28.5.9.4. This field is reserved if the Rate 7/8 Long CW Punctured Supported subfield is 0.

The SC Maximum Number of SU-MIMO Spatial Streams Supported subfield is set to dot11EDMGSCMaxSUSpatialStreams minus 1. The value of this subfield plus 1 indicates the maximum number of SU-MIMO spatial streams for the EDMG SC modulation class that the STA can demodulate.

The OFDM Maximum Number of SU-MIMO Spatial Streams Supported subfield is set to dot11EDMGOFDMMaxSUSpatialStreams minus 1. The value of this subfield plus 1 indicates the maximum number of SU-MIMO spatial streams for the EDMG OFDM modulation class that the STA can demodulate.

The NUC TX Supported subfield is set to 1 if dot11EDMGNUCTXImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports transmission of PPDUs using nonuniform constellation.

The NUC RX Supported subfield is set to 1 if dot11EDMGNUCRXImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports reception of PPDUs using nonuniform constellation.

The π/2-8-PSK Supported subfield is set to 1 if dot11EDMG8PSKImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports SC MCS 12 and SC MCS 13 using 8-PSK modulation.

The Number of Concurrent RF Chains subfield is set to dot11EDMGNumConcurrentRFChains minus 1. The value of this subfield plus 1 indicates the maximum number of concurrent transmit or receive chains of the STA. The value of this field is less than or equal to the value of the Number of DMG Antennas subfield in the Antenna Polarization Capability field.

The STBC Type subfield is set to dot11EDMGSTBCType. If this subfield is 1, it indicates that the STA supports single stream STBC reception. If this subfield is 2, it indicates that the STA supports one or more spatial stream STBC reception; in this case, the maximum number of spatial streams that can be decoded is limited by the minimum of four and the value of the SC Maximum Number of SU-MIMO Spatial Streams Supported subfield for an EDMG SC PPDU and the value of the OFDM Maximum Number of SU-MIMO Spatial Streams Supported subfield for an EDMG OFDM PPDU. If this subfield is 0, the STA does not support STBC. Value of 3 is reserved.

The EDMG A-PPDU subfield is set to 1 if dot11EDMGAPPDUImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports EDMG A-PPDU as described in 10.14.

The Long CW Supported subfield is set to 1 if dot11EDMGLongCWImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports LDPC codeword of length 1344 on code rates 1/2, 5/8, 3/4, and 13/16. If this subfield is 0, the Rate 7/8 Long CW Punctured Supported and Rate 7/8 Long CW Superimposed Supported subfields are set to 0.

### 9.4.2.265.5 Supported Channels subelement

The Data field of the Supported Channels subelement is defined in Figure 9-788aw, where *N* is the integer number of channels and *M* is the integer number of channel aggregation combinations that the STA supports.

| | EDMG Channels Information | EDMG Aggregated Channels Information |
|---|---|---|
| Octets: | *N*+1 | 2×*M*+1 |

**Figure 9-788aw—Data field of the Supported Channels subelement format**

NOTE—As specified in 28.3.4, support for at least one 2.16 GHz channel and one 4.32 GHz channel by an EDMG STA is mandatory.

The EDMG Channels Information subfield is defined in Figure 9-788ax.

| | Number of EDMG Channels | EDMG Channel 1 | … | EDMG Channel N |
|---|---|---|---|---|
| Octets: | 1 | 1 | … | 1 |

**Figure 9-788ax—EDMG Channels Information subfield format**

The Number of EDMG Channels subfield defines the value of *N*.

Each EDMG Channel *i* subfield ($1 \leq i \leq N$) includes the channel number of a channel that is supported by the STA, as defined in Annex E.

The EDMG Aggregated Channels Information subfield is defined in Figure 9-788ay.

| | Number of Channel Aggregation Combinations | Channel Aggregation Combination 1 | … | Channel Aggregation Combination M |
|---|---|---|---|---|
| Octets: | 1 | 2 | … | 2 |

**Figure 9-788ay—EDMG Aggregated Channels Information subfield format**

The Number of Channel Aggregation Combinations subfield defines the value of *M*.

Each Channel Aggregation Combination *i* subfield ($1 \leq i \leq M$) is defined in Figure 9-788az. The channel numbers, as defined in Annex E, of the channels that are aggregated for each channel aggregation combination are included in the Aggregated Channel 1 and Aggregated Channel 2 subfields.

| | Aggregated Channel 1 | Aggregated Channel 2 |
|---|---|---|
| Octets: | 1 | 1 |

**Figure 9-788az—Channel Aggregation Combination subfield format**

### 9.4.2.265.6 MAC Capabilities subelement

The Data field of the MAC Capabilities subelement is defined in Figure 9-788ba.

| | B0 B3 | B4 | B5 B6 | B7 | B8 B15 |
|---|---|---|---|---|---|
| | EDMG Multi-TID Aggregation Support | EDMG All Ack Support | SM Power Save | Scheduled RD Supported | Reserved |
| Bits: | 4 | 1 | 2 | 1 | 8 |

**Figure 9-788ba—Data field of the MAC Capabilities subelement format**

The EDMG Multi-TID Aggregation Support field contains the number of TIDs minus one of QoS Data frames that the STA is able to receive or aggregate in a multi-TID A-MPDU as described in 10.70. A value of zero indicates that the STA does not support EDMG multi-TID aggregation.

The EDMG All Ack Support field is set to 1 to indicate support for the reception of a Multi-TID BlockAck frame under the all ack context when the Ack Type subfield value is 2 (see 10.70.2). The EDMG All Ack Support field is set to 0 otherwise.

The SM Power Save field indicates the support for spatial multiplexing power save for an EDMG STA (see 11.2.6). It also indicates the spatial multiplexing power save mode that is in operation immediately after (re)association. This field is set to 0 for static SM power save mode, 1 for dynamic SM power save mode, and 3 for SM power save disabled or not supported (see 11.2.6). The value of 2 is reserved. This field is valid in a (Re)Association Request frame sent to an AP or a PCP. Otherwise, this field is set to 0 or 3 upon transmission and it ignored upon reception.

NOTE—This field indicates the operational state immediately after (re)association as well as (if not set to 3) a capability.

The Scheduled RD Supported field indicates if the EDMG STA supports the scheduling procedure of the RD protocol described in 10.29.3 and 10.29.4. This field is set to 1 if dot11EDMGScheduledRDImplemented is true. Otherwise, this field is set to 0. When dot11EDMGMIMOSupport is either muAndSuMimo (2) or reciprocalMuMimoAndSuMimo (3), dot11EDMGScheduledRDImplemented is always true.

### 9.4.2.266 EDMG Operation element

The operational parameters of an EDMG BSS provided by an EDMG AP or EDMG PCP are determined by the EDMG Operation element.

The format of the EDMG Operation element is shown in Figure 9-788bb.

| | Element ID | Length | Element ID Extension | Primary Channel | BSS AID | A-BFT Parameters | BSS Operating Channels | Operating Channel Width |
|---|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-788bb—EDMG Operation element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Primary Channel field indicates a 2.16 GHz channel number, as defined in Annex E, of the primary channel of the BSS.

The BSS AID field contains a value in the range 1 to 254 assigned by an AP or PCP to identify the BSS. Other values are reserved.

The A-BFT Parameters field is defined in Figure 9-788bc.

| | RSS Retry Limit | RSS Backoff | Reserved |
|---|---|---|---|
| Bits: | 2 | 2 | 4 |

**Figure 9-788bc—A-BFT Parameters field format**

The RSS Retry Limit subfield defines the value of the retry limit that a STA attempting to access the A-BFT of the BSS uses. If the RSS Retry Limit subfield is set to 0 it indicates 2 retries, if set to 1 it indicates 4 retries, if set to 2 it indicates 6 retries and if set to 3 it indicates 8 retries.

The RSS Backoff subfield defines the value of the backoff that a STA uses when the consecutive number of failed attempts to access the A-BFT of the BSS exceeds the retry limit specified by the RSS Retry Limit subfield. If the RSS Backoff subfield is set to 0 it indicates a backoff of 8, if set to 1 it indicates a backoff of 16, if set to 2 it indicates a backoff of 24 and if set to 4 it indicates a backoff of 32.

The BSS Operating Channels field is a bitmap that indicates the 2.16 GHz channel(s) that are allowed to be used for transmissions in the BSS and is formatted as shown in Figure 9-788bd. In Figure 9-788bd, Ch1 subfield corresponds to channel 1, Ch2 subfield corresponds to channel 2 and so on (channels are defined in Annex E). If a subfield is set to 1, transmission on the indicated channel is allowed; otherwise, if the subfield is set to 0, transmission on the indicated channel is not allowed. The subfield corresponding to the primary channel is always set to 1 and the total number of subfields set to 1 does not exceed four.

| | B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|---|---|---|
| | Ch1 | Ch2 | Ch3 | Ch4 | Ch5 | Ch6 | Ch7 | Ch8 |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 9-788bd—BSS Operating Channels field format**

The Operating Channel Width field is defined in Figure 9-788be and indicates each possible bandwidth that a PPDU transmitted in the BSS can occupy.

| | B0 B3 | B4 B7 |
|---|---|---|
| | Channel BW Configuration | Reserved |
| Bits: | 4 | 4 |

**Figure 9-788be—Operating Channel Width field format**

The Channel BW Configuration subfield encodes the allowed channel bandwidth configurations and is defined in Table 9-322l.

**Table 9-322l—Channel BW Configuration subfield definition**

| Channel BW Configuration subfield value | | PPDU masks that are allowed to be transmitted in the BSS per rules defined in 10.23.2.14 and 10.39.12 | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2.16 GHz | 4.32 GHz | 6.48 GHz | 8.64 GHz | 2.16+2.16 GHz | 4.32+4.32 GHz |
| Reserved | 0–3 | | | | | | |
| Operating on 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz only | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 5 | 1 | 1 | 0 | 0 | 0 | 0 |
| | 6 | 1 | 1 | 1 | 0 | 0 | 0 |
| | 7 | 1 | 1 | 1 | 1 | 0 | 0 |
| Operating on 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, and 2.16+2.16 GHz only | 8 | 1 | 0 | 0 | 0 | 1 | 0 |
| | 9 | 1 | 1 | 0 | 0 | 1 | 0 |
| | 10 | 1 | 1 | 1 | 0 | 1 | 0 |
| | 11 | 1 | 1 | 1 | 1 | 1 | 0 |
| Operating on 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz only | 12 | 1 | 0 | 0 | 0 | 1 | 1 |
| | 13 | 1 | 1 | 0 | 0 | 1 | 1 |
| | 14 | 1 | 1 | 1 | 0 | 1 | 1 |
| | 15 | 1 | 1 | 1 | 1 | 1 | 1 |
| NOTE—“1” denotes an allowed PPDU mask; “0” denotes a disallowed PPDU mask. | | | | | | | |

### 9.4.2.267 EDMG Extended Schedule element

The EDMG Extended Schedule element defines the channel scheduling for an EDMG BSS, including an indication of which channels an allocation is scheduled on.

The format of the EDMG Extended Schedule element is shown in Figure 9-788bf.

| | Element ID | Length | Element ID Extension | EDMG Allocation Control | Number of Allocations | Channel Allocation 1 | … | Channel Allocation N |
|---|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 | 5 or 20 | | 5 or 20 |

**Figure 9-788bf—EDMG Extended Schedule element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The EDMG Allocation Control field is defined in Figure 9-788bg.

| | B0 | B1 B7 |
|---|---|---|
| | Distributed Scheduling Enabled | Reserved |
| Bits: | 1 | 7 |

**Figure 9-788bg—EDMG Allocation Control field format**

The Distributed Scheduling Enabled subfield is set to 1 to indicate that the distributed scheduling mechanism (see 10.68) is enabled. Otherwise, this subfield is set to 0.

The Number of Allocations field indicates the number, *N*, of Channel Allocation fields following it.

Each Channel Allocation field starts with a Scheduling Type subfield, which defines the format of the remaining of the Channel Allocation field.

If the Scheduling Type subfield is 0, the Channel Allocation field contains supplemental allocation information (e.g., bandwidth that the allocation occupies) to the Allocation field in the Extended Schedule element for the same allocation. In this case, the Channel Allocation field is defined in Figure 9-788bh.

| | B0 | B1 B24 | B25 | B26 B33 | B34 |
|---|---|---|---|---|---|
| | Scheduling Type | Allocation Key | Channel Aggregation | BW | Asymmetric Beamforming Training |
| Bits: | 1 | 24 | 1 | 8 | 1 |

| | B35 B49 | B50 B54 | B55 B56 | B57 B58 | B59 B63 |
|---|---|---|---|---|---|
| | Receive Direction | Number of Space-time Slots | Nmax STS | Recommended Transmission Scheme | Reserved |
| Bits: | 15 | 5 | 2 | 2 | 5 |

**Figure 9-788bh—Channel Allocation field format when Scheduling Type is 0**

The contents of the Allocation Key subfield are used to identify the allocation. This is done by matching the contents of this subfield with the information obtained from the Extended Schedule element transmitted in the same frame containing the EDMG Extended Schedule element. The Allocation Key subfield is formatted as shown in Figure 9-788bi.

| | B0 B3 | B4 B11 | B12 B19 | B20 B23 |
|---|---|---|---|---|
| | Allocation ID | Source AID | Destination AID | Reserved |
| Bits: | 4 | 8 | 8 | 4 |

**Figure 9-788bi—Allocation Key field format**

The Allocation ID, Source AID, and Destination AID subfields are collectively used to identify the allocation included as part of the Extended Schedule element.

The Channel Aggregation and BW subfields are defined in Table 28-12. These fields specify the channel(s) on which the allocation is scheduled.

If the Scheduling Type subfield is 1, the Channel Allocation field contains the complete allocation scheduling information. In this case, the Channel Allocation field is defined in Figure 9-788bj.

| | B0 | B1 | B2 B9 | B10 | B11 B25 | B26 B30 |
|---|---|---|---|---|---|---|
| | Scheduling Type | Channel Aggregation | BW | Asymmetric Beamforming Training | Receive Direction | Number of Space-time Slots |
| Bits: | 1 | 1 | 8 | 1 | 15 | 5 |

| | B31 B32 | B33 B34 | B35 B39 | B40 B159 |
|---|---|---|---|---|
| | Nmax STS | Recommended Transmission Scheme | Reserved | Allocation |
| Bits: | 2 | 2 | 5 | 120 |

**Figure 9-788bj—Channel Allocation field format when Scheduling Type is 1**

The Channel Aggregation and BW subfields are defined in Table 28-12. These fields specify the channel(s) on which the allocation is scheduled. The Channel Aggregation and BW subfields are reserved when the Asymmetric Beamforming Training subfield is set to 1.

The Asymmetric Beamforming Training subfield is set to 1 to indicate that this allocation is dedicated to performing the procedure specified in 10.42.10.3. Otherwise, this subfield is set to 0.

The Receive Direction subfield indicates the receive antenna configuration that the PCP or AP uses during the allocation and is formatted as shown in Figure 9-788bk. The Receive Direction subfield is reserved if the Asymmetric Beamforming Training subfield is 1.

| | B0 | B1 B11 | B12 B14 |
|---|---|---|---|
| | IsDirectional | Sector ID | DMG Antenna ID |
| Bits: | 1 | 11 | 3 |

**Figure 9-788bk—Receive Direction subfield format**

The IsDirectional subfield is set to 1 to indicate that the PCP or AP uses a directional, non quasi-omni antenna pattern to receive frames during the allocation, and is set to 0 otherwise.

The Sector ID subfield is reserved if the IsDirectional subfield is 0. Otherwise, the Sector ID subfield indicates the sector that the AP or PCP uses to receive frames during this allocation.

The DMG Antenna ID subfield is reserved if the IsDirectional subfield is 0. Otherwise, the DMG Antenna ID subfield indicates the DMG antenna that the AP or PCP uses to receive frames during this allocation.

The value of the Number of Space-time Slots subfield indicates the number of space-time slots allocated by the AP or PCP for asymmetric beamforming training. The Number of Space-time Slots subfield is reserved if the Asymmetric Beamforming Training subfield is 0. A space-time slot is a time slot in an asymmetric beamforming training allocation in which the AP or PCP listens on the combination of sector and DMG antenna as defined in 10.42.10.3.3.

The value $2^{STS}$, where STS is the value of the Nmax STS subfield, indicates the maximum number of consecutive space-time slots a responder can occupy within a listen period of asymmetric beamforming training. The Nmax STS subfield is reserved if the Asymmetric Beamforming Training subfield is 0. The value $2^{STS}$ is no more than the value of the Number of Space-time Slots subfield.

The Recommended Transmission Scheme subfield is set to 0 to indicate no transmission scheme for the allocation is recommended by the AP or the PCP. The subfield is set to 1 to indicate SISO transmission is recommended by the AP or the PCP for the allocation. The subfield is set to 2 to indicate SU-MIMO transmission is recommended by the AP or the PCP for the allocation. Value of 3 is reserved.

The Allocation subfield is defined in Figure 9-563. Other subfields are defined in the paragraphs above.

### 9.4.2.268 EDMG Channel Measurement Feedback element

The EDMG Channel Measurement Feedback element is used to carry channel measurement feedback data that an EDMG STA has measured on DMG Beacon frames, SSW frames, Short SSW PPDUs or TRN fields of EDMG BRP PPDUs. This channel measurement feedback data is provided in addition to what is provided in the Channel Measurement Feedback element. The EDMG Channel Measurement Feedback element provides a list of sectors per transmit DMG antenna identified during sector sweep or during beam combination, or a list of TX sector combinations identified during SU-MIMO or MU-MIMO beamforming training and that can be used to establish a beamformed SISO, SU-MIMO, or MU-MIMO link, as well as AWV information obtained during beam tracking.

The format and size of the EDMG Channel Measurement Feedback element are defined by the parameter values specified in the accompanying DMG Beam Refinement element or MIMO Feedback Control element. The EDMG Channel Measurement Feedback element is shown in Table 9-322m.

If the RXVECTOR parameter DUAL_POL_TRAINING of the PPDU over which the measurements were performed was 1 and the RXVECTOR parameter FIRST_PATH_TRAINING was 0, the Dual Polarization TRN Measurement field contains the measurements for all measured taps. If the RXVECTOR parameter DUAL_POL_TRAINING of the PPDU over which the measurements were performed was 1 and the RXVECTOR parameter FIRST_PATH_TRAINING was also 1, only the measurements corresponding to the tap #1 (shortest delay) are added to the Dual Polarization TRN Measurement field. The Relative I/Q Component Tap #N, polarization #1 or #2, represent the measured signal strength for the I or Q component for the tap #N and polarization #1 or #2, respectively.

**Table 9-322m—EDMG Channel Measurement Feedback element format**

<table>
<tr><th>Field</th><th>Size (bits)</th><th>Meaning</th></tr>
<tr><td>Element ID</td><td>8</td><td>Defined in 9.4.2.1</td></tr>
<tr><td>Length</td><td>8</td><td>Defined in 9.4.2.1</td></tr>
<tr><td>Element ID Extension</td><td>8</td><td>Defined in 9.4.2.1</td></tr>
<tr><td colspan="3">EDMG Sector ID Order</td></tr>
<tr><td>Sector $ID_1$/$CDOWN_1$/AWV Feedback $ID_1$</td><td>11</td><td rowspan="7">Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$ –<br>Sector ID/CDOWN/AWV feedback ID for $SNR_k$ being obtained, or Sector ID/CDOWN/AWV feedback ID of the $k^{th}$ detected beam.<br><br>TX Antenna $ID_k$ – TX antenna ID corresponding to Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$<br><br>RX Antenna $ID_k$ – RX antenna ID corresponding to Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$</td></tr>
<tr><td>TX Antenna $ID_1$</td><td>3</td></tr>
<tr><td>RX Antenna $ID_1$</td><td>3</td></tr>
<tr><td>Sector $ID_2$/$CDOWN_2$/AWV Feedback $ID_2$</td><td>11</td></tr>
<tr><td>TX Antenna $ID_2$</td><td>3</td></tr>
<tr><td>RX Antenna $ID_2$</td><td>3</td></tr>
<tr><td>…</td><td>…</td></tr>
</table>

**Table 9-322m—EDMG Channel Measurement Feedback element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Sector $ID_{Nmeas}$/ $CDOWN_{Nmeas}$/ AWV Feedback $ID_{Nmeas}$ | 11 | |
| TX Antenna $ID_{Nmeas}$ | 3 | |
| RX Antenna $ID_{Nmeas}$ | 3 | |
| BRP CDOWN | | |
| BRP $CDOWN_1$ | 6 | BRP $CDOWN_k$: BRP CDOWN corresponding to AWV feedback $ID_k$ |
| BRP $CDOWN_2$ | 6 | |
| … | … | |
| BRP $CDOWN_{Nmeas}$ | 6 | |
| Tap Delay | | |
| Relative Delay Tap #1 | 12 | The delay of tap #1 in units of $T_c/N_{CB}$ relative to the path with the shortest delay detected, where $N_{CB}$ is the integer number of contiguous 2.16 GHz channels over which the measurement was taken. |
| Relative Delay Tap #2 | 12 | The delay of tap #2 in units of $T_c/N_{CB}$ relative to the path with the shortest delay detected, where $N_{CB}$ is the integer number of contiguous 2.16 GHz channels over which the measurement was taken. |
| … | … | |
| Relative Delay Tap #Ntaps | 12 | The delay of tap #Ntaps in units of $T_c/N_{CB}$ relative to the path with the shortest delay detected, where $N_{CB}$ is the integer number of contiguous 2.16 GHz channels over which the measurement was taken. |
| Additional EDMG Sector ID Order | | |
| Sector $ID_1$/$CDOWN_1$/ AWV Feedback $ID_1$ | 11 | Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$ – Sector ID/CDOWN/AWV feedback ID for $SNR_k$ being obtained, or Sector ID/CDOWN/AWV feedback ID of the $k^{th}$ detected beam.<br><br>TX Antenna $ID_k$ – TX antenna ID corresponding to Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$<br><br>RX Antenna $ID_k$ – RX antenna ID corresponding to Sector $ID_k$/$CDOWN_k$/AWV Feedback $ID_k$ |
| TX Antenna $ID_1$ | 3 | |
| RX Antenna $ID_1$ | 3 | |
| Sector $ID_2$/$CDOWN_2$/ AWV Feedback $ID_2$ | 11 | |
| TX Antenna $ID_2$ | 3 | |
| RX Antenna $ID_2$ | 3 | |
| … | … | |
| Sector $ID_{Nmeas}$/ $CDOWN_{Nmeas}$/ AWV Feedback $ID_{Nmeas}$ | 11 | |
| TX Antenna $ID_{Nmeas}$ | 3 | |
| RX Antenna $ID_{Nmeas}$ | 3 | |

**Table 9-322m—EDMG Channel Measurement Feedback element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Additional BRP CDOWN | | |
| BRP $CDOWN_1$ | 6 | Additional BRP $CDOWN_k$: BRP CDOWN corresponding to AWV feedback $ID_k$ |
| BRP $CDOWN_2$ | 6 | |
| … | … | |
| BRP $CDOWN_{Nmeas}$ | 6 | |
| Additional Tap Delay | | |
| Relative Delay Tap #1 | 12 | |
| Relative Delay Tap #2 | 12 | |
| … | … | |
| Relative Delay Tap #Ntaps | 12 | |
| Dual Polarization TRN Measurement | | |
| Relative I Component Tap #1 Polarization #1 | 8 | The in-phase component of impulse response for tap #1 (shortest delay), and polarization #1 in the dual polarization TRN |
| Relative Q Component Tap #1 Polarization #1 | 8 | The quadrature component of impulse response for tap #1 (shortest delay), and polarization #1 in the dual polarization TRN |
| Relative I Component Tap #1 Polarization #2 | 8 | The in-phase component of impulse response for Tap #1 (shortest delay), and polarization #2 in the dual polarization TRN |
| Relative Q Component Tap #1 Polarization #2 | 8 | The quadrature component of impulse response for tap #1 (shortest delay), and polarization #2 in the dual polarization TRN |
| Relative I Component Tap #2 Polarization #1 | 8 | The in-phase component of impulse response for tap #2 , and polarization #1 in the dual polarization TRN |
| Relative Q Component Tap #2 Polarization #1 | 8 | The quadrature component of impulse response for tap #2, and polarization #1 in the dual polarization TRN |
| Relative I Component Tap #2 Polarization #2 | 8 | The in-phase component of impulse response for tap #2, and polarization #2 in the dual polarization TRN |
| Relative Q Component Tap #2 Polarization #2 | 8 | The quadrature component of impulse response for tap #2, and polarization #2 in the dual polarization TRN |
| | … | |
| Relative I Component Tap #N Polarization #1 | 8 | The in-phase component of impulse response for tap #N, and polarization #1 in the dual polarization TRN |
| Relative Q Component Tap #N Polarization #1 | 8 | The quadrature component of impulse response for tap #N, and polarization #1 in the dual polarization TRN |
| Relative I Component Tap #N Polarization #2 | 8 | The in-phase component of impulse response for tap #N, and polarization #2 in the dual polarization TRN |
| Relative Q Component Tap #N Polarization #2 | 8 | The quadrature component of impulse response for tap #N, and polarization #2 in the dual polarization TRN |
| Padding | 0–7 | Zero padding to make the EDMG Channel Measurement Feedback element length a multiple of 8 bits |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

When the EDMG Channel Measurement Feedback element is included in a BRP frame, the EDMG Sector ID Order field indicates the TX sector IDs, TX antenna IDs and RX antenna IDs corresponding to the SNRs in the SNR field when the SNR Present subfield of the FBCK-TYPE field is equal to 1 and the Sector Sweep Frame Type field is equal to 0 (i.e., DMG Beacon frame or SSW frame) in the DMG Beam Refinement element contained in the frame. The EDMG Sector ID Order field indicates the CDOWN values and RX antenna IDs corresponding to the SNRs in the SNR field when the SNR Present subfield of the FBCK-TYPE field is equal to 1 and the Sector Sweep Frame Type field is equal to 1 (i.e., Short SSW PPDU) in the DMG Beam Refinement element contained in the frame. The TX Antenna ID subfields of the EDMG Sector ID Order field are reserved when the Sector Sweep Frame Type field is equal to 1 in the DMG Beam Refinement element contained in the frame.

When the EDMG Channel Measurement Feedback element is included in a MIMO BF Feedback frame or when the EDMG Channel Measurement Feedback element is included in a BRP frame with the Sector Sweep Frame Type field of the DMG Beam Refinement element contained in the frame equal to 2, the EDMG Sector ID Order field indicates AWV feedback IDs, TX antenna IDs and RX antenna IDs. The RX Antenna ID subfields of the EDMG Sector ID Order field are reserved when the EDMG Channel Measurement Feedback element is included in the MIMO BF Feedback frame. The BRP CDOWN field indicates BRP CDOWN values. The EDMG Sector ID Order field and the BRP CDOWN field can be divided into $N_{meas}$ SISO ID subsets. Specifically, the $i$ SISO ID subset ($i$ = 1, 2, …, $N_{meas}$) comprises the values of the AWV Feedback IDi, TX Antenna IDi, RX Antenna IDi and BRP CDOWNi subfields, where the AWV Feedback IDi subfield indicates the AWV for a TX DMG antenna having its TX antenna ID equal to the TX Antenna IDi subfield value, which is used to transmit an EDMG BRP-RX/TX PPDU or EDMG BRP-TX PPDU with the BRP CDOWN field set to the BRP CDOWNi subfield value.

Table 9-322n summarizes how the sector and DMG antenna are interpreted on the basis of the value of the Sector Sweep Frame Type field value.

**Table 9-322n—Sector and DMG antenna interpretation based on the Sector Sweep Frame Type field value**

| Sector Sweep Frame Type field value | Basis for sector sweep result | TX sector ID interpretation | TX antenna ID interpretation |
|---|---|---|---|
| 0 | DMG Beacon or SSW frame | Sector ID field value in frame | DMG/CMMGAntenna ID subfield value in frame |
| 1 | Short SSW PPDU | CDOWN field value in PPDU | RF Chain ID field in PPDU |
| 2 | BRP frame | AWV Feedback ID field value in frame | TX Antenna Mask field in EDMG BRP Request element |
| 3 | TRN field as part of beam tracking | AWV Feedback ID field value in frame | N/A |

When the EDMG Channel Measurement Feedback element is carried within a MIMO BF Feedback frame, the number of measurements, $N_{meas}$, is equal to $N_{tsc} \times N_{TX} \times N_{RX}$, where $N_{tsc}$ is given by the Number of TX Sector Combinations Present field in the MIMO Feedback Control element within the MIMO BF Feedback frame, $N_{TX}$ refers to the value indicated by the Number of TX Antennas subfield in the MIMO Feedback Control element within the MIMO BF Feedback frame, and $N_{RX}$ refers to the value indicated by the Number of RX Antennas subfield in the MIMO Feedback Control element within the MIMO BF Feedback frame.

When the EDMG Channel Measurement Feedback element is carried within a MIMO BF Feedback frame, every $N_{TX} \times N_{RX}$ consecutive SISO ID subsets constitute a set that corresponds to a specific TX sector combination (or equivalently a specific TX-RX AWV configuration). Each TX sector combination comprises a single TX sector for each of $N_{TX}$ TX DMG antennas. $N_{tsc}$ TX sector combinations are ranked in the decreasing order of an implementation dependent metric. Specifically, the $j$ set ($j = 1, 2, \ldots, N_{tsc}$), which corresponds to the $j$ TX-RX AWV configuration, comprises the $((j-1) \times N_{TX} \times N_{RX} + 1)$ SISO ID subset to the $(j \times N_{TX} \times N_{RX})$ SISO ID subset. Assume that the MIMO channel corresponding to the $j$ TX-RX AWV configuration is defined by the following equation:

$$H_j = \begin{bmatrix} h_{1,1}^{(j)} & \cdots & h_{1,N_{RX}}^{(j)} \\ \vdots & \ddots & \vdots \\ h_{N_{TX},1}^{(j)} & \cdots & h_{N_{TX},N_{RX}}^{(j)} \end{bmatrix}$$

Here, $h_{m,n}^{(j)}$ ($m = 1, 2, \ldots, N_{TX}$ and $n = 1, 2, \ldots, N_{RX}$) represents the channel between the $m$ TX DMG antenna and the $n$ RX DMG antenna and is indicated by the $((j-1) \times N_{TX} \times N_{RX} + (m-1) \times N_{RX} + n)$ SISO ID subset. In particular, for the $j$ TX sector combination ($j = 1, 2, \ldots, N_{tsc}$), the AWV used by the $m$ TX antenna ($m = 1, 2, \ldots, N_{TX}$) is indicated by the values of the AWV feedback $\text{ID}_l$ and BRP $\text{CDOWN}_l$ subfields, where $l = ((j-1) \times N_{TX} \times N_{RX} + (m-1) \times N_{RX} + n$ and $n$ is any integer between 1 and $N_{RX}$.

NOTE—Since a DMG Beacon frame, SSW frame or Short SSW PPDU transmitted through a TX sector, or a TRN subfield of an EDMG BRP-TX PPDU or an EDMG BRP-RX/TX PPDU transmitted using a TX AWV, can be received by several RX DMG antennas, reception of each DMG Beacon frame, SSW frame, Short SSW PPDU or TRN subfield of an EDMG BRP-TX PPDU or an EDMG BRP-RX/TX PPDU through an RX DMG antenna has an entry in the SNR field, the EDMG Sector ID Order field, the Additional SNR field (if present) and the Additional EDMG Sector ID Order field (if present).

If both the Channel Aggregation Present field and the EDMG Extension Flag field in the accompanying DMG Beam Refinement element are 1 or if the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field in the accompanying MIMO Feedback Control element is 1, the following apply:

— The EDMG Sector ID Order, BRP CDOWN and Tap Delay fields are for the channel that includes the primary channel in case of channel aggregation. Otherwise, the EDMG Sector ID Order, BRP CDOWN and Tap Delay fields are for the channel in which the measurement is taken.
— The Additional EDMG Sector ID Order, Additional BRP CDOWN and Additional Tap Delay fields are for the channel that does not include the primary channel in case of channel aggregation. Otherwise, the Additional EDMG Sector ID Order, Additional BRP CDOWN and Additional Tap Delay fields are not present.

### 9.4.2.269 EDMG Group ID Set element

The EDMG Group ID Set element allows an AP or PCP to define groups of MU capable EDMG STAs to perform DL MU-MIMO beamforming training and transmissions. The EDMG Group ID Set element is transmitted in DMG Beacon frames, Announce frames or MIMO BF Selection frames.

The format of the EDMG Group ID Set element is shown in Figure 9-788bl.

| | Element ID | Length | Element ID Extension | Number of EDMG Groups | EDMG Group Tuples |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | Variable |

**Figure 9-788bl—EDMG Group ID Set element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Number of EDMG Groups field indicates the number of EDMG Group fields.

The EDMG Group Tuples field contains one or more EDMG Group Tuple subfields. Each EDMG Group Tuple subfield has the structure shown in Figure 9-788bm.

| | B0 B7 | B8 B12 | B13 B15 | B16 B23 | B24 B31 | | B(8×(*N*+1)) B(8×(*N*+2) – 1) |
|---|---|---|---|---|---|---|---|
| | EDMG Group ID | Group Size (*N*) | Reserved | AID0 | AID1 | … | AIDN-1 |
| Bits: | 8 | 5 | 3 | 8 | 8 | … | 8 |

**Figure 9-788bm—EDMG Group Tuple subfield format**

The EDMG Group ID subfield is a unique, nonzero value that identifies the group.

The Group Size subfield indicates the number of EDMG STAs that belong to the group, i.e., the number of AID subfields following this subfield minus one.

Each AID subfield contains the AID of an EDMG STA that belongs to the group.

### 9.4.2.270 EDMG BRP Request element

The EDMG BRP Request element provides BRP configuration in addition to the BRP configuration provided in the BRP Request field. The EDMG BRP Request element is defined in Figure 9-788bn.

| | B0 B7 | B8 B15 | B16 B23 | B24 B31 | B32 B39 | B40 B50 | B51 B52 | B53 B56 |
|---|---|---|---|---|---|---|---|---|
| | Element ID | Length | Element ID Extension | L-RX | L-TX-RX | TX Sector ID | Requested EDMG TRN-Unit P | Requested EDMG TRN-Unit M |
| Bits: | 8 | 8 | 8 | 8 | 8 | 11 | 2 | 4 |

| | B57 B58 | B59 | B60 | B61 B63 | B64 B66 | B67 | B68 B73 |
|---|---|---|---|---|---|---|---|
| | Requested EDMG TRN-Unit N | BRP-TXSS | TXSS-INITIATOR | TXSS-PPDUs | TXSS-REPEAT | TXSS-MIMO | BRP CDOWN |
| Bits: | 2 | 1 | 1 | 3 | 3 | 1 | 6 |

| | B74 B81 | B82 B84 | B85 | B86 | B87 | B88 | B89 B90 | B91 B95 |
|---|---|---|---|---|---|---|---|---|
| | TX Antenna Mask | Comeback Delay | First Path Training | Dual Polarization TRN | Digital BF Request | Feedback Type | Nc Index | Reserved |
| Bits: | 8 | 3 | 1 | 1 | 1 | 1 | 2 | 5 |

**Figure 9-788bn—EDMG BRP Request element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The L-RX field indicates the number of TRN-Units requested by the transmitting STA as part of receive beam refinement. When the EDMG BRP Request element is present in a frame, the value of this field overrides the value of the subfield with the same name carried in the BRP Request field.

The L-TX-RX field indicates the requested number of consecutive TRN-Units for which the transmit AWV remains with the same AWV configuration as part of simultaneous receive and transmit beam refinement.

The TX Sector ID field indicates the sector ID that is used when transmitting the frame. If the frame is transmitted using a pattern that is not a sector that has been used in the sector sweep, the value of this field is set to 2047. When the EDMG BRP Request element is present in a frame, the value of this field overrides the value of the subfield with the same name carried in the BRP Request field.

The Requested EDMG TRN-Unit P field indicates the requested number of TRN subfields at the start of a TRN-Unit that use the same AWV, which is the same AWV used in the transmission of the preamble and Data fields of the PPDU, except for the case when the DMG antenna used in the transmission of the PPDU changes at the beginning of the TRN field (see 28.9.2.2.5). A svalue of zero indicates zero requested TRN subfields, a value of one indicates one requested TRN subfield, a value of two indicates two requested TRN subfields and a value of three indicates four requested TRN subfields.

The value of the Requested EDMG TRN-Unit M field plus one indicates the requested number of TRN subfields within a TRN-Unit that can be used for transmit training, as defined in 28.9.2.2. The value of this field plus one is an integer multiple of the value indicated in the Requested EDMG TRN-Unit N field.

The Requested EDMG TRN-Unit N field indicates the requested number of consecutive TRN subfields within EDMG TRN-Unit M that are transmitted using the same AWV. A value of zero indicates one requested TRN subfield, a value of one indicates two requested TRN subfields, a value of two indicates three requested TRN subfields if the Requested EDMG TRN-Unit M field is equal to 2, 5, 8, 11, or 14, a value of two indicates eight requested TRN subfields if the Requested EDMG TRN-Unit M field is equal to 7 or 15, and a value of three indicates four requested TRN subfields.

The BRP-TXSS field is set to 1 to indicate either a request to perform BRP TXSS or to acknowledge a request to perform BRP TXSS, as defined in 10.42.10.5. Otherwise, this field is set to 0.

If the BRP-TXSS field is equal to 1, the TXSS-INITIATOR field set to 1 indicates that the transmitter of the BRP frame is the initiator of a BRP TXSS and the TXSS-INITIATOR field set to 0 indicates that the transmitter of the BRP frame is the responder of a BRP TXSS. If the BRP-TXSS field is equal to 0, the TXSS-INITIATOR field is reserved.

If the BRP-TXSS field and the TXSS-INITIATOR are both equal to 1, the value in the TXSS-PPDUs field plus one indicates the number of EDMG BRP-TX PPDUs necessary for the initiator to perform transmit training. If the BRP-TXSS field is equal to 1 and the TXSS-INITIATOR field is equal to 0, the value in the TXSS-PPDUs field plus one indicates the number of EDMG BRP-TX PPDUs necessary for the responder to perform transmit training if the procedure includes a Responder BRP TXSS (see 10.42.10.5). If the BRP-TXSS field is equal to 0, the TXSS-PPDUs field is reserved.

If the BRP-TXSS field and the TXSS-INITIATOR field are both equal to 1, the TXSS-REPEAT field plus one indicates the number of times that the EDMG BRP-TX PPDUs transmitted in the Responder BRP TXSS is repeated if the BRP TXSS includes a Responder BRP TXSS. If the BRP-TXSS field is equal to 1 and the TXSS-INITIATOR field is equal to 0, the TXSS-REPEAT field plus one indicates the number of times that the EDMG BRP-TX PPDUs transmitted in the Initiator BRP TXSS is repeated. If the BRP-TXSS field is equal to 0, the TXSS-REPEAT field is reserved.

If the BRP-TXSS field and the TXSS-INITIATOR field are both equal to 1, the TXSS-MIMO field set to 1 indicates that the requested BRP TXSS is a MIMO BRP TXSS (see 10.42.10.5), and the TXSS-MIMO field set to 0 indicates that the requested BRP TXSS is a SISO BRP TXSS (see 10.42.10.5). If the BRP-TXSS field and the TXSS-INITIATOR field are not both equal to 1, the TXSS-MIMO field is reserved.

The BRP CDOWN field is a down counter indicating the number of remaining EDMG BRP PPDU transmissions to the end of the BF training.

The TX Antenna Mask field is a bitmap that indicates whether each of eight TX DMG antennas is used in the transmission of the EDMG BRP PPDU. The first bit (i.e., the least significant bit) corresponds to the first TX DMG antenna, the second bit corresponds to the second TX DMG antenna, and so on. A bit is set to 1 to indicate the associated TX DMG antenna is used in the transmission of the EDMG BRP PPDU; otherwise, the bit is set to 0.

The Comeback Delay field indicates that the STA might not be ready with the feedback within BRPIFS. The value in the Comeback Delay field indicates when the device is ready with feedback. The interpretation of this field is defined according to Table 9-322o.

**Table 9-322o—Interpretation of the Comeback Delay field**

| Value | Meaning |
|---|---|
| 0 | Feedback is ready within this frame. |
| 1 | 64 μs |
| 2 | 128 μs |
| 3 | 256 μs |
| 4 | 512 μs |
| 5 | 768 μs |
| 6 | 1024 μs |
| 7 | 2048 μs |

The First Path training field set to 1 indicates that the BRP procedure is designated as a first path training procedure as specified in 10.42.10.6. This field is set to 0 otherwise.

The Dual Polarization TRN field is set to 1 to request a BRP initiator to send TRN subfields with different polarizations for the same AWV as specified in 10.42.10.7. It is set to 0 otherwise.

The Digital BF Request field set to 1 indicates a request for performing digital beamforming. Otherwise, this field is set to 0.

The Feedback Type field indicates the type of feedback requested. Set to 0 for SU and set to 1 for MU.

If the Feedback Type field indicates MU, then the Nc Index field indicates the number of columns, $Nc$, in the compressed beamforming feedback matrix minus 1 for hybrid beamforming feedback in the EDMG OFDM mode. The interpretation of this field is defined according to Table 9-322p.

**Table 9-322p—Encoding of Nc Index field**

| Value | Meaning |
|---|---|
| 0 | $Nc$ = 1. |
| 1 | $Nc$ = 2. |
| 2 | Reserved. |
| 3 | Reserved. |

### 9.4.2.271 EDMG Training Field Schedule element

The EDMG Training Field Schedule element allows an EDMG STA to announce BTIs in which TRN-R subfields are present in PPDUs containing DMG Beacon frames transmitted during the BTI.

The format of the EDMG Training Field Schedule element is shown in Figure 9-788bo.

| | Element ID | Length | Element ID Extension | Next BTI With TRN | TRN Schedule Interval |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 |

**Figure 9-788bo—EDMG Training Field Schedule element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Next BTI With TRN field indicates the number of beacon intervals in which TRN-R subfields are not present in any PPDU transmitted in a BTI. The value of this field is this field is decreased by one at the start of every beacon interval until it reaches zero and is subsequently reset. If the Next BTI With TRN field is 0, TRN-R fields are present in the BTI.

The TRN Schedule Interval field indicates the periodic interval, in number of beacon intervals, at which TRN-R subfields are present in the BTI of one or more consecutive beacon intervals. If the value of this field is 0, there is no periodicity and the presence of TRN-R fields in a BTI is determined solely by the value of the Next BTI With TRN field.

### 9.4.2.272 EDMG Partial Sector Level Sweep element

The EDMG Partial Sector Level Sweep element is used to exchange the length of a sector level sweep to be performed when the link is lost before the STA’s resort to a complete sector level sweep. The format of the element is shown in Figure 9-788bp.

| | Element ID | Length | Element ID Extension | Partial SLS Configuration |
|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 4 |

**Figure 9-788bp—EDMG Partial Sector Level Sweep element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Partial SLS Configuration field is defined in Figure 9-788bq.

| | B0 B5 | B6 B16 | B17 B19 | B20 B22 | B23 B26 | B27 | B28 | B29 B31 |
|---|---|---|---|---|---|---|---|---|
| | Partial Number of Sectors | Total Number of Sectors | Partial Number of Rx Antennas | Total Number of Rx Antennas | Time to Switch to Full Sector Sweep | Agree to Change Initiator/ Responder Roles | Agree to Partial Sector Sweep | Reserved |
| Bits: | 6 | 11 | 3 | 3 | 4 | 1 | 1 | 3 |

**Figure 9-788bq—Partial SLS Configuration field format**

The Partial Number of Sector field indicates the number of sectors the sender intends to transmit per each of the peer STA's receive antennas as part of the partial sector level sweep.

The Total Number of Sector field indicates the number of sectors the sender intends to use as a transmitter per each of the peer STA's receive antennas as part of the complete sector level sweep.

The Partial Number of Rx antennas field indicates the number of RX antennas the sender intends to use when receiving the partial sector sweep.

The Total Number of Rx antennas field indicates the number of RX antennas the sender intends to use when receiving the complete sector level sweep.

When sent by the initiator of the partial sector level sweep exchange, the Time to Switch to Complete Sector Sweep field is the time, in units of one millisecond, after the expiration of the beamformed link maintenance timer (see 11.27.1.1) that the initiator of the exchange proposes to switch to a complete sector level sweep. This field is reserved when sent by the responder of this exchange.

When sent by the initiator of the partial sector level sweep exchange and set to 1, the Agree to Change Initiator/Responder Roles field indicates that the initiator requests to change the roles of initiator/responder in the sector level sweep starting with the expiration of the beamformed link maintenance timer. This field is reserved otherwise.

When sent by the initiator of the partial sector level sweep exchange, the Agree to Partial Sector Sweep field is set to 1. When sent by the responder of the partial sector level sweep exchange, the Agree to Partial Sector Sweep field is set to 1 to indicate agreement to the partial sector level sweep and is set to 0 to indicate disagreement to the partial sector level sweep.

### 9.4.2.273 MIMO Setup Control element

The MIMO Setup Control element, defined in Table 9-322q, is used to carry configuration information required for the SU-MIMO BF training and feedback subphases or the MU-MIMO BF training and feedback subphases.

**Table 9-322q—MIMO Setup Control element format**

| Field | Size (bits) | Meaning |
|---|---|---|
| Element ID | 8 | |
| Length | 8 | |
| Element ID Extension | 8 | |

**Table 9-322q—MIMO Setup Control element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| SU/MU | 1 | This field is set to 0 to indicate SU-MIMO beamforming and is set to 1 to indicate MU-MIMO beamforming. |
| Nonreciprocal/Reciprocal MIMO Phase | 1 | This field is set to 0 to indicate the nonreciprocal MIMO phase and is set to 1 to indicate the reciprocal MIMO phase. |
| EDMG Group ID | 8 | Indicates the EDMG Group ID of target MU group. This field is reserved when the SU/MU field is set to 0. |
| Group User Mask | 32 | |
| L-TX-RX | 8 | Indicates the requested number of consecutive TRN-Units in which the same AWV is used in the transmission of the last *M* TRN subfields of each TRN-Unit. This field is reserved when the SU/MU field is set to 1 or when the SU/MU field is set to 0, the Nonreciprocal/Reciprocal MIMO phase field is set to 1 and the Initiator field is set to 1.<br><br>NOTE—*M* is equal to the value of the Requested EDMG TRN-Unit M field plus 1. |
| Requested EDMG TRN-Unit M | 4 | The value of this field plus one indicates the requested number of TRN subfields in a TRN-Unit that can be used for transmit training, as defined in 28.9.2.2. This field is reserved when the SU/MU field is set to 1 or when the SU/MU field is set to 0, the Nonreciprocal/Reciprocal MIMO phase field is set to 1 and the Initiator field is set to 1. |
| Initiator | 1 | This field is set to 1 to indicate the sender is the initiator and is set to 0 otherwise. This field is set to 1 when the SU/MU field is set to 1. |
| MIMO FBCK-REQ | 10 | Indicates requested channel measurement feedback. |
| Reserved | 7 | |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Group User Mask field is a bitmap that indicates whether an EDMG STA in the target MU group is requested to engage in the subsequent MU-MIMO BF training. The order of EDMG STAs in the Group User Mask field follows the order in which they appear in the corresponding EDMG Group field of the EDMG Group ID Set element defining the target MU group. The first bit (i.e., the least significant bit) of the Group User Mask field corresponds to the first EDMG STA in the MU group, the second bit corresponds to the second EDMG STA, and so on. A bit is set to 1 to indicate that the corresponding EDMG STA is requested to engage in the subsequent MU-MIMO BF training; otherwise, the bit is set to 0. This Group User Mask field is reserved when the SU/MU field is set to 0. If the number of EDMG STAs in the target MU group is smaller than 32, the corresponding bits in the Group User Mask field are set to 0.

The MIMO FBCK-REQ field is defined in Figure 9-788br.

| | Channel Measurement Requested | Number of Taps Requested | Number of TX Sector Combinations Requested | Channel Aggregation Requested |
|---|---|---|---|---|
| Bits: | 1 | 2 | 6 | 1 |

**Figure 9-788br—MIMO FBCK-REQ field format**

If the Channel Measurement Requested subfield is set to 1, the Channel Measurement subfield is requested as part of MIMO BF feedback. Otherwise, set to 0.

The Number of Taps Requested subfield indicates the number of taps requested in each channel measurement. The encoding for this subfield is specified in Table 9-256.

The value of the Number of TX Sector Combinations Requested subfield plus one indicates the number of TX sector combinations requested as part of MIMO BF feedback.

The Channel Aggregation Requested subfield is set to 1 to indicate that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel and to request the channel measurement feedback per channel, in case channel aggregation is used as part of MIMO BF feedback. Otherwise, this subfield is set to 0.

### 9.4.2.274 MIMO Poll Control element

The MIMO Poll Control element is defined in Table 9-322r.

**Table 9-322r—MIMO Poll Control element format**

| Field | Size (bits) | Meaning |
|---|---|---|
| Element ID | 8 | |
| Length | 8 | |
| Element ID Extension | 8 | |
| SU/MU | 1 | This field is set to 0 to indicate SU-MIMO beamforming and is set to 1 to indicate MU-MIMO beamforming. |
| Poll Type | 1 | This field is set to 1 to indicate training PPDU poll used in the reciprocal MU-MIMO beamforming or the MU-MIMO hybrid beamforming feedback phase. It is set to 0 to indicate MIMO BF feedback poll used in the SU-MIMO beamforming or the nonreciprocal MU-MIMO beamforming. |
| L-TX-RX | 8 | Indicates the requested number of consecutive TRN-Units in which the same AWV is used in the transmission of the last *M* TRN subfields of each TRN-Unit. This field is reserved when the Poll Type field is set to 0. |
| Requested EDMG TRN-Unit M | 4 | The value of this field plus one indicates the requested number of TRN subfields in a TRN-Unit can be used for transmit training, as defined in 28.9.2.2. This field is reserved when the Poll Type field is set to 0. |
| Requested EDMG TRN-Unit P | 2 | Indicates the requested number of TRN subfields at the start of a TRN-Unit that use the same AWV. A value of zero indicates zero requested TRN subfields, a value of one indicates one requested TRN subfield, a value of two indicates two requested TRN subfields and a value of three indicates four requested TRN subfields. This field is reserved when the Poll Type field is set to 0. |
| Training Duration | 14 | Indicates the maximum duration, in microseconds, that can be used by the polled responder to transmit EDMG BRP-RX/TX PPDUs and starts following the reception of the MIMO BF Poll frame containing this element. Possible values range from 1 to 16383. This field is reserved when the Poll Type field is set to 0. |
| Reserved | 2 | |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

### 9.4.2.275 MIMO Feedback Control element

The MIMO Feedback Control element, as shown in Table 9-322s, is used to carry configuration information for accompanying Channel Measurement Feedback element, EDMG Channel Measurement Feedback element and/or Digital BF Feedback element.

**Table 9-322s—MIMO Feedback Control element format**

| Field | Size (bits) | Meaning |
|---|---|---|
| Element ID | 8 | |
| Length | 8 | |
| Element ID Extension | 8 | |
| SU/MU | 1 | This field is set to 0 to indicate SU-MIMO beamforming and is set to 1 to indicate MU-MIMO beamforming. |
| Link Type | 1 | This field is set to 0 to indicate initiator link and is set to 1 otherwise. This field is set to 0 when the SU/MU field is set to 1. |
| Comeback Delay | 3 | This field indicates whether MIMO BF feedback is included in the MIMO BF Feedback frame containing the MIMO Feedback Control element or when the EDMG STA transmitting the MIMO Feedback Control element is ready with MIMO BF feedback. The encoding of this field is defined in Table 9-322o. |
| MIMO FBCK-TYPE | 18 | |
| Digital Fbck Control | 30 | Defines the requirements for the digital feedback type. |
| Reserved | 3 | |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The MIMO FBCK-TYPE field is defined in Figure 9-788bs. This field is reserved when the Comeback Delay field is set to a nonzero value.

| | B0 | B1 | B2 B3 | B4 B9 | B10 | B11 | B12 B14 | B15 B17 |
|---|---|---|---|---|---|---|---|---|
| | Channel Measurement Present | Tap Delay Present | Number of Taps Present | Number of TX Sector Combinations Present | Precoder Information Present | Channel Aggregation Present | Number of TX Antennas | Number of RX Antennas |
| Bits: | 1 | 1 | 2 | 6 | 1 | 1 | 3 | 3 |

**Figure 9-788bs—MIMO FBCK-TYPE field format**

If the Channel Measurement Present subfield is set to 1, the Channel Measurement subfield is present as part of the MIMO BF feedback. Otherwise, set to 0.

If the Tap Delay Present subfield is set to 1, the Tap Delay subfield is present as part of the MIMO BF feedback. Otherwise, set to 0.

The Number of Taps Present subfield indicates the number of taps present in each channel measurement. This subfield has the same encoding as the Number of Taps Requested subfield specified in Table 9-256.

The value of the Number of TX Sector Combinations Present subfield plus one indicates the number of TX sector combinations, $N_{tsc}$, for the MIMO BF feedback. The number of measurements, $N_{meas}$, is $N_{TX} \times N_{RX}$ multiples of the number of TX sector combinations, $N_{tsc}$ (see 9.4.2.268).

The Precoder Information Present subfield is set to 1 to indicate that precoding information is present as part of the MIMO BF feedback. Otherwise, it is set to 0.

The Channel Aggregation Present subfield is set to 1 to indicate that, in case of channel aggregation, channel measurement feedback per channel is present. Otherwise, it is set to 0.

The Number of TX Antennas and the Number of RX Antennas subfields describe the $N_{TX}$ and $N_{RX}$ used in each of the $N_{tsc}$ sector combinations.

The Digital Fbck Control field defines the parameters of the accompanying digital BF feedback. The field is defined in Figure 9-788bt, and its subfields are described in Table 9-322t.

| | B0 B2 | B3 B5 | B6 B13 | B14 B15 | B16 B17 | B18 | B19 | B20 B29 |
|---|---|---|---|---|---|---|---|---|
| | Nc Index | Nr Index | Tx Antenna Mask | Ncb | Grouping | Codebook Information | Feedback Type | Number of Feedback Matrices or Feedback Taps |
| Bits: | 3 | 3 | 8 | 2 | 2 | 1 | 1 | 10 |

**Figure 9-788bt—Digital Fbck Control field format**

**Table 9-322t—Definition of subfields within Digital Fbck Control field**

| Subfield | Meaning |
|---|---|
| Nc Index | Indicates the number of columns, *Nc*, in the beamforming feedback matrix minus one:<br>Set to 0 for *Nc* = 1.<br>Set to 1 for *Nc* = 2.<br>Set to 2 for *Nc* = 3.<br>Set to 3 for *Nc* = 4.<br>Set to 4 for *Nc* = 5.<br>Set to 5 for *Nc* = 6.<br>Set to 6 for *Nc* = 7.<br>Set to 7 for *Nc* = 8. |
| Nr Index | Indicates the number of rows, Nr, in a beamforming feedback matrix minus one:<br>Set to 0 for Nr = 1.<br>Set to 1 for Nr = 2.<br>Set to 2 for Nr = 3.<br>Set to 3 for Nr = 4.<br>Set to 4 for Nr = 5.<br>Set to 5 for Nr = 6.<br>Set to 6 for Nr = 7.<br>Set to 7 for Nr = 8. |

**Table 9-322t—Definition of subfields within Digital Fbck Control field *(continued)***

| Subfield | Meaning |
|---|---|
| Tx Antenna Mask | Indicates the Tx Antennas reported in the accompanying Digital BF Feedback element. If the CSI for the $i^{th}$ Tx Antenna is included in the accompanying Digital BF Feedback element, the $i^{th}$ bit in Tx Antenna Mask is set to 1. Otherwise, the $i^{th}$ bit in Tx Antenna Mask is set to 0. |
| Ncb | Indicates the number of contiguous 2.16 GHz channels the measurement was made for minus one:<br>Set to 0 for 2.16 GHz.<br>Set to 1 for 4.32 GHz.<br>Set to 2 for 6.48 GHz.<br>Set to 3 for 8.64 GHz. |
| Grouping | Indicates the subcarrier grouping, Ng, used for beamforming feedback matrix<br>Set to 0 for $N_g = 2$.<br>Set to 1 for $N_g = 4$.<br>Set to 2 for $N_g = 8$.<br>Set to 3 for dynamic grouping; reserved if dynamic grouping is not supported.<br><br>If the Feedback Type subfield is 0, the Grouping subfield is reserved. |
| Codebook Information | Indicates the size of codebook entries.<br><br>If the SU/MU field in the MIMO Feedback Control element is 1:<br>Set to 0 for 6 bits for Ψ, 4 bits for ϕ.<br>Value 1 is reserved.<br><br>If the SU/MU field in the MIMO Feedback Control element is 0:<br>Set to 0 for 9 bits for Ψ , 7 bits for ϕ.<br>Value 1 is reserved. |
| Feedback Type | Indicates which type of feedback is provided. Set to 0 for uncompressed beamforming feedback in time domain (EDMG SC mode) and set to 1 for compressed using Givens-Rotation in frequency domain (EDMG OFDM mode). |
| Number of Feedback Matrices or Feedback Taps | This field is set to the value of the variable *Nsc*. The value 0 is reserved.<br><br>If the Feedback Type subfield is 0, *Nsc* is the number of feedback taps per element of the SC feedback matrix.<br><br>If the Feedback Type subfield is 1 and the Grouping subfield is less than 3, *Nsc* is determined by Table 9-322ac.<br><br>If the Feedback Type subfield is 1 and the Grouping subfield is 3, *Nsc* specifies the number of subcarriers present in the Digital Beamforming Feedback Information field of the Digital BF Feedback element. |

### 9.4.2.276 MIMO Selection Control element

The MIMO Selection Control element is defined in Table 9-322u.

**Table 9-322u—MIMO Selection Control element format**

| Field | Size (bits) | Meaning |
|---|---|---|
| Element ID | 8 | |
| Length | 8 | |
| Element ID Extension | 8 | |
| EDMG Group ID | 8 | Indicates the EDMG group ID of target MU group. |
| Number of MU-MIMO Transmission Configurations | 3 | Indicates the number of MU-MIMO transmission configurations, $N_{conf}$. |
| MU-MIMO Transmission Configuration Type | 1 | This field is set to 0 to indicate the MU-MIMO transmission configurations obtained from the nonreciprocal MU-MIMO BF training. This field is set to 1 to indicate the MU-MIMO transmission configurations obtained from the reciprocal MU-MIMO BF training. |
| Number of TX Antennas | 3 | Indicates the $N_{TX}$ used in each MU-MIMO transmission configuration. |
| Nonreciprocal MU-MIMO BF Training Based Transmission Configuration | | |
| Configuration 1 Group User Mask for Antenna 1 | 32 | Indicates the STA(s) in the target MU group associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User 1 SISO ID Subset Index/RX Antenna ID for Antenna 1 | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| ... | | |
| Configuration 1 User $N_{1,1}^{(u)}$ SISO ID Subset Index/RX Antenna ID for Antenna 1 | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N_{1,1}^{(u)}$ STA associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| ... | | |
| Configuration 1 Group User Mask for Antenna $N_{TX}$ | 32 | Indicates the STA(s) in the target MU group associated with the $N_{TX}$ TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User 1 SISO ID Subset Index/RX Antenna ID for Antenna $N_{TX}$ | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the $N_{TX}$ TX DMG antenna in the first MU-MIMO transmission configuration. |
| ... | | |
| Configuration 1 User $N_{1,N_{TX}}^{(u)}$ SISO ID Subset Index/RX Antenna ID for Antenna $N_{TX}$ | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N_{1,N_{TX}}^{(u)}$ STA associated with the $N_{TX}$ TX DMG antenna in the first MU-MIMO transmission configuration. |
| ... | | |
| Configuration $N_{conf}$ Group User Mask for Antenna 1 | 32 | Indicates the STA(s) in the target MU group associated with the first TX DMG antenna in the $N_{conf}$ MU-MIMO transmission configuration. |

**Table 9-322u—MIMO Selection Control element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Configuration $N_{\text{conf}}$ User 1 SISO ID Subset Index/RX Antenna ID for Antenna 1 | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the first TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| ... | | |
| Configuration $N_{\text{conf}}$ User $N^{(u)}_{N_{conf},1}$ SISO ID Subset Index/RX Antenna ID for Antenna $N_{\text{TX}}$ | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N^{(u)}_{N_{conf},1}$ STA associated with the first TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| ... | | |
| Configuration $N_{\text{conf}}$ Group User Mask for Antenna $N_{\text{TX}}$ | 32 | Indicates the STA(s) in the target MU group associated with the $N_{\text{TX}}$ TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| Configuration $N_{\text{conf}}$ User 1 SISO ID Subset Index/RX Antenna ID for Antenna $N_{\text{TX}}$ | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the $N_{\text{TX}}$ TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| ... | | |
| Configuration $N_{\text{conf}}$ User $N^{(u)}_{N_{conf},N_{TX}}$ SISO ID Subset Index/RX Antenna ID for Antenna $N_{\text{TX}}$ | 12 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N^{(u)}_{N_{conf},N_{TX}}$ STA associated with the $N_{\text{TX}}$ TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| Reciprocal MU-MIMO BF Training Based Transmission Configuration | | |
| Configuration 1 Group User Mask for Antenna 1 | 32 | Indicates the STA(s) in the target MU group associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User 1 AWV feedback ID for Antenna 1 | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User 1 BRP CDOWN for Antenna 1 | 6 | |
| Configuration 1 User 1 RX Antenna ID for Antenna 1 | 3 | |
| ... | | |
| Configuration 1 User $N^{(u)}_{1,1}$ AWV feedback ID for Antenna 1 | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N^{(u)}_{1,1}$ STA associated with the first TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User $N^{(u)}_{1,1}$ BRP CDOWN for Antenna 1 | 6 | |
| Configuration 1 User $N^{(u)}_{1,1}$ RX Antenna ID for Antenna 1 | 3 | |
| ... | | |
| Configuration 1 Group User Mask for Antenna $N_{\text{TX}}$ | 32 | Indicates the STA(s) in the target MU group associated with the $N_{\text{TX}}$ TX DMG antenna in the first MU-MIMO transmission configuration. |

**Table 9-322u—MIMO Selection Control element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Configuration 1 User 1 AWV feedback ID for Antenna $N_{TX}$ | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the $N_{TX}$ TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User 1 BRP CDOWN for Antenna $N_{TX}$ | 6 | |
| Configuration 1 User 1 RX Antenna ID for Antenna $N_{TX}$ | 3 | |
| ... | | |
| Configuration 1 User $N_{1,N_{TX}}^{(u)}$ AWV feedback ID for Antenna $N_{TX}$ | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N_{1,N_{TX}}^{(u)}$ STA associated with the $N_{TX}$ TX DMG antenna in the first MU-MIMO transmission configuration. |
| Configuration 1 User $N_{1,N_{TX}}^{(u)}$ BRP CDOWN for Antenna $N_{TX}$ | 6 | |
| Configuration 1 User $N_{1,N_{TX}}^{(u)}$ RX Antenna ID for Antenna $N_{TX}$ | 3 | |
| ... | | |
| Configuration $N_{conf}$ Group User Mask for Antenna 1 | 32 | Indicates the STA(s) in the target MU group associated with the first TX DMG antenna in the $N_{conf}$ MU-MIMO transmission configuration. |
| Configuration $N_{conf}$ User 1 AWV feedback ID for Antenna 1 | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the first TX DMG antenna in the $N_{conf}$ MU-MIMO transmission configuration. |
| Configuration $N_{conf}$ User 1 BRP CDOWN for Antenna 1 | 6 | |
| Configuration $N_{conf}$ User 1 RX Antenna ID for Antenna 1 | 3 | |
| ... | | |
| Configuration $N_{conf}$ User $N_{N_{conf},1}^{(u)}$ AWV feedback ID for Antenna 1 | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N_{N_{conf},1}^{(u)}$ STA associated with the first TX DMG antenna in the $N_{conf}$ MU-MIMO transmission configuration. |
| Configuration $N_{conf}$ User $N_{N_{conf},1}^{(u)}$ BRP CDOWN for Antenna 1 | 6 | |
| Configuration $N_{conf}$ User $N_{N_{conf},1}^{(u)}$ RX Antenna ID for Antenna 1 | 3 | |
| ... | | |
| Configuration $N_{conf}$ Group User Mask for Antenna $N_{TX}$ | 32 | Indicates the STA(s) in the target MU group associated with the $N_{TX}$ TX DMG antenna in the $N_{conf}$ MU-MIMO transmission configuration. |

**Table 9-322u—MIMO Selection Control element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Configuration $N_{\text{conf}}$ User 1 AWV feedback ID for Antenna $N_{\text{TX}}$ | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the first STA associated with the $N_{\text{TX}}$ TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| Configuration $N_{\text{conf}}$ User 1 BRP CDOWN for Antenna $N_{\text{TX}}$ | 6 | |
| Configuration $N_{\text{conf}}$ User 1 RX Antenna ID for Antenna $N_{\text{TX}}$ | 3 | |
| ... | | |
| Configuration $N_{\text{conf}}$ User $N^{(u)}_{N_{conf},N_{TX}}$ AWV feedback ID for Antenna $N_{\text{TX}}$ | 11 | Indicates the RX AWV, from a receiver's perspective, or RX DMG antenna of the $N^{(u)}_{N_{conf},N_{TX}}$ STA associated with the $N_{\text{TX}}$ TX DMG antenna in the $N_{\text{conf}}$ MU-MIMO transmission configuration. |
| Configuration $N_{\text{conf}}$ User $N^{(u)}_{N_{conf},N_{TX}}$ BRP CDOWN for Antenna $N_{\text{TX}}$ | 6 | |
| Configuration $N_{\text{conf}}$ User $N^{(u)}_{N_{conf},N_{TX}}$ RX Antenna ID for Antenna $N_{\text{TX}}$ | 3 | |
| Padding | 0–7 | Zero padding to make the MIMO Selection Control element length a multiple of 8 bits |

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Configuration $i$ Group User Mask for Antenna $j$ field ($i$ = 1, 2, …, $N_{conf}$ and $j$ = 1, 2, …, $N_{TX}$) is a bitmap that indicates whether each of EDMG STAs in the target MU group is associated with the $j^{\text{th}}$ TX DMG antenna in the $i^{\text{th}}$ MU-MIMO transmission configuration. An MU-MIMO transmission configuration defines a specific subset of STAs in the target MU group and their respective RX AWVs to be used for receiving DL MU-MIMO data transmission. The order of EDMG STAs in the Configuration $i$ Group User Mask for Antenna $j$ field follows the order in which they appear in the corresponding EDMG Group field of the EDMG Group ID Set element containing the target MU group. The first bit (i.e., the least significant bit) corresponds to the first EDMG STA, and the second bit corresponds to the second EDMG STA, and so on. A bit is set to 1 to indicate the corresponding STA is associated with the $j^{\text{th}}$ TX DMG antenna in the $i^{\text{th}}$ MU-MIMO transmission configuration; otherwise, the bit is set to 0. If the number of EDMG STAs in the target MU group is smaller than 32, the corresponding bits in the Configuration $i$ Group User Mask for Antenna $j$ field ($i$ = 1, 2, …, $N_{conf}$ and $j$ = 1, 2, …, $N_{TX}$) is set to 0.

The Nonreciprocal MU-MIMO BF Training Based Transmission Configuration field is not present in the MIMO BF Selection frame when the MU-MIMO Transmission Configuration Type field is set to 1. The Reciprocal MU-MIMO BF Training Based Transmission Configuration field is not present in the MIMO BF Selection frame when the MU-MIMO Transmission Configuration Type field is set to 0.

### 9.4.2.277 EDMG Flow Control Extension Configuration element

The EDMG Flow Control Extension Configuration element is defined in Figure 9-788bu.

| | Element ID | Length | Element ID Extension | RBUFCAP | Flow Control Status | Advanced Recipient Memory Length Exponent | Recipient Memory Capabilities | Optional Subelements |
|---|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Variable |

**Figure 9-788bu—EDMG Flow Control Extension Configuration element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

When sent in an ADDBA Response frame, the RBUFCAP field is as defined in 9.3.1.8.8. This field is reserved when sent in an ADDBA Request frame.

When sent in an ADDBA Response frame, the Flow Control Status field is defined in Figure 9-788bv. This field is reserved when sent in an ADDBA Request frame.

| | B0 | B1 | B2 B7 |
|---|---|---|---|
| | No Memory Kept | Memory Configuration Tag | Reserved |
| Bits: | 1 | 1 | 6 |

**Figure 9-788bv—Flow Control Status field format**

The No Memory Kept and Memory Configuration Tag subfields are defined in 9.3.1.8.1.

When sent in an ADDBA Response frame, the Advanced Recipient Memory Length Exponent field indicates the amount of free space at the recipient's memory at the start of a TXOP or SP. This field is an integer in the range 0 to 9. The length defined by this subfield is equal to $2^{(13 + \text{Advanced Recipient Memory Length Exponent})} - 1$ octets. The value $2^{(13 + \text{Advanced Recipient Memory Length Exponent})}$ is smaller than or equal to the value $2^{(13 + \text{Maximum A-MPDU Length Exponent})}$ as advertised by the STA's EDMG Capabilities element. Only one value for the Advanced Recipient Memory Length Exponent field can be present in all Block Ack agreements. This field applies to all successfully established Block Ack agreements identified by the same pair of Address 1 and Address 2 fields. This field is reserved when sent in an ADDBA Request frame.

The Recipient Memory Capabilities field is defined in Figure 9-788bw.

| | B0 | B1 | B2 | B3 | B4 | B5 B7 |
|---|---|---|---|---|---|---|
| | RBUFCAP Quantity Capable | Advanced Recipient Memory Length Capable | Recipient Memory Multiple Buffer Units Capable | TID Grouping Capable | Two Memory Config Tag Capable | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 1 | 3 |

**Figure 9-788bw—Recipient Memory Capabilities field format**

The RBUFCAP Quantity Capable subfield is set to 1 to indicate support of RBUFCAP values in the range 1 through 254 and is set to 0 otherwise (Table 9-28d).

The Advanced Recipient Memory Length Capable subfield is set to 1 by the recipient to indicate its request to be supported with the Advanced Recipient Memory Length Exponent (Figure 9-788bu) and is set to 0 otherwise.

The Recipient Memory Multiple Buffer Units Capable subfield is set to 1 to indicate support of Memory Unit Size, Maximum MPDU per Memory Unit, and MPDU Split in Buffer values (Figure 9-788bx) and is set to 0 otherwise.

The TID Grouping Capable subfield is set to 1 to indicate support of TID Grouping values (Figure 9-788bx) and set to 0 otherwise.

The Two Memory Config Tag Capable subfield is set to 1 to indicate the capability to support two Memory Configuration Tag values per TID or TID group (Figure 9-788bx) and is set to 0 otherwise.

The Optional Subelements field is defined in Table 9-322v. An EDMG Flow Control Extension Configuration element contains no more than two Recipient Memory Configuration subelements.

**Table 9-322v—Optional subelement IDs for the EDMG Flow Control Extension Configuration element**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Recipient Memory Configuration | Yes |
| 1–220 | Reserved | |
| 221 | Vendor specific | Vendor defined |
| 222–225 | Reserved | |

The Recipient Memory Configuration subelement is defined in Figure 9-788bx.

| | Subelement ID | Length | Memory Configuration Tag | Buffer Unit Size | Recipient Memory Multiple Buffer Units Parameters | | | TID Grouping |
|---|---|---|---|---|---|---|---|---|
| | | | | | Memory Unit Size | Maximum MPDU per Memory Unit | MPDU Split in Buffer | |
| Octets: | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |

**Figure 9-788bx—Recipient Memory Configuration subelement format**

The Subelement ID field is defined in Table 9-322v.

The Length field is defined in 9.4.2.1.

The Memory Configuration Tag subfield indicates one of two recipient memory configurations indicated in ADDBA Response frame within which the EDMG Flow Control Extension Configuration element is included. Allowed values are 0 and 1.

The Buffer Unit Size subfield indicates the size, in octets, of the RBUFCAP to deliver information of the recipient's available memory space to the originator for MPDU delivery. This subfield is set to a value greater than 0 if the RBUFCAP Quantity Capable subfield is 1 and is set to 0 otherwise. The recipient's available memory space, in octets, is equal to RBUFCAP × Buffer Unit Size.

The subfields within the Recipient Memory Multiple Buffer Units Parameters indicate a recipient memory structure constructed from fixed size memory buffers used to store incoming MPDUs.

The Memory Unit Size subfield indicates the size, in octets, of each buffer unit in the recipient's memory.

The Maximum MPDU per Memory Unit subfield indicates the maximum number of MPDUs that can be held in a single buffer. Valid values are 1 through 255, where value 255 indicates that there is no limitation on the number of MPDUs that can be held in a single buffer.

The MPDU Split in Buffer subfield is set to 1 to indicate that an MPDU can be split between memory buffer units in the recipient's memory and is set to 0 otherwise.

The TID Grouping subfield is a bitmap where each bit corresponds to a TID (Figure 9-788by). By setting a bit to one in the TID Grouping subfield, it indicates the TID that correspond to a TID of an ADDBA Response frame within which the Recipient Memory Configuration subelement(s) is transmitted. The recipient memory configuration becomes applicable to all TIDs/TSIDs that have their bit in the TID Grouping subfield set to 1. The RBUFCAP field, No Memory Kept and Memory Configuration Tag subfields delivered in an EDMG Flow Control Extension Configuration element within an ADDBA Response frame and in a BlockAck frame are applicable to all TIDs/TSIDs that correspond to the TIDs/TSIDs of the ADDBA Response frame that contained the TID Grouping subfield. The Advanced Recipient Memory Length Exponent field delivered in an EDMG Flow Control Extension Configuration element of an ADDBA Response frame is applicable to all TIDs/TSIDs that correspond to the TIDs/TSIDs of the ADDBA Response frame that contained the TID Grouping subfield.

| | B0 | B1 | B2 | … | B15 |
|---|---|---|---|---|---|
| | TID 0 | TID 1 | TID 2 | … | TID 15 |
| Bits: | 1 | 1 | 1 | … | 1 |

**Figure 9-788by—TID Grouping subfield format**

### 9.4.2.278 QoS Triggered Unscheduled (QoS-TU) element

The QoS Triggered Unscheduled (QoS-TU) element is used to communicate the QoS triggered unscheduled parameters between a non-AP and non-PCP EDMG STA and an EDMG AP or EDMG PCP.

The QoS Triggered Unscheduled element is defined in Figure 9-788bz.

| | Element ID | Length | Element ID Extension | QoS-TU Parameters | QoS-TU Max MPDU Size |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 2 |

**Figure 9-788bz—QoS Triggered Unscheduled element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The QoS-TU Parameters field contains the QoS-TU AC and the QoS-TU Max A-MPDU Length Exponent subfields as shown in Figure 9-788ca.

| | B0 B3 | B4 | B5 | B6 | B7 |
|---|---|---|---|---|---|
| | QoS-TU Max A-MPDU Length Exponent | QoS-TU AC_VO Flag | QoS-TU AC_VI Flag | QoS-TU AC_BK Flag | QoS-TU AC_BE Flag |
| Bits: | 4 | 1 | 1 | 1 | 1 |

**Figure 9-788ca—QoS-TU Parameters field format**

Each of the QoS-TU ACs Flag subfields is set to 1 to indicate that the corresponding AC (AC_BE, AC_BK, AC_VI, or AC_VO) is QoS triggered unscheduled enabled as described in 11.2.7.2.2; otherwise, it is set to 0.

When sent by a non-PCP and non-AP EDMG STA, the QoS-TU Max A-MPDU Length Exponent subfield is set according to the Maximum A-MPDU Length Exponent subfield described in Table 9-322i. This subfield indicates the maximum A-MPDU size of buffered BUs the STA is prepared to receive during a QoS triggered unscheduled data transmission. When sent by an EDMG PCP or EDMG AP, this field is reserved.

When sent by a non-PCP and non-AP EDMG STA, the QoS-TU Max MPDU Size field indicates the maximum number of buffered BUs (MPDUs) that the STA is prepared to receive during a QoS triggered unscheduled data transmission. When sent by an EDMG PCP or EDMG AP, this field is reserved.

### 9.4.2.279 Unsolicited Block Ack Extension element

The Unsolicited Block Ack Extension element includes information necessary to set up an unsolicited block ack extension agreement between a non-AP and non-PCP STA and an AP or PCP at the association establishment, or between a pair of non-AP and non-PCP STAs using an Information Request and Information Response frame exchange. The format of the element is shown in Figure 9-788cb.

| | Element ID | Length | Element ID Extension | Unsolicited Block Ack Extension Parameters | Block Ack Timeout Value |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 2 |

**Figure 9-788cb—Unsolicited Block Ack Extension element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Unsolicited Block Ack Extension Parameters field is defined in Figure 9-788cc.

| | B0 B7 | B8 | B9 B15 | B16 B26 | B27 | B28 B31 |
|---|---|---|---|---|---|---|
| | Reserved | A-MSDU Supported | Reserved | Buffer Size | Multi-TID Supported | Reserved |
| Bits: | 8 | 1 | 7 | 11 | 1 | 4 |

**Figure 9-788cc—Unsolicited Block Ack Extension Parameters field format**

The A-MSDU Supported subfield is set to 1 to indicate that the STA supports an A-MSDU carried in a QoS Data frame sent under the unsolicited block ack extension. It is set to 0 otherwise.

The Buffer Size subfield is an integer ranging from 1 to 1024 that indicates the number of buffers available for each unsolicited block ack extension agreement.

The Multi-TID Supported subfield is set to 1 to indicate that the STA supports multiple TIDs in unsolicited block ack agreements. An EDMG STA that supports multi-TID in unsolicited block ack agreements also sets the EDMG Multi-TID Aggregation Support field defined in 9.4.2.265.6 to a nonzero value. An EDMG STA that does not support multi-TID as indicated by the EDMG Multi-TID Aggregation Support field defined in 9.4.2.265.6, sets the Multi-TID Supported subfield to 0.

The Block Ack Timeout Value field is defined in 9.4.1.14.

### 9.4.2.280 SAR Configuration element

The Segmentation and Reassembly (SAR) Configuration element is formatted as shown in Figure 9-788cd. The SAR Configuration element can be included in the ADDBA Request and Response frames in case the ADDBA originator requests the recipient to use segmentation and reassembly for a corresponding TID. The SAR Configuration element indicates the specific segmentation parameters for the TID.

| | Element ID | Length | Element ID Extension | SAR Parameters | MSDU Buffer Size | MPDU Buffer Size | Maximum Segmented MSDU Exponent |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 2 | 2 | 1 |

**Figure 9-788cd—SAR Configuration element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The SAR Parameters field is defined in Figure 9-788ce.

| | B0 | B1 B3 | B4 B7 |
|---|---|---|---|
| | SAR Enabled | MSDU Modulo | MPDU Modulo |
| Bits: | 1 | 3 | 4 |

**Figure 9-788ce—SAR Parameters field format**

The SAR Enabled subfield set to 1 indicates that segmentation and reassembly is to be used with the parameters indicated in this element for the corresponding TID.

The MSDU Modulo subfield indicates the number of bits to be allocated to the length of the MSDU Sequence Number subfield within the Sequence Control field. The MPDU Modulo subfield indicates the number of bits to be allocated to the length of the MPDU Sequence Number subfield within the Sequence Control field. The sum of the values of the MSDU Modulo subfield and the MPDU Modulo subfield is equal to fourteen.

The MSDU Buffer Size field indicates the number of buffers available for this particular TID. Each buffer is capable of holding the number of octets equal to the value defined by the Maximum Segmented MSDU Exponent subfield.

The MPDU Buffer Size field indicates the number of buffers available for this particular TID. Each buffer is capable of holding a number of octets equal to the maximum MPDU size as indicated in Table 9-25 for a DMG PPDU, or to the value of the last Maximum MSDU Size field of the TSPEC element agreed between the peers via an ADDTS Request and Response frame exchange for this TID, plus any security encapsulation overhead, MAC header and FCS.

The Maximum Segmented MSDU Exponent subfield specifies the maximum size of the segmented MSDU belonging to the TID under the BA agreement. This subfield is an integer in the range 0 to 9, occupying bit positions 0 through 3 in the Maximum Segmented MSDU Exponent subfield; other bit positions in the subfield are reserved. The maximum segmented MSDU size that is defined by this subfield is equal to $2^{(13 + \text{Maximum Segmented MSDU Exponent})} – 1$ octets.

### 9.4.2.281 TDD Slot Structure element

The TDD Slot Structure element defines the structure of a TDD SP described in 10.39.6.2.2. The format of the TDD Slot Structure element is shown in Figure 9-788cf.

| | Element ID | Length | Element ID Extension | Slot Structure Control | Peer STA Address |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 6 |

| | Slot Structure Start Time | Number of TDD Intervals | TDD Interval Duration | Number of TDD Slots per TDD Interval (*M*) | Slot Structure |
|---|---|---|---|---|---|
| Octets: | 4 | 2 | 2 | 1 | 4×*M* |

**Figure 9-788cf—TDD Slot Structure element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Slot Structure Control field is defined in Figure 9-788cg.

| | B0 B3 | B4 B11 | B12 B15 |
|---|---|---|---|
| | Allocation ID | Maximum Time Synchronization Error | Reserved |
| Bits: | 4 | 8 | 4 |

**Figure 9-788cg—Slot Structure Control field format**

The Allocation ID subfield is set to the same value of the Allocation ID subfield in the Allocation Control field of the Extended Schedule element describing the TDD SP allocation.

The Maximum Time Synchronization Error subfield indicates the maximum time synchronization error, in microseconds, between a transmitter and receiver in either uplink or downlink direction.

The Peer STA Address field is any valid individual or broadcast address that specifies the MAC address of the STA that is the intended recipient of the TDD Slot Structure element. The broadcast address indicates that the TDD Slot Structure element is common for the entire BSS.

The Slot Structure Start Time field indicates the lower 4 octets of the TSF timer at the start of the first TDD interval in which the slot structure takes effect.

The Number of TDD Intervals field indicates the time duration the slot structure holds, in units of TDD intervals.

The TDD Interval Duration field indicates the TDD interval duration in microseconds.

The Number of TDD Slots per TDD Interval field indicates the number of TDD slots in each TDD interval.

The Slot Structure field is defined in Figure 9-788ch. The size of this field is 4×$M$ octets, where $M$ is equal to the value of the Number of TDD Slots per TDD Interval field.

| | TDD Slot 1 Start | TDD Slot 1 Duration | … | TDD Slot M Start | TDD Slot M Duration |
|---|---|---|---|---|---|
| Octets: | 2 | 2 | … | 2 | 2 |

**Figure 9-788ch—Slot Structure field format**

The TDD Slot $i$ Start subfield, $1 \leq i \leq M$, indicates the start time, in microseconds, of the $i^{th}$ TDD slot relative to the beginning of each TDD interval.

The TDD Slot $i$ Duration subfield, $1 \leq i \leq M$, indicates the duration, in microseconds, of the $i^{th}$ TDD slot in each TDD interval.

### 9.4.2.282 TDD Slot Schedule element

The TDD Slot Schedule element defines the access assignment of DMG STAs to TDD slots within a TDD SP (see 10.39.6.2.2). The format of the TDD Slot Schedule element is shown in Figure 9-788ci.

| | Element ID | Length | Element ID Extension | Slot Schedule Control | Peer STA Address | Slot Schedule Start Time |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 6 | 4 |

| | Number of TDD Intervals in the Bitmap | TDD Slot Schedule Duration | Bitmap and Access Type Schedule | Slot Category Schedule |
|---|---|---|---|---|
| Octets: | 2 | 2 | $\left\lceil \frac{Q \times M}{4} \right\rceil$ | $\left\lceil \frac{Q \times M}{4} \right\rceil$ |

**Figure 9-788ci—TDD Slot Schedule element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Slot Schedule Control field is defined in Figure 9-788cj.

| | B0 B3 | B4 | B5 B12 | B13 B15 |
|---|---|---|---|---|
| | Allocation ID | Channel Aggregation | BW | Reserved |
| Bits: | 4 | 1 | 8 | 3 |

**Figure 9-788cj—Slot Schedule Control field format**

The Allocation ID subfield is set to the same value of the Allocation ID subfield in Allocation Control field of the Extended Schedule element describing the SP allocation.

The Channel Aggregation and BW subfields are defined in Table 28-12.

The Peer STA Address field specifies the MAC address of the STA that is the intended recipient of the TDD Slot Structure element.

The Slot Schedule Start Time field indicates the lower 4 octets of the TSF timer at the start of the first TDD interval in which the schedule takes effect.

The Number of TDD Intervals in the Bitmap field indicates the number of TDD intervals described in the Bitmap and Access Type Schedule field following the time indicated by the Slot Schedule Start Time field.

The TDD Slot Schedule Duration field indicates the duration, in microseconds, from the start of the first TDD interval to the end of the last TDD interval in which the schedule takes effect.

The Bitmap and Access Type Schedule field defines the type of a TDD slot and the access permission of a DMG STA to the TDD slots covered by this bitmap. Each pair of consecutive 2 bits indicates the type and access permission of the TDD slot as specified in Table 9-322w (see 10.39.6.2.2 and 11.2.7). The size of the Bitmap and Access Type Schedule field is a function of the value of the Number of TDD Slots per TDD Interval field in the TDD Slot Structure element, *M*, and the value of the Number of TDD Intervals in the Bitmap field, *Q*. If padding is required to make the size of this field an integer number, a TDD slot of type unassigned is used. The TDD slots defined by the Bitmap and Access Type Schedule field are repeated for the duration indicated by the TDD Slot Schedule Duration field value.

**Table 9-322w—Bitmap and Access Type Schedule field encoding**

| Encoding | Behavior of STA that transmits the TDD Slot Schedule element | Behavior of STA that receives the TDD Slot Schedule element |
|---|---|---|
| 0 | TDD slot unassigned | |
| 1 | Simplex TX | Simplex RX |
| 2 | Simplex RX | Simplex TX |
| 3 | Unavailable | |

The Slot Category Schedule field defines the TDD slot category. Each pair of consecutive 2 bits indicates the frame type(s) that are allowed to be transmitted in the corresponding TDD slot defined by the Bitmap and Access Type Schedule field. A value of 0 indicates Basic TDD slot, a value of 1 indicates Data TDD slot and a value of 2 indicates a BF TDD slot. Value of 3 is reserved. The size of the Slot Category Schedule field is a function of the value of the Number of TDD Slots per TDD Interval field in the TDD Slot Structure element, *M*, and the value of the Number of TDD Intervals in the Bitmap field, *Q*. If padding is required to make the size of this field an integer number, a reserved TDD slot category is used.

### 9.4.2.283 TDD Route element

The TDD Route element is used to communicate TDD beamforming results and sector switch configuration as described in 10.42.11 and 11.36. The format of the TDD Route element is shown in Figure 9-788ck.

| | Element ID | Length | Element ID Extension | TDD Route Subelements |
|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | Variable |

**Figure 9-788ck—TDD Route element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The TDD Route Subelements field is defined in Table 9-322x. The TDD Route element contains one or more of the subelements indicated in Table 9-322x.

**Table 9-322x—TDD Route Subelements field format**

| Subelement ID | Name | Length |
|---|---|---|
| 0 | TDD Sector Feedback | Variable |
| 1 | TDD Sector Setting | 25 |
| 2 | TDD Sector Config | Variable |
| 3–220 | Reserved | |
| 221 | Vendor specific | Vendor defined |
| 222–225 | Reserved | |

The TDD Sector Feedback subelement is used to communicate all the initiator TX Sector IDs as received by the responder during a TDD beamforming training procedure described in 10.42.11. The format of the TDD Sector Feedback element is shown in Figure 9-788cl.

| | Subelement ID | Length | Number of Tx Beams | Tx Beam Feedback$_1$ | … | Tx Beam Feedback$_N$ |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 2 | Variable | | Variable |

**Figure 9-788cl—TDD Sector Feedback subelement format**

The Subelement ID subfield is defined in Table 9-322x.

The Length subfield is defined in 9.4.2.1.

The Number of Tx Beams subfield indicates the number of Tx Beam Feedback subfields, *N*, included in the subelement.

Each Tx Beam Feedback subfield has a variable size and is defined in Figure 9-788cm.

| | B0 B8 | B9 B11 | B12 B19 | B20 B23 | B24 B55 | | |
|---|---|---|---|---|---|---|---|
| | TX Sector ID | TX Antenna ID | Number of Decoded RX Sectors | Reserved | Decoded RX Sector Information$_1$ | … | Decoded RX Sector Information$_M$ |
| Bits: | 9 | 3 | 8 | 4 | 32 | | 32 |

**Figure 9-788cm—Tx Beam Feedback subfield format**

The TX Sector ID subfield contains the value of the TX Sector ID subfield in the TDD SSW frame to which the Tx Beam Feedback subfield applies.

The TX Antenna ID subfield contains the value of the TX Antenna ID subfield in the TDD SSW frame to which the Tx Beam Feedback subfield applies.

The Number of Decoded RX Sectors subfield indicates the number of Decoded RX Sector Information subfields, *M*, included in this subfield.

The Decoded RX Sectors Information subfield is defined in Figure 9-788cn.

| | B0 B8 | B9 B11 | B12 B15 | B16 B23 | B24 B31 |
|---|---|---|---|---|---|
| | Decoded RX Sector ID | Decoded RX Antenna ID | Reserved | SNR Report | RSSI Report |
| Bits: | 9 | 3 | 4 | 8 | 8 |

**Figure 9-788cn—Decoded RX Sectors Information subfield format**

The Decoded RX Sector ID subfield indicates the receive sector index used by the responder when it decoded a TDD SSW frame with TX Sector ID and TX Antenna ID subfields matching the corresponding subfields in the Tx Beam Feedback subfield.

The Decoded RX Antenna ID subfield indicates the receive DMG antenna index used by the responder when it decoded a TDD SSW frame with TX Sector ID and TX Antenna ID subfields matching the corresponding subfields in the Tx Beam Feedback subfield.

The SNR Report subfield is set to the value of the SNR achieved while decoding TDD SSW frame(s) with TX Sector ID and TX Antenna ID subfields matching the corresponding subfields in the Tx Beam Feedback subfield. The SNR Report subfield is an unsigned integer referenced to a level of –8 dB. Each step is 0.25 dB. SNR values less than or equal to –8 dB are represented as 0. SNR values greater than or equal to 55.75 dB are represented as 0xFF.

The RSSI Report subfield is set to the value of the received power while receiving the L-STF field of TDD SSW frame(s) with TX Sector ID and TX Antenna ID subfields matching the corresponding subfields in the Tx Beam Feedback subfield. The RSSI Report is a signed integer in the range –128 dBm to 127 dBm and is measured by the PHY as the power observed at the input of the antenna plus the antenna gain, or the equivalent antenna gain for phased array antennas, used to receive the TDD SSW frame(s).

NOTE—When multiple TDD SSW frames are received for the same combination of transmit and receive DMG antennas, and transmit and receive sectors, the SNR and RSSI values reported in the SNR Report and RSSI Report subfields can be a combination of measurements taken over any subset of the received TDD SSW frames.

The TDD Sector Setting subelement is used to request the peer to configure its antenna to a specific receive and transmit sector combination as described in 11.36. The format of the TDD Sector Setting subelement is shown in Figure 9-788co.

| | Subelement ID | Length | TDD Sector Setting Control | Switch Timestamp | Revert Timestamp | TDD Switch Sectors |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 8 | 8 | 6 |

**Figure 9-788co—TDD Sector Setting subelement format**

The Subelement ID subfield is defined in Table 9-322x.

The Length subfield is defined in 9.4.2.1.

The TDD Sector Setting Control subfield is defined in Figure 9-788cp.

| | B0 | B1 | B2 | B3 B7 |
|---|---|---|---|---|
| | Set Sector Request | Set Sector Response | Set Sector Acknowledge | Reserved |
| Bits: | 1 | 1 | 1 | 5 |

**Figure 9-788cp—TDD Sector Setting Control field format**

The Set Sector Request subfield is set to 1 by the initiator to request the responder to change its receiver sector setting according to the Responder RX Sector ID subfield and its transmitter sector setting according to Responder TX Sector ID subfield, with both subfields indicated in the TDD Switch Sectors subfield.

The Set Sector Response subfield is set to 1 by the responder to indicate the reception of a successful TDD Sector Setting subelement with the Set Sector Request subfield equal to 1.

The Set Sector Acknowledge subfield is set to 1 by the initiator to acknowledge the reception of a successful TDD Sector Setting subelement with the Set Sector Response subfield equal to 1.

The Switch Timestamp subfield indicates a future TSF timer value in which the new sector configuration setting is to take effect.

The Revert Timestamp subfield indicates a future TSF timer value in which the previous sector configuration is restored in case sector switching fails.

The TDD Switch Sectors subfield is defined in Figure 9-788cq.

| | B0 B8 | B9 B11 | B12 B20 | B21 B23 |
|---|---|---|---|---|
| | Responder RX Sector ID | Responder RX Antenna ID | Responder TX Sector ID | Responder TX Antenna ID |
| Bits: | 9 | 3 | 9 | 3 |

| | B24 B32 | B33 B35 | B36 B44 | B45 B47 |
|---|---|---|---|---|
| | Initiator RX Sector ID | Initiator RX Antenna ID | Initiator TX Sector ID | Initiator TX Antenna ID |
| Bits: | 9 | 3 | 9 | 3 |

**Figure 9-788cq—TDD Switch Sectors field format**

The Responder RX Sector ID subfield contains the value of the sector ID the responder uses to set its receive sector.

The Responder RX Antenna ID subfield contains the antenna ID the responder uses to set its receive DMG antenna.

The Responder TX Sector ID subfield contains the value of the sector ID the responder uses to set its transmit sector.

The Responder TX Antenna ID subfield contains the antenna ID the responder uses to set its transmit DMG antenna.

The Initiator RX Sector ID subfield contains the value of the sector index the initiator uses to set its receive sector.

The Initiator RX Antenna ID subfield contains the antenna ID the initiator uses to set its receive DMG antenna.

The Initiator TX Sector ID subfield contains the value of the sector index the initiator uses to set its transmit sector.

The Initiator TX Antenna ID subfield contains the antenna ID the initiator uses to set its transmit DMG antenna.

The TDD Sector Config subelement is used to communicate the RX Sector IDs and RX Antenna ID to be used by the responder during the next beam measurement procedure as described in 10.42.11. The format of the TDD Sector Config subelement is shown in Figure 9-788cr.

| | Subelement ID | Length | Number of Config Sectors | Configured Sector$_1$ | … | Configured Sector$_N$ |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 2 | 2 | | 2 |

**Figure 9-788cr—TDD Sector Config subelement format**

The Subelement ID subfield is defined in Table 9-322x.

The Length subfield is defined in 9.4.2.1.

The Number of Config Sectors subfield indicates the number of Configured Sector subfields, *N*, included in the subelement.

Each Configured Sector subfield is defined as indicated in Figure 9-788cs.

| | B0 B8 | B9 B11 | B12 B15 |
|---|---|---|---|
| | Configured RX Sector ID | Configured RX Antenna ID | Reserved |
| Bits: | 9 | 3 | 4 |

**Figure 9-788cs—Configured Sector subfield format**

The Configured RX Sector ID subfield indicates the receive sector index to be used by the responder in the upcoming beam measurement procedure.

The Configured RX Antenna ID subfield indicates the receive DMG antenna index to be used by the responder in the upcoming beam measurement procedure.

### 9.4.2.284 Digital BF Feedback element

The Digital BF Feedback element is transmitted in the MIMO BF Feedback frame and carries feedback information in the form of beamforming feedback matrices and differential SNRs. The feedback information can be used by a transmit beamformer to determine digital beamforming steering matrices, *Q*. This process is described in 10.42.10.2.4. When the Digital BF Feedback element is transmitted in the MIMO BF Feedback frame, the SNR fields within the Channel Measurement Feedback element are interpreted as average SNR per stream, as defined in Table 9-264 (see 9.4.2.136).

As specified in this subclause, the size and configuration of the Digital BF Feedback element depends on the field values in the MIMO Feedback Control element transmitted in the same frame that carries the Digital BF Feedback element. Therefore, all references to fields present in the MIMO Feedback Control element refer to the element transmitted in the same frame that carries the Digital BF Feedback element.

When the Feedback Type subfield within the Digital Fbck Control field is 0, the Digital Beamforming Feedback Information field in the Digital BF Feedback element contains $N_{SC}$ digital beamforming matrices. When $N_{SC} > 1$, a Tap Delay field indicating the tap to which each digital beamforming matrix corresponds to is additionally present. The digital beamforming information in time domain can be represented as a matrix function $V$ given by the following:

$$V\left(n\frac{T_c}{N_{CB}}\right)=\sum_{k=1}^{N_{SC}}\tilde{V}_k\delta\left(\frac{T_c}{N_{CB}}[n-n_k]\right)$$

where

$n_k$ is the delay of the $k^{\text{th}}$ tap and $n_k = 0$ for $k = 1$

$T_c/N_{CB}$ is defined in Table 28-47

$\tilde{V}_k$ is the digital beamforming matrix per tap

$$\delta(n)=\begin{cases}1 & n=0\\ 0 & n\neq 0\end{cases}$$

The components of the digital beamforming matrix per tap $\tilde{V}_k$ are contained in the Digital Beamforming Feedback Matrix $k$ subfield, in uncompressed form, indexed such that the $(i, j)^{\text{th}}$ element of $\tilde{V}_k$ is the $(j - 1) \times Nr + (i - 1)^{\text{th}}$ entry of the $k^{\text{th}}$ Digital Beamforming Feedback Matrix field, shown in Table 9-322y, and $i = 1 \dots Nr$, $j = 1 \dots Nc$, where $Nr$ and $Nc$ are defined by the Nr Index and Nc Index subfields, respectively, in the Digital Fbck Control field. Each digital feedback component is represented as an 8 bit real part, followed by an 8 bit imaginary part. The taps $n_k > 0$ for which each of the beamforming feedback matrices are computed are indicated in the Tap Delay field.

**Table 9-322y—Description of the Digital Beamforming Feedback Matrix *k* subfield in SC mode**

| Subfield | | Size (bits) | Meaning |
|---|---|---|---|
| Digital Beamforming Feedback Matrix *k* | Digital Feedback Component 1 | 16 | Digital beamforming coefficient(s) for stream 1 to TX transmit chain 1 |
| | Digital Feedback Component 2 | 16 | Digital beamforming coefficient(s) for stream 1 to TX transmit chain 2 |
| | … | … | … |
| | Digital Feedback Component $Nr \times Nc$ | 16 | Digital beamforming coefficient for stream $Nr$ to TX transmit chain $Nc$. |

When the Feedback Type within the Digital Fbck Control field is 1, the Digital Beamforming Feedback Information field contains the digital beamforming feedback matrices in compressed form with elements indexed, first, by matrix angles in the order shown in Table 9-73 and, second, by data subcarrier index from lowest frequency to highest frequency. The explanation on how these angles are generated from the beamforming feedback matrix $V$ is given in 19.3.12.3.6. For channel aggregation where the total number of spatial streams is evenly divided between the primary and secondary channels (see 28.3.3.3.2.3), the number of rows and columns in beamforming feedback matrix is an even number. The number of rows in each aggregated channel's beamforming feedback matrix is $Nr/2$ and the number of columns in each aggregated channel's beamforming feedback matrix is $Nc/2$, where $Nr$ and $Nc$ are the values, respectively, indicated by the Nr Index and Nc Index subfields within the Digital Fbck Control field.

The Digital BF Feedback element has the structure and order defined in Table 9-322z, where the value of $n_{bit}$ is defined in Table 9-322aa as a function of the value of the Feedback Type subfield within the Digital Fbck Control field. For channel aggregation, the value of $n_{bit}$ is composed of feedback bits for each aggregated channel.

**Table 9-322z—Digital BF Feedback element format**

| Field | Size (bits) | Meaning |
|---|---|---|
| Element ID | 8 | |
| Length | 8 | |
| Element ID Extension | 8 | |
| Digital Beamforming Feedback Information | | |
| Digital Beamforming Feedback Matrix 1 | $n_{bit}$ | If the Feedback Type subfield is 0, represents the beamforming matrix in time domain for the 1st tap as described above.<br><br>If Feedback Type subfield is 1, represents the beamforming matrix for the 1st subcarrier, indexed by matrix angles in the order shown in Table 9-73. |
| … | … | |
| Digital Beamforming Feedback Matrix $N_{SC}$ | $n_{bit}$ | If the Feedback Type subfield is 0, represents the beamforming matrix in time domain for the $N_{SC}$th tap as described above.<br><br>If Feedback Type subfield is 1, represents the beamforming matrix for the $N_{SC}$th subcarrier, indexed by matrix angles in the order shown in Table 9-73. |
| Differential Subcarrier Index | | |
| Differential subcarrier index $scidx(0) – scidx(1)$ | 3 | When the Grouping subfield is 3, this field represents the number of subcarriers between $scidx(0)$ and $scidx(1)$. Otherwise, it is not present. It is set to $j$ to indicate the distance between the $scidx(0)$ and $scidx(1)$ is $2^j$.<br><br>Set to 0 to indicate 1.<br>Set to 1 to indicate 2.<br>Set to 2 to indicate 4.<br>Set to 3 to indicate 8.<br>Set to 4 to indicate 16.<br>Set to 5 to indicate 32.<br>Values 6 and 7 are reserved. |
| … | … | |

**Table 9-322z—Digital BF Feedback element format *(continued)***

| Field | Size (bits) | Meaning |
|---|---|---|
| Differential subcarrier index $scidx(N_{SC}-2) - scidx(N_{SC}-1)$ | 3 | When the Grouping subfield is 3, this field represents the number of subcarriers between $scidx(N_{SC}-2)$ and $scidx(N_{SC}-1)$. Otherwise, it is not present.<br>It is set to $j$ to indicate the distance between the $scidx(N_{SC}-2)$ and $scidx(N_{SC}-1)$ is $2^j$. |
| Tap Delay | | |
| Relative Tap Delay 2 | 12 | When the Feedback Type subfield is 0 and $N_{SC} > 1$, this field represents the delay of tap #2 in units of $T_c/N_{CB}$ relative to Tap 1. Otherwise, it is not present. |
| … | ... | … |
| Relative Tap Delay $N_{SC}$ | 12 | When the Feedback Type subfield is 0 and $N_{SC} > 1$, this field represents the delay of tap $\#N_{SC}$ in units of $T_c/N_{CB}$ relative to Tap 1. Otherwise, it is not present. |
| MU Exclusive Beamforming Report | | |
| Differential SNR for space-time stream 1 for subcarrier $k = scidx(0)$ | 8 | $D\_SNR_{scidx(0),1}$ as defined in Equation (9-3e) |
| … | … | … |
| Differential SNR for space-time stream $Nc$ for subcarrier $k = scidx(0)$ | 8 | $D\_SNR_{scidx(0),Nc}$ as defined in Equation (9-3e) |
| Differential SNR for space-time stream 1 for subcarrier $k = scidx(1)$ | 4 | $D\_SNR_{scidx(1),1}$ as defined in Equation (9-3d) |
| … | … | … |
| Differential SNR for space-time stream $Nc$ for subcarrier $k = scidx(1)$ | 4 | $D\_SNR_{scidx(1),Nc}$ as defined in Equation (9-3d) |
| … | … | … |
| Differential SNR for space-time stream 1 for subcarrier $k = scidx(N_{SC}-1)$ | 4 | $D\_SNR_{scidx(Nsc-1),1}$ as defined in Equation (9-3d) |
| … | … | … |
| Differential SNR for space-time stream $Nc$ for subcarrier $k = scidx(N_{SC}-1)$ | 4 | $D\_SNR_{scidx(Nsc-1),Nc}$ as defined in Equation (9-3d) |
| Padding | 0–7 | Zero padding to make the Digital BF Feedback element length a multiple of 8 bits |

**Table 9-322aa—Definition of $n_{bit}$**

| Feedback Type subfield value | $n_{bit}$ size (bits) | | |
|---|---|---|---|
| | **2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel** | **2.16+2.16 GHz or 4.32+4.32 GHz channel** | |
| 0 | $2\times 8\times N_c\times N_r$ | $2\times 8\times (N_c/2)\times (N_r/2)$ | 2.16 GHz or 4.32 GHz channel containing the primary channel |
| | | $2\times 8\times (N_c/2)\times (N_r/2)$ | 2.16 GHz or 4.32 GHz channel not containing the primary channel |
| 1 | $N_a\times\left(b_\psi+b_\varphi\right)/2$, with $\boldsymbol{N_\varphi}=\left(\boldsymbol{N_r}\times\frac{\boldsymbol{N_r}+1}{2}-\boldsymbol{N_r}\right)$ and $\boldsymbol{N_\psi}=\left(\boldsymbol{N_r}\times\frac{\boldsymbol{N_r}-1}{2}\right)$, $\boldsymbol{N_a}=\boldsymbol{N_\psi}+\boldsymbol{N_\phi}$ | $N_a\times\left(b_\psi+b_\varphi\right)/2$, with $N_\varphi=\left((N_r/2)\times\frac{(N_r/2)+1}{2}-(N_r/2)\right)$ and $N_\psi=\left((N_r/2)\times\frac{(N_r/2)-1}{2}\right)$, $N_a=N_\psi+N_\phi$ | 2.16 GHz or 4.32 GHz channel containing the primary channel |
| | | $N_a\times\left(b_\psi+b_\varphi\right)/2$ | 2.16 GHz or 4.32 GHz channel not containing the primary channel |

When the Grouping subfield within the Digital Fbck Control field is less than or equal to 2, the subcarrier indices for which the beamforming matrices are computed are defined in Table 9-322ac. When the Grouping subfield within the Digital Fbck Control field is 3, the Digital BF Feedback element includes the Differential Subcarrier Index field marking the number of subcarriers between each two adjacent subcarriers within the feedback report. The subcarrier index set is constructed such that it is a subset of the subcarrier index set defined for $Ng$=2 and the corresponding $N_{CB}$ in Table 9-322ac, such that the edge subcarriers and the subcarriers with indices –2 and 2 are present within the feedback report and the distance between subcarriers within the feedback report is one of the values in {1, 2, 4, 8, 16, 32}.

In Table 9-73, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index subfield within the Digital Fbck Control field, and *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index subfield within the Digital Fbck Control field.

The angles are quantized as defined in Table 9-322ab.

The MU Exclusive Beamforming Report field carries explicit feedback information in the form of differential SNRs contained in the Differential SNR subfields. The MU Exclusive Beamforming Report field is included in the Digital BF Feedback element if the SU/MU field in MIMO Feedback Control element is 1 (MU transmission) and the Feedback Type subfield of the Digital Fbck Control field is 1 (EDMG OFDM mode).

### Table 9-322ab—Quantization of angles

| Quantized $\Psi$ | Quantized $\Phi$ |
|---|---|
| $\psi = \frac{k\pi}{2^{b_\psi+1}} + \frac{\pi}{2^{b_\psi+2}}$ radians<br>where<br>$k = 0, 1, 2, \ldots, 2^{b_\psi} - 1$<br>$b_\psi$ is the number of bits used to quantize $\psi$ (defined by the Codebook Information field of the MIMO Feedback Control element) | $\phi = \frac{k\pi}{2^{b_\phi-1}} + \frac{\pi}{2^{b_\phi}}$ radians<br>where<br>$k = 0, 1, 2, \ldots, 2^{b_\phi} - 1$<br>$b_\phi$ is the number of bits used to quantize $\phi$ (defined by the Codebook Information field of the MIMO Feedback Control element) |

### Table 9-322ac—Subcarriers for which a compressed beamforming feedback matrix is sent back

| $N_{CB}$ | *Ng* | $N_{SC}$ | Subcarriers for which compressed feedback beamforming matrix is sent: *scidx*(0), *scidx*(1), …, *scidx*($N_{SC}$ – 1) (Note that DC subcarriers (0, ±1) are skipped.) |
|---|---|---|---|
| 1 | 2 | 178 | –177,–176,–174,–172,–170,–168,–166,–164,–162,–160,–158,–156,–154,–152,–150, –148,–146,–144,–142,–140,–138,–136,–134,–132,–130,–128,–126,–124,–122,–120, –118,–116,–114,–112,–110,–108,–106,–104,–102,–100,–98,–96,–94,–92,–90,–88,–86, –84,–82,–80,–78,–76,–74,–72,–70,–68,–66,–64,–62,–60,–58,–56,–54,–52,–50,–48,–46, –44,–42,–40,–38,–36,–34,–32,–30,–28,–26,–24,–22,–20,–18,–16,–14,–12,–10,–8,–6,–4, –2,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58, 60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,94,96,98,100,102,104,106,108,110, 112,114,116,118,120,122,124,126,128,130,132,134,136,138,140,142,144,146,148,150, 152,154,156,158,160,162,164,166,168,170,172,174,176,177 |
| | 4 | 90 | –177,–174,–170,–166,–162,–158,–154,–150,–146,–142,–138,–134,–130,–126,–122, –118,–114,–110,–106,–102,–98,–94,–90,–86,–82,–78,–74,–70,–66,–62,–58,–54,–50, –46,–42,–38,–34,–30,–26,–22,–18,–14,–10,–6,–2,2,6,10,14,18,22,26, 30,34, 38,42, 46,50,54,58,62,66,70,74,78,82,86,90,94,98,102,106,110,114,118,122,126,130,134,138, 142,146,150,154,158,162,166,170,174,177 |
| | 8 | 46 | –177,–170,–162,–154,–146,–138,–130,–122,–114,–106,–98,–90,–82,–74,–66,–58,–50, –42,–34,–26,–18,–10,–2,2,10,18,26,34,42,50,58,66,74,82,90,98,106,114,122,130,138, 146,154,162,170,177 |

**Table 9-322ac—Subcarriers for which a compressed beamforming feedback matrix is sent back *(continued)***

| $N_{CB}$ | $Ng$ | $N_{SC}$ | **Subcarriers for which compressed feedback beamforming matrix is sent:** ***scidx*(0), *scidx*(1), …, *scidx*($N_{SC}$ – 1)** (Note that DC subcarriers (0, ±1) are skipped.) |
|---|---|---|---|
| 2 | 2 | 388 | –386,–385,–383,–381,–379,–377,–375,–373,–371,–369,–367,–365,–363,–361,–359,<br>–357,–355,–353,–351,–349,–347,–345,–343,–341,–339,–337,–335,–333,–331,–329,<br>–327,–325,–323,–321,–319,–317,–315,–313,–311,–309,–307,–305,–303,–301,–299,<br>–297,–295,–293,–291,–289,–287,–285,–283,–281,–279,–277,–275,–273,–271,–269,<br>–267,–265,–263,–261,–259,–257,–255,–253,–251,–249,–247,–245,–243,–241,–239,<br>–237,–235,–233,–231,–229,–227,–225,–223,–221,–219,–217,–215,–213,–211,–209,<br>–207,–205,–203,–201,–199,–197,–195,–193,–191,–189,–187,–185,–183,–181,–179,<br>–177,–176,–174,–172,–170,–168,–166,–164,–162,–160,–158,–156,–154,–152,–150,<br>–148,–146,–144,–142,–140,–138,–136,–134,–132,–130,–128,–126,–124,–122,–120,<br>–118,–116,–114,–112,–110,–108,–106,–104,–102,–100,–98,–96,–94,–92,–90,–88,–86,<br>–84,–82,–80,–78,–76,–74,–72,–70,–68,–66,–64,–62,–60,–58,–56,–54,–52,–50,–48,–46,<br>–44,–42,–40,–38,–36,–34,–32,–30,–28,–26,–24,–22,–20,–18,–16,–14,–12,–10,–8,–6,–4,<br>–2,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,<br>60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,94,96,98,100,102,104,106,108,110,<br>112,114,116,118,120,122,124,126,128,130,132,134,136,138,140,142,144,146,148,150,<br>152,154,156,158,160,162,164,166,168,170,172,174,176,177,179,181,183,185,187,189,<br>191,193,195,197,199,201,203,205,207,209,211,213,215,217,219,221,223,225,227,229,<br>231,233,235,237,239,241,243,245,247,249,251,253,255,257,259,261,263,265,267,269,<br>271,273,275,277,279,281,283,285,287,289,291,293,295,297,299,301,303,305,307,309,<br>311,313,315,317,319,321,323,325,327,329,331,333,335,337,339,341,343,345,347,349,<br>351,353,355,357,359,361,363,365,367,369,371,373,375,377,379,381,383,385,386 |
| | 4 | 196 | –386,–385,–381,–377,–373,–369,–365,–361,–357,–353,–349,–345,–341,–337,–333,<br>–329,–325,–321,–317,–313,–309,–305,–301,–297,–293,–289,–285,–281,–277,–273,<br>–269,–265,–261,–257,–253,–249,–245,–241,–237,–233,–229,–225,–221,–217,–213,<br>–209,–205,–201,–197,–193,–189,–185,–181,–177,–174,–170,–166,–162,–158,–154,<br>–150,–146,–142,–138,–134,–130,–126,–122,–118,–114,–110,–106,–102,–98,–94,–90,<br>–86,–82,–78,–74,–70,–66,–62,–58,–54,–50,–46,–42,–38,–34,–30,–26,–22,–18,–14,–10,<br>–6,–2,2,6,10,14,18,22,26,30,34,38,42,46,50,54,58,62,66,70,74,78,82,86,90,94,98,102,<br>106,110,114,118,122,126,130,134,138,142,146,150,154,158,162,166,170,174,177,181,<br>185,189,193,197,201,205,209,213,217,221,225,229,233,237,241,245,249,253,257,261,<br>265,269,273,277,281,285,289,293,297,301,305,309,313,317,321,325,329,333,337,341,<br>345,349,353,357,361,365,369,373,377,381,385,386 |
| | 8 | 101 | –386,–385,–377,–369,–361,–353,–345,–337,–329,–321,–313,–305,–297,–289,–281,<br>–273,–265,–257,–249,–241,–233,–225,–217, –209,–201,–193,–185, –177,–170,–162,<br>–154,–146,–138,–130, –122,–114,–106,–98,–90,–82,–74,–66,–58,–50,–42,–34,–26, –18,<br>–10,–2,2,10,18,26,34,42,50,58,62,70,78,86,94,102,110,118,126,134,142,150,158,166,<br>174,177,185,193,201,209,217,225,233,241,249,257,265,273,281,289,297,305,313,321,<br>329,337,345,353,361,369,377,385,386 |

**Table 9-322ac—Subcarriers for which a compressed beamforming feedback matrix is sent back *(continued)***

| $N_{CB}$ | $Ng$ | $N_{SC}$ | **Subcarriers for which compressed feedback beamforming matrix is sent:** $scidx(0)$, $scidx(1)$, …, $scidx(N_{SC} – 1)$ (Note that DC subcarriers (0, ±1) are skipped.) |
|---|---|---|---|
| 3 | 2 | 598 | –596,–594,–592,–590,–588,–586,–584,–582,–580,–578,–576,–574,–572,–570,–568,–566,–564,–562,–560,–558,–556,–554,–552,–550,–548,–546,–544,–542,–540,–538,–536,–534,–532,–530,–528,–526,–524,–522,–520,–518,–516,–514,–512,–510,–508,–506,–504,–502,–500,–498,–496,–494,–492,–490,–488,–486,–484,–482,–480,–478,–476,–474,–472,–470,–468,–466,–464,–462,–460,–458,–456,–454,–452,–450,–448,–446,–444,–442,–440,–438,–436,–434,–432,–430,–428,–426,–424,–422,–420,–418,–416,–414,–412,–410,–408,–406,–404,–402,–400,–398,–396,–394,–392,–390,–388,–386,–385,–383,–381,–379,–377,–375,–373,–371,–369,–367,–365,–363,–361,–359,–357,–355,–353,–351,–349,–347,–345,–343,–341,–339,–337,–335,–333,–331,–329,–327,–325,–323,–321,–319,–317,–315,–313,–311,–309,–307,–305,–303,–301,–299,–297,–295,–293,–291,–289,–287,–285,–283,–281,–279,–277,–275,–273,–271,–269,–267,–265,–263,–261,–259,–257,–255,–253,–251,–249,–247,–245,–243,–241,–239,–237,–235,–233,–231,–229,–227,–225,–223,–221,–219,–217,–215,–213,–211,–209,–207,–205,–203,–201,–199,–197,–195,–193,–191,–189,–187,–185,–183,–181,–179,–177,–176,–174,–172,–170,–168,–166,–164,–162,–160,–158,–156,–154,–152,–150,–148,–146,–144,–142,–140,–138,–136,–134,–132,–130,–128,–126,–124,–122,–120,–118,–116,–114,–112,–110,–108,–106,–104,–102,–100,–98,–96,–94,–92,–90,–88,–86,–84,–82,–80,–78,–76,–74,–72,–70,–68,–66,–64,–62,–60,–58,–56,–54,–52,–50,–48,–46,–44,–42,–40,–38,–36,–34,–32,–30,–28,–26,–24,–22,–20,–18,–16,–14,–12,–10,–8,–6,–4,–2,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,94,96,98,100,102,104,106,108,110,112,114,116,118,120,122,124,126,128,130,132,134,136,138,140,142,144,146,148,150,152,154,156,158,160,162,164,166,168,170,172,174,176,177,179,181,183,185,187,189,191,193,195,197,199,201,203,205,207,209,211,213,215,217,219,221,223,225,227,229,231,233,235,237,239,241,243,245,247,249,251,253,255,257,259,261,263,265,267,269,271,273,275,277,279,281,283,285,287,289,291,293,295,297,299,301,303,305,307,309,311,313,315,317,319,321,323,325,327,329,331,333,335,337,339,341,343,345,347,349,351,353,355,357,359,361,363,365,367,369,371,373,375,377,379,381,383,385,386,388,390,392,394,396,398,400,402,404,406,408,410,412,414,416,418,420,422,424,426,428,430,432,434,436,438,440,442,444,446,448,450,452,454,456,458,460,462,464,466,468,470,472,474,476,478,480,482,484,486,488,490,492,494,496,498,500,502,504,506,508,510,512,514,516,518,520,522,524,526,528,530,532,534,536,538,540,542,544,546,548,550,552,554,556,558,560,562,564,566,568,570,572,574,576,578,580,582,584,586,588,590,592,594,596 |
| | 4 | 302 | –596,–594,–590,–586,–582,–578,–574,–570,–566,–562,–558,–554,–550,–546,–542,–538,–534,–530,–526,–522,–518,–514,–510,–506,–502,–498,–494,–490,–486,–482,–478,–474,–470,–466,–462,–458,–454,–450,–446,–442,–438,–434,–430,–426,–422,–418,–414,–410,–406,–402,–398,–394,–390,–386,–385,–381,–377,–373,–369,–365,–361,–357,–353,–349,–345,–341,–337,–333,–329,–325,–321,–317,–313,–309,–305,–301,–297,–293,–289,–285,–281,–277,–273,–269,–265,–261,–257,–253,–249,–245,–241,–237,–233,–229,–225,–221,–217,–213,–209,–205,–201,–197,–193,–189,–185,–181,–177,–174, –170,–166,–162, –158,–154,–150,–146,–142,–138,–134,–130,–126,–122,–118,–114,–110,–106,–102,–98,–94,–90,–86,–82,–78,–74,–70,–66,–62,–58,–54,–50,–46,–42,–38,–34,–30,–26,–22, –18,–14, –10,–6,–2,2,6,10,14,18,22, 26,30,34,38,42,46,50,54,58,62,66,70,74,78,82,86,90,94,98,102,106,110,114,118,122,126,130,134,138,142,146,150,154,158,162,166,170,174, 177, 181,185,189,193,197,201,205, 209,213,217,221,225,229,233,237,241,245,249,253,257,261,265,269,273,277,281,285,289,293,297,301,305,309,313,317,321,325,329,333,337,341,345,349,353,357,361,365,369,373,377,381,385, 386, 390,394,398, 402,406,410,414, 418,422, 426,430,434,438,442,446,450,454,458, 462, 466,470,474,478,482,486,490,494,498,502,506,510,514,518,522,526,530,534,538,542, 546,550, 554, 558,562,566,570,574, 578,582,586,590,594,596 |

**Table 9-322ac—Subcarriers for which a compressed beamforming feedback matrix is sent back *(continued)***

| $N_{CB}$ | *Ng* | $N_{SC}$ | **Subcarriers for which compressed feedback beamforming matrix is sent:** **$scidx(0)$, $scidx(1)$, …, $scidx(N_{SC}-1)$** (Note that DC subcarriers (0, ±1) are skipped.) |
|---|---|---|---|
| 3 | 8 | 155 | –596,–594,–586,–578,–570,–562,–554,–546,–538,–530,–522,–514,–506,–498,–490,<br>–482,–474,–466,–458,–450,–442,–434,–426,–418,–410,–402,–394,–386,–385,–377,<br>–369,–361,–353,–345,–337,–329,–321,–313,–305,–297,–289,–281,–273,–265,–257,<br>–249,–241,–233,–225,–217,–209,–201,–193,–185,–177,–170,–162,–154,–146,–138,<br>–130,–122,–114,–106,–98,–90,–82,–74,–66,–58,–50,–42,–34,–26, –18, –10,–2,2,10,18,<br>26,34,42,50,58,62,70,78,86,94,102,110,118,126,134,142,150,158,166,174,177,185,193,<br>201, 209,217, 225,233,241,249,257,265,273,281,289,297,305,313,321,329,337,345,353,<br>361,369,377, 385, 386,394,402,410,418,426,434,442,450,458,466,474,482,490,498,506,<br>514, 522,530,538,546,554, 562,570, 578,586,594, 596 |
| 4 | 2 | 808 | –805,–804,–802,–800,–798,–796,–794,–792,–790,–788,–786,–784,–782,–780,–778,<br>–776,–774,–772,–770,–768,–766,–764,–762,–760,–758,–756,–754,–752,–750,–748,<br>–746,–744,–742,–740,–738,–736,–734,–732,–730,–728,–726,–724,–722,–720,–718,<br>–716,–714,–712,–710,–708,–706,–704,–702,–700,–698,–696,–694,–692,–690,–688,<br>–686,–684,–682,–680,–678,–676,–674,–672,–670,–668,–666,–664,–662,–660,–658,<br>–656,–654,–652,–650,–648,–646,–644,–642,–640,–638,–636,–634,–632,–630,–628,<br>–626,–624,–622,–620,–618,–616,–614,–612,–610,–608,–606,–604,–602,–600,–598,<br>–596,–594,–592,–590,–588,–586,–584,–582,–580,–578,–576,–574,–572,–570,–568,<br>–566,–564,–562,–560,–558,–556,–554,–552,–550,–548,–546,–544,–542,–540,–538,<br>–536,–534,–532,–530,–528,–526,–524,–522,–520,–518,–516,–514,–512,–510,–508,<br>–506,–504,–502,–500,–498,–496,–494,–492,–490,–488,–486,–484,–482,–480,–478,<br>–476,–474,–472,–470,–468,–466,–464,–462,–460,–458,–456,–454,–452,–450,–448,<br>–446,–444,–442,–440,–438,–436,–434,–432,–430,–428,–426,–424,–422,–420,–418,<br>–416,–414,–412,–410,–408,–406,–404,–402,–400,–398,–396,–394,–392,–390,–388,<br>–386,–385,–383,–381,–379,–377,–375,–373,–371,–369,–367,–365,–363,–361,–359,<br>–357,–355,–353,–351,–349,–347,–345,–343,–341,–339,–337,–335,–333,–331,–329,<br>–327,–325,–323,–321,–319,–317,–315,–313,–311,–309,–307,–305,–303,–301,–299,<br>–297,–295,–293,–291,–289,–287,–285,–283,–281,–279,–277,–275,–273,–271,–269,<br>–267,–265,–263,–261,–259,–257,–255,–253,–251,–249,–247,–245,–243,–241,–239,<br>–237,–235,–233,–231,–229,–227,–225,–223,–221,–219,–217,–215,–213,–211,–209,<br>–207,–205,–203,–201,–199,–197,–195,–193,–191,–189,–187,–185,–183,–181,–179,<br>–177,–176,–174,–172,–170,–168,–166,–164,–162,–160,–158,–156,–154,–152,–150,<br>–148,–146,–144,–142,–140,–138,–136,–134,–132,–130,–128,–126,–124,–122,–120,<br>–118,–116,–114,–112,–110,–108,–106,–104,–102,–100,–98,–96,–94,–92,–90,–88,–86,<br>–84,–82,–80,–78,–76,–74,–72,–70,–68,–66,–64,–62,–60,–58,–56,–54,–52,–50,–48,–46,<br>–44,–42,–40,–38,–36,–34,–32,–30,–28,–26,–24,–22,–20,–18,–16,–14,–12,–10,–8,–6,–4,<br>–2,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,<br>60,62,64,66,68,70,72,74,76,78,80,82,84,86,88,90,92,94,96,98,100,102,104,106,108,110,<br>112,114,116,118,120,122,124,126,128,130,132,134,136,138,140,142,144,146,148,150,<br>152,154,156,158,160,162,164,166,168,170,172,174,176,177,179,181,183,185,187,189,<br>191,193,195,197,199,201,203,205,207,209,211,213,215,217,219,221,223,225,227,229,<br>231,233,235,237,239,241,243,245,247,249,251,253,255,257,259,261,263,265,267,269,<br>271,273,275,277,279,281,283,285,287,289,291,293,295,297,299,301,303,305,307,309,<br>311,313,315,317,319,321,323,325,327,329,331,333,335,337,339,341,343,345,347,349,<br>351,353,355,357,359,361,363,365,367,369,371,373,375,377,379,381,383,385,386,388,<br>390,392,394,396,398,400,402,404,406,408,410,412,414,416,418,420,422,424,426,428,<br>430,432,434,436,438,440,442,444,446,448,450,452,454,456,458,460,462,464,466,468,<br>470,472,474,476,478,480,482,484,486,488,490,492,494,496,498,500,502,504,506,508,<br>510,512,514,516,518,520,522,524,526,528,530,532,534,536,538,540,542,544,546,548,<br>550,552,554,556,558,560,562,564,566,568,570,572,574,576,578,580,582,584,586,588,<br>590,592,594,596,598,600,602,604,606,608,610,612,614,616,618,620,622,624,626,628,<br>630,632,634,636,638,640,642,644,646,648,650,652,654,656,658,660,662,664,666,668,<br>670,672,674,676,678,680,682,684,686,688,690,692,694,696,698,700,702,704,706,708,<br>710,712,714,716,718,720,722,724,726,728,730,732,734,736,738,740,742,744,746,748,<br>750,752,754,756,758,760,762,764,766,768,770,772,774,776,778,780,782,784,786,788,<br>790,792,794,796,798,800,802,804,805 |

### Table 9-322ac—Subcarriers for which a compressed beamforming feedback matrix is sent back *(continued)*

| $N_{CB}$ | *Ng* | $N_{SC}$ | **Subcarriers for which compressed feedback beamforming matrix is sent:**<br>***scidx*(0), *scidx*(1), …, *scidx*($N_{SC}$ – 1)**<br>(Note that DC subcarriers (0, ±1) are skipped.) |
|---|---|---|---|
| 4 | 4 | 409 | –805,–804,–800,–796,–792,–788,–784,–780,–776,–772,–768,–764,–760,–756,–752,<br>–748,–744,–740,–736,–732,–728,–724,–720,–716,–712,–708,–704,–700,–696,–692,<br>–688,–684,–680,–676,–672,–668,–664,–660,–656,–652,–648,–644,–640,–636,–632,<br>–628,–624,–620,–616,–612,–608,–604,–600,–596,–594,–590,–586,–582,–578,–574,<br>–570,–566,–562,–558,–554,–550,–546,–542,–538,–534,–530,–526,–522,–518,–514,<br>–510,–506,–502,–498,–494,–490,–486,–482,–478,–474,–470,–466,–462,–458,–454,<br>–450,–446,–442,–438,–434,–430,–426,–422,–418,–414,–410,–406,–402,–398,–394,<br>–390,–386,–385,–381,–377,–373,–369,–365,–361,–357,–353,–349,–345,–341,–337,<br>–333,–329,–325,–321,–317,–313,–309,–305,–301,–297,–293,–289,–285,–281,–277,<br>–273,–269,–265,–261,–257,–253,–249,–245,–241,–237,–233,–229,–225,–221,–217,<br>–213,–209,–205,–201,–197,–193,–189,–185,–181,–177,–174,–170,–166,–162,–158,<br>–154,–150,–146,–142,–138,–134,–130,–126,–122,–118,–114,–110,–106,–102,–98,–94,<br>–90,–86,–82,–78,–74,–70,–66,–62,–58,–54,–50,–46,–42,–38,–34,–30,–26,–22, –18,–14,<br>–10,–6,–2,2,6,10,14,18,22,26,30,34,38,42,46,50,54,58,62,66,70,74,78,82,86,90,94,98,<br>102,106, 110,114, 118, 122,126, 130, 134,138,142,146,150, 154,158,162,166,170,174,<br>177,181,185,189,193,197,201,205,209,213,217,221,225,229,233,237,241,245,249,253,<br>257,261,265,269, 273,277,281, 285,289,293, 297,301,305,309, 313, 317,321, 325,329,<br>333,337,341,345,349,353,357,361,365,369,373,377,381,385,386,390,394,398,402,406,<br>410,414, 418,422, 426,430,434,438,442,446,450,454,458,462,466,470,474,478,482,486,<br>490,494,498,502,506,510,514,518,522,526,530,534,538,542,546,550,554,558,562,566,<br>570,574,578,582,586,590,594,596,596,600,604,608,612,616,620,624,628,632,636,640,<br>644,648,652,656,660,664,668,672,676,680,684,688,692,696,700,704,708,712,716,720,<br>724,728,732,736,740,744,748,752,756,760,764,768,772,776,780,784,788,792,796,800,<br>804, 805 |
| | 8 | 209 | –805,–804,–796,–788,–780,–772,–764,–756,–748,–740,–732,–724,–716,–708,–700,<br>–692,–684,–676,–668,–660,–652,–644,–636,–628,–620,–612,–604,596,–594,–586,–578,<br>–570,–562,–554,–546,–538,–530,–522,–514,–506,–498,–490,–482,–474,–466,–458,<br>–450,–442,–434,–426,–418,–410,–402,–394,–386,–385,–377,–369,–361,–353,–345,<br>–337,–329,–321,–313,–305,–297,–289,–281,–273,–265,–257,–249,–241,–233,–225,<br>–217,–209,–201,–193,–185,–177,–170,–162,–154,–146,–138,–130,–122,–114,–106,<br>–98,–90,–82,–74,–66,–58,–50,–42,–34,–26, –18, –10,–2,2,10,18, 26,34, 42, 50,58,62,<br>70,78,86, 94,102, 110, 118, 126, 134,142,150,158,166,174, 177, 185, 193,201,209,217,<br>225,233,241,249,257,265,273,281,289,297,305,313,321,329,337,345,353,361,369,377,<br>385,386,394,402,410,418,426,434,442,450,458,466,474,482,490,498,506,514,522,530,<br>538,546,554,562,570,578,586,594,596,604,612,620,628,636,644,652,660,668,676,684,<br>692, 700,708, 716,724,732,740,748, 756,764,772,780,788,796,804,805 |

The MU Exclusive Beamforming Report field consists of Differential SNR subfields for each space-time stream (1 to *Nc*) of a subset of the subcarriers spaced *Ng* apart, where *Ng* is the value of the Grouping subfield of the Digital Fbck Control field in the MIMO Feedback Control element, starting from the lowest frequency subcarrier and continuing to the highest frequency subcarrier. No padding is present between $D\_SNR_{k,i}$ in the MU Exclusive Beamforming Report field, even if they correspond to different subcarriers. The subset of subcarriers included is determined by the values of Table 9-322ac. For each subcarrier included, the deviation in dB of the SNR of that subcarrier for each column of *V* relative to the adjacent subcarrier spaced *Ng* apart of the corresponding space-time stream is computed using Equation (9-3d).

$$D\_SNR_{k,i} = min\left( max\left( round\left( 10\log_{10}\left( \frac{\left\| H_k V_{k,i} \right\|^2}{N} \right) - 10\log_{10}\left( \frac{\left\| H_{\tilde{k}} V_{\tilde{k},i} \right\|^2}{N} \right) \right), -8 \right), 7 \right) \tag{9-3d}$$

where

$k$ is the subcarrier index in the range $scidx(1), \ldots, scidx(N_{SC} - 1)$

$\tilde{k}$ is the subcarrier index in the range $scidx(0), \ldots, scidx(N_{SC} - 2)$

$i$ is the space-time stream index in the range $1, \ldots, Nc$

$H_k$ is the estimated MIMO channel for subcarrier $k$

$V_{k,i}$ is column $i$ of the beamforming matrix $V$ for subcarrier $k$

$N$ is the average noise plus interference power, measured at the responder

Each Differential SNR subfield contains the $D\_SNR_{k,i}$ computed using Equation (9-3d) and quantized to 4 bits in the range –8 dB to 7 dB with 1 dB granularity, except for $k = scidx(0)$. $D\_SNR_{scidx(0),i}$ is computed using Equation (9-3e) and quantized to 8 bits in the range –8 dB to 55.75 dB with 0.25 dB granularity.

$$D\_SNR_{scidx(0),i} = 10\log_{10}\left(\frac{\left\| H_{scidx(0)} V_{scidx(0),i} \right\|^2}{N}\right) \tag{9-3e}$$

### 9.4.2.285 TDD Bandwidth Request element

The TDD Bandwidth Request element contains the information needed for bandwidth reservation request during TDD SPs. The format of the TDD Bandwidth Request element is shown in Figure 9-788ct.

| | B0 B7 | B8 B15 | B16 B23 | B24 B31 | B32 B45 |
|---|---|---|---|---|---|
| | Element ID | Length | Element ID Extension | Transmit MCS | Requested TX Percentage |
| Bits: | 8 | 8 | 8 | 8 | 14 |

| | B46 B50 | B51 B55 | B56 B127 | | |
|---|---|---|---|---|---|
| | Number of Queue Parameters | Reserved | Queue Parameter$_1$ | … | Queue Parameter$_N$ |
| Bits: | 5 | 5 | 72 | | 72 |

**Figure 9-788ct—TDD Bandwidth Request element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Transmit MCS field indicates the recommended MCS value to be used for the upcoming non-AP and non-PCP STA to AP or PCP transmission(s).

The Requested TX Percentage field indicates the requested transmit percentage of airtime from the non-AP and non-PCP STA to the AP or PCP in relation to the airtime occupied by the bidirectional traffic between the STA and the AP or PCP. The value is in units of 0.01 percent.

The Number of Queue Parameters field defines the integer number, $N$, of subsequent Queue Parameter fields.

Each Queue Parameter field is defined as shown in Figure 9-788cu.

| | B0 B4 | B5 B7 | B8 B39 | B40 B71 |
|---|---|---|---|---|
| | TID | Reserved | Queue Size | Traffic Arrival Rate |
| Bits: | 5 | 3 | 32 | 32 |

**Figure 9-788cu—Queue Parameter field format**

For values from 0 to 15, the TID subfield indicates the TID corresponding to the queue. A value of 31 indicates that this field is not applicable. Other values are reserved.

The Queue Size subfield indicates the amount of queued traffic at the transmitter, in unit of bytes, corresponding to the TID indicated by the TID subfield.

The Traffic Arrival Rate subfield indicates the arrival rate of the traffic since the last reporting event, in units of 1 kb/s. The method for computing the arrival rate is implementation dependent.

### 9.4.2.286 TDD Synchronization element

The TDD Synchronization element contains the information needed for clock synchronization during TDD SPs. The format of the element is shown in Figure 9-788cv.

| | Element ID | Length | Element ID Extension | Clock Attributes | Time Source | Sync Mode |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 14 | 1 | 1 |

**Figure 9-788cv—TDD Synchronization element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Clock Attributes field format is shown in Figure 9-788cw.

| | Priority 1 | Clock Class | Clock Accuracy | Offset Scaled Log Variance | Priority 2 | Clock Identity |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 1 | 8 |

**Figure 9-788cw—Clock Attributes field format**

The Priority 1, Clock Class, Clock Accuracy, Offset Scaled Log Variance, Priority 2 and Clock Identity subfields indicate attributes of the source of timing locally available to the STA that transmits the element, and are defined the same as priority1, clockClass, clockAccuracy, offsetSceledLogVariance, priority2, and clockIdentity attributes defined in 8.6.2 in IEEE Std 802.1AS-Rev/D8.0.

The Time Source field indicates the type of clock available to the STA transmitting the element. It is defined the same as the timeSource attribute defined in 8.6.2 in IEEE Std 802.1AS-Rev/D8.0.

NOTE 1—The Clock Attributes field is defined similar to the IEEE 802.1AS systemIdentity attribute, as a metric to compare the local clock available to a STA and the clock available to the peer STA that transmits the TDD Clock Attributes element. While the comparison metric and logic are defined the same as IEEE 802.1AS for flexibility, using the IEEE 802.1AS protocol for TDD time synchronization is not required and is beyond the scope of this standard.

NOTE 2—DMG STAs that support TDD channel access can use external timing sources such as GNSS for accurate clock attributes. For example, for a STA with access to a clock that is synchronized to a primary reference time source such as GNSS (i.e., clockClass of 0x06), and has a precision of ±500 ps (i.e., clockAccuracy of 0x23) and a clock variance of 1.497e-22 $s^2$ (i.e., offsetScaledLogVariance 0x3780), the Clock Class, Clock Accuracy and Offset Scaled Log Variance fields are respectively set to 0x06, 0x23 and 0x3780. Refer to IEEE Std 802.1AS for details.

The Sync Mode field indicates access to a local source of timing (e.g., GNSS). The Sync Mode field is set to 1 to indicate that the STA does not have access to a local source of timing at the time of transmitting the element. The Sync Mode field is set to 0 to indicate that the local clock is used by the STA at the time of transmitting the element.

### 9.4.2.287 EDMG Wide Bandwidth Channel Switch element

The EDMG Wide Bandwidth Channel Switch element is included in DMG Beacon frames, Announce frames, or Information Response frames, as defined in 11.8.8.7. The format of the EDMG Wide Bandwidth Channel Switch element is shown in Figure 9-788cx.

| | Element ID | Length | Element ID Extension | EDMG New Operating Channel |
|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 |

**Figure 9-788cx—EDMG Wide Bandwidth Channel Switch element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The EDMG New Operating Channel field is defined in Figure 9-788cy.

| | BSS Operating Channels | Operating Channel Width |
|---|---|---|
| Octets: | 1 | 1 |

**Figure 9-788cy—EDMG New Operating Channel field format**

The BSS Operating Channels subfield and the Operating Channel Width subfield are defined in 9.4.2.266.

### 9.4.2.288 DMG Discovery Assistance element

The DMG Discovery Assistance element indicates parameters and attributes of the discovery assistance. This element is optionally present in FST Setup Request and FST Setup Response frames. The format of the DMG Discovery Assistance element is shown in Figure 9-788cz.

| | Element ID | Length | Element ID Extension | Discovery Assistance Control | Discovery Assistance Request Status Code |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 2 |

| | Discovery Assistance Window Length | Sector Sweep Start Time (Optional) | Temporary AID (Optional) | Dwelling Time (Optional) |
|---|---|---|---|---|
| Octets: | 3 | 4 | 1 | 2 |

**Figure 9-788cz—EDMG Discovery Assistance element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The format of the Discovery Assistance Control field is shown in Figure 9-788da. This field is reserved when the element is contained in an FST Setup Request frame.

| | B0 | B1 | B2 B7 |
|---|---|---|---|
| | Discovery Assistance Type | Dwelling Time Present | Reserved |
| Bits: | 1 | 1 | 6 |

**Figure 9-788da—Discovery Assistance Control field format**

The Discovery Assistance Type subfield is set to 0 to indicate that the Sector Sweep Start Time field is present in this element. When this field is set to 1, the schedule to perform discovery assistance is indicated in the Extended Schedule element and the Temporary AID field is present in this element. This field is reserved when the Discovery Assistance Request Status Code field is not equal to SUCCESS.

The Dwelling Time Present subfield is set to 1 to indicate that the Dwelling Time field is present in the element and is set to 0 otherwise.

The Discovery Assistance Request Status Code field contains the result of the discovery assistance request and is one of the status codes specified in Table 9-52 (Status codes) in 9.4.1.9 (Status Code field). This field is reserved when the element is contained in an FST Setup Request frame.

The Discovery Assistance Window Length field indicates the discovery assistance window length value, in microseconds, as confirmed by the STA transmitting this element. This field is reserved when the element is contained in an FST Setup Request frame.

The Sector Sweep Start Time field indicates the lower 4 octets of the TSF of the DMG BSS at the time the sector sweep transmission starts. This field is present if the Discovery Assistance Type subfield is 0. This field is reserved when the element is contained in an FST Setup Request frame.

The Temporary AID field indicates a temporary AID assigned by an AP or PCP to the STA receiving this element. The temporary AID is used for scheduling discovery assistance. This field is present if the Discovery Assistance Type subfield is 1.

The Dwelling Time field indicates the recommended time, in microseconds, to sweep the receive sectors to scan for beamforming or discovery signals. This field is present if the Dwelling Time Present subfield is 1.

### 9.4.2.289 Extended Link Measurement element

#### 9.4.2.289.1 General

The Extended Link Measurement element contains information used to solicit link measurement report and is optionally included in Link Measurement Request and Link Measurement Report frames. The format of Extended Link Measurement element is shown in Figure 9-788db.

| | Element ID | Length | Element ID Extension | Optional Subelements |
|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | Variable |

**Figure 9-788db—Extended Link Measurement element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Optional Subelements field contains zero or more subelements. The subelement format and ordering of subelements are defined in 9.4.3.

The Subelement ID field values for the defined subelements are shown in Table 9-322ad. A subelement does not appear more than once in the Extended Link Measurement element.

**Table 9-322ad—Optional subelement IDs**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Periodic Report Request | Yes |
| 1 | Extended TPC Configuration | Yes |
| 2 | EDMG Transmit Power | Yes |
| 3 | Periodic Report | Yes |
| 4–255 | Reserved | |

### 9.4.2.289.2 Periodic Report Request subelement

The Periodic Report Request subelement contains information to solicit periodic link measurement report and is optionally included in Link Measurement Request frame. The format of the Data field of the Periodic Report Request subelement is shown in Figure 9-788dc.

| | Report Start Time | Report Interval | Report Count |
|---|---|---|---|
| Octets: | 4 | 2 | 2 |

**Figure 9-788dc—Data field of the Periodic Report Request subelement format**

The Report Start Time subfield indicates the lower 4 octets of the TSF timer at the start of the first report interval.

The Report Interval subfield indicates the interval of time, in microseconds, at which the responding STA needs to take measurements and send an unsolicited Link Measurement Report frame to the requesting STA. Value zero is reserved.

The Report Count subfield indicates the number of report intervals. A responding STA sends an unsolicited Link Measurement Report frame to the requesting STA for every report interval. Value zero is reserved.

### 9.4.2.289.3 Extended TPC Configuration subelement

The Extended TPC Configuration subelement contains information for EDMG transmit power control configuration and is optionally included in a Link Measurement Request frame. The format of the Data field of the Extended TPC Configuration subelement is shown in Figure 9-788dd.

| | B0 | B1 B3 | B4 B7 |
|---|---|---|---|
| | Channel Aggregation | Number of STS | Reserved |
| Bits: | 1 | 3 | 4 |

**Figure 9-788dd—Data field of the Extended TPC Configuration subelement format**

The Channel Aggregation field is set to 1 to indicate that the PPDU containing the Link Measurement Request frame is transmitted over a 2.16+2.16 GHz or a 4.32+4.32 GHz channel, and is set to 0 otherwise.

The Number of STS field indicates the number of STS used in the transmission of the PPDU containing the Link Measurement Request frame. If the Channel Aggregation field is 1, the Number of STS subfield is an even number.

### 9.4.2.289.4 EDMG Transmit Power subelement

The EDMG Transmit Power subelement contains information for transmit power in link measurement and is optionally included in a Link Measurement Request frame. The format of the Data field of the EDMG Transmit Power subelement is shown in Figure 9-788de.

| | Transmit Power Used$_1$ | Max Transmit Power$_1$ | … | Transmit Power Used$_{NSTS}$ | Max Transmit Power$_{NSTS}$ |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | | 1 | 1 |

**Figure 9-788de—Data field of the EDMG Transmit Power subelement format**

Each Transmit Power Used$_i$ field, $1 \leq i \leq N_{STS}$, indicates the transmit power used in the STS *i* to transmit the PPDU containing the Link Measurement Request frame, as described in 9.4.1.20. $N_{STS}$ represents the number of STS.

Each Max Transmit Power$_i$ field, $1 \leq i \leq N_{STS}$, indicates the upper limit on the transmit power of the STS *i* measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. This field is described in 9.4.1.19. Each Max Transmit Power$_i$ field is a 2s complement signed integer providing an upper limit, in a dBm scale, on the transmit power as measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. The maximum tolerance for the value reported in each Max Transmit Power$_i$ field is ±5 dB. The value of each Max Transmit Power$_i$ field is equal to the minimum of the maximum powers at which the STA is permitted to transmit in the operating channel by device capability, policy, and regulatory authority.

### 9.4.2.289.5 Periodic Report subelement

The Periodic Report subelement contains information in response to a periodic link measurement request and is optionally included in a Link Measurement Report frame. The format of the Data field of the Periodic Report subelement is shown in Figure 9-788df.

| | Periodic Report Control | Report Interval Start Time | Statistics Reset Time Offset |
|---|---|---|---|
| Octets: | 1 | 4 | 2 |

**Figure 9-788df—Data field of the Periodic Report subelement format**

The Periodic Report Control field contains indications of whether the responding STA accepts or rejects the periodic link measurement request, and whether the Link Measurement Report frame includes optional fields used for periodic link measurement reports. The field is shown in Figure 9-788dg.

| | B0 | B1 | B2 | B3 B7 |
|---|---|---|---|---|
| | Accept/Reject Periodic Report | Indication for Report Interval Start Time | Indication for Statistics Reset Time Offset | Reserved |
| Bits: | 1 | 1 | 1 | 5 |

**Figure 9-788dg—Period Report Control field format**

The Accept/Reject Periodic Report subfield is set to 1 if the responding STA accepts periodic report, and is set to 0 if the responding STA rejects periodic report.

The Indication for Report Interval Start Time subfield is set to 1 if the Link Measurement Report frame contains the Report Interval Start Time field. It is set to 0 otherwise.

The Indication for Statistics Reset Time Offset subfield is set to 1 if the Link Measurement Report frame contains the Statistics Reset Time Offset field. It is set to 0 otherwise.

The Report Interval Start Time field is optionally present. If present, it indicates the lower 4 octets of the TSF timer at the start of the report interval of the corresponding Link Measurement Report frame.

The Statistics Reset Time Offset field is optionally present. If present, it indicates the relative time offset, in microseconds, of the last event when the reset condition (see 9.4.2.142.6) is met since the start of the corresponding report interval.

### 9.4.2.290 DMG STA Directional Transmit Activity Report element

The format of DMG STA Directional Transmit Activity Report element is shown in Figure 9-788dh.

| | Element ID | Length | Element ID Extension | Control | Link ID | Observation Period Start Time | Observation Period Duration |
|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 2 | 1 | 4 | 4 |

| | Operating Class | Primary Channel | Operating Channels | Operating Channels Width | Optional Subelements |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | Variable |

**Figure 9-788dh—DMG STA Directional Transmit Activity Report element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1.

The Control field is defined in Figure 9-788di.

| | B0 B2 | B3 | B4 | B5 B7 |
|---|---|---|---|---|
| | Channel Access Type | TDD SP | Reciprocal Operation | Reserved |
| Octets: | 3 | 1 | 1 | 3 |

**Figure 9-788di—Control field format**

The Channel Access Type subfield identifies the most used channel access mechanism during the observation period, i.e., the channel access mechanism used by one or more allocations with the largest total airtime inside the observation period. It has the same encoding as the Allocation Type subfield in the Extended Schedule element.

When the Channel Access Type subfield indicates SP channel access (0 or 2), the TDD SP field is set to 1 if majority of the airtime used by SP allocations during the observation period belongs to SPs with TDD Applicable SP subfield set to 1, and set to zero otherwise. The TDD SP subfield is reserved when the Channel Access Type subfield does not indicate SP channel access.

The Reciprocal Operation subfield is set to 1 to indicate that the transmitting STA is using or intends to use the same antenna pattern that it is using for transmission to also receive from other STAs, and is set to 0 otherwise.

The Link ID subfield is a locally unique identifier for data transmit activities targeting a given receiver, or a group of receivers, that are always transmitted data to through a common transmit antenna pattern and transmit power.

NOTE 1—Link ID helps a receiving STA correlate multiple DMG STA Directional Transmit Activity Report elements received through different frames. Specifically, elements with the same Link ID identify a unique transmit activity towards one or more intended receivers that are always using a common (not necessarily fixed) transmit antenna pattern. Link ID is independent of the specific antenna pattern used for transmission, i.e., changing the antenna pattern used to transmit data to the given receiver(s) does not change the Link ID associated with the DMG STA Directional Transmit Activity Report elements that are sent to report the corresponding transmit activity.

The Observation Period Start Time field is set to the lower 4 octets of the measuring STA's TSF timer at the beginning of the observation period.

The Observation Period Duration field is set to the duration of the observation period that all reported metrics apply to, in µs.

The Operating Class field indicates an operating class value as defined in Annex E. The operating class is interpreted in the context of the country specified in the Country element included in the frame.

The Primary Channel field indicates the 2.16 GHz primary channel of the BSS to which the transmitting STA belongs.

The Operating Channels field indicates all 2.16 GHz channels occupied by PPDUs transmitted during the observation period, using the same DMG antenna and antenna pattern as the frame containing the element. The Operating Channels field has the same format as the BSS Operating Channels field in the EDMG Operation element.

The Operating Channels Width field indicates all bandwidths occupied by PPDUs transmitted during the observation period, using the same DMG antenna and antenna pattern as the frame containing the element. The Operating Channels Width field has the same format as the Operating Channels Width field in the EDMG Operation element.

The Optional Subelements field contains two or more subelements. The subelement format and ordering of subelements are defined in 9.4.3.

The Subelement ID field values for the defined subelements are listed in Table 9-322ae.

**Table 9-322ae—Optional subelement IDs**

| Subelement ID | Name | Extensible |
|---|---|---|
| 0 | Directional Transmit Activity | Yes |
| 1 | Transceiver Parameters | Yes |
| 2–255 | Reserved | |

The Directional Transmit Activity subelement Data field format is shown in Figure 9-788dj.

| | Transmit Load | Mean Transmit Time | Maximum Transmit Time | Mean Quiet Time | Maximum Quiet Time |
|---|---|---|---|---|---|
| Octets: | 1 | 4 | 4 | 4 | 4 |

**Figure 9-788dj—Directional Transmit Activity subelement Data field format**

In the following, each 2.16 GHz channel that the frame containing the DMG STA Directional Transmit Activity Report element is transmitted on is referred to as a reported channel.

The Transmit Load subfield contains the percentage of time during the observation period that the local DMG PHY entity was in transmit state and was using the reported channel and Link ID. The subfield is encoded as an 8-bit unsigned integer, linearly scaled, with values of 0 and 255 representing 0% and 100%, respectively.

The Mean Transmit Time and Maximum Transmit Time subfields respectively contain the arithmetic mean and maximum of all continuous transmission periods during the observation period, in µs. For the purpose of calculating these metrics, a continuous transmission period is a period during which the local DMG PHY entity was in transmit state using the reported channel and Link ID, except for short intervals not longer than SIFS.

The Mean Quiet Time and Maximum Quiet Time subfields contain, respectively, the arithmetic mean and maximum of all continuous quiet periods during the observation period, in µs. For the purpose of calculating these metrics, a continuous quiet period is a period longer than SIFS during which the local DMG PHY entity was not in transmit state using the reported channel and Link ID. In the absence of continuous quiet periods during the observation period both subfields are set to 0.

Figure 9-788dk illustrates two examples of Maximum Transmit Time and Maximum Quiet Time calculation.

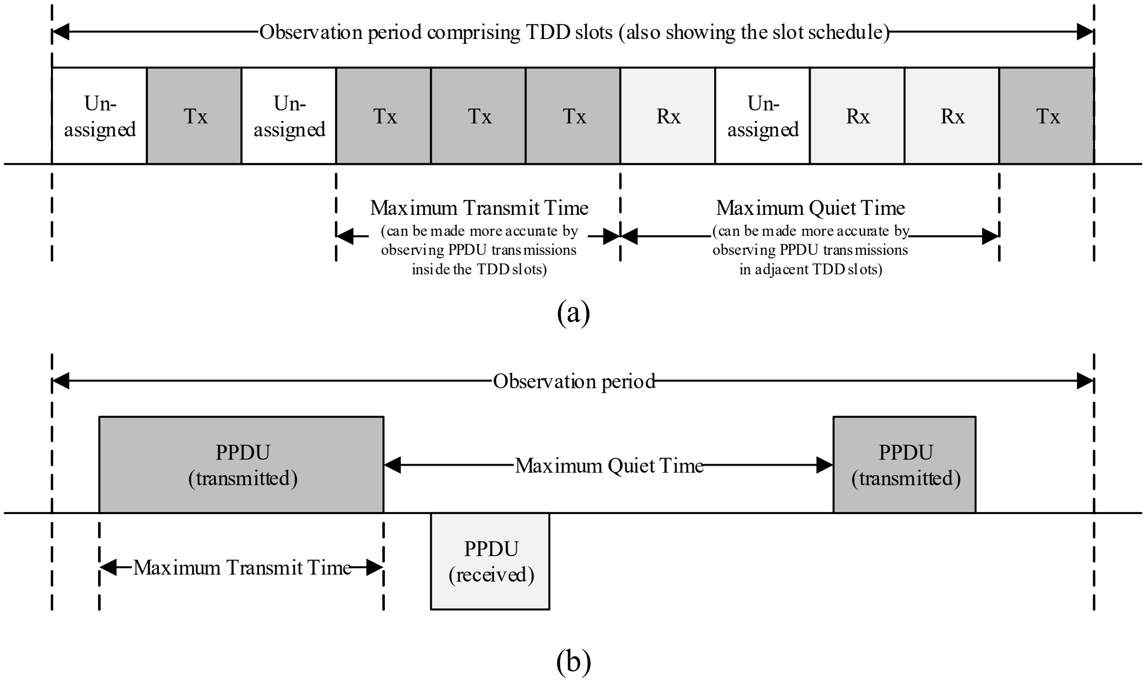


**Figure 9-788dk—Examples of Maximum Transmit Time and Maximum Quiet Time: (a) operation during a TDD SP, (b) operation during other DMG allocations**

The Transceiver Parameters subelement Data field format is shown in Figure 9-788dl.

| | Open-Loop Link Margin | Reserved |
|---|---|---|
| Octets: | 1 | 1 |

**Figure 9-788dl—Transceiver Parameters subelement Data field format**

The Open-Loop Link Margin field is calculated as follows:

$$OPLM = TRP + P_{sensitivity}$$

where

$TRP$ is the total radiated power, in dBm, used to transmit the PPDU that contains the element

$P_{sensitivity}$ is the actual receiver sensitivity for MCS 0, in dBm, and measured as defined in 20.3.3.8

The Open-Loop Link Margin field is encoded as an 8-bit unsigned integer with values 0 through 255, representing –48 to 15.75 dBm in 0.25 dBm steps.

NOTE 2—A STA that receives a frame that contains the DMG STA Directional Transmit Activity Report element (activity report frame, for short) can use the TRP and Additional Sensitivity subfields in the frame to reduce the interference they cause to the frame transmitter. To illustrate, consider STA1 receiving an activity report frame transmitted by STA2, and assume the following definitions:

$G_{RX}^{STA1}(\phi)$ STA1 receive antenna gain in the direction $\phi$ towards STA2 when it received the activity report frame; if needed, STA1 can estimate $\phi$ using the TRN fields of the PPDU that contains the activity report frame.

| | |
|---|---|
| $G_{TX}^{STA1}(\phi)$ | STA1 transmit antenna gain in the direction $\phi$ towards STA2 for a given transmission, possibly using a different DMG antenna configuration from what STA1 was using when it received the activity report frame |
| $G_{RX}^{STA2}(\theta)$ | STA2 receive antenna gain in the direction $\theta$ towards STA1, when STA2 uses the same DMG antenna configuration it was using when it transmitted the activity report frame |
| $G_{TX}^{STA2}(\theta)$ | STA2 transmit antenna gain in the direction $\theta$ towards STA1 |
| $TRP^{STA1}$ | STA1 total radiated power |
| $TRP^{STA2}$ | STA2 total radiated power, as indicated by the value of the TRP field |
| $P_{sensitivity}^{STA2}$ | STA2 actual receiver sensitivity |
| $Loss$ | Path loss between STA1 and STA2 |

The antenna gains are not necessarily the peak gains that STA1 and STA2 can achieve along $\phi$ and $\theta$ directions towards each other. The receive power at STA1 is $P_{RX}^{STA1} = TRP^{STA2} + G_{TX}^{STA2}(\theta) - Loss + G_{RX}^{STA1}(\phi)$. The receive power at STA2, if using the same DMG antenna configuration STA2 used to transmit the activity report frame, is $P_{RX}^{STA2} = TRP^{STA1} + G_{TX}^{STA1}(\phi) - Loss + G_{RX}^{STA2}(\theta)$. Assuming DMG antenna pattern reciprocity for STA2, and substituting $G_{RX}^{STA2}(\theta) - Loss = G_{TX}^{STA2}(\theta) - Loss = P_{RX}^{STA1} - TRP^{STA2} - G_{RX}^{STA1}(\phi)$, it is easy to see that STA1 can keep the receive power at STA2 below STA2 receiver sensitivity by limiting its total radiated power as $TRP^{STA1} \le (TRP^{STA2} + P_{sensitivity}^{STA2}) - (G_{TX}^{STA1}(\phi) - G_{RX}^{STA1}(\phi)) - P_{RX}^{STA1}$, where all parameters on the right-hand side of the inequality are known to STA1.

## 9.5 Fields used in Management and Extension frame bodies and Control frames

### 9.5.1 Sector Sweep field

***Change the first paragraph in 9.5.1 as follows:***

When the Sector Sweep (SSW) field is not transmitted in a DMG Beacon frame, t~~T~~he format of the ~~sector sweep (~~SSW~~)~~ field is shown in Figure 9-846. The format of the field when transmitted in a DMG Beacon frame is shown in Figure 9-846a.

***Change the title of Figure 9-846 as follows:***

**Figure 9-846—SSW field format when not transmitted in a DMG Beacon frame**

***Insert Figure 9-846a into 9.5.1 after Figure 9-846:***

| | B0 | B1 B9 | B10 B15 | B16 B17 | B18 | B19 B21 | B22 | B23 |
|---|---|---|---|---|---|---|---|---|
| | Direction | CDOWN | Sector ID | DMG Antenna ID | Quasi-omni TX | PCP/AP Coverage Parameter | RX Unassociated Short SSW | DMG Antenna ID MSB |
| Bits: | 1 | 9 | 6 | 2 | 1 | 3 | 1 | 1 |

**Figure 9-846a—SSW field format when transmitted in a DMG Beacon frame**

***Insert the following paragraphs at the end of 9.5.1:***

The Quasi-omni TX subfield is set to 1 to indicate that the frame containing the Sector Sweep field is transmitted with a quasi-omni antenna pattern and is set to 0 to indicate that the frame is not transmitted with a quasi-omni antenna pattern.

The PCP/AP Coverage Parameter subfield contains the composite value describing the PCP or AP related link budget parameter specific for the sector and DMG antenna defined in Sector ID and DMG Antenna ID fields. For values 1 through 7, the value of this field is interpreted as (4×PCP/AP Coverage Parameter + 14) and is measured in dBm. This covers a range from 18 dBm to 42 dBm in 4 dBm steps. A value of 0 in the PCP/AP Coverage Parameter subfield indicates that this field to be ignored. The usage of PCP/AP Coverage Parameter subfield is described in 10.39.12.6.

NOTE—An EDMG PCP or EDMG AP can set the PCP/AP Coverage Parameter subfield to EIRP – $G_{omni\_rx}$ – $G_{add\_gain}$, where (a) EIRP is equal to $P + G_{tx}$, and $P$ and $G_{tx}$ are the transmit power and antenna gain, respectively, used in the DMG Beacon frame transmission; (b) $G_{omni\_rx}$ is the antenna gain of the AP or PCP receiver when in quasi-omni receive mode; and (c) $G_{add\_gain}$ is equal to $P_{min\_sensitivity} – P_{sensitivity}$, where $P_{min\_sensitivity}$ is the receiver sensitivity for MCS 0 defined in Table 20-3 and $P_{sensitivity}$ is the actual PCP or AP receiver sensitivity. Since the values of $G_{omni\_rx}$ and $G_{tx}$ can change for different directions, the value of the PCP/AP Coverage Parameter subfield in DMG Beacon frames transmitted through different sectors can be different.

The RX Unassociated Short SSW subfield is set to 1 to indicate that the EDMG STA supports reception of Short SSW PPDUs from unassociated STAs during a CBAP. Otherwise, it is set to 0.

The DMG Antenna ID MSB subfield is prepended to the DMG Antenna ID subfield to create a single 3-bit field.

### 9.5.3 Sector Sweep Feedback field

***Change the first paragraph in 9.5.3 as follows:***

When the SSW Feedback field is transmitted as part of an ISS, the format of the field is as shown in Figure 9-848. Otherwise, the format of the SSW Feedback field is as shown in Figure 9-849 when the EDMG Extension Flag subfield is 1 and in Figure 9-849a when the EDMG Extension Flag subfield is 0.

***Change Figure 9-848 and Figure 9-849 as follows:***

| | B0 B8 | B9 B10 | B11 B15 | B16 | B17 B21 ~~B23~~ | B22 | B23 |
|---|---|---|---|---|---|---|---|
| | Total Sectors in ISS | Number of RX DMG Antennas | Reserved | Poll Required | Reserved | Unsolicited RSS Enabled | Reserved |
| Bits: | 9 | 2 | 5 | 1 | ~~7~~ 5 | 1 | 1 |

**Figure 9-848—SSW Feedback field format when transmitted as part of an ISS**

| | B0 B5 | B6 B7 | B8 B15 | B16 | B17 B21 ~~B23~~ | B22 | B23 |
|---|---|---|---|---|---|---|---|
| | Sector Select | DMG Antenna Select | SNR Report | Poll Required | Sector Select MSB ~~Reserved~~ | DMG Antenna Select MSB | EDMG Extension Flag |
| Bits: | 6 | 2 | 8 | 1 | ~~7~~ 5 | 1 | 1 |

**Figure 9-849—SSW Feedback field format when not transmitted as part of an ISS and the EDMG Extension Flag subfield is 1**

***Insert Figure 9-849a into 9.5.3 after Figure 9-849:***

| | B0 B5 | B6 B7 | B8 B15 | B16 | B17 B21 | B22 | B23 |
|---|---|---|---|---|---|---|---|
| | Sector Select | DMG Antenna Select | SNR Report | Poll Required | Reserved | Unsolicited RSS Enabled | EDMG Extension Flag |
| Bits: | 6 | 2 | 8 | 1 | 5 | 1 | 1 |

**Figure 9-849a—SSW Feedback field format when not transmitted as part of an ISS and the EDMG Extension Flag subfield is 0**

***Insert the following paragraphs into 9.5.3 after the third paragraph ("The Number of TX DMG Antennas subfield ...."):***

The EDMG Extension Flag subfield is 0 when the Sector Sweep Feedback field is transmitted within an SSW frame, and when transmitted within an SSW-Feedback and SSW-Ack frame sent in response to an ISS or an RSS that used the SSW frame. Otherwise, the EDMG Extension Flag subfield is 1.

The selected sector depends on the value of the EDMG Extension Flag subfield.

***Change the following text of 9.5.3 (including the original fourth and fifth paragraphs of this subclause as published in IEEE Std 802.11-2020):***

If the EDMG Extension Flag subfield is 0, t~~T~~he Sector Select subfield contains the value of the Sector ID subfield of the SSW field within the frame that was received with best quality in the immediately preceding sector sweep. The determination of which PPDU was received with best quality is implementation dependent. ~~Possible values of this subfield range from 0 to 63.~~

If the EDMG Extension Flag subfield is 1, the Sector Select MSB subfield is prepended to the Sector Select subfield to form a single 11-bit subfield representing the value of the CDOWN field within the Short SSW PPDU that was received with the best quality in the immediately preceding sector sweep. The determination of which PPDU was received with the best quality is implementation dependent.

The interpretation of the DMG Antenna Select subfield depends on the value of the EDMG Extension Flag subfield.

If the EDMG Extension Flag subfield is 0, t~~T~~he DMG Antenna Select subfield indicates the value of the DMG Antenna ID subfield of the SSW field within the frame that was received with best quality in the immediately preceding sector sweep. The determination of which frame was received with best quality is implementation dependent.

If the EDMG Extension Flag subfield is 1, the DMG Antenna Select MSB subfield is prepended to the DMG Antenna Select subfield to form a single 3-bit subfield representing the value of the RF Chain ID field within the Short SSW PPDU that was received with the best quality in the immediately preceding sector sweep. The determination of which PPDU was received with the best quality is implementation dependent.

The Unsolicited RSS Enabled subfield is set to 1 to indicate that the STA is capable of receiving an unsolicited RSS and completing the SLS with any other STA that opportunistically receives this ISS or RSS, but that is not the STA addressed by this ISS or RSS (see 10.42.6.2). This subfield is set to 0 otherwise.

### 9.5.4 BRP Request field

***Change Figure 9-850 as follows:***

| | B0 B4 | B5 | B6 | B7 | B8 | B9 | B10 | B11 B16 |
|---|---|---|---|---|---|---|---|---|
| | L-RX | TX-TRN-REQ | MID-REQ | BC-REQ | MID-Grant | BC-Grant | Chan-FBCK-CAP | TX Sector ID |
| Bits: | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |

| | B17 B24 | B25 B26 | B27 | B28 | ~~B27~~ B29 B31 |
|---|---|---|---|---|---|
| | Other_AID | TX DMG Antenna ID | EDMG-SHORT-BRP | EDMG-SHORT-FBCK | Reserved |
| Bits: | 8 | 2 | 1 | 1 | ~~5~~ 3 |

**Figure 9-850—BRP Request field format**

***Change the seventh paragraph in 9.5.4 as follows:***

The TX sector ID subfield indicates the sector ID that is used when transmitting the PPDU. If the PPDU is transmitted using a pattern that is not a sector that has been used in the sector sweep, this subfield is set to 0x63. This subfield is reserved if the BRP Request field is transmitted within an SSW-Feedback frame with the EDMG Extension Flag subfield set to 1 or within an SSW-Ack frame with the EDMG Extension Flag subfield set to 1.

***Change the ninth paragraph in 9.5.4 as follows:***

The TX DMG Antenna ID subfield indicates the DMG antenna ID that is used when transmitting the PPDU. This subfield is reserved if the BRP Request field is transmitted within an SSW-Feedback frame with the EDMG Extension Flag subfield set to 1 or within an SSW-Ack frame with the EDMG Extension Flag subfield set to 1.

***Insert the following paragraphs at the end of 9.5.4:***

The EDMG-SHORT-BRP subfield is set to 1 to indicate that an EDMG BRP field is present following the BRP Request field. Otherwise, this field is set to 0.

The EDMG-SHORT-FBCK subfield is set to 1 to indicate that an EDMG Short FBCK field is present in the frame following the EDMG BRP field. Otherwise, this field is set to 0. This subfield is reserved if the EDMG-SHORT-BRP subfield is 0.

### 9.5.5 Beamforming Control field

***Change Figure 9-851 and Figure 9-852 as follows:***

| | B0 | B1 | B2 | B3 B9 | B10 B11 | B12 | ~~B12~~ B13 B15 |
|---|---|---|---|---|---|---|---|
| | Beamforming Training | IsInitiatorTXSS | IsResponderTXSS | Total Number of Sectors | Number of RX DMG Antennas | Unsolicited RSS | Reserved |
| Bits: | 1 | 1 | 1 | 7 | 2 | 1 | ~~4~~ 3 |

**Figure 9-851—BF Control field format when both IsInitiatorTXSS and IsResponderTXSS subfields are equal to 1 and the BF Control field is transmitted in Grant or Grant Ack frames**

| | B0 | B1 | B2 | B3 B8 | B9 | B10 B11 ~~B15~~ | B12 | B13 B15 |
|---|---|---|---|---|---|---|---|---|
| | Beamforming Training | IsInitiatorTXSS | IsResponderTXSS | RXSS Length | RXSSTxRate | Reserved | Unsolicited RSS | Reserved |
| Bits: | 1 | 1 | 1 | 6 | 1 | ~~6~~ 2 | 1 | 3 |

**Figure 9-852—BF Control field format in all other cases**

***Change the third and fourth paragraphs in 9.5.5 as follows:***

The IsInitiatorTXSS subfield is set to 1 to indicate that the source DMG STA starts the beamforming training with an initiator TXSS. This subfield is set to 0 to indicate that the source DMG STA starts the BF training with an initiator RXSS. The IsInitiatorTXSS subfield is ignored if the Unsolicited RSS field is set to 1.

The IsResponderTXSS subfield is set to 1 to indicate that the destination DMG STA, or the source EDMG STA if the Unsolicited RSS subfield is set to 1, starts the RSS with a responder TXSS. This subfield is set to 0 to indicate that the destination DMG STA, or the source EDMG STA if the Unsolicited RSS subfield is set to 1, is to initiate the RSS with a responder RXSS.

***Insert the following paragraphs and Table 9-343a into 9.5.5 after the fourth paragraph:***

The Unsolicited RSS subfield is set to 1 to indicate the source EDMG STA intends to initiate an unsolicited RSS at the start of the TXOP or SP. This subfield is set to 0 to indicate the source EDMG STA intends to initiate an SLS with the ISS at the start of the allocation.

The interpretation of the IsInitiatorTXSS, IsResponderTXSS, and Unsolicited RSS subfields are indicated in Table 9-343a.

**Table 9-343a—IsInitiatorTXSS, IsResponderTXSS, and Unsolicited RSS subfields**

| Bit 1 | Bit 2 | Bit 12 | Meaning |
|---|---|---|---|
| 1 | 0 | 0 | Initiator TXSS and Responder RXSS |
| 0 | 1 | 0 | Initiator RXSS and Responder TXSS |
| 1 | 1 | 0 | Initiator TXSS and Responder TXSS |
| 0 | 0 | 0 | Initiator RXSS and Responder RXSS |
| N/A | 1 | 1 | Responder TXSS only (no ISS) |
| N/A | 0 | 1 | Responder RXSS only (no ISS) |

***Insert the following subclauses (9.5.7, 9.5.8, and 9.5.9, including Figure 9-853a through Figure 9-853d) after 9.5.6:***

### 9.5.7 EDMG BRP field

The EDMG BRP field combines the EDMG BRP Request element and the DMG Beam Refinement element into a fixed size field for use in a fixed sized version of the BPR frame (see 9.6.21.3). The EDMG BRP field is defined in Figure 9-853a.

| | B0 | B1 B8 | B9 | B10 | B11 | B12 | B13 B24 | B25 B36 | B37 B39 | B40 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initiator | L-RX | TX-train-response | RX-train-response | TX-TRN-OK | TXSS-FBCK-REQ | TX Sector ID | BS-FBCK | BS-FBCK Antenna ID | MID Extension |
| Bits: | 1 | 8 | 1 | 1 | 1 | 1 | 12 | 12 | 3 | 1 |

| | B41 | B42 B49 | B50 B51 | B52 B55 | B56 B57 | B58 | B59 | B60 B62 |
|---|---|---|---|---|---|---|---|---|
| | BRP-TXSS-OK | L-TX-RX | Requested EDMG TRN-Unit P | Requested EDMG TRN-Unit M | Requested EDMG TRN-Unit N | BRP-TX SS | TXSS-INITIATOR | TXSS-PPDUs |
| Bits: | 1 | 8 | 2 | 4 | 2 | 1 | 1 | 3 |

| | B63 B64 | B65 B67 | B68 | B69 B74 | B75 B82 | B83 | B84 | B85 B87 |
|---|---|---|---|---|---|---|---|---|
| | Sector Sweep Frame Type | TXSS-REPEAT | TXSS-MIMO | BRP CDOWN | TX Antenna Mask | First Path Training | Dual Polarization TRN | Reserved |
| Bits: | 2 | 3 | 1 | 6 | 8 | 1 | 1 | 3 |

**Figure 9-853a—EDMG BRP field format**

The Initiator, TX-train-response, RX-train-response, TX-TRN-OK, TXSS-FBCK-REQ, BS-FBCK, BS-FBCK Antenna ID, Sector Sweep Frame Type, and MID Extension subfields are defined in 9.4.2.129.

The L-RX, TX Sector ID, L-TX-RX, Requested EDMG TRN-Unit P, Requested EDMG TRN-Unit M, Requested EDMG TRN-Unit N, BRP-TXSS, TXSS-INITIATOR, TXSS-PPDUs, TXSS-REPEAT, TXSS-MIMO, BRP CDOWN, TX Antenna Mask, First Path Training, and Dual Polarization TRN subfields are defined in 9.4.2.270.

### 9.5.8 Short BRP Feedback field

The Short BRP Feedback field carries feedback information of up to 16 sectors and is defined in Figure 9-853b.

| | B0 B31 | B32 B63 | | B480 B511 |
|---|---|---|---|---|
| | Sector Measurement 0 | Sector Measurement 1 | … | Sector Measurement 15 |
| Bits: | 32 | 32 | | 32 |

**Figure 9-853b—Short BRP Feedback field format**

Each Sector Measurement *i* subfield, $0 \le i \le 15$, has the same format and is defined in Figure 9-853c.

| | B0 B10 | B11 B16 | B17 B19 | B20 B22 | B23 B30 | B31 |
|---|---|---|---|---|---|---|
| | Sector ID/CDOWN/AWV ID | BRP CDOWN | TX Antenna ID | RX Antenna ID | SNR | Reserved |
| Bits: | 11 | 6 | 3 | 3 | 8 | 1 |

**Figure 9-853c—Sector Measurement subfield format**

If the Sector Measurement subfield contains the feedback for a sector sweep performed using SSW frames, or Short SSW PPDUs, or DMG Beacon frames, the Sector ID/CDOWN/AWV ID subfield indicates the Sector ID of a PPDU received in the sector sweep, the TX Antenna ID subfield indicates the DMG antenna ID indicated in the PPDU, and the RX Antenna ID subfield indicates the receive DMG antenna through which the SNR contained in the SNR subfield was measured.

If the Sector Measurement subfield contains the feedback for a sector sweep performed using BRP-TX PPDUs, the Sector ID/CDOWN/AWV ID subfield contains the AWV feedback ID of the TRN subfields over which the SNR in the SNR subfield was measured. The BRP CDOWN field contains the value of the BRP CDOWN field in the BRP frame through in which the SNR in the SNR subfield was measured. The TX Antenna ID subfield has the value of the TX Antenna Mask field in the received BRP frame and the RX Antenna ID subfield indicates the receive DMG antenna through which the SNR in the SNR subfield was measured.

The encoding of the SNR subfield is defined in 9.4.2.136. A value of 254 in the SNR subfield indicates SNR values greater than or equal to 55.5 dB. A value of 255 indicates that this Sector Measurement subfield is invalid.

### 9.5.9 Sector Feedback field

The Sector Feedback field is defined in Figure 9-853d.

| | RA | SSW Feedback | BRP Request | Beamformed Link Maintenance |
|---|---|---|---|---|
| Octets: | 6 | 3 | 4 | 1 |

**Figure 9-853d—Sector Feedback field format**

The RA field contains the MAC address of the STA that is the intended destination of the Sector Feedback field.

The SSW Feedback field is defined in Figure 9-848.

The BRP Request field is defined in 9.5.4.

The Beamformed Link Maintenance field is defined in 9.5.6.

## 9.6 Action frame format details

### 9.6.4 Block Ack Action frame details

#### 9.6.4.2 ADDBA Request frame format

***Change Table 9-360 as follows:***

**Table 9-360—ADDBA Request frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Block Ack Action |
| 3 | Dialog Token |
| 4 | Block Ack Parameter Set |
| 5 | Block Ack Timeout Value |
| 6 | Block Ack Starting Sequence Control |
| 7 | GCR Group Address element (optional) |
| 8 | Multi-band (optional) |
| 9 | TCLAS (optional) |
| 10 | ADDBA Extension (optional) |
| 11 | EDMG Flow Control Extension Configuration (optional) |
| 12 | SAR Configuration (optional) |

***Change the fourth paragraph in 9.6.4.2 as follows:***

For an unsolicited block ack extension agreement, the Dialog Token field is set to 0. Otherwise, t~~T~~he Dialog Token field is set to a nonzero value chosen by the STA.

***Insert the following paragraphs at the end of 9.6.4.2:***

The EDMG Flow Control Extension Configuration element is defined in 9.4.2.277.

The SAR Configuration element is defined in 9.4.2.280.

#### 9.6.4.3 ADDBA Response frame format

*Change Table 9-361 as follows:*

**Table 9-361—ADDBA Response frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Block Ack Action |
| 3 | Dialog Token |
| 4 | Status Code |
| 5 | Block Ack Parameter Set |
| 6 | Block Ack Timeout Value |
| 7 | GCR Group Address element (optional) |
| 8 | Multi-band (optional) |
| 9 | TCLAS (optional) |
| 10 | ADDBA Extension (optional) |
| 11 | Originator Preferred MCS (optional) |
| 12 | EDMG Flow Control Extension Configuration (optional) |
| 13 | SAR Configuration (optional) |

*Insert the following paragraphs at the end of 9.6.4.3:*

The EDMG Flow Control Extension Configuration element is defined in 9.4.2.277.

The SAR Configuration element is defined in 9.4.2.280 and is included in the frame if a SAR Configuration element was included in the corresponding ADDBA Request frame.

### 9.6.6 Radio Measurement action details

#### 9.6.6.4 Link Measurement Request frame format

*Change Figure 9-862 as follows:*

| | Category | Radio Measurement Action | Dialog Token | Transmit Power Used | Max Transmit Power | Extended Link Measurement |
|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 1 | 1 | Variable |

**Figure 9-862—Link Measurement Request frame Action field format**

*Insert the following paragraph at the end of 9.6.6.4:*

The Extended Link Measurement field is optionally present. When present, it contains an Extended Link Measurement element.

### 9.6.6.5 Link Measurement Report frame format

***Change Figure 9-863 as follows:***

| | Category | Radio Measurement Action | Dialog Token | TPC Report element | Receive Antenna ID | Transmit Antenna ID | RCPI | RSNI |
|---|---|---|---|---|---|---|---|---|
| Octets: | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 |

| | DMG Link Margin | DMG Link Adaptation Acknowledgment | Extended Link Measurement |
|---|---|---|---|
| Octets: | Variable | Variable | Variable |

**Figure 9-863—Link Measurement Report frame Action field format**

***Change the fourth paragraph in 9.6.6.5 as follows:***

The Dialog Token field is set to the value of the Dialog Token field in the last received corresponding Link Measurement Request frame.

***Change the sixth paragraph in 9.6.6.5 as follows:***

The Receive Antenna ID field contains the identifying number for the antenna(s) or DMG antenna used to receive the corresponding Link Measurement Request frame or the last received frame from the requesting STA within the corresponding report interval. The antenna ID or DMG antenna ID is defined in 9.4.2.39.

***Change the eighth and ninth paragraphs in 9.6.6.5 as follows:***

The RCPI field indicates the received channel power of the corresponding Link Measurement Request frame or the last received frame from the requesting STA within the corresponding report interval, which is a logarithmic function of the received signal power, as defined in 9.4.2.37.

The RSNI field indicates the received signal-to-noise indication for the corresponding Link Measurement Request frame or the last received frame from the requesting STA within the corresponding report interval, as described in 9.4.2.40.

***Insert the following paragraph at the end of 9.6.6.5:***

The Extended Link Measurement field is optionally present. When present, it contains an Extended Link Measurement element.

### 9.6.7 Public Action details

#### 9.6.7.1 DMG Action field

***Insert the following row into Table 9-364 in numeric order, and change the Reserved row accordingly:***

**Table 9-364—Public Action field values**

| Public Action field value | Description |
|---|---|
| 46 | DMG STA Directional Transmit Activity Report |

***Insert the following subclause (9.6.7.48, including Figure 9-909a) after 9.6.7.47:***

#### 9.6.7.48 DMG STA Directional Transmit Activity Report frame format

The DMG STA Directional Transmit Activity Report frame is transmitted by a DMG STA to describe the transmit activity of the STA for a given antenna pattern and over a given observation period. The information included in the frame can help a receiving STA take actions to eliminate or mitigate both the interference caused by the STA transmitting the frame, and the interference caused by the receiving STA to the transmitting STA. The format of the DMG STA Directional Transmit Activity Report frame Action field is shown in Figure 9-909a.

| | Category | Public Action | Timestamp | Country element | DMG STA Directional Transmit Activity Report element |
|---|---|---|---|---|---|
| Octets: | 1 | 1 | 8 | Variable | Variable |

**Figure 9-909a—DMG STA Directional Transmit Activity Report frame Action field format**

The Category field is defined in 9.4.1.11.

The Public Action field is defined in 9.6.7.1.

The Timestamp field is defined in 9.4.1.10.

The Country element is defined in 9.4.2.8.

The DMG STA Directional Transmit Activity Report element is defined in 9.4.2.290.

### 9.6.10 Protected Dual of Public Action frames

***Insert the following row into Table 9-404 in numeric order, and change the Reserved row accordingly:***

**Table 9-404—Public Action field values defined for Protected Dual of Public Action frames**

| Public Action field value | Description | Defined in |
|---|---|---|
| 32 | Protected DMG STA Directional Transmit Activity Report | 9.6.7.48 |

### 9.6.19 DMG Action frame details

#### 9.6.19.1 DMG Action field

***Insert the following row at the end of Table 9-457:***

**Table 9-457—DMG Action field values**

| DMG Action field value | Meaning |
|---|---|
| 23 | Protected Announce |

#### 9.6.19.2 Power Save Configuration Request frame format

***Insert the following row at the end of Table 9-458:***

**Table 9-458—Power Save Configuration Request frame Action field format**

| Order | Information |
|---|---|
| 6 | QoS Triggered Unscheduled element (optional) |

***Insert the following paragraph at the end of 9.5.19.2:***

The QoS Triggered Unscheduled element is defined in 9.4.2.278.

#### 9.6.19.3 Power Save Configuration Response frame format

***Insert the following row at the end of Table 9-459:***

**Table 9-459—Power Save Configuration Response frame Action field format**

| Order | Information |
|---|---|
| 7 | QoS Triggered Unscheduled element (optional) |

***Insert the following paragraph at the end of 9.6.19.3:***

The QoS Triggered Unscheduled element is defined in 9.4.2.278.

***Insert the following subclause (9.6.19.23) after 9.6.19.22:***

#### 9.6.19.23 Protected Announce frame format

The Protected Announce frame allows robust STA-STA communications of the same information that is conveyed in the nonrobust Announce frame (see 9.6.21.2).

The format of the robust Protected Announce and nonrobust Announce frame is the same and defined in 9.6.21.2. The Category field value differentiates whether the frame is robust or not.

### 9.6.21 Unprotected DMG Action frame details

#### 9.6.21.1 Unprotected DMG Action field

*Change Table 9-486 as follows:*

**Table 9-486—Unprotected DMG Action field values**

| Unprotected DMG Action field value | Meaning |
|---|---|
| 0 | Announce |
| 1 | BRP |
| 2 | MIMO BF Setup |
| 3 | MIMO BF Poll |
| 4 | MIMO BF Feedback |
| 5 | MIMO BF Selection |

#### 9.6.21.2 Announce frame format

*Change Table 9-487 as follows (unchanged rows not shown):*

**Table 9-487—Announce frame Action field format**

| Order | Information | | Notes |
|---|---|---|---|
| ... | | | |
| 2 | Unprotected DMG Action | DMG Action | The Unprotected DMG Action field is defined in 9.6.21.1 and is sent when the Announce frame is transmitted unprotected.<br>The DMG Action field is defined in DMG Action field and is sent when the Announce frame is transmitted protected. |
| ... | | | |
| 30 | TDD Slot Structure | | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD slot timing. |
| 31 | TDD Slot Schedule | | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the type of the TDD slot and the access permission. |
| 32 | TDD Route | | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the TDD beamforming results and sector switch configuration. |
| 33 | DMG Link Margin | | This element is optionally present. If present, the element specifies the parameters needed for link maintenance. |
| 34 | TDD Bandwidth Request | | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the parameters needed for bandwidth reservation during TDD SPs. |

**Table 9-487—Announce frame Action field format *(continued)***

| Order | Information | Notes |
|---|---|---|
| 35 | TDD Synchronization | This element is optionally present if dot11TDDOptionImplemented is true; otherwise, not present. If present, the element specifies the information needed for clock synchronization during TDD SPs. |
| 36 | EDMG Capabilities | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 37 | EDMG Operation | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 38 | EDMG Extended Schedule | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 39 | EDMG Group ID Set | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 40 | EDMG Training Field Schedule | This element is optionally present if dot11EDMGOptionImplemented is true. |
| 41 | Time Advertisement | Optionally present if dot11UTCTSFOffsetActivated is true |

### 9.6.21.3 BRP frame format

***Change the first paragraph in 9.6.21.3 as follows:***

The BRP frame is an Action No Ack frame. The BRP frame Action field format is one of two variants depending upon the value of the EDMG-SHORT-BRP subfield within the BRP Request field. If the value of the EDMG-SHORT-BRP subfield is 1, the format of the BRP frame Action field is shown in Table 9-488a. In all other cases, t~~T~~he format of a BRP frame Action field is shown in Table 9-488.

***Change Table 9-488 as follows:***

**Table 9-488—BRP frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | BRP Request field |
| 5 | DMG Beam Refinement element |
| 6 | Zero or more Channel Measurement Feedback elements |
| 7 | Enhanced Beam Tracking element |
| 8 | SSW Report element |
| 9 | EDMG Partial Sector Level Sweep element (optional) |
| 10 | EDMG BRP Request element (optional) |
| 11 | Zero or more EDMG Channel Measurement Feedback elements |

***Insert Table 9-488a into 9.6.21.3 after Table 9-488:***

**Table 9-488a—BRP frame Action field format when the EDMG-SHORT-BRP subfield is 1**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | BRP Request field |
| 5 | EDMG BRP field |
| 6 | Short BRP Feedback field (optional) |

***Insert the following paragraphs into 9.6.21.3 after the eighth paragraph ("The BRP frame ..."):***

The EDMG Partial Sector Level Sweep element is defined in 9.4.2.272.

The EDMG BRP Request element is defined in 9.4.2.270. If this element is present in the frame, the value of a field within this element overrides the value of the field with the same name in the BRP Request field contained in the frame.

The EDMG Channel Measurement Feedback element is defined in 9.4.2.268. If an EDMG Channel Measurement Feedback element appears in the frame, then at least one Channel Measurement Feedback element is also included in the frame.

The EDMG BRP field is defined in 9.5.7.

The Short BRP Feedback field is defined in 9.5.8.

***Insert the following subclauses (9.6.21.4 through 9.6.21.7, including Table 9-488b through Table 9-488e) after 9.6.21.3:***

### 9.6.21.4 MIMO BF Setup frame format

The MIMO BF Setup frame is an Action No Ack frame. The format of a MIMO BF Setup frame Action field is shown in Table 9-488b.

**Table 9-488b—MIMO BF Setup frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | MIMO Setup Control element |

The Category field is defined in 9.4.1.11.

The Unprotected DMG Action field is defined in 9.6.21.1.

The Dialog Token field is set to a value chosen by the STA sending the frame to uniquely identify the transaction.

The MIMO Setup Control element is defined in 9.4.2.273.

### 9.6.21.5 MIMO BF Poll frame format

The MIMO BF Poll frame is an Action No Ack frame. The format of a MIMO BF Poll frame Action field is shown in Table 9-488c.

**Table 9-488c—MIMO BF Poll frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | MIMO Poll Control element |

The Category field is defined in 9.4.1.11.

The Unprotected DMG Action field is defined in 9.6.21.1.

The Dialog Token field is set to a value chosen by the STA sending the frame to uniquely identify the transaction.

The MIMO Poll Control element is defined in 9.4.2.274.

### 9.6.21.6 MIMO BF Feedback frame format

The MIMO BF Feedback frame is an Action No Ack frame. The format of a MIMO BF Feedback frame Action field is shown in Table 9-488d.

**Table 9-488d—MIMO BF Feedback frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | MIMO Feedback Control element |
| 5 | Zero or more Channel Measurement Feedback elements |
| 6 | Zero or more EDMG Channel Measurement Feedback elements |
| 7 | Zero or more Digital BF Feedback elements |

The Category field is defined in 9.4.1.11.

The Unprotected DMG Action field is defined in 9.6.21.1.

The Dialog Token field is set to a value chosen by the STA sending the frame to uniquely identify the transaction.

The MIMO Feedback Control element is defined in 9.4.2.275.

The Channel Measurement Feedback element is defined in 9.4.2.136.

The EDMG Channel Measurement Feedback element is defined in 9.4.2.268.

The Digital BF Feedback element is defined in 9.4.2.284.

The MIMO BF Feedback frame contains more than one Channel Measurement Feedback element if the measurement information exceeds 255 octets. The content of each Channel Measurement Feedback element that follows the first one in a single MIMO BF Feedback frame is a continuation of the content in the previous element. The SNR, Channel Measurement, Additional SNR and Additional Channel Measurement subfields can be split between several elements. Each Channel Measurement Feedback element that is not the last Channel Measurement Feedback element in the frame is 257 octets long. Channel measurement information for a single channel measurement is always contained within a single MIMO BF Feedback frame.

The MIMO BF Feedback frame contains more than one EDMG Channel Measurement Feedback element if the measurement information exceeds 254 octets. The content of each EDMG Channel Measurement Feedback element that follows the first one in a single MIMO BF Feedback frame is a continuation of the content in the previous element. The EDMG Sector ID Order, BRP CDOWN, Tap Delay, Additional EDMG Sector ID Order, Additional BRP CDOWN and Additional Tap Delay fields can be split between several elements. Each EDMG Channel Measurement Feedback element that is not the last EDMG Channel Measurement Feedback element in the frame is 257 octets long. Channel measurement information for a single channel measurement is always contained within a single MIMO BF Feedback frame.

NOTE—The length of a MIMO BF Feedback frame can limit the choice of channel measurement parameters such as the number of measurements and the number of taps.

### 9.6.21.7 MIMO BF Selection frame format

The MIMO BF Selection frame is an Action No Ack frame. The format of a MIMO BF Selection frame Action field is shown in Table 9-488e.

**Table 9-488e—MIMO BF Selection frame Action field format**

| Order | Information |
|---|---|
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | MIMO Selection Control element |
| 5 | EDMG Group ID Set element (optional) |

The Category field is defined in 9.4.1.11.

The Unprotected DMG Action field is defined in 9.6.21.1.

The Dialog Token field is set to a value chosen by the STA sending the frame to uniquely identify the transaction.

The MIMO Selection Control element is defined in 9.4.2.276.

The EDMG Group ID Set element is defined in 9.4.2.269. The element contains the updated list of MU groups following completion of the MU MIMO beamforming training.

## 9.7 Aggregate MPDU (A-MPDU)

### 9.7.1 A-MPDU format

***Change the third and fourth paragraphs in 9.7.1 as follows:***

In an HT or DMG PPDU, the final A-MPDU subframe is not padded. In a VHT, EDMG, or S1G PPDU, padding is added as described below.

The EOF Padding field is shown in Figure 9-972. This is present only in a VHT, EDMG, S1G, or HE PPDU.

***Change the introductory sentence of sixth paragraph in 9.7.1 as follows (the list items and Figure 9-973 remain unchanged):***

In a VHT PPDU, EDMG PPDU, or S1G PPDU, the following padding is present, as determined by the rules in 10.12.6:

***Change the eighth and ninth paragraphs in 9.7.1 as follows:***

The maximum length of an A-MPDU in an HT PPDU is 65 535 octets. The maximum length of an A-MPDU in a DMG PPDU is 262 143 octets. The maximum length of an A-MPDU pre-EOF padding in a VHT PPDU is 1 048 575 octets. The maximum length of an A-MPDU in an EDMG PPDU is 4 194 303 octets. The length of an A-MPDU addressed to a particular STA can be further constrained as described in 10.12.2.

The structure of the MPDU delimiter ~~when transmitted by a non-DMG STA~~ is defined in Figure 9-974. ~~The structure of the MPDU Delimiter field when transmitted by a DMG STA is shown in Figure 9-975.~~

***Change the title of Figure 9-974 as follows:***

**Figure 9-974—MPDU delimiter ~~(non-DMG)~~**

***Delete Figure 9-975 ["MPDU delimiter (DMG)"].***

***Change the tenth paragraph in 9.7.1 as follows:***

The fields of the MPDU delimiter ~~when transmitted by a non-DMG STA~~ are defined in Table 9-527. ~~The fields of the MPDU delimiter when transmitted by a DMG STA are defined in Table 9-528.~~

***Change Table 5-527 as follows:***

**Table 9-527—MPDU delimiter fields ~~(non-DMG)~~**

| Field | Size (bits) | Description |
|---|---|---|
| EOF | 1 | End of frame indication. Set to 1 in an A-MPDU subframe that has 0 in the MPDU Length field and that is used to pad the A-MPDU in a VHT PPDU as described in 10.12.6. Set to 1 in the MPDU delimiter of an S-MPDU as described in 10.12.7. Set to 0 otherwise.<br>In a DMG PPDU, this field is reserved. In an EDMG PPDU, it is set to 1 in EOF padding subframes and set to 0 otherwise (see 10.12.7). |
| Reserved | 1 | |
| MPDU Length | 14 | Length of the MPDU in octets. Set to 0 if no MPDU is present. An A-MPDU subframe with 0 in the MPDU Length field is used as defined in 10.12.3 to meet the minimum MPDU start spacing requirement and also to pad the A-MPDU to fill the available octets in a VHT PPDU as defined in 10.12.6. |
| CRC | 8 | 8-bit CRC of the preceding 16 bits. |
| Delimiter Signature | 8 | Pattern that can be used to detect an MPDU delimiter when scanning for an MPDU delimiter.<br>The unique pattern is 0x4E (see NOTE). |
| NOTE–The ASCII value of the character ‘N’ was chosen as the unique pattern for the value in the Delimiter Signature field. | | |

***Delete Table 9-528 [“MPDU delimiter fields (DMG)”].***

***Insert the following paragraph and Figure 9-976a into 9.7.1 after Figure 9-976 [“MPDU Length field (non-DMG)”]:***

The format of the MPDU Length field when transmitted by a DMG STA is shown in Figure 9-976a. The MPDU Length Low subfield contains the 13 low order bits of the MPDU length. The MPDU Length High subfield contains one high order bit of the MPDU length.

| | B0 | B1 B13 |
|---|---|---|
| | MPDU Length High | MPDU Length Low |
| Bits: | 1 | 13 |

**Figure 9-976a—MPDU Length field format (DMG)**

***Replace Equation (9-5) with the following equation (change is on the (E)DMG PPDU equation):***

$$L_{MPDU} = \begin{cases} L_{low} + L_{high} \times 4096, & \text{VHT PPDU} \\ L_{low}, & \text{HT PPDU} \\ L_{low} + L_{high} \times 8192, & \text{DMG PPDU and EDMG PPDU} \end{cases} \quad (9\text{-}5)$$

### 9.7.3 A-MPDU contents

***Insert the following text into 9.7.3 after NOTE 3:***

NOTE 4—If a STA transmits an A-MPDU in a TDD slot, the contents of the A-MPDU follows the TDD slot category as defined in 10.39.6.2.2.

NOTE 5— Limits on using BRP frames in A-MPDU are defined in 10.42.6.4.1.

An A-MPDU carried in an EDMG PPDU can include MPDUs with different values for the TID field as described in 10.70.

***Change Table 9-530 as follows:***

**Table 9-530—A-MPDU contents in the data enabled immediate response context**

<table>
<tr><th>MPDU description</th><th colspan="2">Conditions</th></tr>
<tr><td>Ack</td><td>If the preceding PPDU contains an MPDU that requires an Ack frame response, a single Ack frame at the start of the A-MPDU.</td><td rowspan="3">Of these, in a non-DMG STA: at most one MPDUs is present.<br><br>Of these, in a non-EDMG STA: at most one Ack frame is present, and zero or more HT-immediate BlockAck frames are present.<br><br>Of these, in an EDMG STA: at most one Ack frame is present. Zero or more HT-immediate BlockAck frames or zero or more EDMG Multi-TID BlockAck frames are present, but not both block ack variants are present in the same A-MPDU.</td></tr>
<tr><td>HT-immediate BlockAck</td><td>In a non-DMG STA: if the preceding PPDU contains an implicit or explicit block ack request for a TID for which an HT-immediate block ack agreement exists, at most one BlockAck frame for this TID, in which case it occurs at the start of the A-MPDU.<br><br>In a DMG STA: if the preceding PPDU contains an implicit or explicit block ack request for a TID for which an HT-immediate block ack agreement or an unsolicited block ack extension agreement exists, one or more copies of the same BlockAck for this TID.</td></tr>
<tr><td>EDMG Multi-TID BlockAck</td><td>In an EDMG STA: if the preceding PPDU that carried a multi-TID A-MPDU contains implicit or explicit block ack requests for multiple TIDs for which an HT-immediate block ack agreement exists, one or more copies of the same EDMG Multi-TID BlockAck frame.</td></tr>
<tr><td>Action No Ack</td><td colspan="2">Action No Ack frames.</td></tr>
</table>

**Table 9-530—A-MPDU contents in the data enabled immediate response context *(continued)***

<table>
<tr><th>MPDU description</th><th colspan="2">Conditions</th></tr>
<tr><td>Data frames sent under an HT-immediate block ack agreement</td><td>QoS Data frames with the same TID, which corresponds to an HT-immediate block ack agreement. See NOTE 1.<br><br>QoS Data frames with different TIDs, which corresponds to multiple HT-immediate block ack agreements. See NOTE 2.</td><td rowspan="3">Of these, at most one of the following is present in a non-DMG BSS:<br>— One or more QoS Data frames with the Implicit BAR ack policy<br>— A BlockAckReq frame<br><br>Of these, at most one of the following is present in a DMG BSS:<br>— One or more QoS Data frames with the Implicit BAR ack policy<br>— QoS Null frame with the No Ack ack policy<br>— A BlockAckReq frame with an optional QoS Null frame with No Ack ack policy<br><br>Of these, any of the following is present in an EDMG BSS:<br>— One or more QoS Data frames with different TIDs and at the most one Action frame.<br>— One or more QoS Null frames with No Ack ack policy.<br>— One of BlockAckReq or Multi-TID BlockAckReq frame, but not both in the same A-MPDU.</td></tr>
<tr><td>QoS Null frames with the No Ack ack policy</td><td>In a DMG BSS, QoS Null frames with the No Ack ack policy.</td></tr>
<tr><td>Immediate BlockAckReq</td><td>At most one BlockAckReq frame with a TID that corresponds to an HT-immediate block ack agreement or an unsolicited block ack extension agreement. It is not present if any QoS Data frames for that TID are present.<br><br>Multi-TID BlockAckReq frame with TIDs that correspond to an HT-immediate block ack agreement. It is not present if any QoS Data frames for those TIDs are present.<br><br>This is the last MPDU in the A-MPDU.</td></tr>
<tr><td>Management frame requires Ack or Action Ack frames</td><td colspan="2">At most one Action Ack in case of an EDMG STA supporting Multi-TID BlockAck.</td></tr>
<tr><td>Block Ack Schedule</td><td colspan="2">In an EDMG BSS, one or more copies of the Block Ack Schedule frame is present when transmitted within an EDMG MU PPDU.</td></tr>
<tr><td>Data without a block ack agreement</td><td colspan="2">QoS Data frames with a TID that does not have an established block ack agreement. These one per TID MPDUs with the Ack Policy field equal to Scheduled Ack are conveyed in an EDMG MU-MIMO PPDU.</td></tr>
<tr><td colspan="3">NOTE 1—These MPDUs all have the ack policy, which is ~~either~~ Implicit BAR, ~~or~~ Block Ack, or Scheduled Ack.<br>NOTE 2—The agreement can be established using an ADDBA exchange or under an unsolicited block ack extension.</td></tr>
</table>

***Change Table 9-533 as follows:***

**Table 9-533—A-MPDU contents in the control response context**

<table>
<tr><th>MPDU</th><th colspan="2">Conditions</th></tr>
<tr><td>Ack</td><td>Ack frame transmitted in response to an MPDU that requires an Ack frame.</td><td rowspan="3">One of these is present at the start of the A-MPDU; these are not present other than at the start of the A-MPDU.</td></tr>
<tr><td>BlockAck</td><td>BlockAck frame with a TID that corresponds to an HT-immediate block ack agreement. See NOTE.</td></tr>
<tr><td>EDMG Multi-TID BlockAck</td><td>If the preceding PPDU that carried a multi-TID A-MPDU contains an implicit or explicit block ack requests for multiple TIDs for which an HT-immediate block ack agreement exists, one or several copies of the same EDMG Multi-TID BlockAck frame.</td></tr>
<tr><td>Action No Ack</td><td colspan="2">BRP +HTC frames.<br>Action No Ack +HTC frames containing an explicit feedback response.<br>Action No Ack frames that are Flow Suspension frames or Flow Resumption frames.</td></tr>
<tr><td colspan="3">NOTE—This condition is applicable for BlockAck variants established by block ack agreements and is not applicable for the EDMG Multi-TID BlockAck where the condition depends on a preceding PPDU.</td></tr>
</table>

# 10. MAC sublayer functional description

## 10.3 DCF

### 10.3.1 General

***Change the eighth paragraph in 10.3.1 as follows:***

The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder. Similarly, an RTS/DMG CTS exchange by EDMG STAs performs fast collision inference on the secondary channel, secondary1 channel, and secondary2 channel and helps the EDMG STA transmitting the RTS to determine the available bandwidth at the responder.

### 10.3.2 Procedures common to the DCF and EDCAF

#### 10.3.2.3 IFS

##### 10.3.2.3.4 PIFS

***Insert the following list item into 10.3.2.3.4 at the end of the dashed list of the second paragraph (“The PIFS may be used ....”):***

— An EDMG STA performing CCA in the secondary, secondary1, and secondary2 channels before transmitting a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz mask PPDU using EDCA channel access, as described in 10.23.2.

***Change the third paragraph in 10.3.2.3.4 as follows:***

With the exception of performing CCA in the secondary channel (where the timing is defined in 11.16.9 for an HT STA and defined in 10.39.12.2 for an EDMG STA), a STA using PIFS starts its transmission after its CS mechanism (see 10.3.2.1) determines that the medium is idle at the TxPIFS slot boundary, as defined in 10.3.7 and 10.23.2.4.

##### 10.3.2.3.8 SBIFS

***Change 10.3.2.3.8 as follows:***

The SBIFS shall ~~be used to~~ separate ~~multiple~~ PPDU transmissions in each of the following cases:

a) Back-to-back PPDU transmissions from a single transmitter during a receive sector sweep or TDD beamforming, or

b) Back-to-back PPDU transmissions when each PPDU transmission occurs with a different transmit antenna configuration and no SIFS-separated response transmission is expected, or

c) Back-to-back PPDU transmissions from a single transmitter when each PPDU transmission occurs with a different transmit RF chain and no SIFS-separated response transmission is expected.

The duration of SBIFS is determined by the aSBIFSTime PHY characteristic. The SBIFS is the time from the end of the last symbol of the previous frame to the beginning of the first symbol of the preamble of the subsequent frame as seen on the WM. A STA shall not allow the space between PPDUs ~~frames~~ that are defined to be separated by a SBIFS, as measured at the DMG antenna ~~on the medium~~, to be less than aSBIFSTime or to be more than aSBIFSTime + aSBIFSAccuracy. Two PPDUs ~~frames~~ separated by a SBIFS shall both be either DMG PPDUs or EDMG PPDUs.

### 10.3.2.3.10 MBIFS

***Change 10.3.2.3.10 as follows:***

The MBIFS shall be used between the BTI and the A-BFT and between the ISS, RSS, SSW-Feedback, and SSW-Ack. In a BRP TXSS, MBIFS shall be used in between the first three transmitted BRP PPDUs (see 10.42.10.5). MBIFS is equal to 3×aSIFSTime. An implementation of a DMG STA shall not allow the space between frames that are defined to be separated by an MBIFS, as measured on the medium, to vary from the nominal MBIFS by more than –0% or +10% × (aSlotTime – aAirPropagationTime).

### 10.3.2.3.11 LBIFS

***Change 10.3.2.3.11 as follows:***

The LBIFS shall be used between two consecutive transmissions that use different DMG antennas but with common RF chain, ~~between transmissions employing different DMG antennas~~ and when the recipient STA is expected to switch DMG antennas. LBIFS is equal to TXTIME(SSW) + 2×SBIFS, except when used as part of an ISS or an RSS employing Short SSW PPDUs, in which case LBIFS is equal to 2×TXTIME(Short SSW) + 3×SBIFS. An implementation of a DMG STA shall not allow the space between frames that are defined to be separated by an LBIFS, as measured on the medium, to vary from the nominal LBIFS by more than –0% or +10% × (aSlotTime – aAirPropagationTime).

### 10.3.2.9 CTS and DMG CTS procedure

***Insert the following text at the end of 10.3.2.9:***

An EDMG STA that is addressed by an RTS frame sent in non-EDMG duplicate PPDU format to establish a TXOP shall behave as follows:

If the NAV in the primary channel indicates idle, then

- The STA shall respond with a DMG CTS frame transmitted in non-EDMG or non-EDMG duplicate PPDU format after a SIFS.
- In case the DMG CTS frame is sent in a non-EDMG duplicate PPDU format in response to an RTS sent to establish a TXOP for the transmission of a SISO or an MU PPDU, the TXVECTOR shall be configured as follows:
  - The SCRAMBLER_INIT_SETTING parameter shall be set to indicate Channel_BW if the channel combinations are covered in Table 28-6; otherwise, it shall be set to indicate CONTROL_TRAILER and the parameter CT_TYPE shall be set to CTS_DTS.
  - If the CCA of all the channels that were indicated in the RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING were idle for a duration of PIFS prior to the start of the RTS frame, the CH_BANDWIDTH parameter shall be exactly the same as that were indicated in the RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING. Otherwise, the CH_BANDWIDTH parameter shall be set to a subset of the channels that were indicated in the

RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING encoded as defined in Table 28-6 or in the control trailer and where the CCA of such channels were idle for a duration of PIFS prior to the start of the RTS frame.
  - The CH_BANDWIDTH_SIGNALING parameter shall be set to the encoded value of the set of channels indicated by the CH_BANDWIDTH parameter as defined in Table 28-6 or in the control trailer.
- In case the DMG CTS is sent in a non-EDMG duplicate PPDU format in response to an RTS sent to establish a TXOP for the transmission of an SU MIMO PPDU, the TXVECTOR shall be configured as follows:
  - The SCRAMBLER_INIT_SETTING parameter shall be set to indicate CONTROL_TRAILER and the parameter CT_TYPE shall be set to CTS_DTS.
  - If the CCA of all the channels that were indicated in the RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING were idle for a duration of PIFS prior to the start of the RTS frame, the CH_BANDWIDTH parameter shall be exactly the same as that were indicated in the RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING. Otherwise, the CH_BANDWIDTH parameter shall be set to a subset of the channels that were indicated by the RTS's RXVECTOR parameter CH_BANDWIDTH and for which the CCA of such channels were idle for a duration of PIFS prior to the start of the RTS frame.

Otherwise,
- The STA shall not respond with a DMG CTS frame.
- Except in the case of an RTS frame used for MU-MIMO channel access (see 10.39.12.4.4), the STA may respond with a DMG DTS frame in a non-EDMG or non-EDMG duplicate PPDU after a SIFS. In case the DMG DTS frame is sent in a non-EDMG duplicate PPDU format, the STA shall set the Duration, NAV-SA and NAV-DA fields of the DMG DTS frame to zero and shall set the TXVECTOR parameters as follows:
  - The SCRAMBLER_INIT_SETTING parameter shall be set to indicate Channel_BW.
  - The CH_BANDWIDTH parameter shall be set to the channels that were indicated in the RTS's RXVECTOR parameter CH_BANDWIDTH_SIGNALING encoded as defined in Table 28-6.
  - The CH_BANDWIDTH_SIGNALING parameter shall be set to the encoded value of the set of channels indicated by the CH_BANDWIDTH parameter as defined in Table 28-6.

An EDMG STA that is addressed by an RTS frame sent to establish TXOP for transmission of at least one MIMO PPDU shall follow the procedure defined in 10.39.12.4.

#### 10.3.2.11 Acknowledgment procedure

***Insert the following paragraph into 10.3.2.11 after the fourth paragraph ("Otherwise, upon reception .....”):***

A STA operating in an SP with TDD channel access (see 10.39.6.2.2), upon reception of a frame that requires acknowledgment shall transmit an Ack or BlockAck frame at the start of the earliest occurring TDD slot the STA is assigned to, with the Bitmap and Access Type Schedule field of the TDD slot set to TX, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.282).

***Insert the following paragraphs into 10.3.2.11 after the now sixth paragraph ("If a PHY-RXSTART.indication primitive ....”):***

A STA operating in an SP with TDD channel access (see 10.39.6.2.2) has AckTimeout interval value equal to the duration from the PHY-TXEND.confirm primitive of the current frame to the end of the earliest occurring TDD slot the addressed recipient of the MPDU is assigned to, with the Bitmap and Access Type Schedule field of the TDD slot set to RX, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.282).

When a STA operating in an SP with TDD channel access transmits, in a TDD slot, an MPDU that has an Ack Policy of Normal Ack, the STA shall not transmit another MPDU that has an Ack Policy of Normal Ack to the same receiver until the corresponding Ack frame is received or the end of the AckTimeout interval, whichever comes first.

### 10.3.2.13 MU acknowledgment procedure

#### 10.3.2.13.1 Acknowledgment procedure for DL MU PPDU in SU PPDU

***Insert the following text, Figure 10-14a-1, and Figure 10-14a-2 into 10.3.2.13.1 after the third paragraph ("Recovery within the TXOP ....") (i.e., before NOTE 2):***

An EDMG STA indicates that it is DL MU-MIMO capable by setting the MU-MIMO Supported subfield in the STA's EDMG Capabilities element to 1. An EDMG MU-MIMO initiator shall not transmit an EDMG MU-MIMO PPDU to an EDMG STA that does not have the MU-MIMO Supported subfield equal to 1.

An EDMG STA that is DL MU-MIMO capable shall support the Multi-TID BlockAck frame. An MU-MIMO initiator may transmit an MPDU with TID for which a BlockAck agreement does not exist. In this case, the MU-MIMO responder shall respond to the MPDU with a Multi-TID BlockAck frame following the rules defined in 10.70.2.

An EDMG STA that is DL MU-MIMO capable and that has the EDMG Multi-TID Aggregation Support subfield of its EDMG Capabilities element set to a nonzero value

- May set the EDMG All Ack Support subfield in the STA's EDMG Capabilities element to 1 and
- Shall follow rules defined in 10.70.

The acknowledgment procedure performed by EDMG STAs that receive an MPDU within an EDMG MU PPDU from an MU-MIMO initiator shall follow the schedule defined by the MU-MIMO initiator.

An MU-MIMO initiator shall set the ack policy of MPDUs contained in each A-MPDU transmitted within an EDMG MU PPDU to Scheduled Ack and shall include at least one Block Ack Schedule frame in each A-MPDU transmitted within an EDMG MU PPDU. Each Block Ack Schedule frame shall contain the scheduling information for the EDMG STA that is an intended receiver of the A-MPDU. An MU-MIMO initiator shall set the value of the Response Duration subfield of the Block Ack Schedule frame equal to the duration of the expected BlockAck frame or EDMG Multi-TID BlockAck frame (see 10.25.5) transmission from a STA addressed by an A-MPDU within a transmitted MU PPDU. The value of the expected transmission should be calculated using MCS 0. The values of all subfields of the Block Ack Schedule frame shall not change if transmitted multiple times in the same A-MPDU. An MU-MIMO initiator shall set the value of the Response Offset subfield of the Block Ack Schedule frame to SIFS in an A-MPDU transmitted to a STA that is expected to be the first responder.

An EDMG STA shall transmit a BlockAck frame or EDMG Multi-TID BlockAck frame in response to a received EDMG MU PPDU immediately after a period of time equal to the value of the Response Offset subfield from the end of EDMG MU PPDU. The Response Offset subfield is contained in the Block Ack Schedule frame within the MU PPDU.

If an MU-MIMO initiator does not intend to elicit a BlockAck frame or EDMG Multi-TID BlockAck frame from a STA addressed by an A-MPDU within a transmitted MU PPDU, it shall set the Ack Policy field equal to No Ack or Block Ack as defined in Table 9-13 and shall set the values of the Response Offset field and Response Duration field within the frame to 0.

If an expected BlockAck frame or EDMG Multi-TID BlockAck frame from a STA was not received by an MU-MIMO initiator, the initiator may transmit a BlockAckReq frame or Multi-TID BlockAckReq frame (see 10.25.5) to that STA immediately after a period of time equal to the value of the Next PPDU Start Offset subfield starting from the end of EDMG MU PPDU. The Next PPDU Start Offset subfield is contained in the Block Ack Schedule frame within the MU PPDU.

The entire MU sequence shall not exceed the established TXOP duration.

An example of an A-MPDU transmitted in an EDMG MU PPDU is shown in Figure 10-14a-1. In this example, an A-MPDU contains three Block Ack Schedule frames: one at the beginning and two at the end of the A-MPDU.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Block Ack Schedule** | QoS Data frame (Ack Policy=01) | QoS Data frame (Ack Policy=01) | ... | QoS Data frame (Ack Policy=01) | **Block Ack Schedule** | **Block Ack Schedule** |

**Figure 10-14a-1—Example of A-MPDU transmitted in EDMG MU PPDU**

An example of the EDMG MU PPDU frame acknowledgment procedure for three EDMG STAs with the illustration of scheduling information delivered to them is shown in Figure 10-14a-2. In this example, the value of the Next PPDU Start Offset field is the same for all STAs.

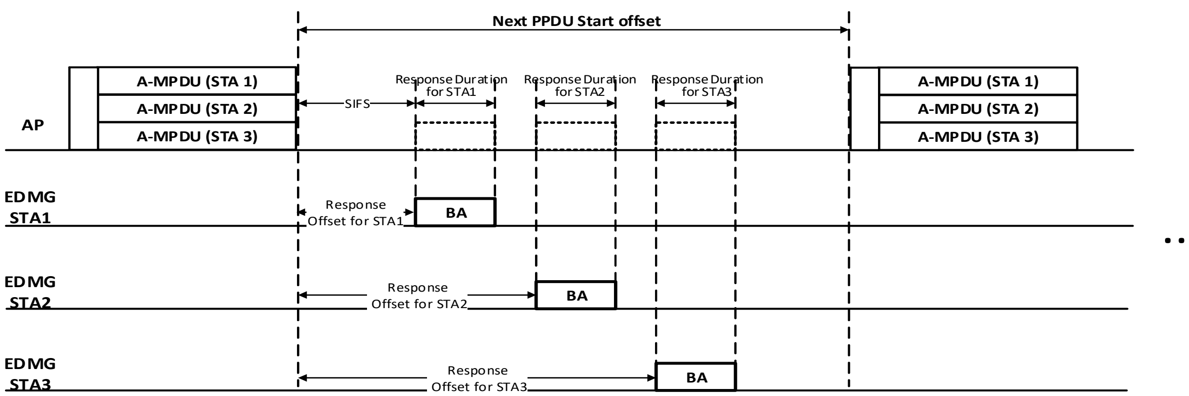


**Figure 10-14a-2—Example of TXOP containing EDMG MU PPDU transmission**

### 10.3.2.14 Duplicate detection and recovery

#### 10.3.2.14.2 Acknowledgment procedure for DL MU PPDU in MU format

***Insert NOTE 1 into 10.3.2.14.2 after the first paragraph ("A STA maintains ...."), and change the subsequent note in this subclause to "NOTE 2":***

NOTE 1—Under a block ack agreement using segmentation and reassembly (see 10.69), the MPDU sequence number is represented by a $2^{\text{MPDU Modulo}}$ counter and the MSDU sequence number is represented by $2^{\text{MSDU Modulo}}$ counter (see 9.2.4.4.1a), where MPDU Modulo and MSDU Modulo are as defined in the SAR Configuration element (see 9.4.2.280).

***Insert the following subclause (10.3.2.18) after 10.3.2.17:***

### 10.3.2.18 EDMG RTS procedure

In order to establish a TXOP with a peer EDMG STA, an EDMG STA shall transmit an RTS frame. For channel combinations covered in Table 28-6, the TXVECTOR parameter CH BANDWIDTH shall be set according to rules specified in 10.23.2.14. For those combinations that are not covered in Table 28-6, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER.

If a TXOP is established to send at least one SU MIMO or MU MIMO PPDU, and the number of bits set to 1 in the TXVECTOR parameter CH_BANDWIDTH is greater than 1, the RTS frame shall be sent in non-EDMG duplicate PPDU format, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to indicate CONTROL_TRAILER and the parameter CT_TYPE shall be set to GRANT_RTS_CTS2Self.

If a TXOP is established to send at least one SU MIMO or MU MIMO PPDU, and the number of bits set to 1 in the TXVECTOR parameter CH_BANDWIDTH is equal to 1, the RTS frame shall be sent in non-EDMG PPDU format, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to indicate CONTROL_TRAILER and the parameter CT_TYPE shall be set to GRANT_RTS_CTS2Self.

If a TXOP is established to send PPDUs using a single transmit chain and the number of bits set to 1 in the CH_BANDWIDTH parameter is greater than 1:

- The RTS frame shall be sent in non-EDMG duplicate PPDU format.
- The TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to Channel_BW for channel combinations covered in Table 28-6; otherwise, for those combinations that are not covered in Table 28-6 the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER.
- The TXVECTOR parameter CH_BANDWIDTH_SIGNALING shall be set to the encoded value of the set of channels indicated by the CH_BANDWIDTH parameter as defined in Table 28-6.

If the number of bits set to 1 in the CH_BANDWIDTH parameter is equal to 1, STA may perform one of the following:

- Follow the procedure defined in the paragraph above, or
- Transmit the RTS in non-EDMG format and follow the procedure defined in 10.3.2.4.

A CF-End frame sent to truncate a TXOP initiated by RTS frame carried in a non-EDMG duplicate PPDU format shall be sent using a non-EDMG duplicate PPDU format. The TXVECTOR parameters CHANNEL_AGGREGATION and CH_BANDWIDTH_SIGNALING of the CF-End frame shall be set to the same values as indicated by the RXVECTOR parameters of the DMG CTS frame, if received, or to the same values as indicated by the TXVECTOR parameters of the RTS frame otherwise.

An EDMG STA transmitting an RTS frame to establish a TXOP for the transmission of at least one MIMO PPDU or a SISO PPDU using multiple transmit chains with hybrid beamforming follows the procedure defined in 10.39.12.4.

## 10.6 Multirate support

### 10.6.7 Multirate support for DMG STAs

#### 10.6.7.1 Usage of DMG Control modulation class

***Change 10.6.7.1 as follows:***

The DMG Control modulation class has only one MCS, which is DMG MCS 0 defined in Clause 20. The DMG Beacon, SSW-Feedback, SSW-Ack, RTS, DMG CTS, DMG CTS-to-self, DMG DTS, CF-End, Grant, SPR, Poll, Sector Ack, TDD Beamforming frames (i.e., TDD SSW, TDD SSW Feedback and TDD SSW Ack), and first BRP PPDU in beam refinement shall be transmitted using the DMG Control modulation class. In the case of an RXSS that was specified through the Beamforming Control field with the value of the RXSSTxRate subfield equal to 1 and the RXSSTxRate Supported field in the DMG Capabilities element of the STA performing the RXSS is 1, the first SSW frame of the RXSS shall be transmitted using the DMG Control modulation class, and the remaining frames of the RXSS shall be transmitted using MCS 1 of the DMG SC modulation class. In all other cases, the SSW frames shall be transmitted using the DMG Control modulation class. Other DMG beamforming training frames may be transmitted using the DMG Control modulation class or the DMG SC modulation class.

#### 10.6.7.2 Rate selection rules for Control frames transmitted by DMG STAs

***Change the first paragraph in 10.6.7.2 as follows:***

This subclause describes the rate selection rules for Control frames transmitted by DMG STAs. The rate selection rules apply only for MCSs defined in Clause 20 and in Clause 28.

***Change the sixth paragraph in 10.6.7.2 as follows:***

A STA transmitting an Ack frame or a BlockAck frame in response to a frame sent using the DMG SC modulation class shall use an MCS from the mandatory MCS set of the DMG SC modulation class as long as (a) the selected MCS has a Data Rate that does not exceed the Data Rate of the last frame that elicited the response, and (b) no other MCS satisfying condition (a) results in a shorter frame transmission time.

***Insert the following text into 10.6.7.2 after the sixth paragraph:***

An EDMG STA transmitting an Ack frame or a BlockAck frame in response to a frame sent using the EDMG SC modulation class or EDMG OFDM modulation class shall

— Use the rules applicable to an DMG STA rules when the number of bits set to 1 in the CH_BANDWIDTH parameter in the RXVECTOR of the received EDMG PPDU is equal to 1 (i.e., a single 2.16 GHz channel).
— Use MCS1 when the Ack or BlockAck frame is sent within a non-EDMG duplicate PPDU and the number of bits set to 1 in the CH_BANDWIDTH parameter is greater than 1.
— Use one of MCS 1 through MCS 4 from the mandatory MCS set of the EDMG SC modulation class when the ACK or BlockAck frame is sent within an EDMG PPDU as long as (a) the selected MCS has a Data Rate that does not exceed the Data Rate of the frame that elicited the response, and (b) no other MCS satisfying condition (a) results in a shorter frame transmission time.
— In case the PPDU containing the Ack frame or a BlockAck frame carries a control trailer that provides spatial stream feedback, it shall be transmitted using MCS 0 and shall follow the rules defined in 10.43.4.

The rules in this subclause and in 10.6.7.7 do not apply to Block Ack Schedule frames carried within an A-MPDU. The rate selection rules that apply to a Block Ack Schedule frame are those applying to Data frames (see 10.6.7.4).

Rules for channel width selection of Control frames for an EDMG STA are specified in 10.6.7.6.

#### 10.6.7.3 Rate selection for group addressed Data and Management frames transmitted by DMG STAs

***Change the first paragraph in 10.6.7.3 as follows:***

This subclause describes the rate selection rules for group addressed Data and Management frames transmitted by DMG STAs. These rate selection rules apply only ~~for~~ to MCSs defined in Clause 20 and in Clause 28.

***Insert the following paragraph at the end of 10.6.7.3:***

Group addressed DMG STA Directional Transmit Activity Report frames shall be transmitted using DMG MCS 0.

#### 10.6.7.4 Rate selection for individually addressed Data and Management frames transmitted by DMG STAs

***Change the first and second paragraphs in 10.6.7.4 as follows:***

This subclause describes the rate selection rules for individually addressed Data and Management frames as transmitted by DMG STAs. These rate selection rules apply only ~~for~~ to MCSs defined in Clause 20 and in Clause 28.

An individually addressed Data or Management frame transmitted to a non-EDMG STA shall be sent using an MCS supported by the receiver STA, as reported in the maximum receive MCS subfields in the Supported MCS Set field of the DMG STA Capability Information field and in the Extended SC MCS Capabilities field of the DMG Capabilities element carried in Management frames transmitted by the receiver STA.

***Insert the following paragraph into 10.6.7.4 after the second paragraph:***

An individually addressed Data, Management, and Block Ack Schedule frame transmitted to an EDMG STA shall be sent using a combination of MCSs, number of spatial streams and bandwidth supported by the STA, as reported in the

— Maximum receive MCS subfields in the Supported MCS Set subfield within the DMG STA Capability Information field and within the Extended SC MCS Capabilities field of the STA's last transmitted DMG Capabilities element.
— Maximum receive MCS subfields within the Supported MCS field of the STA's last transmitted EDMG Capabilities element.
— Maximum PHY Rate subfield within the Supported MCS field of the STA's last transmitted EDMG Capabilities element.
— If present in the STA's last transmitted EDMG Capabilities element, the maximum number of spatial streams and LDPC codeword supported subfields.

***Change the now fourth paragraph in 10.6.7.5 as follows:***

When the capabilities ~~Supported MCS set~~ of the receiving STA are ~~is~~ not known, the transmitting STA shall transmit using an MCS from the mandatory MCS set of the DMG control or SC mode. In addition for an EDMG STA, the TXVECTOR parameter LDPC_CW_TYPE shall be set to SHORT.

### 10.6.7.5 Rate selection for BRP PPDUs

***Insert the following paragraph at the end of 10.6.7.5:***

If an EDMG BRP PPDU is sent during a BRP transaction to perform beamforming training over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz or 4.32+4.32 GHz channel, the EDMG BRP PPDU should be transmitted with MCS 0.

***Insert the following subclauses (10.6.7.6, 10.6.7.8, and 10.6.7.8) after 10.6.7.5:***

### 10.6.7.6 Channel Width selection for Control frames transmitted by EDMG STAs

The rules in this subclause, combined with the rules in 10.6.7.2, determine the format of Control frames that are not RTS, DMG CTS, DMG DTS or CF-End frames.

Channel width selection rules for DMG CTS and DMG DTS frames are specified in 10.3.2.9.

Channel width selection rules for RTS and CF-End frames are specified in 10.3.2.18.

An EDMG STA that sends a Control frame in response to a frame carried in an EDMG PPDU shall set the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION to the value indicated by the RXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the frame eliciting the response.

An EDMG STA that sends a Control frame in response to a frame carried in a non-EDMG duplicate PPDU shall set the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION as follows:

- If the frame that elicited the response includes the channel bandwidth information in the RXVECTOR parameter CH_BANDWIDTH_SIGNALING or BW_IN_CT, CH_BANDWIDTH and CHANNEL_AGGREGATION shall be set to a value that represents the equivalent channels indicated by the CH_BANDWIDTH_SIGNALING or BW_IN_CT parameter, respectively.
- Otherwise, if the STA received at least one EDMG PPDU as part of the current frame exchange sequence, CH_BANDWIDTH and CHANNEL_AGGREGATION shall be set to respectively, the value of the RXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the last received EDMG PPDU in the current frame exchange sequence.
- Otherwise, if the STA transmitted at least one EDMG PPDU or non-EDMG duplicate PPDU as part of the current frame exchange sequence, CH_BANDWIDTH and CHANNEL_AGGREGATION shall be set to, respectively, the value of the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the last EDMG PPDU or non-EDMG duplicate PPDU, whichever came later, transmitted by the STA in the current frame exchange sequence.
- Otherwise, CH_BANDWIDTH and CHANNEL_AGGREGATION shall be set to, respectively, the estimated value of the RXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the frame that elicited the response.

#### 10.6.7.7 Control frame TXVECTOR parameter restrictions

A STA shall not transmit a Control frame with the TXVECTOR parameter GI_TYPE set to a value that is not equal to NORMAL.

A STA shall not transmit a Control frame with the TXVECTOR parameter EDMG_MODULATION set to EDMG_OFDM_MODE.

A STA shall not transmit a Control frame with the TXVECTOR parameter NUM_STS set to a value greater than one.

A STA shall not transmit a Control frame with the TXVECTOR parameter NUM_USERS set to a value greater than one.

A STA shall not transmit a Control frame with the TXVECTOR parameter LDPC_CW_TYPE set to LONG.

#### 10.6.7.8 Channel Width selection for individually addressed Data and Management frames transmitted by EDMG STAs

A TXOP holder that transmits a Data or Management frame during a TXOP that was established using the bandwidth negotiation procedures specified in 10.3.2.9 and 10.3.2.18 shall set the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION according to the following rules:

— The CH_BANDWIDTH and CHANNEL_AGGREGATION parameters shall be set to channels that were indicated in the RXVECTOR parameter CH_BANDWIDTH_SIGNALING, if a control trailer is not present, or parameter BW_IN_CT, if a control trailer is present, of the DMG CTS frame transmitted in a non-EDMG duplicate or non-EDMG PPDU that established the TXOP.
— The CH_BANDWIDTH and CHANNEL_AGGREGATION parameters may indicate a subset of the channels that were indicated as used in an immediately preceding received PPDU in the TXOP, if any, provided the transmitted PPDU is an EDMG PPDU.
— The CH_BANDWIDTH and CHANNEL_AGGREGATION parameters shall not indicate channels that were not used by all previous PPDUs sent in same TXOP.

A TXOP responder that transmits a PPDU as a result of a reverse direction grant shall set the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the PPDU to the value of the RXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the received EDMG PPDU addressed to the TXOP responder and that granted the reverse direction.

### 10.6.10 Modulation classes

***Change Table 10-9 as follows (not all rows are shown):***

**Table 10-9—Modulation classes**

| Description of modulation | Condition that selects this modulation class | | | |
|---|---|---|---|---|
| | Clause 15 to Clause 18 PHYs, or Clause 20 PHY, or Clause 24 PHY, or Clause 25 PHY, or Clause 28 PHY | Clause 19 PHY | Clause 21 PHY | Clause 27 PHY |
| ... | | | | |

**Table 10-9—Modulation classes *(continued)***

| Description of modulation | Condition that selects this modulation class | | | |
|---|---|---|---|---|
| | Clause 15 to Clause 18 PHYs, or Clause 20 PHY, or Clause 24 PHY, or Clause 25 PHY, or Clause 28 PHY | Clause 19 PHY | Clause 21 PHY | Clause 27 PHY |
| EDMG Control | Clause 28 transmission<br><br>FORMAT is EDMG and EDMG_MODULATION is EDMG_C_MODE | N/A | N/A | N/A |
| EDMG SC | Clause 28 transmission<br><br>FORMAT is EDMG, EDMG_MODULATION is EDMG_SC_MODE | N/A | N/A | N/A |
| EDMG OFDM | Clause 28 transmission<br><br>FORMAT is EDMG, EDMG_MODULATION is EDMG_OFDM_MODE | N/A | N/A | N/A |

## 10.12 A-MPDU operation

### 10.12.2 A-MPDU length limit rules

***Change the first paragraph in 10.12.2 as follows:***

A STA indicates in the Maximum A-MPDU Length Exponent field in its HT Capabilities element the maximum A-MPDU length that it can receive in an HT PPDU. A STA indicates in the Maximum A-MPDU Length Exponent field in its VHT Capabilities element the maximum length of the A-MPDU pre-EOF padding that it can receive in a VHT PPDU. A STA indicates in the Maximum A-MPDU Length Exponent field in its S1G Capabilities element the maximum length of the A-MPDU pre-EOF padding that it can receive in an S1G PPDU. A STA indicates in the Maximum A-MPDU Length Exponent field in its DMG Capabilities element the maximum A-MPDU length that it can receive in a DMG PPDU. A STA indicates the maximum length of the A-MPDU pre-EOF padding that it can receive in an HE PPDU in the Maximum A-MPDU Length Exponent field in its HT Capabilities, VHT Capabilities, and HE 6 GHz Band Capabilities elements (if present) and in the Maximum A-MPDU Length Exponent Extension field in its HE Capabilities element. A STA indicates in the Maximum A-MPDU Length Exponent field in its EDMG Capabilities element the maximum length of the A-MPDU that it can receive in an EDMG PPDU.

***Change the fifth paragraph in 10.12.2 as follows:***

A STA shall not transmit an A-MPDU in an HT PPDU that is longer than the value indicated by the Maximum A-MPDU Length Exponent field in the HT Capabilities element received from the intended receiver. MPDUs in an A-MPDU carried in an HT PPDU shall be limited to a maximum length of 4095 octets. A STA shall not transmit an A-MPDU in a VHT PPDU where the A-MPDU pre-EOF padding length is longer than the value indicated by the Maximum A-MPDU Length Exponent field in the VHT Capabilities element received from the intended receiver. An S1G STA shall not transmit an A-MPDU in an S1G PPDU where the A-MPDU pre-EOF padding length field is longer than the value indicated by the Maximum A-MPDU Length Exponent field in the S1G Capabilities element received from the intended receiver. A STA shall not transmit an A-MPDU in a DMG PPDU that is longer than the value indicated by the Maximum A-MPDU Length Exponent field in the DMG Capabilities element received from the intended receiver. A STA shall not transmit an A-MPDU in an EDMG PPDU that is longer than the value indicated by the Maximum A-MPDU Length Exponent field in the EDMG Capabilities element received from the intended receiver.

### 10.12.4 A-MPDU aggregation of group addressed Data frames

***Insert the following list items into 10.12.4 at the end of the dashed list of the fourth paragraph ("When a STA ...."):***

— If the PPDU is an EDMG PPDU, the maximum A-MPDU length exponent value that applies is the minimum value in the Maximum A-MPDU Length Exponent subfield of the A-MPDU Parameters field of the EDMG Capabilities element of all EDMG STAs associated with the AP or PCP.
— If the PPDU is an EDMG PPDU, the minimum MPDU start spacing value that applies is the maximum value in the Minimum MPDU Start Spacing subfield of the A-MPDU Parameters field of the EDMG Capabilities element of all EDMG STAs associated with the AP or PCP.

### 10.12.7 Setting the EOF/Tag field of the MPDU delimiter

***Insert the following paragraphs into 10.12.7 after the second paragraph ("An MPDU that is the only ...."):***

In an EDMG PPDU, the EOF padding can be used to indicate that no more MPDUs are present at end of the A-MPDU in the case the PSDU length exceeds the accumulated size of A-MPDU subframes plus the number of bytes used for MPDU start spacing.

In the sequence of A-MPDU subframes transmitted in an EDMG PPDU, the EOF field is set as follows:

— Shall be set to 0 in all A-MPDU subframes if the subframe's MPDU Length field is nonzero.
— May be set to 1 in all A-MPDU subframes if the subframe's MPDU Length field is 0 and no A-MPDU subframe with nonzero value in the subframe's MPDU Length field is set for transmission in the A-MPDU subframes sequence after the subframe with MPDU Length field equal to 0 is transmitted.

## 10.13 PPDU duration constraint

***Insert the following paragraph at the end of 10.13:***

A STA shall not transmit an EDMG PPDU that has a duration (as determined by the PLME-TXTIME.confirm primitive defined in 6.5.6) that is greater than aPPDUMaxTime defined in Table 20-32.

***Change the title and text of 10.14 as follows:***

## 10.14 DMG A-PPDU and EDMG A-PPDU operation

A DMG STA is DMG aggregate PPDU (A-PPDU) capable if the A-PPDU supported field within the STA's DMG Capabilities element is 1. Otherwise, the STA is not DMG A-PPDU capable.

An EDMG STA is EDMG A-PPDU capable if the EDMG A-PPDU subfield within the STA's EDMG Capabilities element is 1. Otherwise, the STA is not EDMG A-PPDU capable.

A DMG STA shall not transmit ~~an~~ DMG A-PPDU ~~aggregate~~ to a STA that is not DMG A-PPDU capable.

An EDMG STA shall not transmit an EDMG A-PPDU to a STA that is not EDMG A-PPDU capable.

~~An A-PPDU is a sequence of two or more PPDUs transmitted without IFS, preamble, and with a PHY-dependent separation between PPDU transmissions.~~ All PPDUs within ~~an~~ DMG A-PPDU shall have the ADD-PPDU parameter of the TXVECTOR set to ADD-PPDU, except for the last PPDU in the DMG A-PPDU that shall have this parameter set to NO-ADD-PPDU. An EDMG PPDU shall have the ADD-PPDU parameter of the TXVECTOR set to NO-ADD-PPDU. All PPDUs within an EDMG A-PPDU shall have the EDMG_ADD_PPDU parameter of the TXVECTOR set to ADD-PPDU, except for the last PPDU in the EDMG A-PPDU that shall have this parameter set to NO-ADD-PPDU. A DMG PPDU and an EDMG PPDU shall not be included in the same A-PPDU.

The value of a TXVECTOR parameter of a PPDU belonging to a DMG A-PPDU or an EDMG A-PPDU might differ from the value of the same TXVECTOR parameter of another PPDU in the same A-PPDU, including the MCS parameter.

A PPDU within an A-PPDU shall contain an A-MPDU. All MPDUs within A-MPDUs within an A-PPDU shall have the same values for the TA and RA fields. All QoS Data frames within A-MPDUs within an A-PPDU shall have the same ack policy. If a frame that requires an immediate response is present within an A-PPDU, it shall be transmitted in the last A-MPDU of the A-PPDU.

The transmission duration of an A-PPDU shall be no greater than aPPDUMaxTime (see Table 20-30).

## 10.23 HCF

### 10.23.2 HCF contention based channel access (EDCA)

#### 10.23.2.3 EDCA TXOPs

***Change 10.23.2.3 as follows:***

There are three modes of EDCA TXOP defined: initiation of an EDCA TXOP, sharing an EDCA TXOP, and multiple frame transmission within an EDCA TXOP. Initiation of the TXOP occurs when the EDCA rules permit access to the medium. Sharing of the EDCA TXOP occurs when an EDCAF within an AP or

PCP that support~~s~~ DL-MU-MIMO has obtained access to the medium, making the corresponding AC the primary AC, and includes traffic from queues associated with other ACs in VHT, EDMG, or S1G MU PPDUs transmitted during the TXOP. Multiple frame transmission within the TXOP occurs when an EDCAF retains the right to access the medium following the completion of a frame exchange sequence, such as on receipt of an Ack frame.

### 10.23.2.7 Sharing an EDCA TXOP

***Change the first paragraph in 10.23.2.7 as follows:***

The AC associated with the EDCAF that gains an EDCA TXOP is referred to as the *primary AC*. Frames from ACs other than the primary AC shall not be included in the TXOP, with the following exceptions (TXOP sharing):

— For a multi-TID A-MPDU in an HE MU PPDU transmitted by an AP, frames from any AC may be included as defined in 26.6.3. Otherwise, frames from a higher priority AC may be included when at least one frame from the primary AC has been transmitted and all frames from the primary AC have been transmitted.

  NOTE 1—The frames from a higher priority AC might be included in successive PPDUs in the TXOP and/or in one or more MU PPDUs.

— When a VHT AP, EDMG AP, or PCP supports DL-MU-MIMO, frames from a lower priority AC may be included in a VHT or EDMG MU PPDU with the TXVECTOR parameter NUM_USERS > 1 when these frames do not increase the duration of the VHT or EDMG MU PPDU beyond that required for the transmissions of the frames of the primary AC and any frames from a high priority AC. For a given user, any frames from the primary AC shall be transmitted first, and then any frames from a higher priority AC immediately next.

— When an HE AP transmits an HE MU PPDU, frames from higher or lower priority AC may be included in the HE MU PPDU when these frames do not increase the duration of the HE MU PPDU beyond that required for the transmissions of the frames of the primary AC and any frames from a high priority AC. For a given user, any frames from the primary AC shall be transmitted first, and then any frames from a higher priority AC immediately next.

***Change NOTE 2 as follows:***

NOTE 2—An AP or PCP can protect an immediate response by preceding the DL-MU-MIMO PPDU (which might have TXVECTOR parameter NUM_USERS > 1) with an RTS/CTS, MU-RTS Trigger/CTS frame exchange, or a CTS-to-self transmission.

### 10.23.2.8 Multiple frame transmission in an EDCA TXOP

***Insert the following note into 10.23.2.8 after NOTE 2, and renumber the subsequent notes in this subclause accordingly:***

NOTE 3—PIFS is used by an EDMG STA to perform CCA in the secondary, secondary1, and secondary2 channels before receiving RTS (see 10.3.2).

***Insert the following subclause (10.23.2.14, including Table 10.21a) after 10.23.2.13:***

### 10.23.2.14 EDCA channel access in an EDMG BSS

If the MAC receives a PHY-CCA.indication primitive with the channel-list parameter present, the channels considered busy are defined in Table 10-21a. Channels not indicated as busy are considered idle.

When a STA and the BSS, of which the STA is a member, both support multiple channel widths, an EDCA TXOP is obtained based solely on activity of the primary channel. “Idle medium” in this subclause means “idle primary channel.” Likewise “busy medium” means “busy primary channel.”

Once an EDCA TXOP has been obtained according to this subclause, further constraints defined in 10.39.12.2 and 10.23.2 might limit the width of transmission during the TXOP or deny the channel access, based on the state of CCA on secondary channels.

**Table 10-21a—Channels indicated busy by the channel-list parameter**

| PHY-CCA.indication primitive channel-list parameter | Busy channels |
|---|---|
| Primary | Primary |
| secondary | First secondary channel |
| secondary1 | Second secondary channel |
| secondary2 | Third secondary channel |

In the following description, the CCA is sampled according to the timing relationships defined in 10.3.7. Slot boundaries are determined solely by activity on the primary channel. “Channel idle for an interval of PIFS” means that the STATE parameter of the most recent PHY-CCA.indication primitive was IDLE, and no PHY-CCA.indication (BUSY) occurred during an interval of PIFS that ends at the start of transmission, the CCA for that channel was determined to be idle.

If a STA is permitted to begin a TXOP (as defined in 10.23.2.4) and the STA has at least one MSDU pending for transmission for the AC of the permitted TXOP, the STA shall perform exactly one of the following actions on the primary, secondary, seconday1, and secondary2 channels defined in Table 8-5a, which is based on the BSS Operating Channels field and Primary Channel field within the EDMG Operation element transmitted by an EDMG AP or an EDMG PCP:

a) Transmit an 8.64 GHz mask PPDU if the secondary, secondary1 and secondary2 channels are contiguous and secondary, secondary1 and secondary2 were idle during an interval of PIFS immediately preceding the start of the TXOP.
b) Transmit a 4.32+4.32 GHz mask PPDU if the primary and secondary channels are contiguous, secondary1 and secondary2 channels are contiguous and secondary, secondary1 and secondary2 channels were idle during an interval of PIFS immediately preceding the start of the TXOP.
c) Transmit a 6.48 GHz mask PPDU if the primary, secondary and secondary1 channels are contiguous and the secondary and secondary1 channels were idle during an interval of PIFS immediately preceding the start of the TXOP or if the primary, secondary1 and secondary2 channels are contiguous and secondary1 and secondary2 channels were idle during an interval of PIFS immediately preceding the start of the TXOP.
d) Transmit a 4.32 GHz mask PPDU if the primary and secondary channels are contiguous and the secondary channel was idle during an interval of PIFS immediately preceding the start of the TXOP

or if the primary and secondary1 channels are contiguous and the secondary1 channel was idle during an interval of PIFS immediately preceding the start of the TXOP.

e) Transmit a 2.16+2.16 GHz mask PPDU if the secondary, secondary1 or secondary2 channels were idle during an interval of PIFS immediately preceding the start of the TXOP.

f) Transmit a 2.16 GHz mask PPDU on the primary channel.

g) Restart the channel access attempt by invoking the backoff procedure as specified in 10.23.2 as though the medium is busy on the primary channel as indicated by either physical or virtual CS and the backoff timer has a value of 0.

NOTE 1–In the case of rule g), the STA selects a new random number using the current value of CW[AC], and the retry counters are not updated [as described in 10.23.2.8; backoff procedure invoked for event a)].

NOTE 2–For an EDMG STA, an EDCA TXOP is obtained based on activity on the primary channel (see 10.23.2.4). The width of transmission is determined by the CCA status of the nonprimary channels during an interval of PIFS before transmission (see EDMG description in 10.3.2).

An EDMG STA that initiates a PPDU transmission to peer EDMG STA shall set the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the PPDU to a subset of the channels in which the CCA were idle according to Table 8-5a, and shall set the TXVECTOR parameter SCRAMBLER_INIT_SETTING to a value that provides bandwidth information to the peer STA.

## 10.25 Block acknowledgment (block ack)

### 10.25.1 Introduction

***Change the second paragraph in 10.25.1 as follows:***

The block ack mechanism is initialized by an exchange of ADDBA Request/Response frames, except for GLK-GCR block ack or by using the unsolicited block ack extension mechanism. After initialization, blocks of QoS Data frames may be transmitted from the originator to the recipient. A block may be started within a polled TXOP, within an SP, or by winning EDCA contention. The number of frames in the block is limited, and the amount of state that is to be kept by the recipient is bounded. The MPDUs within the block of frames are acknowledged by a BlockAck frame, which is requested by a BlockAckReq frame.

***Insert the following paragraphs at the end of 10.25.1:***

Under a block ack agreement using segmentation and reassembly, operations on MSDU Sequence Number and MPDU Sequence Number are performed modulo $2^{\text{MSDU Modulo}}$ and modulo $2^{\text{MPDU Modulo}}$ respectively (see 10.69), where MSDU Modulo and MPDU Modulo correspond to the values of the MSDU Modulo and MPDU Modulo subfields, respectively, defined in the SAR Configuration element. Comparisons between MPDU sequence number and MSDU sequence number are circular modulo $2^{\text{MPDU Modulo}}$ and $2^{\text{MSDU Modulo}}$, respectively, i.e., the sequence number space is considered divided into two parts, one of which is “old” and one of which is “new,” by means of a boundary created by adding half the sequence number range to the current start of receive window (modulo $2^{\text{MPDU Modulo}}$ and $2^{\text{MSDU Modulo}}$, respectively). The Block Ack Starting Sequence Control subfield within the BlockAckReq frame represents the MPDU starting sequence number.

The EDMG flow control is an amendment to the block ack mechanism to prevent overloading of the recipient’s memory space, which may happen in case the link speed is higher than STA’s capability to process or consume incoming data. The EDMG flow control adjusts to the recipient’s capabilities to optimize network utilization.

### 10.25.2 Setup and modification of the block ack parameters

***Change the 12th paragraph in 10.25.2 as follows:***

If the value in the Buffer Size field of the ADDBA Response frame is smaller than the value in the ADDBA Request frame, the originator shall change the size of its transmission window ($WinSize_O$) so that it meets the following conditions:

— Is not greater than the value in the Buffer Size field of the ADDBA Response frame.
— Is not greater than 64 if the sender or receiver of the ADDBA Response frame is a non-HE STA or if the STAs that establish the block ack agreement are HT STAs or DMG STAs that are not EDMG STAs.
— Is not greater than 256 if the sender and receiver of the ADDBA Response frame are HE STAs.
— Is not greater than 1024 if the STAs that establish the block ack agreement are EDMG STAs.

***Insert the following paragraph into 10.25.2 after the 12th paragraph:***

When a block ack agreement is established between two EDMG STAs, the size of the Block Ack bitmap the recipient shall use depends on the established size of the transmission window (WinSizeO). The size of the Block Ack bitmap for an EDMG STA shall be one of 64, 128, 256, 512, or 1024 bits. The size of the Block Ack bitmap shall be the smallest size that is greater than WinSizeO for the established block ack agreement.

***Insert the following text at the end of 10.25.2:***

An originator may include the SAR Configuration element in the ADDBA Request frame if the recipient supports segmentation and reassembly as indicated by the Segmentation and Reassembly Support subfield within the recipient's DMG Capabilities element. If the SAR Enabled field is set to 1 in a SAR Configuration element transmitted within an ADDBA Request frame, the value of the MPDU Modulo subfield shall be more than or equal to 7 and less than or equal to 12, and the sum of the MPDU Modulo and MSDU Modulo subfields shall be equal to 14. If the recipient accepts the SAR configuration within a received ADDBA Request frame, the recipient shall transmit an ADDBA Response frame that includes the SAR Configuration element with the SAR Enabled subfield set to 1, and the MSDU Modulo and MPDU Modulo subfields set to the same value of the MSDU Modulo and MPDU Modulo subfields received in the ADDBA Request frame. A recipient may reject the SAR configuration by setting the SAR Enabled field within the SAR Configuration element in the ADDBA Response to zero or by not including the SAR Configuration element in the ADDBA Response frame. The size of the originator's transmission window shall not be greater than value in the Buffer Size subfield of the Block Ack Parameter Set field of the ADDBA Response frame in the case that the recipient rejects the SAR configuration, but responds with a status code of SUCCESS in the ADDBA Response frame. The originator shall set the Sequence Number field to zero in the first MPDU it transmits under an established block ack agreement in case the recipient rejects the SAR configuration, but responds with a status code of SUCCESS in the ADDBA Response frame.

When a block ack agreement with segmentation and reassembly is established, a DMG originator may change the size of its transmission window if the value in the MPDU Buffer Size or MSDU Buffer Size fields within the SAR Configuration element contained in an ADDBA Response frame are larger than the corresponding field values transmitted in the ADDBA Request frame. If the value in the MSDU Buffer Size or the MPDU Buffer Size fields in the ADDBA Response frame is smaller than the corresponding value in the ADDBA Request frame, the originator shall change the size of its transmission window ($\text{WinSize}_\text{O}$ or $\text{WinSize}_\text{OJ}$) so that it is not larger than the value of the field in the ADDBA Response frame and not larger than 1024. In addition, the MPDU Buffer Size subfield shall not exceed the value of $2^{(\text{MPDU Modulo-2})}$ and shall be equal or larger than the value of the resulting maximum segmented MSDU size as indicated by the Maximum Segmented MSDU Exponent subfield in the recipient's SAR Configuration element divided by the maximum MPDU size as defined in 9.4.2.280. The originator may set the MSDU Buffer Size subfield to a value greater than $2^{\text{MSDU Modulo} - 2}$ if the MPDU Modulo subfield is set to a value greater than 9; in this case, the recipient may receive multiple MSDUs or A-MSDUs with identical SNs that are not detected.

An EDMG originator STA may insert an EDMG Flow Control Extension Configuration element in an ADDBA Request frame. In this case, no subelements shall be present in the EDMG Flow Control Extension Configuration element.

An EDMG recipient STA that responds to an ADDBA Request frame that contains an EDMG Flow Control Extension Configuration element should insert an EDMG Flow Control Extension Configuration element in the ADDBA Response frame sent as response. A Recipient Memory Configuration subelement shall be included in the EDMG Flow Control Extension Configuration element sent by the recipient if at least one subfield, except for the Advanced Recipient Memory Length Capable subfield, in the Recipient Memory Capabilities field of the EDMG Flow Control Extension Configuration element is nonzero.

EDMG STAs that established a block ack agreement with or without exchange of an EDMG Flow Control Extension Configuration element shall follow the flow control operation rules defined in 10.25.6.5, 10.25.6.6, and 10.25.6.7.

The following negotiation rules apply to EDMG STAs (EDMG originator and EDMG recipient) that exchange ADDBA Request and ADDBA Response frames.

An EDMG originator or EDMG recipient support those recipient memory capabilities for which the corresponding subfields in the Recipient Memory Capabilities field of the EDMG originator or EDMG recipient, respectively, are set to 1 in ADDBA Request and ADDBA Response frames of the block ack agreement established between the EDMG originator and EDMG recipient, and do not support otherwise.

An EDMG recipient shall not respond with Status Code = SUCCESS in an ADDBA Response frame if the EDMG recipient sets to one at least one of the subfields within the recipient’s Recipient Memory Capabilities field and:

— The same subfield is set to 0 in the Recipient Memory Capabilities field in the corresponding ADDBA Request frame received from EDMG originator; or
— No EDMG Flow Control Extension Configuration element is present in the corresponding ADDBA Request frame.

NOTE 4—Status Code values REFUSED, REFUSED_REASON_UNSPECIFIED, REQUEST_DECLINED, or INVALID_PARAMETERS can be used in the aforementioned case.

The recipient memory multiple buffer units capability is supported in a successfully established block ack agreement if both the originator and recipient set the RBUFCAP Quantity Capable and Recipient Memory Multiple Buffer Units Capable subfields to 1 in their respective EDMG Flow Control Extension Configuration elements transmitted in the ADDBA Request and ADDBA Response frames. Otherwise, the recipient memory multiple buffer units capability is not supported.

The memory config tag capability is supported in a successfully established block ack agreements if both the originator and recipient set the RBUFCAP Quantity Capable and Two Memory Config Tag Capable subfields to 1 in their respective EDMG Flow Control Extension Configuration elements transmitted in the ADDBA Request and ADDBA Response frames. Otherwise, the memory config tag capability is not supported.

The advanced recipient memory length capability is supported in a successfully established block ack agreement if the recipient set the Advanced Recipient Memory Length Capable subfield to 1 in its EDMG Flow Control Extension Configuration element transmitted in the ADDBA Response. Otherwise, the advanced recipient memory length capability is not supported.

The TID grouping capability is supported in a successfully established block ack agreements if both the originator and recipient set the TID Grouping Capable and the RBUFCAP Quantity Capable subfields to 1 in their respective EDMG Flow Control Extension Configuration elements transmitted in the ADDBA Request and ADDBA Response frames. The Recipient Memory Capabilities field and fields within the Recipient Memory Configuration subelement for TIDs that were set to 1 in the TID Grouping subfield shall be identical in the ADDBA Response frame.

An EDMG STA that has successfully negotiated a block ack agreement shall obey the following rules as a recipient in addition to the rules specified in 10.25.6. The recipient may transmit an unsolicited ADDBA Response frame that is not a response to an ADDBA Request frame to update the RBUFCAP subfield and Advanced Recipient Memory Length field values. The unsolicited ADDBA Response frame is sent by the recipient that is a TXOP holder or source of an SP. The Dialog Token field of an unsolicited ADDBA Response frame shall be set to 0 and the Status Code field shall be set to SUCCESS. An EDMG Flow Control Extension Configuration element shall be included in the ADDBA Response frame, and the element shall not contain a Recipient Memory Configuration subelement. The RBUFCAP subfield and Advanced Recipient Memory Length Exponent field values shall comply, respectively, with the RBUFCAP quantity and advanced recipient memory length capabilities that established the block ack agreement. After transmitting an unsolicited ADDBA Response frame, the recipient may

— Transmit a Grant frame to the TXOP responder or SP destination (see 10.39.7.3) to relinquish the remainder of the TXOP or SP, respectively; or
— Grant a reverse direction (see 10.29) to the TXOP responder or SP destination.

An EDMG STA that has successfully negotiated a block ack agreement shall obey the following rules as an originator in addition to rules specified in 10.25.6. The originator that receives an ADDBA Response frame with the Dialog Token field equal to 0 shall ignore the Block Ack Parameter Set and Block Ack Timeout Value fields of the frame. In addition, the originator shall update the local values of the RBUFCAP and Advanced Recipient Memory Length Exponent field values to the values received in the ADDBA Response frame, provided it is in compliance with RBUFCAP quantity and advanced recipient memory length capabilities.

Support for the unsolicited block ack extension is a capability of a recipient. Support for the unsolicited block ack extension by the recipient is advertised by insertion of the Unsolicited Block Ack Extension element in all transmitted Probe Request, Probe Response, Association Request, Association Response, Reassociation Request, Reassociation Response, Information Request and Information Response frames. An originator shall not use the unsolicited block ack extension mechanism with a recipient that does not support the mechanism.

An unsolicited block ack extension agreement is established per <TA, RA, TID> tuple. The unsolicited block ack extension agreement is considered set up if the following conditions apply:

— The recipient transmits and the originator receives a BlockAck frame in response to an MPDU with the Ack Policy field set to Implicit Block Ack Request sent by the originator; and
— Prior to the reception of the BlockAck frame, the originator does not receive an ADDBA Response frame with Status Code equal to SUCCESS with the same <TA, RA, TID> tuple as the BlockAck frame <TA, RA, TID> tuple.

Parameters of the established unsolicited block ack extension agreement are equal to those advertised by the recipient in the recipient's Unsolicited Block Ack Extension element.

A pair of EDMG STAs that have an established unsolicited block ack agreement shall follow the RBUFCAP operation rules defined in 10.25.6.5 and 10.25.6.7.

An unsolicited block ack extension agreement may be torn down by transmitting a DELBA frame as defined in 10.25.3.

### 10.25.5 Selection of BlockAck and BlockAckReq variants

***Insert the following paragraph into 10.25.5 after the third paragraph ("In a DMG BSS, if the Extended Compressed ...."):***

In a DMG BSS, BlockAck and BlockAckReq frames transmitted between EDMG STAs as part of the HT-immediate agreement shall be of EDMG Compressed BlockAck frame variant and Compressed BlockAckReq variant or of EDMG Multi-TID BlockAck variant and Multi-TID BlockAckReq variant, respectively.

***Insert the following paragraphs at the end of 10.25.5:***

An EDMG STA that has a value of 0 in the EDMG Multi-TID Aggregation Support subfield of the STA's EDMG Capabilities element shall not initiate transmission of Multi-TID BlockAckReq variant frames.

An EDMG STA shall not transmit a Multi-TID BlockAckReq variant frame to a peer STA that has a value of 0 in the EDMG Multi-TID Aggregation Support subfield within the peer STA's EDMG Capabilities element.

An EDMG STA that indicates a nonzero value in the EDMG Multi-TID Aggregation Support subfield of the STA's EDMG Capabilities element shall respond with an EDMG Multi-TID BlockAck variant frame to a received Multi-TID BlockAckReq variant frame.

An EDMG STA that indicates a nonzero value in the EDMG Multi-TID Aggregation Support subfield of the STA's EDMG Capabilities element shall respond with an EDMG Multi-TID BlockAck variant frame to an A-MPDU that contains MPDUs of different TIDs and Ack policy equal to Normal Ack or Scheduled Ack. The STA shall set to 1 the Management Ack subfield in the BA Control field of the EDMG Multi-TID BlockAck variant frame to acknowledge an Action Ack or Management frame received within the multi-TID A-MPDU.

An EDMG Multi-TID BlockAck frame shall not include more than one BA Information field for a specific TID.

An EDMG STA shall respond with a Multi-TID BlockAck frame to an A-MPDU conveyed in an EDMG MU-MIMO PPDU that contains an MPDU with a TID without a block ack agreement.

### 10.25.6 HT-immediate block ack extensions

#### 10.25.6.1 Introduction to HT-immediate block ack extensions

***Insert the following paragraphs at the end of 10.25.6.1:***

An EDMG STA shall support HT-immediate block ack with EDMG flow control extension.

An HT-immediate block ack agreement in which the SAR Configuration element was included in the both the ADDBA Request and ADDBA Response frames and that had the SAR Enabled subfield set to 1 in both frames is considered as a block ack agreement with segmentation and reassembly.

After setting up an immediate block ack agreement following the procedure in 10.25.2, and having gained access to the medium and established protection, if necessary, an originator that is a DMG STA may transmit a block of QoS Data frames separated by SIFS as follows:

— The total number of frames shall not exceed the Buffer Size subfield value in the associated ADDBA Response frame and subject to any additional duration limitations based on the channel access mechanism; and
— If the block ack agreement is between a pair of EDMG STAs, the memory occupied by the frames shall not exceed the values computed in Table 10-21c and in Table 10-21d. The actual RBUFCAP value is delivered by the EDMG Compressed BlockAck, EDMG Multi-TID BlockAck, EDMG Flow Control Extension Configuration element in the ADDBA Response frame or the RBUFCAP update of other TIDs as indicated in TID Grouping field of the Recipient Memory Configuration subelement, whichever comes later. If the ADDBA Response frame does not contain an EDMG Flow Control Extension Configuration element, the relevant originator parameters shall be considered as receiving an RBUFCAP with value Receiver Buffer Empty (9.3.1.8.8).

Each of the frames shall have the Ack Policy Indicator subfield in the QoS Control field set to Block Ack. The RA field of the frames shall be the recipient's individual address. The originator requests acknowledgment of outstanding QoS Data frames by sending a BlockAckReq frame. The recipient shall maintain a block ack record for the block. An EDMG recipient shall maintain free memory space for the established block ack agreement(s) (10.25.6.5).

An EDMG recipient that is TXOP holder or source of an SP may transmit ADDBA Response frames to the originator as defined in 10.25.2.

#### 10.25.6.2 HT-immediate block ack architecture

***Change the first paragraph in 10.25.6.2 as follows (Figure 10-36 remains unchanged):***

The HT-immediate block ack rules are explained <u>in this subclause</u> in terms of the architecture shown in Figure 10-36<u> and in Figure 10-36a for non-EDMG and EDMG STAs, respectively</u>~~ and explained in this subclause~~.

***Insert Figure 10-36a into 10.25.6.2 after Figure 10-36:***

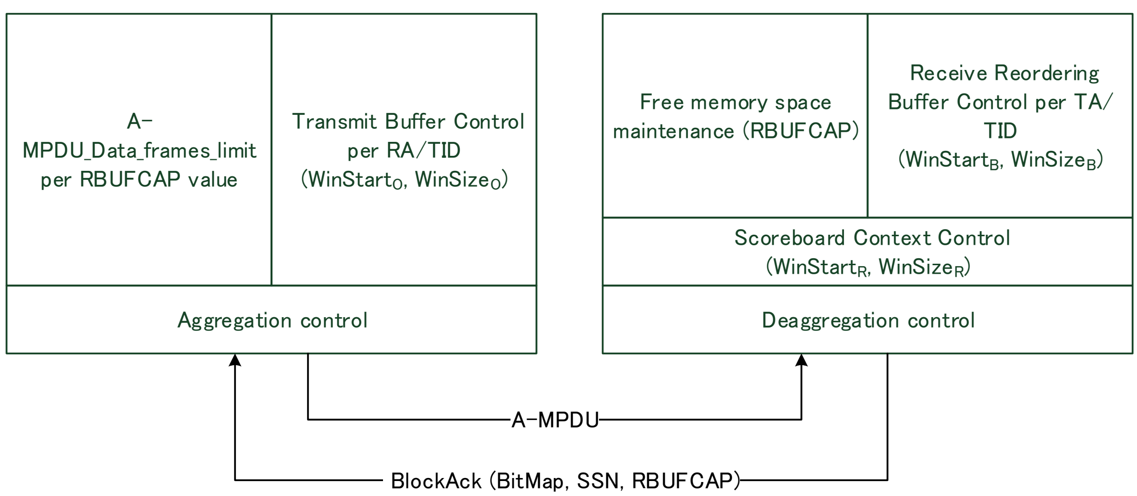


**Figure 10-36a—HT-immediate block ack architecture with EDMG flow control**

***Insert the following paragraphs into 10.25.6.2 after the third paragraph ("WinSizeO is ...."):***

In a block ack agreement with segmentation and reassembly, the originator maintains a transmit buffer control that uses $WinStart_{OJ}$ and $WinSize_{OJ}$ to submit MPDUs for transmission and releases transmit buffers upon reception of BlockAck frames from the recipient. $WinStart_{OJ}$ is the MSDU SSN value of the transmit window and $WinSize_{OJ}$ is the value of the MSDU Buffer Size field in the recipient's SAR Configuration element that established the block ack agreement.

An EDMG originator uses RBUFCAP to limit the number of transmitted MPDUs to not exceed the available free memory space at an EDMG recipient.

***Change the now eighth paragraph in 10.25.6.2 as follows:***

For each HT-immediate block ack agreement, the recipient chooses either full-state or partial-state operation (this choice is known only to the recipient). A STA may simultaneously use full-state operation for some agreements and partial-state operation for other agreements. The scoreboard context control stores an acknowledgment bitmap containing the current reception status of MSDUs or A-MSDUs for HT-immediate block ack agreements. Under a block ack agreement with segmentation and reassembly, the scoreboard context control stores an acknowledgment bitmap containing the current reception status of MPDUs. Under full-state operation, status is maintained in statically assigned memory. Under partial-state operation, status is maintained in a cache memory; therefore, the status information is subject to cache replacement. This entity provides the bitmap and the value for the Starting Sequence Number subfield to be sent in BlockAck frame responses to the originator.

***Insert the following paragraph into 10.25.6.2 after the now eighth paragraph:***

An EDMG recipient contains a free memory space maintenance entity. This entity is responsible to compute the RBUFCAP value. This entity provides the RBUFCAP value subfield to be sent in BlockAck and in ADDBA Response frames to an EDMG originator.

### 10.25.6.3 Scoreboard context control during full-state operation

***Change the item a) in the lettered list in 10.25.6.3 as follows:***

a) At HT-immediate block ack agreement establishment:
   1) In a block ack agreement that does not use segmentation and reassembly, $WinStart_R = SSN$ from the ADDBA Request frame that elicited the ADDBA Response frame that established the HT-immediate block ack agreement or from an MPDU that synchronized an unsolicited block ack agreement. Otherwise, $WinStart_R = MPDU\ SSN$ from the ADDBA Request frame that elicited the ADDBA Response frame that established the block ack agreement.
   2) $WinEnd_R = WinStart_R + WinSize_R – 1$

***Change the introductory text of items b) and c) in the lettered list in 10.25.6.3 as follows:***

b) For each received Data frame that is related with a specific full-state operation HT-immediate block ack agreement, the block acknowledgment record for that agreement is modified as follows, where *SN* is the value of the Sequence Number subfield of the received Data frame if segmentation and reassembly is not used and is the value of the MPDU Sequence Number subfield of the received Data frame when segmentation and reassembly is used, and *FN* is equal to 0 except when the received Data frame is part of an A-MPDU that is not an S-MPDU carried in an S1G PPDU in which case *FN* is equal to the value of the Fragment Number subfield of the received Data frame:

c) For each received BlockAckReq frame that is related with a specific full-state operation HT-immediate block ack agreement that is not a protected block ack agreement, the block acknowledgment record for that agreement is modified as follows, where *SSN* is the value from the Starting Sequence Number subfield of the received BlockAckReq frame if segmentation and reassembly is not used and is the value from the MPDU Starting Sequence Number subfield of the received BlockAckReq frame when segmentation and reassembly is used:

### 10.25.6.4 Scoreboard context control during partial-state operation

***Change item a) in the lettered list in 10.25.6.4 as follows:***

a) During partial-state operation without segmentation and reassembly, $WinStart_R$ is determined by the Sequence Number subfield value of received Data frames and by the Starting Sequence Number subfield value of received BlockAckReq frames as described below. During partial-state operation with segmentation and reassembly, $WinStart_R = MPDU\ SSN$ from the ADDBA Request frame that elicited the ADDBA Response frame that established the block ack agreement.

***Change the introductory text of item b) in the lettered list in 10.25.6.4 as follows:***

b) For each received Data frame that is related with a specific partial-state operation HT-immediate block ack agreement, when no temporary record for the agreement related with the received Data frame exists at the time of receipt of the Data frame, a temporary block acknowledgment record is created as follows, where SN is the value of the Sequence Number subfield of the received Data frame if segmentation and reassembly is not used and is the value of the MPDU Sequence Number subfield of the received Data frame when segmentation and reassembly is used, and *FN* is equal to 0 except when the received Data frame is part of an A-MPDU that is not an S-MPDU carried in an S1G PPDU in which case *FN* is equal to the value of the Fragment Number subfield of the received Data frame:

***Change the introductory text of item d) in the lettered list in 10.25.6.4 as follows:***

d) For each received BlockAckReq frame that is related with a specific partial-state operation HT-immediate block ack agreement that is not a protected block ack agreement, when no temporary record for the agreement related with the received frame exists at the time of receipt of the frame, a temporary block acknowledgment record is created as follows, where SSN is the starting value of the Sequence Number subfield of the received BlockAckReq frame if segmentation and reassembly is not used and is the value of the MPDU Starting Sequence Number subfield of the received BlockAck frame when segmentation and reassembly is used:

### 10.25.6.5 Generation and transmission of BlockAck frames by an HT STA, DMG STA, or S1G STA

***Insert the following paragraphs into 10.25.6.5 after the first paragraph ("Except when ...."):***

A STA operating in an SP with TDD channel access (see 10.39.6.2.2) that receives a PPDU that contains a BlockAckReq frame in which the Address 1 field matches its MAC address during either full-state or partial-state operation shall transmit a PPDU containing a BlockAck frame starting at the earliest occurring TDD slot the STA is assigned to, with the Bitmap and Access Type Schedule field of the TDD slot set to TX, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element.

A STA operating in an SP with TDD channel access (see 10.39.6.2.2) that receives an A-MPDU that contains one or more MPDUs in which the Address 1 field matches its MAC address with the Ack Policy field equal to Normal Ack (i.e., implicit block ack request) during either full-state operation or partial-state operation shall transmit a PPDU containing a BlockAck frame starting at the earliest occurring TDD slot the STA is assigned to, with the Bitmap and Access Type Schedule field of the TDD slot set to TX, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element.

***Insert the following paragraphs and Table 10-21b at the end of 10.25.6.5:***

If an EDMG STA transmits a BlockAck frame in response to a BlockAckReq frame or an A-MPDU with Ack Policy equal to Normal Ack (i.e., implicit block ack request) during either full-state or partial-state operation, the EDMG STA shall calculate the free memory space value at the generation and transmission of the BlockAck frame. The RBUFCAP subfield value in the transmitted BlockAck frame shall be computed as defined in Table 10-21b. The free memory space is an estimation of the amount of free memory available at the recipient to collect MPDUs at the time of and during reception of a forthcoming A-MPDU.

Within an unsolicited block ack agreement, the RBUFCAP value used by an EDMG STA for the RBUFCAP calculation in Table 10-21b shall assume that the RBUFCAP Quantity Capable subfield value is “Not Supported” and shall not use a value between 1 and 254, inclusive.

**Table 10-21b—RBUFCAP value calculation**

| Free memory space comparison | RBUFCAP Quantity Capable subfield value (10.25.2) | RBUFCAP subfield value |
|---|---|---|
| Free memory space ≥ $(2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1)$ | Supported | Receiver Buffer Empty |
| Free memory space ≥ $(2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1)$ | Not supported | Receiver Buffer Empty |
| Free memory space < $(2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1)$ | Supported | Int [Free memory space/ Buffer Unit Size] |
| Free memory space < $(2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1)$ | Not supported | Receiver Buffer Full |

### 10.25.6.6 Receive reordering buffer control operation

#### 10.25.6.6.1 General

***Change 10.25.6.6.1 as follows:***

The behavior described in this subclause, 10.25.6.6.2, and 10.25.6.6.3 applies to a STA that uses either partial-state operation or full-state operation for an HT-immediate block ack agreement.

<u>For each HT-immediate block ack agreement that does not use segmentation and reassembly,</u> ~~A~~<u>a</u> receive reordering buffer shall be maintained for each HT-immediate block ack agreement. Each receive reordering buffer includes a record comprising the following:

— Buffered MSDUs or A-MSDUs that have been received, but not yet passed up to the next MAC process

— A $\mathit{WinStart}_B$ parameter, indicating the value of the Sequence Number subfield of the first (in order of ascending sequence number) MSDU or A-MSDU that has not yet been received
— A $\mathit{WinEnd}_B$ parameter, indicating the highest sequence number expected to be received in the current reception window
— A $\mathit{WinSize}_B$ parameter, indicating the size of the reception window

For each HT-immediate block ack agreement that does not use segmentation and reassembly and is not part of an unsolicited block ack agreement, WinStart and WinEnd variables shall be initialized as follows:

— $\mathit{WinStart}_B$ is initialized to the Starting Sequence Number subfield value of the ADDBA Request frame that elicited the ADDBA Response frame that established the HT-immediate block ack agreement.
— $\mathit{WinEnd}_B$ is initialized to $\mathit{WinStart}_B + \mathit{WinSize}_B - 1$, where $\mathit{WinSize}_B$ is set to the smaller of *BitmapLength* and the value of the Buffer Size field of the ADDBA Response frame that established the block ack agreement.

~~Any MSDU or A-MSDU that has been passed up to the next MAC process shall be deleted from the receive reordering buffer.~~

For each HT-immediate block ack agreement that does not use segmentation and reassembly, ~~T~~the recipient shall always pass MSDUs or A-MSDUs up to the next MAC process in order of increasing Sequence Number subfield value.

For each HT-immediate block ack agreement that uses segmentation and reassembly, a receive reordering buffer shall be maintained. Each receive reordering buffer includes a record comprising the following:

— Buffered MPDUs belonging to MSDUs or A-MSDUs that have been received, but not yet passed up to the next MAC process.
— A $\mathit{WinStart}_B$ parameter, indicating the value of the MPDU Sequence Number subfield of the first (in order of ascending sequence number) MPDU that has not yet been received.
— A $\mathit{WinEnd}_B$ parameter, indicating the highest MPDU sequence number expected to be received in the current reception window.
— A $\mathit{WinSize}_B$ parameter, indicating the size of the reception window.

For each HT-immediate block ack agreement that uses segmentation and reassembly, WinStart and WinEnd variables shall be initialized as follows:

— $\mathit{WinStart}_B$ is initialized to the MPDU Starting Sequence Number subfield value of the ADDBA Request frame that elicited the ADDBA Response frame that established the block ack agreement.
— $\mathit{WinEnd}_B$ is initialized to $\mathit{WinStart}_B + \mathit{WinSize}_B - 1$, where $\mathit{WinSize}_B$ is set to the smaller of 1024 and the value of the MPDU Buffer Size field of the ADDBA Response frame that established the block ack agreement.

For each HT-immediate block ack agreement that uses segmentation and reassembly, the recipient shall always pass MSDUs or A-MSDUs up to the next MAC process in order of increasing MSDU Sequence Number subfield value.

Any MSDU or A-MSDU that has been passed up to the next MAC process shall be deleted from the receive reordering buffer.

#### 10.25.6.6.2 Operation for each received Data frame

***Insert the following subclause heading for 10.25.6.6.2.1 immediately after the heading for 10.25.6.6.2 (the original text of 10.25.6.6.2 as published in IEEE Std 802.11-2020 becomes the text of 10.25.6.6.2.1):***

##### 10.25.6.6.2.1 Block ack agreements not using segmentation and reassembly

***Change the introductory text of the first paragraph in 10.25.6.6.2.1 as follows:***

For each received Data frame that is related to a specific HT-immediate block ack agreement that does not use segmentation and reassembly, the receive reordering buffer record shall be modified as follows, where SN is the value of the Sequence Number subfield of the received MPDU:

***Change the introductory text of item a)2) in the lettered list in 10.25.6.6.2.1 as follows:***

a) ...
   1) ...
   2) Pass MSDUs or A-MSDUs up to the next MAC process if they are stored in the buffer in order of increasing value of the Sequence Number subfield starting with the MSDU or A-MSDU that has $SN=WinStart_B$ or if $SN>WinStart_B$, the STA is a non-EDMG STA, and one of the following conditions is met:

***Insert the following subclause (10.25.6.6.2.2) after 10.25.6.6.2.1:***

##### 10.25.6.6.2.2 Block ack agreements using segmentation and reassembly

For each received data MPDU that is related to a specific block ack agreement using segmentation and reassembly, the receive reordering buffer record shall be modified as follows, where MPDU_SN is the value of the Sequence Number subfield of the received MPDU:

a) If $WinStart_B \le MPDU\_SN \le WinEnd_B$,
   1) Store the received MPDU in the buffer if no MPDU with the same sequence number is already present; otherwise, discard the MPDU.
   2) Pass to the next MAC process any complete MSDUs or A-MSDUs in the buffer, which includes all MPDUs with the same value of *MSDU_SN* in increasing order of MPDU_SN, from the *MPDU_SN* with Start of MSDU subfield equal to 1 until the MPDU with End of MSDU subfield equal to 1 and which their MPDU_SN starts with $MPDU\_SN = WinStart_B$ and proceeds sequentially until there is no buffered MPDUs for the next *MPDU_SN*. An MSDU or A-MSDU is complete if all MPDUs identified with the same MSDU_SN from the *MPDU_SN* with Start of MSDU subfield equal to 1 until the MPDU with End of MSDU subfield equal to 1 are present in the receive reordering buffer.
   3) Set $WinStart_B$ to the value of the MPDU_SN subfield of the last MPDU of the MSDU or A-MSDU that was passed up to the next MAC process plus one.
   4) Set $WinEnd_B = WinStart_B + WinSize_B – 1$.
b) If $WinEnd_B < MPDU\_SN < WinStart_B + 2^{\text{MPDU Modulo-1}}$,
   1) Store the received MPDU in the buffer if no MPDU with the same sequence number is already present; otherwise, discard the MPDU.
   2) Set $WinEnd_B = MPDU\_SN$.
   3) Set $WinStart_B = WinEnd_B – WinSize_B + 1$.

4) Pass to the next MAC process any complete MSDUs or A-MSDUs in the buffer, which include all MPDUs with the same value of *MSDU_SN* in increasing order of *MPDU_SN*, from the *MPDU_SN* with Start of MSDU subfield equal to 1 until the MPDU with End of MSDU subfield equal to 1 and which their *MPDU_SN* is lower than $WinStart_B$. Gaps may exist in the MPDU_SN subfield, in this case the recipient shall discard the MSDUs or A-MSDUs with missing *MPDU_SN* and may inform the next MAC process of the incomplete or missing *MSDU_SN*.

5) Set $WinStart_B$ to the value of the *MPDU_SN* of the last MSDU or A-MSDU that was passed up to the next MAC process plus one.

6) Set $WinEnd_B = WinStart_B + WinSize_B - 1$.

c) If $WinStart_B + 2^{\text{MPDU Modulo-1}} \leq MPDU\_SN < WinStart_B$, discard the MPDU.

An originator shall not transmit a segmented MSDU if the size of the segmented MSDU is greater than the value defined by the Maximum Segmented MSDU Exponent subfield of the recipient's SAR Configuration element.

### 10.25.6.6.3 Operation for each received BlockAckReq

***Insert the following subclause heading for 10.25.6.6.3.1 immediately after the heading for 10.25.6.6.3 (the original text of 10.25.6.6.3 as published in IEEE Std 802.11-2020 becomes the text of 10.25.6.6.3.1):***

#### 10.25.6.6.3.1 Block ack agreements not using segmentation and reassembly

***Change the introductory text of the first paragraph in 10.25.6.6.3.1 as follows:***

For each received BlockAckReq frame that is related with a specific HT-immediate block ack agreement <u>that does not use segmentation and reassembly</u>, the receive reordering buffer record is modified as follows, where SSN is the Starting Sequence Number subfield value of the received BlockAckReq frame:

***Insert the following subclause (10.25.6.6.3.2) after 10.25.6.6.3.1:***

#### 10.25.6.6.3.2 Block ack agreements using segmentation and reassembly

For each received BlockAckReq frame that is related with a specific block ack agreement that uses segmentation and reassembly, the receive reordering buffer record is modified as follows, where *MPDU_SSN* is the MPDU Starting Sequence Number subfield value of the received BlockAckReq frame:

a) If $WinStart_B < MPDU\_SSN < WinStart_B + 2^{\text{MPDU Modulo-1}}$,

1) In a block ack agreement that is not a protected block ack agreement, set $WinStart_B = MPDU\_SSN$. See 10.25.7 for a protected block ack agreement.

2) Set $WinEnd_B = WinStart_B + WinSize_B - 1$.

3) Pass to the next MAC process any complete MSDUs or A-MSDUs in the buffer, which include all MPDUs with the same value of *MSDU_SN* in increasing order of MPDU_SN, from the *MPDU_SN* with Start of MSDU subfield equal to 1 until the MPDU with End of MSDU subfield equal to 1 and which their *MPDU_SN* is lower than $WinStart_B$. Gaps may exist in the MPDU_SN subfield, in this case the recipient shall discard the MSDUs or A-MSDUs with missing *MPDU_SN* and may inform the next MAC process of the incomplete or missing MSDUs or A-MSDUs.

4) Pass to the next MAC process any complete MSDUs or A-MSDUs in the buffer, which include all MPDUs with the same value of *MSDU_SN* in increasing order of *MPDU_SN*, from the

*MPDU_SN* set with the Start of MSDU subfield equal to 1 until the MPDU with End of MSDU subfield equal to 1 and which their MPDU_SN starts with $MPDU\_SN = WinStart_B$ and proceeds sequentially until there is no buffered MPDUs for the next *MPDU_SN*.

5) Set $WinStart_B$ to the *MPDU_SN* value of the last MSDU or A-MSDU that was passed up to the next MAC process plus one.

6) Set $WinEnd_B = WinStart_B + WinSize_B – 1$.

b) If $WinStart_B + 2^{\text{MPDU Modulo-1}} \leq MPDU\_SSN < WinStart_B$, do not make any changes to the receive reordering buffer record.

### 10.25.6.7 Originator’s behavior

***Insert the following subclause heading for 10.25.6.7.1 immediately after the heading for 10.25.6.7 (the original text of 10.25.6.7 as published in IEEE Std 802.11-2020 becomes the text of 10.25.6.7.1):***

#### 10.25.6.7.1 General

***Insert the following paragraphs into 10.25.6.7.1 after the first paragraph (“A STA may ....”):***

A DMG STA originator operating in an SP with TDD channel access (see 10.39.6.2.2) expects to receive a BlockAck frame response in the earliest occurring TDD slot with slot category of the TDD slot set to Basic TDD slot as defined in 10.25.6.5 if at least one Data frame is received without error.

A DMG STA originator operating in an SP with TDD channel access (see 10.39.6.2.2) shall not transmit to a peer STA more than one MPDU or A-MPDU that has an Ack Policy of Normal Ack per each occurrence of a TDD slot the peer STA is assigned to, with the Bitmap and Access Type Schedule field of the TDD slot set to TX, and with slot category of the TDD slot set to Basic TDD slot or Data TDD slot, as indicated in the TDD Slot Schedule element.

***Change the now 10th paragraph in 10.25.6.7.1 as follows:***

The originator may transmit QoS Data frames with a TID matching a block ack agreement in any order provided that their sequence numbers lie within the current transmission window. The originator may transmit an MPDU with a sequence number that is beyond the current transmission window ($SN > WinStart_O + WinSize_O – 1$), in which case the originator’s transmission window (and the recipient’s window) is moved forward. The originator should not transmit an MPDU with a sequence number that is before the current transmission window (i.e., $SN < WinStart_O$). Under a block ack agreement with segmentation and reassembly, the originator may transmit QoS Data frames with a TID matching an established block ack agreement in any order provided that their *MPDU_SN* and MSDU_SN are within the current transmission window. The originator may transmit an MPDU with an *MSDU_SN* that is beyond the current transmission window ($MSDU\_SN > WinStart_{OJ} + WinSize_{OJ} – 1$), in which case the originator’s transmission window (and the recipient’s window) is moved forward. The originator shall not transmit MSDUs or A-MSDUs that are lower than the current transmission window (i.e., $SN < WinStart_{OJ}$) in case the MSDU Modulo subfield was set to a value smaller than 5.

***Change the now 13th and 14th paragraphs in 10.25.6.7.1 as follows:***

The originator may send a BlockAckReq frame for block ack agreement that is not a protected block ack agreement or a robust ADDBA Request frame for protected block ack agreement when a QoS Data frame that was previously transmitted within an A-MPDU that had the Normal Ack Policy field is discarded due to exhausted MSDU lifetime. The purpose of this BlockAckReq or robust ADDBA Request frame is to shift the recipient's $WinStart_B$ value past the hole in the sequence number space that is created by the discarded Data frame and thereby to allow the earliest possible passing of buffered frames up to the next MAC process. Under a block ack agreement with segmentation and reassembly, the BlockAckReq frame shall contain only *MPDU_SSN* and the robust ADDBA Request frame shall contain only *MPDU_SSN* and MSDU_SSN fields of an MPDU that has the value of the Start of MSDU subfield equal to 1.

An originator that is a DMG STA shall transmit MPDUs sent under a block ack agreement such that:

- If the originator or the recipient are a non-EDMG STA,
  - MPDUs that need to be retransmitted are transmitted first, in sequential order of sequence number, starting from the oldest MPDU that needs to be retransmitted.
  - MPDUs that are being transmitted for the first time are sent after any MPDUs that need to be retransmitted, in sequential order of sequence number, starting from the oldest MPDU that has not been transmitted.
- QoS Data MPDUs are transmitted with Block Ack ack policy if the A-MPDU that contains them is followed after SIFS or RIFS by another A-MPDU.

***Insert the following paragraphs, Table 10-21c, and Table 10-21d at the end of 10.25.6.7.1:***

At the start of a data transfer sequence that has an established Block Ack agreement, an originator that is an EDMG STA shall not transmit a frame with a PSDU size greater than *FlowControlByteCountLimit*, where *FlowControlByteCountLimit* is defined per the configuration obtained during the Block Ack agreement establishment for the respective TID or group of TIDs described in Table 10-21c and per the computation described in 10.25.6.7.2.

**Table 10-21c—FlowControlByteCountLimit computation at the start of a data transfer sequence**

| According to Block Ack agreement | | As received via BlockAck or ADDBA Response frame | | FlowControlByteCount Limit |
|---|---|---|---|---|
| **Advanced recipient memory length capable** | **Recipient buffer quantity capable** | **Updated RBUFCAP** | **No Memory Kept** | |
| 0 | N/A | Receiver Buffer Full | N/A | Zero (see NOTE) |
| N/A | N/A | Receiver Buffer Empty | 0 | $2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1$ |
| 1 | N/A | N/A | 1 | $2^{(13 + \text{Advanced Recipient Memory Length Exponent})} - 1$ |
| 0 | N/A | Receiver Buffer Empty or Receiver Buffer Available | 1 | Zero (see NOTE) |
| N/A | 1 | Receiver Buffer Available | 0 | Receiver Buffer Available × Buffer Unit Size |
| NOTE—An originator can poll a responder's RBUFCAP value. | | | | |

During a data transfer sequence that has an established Block Ack agreement, an originator that is an EDMG STA shall not transmit a frame with a PSDU size greater than *FlowControlByteCountLimit*, where *FlowControlByteCountLimit* is defined per the configuration obtained during the Block Ack agreement establishment for the respective TID or group of TIDs described in Table 10-21d and per the computation described in 10.25.6.7.2.

**Table 10-21d—FlowControlByteCountLimit computation during a data transfer sequence**

| According to Block Ack agreement | As received via BlockAck or ADDBA Response frame | FlowControlByteCountLimit |
|---|---|---|
| Recipient buffer quantity capable | Updated RBUFCAP | |
| N/A | Receiver Buffer Full | Zero (see NOTE) |
| N/A | Receiver Buffer Empty | $2^{(13 + \text{Maximum A-MPDU Length Exponent})} - 1)$ |
| 1 | Receiver Buffer Available | Receiver Buffer Available × Buffer Unit Size |
| NOTE—An originator can poll a responder's RBUFCAP value. | | |

***Insert the following subclause (10.25.6.7.2, including Figure 10-36b) after 10.25.6.7.1:***

### 10.25.6.7.2 Number of MPDUs per FlowControlByteCountLimit computation

Figure 10-36b specifies the algorithm used to compute the number of MPDUs satisfying a given *FlowControlByteCountLimit* based on Table 10-21c and Table 10-21d. In this algorithm, the following apply:

- *numOfMpdusForTx* indicates the number of pending MPDUs in the transmit queue that are within the transmission window.
- If the recipient memory multiple buffer units capability is not supported, then the parameters *maxMpduInMem* and *mpduSplitInBuffer* are assigned with values 255 and 1, respectively.
- Parameters *unitBufferSize*, *rbufcap*, *memoryUnitSize*, *maxMpduInMem*, and *mpduSplitInBuffer* correspond to the last EDMG flow control parameters as received from a TID within a group of TIDs and with the respective memory configuration tag.
- *mpduForTx[k]* contains the size of the MPDU at location *k* in the transmit queue with the padding for minimum A-MPDU spacing and A-MPDU delimiter alignment, if required.
- For a multi-TID A-MPDU containing TIDs not included in a TID group, the algorithm computes the number of MPDUs for each TID using the *FlowControlByteCountLimit* of that TID. For a multi-TID A-MPDU containing TIDs included in a TID group, the algorithm computes the number of MPDUs for all the TIDs using the recent calculated *FlowControlByteCountLimit* for any TID within the TID group.

```
int calcAggregationMemory(IN int FlowControlByteCountLimit, IN int memoryUnitSize, IN int
maxMpduInMem, IN int mpduSplitInBuffer, IN int mpduForTx[], IN int numOfMpdusForTx, OUT
int mpduToSend[])
{
       int           memoryToUse = FlowControlByteCountLimit;
       int           freeMemory  = memoryUnitSize;
       int           k = 0;
       int           numOfMpdusInMemoryUnit = 0;
       bool          bIsMpduInserted;

//Adding MPDUs to the queue as long as there are MPDUs in TX Queue and recipient memory
buffer is not full

       while (k < numOfMpdusForTx && (memoryToUse >= mpduForTx[k]))
       {
              bIsMpduInserted = true;

// Handle the case when MPDU[k] has enough memory in one Memory Buffer Unit hence it is
added to the aggregation
              if (freeMemory >= mpduForTx[k])
              {
                      mpduToSend[k] = mpduForTx[k];
                      k++;
                      numOfMpdusInMemoryUnit++;
                      freeMemory -= mpduForTx[k];
                      memoryToUse -= mpduForTx[k];
              }

// Handle the case when MPDU[k] doesn't have enough memory in one Memory Buffer Unit
however it can be spiltted among several buffers hence it is added to the aggregation

              else if (mpduSplitInBuffer == 1)
                                     {
                      mpduToSend[k] = mpduForTx[k];
                      k++;

                      //Calculating the free memory space from the last used Memory Buffer
Unit
                      freeMemory  =  memoryUnitSize  -  ((mpduForTx[k]  -  freeMemory)  %
memoryUnitSize);

                      //The case where MPDU was placed in whole in the previous buffer
                      if (freeMemory == memoryUnitSize)
                      {
                             numOfMpdusInMemoryUnit = 0;
                      }
                      else
                      {
                             numOfMpdusInMemoryUnit = 1;
                      }

                      memoryToUse -= mpduForTx[k];
              }
              else
              {
                      bIsMpduInserted = false;
              }
```

**Figure 10-36b—Algorithm for computation of FlowControlByteCountLimit**
*(continued on next page)*

```
//Handle the case where the MPDU cannot be inserted to current Memory Buffer Unit, free
memory is decreased and new Memory Buffer Unit is allocated

            if ((maxMpduInMem != 255 && numOfMpdusInMemoryUnit == maxMpduInMem) ||
                    ((false == bIsMpduInserted) && (mpduSplitInBuffer == 0)))
            {
                    memoryToUse -= freeMemory;
                    freeMemory = memoryUnitSize;
                    numOfMpdusInMemoryUnit = 0;
            }
    }

    return k;
}
```

**Figure 10-36b—Algorithm for computation of FlowControlByteCountLimit**
*(continued from previous page)*

### 10.25.6.8 Maintaining block ack state at the originator

***Insert the following paragraph at the end of 10.25.6.8:***

Under a block ack agreement with segmentation and reassembly, the originator shall update $WinStart_{OJ}$ and $WinEnd_{OJ}$ at the arrival of a BlockAck frame. At each subsequent MPDU sent with End of MSDU subfield set to 1 in the Sequence Control field, $WinStart_{OJ}$ shall be set to $MSDU\_SN$+1 and $WinEnd_{OJ}$ shall be set to $WinStart_{OJ} + WinSize_{OJ} - 1$ if following conditions are met:

— The MPDU is indicated as acknowledged in the Block Ack bitmap.
— All preceding MPDUs starting from MPDU_SN with Start of MSDU subfield set to 1 in the Sequence Control field are indicated as successfully delivered.

### 10.25.7 Protected block ack agreement

***Change the last paragraph in 10.25.7 as follows:***

A STA that has successfully negotiated a protected block ack agreement shall obey the following rules as a block ack recipient in addition to rules specified in 10.25.6.3 to 10.25.6.6:

— The recipient STA shall respond to a BlockAckReq frame from a PBAC enabled originator with an immediate BlockAck frame. The Block Ack Starting Sequence Control subfield value shall be ignored for the purposes of updating the value of $\text{WinStart}_B$. The Block Ack Starting Sequence Control subfield value may be utilized for the purposes of updating the value of $\text{WinStart}_R$. If the Block Ack Starting Sequence Control subfield value is greater than $\text{WinEnd}_B$ or less than $\text{WinStart}_B$, dot11PBACErrors shall be incremented by 1. If, for a block ack agreement with segmentation and reassembly, the MPDU Starting Sequence subfield value is greater than $\text{WinEnd}_B$ or less than $\text{WinStart}_B$, dot11PBACErrors shall be incremented by 1.
— Upon receipt of a valid robust ADDBA Request frame for an established protected block ack agreement whose TID and transmitter address are the same as those of the block ack agreement, the STA shall update its $\text{WinStart}_R$ and $\text{WinStart}_B$ values based on the starting sequence number in the robust ADDBA Request frame according to the procedures outlined for reception of BlockAckReq frames in 10.25.6.3, 10.25.6.4, 10.25.6.6.1, and 10.25.6.6.3, while treating the starting sequence number as though it were the SSN of a received BlockAckReq frame or, in case of a block ack agreement with segmentation and reassembly, treating the MPDU starting sequence number as though it were the MPDU SSN of a received BlockAckReq frame. Values in other fields of the ADDBA Request frame shall be ignored.

***Insert the following subclauses (10.25.10 through 10.25.10.6) after 10.25.9.6:***

### 10.25.10 Unsolicited block ack extension

#### 10.25.10.1 Introduction

The unsolicited block ack is an extension to the HT-Immediate block ack mechanism that allows transmission of A-MPDUs without the need for a prior exchange of ADDBA Request and ADDBA Response frames to setup the agreement. The unsolicited block ack extension also enables optimizing the buffering requirements needed at the recipient side with the ability to share the recipient resources among all originators.

A recipient that supports the unsolicited block ack extension is ready to use this mechanism with an originator following the exchange of frames as specified in 10.25.2.

#### 10.25.10.2 Unsolicited block ack extension agreement architecture

The unsolicited block ack extension to the HT-immediate block ack architecture is identical to the HT-immediate block ack extension architecture described in 10.25.6.2 with the following rules:

— $\text{WinSize}_\text{O}$ is the value of the Buffer Size field advertised in the recipient's Unsolicited Block Ack Extension element.
— $\text{WinStart}_\text{O}$ is equal to the sequence number of the first MPDU inside the first A-MPDU sent with a specific tuple <TA, RA, TID>.
— The recipient shall only use full-state operation of the scoreboard context control.

#### 10.25.10.3 Scoreboard context control during full-state operation

The scoreboard context control for the unsolicited block ack extension mechanism shall follow the rules of full-state operation defined in 10.24.7.3 with the following additional rule. When the recipient flushes buffers in the reordering buffer control, the bits in the bitmap position in the block acknowledgment record for the SNs that are higher than the lowest SN of all unsuccessful MPDUs and lower than the highest SN of all successful MPDUs are set to 0. $WinStart_R$, $WinSize_R$, and $WinEnd_R$ remain unchanged.

#### 10.25.10.4 Generation and transmission of BlockAck frames

The recipient shall follow the same rules defined in 10.25.6.5.

#### 10.25.10.5 Receive reordering buffer control operation

The receive reordering buffer control behaves the same as in the HT-Immediate block ack agreement defined in 10.25.6.6, with the ability of the recipient to flush the buffers when it starts receiving from a different originator or TID.

Under the unsolicited block ack extension mechanism, the parameters are initialized as follows:

— $WinSize_B$ is set to the value of the Buffer Size field advertised in the Unsolicited Block Ack Extension element.
— When the unsolicited block ack extension agreement is established, $WinEnd_B$ is initialized to the sequence number of the first MPDU inside the first A-MPDU sent with a specific tuple <TA, RA, TID>, and $\text{WinStart}_\text{B}$ is set to $WinEnd_B - WinSize_B + 1$.
— The buffered MSDUs in the receive reordering buffer control may be flushed when the STA starts receiving from a different <TA, TID> pair.

The recipient shall pass MSDUs and A-MSDUs up to the next MAC process in order of increasing sequence number.

#### 10.25.10.6 Originator behavior and block ack state maintenance

In addition to the rules defined for the HT-immediate block ack extension specified in 10.25.6.7 and 10.24.7.8, an originator that utilizes the unsolicited block ack extension mechanism:

- Shall not transmit an A-MPDU corresponding to a tuple <TA, RA, TID> before synchronizing at the recipient the *SSN*, $WinStart_R$, and $WinStart_B$ parameters for the specific tuple. The originator may transmit either an MPDU or a BlockAckReq frame to initiate the synchronization. Synchronization is confirmed by reception of an Ack frame from the recipient when an MPDU was used, or by a BlockAck frame when a BlockAckReq was used.
- Shall not release transmitted buffers (MPDUs) with *SN* equal or higher than the first unsuccessful MPDU.
- At the end of a TXOP or SP, shall set to 0 the acknowledgment status of MPDUs with *SN* equal or higher than the first unsuccessful MPDU even if such MPDUs have been already positively acknowledged.
- At the start of the next TXOP or SP, may transmit all the MPDUs with *SN* equal or higher than the first unsuccessful MPDU, or may send a BlockAckReq frame with *SSN* equal to the *SN* of the first unsuccessful MPDU to determine the state of the buffers at the recipient and retransmit MPDUs that are not received or flushed by the recipient.

The originator shall not use the multi-TID variant with a recipient if the recipient has not set the Multi-TID Supported subfield in the recipient's Unsolicited Block Ack Extension element to 1.

## 10.27 Protection mechanisms

***Insert the following subclause (10.27.7) after 10.27.6:***

### 10.27.7 Protection mechanisms for transmissions of EDMG PPDUs

The intent of the protection mechanism is to cause an EDMG STA not to transmit an EDMG PPDU unless it has attempted to update the NAV of receiving non-EDMG STAs. The updated NAV period shall be longer than or equal to the total time required to send the Data and any required response frames. An EDMG STA shall use protection if a TXOP is obtained using the contention based channel access and may use protection at service period access. The protection mechanism does not need to be used if all PPDUs in the obtained TXOP are transmitted by MCS 0.

Frames used to support the protection mechanism shall be transmitted using MCS 0 as defined in Clause 20 or non-EDMG duplicate control mode MCS 0 as defined in Clause 28, so STAs in the BSA that receive such frames are able to learn the duration of the exchange even if they cannot detect the EDMG signals using their CCA function.

RTS, DMG CTS, DMG CTS-to-self, DMG DTS and CF-End frames are used as the protection mechanism according to the procedures defined in 10.3.2.4, 10.3.2.9, and 10.3.2.18. The rules for calculating the Duration field value of RTS/DMG CTS frames are unchanged when using RTS/DMG CTS frames as a protection mechanism.

Control frames that are not RTS, DMG CTS, DMG CTS-to-self, DMG DTS and CF-End frames are sent according to the rules defined in 10.6.7.2 and 10.6.7.6.

## 10.29 Reverse direction protocol

### 10.29.1 General

***Change the first paragraph in 10.29.1 as follows:***

The RD protocol may be supported by an HT STA, by an S1G STA, and by a DMG STA that is not an EDMG STA. The RD protocol shall be supported by an EDMG STA if dot11DMGChannelAccessScheme is either dmgChannelAccessOnly or dmgAndTddMixedChannelAccess. A STA receiving an RDG is never required to use the grant.

***Change the third paragraph in 10.29.1 as follows:***

A DMG STA indicates support of the RD protocol ~~feature~~ using the Reverse Direction subfield of the DMG STA Capability Information field of the DMG Capabilities element. A STA shall set the Reverse Direction subfield to 1 in frames that it transmits containing the DMG Capabilities element if dot11RDResponderOptionImplemented is true. Otherwise, the STA shall set the Reverse Direction subfield to 0. For an EDMG STA, dot11RDResponderOptionImplemented shall always be set to true if dot11DMGChannelAccessScheme is either dmgChannelAccessOnly or dmgAndTddMixedChannelAccess. In a DMG STA, the RDG/More PPDU subfield and the AC Constraint subfield are present in the QoS Control field.

### 10.29.3 Rules for RD initiator

***Change the first paragraph in 10.29.3 as follows:***

An RDG shall not be present unless the MPDU carrying the grant, or every MPDU carrying the grant in an A-MPDU, matches one of the following conditions:

— For a STA that is not an EDMG STA, a~~A~~ QoS Data frame with an ack policy other than PSMP Ack, No explicit acknowledgment, or Scheduled Ack (i.e., including Implicit BAR), or
— For an EDMG STA, a QoS Data frame with the Ack Policy field equal to any value except PSMP Ack or No explicit acknowledgment, or
— For a non-DMG STA, a~~A~~ BlockAckReq frame related to an HT-immediate block ack agreement, or
— For a non-DMG STA, a~~A~~n MPDU not needing an immediate response (e.g., block ack under an HT-immediate block ack agreement, or Action No Ack).

***Insert the following paragraph into 10.29.3 after the fourth paragraph ("An RD initiator that sets ..."):***

If an RD initiator and an RD responder are EDMG STAs with the Scheduled RD Supported field in their EDMG Capabilities element equal to 1, then the RD initiator may set the ack policy of MPDUs contained in A-MPDU transmitted within an RDG PPDU to Scheduled Ack. In this case, the RD initiator shall include at least one Block Ack Schedule frame with Response Offset and Response Duration fields set to nonzero values in an A-MPDU transmitted within the RDG PPDU. If an A-MPDU is transmitted not as a part of an EDMG MU PPDU, the RD initiator shall set the value of the Response Offset field in the Block Ack Schedule frame equal to SIFS.

***Change the now sixth paragraph in 10.29.3 as follows:***

An RD initiator shall not transmit a +HTC or DMG frame with the RDG/More PPDU subfield set to 1 that requires a response MPDU that is not one of the following frames:

— Ack
— Compressed BlockAck
— Extended Compressed BlockAck
— Multi-STA BlockAck
— EDMG Compressed BlockAck
— EDMG Multi-TID BlockAck

***Insert the following paragraph at the end of 10.29.3:***

The value in the TID Aggregation Limit subfield in a transmitted Block Ack Schedule frame shall be less than or equal to $MT + 1$, where $MT$ is the value indicated in the EDMG Multi-TID Aggregation Support subfield within the EDMG Capabilities element transmitted by the EDMG AP or EDMG PCP of the BSS.

### 10.29.4 Rules for RD responder

***Change the first paragraph in 10.29.4 as follows:***

If an RDG was granted by an MPDU contained in an A-MPDU with the ack policy different from Scheduled Ack, an ~~An~~ RD responder shall transmit the initial PPDU of the RD response burst a SIFS after the reception of the RDG PPDU. PPDUs in a response burst are separated by SIFS or RIFS. The RIFS rules in the RD are the same as in the forward direction; the use of RIFS is constrained as defined in 10.3.2.3.2 and 10.28.3.3.

***Insert the following paragraph into 10.29.4 after the first paragraph:***

If an RDG was granted by an MPDU contained in an A-MPDU with the ack policy equal to Scheduled Ack, an RD responder shall transmit the initial PPDU of the RD response burst at a time equal to *T_Offset* from the end of RDG PPDU, where *T_Offset* is the value of Response Offset subfield of the Block Ack Schedule frame in the A-MPDU that has the MPDU that granted the RDG. The duration of the RD response burst shall not exceed the value of the Response Duration subfield of the Block Ack Schedule frame in the A-MPDU that has the MPDU that granted the RDG.

***Change the now third paragraph in 10.29.4 as follows:***

The recipient of an RDG may decline the RDG by

— Not transmitting any frames following the RDG PPDU if no response is otherwise required, or
— For a non-DMG STA, t~~T~~ransmitting a control response frame with the RDG/More PPDU subfield set to 0, or
— For a non-DMG STA, t~~T~~ransmitting a control response frame that contains no HT Control field, or
— Transmitting a control response frame aggregated with other MPDUs with the RDG/More PPDU subfield set to 0.

***Change the now seventh paragraph in 10.29.4 as follows:***

For an EDMG Multi-TID A-MPDU or an EDMG MU PPDU, if the AC Constraint subfield is equal to 1, the RD responder shall transmit Data frames following the rules specified in this subclause and in 10.70. Otherwise, i~~I~~f the AC Constraint subfield is equal to 1 in the last frame received from an RD initiator,

— A non-HE RD responder shall transmit Data frames of only the same AC as the last frame received from the RD initiator.
— An HE RD responder may transmit an A-MPDU or multi-TID A-MPDU with MPDUs from one or more ACs that have a priority that is equal to or higher than the lowest priority AC of the MPDU(s) carried in the last PPDU received from the RD initiator (see 10.12) and if the RD initiator is an HE STA subject to the additional rules defined in 26.6.3.

***Insert the following paragraphs at the end of 10.29.4:***

As part of an RDG, an RD responder that is a DMG STA shall not transmit a PPDU following a BlockAck frame unless the BlockAck frame is transmitted as part of an A-MPDU that includes an MPDU (e.g., QoS Null) that has the RDG/More PPDU subfield set to 1.

The following provides additional rules for an RD responder that constructs a multi-TID A-MPDU in response to an MU PPDU.

A non-AP and non-PCP EDMG STA with dot11EDMGAMPDUwithMultipleTIDOptionImplemented set to true shall not send a multi-TID A-MPDU to an EDMG AP or EDMG PCP unless all the following conditions are met:

— The EDMG Multi-TID Aggregation Support subfield in the AP's or PCP's EDMG Capabilities element is greater than 0.
— The RDG/More PPDU subfield is set to 1 in the QoS Control field of all MPDU(s) in the EDMG MU PPDU transmitted by the AP or PCP.
— The TID Aggregation Limit field in the Block Ack Schedule frame sent to the STA within the EDMG MU PPDU is nonzero.

The EDMG STA may aggregate in a multi-TID A-MPDU QoS Data frames with multiple TIDs as defined in Table 9-530 or Table 9-531.

The number of different TID values for QoS Data frames in the multi-TID A-MPDU shall not exceed the value in the TID Aggregation Limit subfield in the Block Ack Schedule frame the EDMG STA received in the MU PPDU. The multi-TID A-MPDU may contain no more than one Management frame, with exception of Action no Ack frames that can occur more than once. Any number of QoS Null frames with the Ack Policy field set to No Ack may be aggregated in the A-MPDU, irrespective of the value of the TID Aggregation Limit subfield and the value of the Preferred AC subfield in the Block Ack Schedule frame.

A Multi-TID BlockAck frame is used to acknowledge the MPDUs in a multi-TID A-MPDU. The rules for Multi-TID BlockAck are defined in 10.70.

When a multi-TID A-MPDU is sent in an SP in response to an MPDU with the RD Grant field set to 1 and the AC Constraint field set to 0 as specified in 10.29.3, an EDMG STA may aggregate MPDUs from any TID in the multi-TID A-MPDU for transmission in the SP as long as the transmission of the multi-TID A-MPDU does not cause the STA to exceed the current SP duration.

An EDMG STA operating as an RD responder that constructs a multi-TID A-MPDU in response to an MU PPDU shall aggregate MPDUs in the A-MPDU in the following order:

- MPDUs with TIDs originating from the same or higher AC as indicated in the Preferred AC subfield of the received Block Ack schedule frame.
- MPDUs with TIDs originating from any other AC in the A-MPDU carried in the MU PPDU, if the responding EDMG STA has no buffered MPDU for TIDs belonging to the same or higher priority AC indicated in the Preferred AC subfield.
- MPDUs with TIDs originating from other ACs within the remaining time of the Response Duration subfield value indicated in the Block Ack Schedule Information field of the received Block Ack Schedule frame.

***Insert the following subclause (10.29.5, including Figure 10-41a) after 10.29.4:***

### 10.29.5 Reverse direction for EDMG DL MU-MIMO

An EDMG STA with dot11EDMGScheduledRDImplemented equal to true shall support the reverse direction for EDMG DL MU-MIMO mechanism described in this subclause.

To start a DL MU PPDU transmission with reverse direction, an AP or PCP shall set the RDG/More PPDU subfield to 1 and the Ack Policy Indicator subfield to Scheduled Ack in the QoS Control field of an MPDU contained in the PPDU and addressed to the intended RD responder. The AP or PCP shall also include at least one Block Ack Schedule frame with nonzero Response Offset, Response Duration and Next PPDU Start Offset fields in an A-MPDU addressed to the intended RD responder.

Upon receiving an RD grant as part of a DL MU-MIMO transmission, an RD responder shall respond according to the rules that are defined in 10.29.4. The duration of the RD response burst shall be equal to the value of the Response Duration subfield of the last Block Ack Schedule frame received from the RD initiator.

An RD responder that intends to elicit a BlockAck frame from the RD initiator shall set the Ack Policy Indicator subfield of MPDUs addressed to RD initiator to Scheduled Ack.

Upon receiving an RD response burst with the ack policy of MPDUs contained in A-MPDU equal to Scheduled Ack, the RD initiator that granted an RD as part of a DL MU-MIMO transmission shall respond to the RD responder by aggregating a BlockAck frame into the next PPDU transmitted to the RD responder.

Figure 10-41a illustrates an example of the RD sequence during DL MU-MIMO transmissions. The RD initiator (e.g., an AP) transmits an MU PPDU to STA 1 and STA 2. The RD initiator requests a BlockAck frame and grants an RD to STA 1 by setting RDG/More PPDU to 1, Ack Policy Indicator subfield set to Scheduled Ack and including a Block Ack Schedule frame with the schedule for the RD response burst. The A-MPDU sent to STA 2 has RDG/More PPDU set to 0, Ack Policy set to Scheduled Ack and includes a Block Ack Schedule frame with the schedule for a BlockAck frame transmission.

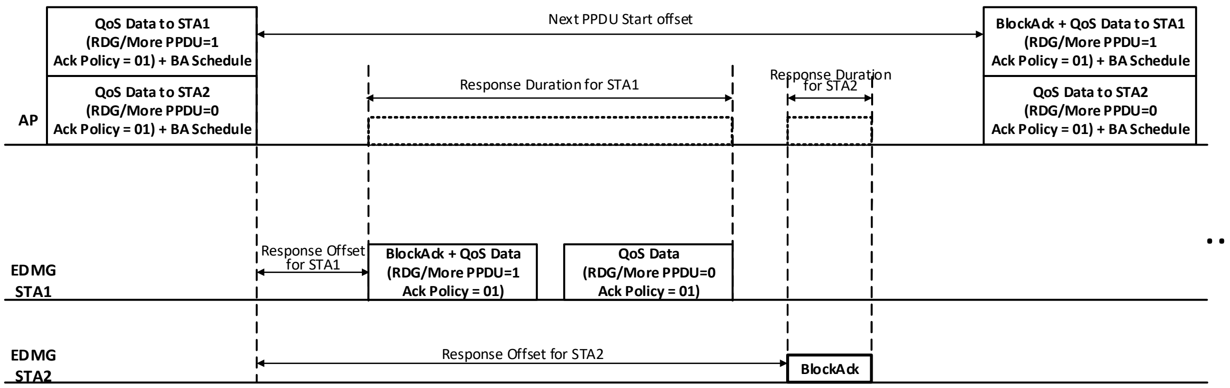


**Figure 10-41a—Example of reverse direction for DL MU-MIMO**

Following the reception of the RD grant, STA 1 transmits its RD response burst in multiple PPDUs during the scheduled time slot defined by Response Offset and Response Duration subfields of the received Block Ack Schedule frame. The first PPDU is an A-MPDU, which includes the BlockAck to the RD initiator and QoS Data frames with RDG/More PPDU equal to 1. A PPDU in the RD response burst contains QoS DATA with RDG/More PPDU equal to 1 if it is not the last PPDU, and it contains QoS Data with RDG/More PPDU equal to 0 if it is the last PPDU of the RD response burst. STA 1 requests the acknowledgment for the RD response burst by setting the Ack Policy Indicator subfield to Scheduled Ack. STA 2 did not receive an RD grant, and so it uses the scheduled time slot for the transmission of only a BlockAck frame. After a period of time equal to the value of the Next PPDU Start Offset subfield starting from the end of the EDMG MU PPDU, the AP transmits another MU PPDU to both STA 1 and STA 2. In addition to QoS Data and Block Ack Schedule frames, the A-MPDU sent to STA 1 also includes a BlockAck to the RD response burst.

## 10.39 DMG and CMMG channel access

### 10.39.2 Access periods within a beacon interval

***Insert the following paragraph into 10.39.2 after the third paragraph ("Figure 10-55 illustrates ...."):***

In an EDMG BSS, the following apply:

- — Frames sent during the BTI and ATI shall be transmitted on only the primary channel of the BSS.
- — The A-BFT shall be present on the primary channel of the BSS and can also be present on the secondary or secondary1 channel of the BSS (see 10.42.5.1).
- — Transmissions within a CBAP or an SP may span the primary channel and the secondary channel(s).
- — The channel width of the primary channel is 2.16 GHz.

### 10.39.3 ATI transmission rules

***Change the third paragraph in 10.39.3 as follows:***

During an ATI, request and response frames are exchanged between the AP or PCP and any subset of STAs. The AP or PCP initiates all frame exchanges that occur during the ATI. The ATI shall not start sooner than Max(guard time, MBIFS), where guard time is defined in 10.36.6.5, following the end of the previous A-BFT when an A-BFT is present in the beacon interval or following the end of the previous BTI when an ABFT is not present but a BTI is present in the beacon interval. The ATI shall not start before TBTT if the

ATI is the first period in the beacon interval ~~(the ATI is never the first period in the beacon interval in an infrastructure BSS; see 11.1.2.1)~~. Once the ATI starts, the AP or PCP may start transmission of a request frame immediately or it may delay the transmission of the request frame if the medium is determined by the CCA mechanism to be busy.

### 10.39.4 DTI transmission rules

***Change the third paragraph in 10.39.4 as follows:***

A DMG or CMMG STA shall be capable of processing Grant frames. An EDMG STA shall be capable of processing Grant Ack frames and shall set the Grant Ack Supported field to 1 in the STA's DMG Capabilities element. A non-AP and non-PCP DMG or CMMG STA shall be capable of processing Poll frames and the Extended Schedule element. An AP or PCP shall be capable of processing SPR frames transmitted by a non-AP and non-PCP STA and responding to an SPR frame with a Grant frame.

***Insert the following paragraph at the end of 10.39.4:***

A STA shall be capable of receiving MPDUs of arbitrary length that is less than or equal to the MPDU size advertised by the STA (see Table 9-25).

### 10.39.6 Channel access in scheduled DTI

#### 10.39.6.1 General

***Change the third paragraph in 10.39.6.1 as follows (including splitting the paragraph into two paragraphs):***

The schedule of the DTI of a beacon interval shall be communicated through the Extended Schedule element and, in an EDMG BSS, also through the EDMG Extended Schedule element. The AP or PCP transmits the Extended Schedule element in either or both an Announce frame or a DMG Beacon frame. If the Extended Schedule element includes at least one TDD SP, it shall be transmitted in a DMG Beacon frame. The Extended Schedule element shall contain the scheduling information of all allocations in the DTI, except if transmitted in an EDMG BSS where the Extended Schedule element may exclude one or more allocations that are included in EDMG Extended Schedule element transmitted through at least one sector. The same Allocation field shall not appear more than once in the Extended Schedule element transmitted in a beacon interval. The content of the Extended Schedule element and the EDMG Extended Schedule element communicated in a beacon interval shall not change if transmitted more than once in the beacon interval, except ~~that~~ as follows;

— ~~i~~If the STA transmitting the Extended Schedule element or the EDMG Extended Schedule element is a PCP with multiple DMG antennas, then the value of the PCP Active field of CBAP allocations within the Extended Schedule element or the EDMG Extended Schedule element might change when ~~this~~ these elements are ~~is~~ transmitted through different DMG antennas.

— For the EDMG Extended Schedule element, fields that are related to directional allocation (10.39.12.3) or beamforming training allocation (10.42.10.3.3) may change during the beacon interval when transmitted through different sectors.

The AP or PCP should schedule SPs for a STA such that the scheduled SPs do not overlap in time with the traffic scheduling constraints indicated by this STA in the Traffic Scheduling Constraint Set field of the associated DMG TSPEC element.

### 10.39.6.2 Service period (SP) allocation

***Insert the following subclause heading for 10.39.6.2.1 immediately after the heading for 10.39.6.2 (the original text of 10.39.6.2 as published in IEEE Std 802.11-2020 becomes the text of 10.39.6.2.1):***

#### 10.39.6.2.1 General

***Insert the following paragraphs into 10.39.6.2.1 after the first paragraph ("The AP or PCP ...."):***

If an SP has the TDD Applicable SP subfield in an Allocation field within an Extended Schedule element equal to 1, it is an SP with TDD channel access (i.e., TDD SP) and the rules specified in 10.39.6.2.2 for TDD channel access during the SP shall apply. Otherwise, the TDD channel access rules shall not apply and the SP does not use the TDD channel access rules.

A DMG STA may transmit in a TDD SP only if the TDD Channel Access Supported subfield in the STA's DMG Capabilities element is 1. Otherwise, the DMG STA shall not transmit in the TDD SP.

A TDD SP comprises a sequence of TDD intervals that, in turn, comprise a sequence of TDD slots (see 10.39.6.2.2). TDD intervals and TDD slots exist only in a TDD SP. Unless otherwise specified, the rules applicable to an SP shall also be applicable to TDD slots within a TDD SP.

***Change the now sixth and seventh paragraphs in 10.39.6.2.1 as follows:***

An SP that is not a TDD SP is assigned to the source CMMG STA identified in the Source AID subfield in an Allocation field that is not an obsolete allocation within the Extended Schedule element. The source CMMG STA shall initiate the frame exchange sequence that takes place during the SP at the start of the SP, except when the source CMMG STA intends to establish a CMMG protected period in which case the rules described in 10.39.6.6 shall be followed before the source CMMG STA initiates the frame exchange in the SP. The SP allocation identifies the TC or TS for which the allocation is made; however, the type of traffic transmitted is not restricted to the specified TC or TS (11.4.1).

Except when transmitting a frame as part of the SP recovery procedure (10.39.6.7) or transmitting a response to the source DMG STA or transmitting a PPDU as part of an RD response burst (10.29) or in a TDD slot, the STA identified by the Destination AID field in the Extended Schedule element should be in the receive state for the duration of the SP in order to receive transmissions from the source DMG STA. If the Destination AID field of the scheduled SP is equal to the broadcast AID and if the Source AID field of the scheduled SP is not equal to the broadcast AID, then all STAs on the PBSS/infrastructure BSS should be in the receive state in order to receive transmissions from the source DMG STA for the duration of the SP. Subclause 10.39.7 describes the rules for when the scheduled SP has both the Source and Destination AID fields equal to the broadcast AID.

***Change the now 17th and 18th paragraphs in 10.39.6.2.1 as follows:***

Except for an SP using TDD channel access and under the conditions specified in 10.39.6.2.2, i~~I~~n no case shall the source or destination DMG STA extend a transmission frame exchange sequence that started during an SP beyond the end of that SP. A STA that initiates a sequence shall check that the frame exchange sequence, including any control frame responses, completes before the end of the SP.

When scheduling two adjacent SPs where at least one of the SPs has the TDD Applicable SP subfield set to 0, the AP or PCP should allocate the SPs separated by at least aDMGPPMinListeningTime if one or more of the source or destination DMG STAs participate in both SPs. Otherwise, there is no separation between the SPs (see 10.39.6.2.2).

***Insert the following subclause (10.39.6.2.2, including Figure 10-57a, Figure 10-57b, and Table 10-29a) after 10.39.6.2.1:***

#### 10.39.6.2.2 SP with TDD channel access

A DMG AP or DMG PCP shall set the AllocationType subfield to 0 and the TDD Applicable SP subfield to 1 in an Allocation field within an Extended Schedule element to indicate a TDD SP allocation.

When allocating a TDD SP, the AP or PCP shall set both of the Source AID and Destination AID subfields in the corresponding Allocation field to 0.

If an Extended Schedule element includes at least one TDD SP, a DMG PCP or DMG AP shall include the Extended Schedule element in each transmitted DMG Beacon frame.

The structure of TDD SP is shown in Figure 10-57a. A TDD SP consists of one or more consecutive and adjacent TDD intervals specified by the TDD Slot Structure element. A TDD interval comprises one or more TDD slots.

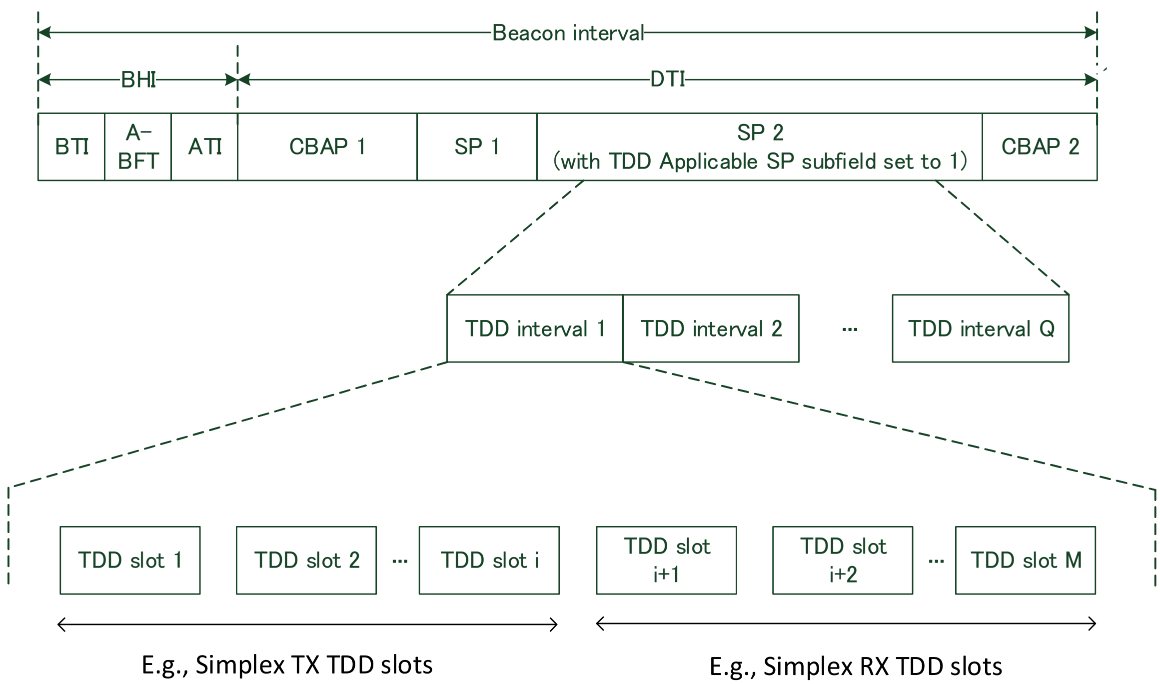


**Figure 10-57a—Example of TDD SP**

The parameters of the TDD structure within a TDD SP are defined by the TDD Slot Structure element. A non-AP and non-PCP STA shall not transmit a TDD Slot Structure element. A DMG AP or DMG PCP shall transmit a TDD Slot Structure element to each non-AP and non-PCP DMG STA that is expected to transmit or receive during a TDD SP. TDD Slot Structure elements may be included in DMG Beacon or Announce frames transmitted by the DMG AP or DMG PCP. Upon reception of a TDD Slot Structure element corresponding to allocations identified by the Allocation ID subfield value within the element, a DMG STA shall adopt the TDD slot structure within the element for all the TDD SPs identified by the same Allocation ID subfield value at the time indicated by the value of the Slot Structure Start Time field in the element. From the time the DMG STA receives an updated TDD Slot Structure element until the TDD structure is adopted, the current TDD structure shall remain in effect.

The assignment of the TDD slots within a TDD SP is done through the TDD Slot Schedule element. Except for the transmission of a TDD Beamforming frame prior to association, a DMG STA shall not transmit during a TDD SP unless it receives a TDD Slot Schedule element that indicates it is assigned, by the DMG AP or DMG PCP, to at least one TDD slot within the TDD SP that has the Bitmap and Access Type Schedule field for the STA equal to TX. Within a TDD SP, a STA shall not transmit outside the boundaries of a TDD slot it is assigned to with the Bitmap and Access Type Schedule field equal to TX, except between two adjacent TDD slots of the same category and with same destination STA. The DMG AP or DMG PCP shall transmit the TDD Slot Schedule element to each DMG STA that is assigned to access the TDD SP; this transmission shall be done using an Announce frame and Association Response frame before the time indicated by the value of the Slot Schedule Start Time field within the element. Upon reception of a TDD Slot Schedule element corresponding to allocations identified by the Allocation ID subfield value within the element, a DMG STA shall adopt the schedule within the element at the time indicated by the value of the Slot Schedule Start Time field within the element.

Figure 10-57b depicts an example of the TDD slot timing and access permissions provided by the TDD Slot Structure element and the TDD Slot Schedule element. Starting from the value indicated in the Slot Structure Start Time field, the TDD slot structure repeats each beacon interval. The Slot Structure Start Time field is equal to TBTT2 in this example. In each beacon interval, the TDD intervals indicated by the Number of TDD intervals field, $n$, occupies the entire beacon interval. Each TDD interval has a duration equal to value of the TDD Interval Duration field, $k$, so that $k \times n$ equals the beacon interval duration. Each TDD interval contains $M$ TDD slots indicated in the Number of TDD Slots per TDD Interval field ($M$ is equal to 3 in this example). Each TDD slot in a TDD Interval is defined by a pair of TDD slot start and TDD slot duration in the Slot Structure field. In the example, starting from value T as indicated in the Slot Schedule Start Time field, a new slot schedule becomes active. The Bitmap and Access Type Schedule field and the Slot Category Schedule field in the TDD Slot Schedule element indicates access type and slot category for each of the $M \times Q$ TDD slots, where $Q$ is the value of the Number of TDD Intervals in the Bitmap field ($Q$ is equal to 2 in this example). The bitmap that indicates the access type and the slot category for the $M \times Q$ TDD slots is repeated during the time indicated by the value of the TDD Slot Schedule Duration field.

A non-AP and non-PCP DMG STA may transmit a TDD Slot Schedule element in an Announce frame or (Re)Association Request frame to a DMG AP or DMG PCP. In this case, the Bitmap and Access Type Schedule field in the element indicates the availability of the STA, which can be used as input to the AP or PCP scheduling.

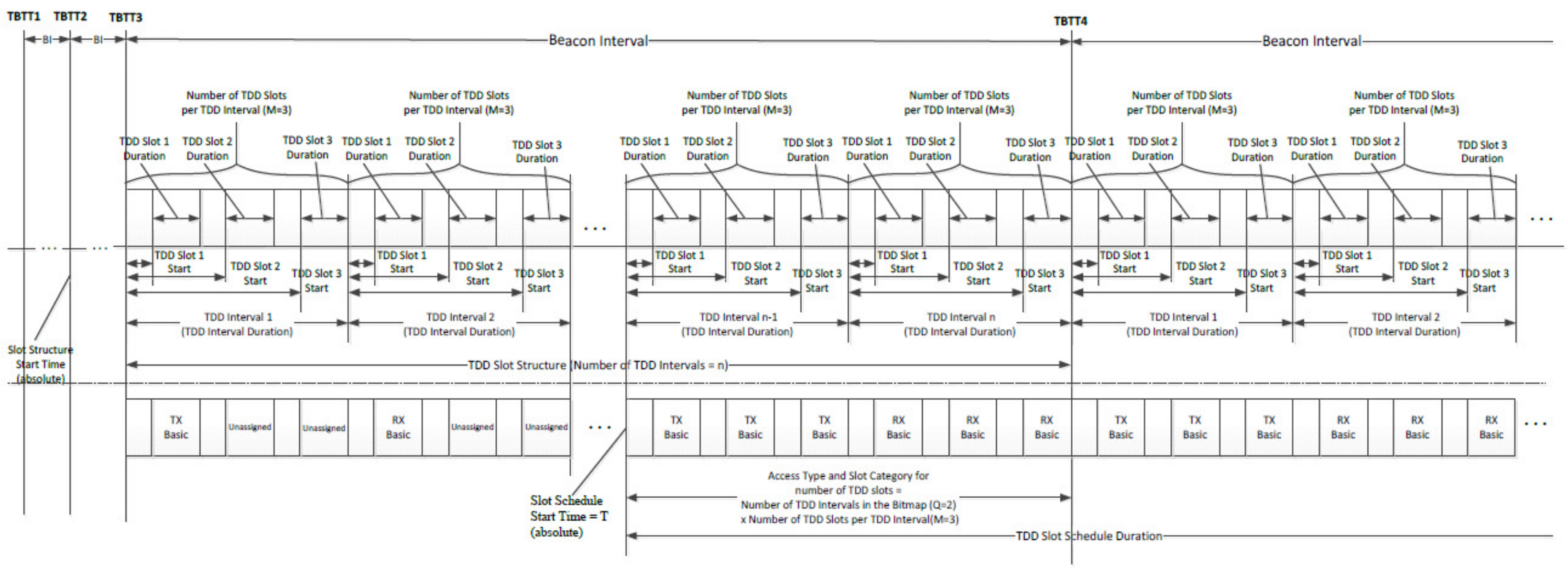


**Figure 10-57b—Example of TDD Slot Structure and TDD Slot Schedule elements relationship**

TDD slots shall not overlap in time. A TDD slot can be a simplex TDD slot, an unavailable TDD slot, or an unassigned TDD slot. A STA shall not transmit in an unassigned TDD slot or an unavailable TDD slot. RX and TX operations during a simplex TDD slot depend on the STA behavior indicated in the Bitmap and Access Type Schedule field defined in Table 9-322w as follows:

— A STA shall not transmit in a simplex TDD slot if the Bitmap and Access Type Schedule field indicates a value different from TX for the STA for the TDD slot.
— In a simplex TDD slot that has the Bitmap and Access Type Schedule field for the STA equal to TX, the STA can transmit to the peer STA assigned to the TDD slot.
— In a simplex TDD slot that has the Bitmap and Access Type Schedule field for the STA equal to RX, the STA shall be beamformed towards the peer STA assigned to the TDD slot, shall be ready to receive at least *RxTDDSlotAdvanceTime* before the start of the TDD Slot and shall remain in the receive state for the duration of the TDD slot in order to receive transmissions from the peer STA. *RxTDDSlotAdvanceTime* is computed as follows:

$$RxTDDSlotAdvanceTime = Ceil\,(T_{ME} + T_P, T_{TR})$$

where

$T_{ME}$ is the value of the Maximum Time Synchronization Error subfield in the TDD Slot Structure element describing the TDD SP, in µs
$T_P$ is aTDDAirPropagationTime, in µs
$T_{TR}$ is aTSFResolution, in µs

Provided the STA behavior is the same in adjacent TDD slots, transmissions and receptions in adjacent TDD slots that are assigned to the same pair of STAs may continue in between the adjacent TDD slots.

When an AP or PCP receives a TDD Slot Schedule element from a STA that indicates a TDD slot is an unavailable TDD slot for that STA, the AP or PCP shall not schedule any transmission or reception in this TDD slot for that STA.

Each TDD slot is of one of the following categories: Basic, Data and BF. Table 10-29a lists the frames that are allowed to be transmitted during each slot category, together with the transmit order of those frames within the TDD slot.

The reverse direction protocol (see 10.29) shall not be used in a TDD SP.

A DMG STA that has TDD Channel Access Supported subfield in the STA's DMG Capabilities element equal to 1 shall set to 1 at least one of the following subfields in a transmitted DMG Link Margin element: PPDU Statistics Present subfield, LDPC Statistics Present subfield or SC/OFDM Statistics Present subfield.

The Duration field in frames sent in an SP with TDD channel access shall be set as follows: bits 0–13 set to 0, and bits 14–15 set to 1.

**Table 10-29a—Allowed frames and transmit order for each TDD slot category**

| TDD slot category | Allowed frames | MPDU transmit order | Conditions | |
|---|---|---|---|---|
| Basic | Control: Ack, BlockAck, DMG CTS-to-self, BlockAckReq<br><br>Extension<br><br>Management<br><br>Data | — Ack (as standalone PPDU, or as part of an A-MPDU; see NOTE 1).<br>— BlockAck (as standalone PPDU, or as part of an A-MPDU; see NOTE 1).<br>— As many Extension and Management frames as available, or fitting in the TDD slot.<br>— Zero or more Data frames, optionally followed by a BlockAckReq frame.<br><br>Optionally, repeat the steps until the end of the TDD slot. See NOTE 3. | — If present, Ack shall be the first frame in the slot.<br>— If present, BlockAck shall be the first frame in the slot, unless preceded by an Ack frame.<br>— Management and Data frames may be aggregated following the rules in 9.7.3, as long as all buffered Management frames are present in the A-MPDU. | — The following frames may appear only once during the TDD slot: Ack, BlockAck, and BlockAckReq.<br>— PPDUs containing Data or Management frames may be preceded and/or followed by DMG CTS-to-self frames. |
| Data | | — As many Data frames as available, or fitting in the TDD slot, optionally followed by a BlockAckReq frame.<br>— Ack (as standalone PPDU, or as part of an A-MPDU; see NOTE 1 and NOTE 2).<br>— BlockAck (as standalone PPDU, or as part of an A-MPDU; see NOTE 1 and NOTE 2).<br>— Zero or more Extension and Management frames.<br><br>Optionally, repeat the steps until the end of the TDD slot. See NOTE 4. | — Data and Management frames can be aggregated following the rules in 9.7.3, as long as all buffered Data frames are present in the A-MPDU. | |

**Table 10-29a—Allowed frames and transmit order for each TDD slot category *(continued)***

| TDD slot category | Allowed frames | MPDU transmit order | Conditions | |
|---|---|---|---|---|
| BF | TDD Beamforming | — TDD SSW<br>— TDD SSW Feedback<br>— TDD SSW Ack | | |

NOTE 1—Action No Ack frames can also be aggregated with Ack or BlockAck frames and sent as part of an A-MPDU in control response context, as defined in 9.7.3. Action No Ack frames sent in this fashion are allowed to not follow the MPDU transmit order defined for the slot category.

NOTE 2—Opportunistic transmission of Ack and BlockAck frames in Data TDD slots does not change the timeout rules defined in 10.3.2.11.

NOTE 3—Repeating these steps during the TDD slot means that once STA has transmitted all buffered Management frames, it can transmit zero or more Data frames (optionally followed by a BlockAckReq frame) before it checks for new Management frames to transmit.

NOTE 4—Repeating these steps during the TDD slot means that once STA has transmitted all buffered Data frames, it can transmit Ack, BlockAck, and zero or more Management frames before it checks for new Data frames to transmit.

### 10.39.7 Dynamic allocation of service period

#### 10.39.7.2 Polling period (PP)

***Change the fifth paragraph in 10.39.7.2 as follows:***

A STA that receives an individually addressed Poll frame shall respond to the AP or PCP with a single directional and individually addressed SPR frame at the time offset from the end of the Poll frame indicated in the Response Offset field within the received Poll frame. The Duration field within the SPR frame shall be set to the value of the Duration field contained in the received Poll frame, minus the value of the Response Offset field contained in the received Poll frame, minus the time taken to transmit the SPR frame. If the AP or PCP is an EDMG STA and the AllocationType field within the SPR is equal to SP, the STA may set the TXVECTOR parameter SCRAMBLER_INIT_SETTING to CONTROL_TRAILER and CT_TYPE to SPR to request the PCP or AP to grant the SP allocation on a specific channel or over a specified channel bandwidth.

#### 10.39.7.3 Grant period (GP)

***Insert the following paragraph into 10.39.7.3 after the fourth paragraph ("To commence the GP, ...."):***

If the source DMG STA, destination DMG STA and the STA transmitting the Grant frame are all EDMG STAs, a granted dynamic allocation should meet the bandwidth requirements specified in the received SPR frame.

***Change the now seventh paragraph in 10.39.7.3 as follows:***

During an SP between a source DMG STA and a destination DMG STA, the source DMG STA may transmit a Grant frame to the destination DMG STA to relinquish the remainder of the SP to the destination DMG STA. In the Allocation Info field of the transmitted Grant frame, the source DMG STA shall set source AID field to the AID of the destination DMG STA, the destination AID field to the AID of the source DMG STA, the AllocationType field set to indicate SP, and the Allocation Duration field set to a value of 32 768 as defined in 9.5.2. The Duration field in the Grant frame shall be set to the time remaining in the SP minus TXTIME (Grant frame) minus aSIFSTime. The Beamforming Training subfield within the Beamforming Control field of the Grant frame shall be set to 0. ~~Upon transmission of the Grant frame with the Beamforming Training field equal to 0, f~~For the remainder of the SP, the roles of source DMG STA and destination DMG STA are swapped between the STAs. If both the source STA and destination STA are EDMG STAs, and if any bit in the CH_BANDWIDTH parameter in the RXVECTOR of the received Grant frame was 0, the destination STA shall not transmit frames with the corresponding bit in the TXVECTOR parameter CH_BANDWIDTH set to 1, and shall be subject to the channel access rules in 10.39.12.2.1.

***Change the now ninth paragraph in 10.39.7.3 as follows:***

During a TXOP between a TXOP holder and a TXOP responder, the TXOP holder may transmit a Grant frame to the TXOP responder to relinquish the remainder of the TXOP to the TXOP responder. In the transmitted Grant frame, the TXOP holder shall set the source AID field to the AID of the TXOP responder, the destination AID field to the AID of the TXOP holder, the AllocationType field to indicate CBAP, and the Allocation Duration field to a value of 32 768 as defined in 9.5.2. For CMMG STAs, the Channel Band field shall be set to the same channel and bandwidth as the original TXOP. The Duration field in the Grant frame shall be set to the time remaining in the TXOP minus TXTIME (Grant frame) minus aSIFSTime. The Beamforming Training subfield within the Beamforming Control field of the Grant frame shall be set to 0. ~~Upon transmission of the Grant frame with the Beamforming Training field equal to 0, f~~For the remainder of the TXOP, the roles of TXOP holder and TXOP responder are swapped between the STAs. If both the TXOP holder and TXOP responder are EDMG STAs, and if any bit in the CH_BANDWIDTH parameter in the RXVECTOR of the received Grant frame was 0, the TXOP responder shall not transmit frames with the corresponding bit in the TXVECTOR parameter CH_BANDWIDTH set to 1, and shall be subject to the channel access rules in 10.39.12.2.1.

***Insert the following subclauses (10.39.12 through 10.39.12.6, including Figure 10-61a through Figure 10-61e) after 10.39.11:***

### 10.39.12 EDMG channel access

#### 10.39.12.1 General

This subclause specifies channel access rules that are applicable to an EDMG STA. These rules are in addition to the rules specified in 10.3, 10.23, and 10.29, which are applicable to DMG STAs.

An EDMG STA shall set dot11EDMGOptionImplemented to true.

An EDMG STA shall set the EDMG Supported subfield in the DMG Parameters field to 1 in transmitted frames.

#### 10.39.12.2 Channel access over multiple channels

##### 10.39.12.2.1 Channel access rules

The following apply to transmissions performed in an EDMG BSS:

— Transmissions shall not occupy a bandwidth that exceeds the equivalent of four 2.16 GHz channels.
— Transmissions shall be confined to the channel number indicated by the primary channel, the channels indicated in the EDMG Operation element, and the channels indicated in the EDMG Capabilities element.

An EDMG STA shall not transmit an EDMG PPDU to a peer EDMG STA over a channel that is not supported by the peer STA as indicated in the Supported Channels field in the peer STA's EDMG Capabilities element.

An EDMG STA may transmit a Grant frame to a peer EDMG STA to indicate intent to transmit an EDMG PPDU to the peer STA over a 4.32 GHz, 2.16+2.16 GHz, 6.48 GHz, 4.32+4.32 GHz, or 8.64 GHz channel at the time indicated by the sum of the Allocation Duration field and the Duration field within the Grant frame following the end of the Grant frame transmission as described in 9.5.2. When a peer EDMG STA receives the Grant frame, it may

- Limit its receiver bandwidth to 2.16 GHz until the time indicated by the sum of the Allocation Duration field and the Duration field; or
- Configure its receive DMG antenna(s) to a directional antenna pattern only at the time indicated by the sum of the Allocation Duration field and the Duration field, allowing it to employ a quasi-omni antenna pattern beforehand. This would allow the peer EDMG STA to receive from a wider coverage area.

To do this, in the TXVECTOR of the transmitted Grant frame the EDMG STA shall set the TXVECTOR parameter SCRAMBLER_INIT_SETTING to CONTROL_TRAILER, the parameter CT_TYPE to GRANT_RTS_CTS2Self, the parameter IS_CHANNEL_NUMBER to ChannelWidth and the parameter BW_IN_CT to indicate the bandwidth with which the EDMG PPDU is going to be transmitted.

An EDMG AP or EDMG PCP may use the EDMG Extended Schedule element to allocate an SP or a CBAP over channels with different bandwidths. For partially or fully overlapping allocations, both the source AID and the destination AID of each allocation shall be different from both the source AID and destination AID of every other overlapping allocation. Channels used for such allocations shall be included in the EDMG Operation element transmitted by the AP or PCP. An allocation and channel access within the allocation follow the following rules:

- If the allocation is an SP, then
  - The allocation does not have to include the primary channel.
  - If the allocation does not include the primary channel, the allocation shall not span more than one 2.16 GHz channel.
- If the allocation is a scheduled CBAP, then channel access during the allocation shall include the primary channel.
- Any transmissions within the allocation shall not exceed the corresponding bandwidth for this allocation.

If the CBAP Only field in a transmitted DMG Beacon frame is 1, then channel access within the CBAP of the DTI specified by the DMG Beacon frame shall include the primary channel.

If an EDMG Extended Schedule element that has at least one Channel Allocation field with the Scheduling Type subfield equal to 0 is present in a transmitted frame, an Extended Schedule element shall also be present in the same frame. The Allocation Key subfield of a Channel Allocation field with the Scheduling Type subfield equal to 0 shall have its contents matched to the tuple <Source AID, Destination AID, Allocation ID> of an Allocation field in the Extended Schedule element for the same allocation. A Channel Allocation field with the Scheduling Type subfield equal to 0 included in the EDMG Extended Schedule element shall be ignored if the contents of its Allocation Key subfield do not match to the tuple <Source AID, Destination AID, Allocation ID> of any Allocation field in the Extended Schedule element.

For an allocation that does not include the primary channel, the allocation information shall be present in the EDMG Extended Schedule element only. This shall be indicated by setting the value of the Scheduling Type subfield for the allocation to 1.

#### 10.39.12.2.2 CCA in secondary channels

An EDMG STA shall maintain physical and virtual CS on a primary channel as specified in 10.3.2.

To perform the procedure specified in 10.23.2.14, an EDMG STA shall be capable of performing energy detection on each of its supported channels that are also supported by the AP or PCP, as indicated in the AP's or PCP's EDMG Operation element.

At the specific slot boundaries (see Figure 10-25) determined by the STA based on the primary channel CCA, when the transmission begins a TXOP using EDCA (as described in 10.23.2.4), the STA may transmit on secondary channels only if the respective secondary channel has also been idle during the times the primary channel CCA is performed (defined in 10.23.2.4) for an interval of PIFS immediately preceding the expiration of the backoff counter.

#### 10.39.12.3 Directional allocation

A directional allocation is an allocation during which an EDMG AP or EDMG PCP uses a directional, non quasi-omni DMG antenna pattern to receive frames. Directional allocation can facilitate the frame exchange between an EDMG AP or EDMG PCP and an EDMG STA through the use of a directional link, particularly for those STAs that have asymmetric links (see 10.42.10.3).

To schedule a directional allocation, an EDMG AP or EDMG PCP shall set the IsDirectional subfield in the Receive Direction subfield within the corresponding Channel Allocation field of the EDMG Extended Schedule element to one. The decision to schedule a directional allocation is implementation dependent, but may be as a result of performing the procedure specified in 10.42.10.

Within the Channel Allocation field in the EDMG Extended Schedule element that specifies a directional allocation, the Sector ID and DMG Antenna ID subfields of a directional allocation shall be set to the sector and DMG antenna, respectively, that the PCP or AP uses to receive frames during the entire allocation. A non-PCP and non-AP EDMG STA receiving such allocation shall stay awake during the allocation if the value of the Sector ID and DMG Antenna ID subfields identified in the allocation correspond to a sector and DMG antenna reported by the STA to the PCP or AP in the last beamforming feedback to the PCP or AP, respectively. If the value of the Sector ID and DMG Antenna ID subfields identified in the allocation do not correspond to a sector and DMG antenna reported by the STA to the PCP or AP in the last beamforming feedback, the non-PCP and non-AP EDMG STA shall not access the directional allocation.

Channel access during a directional allocation shall follow the same rules that are applicable to a CBAP (see 10.39.6.3) if the directional allocation is of type CBAP and shall follow the same rules that are applicable to an SP (see 10.39.6.2) if the directional allocation is of type SP.

#### 10.39.12.4 MIMO channel access

#### 10.39.12.4.1 General

This subclause describes the MIMO channel access mechanisms that are applicable to EDMG STAs. General MIMO channel access rules are defined in 10.39.12.4.2. The SU-MIMO channel access procedure and the MU-MIMO channel access procedure are specified in 10.39.12.4.3 and 10.39.12.4.4, respectively, and EDMG STAs using these procedures shall also follow the MIMO channel access rules specified in 10.39.12.4.2.

In this subclause, the EDMG STA that obtains a TXOP or is the source STA of an allocated SP and that initiates the MIMO channel access procedure is referred to as the initiator, and the EDMG STA(s) that are addressed by the MIMO channel access is referred to as the responder(s).

#### 10.39.12.4.2 MIMO channel access rules

An EDMG STA that has either the MU-MIMO Supported subfield set to 1 or the SU-MIMO Supported subfield set to 1 in the Beamforming Capability subelement of its EDMG Capabilities element shall maintain physical and virtual CS and backoff procedure as specified in 10.23.2. This allows the STA to be able to transmit and receive a single space time-stream PPDU (i.e., using SISO transmission) for the establishment of a TXOP when a subsequent transmission of a PPDU with multiple space-time streams is to take place.

When an EDMG STA that has either the MU-MIMO Supported set to 1 or the SU-MIMO Supported set to 1 in the Beamforming Capability subelement of its EDMG Capabilities element attempts to obtain a TXOP for MIMO transmission, CCA shall be maintained such that at least all the MIMO RX DMG antennas corresponding to the MIMO TX DMG antennas intended to be used in the TXOP, which have been determined by applying the beamforming protocols defined in 10.42.10.2.2 or in 10.42.10.2.3, are observed. The STATE parameter of PHY-CCA.indication can be one of two values: BUSY or IDLE. The parameter value is BUSY if the assessment of the channel by the PHY determines that the channel on at least one of the MIMO TX antennas intended to be used in the TXOP is not idle. The parameter value is IDLE if the assessment by the PHY of the channel on all of the MIMO TX antennas intended to be used in the TXOP determines that the channel is idle.

In the following, “MIMO channel was idle for an interval of PIFS” means that the STATE parameter of the most recent PHY-CCA.indication primitive that sensed at least all the MIMO TX antennas intended to be used in the TXOP was IDLE for an interval of PIFS that ends at the start of the transmission. “MIMO channel was busy” means that the STATE parameter of the most recent PHY-CCA.indication primitive that sensed at least one of the MIMO TX antennas intended to be used in the TXOP was BUSY.

The initiator uses the procedures in 10.3 and 10.23.2 to obtain a TXOP, or use the procedures in 11.4.13 to obtain an SP allocation prior to initiating MIMO channel access.

When the channel is clear for SISO transmission (physical and virtual CS are clear) for the corresponding DMG antenna that is used for SISO transmission to establish a TXOP and the backoff timer reaches 0, a STA is permitted to obtain the TXOP. If the initiator has at least one MSDU pending for transmission during the permitted TXOP, the initiator shall perform exactly one of the following actions:

- Transmit a MIMO PPDU or initiate the hybrid beamforming protocol if the MIMO channel was idle for an interval of PIFS immediately preceding the start of the TXOP.
- Transmit a PPDU using a single transmit chain with the same DMG antenna that was used to obtain the TXOP or cancel the hybrid beamforming protocol if any DMG antenna connected to an active receive chain indicates busy during an interval of PIFS immediately preceding the start of the TXOP.
- Restart the channel access attempt by invoking the backoff procedure as specified in 10.23.2 as though the medium is busy as indicated by either physical or virtual CS and the backoff timer has a value of 0.

In the case of an SP, if the initiator has at least one MSDU pending for transmission during the SP, the initiator transmits a MIMO PPDU or initiates the hybrid beamforming protocol at the start of the SP.

If the Grant Required field within a responder’s EDMG Capabilities element is 1, the initiator shall transmit a Grant frame with a control trailer in a CBAP to this responder before initiating MIMO channel access or the hybrid beamforming protocol, to indicate the intent to transmit a MIMO PPDU to the responder or announce the start of the hybrid beamforming protocol respectively. Otherwise, if the Grant Required field within a responder’s EDMG Capabilities is 0, the initiator may optionally transmit a Grant frame to the responder.

In the transmitted Grant frame, the value of the Allocation Duration field plus the Duration field of the Grant frame indicates the estimated time offset from the PHY-TXEND.indication primitive of the Grant frame transmission when the initiator intends to initiate access to the channel to transmit to or start the hybrid beamforming protocol with the responder. For the transmitted Grant frame, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER, the parameter CT_TYPE shall be set to GRANT_RTS_CTS2Self, and the NEXT_TX_SISO parameter shall be set to NextTxMultiAntenna. For hybrid beamforming training, the HBF_TRAINING parameter shall be set NextHBF to indicate that the following transmission from this STA is hybrid beamforming training. The MU_MIMO_NEXT parameter shall be set to NextNotMUMIMO to indicate that the following transmission (see 10.42.10.2.2) or hybrid beamforming training (see 10.42.10.2.4) is performed in SU-MIMO or shall be set to NextMUMIMO to indicate that the following transmission (see 10.42.10.2.3) or hybrid beamforming training is performed in MU-MIMO. The control trailer shall also indicate the corresponding DMG antenna configuration for the upcoming MIMO transmission or hybrid beamforming training through the TXVECTOR parameters TX_SECTOR_CONFIG_INDEX, MU_MIMO_TX_CONFIG_TYPE and MU_MIMO_TX_CONFIG_INDEX.

If an EDMG STA receives a Grant frame with a control trailer indicating an SU-MIMO or MU-MIMO transmission, or hybrid beamforming training and is able to receive the SU-MIMO or MU-MIMO transmission or perform hybrid beamforming training at the target time indicated by the Grant frame, the EDMG STA shall

- Transmit a Grant Ack frame in response to the received Grant frame.
- In the case when the STA received a Grant frame with a control trailer indicating SU-MIMO transmission or the start of the hybrid beamforming training protocol, for this transmitted Grant Ack frame, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER and the parameter CT_TYPE shall be set to GRANT_RTS_CTS2Self. If it uses SU-MIMO for the transmission in the opposite direction, i.e., from the responder to the initiator, or desires to announce the hybrid beamforming protocol in the opposite direction, the TXVECTOR parameter NEXT_TX_SISO of the Grant Ack shall be set to NextTxMultiAntenna. For hybrid beamforming training, the HBF_TRAINING parameter shall be set NextHBF to indicate that the following transmission from this STA is hybrid beamforming training. The control trailer shall also indicate the corresponding DMG antenna configuration for the upcoming SU-MIMO transmission or hybrid beamforming training in the opposite direction using the TXVECTOR parameter TX_SECTOR_CONFIG_INDEX. If the responder STA intends to use SISO for the transmission in the opposite direction, the TXVECTOR parameter NEXT_TX_SISO of the Grant Ack shall be set to NextTxSingleAntenna.
- Configure its DMG antennas according to the settings included in the control trailer of the received Grant frame within a time period determined by the value of the Allocation Duration field plus the value of the Duration field of the received Grant frame starting from the PHY-TXEND.indication primitive of the Grant frame transmission.

#### 10.39.12.4.3 SU-MIMO channel access procedure

An EDMG STA is SU-MIMO capable if the SU-MIMO Supported field in the STA’s EDMG Capabilities element is equal to 1. The SU-MIMO channel access procedure describes how an SU-MIMO capable initiator and an SU-MIMO capable responder shall access the channel to start exchanging one or more EDMG SU PPDUs using SU-MIMO, and also describes how an SU-MIMO capable initiator and responder that are also hybrid beamforming capable start an hybrid beamforming protocol.

Prior to initiating the SU-MIMO channel access with a responder, an initiator shall perform SU-MIMO beamforming with the responder (see 10.42.10.2.2).

An EDMG STA, the SU-MIMO initiator, initiates SU-MIMO channel access by transmitting an RTS frame or a DMG CTS-to-self frame to the intended SU-MIMO responder. The SU-MIMO initiator shall transmit the RTS or DMG CTS-to-self frame with a control trailer to the SU-MIMO responder. The RTS or DMG CTS-to-self frame shall be transmitted using the same set of DMG antennas and antenna configuration planned to be used during the SU-MIMO transmission or hybrid beamforming training, and with a CSD between the transmissions in different antennas as defined in 28.4.7.2 and 28.4.7.3.3. For the transmitted RTS or DMG CTS-to-self frame, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER, the parameter CT_TYPE shall be set to GRANT_RTS_CTS2Self, the NEXT_TX_SISO parameter shall be set to NextTxMultiAntenna and the MU_MIMO_NEXT parameter shall be set to NextNotMUMIMO to indicate that the following transmission or hybrid beamforming training is performed in SU-MIMO. For hybrid beamforming training, the HBF_TRAINING parameter shall be set NextHBF to indicate that the following transmission from this STA is hybrid beamforming training. The control trailer shall also indicate the corresponding DMG antenna configuration for the upcoming SU-MIMO transmission or hybrid beamforming training through the TXVECTOR parameter TX_SECTOR_CONFIG_INDEX.

If an SU-MIMO initiator transmits to a responder a DMG CTS-to-self frame that contains a control trailer indicating an SU-MIMO transmission, all the PPDUs transmitted by the initiator to the responder within this TXOP shall use the antenna setting indicated in the TXVECTOR parameter TX_SECTOR_CONFIG_INDEX. For transmissions in the opposite direction, the initiator should configure its receive DMG antennas according to the settings included in the control trailer of the last Grant Ack frame received from the responder and the responder should use the antenna setting indicated in this same transmitted Grant Ack frame. If there was no prior Grant/Grant Ack frame exchange between the initiator and the responder, the SISO antenna setting should be used instead.

If an SU-MIMO initiator uses a DMG CTS-to-self frame to switch to SU-MIMO transmission in a TDD slot, the initiator and responder shall communicate using SU-MIMO transmissions until one of the following occurs:

- The initiator transmits to the responder a DMG CTS-to-self frame with TXVECTOR parameters CT_TYPE set to GRANT_RTS_CTS-2self and NEXT_TX_SISO set to NextTxSingleAntenna; or
- Beamforming training between the initiator and responder.

If a responder receives an RTS frame with a control trailer indicating an SU-MIMO transmission or a hybrid beamforming announcement addressed to itself and is able to perform the SU-MIMO reception or hybrid beamforming training, the responder shall

- Configure its DMG antennas according to the settings indicated in the RXVECTOR parameter TX_SECTOR_CONFIG_INDEX of the received RTS frame.
- Transmit a DMG CTS frame with a control trailer in response of the received RTS frame. For this transmitted DMG CTS frame, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER and the parameter CT_TYPE shall be set to CTS_DTS.
- If the responder uses SU-MIMO for the transmission in the opposite direction (i.e., from the EDMG STA receiving the RTS frame to the EDMG STA transmitting the RTS frame) or desires to announce the hybrid beamforming protocol in the opposite direction, the TXVECTOR parameter NEXT_TX_SISO of the DMG CTS frame shall be set to NextTxMultiAntenna and the MU_MIMO_NEXT parameter shall be set to NextNotMUMIMO. For hybrid beamforming training, the HBF_TRAINING parameter shall be set NextHBF to indicate that the following transmission from this STA is hybrid beamforming training. The control trailer shall also indicate the corresponding DMG antenna configuration for the upcoming SU-MIMO transmission or hybrid beamforming training in the opposite direction using the TXVECTOR parameter TX_SECTOR_CONFIG_INDEX. The DMG CTS frame shall be transmitted using the same set of DMG antennas and antenna configuration planned to be used during the SU-MIMO transmission or hybrid beamforming training, and with a CSD between the transmissions in different antennas as defined in 28.4.7.2 and 28.4.7.3.3.

— If the responder uses SISO for the transmission in the opposite direction, the TXVECTOR parameter NEXT_TX_SISO of the DMG CTS frame shall be set to NextTxSingleAntenna and the DMG CTS frame shall be sent using the SISO antenna setting.

Alternatively, if the responder is not able to perform the SU-MIMO reception or hybrid beamforming training, it may transmit a DMG DTS frame with a control trailer to the initiator to provide further information. The DMG DTS frame shall be sent using the SISO antenna setting.

A responder that receives a DMG CTS-to-self frame with a control trailer indicating a SU-MIMO transmission or hybrid beamforming training addressed to itself and is able to perform the SU-MIMO reception or hybrid beamforming training shall

— Configure its DMG antennas according to the settings included in the RXVECTOR parameter TX_SECTOR_CONFIG_INDEX of the received CTS-to-self frame; and
— Begin the SU-MIMO reception or hybrid beamforming training SIFS following the end of the DMG CTS-to-self frame transmission by the initiator.

Figure 10-61a and Figure 10-61b illustrate examples of frame exchange sequences using the SU-MIMO channel access procedure.

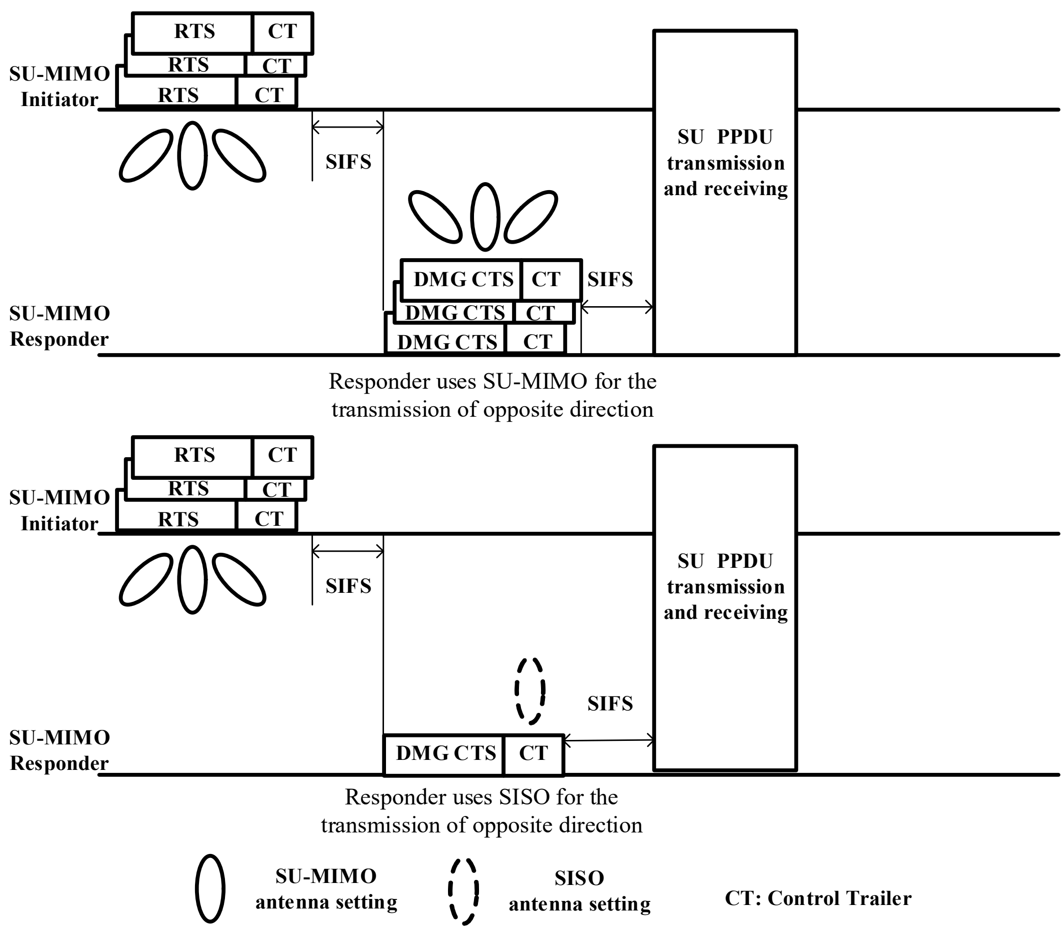


**Figure 10-61a—SU-MIMO channel access procedure when RTS/DMG CTS is used**

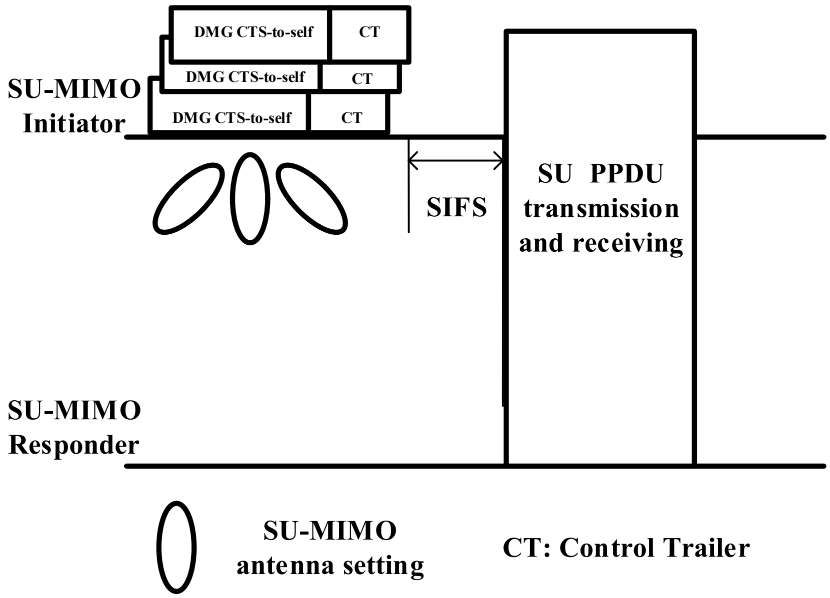


**Figure 10-61b—SU-MIMO channel access procedure when DMG CTS-to-self is used**

An SU-MIMO initiator may send a CF-End frame to reset the NAV and release the remaining time of the TXOP. If the CF-End is transmitted, it shall be sent using the same set of DMG antennas and antenna configuration during the SU-MIMO transmission or hybrid beamforming training and a CSD between the transmissions in different antennas as defined in 28.4.7.2.

### 10.39.12.4.4 MU-MIMO channel access procedure

An EDMG STA is MU-MIMO capable if the MU-MIMO Supported subfield of the Beamforming Capability subelement in the STA's EDMG Capabilities element is 1. The MU-MIMO channel access procedure describes how an MU-MIMO capable initiator and multiple MU-MIMO capable responders shall access the channel to start exchanging one or more EDMG MU PPDUs, and also describes how an MU-MIMO capable initiator and multiple MU-MIMO capable responders that are also hybrid beamforming capable (see 10.42.10.2.4) start the hybrid beamforming protocol.

Prior to initiating the MU-MIMO channel access with a set of responder STAs within an MU group, the initiator shall

— Include the MU group within the EDMG Group ID Set element and communicate the resulting element to the STAs in the BSS (see 10.42.10.2.3.1).
— Perform MU-MIMO beamforming with the responders of the MU group (see 10.42.10.2.3).

An EDMG STA initiates MU-MIMO channel access by transmitting an RTS frame or a DMG CTS-to-self frame to the intended MU-MIMO group of responders. The EDMG STA shall transmit the RTS frame or DMG CTS-to-self frame with a control trailer to the group of responders. The RTS or DMG CTS-to-self frame shall be transmitted using the same set of DMG antennas and antenna configuration planned to be used during the MU-MIMO transmission or hybrid beamforming training, and a CSD between the transmissions in different antennas as defined in 28.4.7.2. The TA field of the transmitted DMG CTS-to-self frame shall be set to the broadcast address.

For the transmitted RTS or DMG CTS-to-self frame, the TXVECTOR parameter SCRAMBLER_INIT_SETTING shall be set to CONTROL_TRAILER, the parameter CT_TYPE shall be set to GRANT_RTS_CTS2self, the parameter NEXT_TX_SISO shall be set to NextTxMultiAntenna, and the parameter MU_MIMO_NEXT shall be set to NextMUMIMO to indicate that the following PPDU transmitted by the initiator is an EDMG MU PPDU. In addition to the previous settings, for hybrid beamforming training the HBF_TRAINING parameter shall be set NextHBF to indicate that the following transmission from this STA is hybrid beamforming training. The TXVECTOR parameter EDMG_GROUP_ID shall be set to the value that identifies the corresponding group of responders that are the intended destinations of the EDMG MU PPDU to be transmitted or the intended recipients of the hybrid beamforming training. The TXVECTOR parameters MU_MIMO_TX_CONFIG_TYPE and MU_MIMO_TX_CONFIG_INDEX indicate the corresponding DMG antenna configuration for the upcoming MU-MIMO transmission or hybrid beamforming training. The RA field of the RTS shall be set to the broadcast address. After transmitting the RTS frame, the initiator should configure its receive antenna to a quasi-omni receive pattern to receive the DMG CTS.

An initiator that transmits an RTS frame or a DMG CTS-to-self frame addressed to an MU group shall set the TXVECTOR parameter IS_CHANNEL_NUMBER to ChannelWidth and shall set the BW_IN_CT to indicate the bandwidth to be used for all EDMG MU PPDU transmissions within the TXOP or SP allocation.

When a responder receives an RTS frame addressed to an MU group and belongs to the corresponding MU-MIMO transmission configuration indicated in the control trailer, if the responder is able to perform the MU-MIMO reception then it shall

- Transmit a DMG CTS frame back to the initiator employing the most recent SISO antenna configuration used between the responder and the initiator. The TA field of the DMG CTS frame shall be set to the broadcast address.
- Following the transmission of the DMG CTS frame, the responder shall then configure its antennas according to the settings indicated in the RXVECTOR parameters MU_MIMO_TX_CONFIG_TYPE and MU_MIMO_TX_CONFIG_INDEX of the received RTS frame.

For the successful reception of the DMG CTS frame, the difference in time between all the DMG CTS transmissions as measured at the receiving STA should be no more than $T_{GI\ normal}$ (see 28.5.2.2). A STA that transmits the DMG CTS should precompensate for carrier frequency offset error to mitigate the frequency error in the transmitted signal.

The MU-MIMO transmission or hybrid beamforming training shall begin a SIFS + 10% × (aSlotTime – aAirPropagationTime) interval following the reception or expected reception of the DMG CTS frame by the initiator. This is shown in Figure 10-61c.

NOTE—If an RTS/DMG CTS frame exchange is used to obtain MU-MIMO channel access, the successful reception of the DMG CTS frame at the initiator is not required to proceed with the MU-MIMO channel access.

When a responder receives a DMG CTS-to-self frame addressed to an MU group and belongs to the corresponding MU-MIMO transmission configuration indicated in the control trailer, if the responder is able to perform the MU-MIMO reception then it shall configure its antennas according to the settings indicated in the RXVECTOR parameters MU_MIMO_TX_CONFIG_TYPE and MU_MIMO_TX_CONFIG_INDEX of the received CTS-to-self frame. The MU-MIMO transmission or hybrid beamforming shall begin a SIFS following the end of the DMG CTS-to-self frame transmission by the initiator. This is shown in Figure 10-61d.

Subclause 10.3.2.13 describes the MU PPDU acknowledgment procedure.

The initiator may send a CF-End frame to one or more responders in an MU-MIMO TXOP to truncate the TXOP.

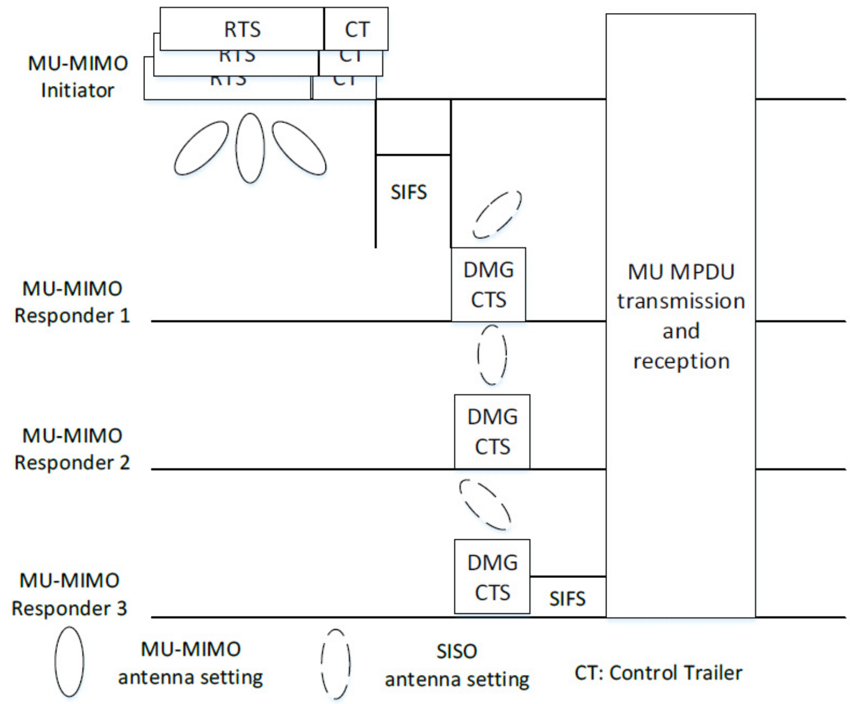


**Figure 10-61c—MU-MIMO channel access flow when RTS/DMG CTS is used**

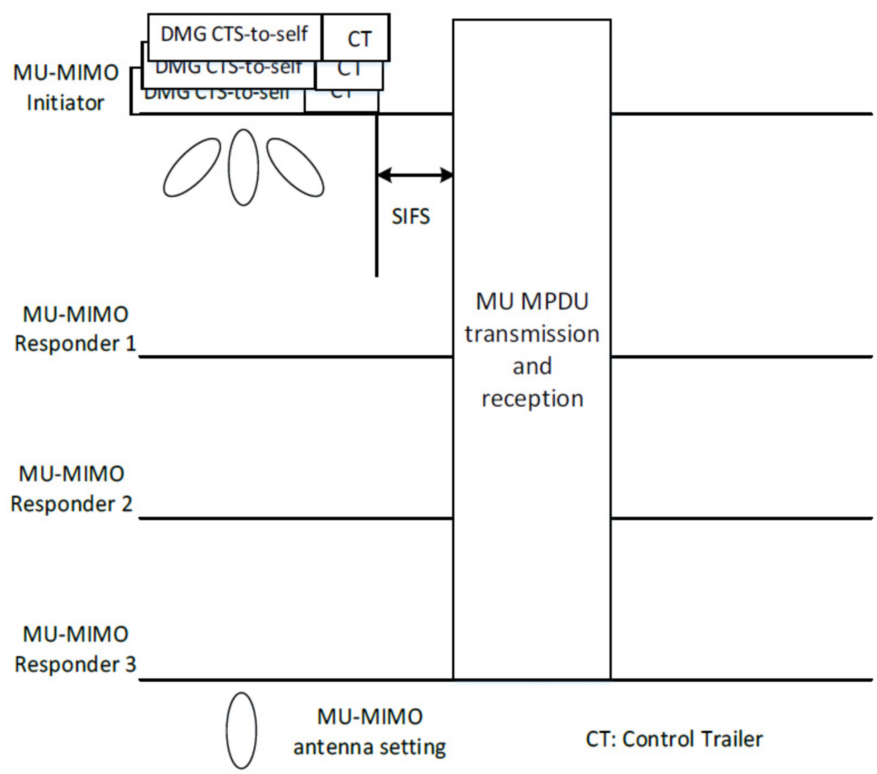


**Figure 10-61d—MU-MIMO channel access flow when DMG CTS-to-self is used**

### 10.39.12.5 Control trailer

To provide additional control signaling, a control trailer may be inserted in a control mode PPDU transmitted to an EDMG STA. An EDMG STA shall set the TXVECTOR parameter SCRAMBLER_INIT_SETTING to CONTROL_TRAILER to indicate the presence of the control trailer in a control mode PPDU and shall set the TXVECTOR parameter CT_TYPE to indicate the type of control trailer to be included in the PPDU. The control trailer is defined in 28.3.7.

### 10.39.12.6 "Near-Far" self classification

A non-PCP and non-AP EDMG STA may estimate whether its signal can be successfully received by an EDMG PCP or EDMG AP that is listening in quasi-omni mode, i.e., to classify itself as a "Near" or a "Far" STA to the PCP or AP. This allows the EDMG STA to decide whether to access the A-BFT (if it is classified as "Near") or to use asymmetric beamforming (if it classified as "Far") as defined in 10.42.10.3. To enable this, the PCP or AP informs EDMG STAs about its link budget parameters combined in one value, the PCP/AP Coverage Parameter subfield, which is transmitted in the SSW field of the DMG Beacon frame.

An EDMG STA may classify itself as a "Near" STA if the following inequality is true:

$$P_{APrx} = (EIRP_{STA} - G_{STArx}) + RSSI - C > P_{min\_sensitivity}$$

where

| | |
|---|---|
| $P_{APrx}$ | is an estimation by the STA of the expected power that the STA's transmission is received by the PCP/AP |
| $EIRP_{STA}$ | is set to $P_{STA} + G_{STAtx}$, where $P_{STA}$ and $G_{STAtx}$ are the transmit power and antenna gain for the expected STA transmission |
| $G_{STArx}$ | is the STA's receive antenna gain during DMG Beacon reception |
| $RSSI$ | is the power that was measured by the STA during DMG Beacon reception |
| $C$ | is the value of the PCP/AP Coverage Parameter subfield contained in the SSW field within the received DMG Beacon frame |
| $P_{min\_sensitivity}$ | is the receiver sensitivity for MCS 0 defined in Table 20-3 |

Otherwise if the above inequality is false, the EDMG STA may classify itself as a "Far" STA.

Figure 10-61e illustrates an example behavior used by an EDMG STA to classify itself as "Near" or "Far". After reception of a DMG Beacon frame from an EDMG PCP or EDMG AP that has a valid PCP/AP Coverage Parameter subfield in the SSW field, the EDMG STA checks inequality specified above. In case the inequality is true, EDMG STA classifies itself as a "Near" EDMG STA for this PCP/AP and decides to access the A-BFT or the DTI. In case the inequality is false, the EDMG STA classifies itself as a "Far" EDMG STA for this PCP or AP, and therefore it decides to skip the A-BFT and use asymmetric beamforming, if scheduled by the PCP or AP, to establish communication with the PCP or AP.

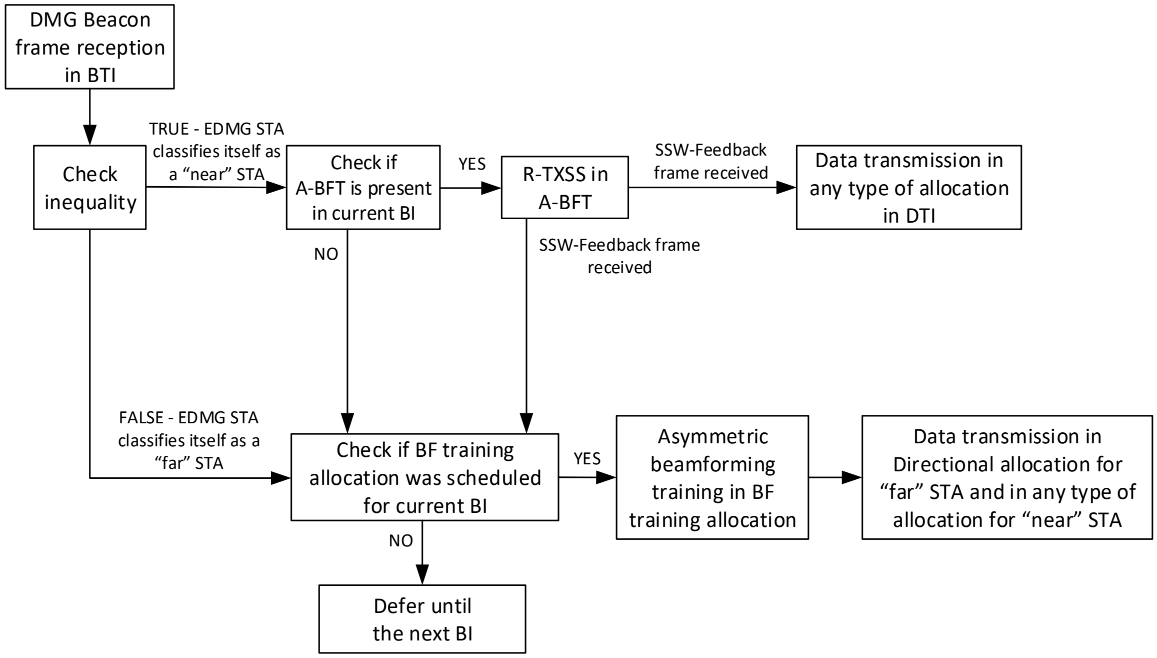


**Figure 10-61e—Example behavior for "Near-Far" self classification**

## 10.42 DMG beamforming

### 10.42.1 General

***Change the first paragraph in 10.42.1 as follows (Figure 10-67 remains unchanged):***

Beamforming (BF) is a mechanism that is used by a pair of STAs to achieve the necessary DMG link budget for subsequent communication. BF training is a bidirectional sequence of BF frame or Short SSW PPDU transmissions that uses sector sweep and provides the necessary signaling to allow each STA to determine appropriate antenna system settings for both transmission and reception. After the successful completion of BF training, BF is said to be established. A BF frame is an SSW frame, a DMG Beacon frame, an SSW-Feedback frame, an SSW-Ack frame or a BRP frame. Figure 10-67 gives an example of the beamforming training procedure.

***Insert the following paragraph into 10.42.1 after the first paragraph:***

Short SSW PPDUs are used between EDMG STAs. Unless otherwise specified, the rules applicable to transmission of SSW frames specified in this subclause are also applicable to transmission of Short SSW PPDUs.

***Insert the following paragraphs at the end of 10.42.1:***

A non-AP and non-PCP initiator or a non-AP and non-PCP unsolicited RSS responder may send an SPR frame to request a dynamic allocation of a service period to the AP or PCP to perform beamforming training. If either the initiator or the responder is an AP or a PCP and both initiator and responder are EDMG STAs that have an established control mode link between them, then the AP or PCP shall send a Grant frame to the responder (or the initiator of an unsolicited RSS). The non-AP and non-PCP STA shall respond with a Grant

Ack frame to the AP or PCP, as appropriate, to update the last negotiated Total Number of Sectors field and Number of RX DMG Antennas field with respect to each other before starting an SLS procedure in the same CBAP or SP.

If both the initiator and the responder are non-AP and non-PCP EDMG STAs, the initiator (or the responder of an unsolicited RSS) may send an SPR frame in a PPDU with the NUM_SECTORS and NUM_ANT parameters of TXVECTOR set to, respectively, the number of sectors of the I-TXSS (or R-TXSS if an unsolicited RSS) and the requested number of repetitions of the R-TXSS in the SLS to be performed. If the AP or PCP did not receive an SPR frame in a PPDU with a control trailer from the initiator (or the responder of an unsolicited RSS) immediately prior to a GP, the AP or PCP shall set the Number of RX DMG Antennas field to 1 and set the Total Number of Sectors field to the value indicated in the Total Number of Sectors field in the last DMG Capabilities element received from the initiator (or the responder of an unsolicited RSS) in a Grant frame transmitted to the responder (or the initiator of an unsolicited RSS) during the GP.

### 10.42.2 Sector-level sweep (SLS) phase

#### 10.42.2.1 General

***Insert the following paragraphs into 10.42.2.1 after the sixth paragraph ("During the SLS phase ...."):***

If an initiator uses SSW frames to perform the ISS, the responder shall use SSW frames to perform the RSS. If an initiator uses Short SSW PPDUs to perform the ISS, the responder shall use Short SSW PPDUs to perform the RSS.

A STA shall not transmit a Short SSW PPDU to another STA that is not an EDMG STA. A STA performing an ISS or an RSS using Short SSW PPDUs shall increase the value of the CDOWN field within the Short SSW PPDU by two for each LBIFS contained as part of a sector sweep.

An EDMG STA that supports reception of Short SSW PPDUs from unassociated STAs during CBAP allocations shall set the RX Unassociated Short SSW subfield in the Sector Sweep field to 1 within transmitted DMG Beacon frames.

***Change the now 13th paragraph in 10.42.2.1 as follows:***

Except when used to implement radar functionality as described in Annex AB, the following rules apply to a PPDU transmitted as part of a sector sweep:

- ~~A~~ The PPDU ~~frame~~ transmitted by a non-EDMG STA as part of a sector sweep does not include a TRN field ~~training fields~~. A non-EDMG STA shall set the TRN-LEN parameter of the TXVECTOR to 0 for a frame transmitted as part of a sector sweep.
- The PPDU transmitted by an EDMG STA as part of a sector sweep and that does not include a DMG Beacon does not also include a TRN field. An EDMG STA shall set the TRN-LEN parameter of the TXVECTOR to 0 for a frame transmitted as part of a sector sweep and that is not a DMG Beacon.

### 10.42.2.2 Initiator sector sweep (ISS)

#### 10.42.2.2.1 General

***Change the third and fourth paragraphs in 10.42.2.2.1 as follows:***

An initiator may employ ~~either~~ DMG Beacon frames, ~~or~~ SSW frames, or Short SSW PPDUs in the ISS. If the initiator begins an ISS with the transmission of a DMG Beacon frame, it shall use the DMG Beacon frame for all subsequent transmissions during the ISS. ~~Conversely, i~~If the initiator begins an ISS with the transmission of an SSW frame, it shall use the SSW frame for all subsequent transmissions during the ISS. If the initiator begins an ISS with the transmission of a Short SSW PPDU, it shall use the Short SSW PPDU for all subsequent transmissions during the ISS. A responder never begins an ISS.

The initiator shall set the Direction subfield in the Sector Sweep field to 0 within each DMG Beacon and SSW frame transmitted during an ISS. The initiator shall set the TXVECTOR parameter SSSW_DIR to Initiator within each Short SSW PPDU transmitted during an ISS.

***Insert the following paragraphs into 10.42.2.2.1 after the fourth paragraph:***

During a CBAP, an EDMG STA may obtain a TXOP with an unsolicited RSS by transmitting a Grant frame at the beginning of the TXOP or use an existing TXOP for an unsolicited RSS (see 10.42.6.2). If a TXOP is obtained through the transmission of a Grant frame and the TXOP holder intends to continue the TXOP with an unsolicited RSS, the TXOP holder shall set the Unsolicited RSS subfield in the Grant frame to 1 to indicate the SLS begins with an unsolicited RSS and is performed without an ISS.

If an SP is allocated with the Unsolicited RSS subfield in the BF Control field set to 1, the source STA shall set the Direction subfield in the SSW frame(s) to 1 to indicate the SLS begins with an unsolicited RSS and is performed without an ISS.

#### 10.42.2.2.2 Initiator TXSS

***Insert the following paragraph into 10.42.2.2.2 after the fourth paragraph ("During an initiator TXSS, ....."):***

An initiator that is not associated to the responder may transmit Short SSW PPDUs during the initiator TXSS if it has received a DMG Beacon frame from the responder with the RX Unassociated Short SSW subfield in the Sector Sweep field set to 1. In this case, in the Short SSW PPDU the initiator shall set the TXVECTOR parameter SSSW_ADD_MODE to IndividualAddr, SSSW_SOURCE_AID, and SSSW_DESTINATION_AID parameters to random values between [0, 255] and the SSSW_UNASSOCIATED parameter to 1. The values of the SSSW_SOURCE_AID and SSSW_DESTINATION_AID parameters shall not change between Short SSW PPDUs transmitted within the same initiator TXSS.

### 10.42.2.3 Responder sector sweep (RSS)

#### 10.42.2.3.1 General

***Change the third and fourth paragraphs in 10.42.2.3.1 as follows:***

The responder initiates an RSS with the transmission of an SSW frame if the preceding ISS was performed with at least one SSW frame~~, which is the only frame allowed during an RSS~~. The responder initiates an

RSS with the transmission of a Short SSW PPDU if the preceding ISS was performed with at least one Short SSW PPDU. If the ISS was performed in the BTI, the responder behaviour in the A-BFT is described in 10.42.5.2.

The responder shall set the Direction subfield in the Sector Sweep field to 1 within each SSW frame transmitted during an RSS. The responder shall set the TXVECTOR parameter SSSW_DIR to Responder within each Short SSW PPDU transmitted during an RSS.

### 10.42.2.3.2 Responder TXSS

***Insert the following paragraph into 10.42.2.3.2 after the third paragraph ("When the RXSS ...."):***

A responder that has transmitted a DMG Beacon frame with the RX Unassociated Short SSW subfield in the Sector Sweep field set to 1 and that receives a Short SSW PPDU as part of an ISS with the Direction field set to 0 and the Unassociated field set to 1 during the CBAP, shall initiate a responder TXSS using Short SSW PPDUs following the completion of the ISS. In this case, the responder shall set the Source AID field and Destination AID field in transmitted Short SSW PPDUs to the values of the Source AID field and Destination AID field, respectively, in the received Short SSW PPDUs during the ISS.

***Change the now eighth paragraph in 10.42.2.3.2 as follows:***

The responder shall set the Sector Select field and the DMG Antenna Select field in each transmitted SSW frame to the value of the Sector ID field and DMG Antenna ID field, respectively, of the frame received with the best quality during the ISS. The responder shall set the Short SSW Feedback field in each transmitted Short SSW PPDU to the value of the CDOWN field of the Short SSW PPDU that was received with the best quality during the preceding initiator TXSS. The determination of which frame is received with best quality is implementation dependent and beyond the scope of this standard. The responder shall set the SNR Report field in transmitted SSW frames to the SNR measured for the frame indicated by the Sector Select field and DMG Antenna Select field.

***Insert the following paragraph into 10.42.2.3.2 after the now ninth paragraph ("If the initiator ...."):***

If the initiator transmitted Short SSW PPDUs with the Unassociated field set to 1 during the ISS, it shall match the transmitted Source AID field and Destination AID field values with the received Source AID field and Destination AID field values, respectively, in the received Short SSW PPDUs during the RSS to determine if it is the intended recipient of the RSS.

### 10.42.2.4 Sector sweep (SSW) feedback

***Change the fourth paragraph in 20.42.2.4 as follows:***

When a responder TXSS comprising SSW frames was performed during the preceding RSS, the initiator shall set the Sector Select field and the DMG Antenna Select field in the SSW-Feedback frame it transmits to the value of the Sector ID field and DMG Antenna ID field, respectively, of the frame received with the best quality during the responder TXSS. The determination of which frame is received with the best quality is implementation dependent and beyond the scope of this standard. In addition, the initiator shall set the SNR Report field to the SNR measured for the frame received by the sector and DMG antenna indicated by the Sector Select field and DMG Antenna Select field. The SSW-Feedback frame shall be transmitted through the sector identified by the value of the Sector Select field and DMG Antenna Select field received from the responder during the preceding responder TXSS.

***Insert the following paragraph into 10.42.2.4 after the fourth paragraph:***

When a responder TXSS comprising Short SSW PPDUs was performed during the preceding RSS, the initiator shall transmit an SSW-Feedback frame through the sector identified by the value of the Short SSW Feedback field received from the responder during the responder TXSS. In the SSW-Feedback frame, the initiator shall set the EDMG Extension Flag subfield to 1, the Sector Select and Sector Select MSB subfields to represent the value of the CDOWN field within the Short SSW PPDU that was received with the best quality during the responder TXSS, and shall set the DMG Antenna Select and DMG Antenna Select MSB subfields to the value of the RF Chain ID field within the same Short SSW PPDU. The determination of which PPDU is received with the best quality is implementation dependent and beyond the scope of this standard, but should be based on the reception quality measured over the DMG antenna used to transmit the current SSW-Feedback frame. In addition, the initiator shall set the SNR Report field to the SNR measured for the PPDU received by the sector and DMG antenna indicated by the Sector Select, Sector Select MSB, DMG Antenna Select and DMG Antenna Select MSB subfields.

### 10.42.2.5 SSW ack

***Change the second paragraph in 10.42.2.5 as follows:***

When a responder TXSS is performed during an RSS, the responder shall transmit an SSW-Ack frame to the initiator to perform an SSW ack procedure. The SSW-Ack frame shall be transmitted through the sector identified by the value of the Sector Select field and the DMG Antenna Select field received from the initiator in the last SSW-Feedback frame if the RSS comprises SSW frames, and by the value of the Sector Select subfield, Sector Select MSB subfield, DMG Antenna Select subfield, and DMG Antenna Select MSB subfield received from the initiator in the last SSW-Feedback frame if the RSS comprises Short SSW PPDUs. If the RSS comprises Short SSW PPDUs, the Sector Select field and the Sector Select MSB field in the SSW-Ack frame shall be set to values corresponding to a sector from the same initiator DMG antenna that was used to transmit the preceding SSW-Feedback frame. The values should be based on the reception quality measured over the same DMG antenna used to transmit the current SSW-Ack frame and may correspond to a sector different from the sector indicated by the Short SSW Feedback field in Short SSW PPDUs transmitted during the RSS.

***Insert the following paragraph into 10.42.2.5 after the second paragraph:***

When an initiator TXSS comprising of Short SSW PPDUs with the Unassociated field set to 1 is performed during the ISS, the Sector Select subfield, Sector Select MSB subfield, DMG Antenna Select subfield and DMG Antenna Select MSB subfield in the SSW-Ack frame are ignored.

***Change the last paragraph in 10.42.2.5 as follows:***

If the RSS comprises SSW frames, a~~A~~t the start of an SSW ack procedure, the initiator should have its receive antenna array configured to a quasi-omni antenna pattern using the DMG antenna through which it received with the highest quality during the RSS, or the best receive sector if an RXSS has been performed during the RSS, and should not change its receive antenna configuration while it attempts to receive from the responder until the expected end of the SSW ack procedure. If the RSS comprises Short SSW PPDUs, at the start of an SSW ack procedure, the initiator should have its receive antenna array configured to a quasi-omni antenna pattern using the DMG antenna used to transmit the preceding SSW-Feedback frame.

### 10.42.3 Beam Refinement Protocol (BRP) phase

#### 10.42.3.1 General

***Insert the following paragraphs into 10.42.3.1 after the 9th paragraph ("A receive beam ...."):***

An EDMG STA may enable training of both TX and RX on the same PPDU by setting the TXVECTOR parameter EDMG_TRN_LEN to a value greater than 0 and the parameter RX_TRN_PER_TX_TRN to a value greater than one.

Prior to transmitting an EDMG PPDU on a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel, an EDMG STA may use the BRP phase described in this subclause or the BRP TXSS protocol defined in 10.42.10.5 to perform beamforming training over the channel.

***Change the title of Figure 10-72 as follows:***

**Figure 10-72—Example of beam refinement transaction outside of TDD SP allocation**

***Starting with the now 13th paragraph, change the remaining text of 10.42.3.1 as follows:***

A beam refinement response is separated from a preceding beam refinement request by at least a SIFS and at most a BRPIFS provided sufficient time is available for the complete transmission of those frames within the SP allocation that is not a TDD SP or TXOP. Similarly, a beam refinement request, if any, is separated from a preceding beam refinement response by at least a SIFS and at most a BRPIFS provided sufficient time is available for the complete transmission of the beam refinement request within the SP allocation that is not a TDD SP or TXOP.

An EDMG STA may send a beam refinement request to a peer EDMG STA with the EDMG-SHORT-BRP subfield within the BRP Request field set to 1. The peer EDMG STA shall send the response to this request separated by at least SIFS and at most MBIFS from the reception of the request. In this case, the response shall also have the EDMG-SHORT-BRP subfield within the BRP Request field set to 1.

In a TDD SP, a non-AP and non-PCP STA transmits a beam refinement response to a preceding beam refinement request from an AP or PCP in the earliest occurring TDD slot the non-AP and non-PCP STA is assigned to, with access permission of the TDD slot set to simplex RX TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.282).

In a TDD SP, an AP or PCP transmits a beam refinement response to a preceding beam refinement request from a non-AP and non-PCP STA in the earliest occurring TDD slot the non-AP and non-PCP STA is assigned to, with access permission of the TDD slot set to simplex TX TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.282).

When performing BRP outside a TDD SP allocation, if a responding STA requires longer than SIFS to transmit a BRP frame as a response for beam refinement training request from a requesting STA, the responding STA should keep the IFS not longer than SIFS by transmitting one or more PPDUs to the requesting STA.

When the beam refinement occurs within the same allocation as the SLS, the SLS initiator is the beam refinement initiator. If the beam refinement occurs in a separate allocation, the STA that transmits the first beam refinement request is the beam refinement initiator. The other STA is the beam refinement responder.

A beam refinement transaction is complete when one of the following conditions is met:

a) The initiator determines that it does not need further training and it has received a BRP frame with no training requests from the beam refinement responder.

b) When performing BRP outside of a TDD SP allocation, a~~A~~ duration equal to BRPIFS plus aSlotTime has elapsed since the last transmission from the beam refinement initiator to the refinement responder without a response from the beam refinement responder.

c) When performing BRP in a TDD SP allocation, a response from the beam refinement responder is not received in the earliest occurring TDD slot that allows for its transmission.

In Figure 10-72, the first PPDU (from the initiator) has TX-TRN-REQ=1, the L-RX field has a value greater than 0 and TRN-T subfields are appended to the PPDU. The second PPDU (from the responder) has a value greater than 0 in the L-RX field, the TX-train-response field set to 1, the RX-train-response field set to 1, and TRN-R subfields are appended to the PPDU. The last PPDU (from the initiator) has RX-train-response set to 1 and TRN-R subfields are appended to the PPDU.

### 10.42.4 Beamforming in BTI

***Change 10.42.4 (including inserting Figure 10-74a and Figure 10-74b) as follows:***

In the BTI, the AP or PCP performs an initiator TXSS as the first part of the SLS with the transmission of at least one DMG Beacon frame. The AP or PCP does not transmit SSW frames in the BTI (10.42.2.2.1).

The AP or PCP may fragment the initiator TXSS over multiple consecutive BTIs by not transmitting a DMG Beacon frame through all sectors available to the AP or PCP in a single BTI. In a BTI with a fragmented initiator TXSS, the AP or PCP shall transmit DMG Beacon frames with the Fragmented TXSS field set to 1. Otherwise, the AP or PCP shall set the Fragmented TXSS field to 0. The AP or PCP shall not change the duration of the next BTI if at least one of the DMG Beacon frames transmitted in the current BTI have the Fragmented TXSS field set to 1. The CDOWN field shall be set to the total number of transmissions remaining to the end of the initiator TXSS, such that the last DMG Beacon frame transmission of the initiator TXSS has the CDOWN field set to 0 (i.e., in a fragmented TXSS, the value of the CDOWN field covers the total number of transmissions remaining in the fragmented TXSS). The TXSS Span field shall be set to the total number of beacon intervals it takes the AP or PCP to complete the entire TXSS phase.

The Duration field within each transmitted DMG Beacon frame shall be set to the time remaining until the end of the current BTI, except in an EDMG BSS if the value of the Next A-BFT subfield is equal to 0 and the value of the A-BFT Multiplier subfield is greater than 0 in the transmitted DMG Beacon frame. In this case, the value of the Duration field shall be set to the time remaining until the end of the transmission of the last DMG Beacon frame in the BTI plus MBIFS plus the duration equivalent to the multiplication of the value of the A-BFT Length subfield and the value of the A-BFT Multiplier subfield. In the latter case, the duration of the BTI covers DMG Beacon transmissions and the additional SSW slots that are present in the A-BFT (see 10.42.5).

When an AP or PCP has more than one DMG antenna, the TXSS shall cover all of the sectors in all DMG antennas. The TXSS Span field indicates the total number of beacon intervals it takes the AP or PCP to cover all sectors in all DMG antennas. The value of the TXSS Span field shall be lower than dot11MaximalSectorScan.

A ~~The~~ non-EDMG AP or non-EDMG PCP, or an EDMG AP or EDMG PCP with a single RF chain, shall not change DMG antennas within a BTI. For an EDMG AP or EDMG PCP having multiple RF chains, the EDMG AP or EDMG PCP may switch from one RF chain to another RF chain within a BTI. The set of DMG antennas that are used for DMG Beacon transmission in a BTI form a DMG antenna group. The EDMG AP or EDMG PCP shall not change DMG antennas for the RF chains used within a BTI.

Figure 10-74a shows an example of an EDMG AP or EDMG PCP using a DMG antenna group consisting of DMG antenna 0 and 1 in the BTI and the A-BFT of a first beacon interval, and using another DMG antenna group consisting of DMG antenna 2 and 3 in the BTI and the A-BFT of the following beacon interval.

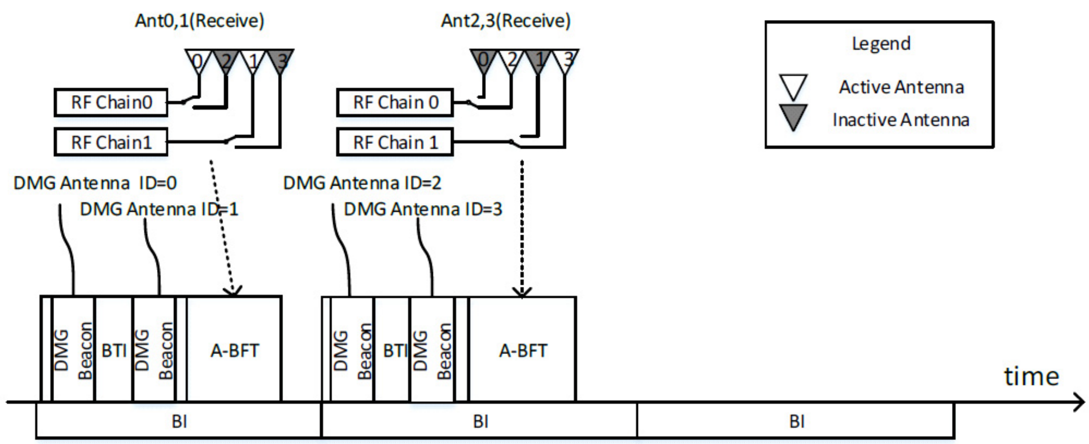


**Figure 10-74a—Example of use of multiple DMG antennas during BTI and A-BFT**

The AP or PCP has a regular schedule of transmitting through each DMG antenna (see 10.42.5.4).

NOTE—If an unassociated responder receives a DMG Beacon frame in the BTI with a fragmented initiator TXSS, the responder may start a responder TXSS in the following A-BFT or can perform beamforming training for asymmetric links in a subsequent allocation (see 10.42.10.3). Alternatively, the responder ~~or it~~ may scan for the number of beacon intervals indicated in a received TXSS Span field in order to cover a complete initiator TXSS and find a suitable TX sector from the AP or PCP to start a responder TXSS or beamforming training for asymmetric links.

Each subfield in the Beacon Interval Control field and DMG Parameters field of each DMG Beacon frame transmitted by the AP or PCP shall retain the same value from start to completion of a TXSS phase.

A PPDU containing a DMG Beacon frame transmitted by an EDMG STA may include TRN-R subfields within the TRN field of the PPDU to enable receive training by an EDMG STA receiving the DMG Beacon. Figure 10-74b depicts an example of how an EDMG STA receiving such a DMG Beacon may use the TRN field appended to a DMG Beacon frame to perform receive beamforming. Although inclusion of TRN-R subfields within a PPDU does not require prior scheduling, the EDMG STA transmitting the DMG Beacon may announce the presence of TRN-R subfields in a subsequent BTI by transmitting an EDMG Training Field Schedule element in DMG Beacon, Announce, Probe Response or Association Response frames.

An EDMG STA may set the TRN-LEN parameter of the TXVECTOR of a PPDU containing a DMG Beacon frame to a value greater than or equal to 0 if the PPDU_TYPE parameter of the TXVECTOR is set to TRN-R. The PPDU_TYPE parameter of the TXVECTOR of a PPDU containing a DMG Beacon frame shall not be set to TRN-T.

If a DMG Beacon frame is transmitted by an EDMG STA using a quasi-omni antenna pattern, the Quasi-omni TX subfield in the Sector Sweep field in the frame shall be set to 1. An EDMG STA may append receive training (TRN-R) subfields to DMG Beacon frames transmitted with the Quasi-omni TX subfield in the Sector Sweep field set to 1 to enable receive training and, subsequently, selection of a transmit sector by a receiving STA that supports antenna reciprocity or antenna pattern reciprocity. Antenna reciprocity and antenna pattern reciprocity are indicated by setting the DMG Antenna Reciprocity field and Antenna Pattern Reciprocity field in the DMG Capabilities element to 1, respectively.

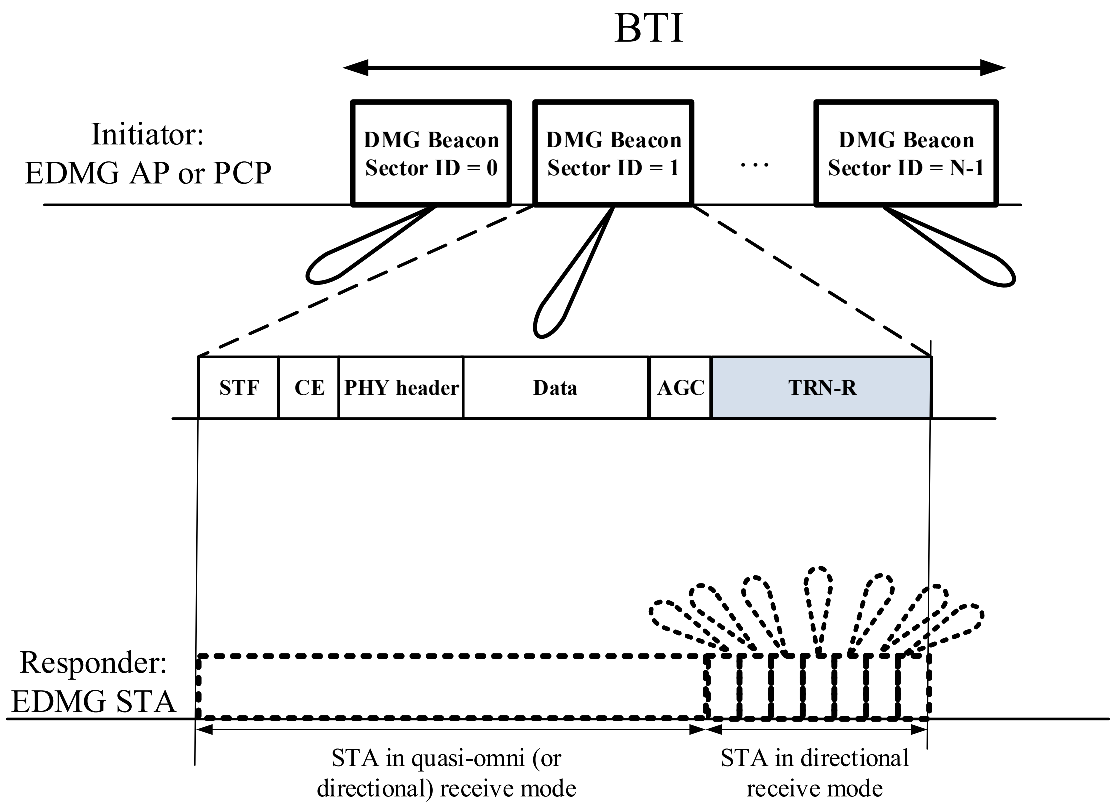


**Figure 10-74b—Receive beamforming training during the BTI through the use of TRN-R fields**

### 10.42.5 Beamforming in A-BFT

#### 10.42.5.1 Allocation of A-BFT

***Insert the following paragraphs at the end of 10.42.5.1:***

When allocating an A-BFT over the primary channel, an EDMG PCP or EDMG AP may also allocate an A-BFT over a secondary channel. This is indicated by the A-BFT in Secondary Channel subfield in the Beacon Interval Control field of a DMG Beacon frame. The A-BFT allocated over the secondary channel has the same start time, length and SSW slot configuration as the A-BFT allocated on the primary channel and signaled through the Beacon Interval Control field of the DMG Beacon frame. An EDMG STA may access the A-BFT allocated over a secondary channel and, in this case, shall use the same access rules specified in this subclause.

An EDMG AP or EDMG PCP that transmits a DMG Beacon frame with the value of the A-BFT in Secondary Channel subfield set to a nonzero value shall be capable of simultaneously receiving SSW frames transmitted by EDMG STAs during the corresponding A-BFT on the primary and adjacent secondary channels and, in response, shall be capable of simultaneously transmitting SSW-Feedback frames on the primary and adjacent secondary channels using the same sector of the same DMG antenna as indicated in the SSW frame(s) received within the same SSW slot.

To accommodate a larger number of STAs attempting access during the A-BFT, the number of SSW slots available to EDMG STAs in an A-BFT can be increased compared to what is available to non-EDMG STAs. The presence of additional SSW slots is indicated through the A-BFT Multiplier subfield in the Beacon Interval Control field in a DMG Beacon frame. When the A-BFT Multiplier field is nonzero and the Next A-BFT field is 0, an EDMG STA subtracts (A-BFT Multiplier × A-BFT Length) from the value of the Duration field of the received DMG Beacon frame to determine the start time of the additional SSW slots available to the EDMG STA. These additional SSW slots are then immediately followed by the SSW slots available to both EDMG and non-EDMG STAs, which is indicated by the value of the A-BFT Length field. Thus, from an EDMG STA's perspective, the A-BFT contains A-BFT Length × (1 + A-BFT Multiplier) SSW slots.

### 10.42.5.2 Operation during the A-BFT

***Insert the following paragraph into 10.42.5.2 after the second paragraph ("In the A-BFT, the AP ...."):***

In all cases, a DMG STA may use SSW frames to perform an RSS during the A-BFT. If the BSS is an EDMG BSS and if the STA is associated with the BSS, an EDMG STA may use Short SSW PPDUs (see 28.9.1) instead of SSW frames to perform an RSS during the A-BFT. When using Short SSW PPDUs, an EDMG STA can transmit more Short SSW PPDUs within an SSW slot compared to when SSW frames are used.

***Change the now sixth paragraph (including inserting Table 10-30a) in 10.42.5.2 as follows:***

The A-BFT is slotted and the length of the A-BFT is an integer multiple of the sector sweep slot time. The structure of the A-BFT when SSW frames are used is shown in Figure 10-75. The structure of the A-BFT when Short SSW PPDUs are used is shown in Figure 10-75a. ~~The~~ A non-EDMG AP or non-EDMG PCP shall announce the size of the A-BFT in the A-BFT Length subfield of the Beacon Interval Control field (9.3.4.2), while an EDMG AP or EDMG PCP shall also use the A-BFT Multiplier subfield of the Beacon Interval Control field. The first SSW slot begins at the start of the A-BFT, and the following SSW slots are adjacent and nonoverlapping. An SSW slot (Figure 10-76) is a period of time within the A-BFT that can be used by a responder to transmit at least one SSW frame. An SSW slot has a duration of aSSSlotTime. aSSSlotTime is defined to be

aSSSlotTime = aAirPropagationTime + aSSDuration + MBIFS + aSSFBDuration + MBIFS

where

| | |
|---|---|
| aAirPropagationTime | accounts for the propagation delay between the initiator and the responder |
| aSSDuration ~~(11.37)~~ | provides, if the STA transmits SSW frames in the A-BFT, time for a responder to transmit up to the number of SSW frames announced in the FSS subfield of the Beacon Interval Control field in the DMG Beacon (see 11.37); otherwise, if the STA transmits Short SSW PPDUs in the A-BFT, the number of Short SSW PPDUs the STA may transmit is a function of the value of the FSS subfield of the Beacon Interval Control field in the DMG Beacon as indicated by Table 10-30a |
| aSSFBDuration | provides time for the initiator to perform an SSW feedback procedure (see 11.37) |

**Table 10-30a—Number of Short SSW PPDUs as a function of the FSS subfield value**

| Value of the FSS subfield | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Short SSW PPDUs | 1 | 3 | 4 | 6 | 8 | 9 | 11 | 12 | 14 | 16 | 17 | 19 | 21 | 22 | 24 | 25 |

***Change the title of Figure 10-75 as follows:***

**Figure 10-75—A-BFT structure when SSW frames are used**

***Insert Figure 10-75a into 10.42.5.2 after Figure 10-75:***

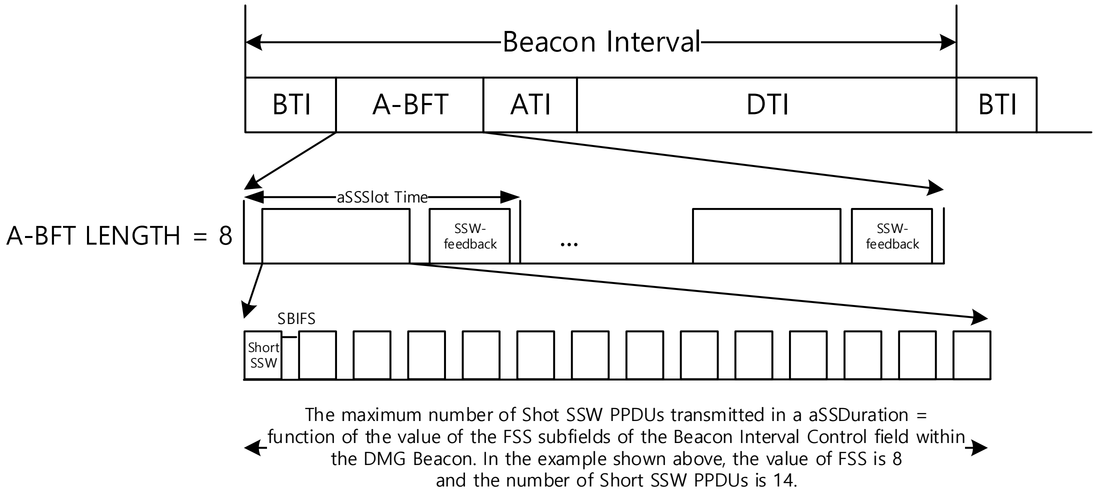


**Figure 10-75a—A-BFT structure when Short SSW PPDUs are used**

***Change the now ninth paragraph in 10.42.5.2 as follows (including splitting the paragraph into two paragraphs) (Figure 10-76 remains unchanged):***

At the start of each A-BFT, the responder(s) shall invoke a random backoff procedure to initiate or resume an RSS as follows. If either the initiator or the responder is a non-EDMG STA, t~~T~~he random backoff procedure begins at the start of the A-BFT with the responder selecting a backoff count as a random integer drawn from a uniform distribution [0, A-BFT Length), i.e., 0 to A-BFT Length – 1, where A-BFT Length is the value of the A-BFT Length field in the last received DMG Beacon. If both the initiator and the responder are EDMG STAs, the random backoff procedure begins at the start of the A-BFT with the responder:

— Selecting a single 2.16 GHz channel where the A-BFT is present based on the value of the A-BFT in Secondary Channel subfield in the last received DMG Beacon. Any frame transmission between the initiatior and responder during the A-BFT shall be performed using the selected channel.
— Selecting a backoff count as a random integer drawn from a uniform distribution [0, A-BFT Length + A-BFT Length × A-BFT Multiplier), i.e., 0 to A-BFT Length + A-BFT Length × A-BFT Multiplier – 1, where A-BFT Length and A-BFT Multiplier are the values of the A-BFT Length and A-BFT Multiplier fields, respectively, in the last received DMG Beacon.

The responder shall decrement the backoff count by one at the end of each SSW slot, even if the CS function at the responder indicates the medium busy condition for that SSW slot. The responder may initiate the RSS only at the start of the SSW slot for which the backoff count is 0 at the beginning of the SSW slot. See Figure 10-76.

***Change the now 12th paragraph in 10.42.5.2 as follows (including splitting the paragraph into two paragraphs):***

For a non-EDMG AP or a non-EDMG PCP or if the A-BFT in Secondary Channel subfield is 0, t~~T~~he initiator shall initiate an SSW feedback procedure to a responder (10.42.2.4) at a time such that the beginning of the first symbol of the SSW-Feedback frame on the WM occurs at aSSFBDuration + MBIFS before the end of the SSW slot. If the A-BFT in Secondary Channel subfield is set to a nonzero value and an EDMG AP or EDMG PCP received SSW frames transmitted from different EDMG STAs on the primary channel and/or adjacent secondary channel(s) with the same Sector ID and the DMG Antenna ID subfield values, the initiator shall initiate an SSW feedback procedure to the responder(s) on the corresponding primary channel and/or adjacent channel(s) at a time such that the beginning of the first symbol of the SSW-Feedback frame(s) on the WM occurs at aSSFBDuration + MBIFS before the end of the SSW slot. If the A-BFT in Secondary Channel subfield is set to a nonzero value and an EDMG AP or EDMG PCP received SSW frame(s) transmitted from different EDMG STAs on the primary channel and/or adjacent secondary channel(s) with different Sector ID or DMG Antenna ID subfield values, the initiator shall initiate an SSW feedback procedure to the responder on the primary channel at a time such that the beginning of the first symbol of the SSW- Feedback frame on the WM occurs at aSSFBDuration + MBIFS before the end of the SSW slot, and/or should initiate the SSW feedback procedure to the responder(s) on the adjacent secondary channel(s) at a time such that the beginning of the first symbol of the SSW-Feedback frame on the WM occurs at aSSFBDuration + MBIFS before the end of the next available SSW slot (s).

A responder that transmitted at least one SSW frame or Short SSW PPDU within an SSW slot should ~~shall~~ be in quasi-omni receive mode for a period of aSSFBDuration ending MBIFS before the end of the SSW slot. The initiator may initiate an SSW feedback procedure to the responder at an SSW slot even if the responder did not complete RSS within that SSW slot. If the initiator transmits an SSW-Feedback under this circumstance, it can transmit an Announce frame to the responder in an ATI. Following the reception of the Announce frame, the responder can respond with an SPR frame requesting time for the responder to continue with the RSS. Alternatively, the responder can transmit an SPR frame to the AP or PCP in accordance with the channel access rules.

***Change the now 16th paragraph in 10.42.5.2 as follows (including splitting the paragraph into two paragraphs):***

The responder may attempt to restart the RSS within the same A-BFT if it does not receive an SSW-Feedback frame from the initiator by the end of the SSW slot in which it completes the RSS. To do this, the responder shall invoke the random backoff procedure beginning at the start of the SSW slot following the completion of the RSS. If either the initiator or the responder is a non-EDMG STA, t~~T~~he responder shall select a backoff count as a random integer drawn from a uniform distribution [0, A-BFT Length), i.e., 0 to A-BFT Length – 1, where A-BFT Length is the value of the A-BFT Length field in the last received DMG Beacon. If both the initiator and the responder are EDMG STAs, the random backoff procedure begins at the start of the A-BFT with the responder:

— Selecting a single 2.16 GHz channel where the A-BFT is present based on the value of the A-BFT in Secondary Channel subfield in the last received DMG Beacon. Any frame exchange between the initiator and responder during the A-BFT shall be performed using the selected channel.
— Selecting a backoff count as a random integer drawn from a uniform distribution [0, A-BFT Length + A-BFT Length × A-BFT Multiplier), i.e., 0 to A-BFT Length + A-BFT Length × A-BFT Multiplier – 1, where A-BFT Length and A-BFT Multiplier are the values of the A-BFT Length and A-BFT Multiplier fields, respectively, in the last received DMG Beacon.

The responder shall decrement the backoff count by one at the end of each SSW slot, even if the CS function at the responder indicates the medium busy condition for that SSW slot. The responder may restart the RSS at the start of the SSW slot for which the backoff count is 0 at the beginning of the SSW slot provided the A-BFT still has SSW slots available.

***Change the now 19th paragraph in 10.42.5.2 as follows:***

Each STA maintains a counter, FailedRSSAttempts, of the consecutive number of times the STA initiates RSS during A-BFTs but does not successfully receive an SSW-Feedback frame as a response. If FailedRSSAttempts exceeds ~~dot11~~RSSRetryLimit, the STA shall select a backoff count as a random integer drawn from a uniform distribution [0, ~~dot11~~RSSBackoff), i.e., 0 to ~~dot11~~RSSBackoff – 1. For a non-EDMG STA the value of RSSRetryLimit is equal to dot11RSSRetryLimit and the value of RSSBackoff is equal to dot11RSSBackoff, and for an EDMG STA the value of RSSRetryLimit is equal to the value of the RSS Retry Limit subfield in the last received EDMG Operation element and the value of RSSBackoff is equal to the value the RSS Backoff subfield in the last received EDMG Operation element. The responder shall decrement the backoff count by one at the end of each A-BFT period in the following beacon intervals. The responder may re-initiate RSS only during an A-BFT when the backoff count becomes zero. The STA shall set FailedRSSAttempts to 0 upon successfully receiving an SSW-Feedback frame during the A-BFT.

### 10.42.5.4 Beamforming in A-BFT with multiple DMG antennas

***Change 10.42.5.4 as follows:***

A~~n~~ non-EDMG AP or non-EDMG PCP, or an EDMG AP or EDMG PCP that used one RF chain in the last BTI, shall receive through a quasi-omni antenna pattern from a single DMG antenna throughout an A-BFT unless RXSS is used in the A-BFT, in which case it switches through antenna patterns as described in 10.42.5.2. An EDMG AP or EDMG PCP that used multiple RF chains to transmit DMG Beacon frames in the last BTI shall simultaneously receive throughout the A-BFT with a quasi-omni antenna pattern from each DMG antenna used in the last BTI.

An AP or PCP shall have an A-BFT every *k* beacon intervals, where *k* is the value indicated by the N BIs A-BFT subfield in the Beacon Interval Control field. In an A-BFT, the non-EDMG AP or non-EDMG PCP, or an EDMG AP or EDMG PCP with one or multiple DMG antennas but that used one RF chain in the last BTI, shall receive in a quasi-omni antenna pattern using the DMG antenna indicated by the value of the DMG Antenna ID subfield within the SSW field transmitted in the DMG Beacon. A~~n~~ non-EDMG AP or non-EDMG PCP, or an EDMG AP or EDMG PCP having a single RF chain, with multiple DMG antennas has a regular schedule of receiving through each DMG antenna corresponding to the DMG antenna in which a DMG Beacon frame is transmitted through. The AP or PCP shall switch RX DMG antenna every *l* allocations, where *l* is the value of the N A-BFT in Ant subfield within the Beacon Interval Control field.

In an A-BFT, an EDMG AP or EDMG PCP that used multiple RF chains and the same number of DMG antennas within one DMG antenna group in the last BTI shall receive in a quasi-omni antenna pattern through each DMG antenna indicated by the values of the DMG Antenna ID subfields within the Sector Sweep fields transmitted in one or multiple DMG Beacon frames during the last BTI. DMG Beacon frames transmitted from different DMG antennas have different values in their DMG Antenna ID subfields. An EDMG AP or EDMG PCP having multiple RF chains and multiple DMG antenna groups has a regular schedule of receiving through each DMG antenna group corresponding to the DMG antennas in which a DMG Beacon frame is transmitted through. The EDMG AP or EDMG PCP with multiple RF chains shall switch RX DMG antenna group every *l* allocations, where *l* is the value of the N A-BFT in Ant subfield within the Beacon Interval Control field.

In each DMG Beacon, the A-BFT Count subfield in the Beacon Interval Control field indicates the number of A-BFTs that have passed since the AP or PCP last switched RX DMG antennas.

### 10.42.6 Beamforming in DTI

#### 10.42.6.2 SLS phase execution

***Insert the following text and Figure 10-76a at the end of 10.42.6.2, and change the note earlier in this subclause to "NOTE 1":***

An EDMG STA that is a TXOP holder or is an SP source may transmit SSW frame(s) with the Direction subfield set to 1 and the RA field set to the TA field of an SSW frame that the STA received with the Unsolicited RSS Enabled field set to 1.

NOTE 2—If a TXOP holder or source STA of an SP transmits SSW frames with the Direction field set to 1 at the beginning of a TXOP or SP, respectively, the STA is considered as the responder for an ISS or RSS that occurred in an earlier BTI, TXOP or SP. The EDMG STA performing the ISS or RSS in the earlier BTI, TXOP or SP is considered as the initiator for the subsequent unsolicited RSS.

If an EDMG STA receives a DMG Beacon or SSW frame from an EDMG STA with the Unsolicited RSS Enabled subfield equal to 1, the STA may process the received DMG Beacon or SSW frames as a responder even if the A-BFT is not present for the case of a received DMG Beacon frame, or even if the STA's MAC address does not match the RA field for the case of a received SSW frame. The STA may then perform an RSS with the initiator in response to the received SSW frames in a subsequent TXOP or SP. This is known as an unsolicited RSS.

If an EDMG STA receives a DMG Beacon or SSW frame with the Unsolicited RSS Enabled subfield equal to 1 and if, as a result, an unsolicited RSS is performed, the EDMG STA shall complete the unsolicited RSS within the same beacon interval in which the DMG Beacon or SSW frame was received.

An EDMG STA shall not perform an unsolicited RSS in response to a DMG Beacon or SSW frame with the Unsolicited RSS Enabled subfield equal to 0.

An unsolicited RSS takes place when all of the following conditions are met:

a) A first EDMG STA transmits a DMG Beacon or SSW frame with the Unsolicited RSS Enabled subfield set to 1; and
b) Following the transmission of a DMG Beacon or SSW frame with the Unsolicited RSS Enabled subfield set to 1, the first EDMG STA receives an SSW frame from a second EDMG STA that is not a response to an immediately preceding ISS or RSS and that has the Direction field equal to 1 and the RA field equal to the first STA's MAC address; and
c) In the case the first STA transmitted an SSW frame in condition a), the second STA that transmitted the SSW frame identified in condition b) is different from the STA addressed by the SSW frame transmitted by the first STA in condition a).

An EDMG STA that receives an unsolicited RSS shall perform an SSW Feedback as specified in 10.42.2.4.

An EDMG STA that transmitted an unsolicited RSS shall wait for MBIFSTimeout interval, which has a value of MBIFS + aSlotTime + aRxPHYStartDelay, starting at the PHY-TXEND.confirm primitive of the last SSW frame transmitted as part of the unsolicited RSS. If a PHY-RXSTART.indication primitive does not occur during the MBIFSTimeout interval, the STA concludes that the unsolicited RSS failed and may initiate an ISS to the STA to which the unsolicited RSS was transmitted.

Figure 10-76a shows an example of an unsolicited RSS. STA A that performs an ISS or RSS with STA C sets the Unsolicited RSS Enabled subfield to 1 to indicate it is operating as an initiator corresponding to a potential unsolicited RSS in a subsequent TXOP or SP. STA B (TXOP holder or source STA of the SP) transmitting SSW frames with the Direction subfield set to 1 at the beginning of a TXOP or SP (e.g., TXOP2 or SP2) is considered as the responder of STA A for the ISS or RSS in the earlier BTI, TXOP or SP (e.g., TXOP1 or SP1). In the TXOP2 or SP2, if an SSW frame with the Direction subfield set to 1 is received, STA A operates as the initiator and responds with an SSW-Feedback frame without performing an ISS.

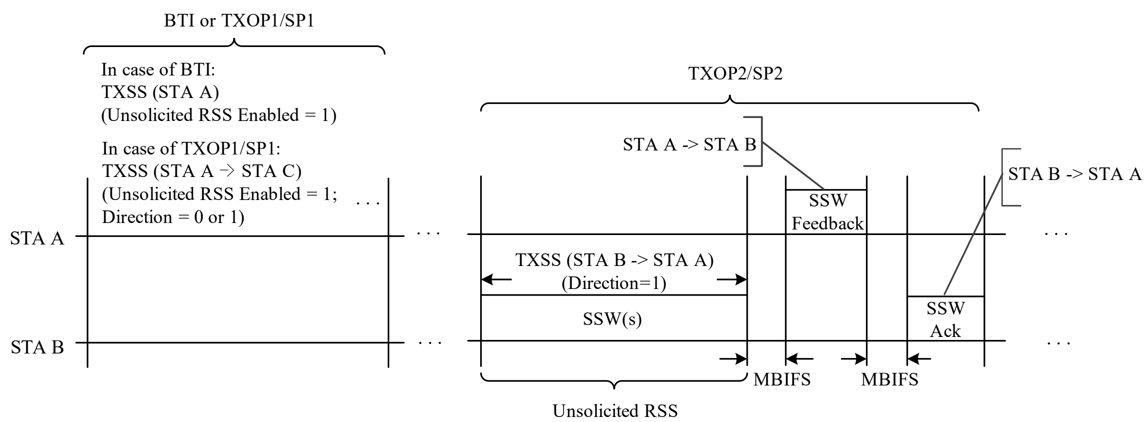


**Figure 10-76a—Example of unsolicited RSS**

### 10.42.6.3 Multiple sector ID capture (MIDC) subphase

#### 10.42.6.3.3 MIDC subphase with MID subphase only

***Change item b) in the lettered list in 10.42.6.3.3 as follows:***

b) *Executing the MID subphase*: The execution of the MID subphase for the responder link (i.e., R-MID) is used as an example. Execution of the MID subphase for the initiator link (i.e., I-MID) is similar, except for a change in the direction of the corresponding frames. In an R-MID subphase, the responder shall transmit one BRP-RX PPDU each from one of the chosen TX sectors. In each PPDU, it shall indicate the sector ID of the TX sector used using the Sector ID field in the BRP Request field. Each transmitted BRP-RX PPDU should be appended with multiple TRN-R subfields such that the initiator can train its receiver antenna during the R-MID subphase. The initiator shall train its receiver antenna by cycling through its choice of RX AWVs while receiving the TRN-R subfields. The initiator shall indicate to the responder the number of TRN-R subfields to be appended using the L-RX field in the BRP Request field during the SLS phase or the BRP setup subphase. For all BRP-RX PPDUs except the last one, the responder shall also set the MID Extension field to 1. An EDMG responder, responding to an EDMG initiator, may choose to use a single PPDU for training during the MID phase by setting the TXVECTOR parameter EDMG_TRN_LEN to a value greater than 0 and the parameter RX_TRN_PER_TX_TRN to a value equal to the value of the L-RX subfield transmitted during the last SLS phase or last BRP setup subphase, whichever is later. The EDMG responder shall then transmit through a list of chosen sectors during the TRN field of the transmitted PPDU. For each of the responder's TX sector, the initiator shall perform RX AWV training. In the feedback, the initiator shall set the BS-FBCK and BS-FBCK MSB fields to the AWV ID rather than the sector ID, where the first TX sector has AWV ID equal to 0.

In the R-MID subphase, the initiator shall send a BRP frame with feedback. This BRP frame should be sent using the best TX sector as determined in the SLS phase, while the responder should use a quasi-omni pattern to receive this frame. The feedback included in this BRP frame should be (i) the BS-FBCK field set to the TX sector ID or the AWV ID (if an EDMG BRP-TX or EDMG BRP-RX/TX PPDU was used) of the ~~BRP-RX PPDU received with the highest link quality~~ sector or AWV received with the best quality, and (ii) the ordered list of transmit sectors (based on received link quality during the R-MID) using the Sector ID Order subfield. An EDMG STA returns the ordered list in the EDMG Sector ID Order field.

### 10.42.6.4 BRP phase execution

#### 10.42.6.4.1 General

***Insert the following text into 10.42.6.4.1 after the third paragraph ("The responding STA ...."):***

An EDMG STA responding to a transmit beam refinement training request in which the EDMG-SHORT-BRP subfield was 0 may respond within MBIFS with a BRP frame in which the Comeback Delay field in the EDMG BRP Request element is set to a nonzero value. This indicates that the STA is not ready with the feedback within BRPIFS from the request. The value in the Comeback Delay field indicates when the responding STA is ready. The requesting STA may send a BRP frame with a feedback request that contains no training requests and that has the same dialog token as the frame that originally solicited the response after the comeback delay has elapsed; in this case, the responding STA shall respond with feedback within MBIFS. If the TXOP or SP ended before the comeback delay elapsed, the responder may send the feedback in a BRP frame as part of another TXOP or SP. The dialog token within the feedback frame shall be the same as in the BRP frame soliciting the response.

An EDMG STA responding to a transmit beam refinement training request in which the EDMG-SHORT-BRP subfield was 1 shall respond within MBIFS with a BRP frame that has the EDMG-SHORT-BRP subfield set to 1 and the EDMG-SHORT-FBCK subfield set to 1. The number of valid AWV feedback IDs ($N_{AID}$) in the Short BRP Feedback field shall comply with the following equation:

$$N_{AID} = \begin{cases} 16 & P \geq 16 \\ P & P < 16 \end{cases}$$

where

$$P = \sum_{k=1}^{K} L_k \times \frac{M_k}{N_k} \times T_k$$

| | |
|---|---|
| $L_K$, $M_K$, $N_K$, and $T_k$ | are the values of the EDMG_TRN_LEN, EDMG_TRN_M, EDMG_TRN_N and NUM_TX_CHAINS parameters, respectively, in the RXVECTOR of the $k^{th}$ EDMG BRP PPDU of the TXSS |
| $K$ | is the total number of EDMG BRP PPDU received in the BRP TXSS or BRP-TX |

If $N_{AID}$ < 16, the (16 – $N_{AID}$) Sector Measurement subfields of the Short BRP Feedback field shall be denoted as invalid by setting the SNR subfield to 0xFF as defined in 9.5.8.

***Starting with the now 10th paragraph, change the remaining text of 10.42.6.4.1 as follows:***

<u>In a beam refinement transaction outside of a TDD SP allocation, a</u> ~~A~~ STA that has transmitted a BRP frame with the Initiator field set to 1 and has not received a response BRPIFS after the transmission may retransmit the frame.

<u>In a beam refinement transaction in a TDD SP allocation, a STA that has transmitted a BRP frame with the Initiator field set to 1 and has not received a response in the earliest occurring TDD slot the STA is assigned to, with access permission of the TDD slot set to simplex TX TDD slot, and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element, after the transmission may retransmit the frame, according to the TDD channel access rules (see 10.39.6.2.2).</u>

A STA may request a TXSS sector list feedback by sending a BRP frame with the TXSS-FBCK-REQ field set to 1, the SNR Requested subfield within the FBCK-REQ field set to 1 and the remaining subfields within the FBCK-REQ field set to 0. The responding STA shall respond with a BRP frame with the SNR Present subfield within the FBCK-TYPE field set to 1 and Sector ID Order Present subfield set to 1, with a list of sector IDs indicating the sector IDs of the received SSW frames or DMG Beacon frames, and with the SNR values with which those frames were received in the last TXSS. The Number of Measurements subfield in the FBCK-TYPE field is set to indicate the number of sectors received during the last SLS for which an SNR measurement is included.

An EDMG STA may request a TXSS sector list feedback from a peer EDMG STA by sending a BRP frame with the BF Training Type field set to 0, the TXSS-FBCK-REQ field set to 1, the SNR Requested subfield within the FBCK-REQ field set to 1 and the remaining subfields within the FBCK-REQ field set to 0. The responding EDMG STA shall respond with a BRP frame with the BF Training Type field set to 0, the SNR Present and Sector ID Order subfields within the FBCK-TYPE field set to 1, the EDMG Extension Flag field set to 1 and the EDMG Channel Measurement Present field set to 1. In the EDMG Sector ID Order field, the SISO IDs indicate the sector IDs/CDOWN/AWV IDs, TX antennas and RX antennas of sectors that were used for reception in the last TXSS. The SNRs subfield in the Channel Measurement Feedback field indicates the SNRs on the sectors used for reception. The last TXSS may have been performed using DMG Beacon frames, SSW frames, Short SSW PPDUs or BRP-TX PPDUs. If the last TXSS was performed using BRP-TX PPDUs:

— The BRP-CDOWNs associated with each SISO ID indicate the BRP-CDOWN of the received BRP-TX PPDU.
— The Number of Measurements subfield of the FBCK-TYPE field is at least the minimum of {16, $P$}, where $P = \sum_{k=1}^{K} L_k \times \frac{M_k}{N_k} \times T_k$, and $L_k$, $M_k$, $N_k$, and $T_k$ are the values of the EDMG_TRN_LEN, EDMG_TRN_M, EDMG_TRN_N, and NUM_TX_CHAINS parameters, respectively, in the RXVECTOR of the received BRP-TX PPDUs and $k$ is the total number of BRP-TX PPDUs received in the TXSS.

An EDMG STA responding to a TXSS sector list feedback request in which the EDMG-SHORT-BRP subfield was 0 may respond within MBFIS with a BRP frame in which the Comeback Delay field in the EDMG BRP Request element is set to a nonzero value. This indicates that the STA is not ready with the feedback within BRPIFS from the request. The value in the Comeback Delay field indicates when the responding STA is ready. The requesting STA may send a BRP frame with a feedback request that contains no training requests and that has the same dialog token as the frame that originally solicited the response after the comeback delay has elapsed; in this case, the responding STA shall respond with feedback within MBIFS. If the TXOP or SP ended before the comeback delay elapses, the responder may send the feedback in a BRP frame as part of another TXOP or SP. The dialog token within the feedback frame shall be the same as in the BRP frame soliciting the response.

An EDMG STA may request a TXSS sector list feedback from a peer EDMG STA by sending a BRP frame with the EDMG-SHORT-BRP subfield, TXSS-FBCK-REQ subfield and the SNR Requested subfield within the FBCK-REQ set to 1. The responding EDMG STA shall send a BRP frame with the EDMG-SHORT-BRP subfield and the EDMG-SHORT-FBCK subfield set to 1 within MBIFS from the reception of the request.

A STA shall not set the TXSS-FBCK-REQ and the TX-TRN-REQ fields to 1 in the same BRP frame.

Two or more BRP frames shall not be aggregated in the same A-MPDU. A BRP frame that contains a beam refinement request may be aggregated with another frame in the same A-MPDU only if the other frame is a single Ack, BA or QoS Null frame. A BRP frame that does not contain a beam refinement request may be aggregated with another frame in the same A-MPDU if the other frame is a single Data, Management (except BRP), Ack, Block Ack or QoS Null frame.

The Duration field within each BRP frame is set to the time remaining until the end of the current allocation, when transmitted within an SP. Otherwise, it is set to the time remaining until the end of the TXOP.

An initiator EDMG STA may include an EDMG Partial Sector Level Sweep element within a BRP frame transmitted as part of a BRP transaction. The responder EDMG STA shall respond with a BRP frame with an EDMG Partial Sector Level Sweep element representing its preferences for a sector sweep that takes place following the expiration of the beamformed link maintenance timer. If the initiator sets the Agree to Change Initiator/Responder Roles field to 1 and the responder agrees to change beamforming initiator/ responder roles when the beamformed link maintenance timer expires, the responder shall set the Agree to Change Initiator/Responder Roles field to 1. If the initiator sets the Agree to Change Initiator/Responder Roles field to 0, this field is ignored. If the responder sets the Agree to Partial Sector Level Sweep to 1, the exchange is considered successful; otherwise, it is considered as failed.

An EDMG STA that supports 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz or 4.32+4.32 GHz PPDU transmission shall not set the DMG TRN RX Only Capable subfield in the STA's EDMG Capabilities element to one. Otherwise, the STA may set the DMG TRN RX Only Capable subfield to one.

A 4.32 GHz EDMG PPDU transmission that includes a TRN field shall have the DMG_TRN parameter of the TXVECTOR set to 0.

A 2.16 GHz EDMG PPDU transmitted using a single space-time stream that includes the TRN field and is addressed to a STA that has the DMG TRN RX Only Capable subfield set to 1 in the STA's EDMG Capabilities element shall have the DMG_TRN parameter of the TXVECTOR set to 1 and the EDMG_TRN_LEN parameter of the TXVECTOR set to a value greater than 0 and less than 32. Otherwise, the DMG_TRN parameter of the TXVECTOR shall be set to 0. If the EDMG_TRN_LEN parameter of the TXVECTOR of a PPDU sent to a STA that has set the DMG TRN RX Only Capable subfield equal to 1 is greater than 0, the CH_BANDWIDTH parameter shall be set to a value having only 1 bit set to 1.

A EDMG STA that receives an EDMG BRP frame with RXVECTOR parameter DMG_TRN equal to 1, with the Channel Measurement Requested subfield of the FBCK-REQ field in the DMG Beam Refinement element within the frame equal to 1 and that has set the Chan-FBCK-CAP subfield to 1 in the last BRP Request field sent to the transmitter of the EDMG BRP frame, shall use the Channel Measurement Feedback element in its response to the received EDMG BRP frame.

#### 10.42.6.4.2 Beam refinement transaction

***Insert the following paragraph at the end of 10.42.6.4.2:***

All PPDUs in a BRP transaction are transmitted with the same bandwidth and with the same channel aggregation setting. In a BRP transaction, except for the first PPDU of the BRP transaction, an EDMG initiator shall set the values of the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of a PPDU to the same corresponding values used in the preceding PPDU transmitted by the initiator in the BRP transaction. In a BRP transaction, an EDMG responder shall transmit a PPDU with TXVECTOR parameter CH_BANDWIDTH equal to the value of the RXVECTOR parameter CH_BANWDITH of the PPDU that elicited the response, and with TXVECTOR parameter CHANNEL_AGGREGATION equal to the value of the RXVECTOR parameter CHANNEL_AGGREGATION of the PPDU that elicited the response.

### 10.42.7 Beam tracking

***Change the first part of 10.42.7 as follows (including the original first five paragraphs of this subclause as published in IEEE Std 802.11-2020), and renumber the subsequent notes in this subclause accordingly:***

Beam tracking enables an initiator or responder to track changes in the AWVs of its DMG antennas and/or the spatial mapping matrix *Q* (defined in Clause 28) without the need to perform a complete BRP procedure. Analog beam tracking allows DMG STAs to track changes in the AWVs of its DMG antennas. Baseband beam tracking allows EDMG STAs to track changes in the spatial mapping matrix *Q* for SU and MU MIMO transmissions that use digital beamforming (see Clause 28).

Beam tracking may be one of the following:

- Initiator receive beam tracking
- Initiator transmit beam tracking
- Responder receive beam tracking

A STA (beam tracking initiator) may request a peer STA (beam tracking responder) to provide receive beam tracking training signals to the initiator on the next PPDU transmitted by the responder. The initiator does this by setting, in a transmitted PPDU, the TXVECTOR parameter BEAM_TRACKING_REQUEST to BEAM-TRACKING-REQUESTED, TRN_LEN to the number of requested TRN subfields as described in 20.9.2.2.3 and PPDU_TYPE to TRN-R. Otherwise, the BEAM_TRACKING_REQUEST parameter shall be set to BEAM-TRACKING-NOT-REQUESTED.

An EDMG STA (beam tracking initiator) may request a peer EDMG STA (beam tracking responder) to perform receive beam tracking by setting, in a transmitted PPDU, the TXVECTOR parameter EDMG_BEAM_TRACKING_REQUEST to BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE to Analog Beam Tracking or Baseband Beam Tracking, BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOT-REQUESTED, EDMG_TRN_LEN to the number of requested TRN units as described in 28.9.2.2, and EDMG_PPDU_TYPE to EDMG-TRN-R. Otherwise, the EDMG_BEAM_TRACKING_REQUEST parameter shall be set to BEAM-TRACKING-NOT-REQUESTED.

A beam tracking responder that receives a PPDU requesting receive beam tracking with the BEAM_TRACKING_REQUEST or EDMG_BEAM_TRACKING_REQUEST parameter in the RXVECTOR set to BEAM-TRACKING-REQUESTED and the PPDU_TYPE in the RXVECTOR set to TRN-R shall

- If BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-REQUESTED, follow the rules described in 20.9.2.2 and shall include a beam refinement AGC field and TRN-R subfields appended to the next PPDU that is transmitted to the initiator in the same allocation, with an MCS index greater than 0. The value of the_TRN-LEN parameter in the TXVECTOR of that PPDU shall be equal to the value of the TRN-LEN parameter in the RXVECTOR of the PPDU from the initiator.
- If BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE parameter in the RXVECTOR is Baseband Beam Tracking, and EDMG_PPDU_TYPE parameter in the RXVECTOR is EDMG-TRN-R, follow the rules described in 28.9.2.2 and shall include TRN-R subfields to the following PPDU transmitted to the initiator in the same allocation, with an MCS index greater than 0. The following PPDU from the responder to the initiator shall have the value of the TXVECTOR parameter EDMG_PPDU_TYPE equal to EDMG-TRN-R and the value of the TXVECTOR parameter EDMG_TRN_LEN equal to the value of the EDMG_TRN_LEN parameter in the RXVECTOR of the PPDU from the initiator.

— If BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE parameter in the RXVECTOR is Analog Beam Tracking, and EDMG_PPDU_TYPE parameter in the RXVECTOR is EDMG-TRN-R, follow the rules described in 28.9.2.2 and the beam tracking responder shall respond with either an EDMG BRP-RX PPDU or an EDMG BRP-RX/TX PPDU to the initiator in the same allocation, with an MCS index greater than 0. If the responder sends an EDMG BRP-RX PPDU, the value of TXVECTOR parameter EDMG_TRN_LEN in the following PPDU from the responder to the initiator shall be equal to the value of the EDMG_TRN_LEN parameter in the RXVECTOR of the PPDU from the initiator. If the responder sends EDMG BRP-RX/TX PPDU, the value of TXVECTOR parameter RX_TRN_PER_TX_TRN in the following PPDU from the responder to the initiator shall be equal to the value of the EDMG_TRN_LEN parameter in the RXVECTOR of the PPDU from the initiator.

If a beam tracking responder sends an EDMG BRP-RX/TX PPDU in response to an analog receive beam tracking request, the beam tracking initiator may aggregate in an A-MPDU a BRP frame that contains an EDMG Channel Measurement Feedback element with the feedback (see 10.42.6.4.1). The feedback type shall be the same as the feedback type in the last BRP frame that was transmitted from the responder to the initiator with TX-TRN-REQ equal to 1. If the initiator has never received a BRP frame from the responder with TX-TRN-REQ equal to 1, the initiator shall respond with all subfields of the FBCK-TYPE field equal to 0 and set the BS-FBCK field to the AWV feedback ID corresponding to the TRN subfields received with the best quality.

If the EDMG_BEAM_TRACKING_TYPE parameter in the RXVECTOR is not equal to Baseband Beam Tracking or the received PPDU is not EDMG, a ~~A~~ responder may ignore a request for beam tracking within an allocation if no PPDUs with an MCS index greater than 0 are transmitted from the responder to the initiator within the allocation.

NOTE 1—If the EDMG_BEAM_TRACKING_TYPE parameter in the RXVECTOR is Baseband Beam Tracking, the digital beamformers at the initiator can be set to a predetermined orthogonal matrix (e.g., the identity matrix) during the transmission of the appended TRN-R subfields only and the measurement at the initiator is based on the appended TRN-R subfields.

A beam tracking initiator requesting transmit beam tracking shall either

— ~~s~~Set the BEAM_TRACKING_REQUEST parameter in the TXVECTOR to BEAM-TRACKING-REQUESTED, PPDU_TYPE to TRN-T, TRN-LEN to the number of TRN Units as described in 20.9.2.2.3, and append an AGC field and TRN-T subfields to the PPDU; or
— Set the EDMG_BEAM_TRACKING_REQUEST parameter in the TXVECTOR to BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE to Analog Beam Tracking or Baseband Beam Tracking, BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOT-REQUESTED, EDMG_PPDU_TYPE to EDMG-TRN-T, and EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N as described in 28.9.2.2, and append TRN-T subfields to the PPDU.

NOTE 2—If the EDMG_BEAM_TRACKING_TYPE parameter in the TXVECTOR is Baseband Beam Tracking, then EDMG_TRN_LEN TRN units are appended to the PPDU (each with EDMG_TRN_P TRN subfields) and are transmitted using the same AWV as the preamble and Data fields of the PPDU. The digital beamformer for the responder can be set to a predetermined orthogonal matrix (e.g., the identity matrix) during the transmission of the appended TRN-T subfields only and the measurement is based on the appended TRN-T subfields.

A beam tracking initiator shall not initiate transmit beam tracking if the beam tracking responder has indicated lack of support by setting the DMG STA Beam Tracking Time Limit field to zero.

The beam tracking responder may aggregate in an A-MPDU a BRP frame that contains a Channel Measurement Feedback element with the feedback (see 10.42.6.4.1) ~~the feedback inside an A-MPDU in a~~

~~frame sent from the responder to the initiator according to the rules specified in 10.42.6.4.1~~. The initiator may allocate time for the feedback through a reverse direction grant, provided the reverse direction protocol is supported by both the initiator and responder. The feedback type shall be the same as the feedback type in the last BRP frame that was transmitted from the initiator to the responder with TX-TRN-REQ equal to 1. If the NUM_TX_CHAINS parameter in the RXVECTOR of the frame that elicits the feedback is greater than 1, the responder may send the feedback in a MIMO BF Feedback frame. If the responder has never received a BRP frame from the initiator with TX-TRN-REQ equal to 1,

- If the BEAM_TRACKING_REQUEST parameter in the RXVECTOR of the PPDU sent by the initiator requesting beam tracking is BEAM-TRACKING-REQUESTED, the responder shall respond with all subfields of the FBCK-TYPE field equal to 0 and set the BS-FBCK field to the index of the TRN-T subfield that was received with the best quality.
- If, in the PPDU sent by the initiator requesting beam tracking, BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-REQUESTED and EDMG_BEAM_TRACKING_TYPE in the RXVECTOR is Baseband Beam Tracking, the initiator shall include a FBCK-REQ in a DMG Beam Refinement element to request the needed feedback. The responder shall respond with the requested feedback in a MIMO BF Feedback frame.
- If, in the PPDU sent by the initiator requesting beam tracking, BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_REQUEST parameter in the RXVECTOR is BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE in the RXVECTOR is Analog Beam Tracking, and EDMG_PPDU_TYPE is equal to EDMG-TRN-T, the responder shall respond with all subfields of the FBCK-TYPE field equal to 0 and set the BS-FBCK field to the AWV feedback ID corresponding to the TRN subfields received with the best quality.

A beam tracking initiator may also request a beam tracking responder to perform receive beam tracking by setting the TXVECTOR parameter BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOTREQUESTED, the TRN_LEN parameter to a nonzero value, the PPDU_TYPE parameter to TRN-R, and append an AGC field and TRN-R subfields to the transmitted PPDU.

A beam tracking responder that receives a PPDU with the BEAM_TRACKING_REQUEST parameter in the RXVECTOR equal to BEAM-TRACKING-NOT-REQUESTED, the TRN_LEN parameter in RXVECTOR having a nonzero value and the PPDU_TYPE parameter in the RXVECTOR equal to TRN-R, shall follow the rules described in 20.9.2.2 and may use the beam refinement AGC field and TRN-R subfields appended to the received PPDU to perform receive beam training.

A beam tracking initiator may request that a beam tracking responder performs receive beam tracking by setting the TXVECTOR parameter EDMG_BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_TYPE to Analog Beam Tracking, BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOT-REQUESTED, EDMG_PPDU_TYPE to EDMG-TRN-R, EDMG_TRN_LEN to a nonzero value, and appending TRN-R subfields to the PPDU.

A beam tracking responder that receives a PPDU with RXVECTOR parameter BEAM_TRACKING_REQUEST equal to BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_REQUEST equal to BEAM-TRACKING-NOT-REQUESTED, EDMG_BEAM_TRACKING_TYPE to Analog Beam Tracking, EDMG_PPDU_TYPE equal to EDMG-TRN-R, and EDMG_TRN_LEN to a nonzero value shall follow the rules described in 28.9.2.2 and may use the TRN-R subfields appended to the received PPDU to perform receive beam training. A beam tracking initiator may use the procedures specified above to request a beam tracking responder to perform both transmit and receive beam tracking on the same PPDU. This is done by, on top of the corresponding TXVECTOR parameter configuration specified above, setting the TXVECTOR parameter RX_TRN_PER_TX_TRN to a value greater than 0 and EDMG_PPDU_TYPE to EDMG-TRN-T. In this case, the beam tracking initiator and beam tracking responder shall use the rules described in 28.9.2.2 to perform both transmit and receive training over the TRN subfields appended to the transmitted PPDU.

A beam tracking initiator requesting simultaneous receive and transmit beam tracking shall set the EDMG_BEAM_TRACKING_REQUEST parameter in the TXVECTOR to BEAM-TRACKING-REQUESTED, EDMG_BEAM_TRACKING_TYPE to Analog Beam Tracking, BEAM_TRACKING_REQUEST to BEAM-TRACKING-NOT-REQUESTED, EDMG_PPDU_TYPE to EDMG-TRN-T, the TXVECTOR parameter RX_TRN_PER_TX_TRN to a value greater than 0, and the parameters EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N as described in 28.9.2.2, and append a TRN field to the PPDU. The feedback sent by the beam tracking responder shall follow the same specification defined for the transmit beam tracking procedure.

***Insert the following paragraph into 10.42.7 after the now 17th paragraph ("A beam tracking initiator may transmit ...."):***

In addition, a beam tracking initiator or beam tracking responder may request baseband beam tracking if at least one of the following conditions is met:

— The performance of the system is degraded in a hybrid beamforming transmission and the initiator would like to reestimate the spatial mapping matrix $Q$ as part of the link adaptation procedure.
— The initiator did not determine the spatial mapping matrix $Q$ as part of the hybrid beamforming setup procedure, i.e., based on channel measurements reported as feedback to the MIMO training procedure or hybrid beamforming feedback during a hybrid beamforming training procedure as described in item b) in 10.42.10.2.4.8. In this case, the AWVs of the DMG antennas at the transmitter and receiver have been identified, but a procedure to determine the spatial mapping matrix $Q$ is still needed.

***Change the 19th and 20th paragraphs in 10.42.7 as follows:***

If the beam tracking initiator does not receive the expected feedback from the beam tracking responder within a time period that is less than the beam tracking time limit plus BRPIFS of the last request, the beam tracking request has failed.

If the initiator receives the expected feedback from the responder within a time period that is greater than or equal to the beam tracking time limit plus BRPIFS of the last request, the initiator should ignore it.

***Insert the following paragraph at the end of 10.42.7:***

If the beam tracking procedure includes the transmission of BRP-TX or EDMG BRP-TX PPDUs, both STAs (initiator and responder) shall not change their antenna settings, except during the transmission of the TRN field in PPDUs used to perform beam tracking, during the procedure. If the beam tracking procedure includes the transmission of EDMG BRP-RX/TX PPDUs, both STAs (initiator and responder) shall not change their antenna settings, except during the transmission and reception of the TRN field in PPDUs used to perform beam tracking, during the procedure. The STAs shall use the beam tracking procedure feedback and then update their antenna settings before their next TXOP or SP.

***Insert the following subclauses [10.47.10 through 10.47.11.7, including Figure 10-94a through Figure 10-94x, Table 10-31a, and Equation (10-19) through Equation (10-26)] after 10.47.9:***

### 10.42.10 EDMG beamforming

#### 10.42.10.1 General

This subclause specifies beamforming mechanisms that are applicable to an EDMG STA. These mechanisms are in addition to the mechanisms specified in the remainder of 10.42, which are applicable to DMG STAs.

If an EDMG STA transmits a BRP frame with the TXVECTOR parameter EDMG_TRN_LEN > 0, the EDMG_PPDU_TYPE parameter equal to either EDMG-TRN-T or EDMG-TRN-R/T, the Channel Measurement Requested subfield in the FBCK-REQ field of the DMG Beam Refinement element equal to 1 and the TX-TRN-REQ subfield in the BRP Request field equal to 1, the TXVECTOR parameter EDMG_TRN_P shall not be set to 0.

If an EDMG STA transmits a BRP frame and all the addressed receivers' EDMG Capabilities elements include the Beamforming Capability subelement, the TXVECTOR parameter EDMG_BRP_MIN_SC_BLOCKS shall be set to the largest value of the Requested BRP SC Blocks subfield of all receiver STAs.

If an EDMG STA transmits a BRP frame and at least one of the addressed receivers' EDMG Capabilities element does not include the Beamforming Capability subelement, the TXVECTOR parameter EDMG_BRP_MIN_SC_BLOCKS shall be set to aBRPminSCBlocks that is specified in 20.11.4.

A STA can utilize the information from a peer STA's antenna polarization in order to enhance the beamformed link quality with the peer STA. Antenna polarization capability is contained in the Antenna Polarization Capability field in a STA's EDMG Capabilities element. For example, if a STA is synthesizable polarization capable and a peer STA is linear polarization capable, the STA can employ circularly polarized antenna to do initial beamforming training with the peer STA to avoid polarization alignment loss. Once initial beamforming training is completed, the STA can further perform beam refinement by switching to a linear polarized antenna and performing polarization alignment using BRP.

#### 10.42.10.2 MIMO beamforming

##### 10.42.10.2.1 General

This subclause describes the procedures used to perform SU-MIMO and MU-MIMO beamforming training and enable MIMO communication between an initiator and one or more responders. The procedures described in this subclause are performed in the DTI of a beacon interval and shall not be initiated unless the initiator and the intended responder(s) have an established control mode link between them.

The Sector ID Order and Tap Delay fields shall not be present in the Channel Measurement Feedback element included in any MIMO BF Feedback frame transmitted during SU-MIMO or MU-MIMO BF training.

The SNR field shall be present in the Channel Measurement Feedback element included in any MIMO BF Feedback frame transmitted during SU-MIMO or MU-MIMO BF training. The EDMG Sector ID Order field (containing AWV feedback IDs and TX antenna IDs) and the BRP CDOWN field shall be present in the EDMG Channel Measurement Feedback element included in any MIMO BF Feedback frame transmitted during SU-MIMO or MU-MIMO BF training.

#### 10.42.10.2.2 SU-MIMO beamforming

##### 10.42.10.2.2.1 General

An EDMG STA is SU-MIMO capable if the SU-MIMO Supported subfield of the Beamforming Capability subelement in the STA's EDMG Capabilities element is 1. An SU-MIMO capable STA supports both SU-MIMO transmission and reception and the SU-MIMO beamforming protocol described in this subclause.

The SU-MIMO beamforming protocol supports beamforming training for subsequent transmission and reception of multiple spatial streams between an SU-MIMO capable initiator and an SU-MIMO capable responder. The SU-MIMO beamforming protocol enables the determination of transmit antenna settings and the corresponding receive antenna settings for simultaneous transmission of multiple spatial streams from the initiator to the responder or vice versa.

The SU-MIMO beamforming protocol can also be used to enable transmit beamforming and receive beamforming operation between the initiator and the responder in which a single spatial stream is transmitted through multiple DMG antennas using the determined transmit antenna settings and received through multiple DMG antennas using the determined corresponding receive antenna settings.

The SU-MIMO beamforming protocol comprises the following consecutive phases:

- SISO phase
- MIMO phase

##### 10.42.10.2.2.2 SISO phase

This subclause describes the SISO phase performed outside of a TDD SP. When the SISO phase is performed in a TDD SP, the SISO phase comprises TDD BF procedure (see 10.42.11).

The objective of the SISO phase is to enable the initiator to collect feedback of the last initiator TXSS from the responder and also enables the responder to collect feedback of the last responder TXSS from the initiator.

The SISO phase comprises either a MIMO BRP TXSS procedure (see 10.42.10.5) or a SISO feedback procedure. When the SISO phase comprises a MIMO BRP TXSS procedure, it includes a setup phase, an Initiator BRP TXSS, a Responder BRP TXSS, and a feedback phase as defined in 10.42.10.5. In particular, the BRP frame sent by the initiator during the setup phase to start the SISO phase shall have the BRP-TXSS, TXSS-INITIATOR and TXSS-MIMO fields within the EDMG BRP Request element all set to 1.

In the BRP frame sent by the initiator during the feedback phase, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates AWV feedback IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the Responder BRP TXSS. The BRP CDOWN field in the EDMG Channel Measurement Feedback element indicates BRP CDOWNs of the PPDUs in which these sectors were received. The SNR field in the Channel Measurement Feedback element indicates the SNRs with which these sectors were received. If the number of sectors for a pair of TX and RX DMG antennas that were received in the responder BRP TXSS is larger than aMinTXSSSectorFBCnt, the BRP frame shall contain feedback for at least aMinTXSSSectorFBCnt received sectors for the pair of TX and RX DMG antennas. Otherwise, the BRP frame shall contain feedback for all the received sectors for the pair of TX and RX DMG antennas.

In the BRP frame sent by the responder during the feedback phase, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates AWV feedback IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the Initiator BRP TXSS. The BRP CDOWN field in the EDMG Channel Measurement Feedback element indicates BRP CDOWNs of the BRP PPDUs in which these sectors were received. The SNR field in the Channel Measurement Feedback element indicates the SNRs with which these sectors were received. If the number of sectors for a pair of TX and RX DMG antennas that were received in the initiator BRP TXSS is larger than aMinTXSSSectorFBCnt, the BRP frame shall contain feedback for at least aMinTXSSSectorFBCnt received sectors for the pair of TX and RX DMG antennas. Otherwise, the BRP frame shall contain feedback for all the received sectors for the pair of TX and RX DMG antennas.

When the SISO phase comprises a SISO feedback procedure, the initiator shall send a BRP frame to the responder. The DMG Beam Refinement element included in the BRP frame shall have the BF Training Type, TXSS-FBCK-REQ, EDMG Extension Flag and EDMG Channel Measurement Present fields set to 1, the SNR Requested and Sector ID Order Requested subfields within the FBCK-REQ field set to 1, the remaining subfields within the FBCK-REQ field set to 0, and the SNR Present, Sector ID Order Present, Channel Measurement Present, Tap Delay Present and Link Type subfields within the FBCK-TYPE field set to 1, 1, 0, 0, and 1, respectively.

The last responder TXSS may have been performed using SSW frames, Short SSW PPDUs or EDMG BRP-TX PPDUs.

- If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 0, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the sector IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last responder TXSS.
- If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 1, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the CDOWNs and RX antennas of all or a subset of sectors that were received in the last responder TXSS.
- If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 2, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicate AWV feedback IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last responder TXSS.

The BRP CDOWN field in the EDMG Channel Measurement Feedback element indicates the BRP CODWNs of the BRP PPDUs in which these sectors were received. The SNR field in the Channel Measurement Feedback element indicates the SNRs with which these sectors were received. If the number of sectors for a pair of TX and RX DMG antennas that were received in the last responder TXSS is larger than aMinTXSSSectorFBCnt, the BRP frame shall contain feedback for at least aMinTXSSSectorFBCnt received sectors for the pair of TX and RX DMG antennas. Otherwise, the BRP frame shall contain feedback for all the received sectors for the pair of TX and RX DMG antennas.

The responder shall send a BRP frame to the initiator within an MBIFS following the reception of the BRP frame from the initiator. The DMG Beam Refinement element included in the BRP frame shall have the BF Training Type, EDMG Extension Flag and EDMG Channel Measurement Present fields set to 1, all the subfields within the FBCK-REQ field set to 0, and the SNR Present, Sector ID Order Present, Channel Measurement Present, Tap Delay Present and Link Type subfields within the FBCK-TYPE field set to 1, 1, 0, 0, and 0, respectively.

The last initiator TXSS may have been performed using DMG Beacon frames, SSW frames, Short SSW PPDUs or EDMG BRP-TX PPDUs.

- If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 0, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the sector IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last initiator TXSS.
- If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 1, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the CDOWNs and RX antennas of all or a subset of sectors that were received in the last initiator TXSS.

— If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 2, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates AWV feedback IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last initiator TXSS.

The BRP CDOWN field in the EDMG Channel Measurement Feedback element indicates the BRP CODWNs of the BRP PPDUs in which these sectors were received. The SNR field in the Channel Measurement Feedback element indicates the SNRs with which these sectors were received. If the number of sectors for a pair of TX and RX DMG antennas that were received in the last initiator TXSS is larger than aMinTXSSSectorFBCnt, the BRP frame shall contain feedback for at least aMinTXSSSectorFBCnt received sectors for the pair of TX and RX DMG antennas. Otherwise, the BRP frame shall contain feedback for all the received sectors for the pair of TX and RX DMG antennas.

During the SISO feedback procedure, all transmissions should use the DMG control mode.

#### 10.42.10.2.2.3 MIMO phase—general

The MIMO phase enables the training of transmit and receive sectors and DMG antennas to determine best combinations of transmit and receive sectors and DMG antennas for SU-MIMO operation.

When the MIMO phase is performed outside of a TDD SP, the initiator starts the MIMO phase an MBIFS following the end of the SISO phase. When the MIMO phase is performed in a TDD SP, after the end of TDD beamforming, each subphase should start within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element.

The MIMO phase consists of a nonreciprocal MIMO phase (see 10.42.10.2.2.4) or a reciprocal MIMO phase (see 10.42.10.2.2.5).

The nonreciprocal MIMO phase shall be supported by all EDMG STAs that are SU-MIMO capable. The reciprocal MIMO phase shall be supported by all EDMG STAs that are SU-MIMO capable and have the Antenna Pattern Reciprocity subfield in the DMG Capabilities element equal to 1.

The MIMO BF Setup frame, MIMO BF Poll frame and MIMO BF Feedback frame sent in the MIMO phase of an SU-MIMO beamforming shall be transmitted by applying spatial expansion and mapping a single space-time stream to all $N_{TX}$ transmit chains to be trained in the procedure. The MIMO BF Setup frame, MIMO BF Poll frame and MIMO BF Feedback frame should be sent using the EDMG control mode.

BRP frames sent in the MIMO phase of an SU-MIMO beamforming shall be transmitted using EDMG PPDUs by applying spatial expansion and mapping a single space-time stream to all $N_{TX}$ transmit chains to be trained in the procedure. The TRN field of each EDMG BRP-RX/TX PPDU used in SU-MIMO beamforming shall consist of $N_{TX}$ orthogonal waveforms as defined in 28.9.2.

At the beginning of the MIMO phase of an SU-MIMO beamforming, if an implementation has not yet determined AWVs to use in some of its transmit chains (for example, if an STA has been using a single transmit chain before the MIMO phase), the AWVs used by such chains should be selected in an implementation dependent manner.

The AWVs used in the transmission of a MIMO BF Feedback frame, MIMO BF Poll frame and all fields except for the TRN field of each EDMG BRP-RX/TX PPDU shall be the same as those used in the transmission of MIMO BF Setup frame. Similarly, the AWVs used in the reception of a MIMO BF Feedback frame, MIMO BF Poll frame and all fields except for the TRN field of each EDMG BRP-RX/TX PPDU shall be the same as those used in the reception of MIMO BF Setup frame.

### 10.42.10.2.2.4 MIMO phase–nonreciprocal

The nonreciprocal MIMO phase is shown in Figure 10-94a and consists of four subphases: an SU-MIMO BF setup subphase, an initiator SU-MIMO BF training (SMBT) subphase, a responder SMBT subphase, and an SU-MIMO BF feedback subphase.

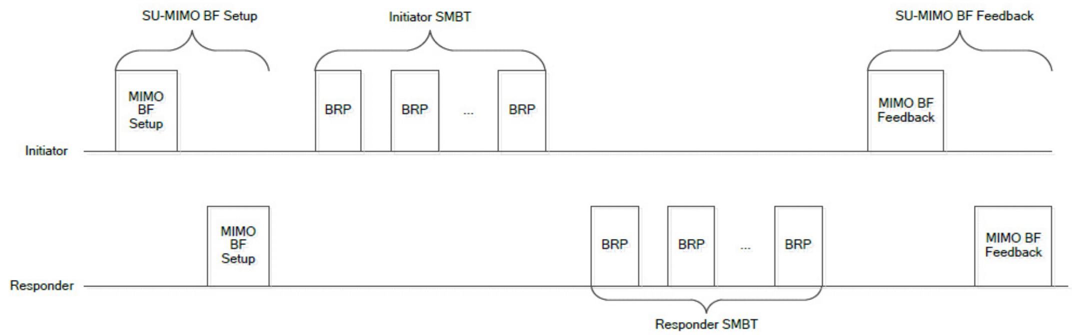


**Figure 10-94a—Nonreciprocal MIMO phase of SU-MIMO beamforming**

It is mandatory to perform the SU-MIMO BF setup subphase.

In the SU-MIMO BF setup subphase, the initiator shall send a MIMO BF Setup frame with the TA field and the RA field set to the MAC addresses of the initiator and the responder, respectively. The MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying SU-MIMO BF training. In the MIMO Setup Control element of the MIMO BF Setup frame, the SU/MU and Nonreciprocal/Reciprocal MIMO Phase fields shall be set to 0 and the Initiator field shall be set to 1. The L-TX-RX field and the Requested EDMG TRN-Unit M field shall indicate the number of TRN subfields requested for receive AWV training in the following responder SMBT subphase. The number of transmit sector combinations requested for the initiator link ($N_{tsc}^{(I)}$) shall be indicated in the Number of TX Sector Combinations Requested subfield of the MIMO FBCK-REQ field. Whether time domain channel response is requested as part of SU-MIMO BF feedback shall be indicated in the Channel Measurement Requested subfield of the MIMO FBCK-REQ field. If the time domain channel response is requested as part of SU-MIMO BF feedback, the Channel Measurement Requested subfield of the MIMO FBCK-REQ field shall be set to 1 and the Number of Taps Requested subfield of the MIMO FBCK-REQ field shall indicate the number of channel taps requested in time domain channel response. For channel aggregation, the Channel Aggregation Requested subfield of the MIMO FBCK-REQ field should be set to 1. Additionally, based on the SNRs of the transmit sectors collected from the responder in the SISO phase, the initiator may select a subset of candidate transmit sectors per DMG antenna to reduce the initiator SMBT training time. Each DMG antenna should have the similar number of candidate transmit sectors in order to avoid biasing a DMG antenna. The L-TX-RX subfield and the Requested EDMG TRN-Unit M subfield of the MIMO BF Setup frame shall indicate the number of TRN subfields requested for receive AWV training in the following responder SMBT subphase.

NOTE 1—If the initiator has antenna pattern reciprocity, the subset of candidate transmit sectors per DMG antenna selected by the initiator for the initiator SMBT subphase can also be used to reduce the number of TRN subfields required for receive AWV training in the following responder SMBT subphase.

In the MIMO phase outside of a TDD SP, the responder shall send a MIMO BF Setup frame a SIFS following the reception of the MIMO BF Setup frame from the initiator. In the MIMO phase in a TDD SP, upon reception of the MIMO BF Setup frame from the initiator, the responder shall send a MIMO BF Setup frame within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

The TA field and the RA field of the MIMO BF Setup frame shall be set to the MAC address of the responder and the initiator, respectively. The MIMO BF Setup frame shall indicate the same dialog token value in the Dialog Token field as in the MIMO BF Setup frame received from the initiator. In the MIMO Setup Control element of the MIMO BF Setup frame, the SU/MU, Nonreciprocal/Reciprocal MIMO Phase and Initiator fields shall be set to 0. The L-TX-RX field and the Requested EDMG TRN-Unit M field shall indicate the number of TRN subfields requested for receive AWV training in the following initiator SMBT subphase. The number of transmit sector combinations requested for the responder link ($N_{tsc}^{(R)}$) shall be indicated in the Number of TX Sector Combinations Requested subfield of the MIMO FBCK-REQ field. Whether time domain channel response is requested as part of SU-MIMO BF feedback shall be indicated in the Channel Measurement Requested subfield of the MIMO FBCK-REQ field. If the time domain channel response is requested as part of SU-MIMO BF feedback, the Channel Measurement Requested subfield of the MIMO FBCK-REQ field shall be set to 1 and the Number of Taps Requested subfield of the MIMO FBCK-REQ field shall indicate the number of channel taps requested in time domain channel response. The Channel Aggregation Requested subfield of the MIMO FBCK-REQ field shall be set to the same value as its counterpart in the MIMO BF Setup frame received from the initiator. Additionally, based on the SNRs of the transmit sectors collected from the initiator in the SISO phase, the responder may select a subset of candidate transmit sectors per DMG antenna to reduce the responder SMBT training time. Each DMG antenna should have the similar number of candidate transmit sectors in order to avoid biasing a DMG antenna. The L-TX-RX subfield and the Requested EDMG TRN-Unit M subfield of the MIMO BF Setup frame shall indicate the number of TRN subfields requested for receive AWV training in the following initiator SMBT subphase.

NOTE 2—If the responder has antenna pattern reciprocity, the subset of candidate transmit sectors per DMG antenna selected by the responder for the responder SMBT subphase can also be used to reduce the number of TRN subfields required for receive AWV training in the following initiator SMBT subphase.

When the MIMO phase is performed outside of a TDD SP, the initiator shall initiate the initiator SMBT subphase an MBIFS following the reception of the MIMO BF Setup frame from the responder. When the MIMO phase is performed in a TDD SP, upon reception of the MIMO BF Setup frame from the responder, the initiator shall initiate the initiator SMBT subphase within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

In the initiator SMBT subphase, the initiator shall transmit EDMG BRP-RX/TX PPDUs to the responder. Each EDMG BRP-RX/TX PPDU shall be separated by SIFS. When performed within a TDD SP and there is not enough time within a TDD slot to transmit all EDMG BRP-RX/TX PPDUs, the remaining EDMG BRP-RX/TX PPDUs are transmitted within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element. Each transmitted EDMG BRP-RX/TX PPDU is used to train one or more transmit sectors and, for each transmit sector, a number of receive AWVs. In each EDMG BRP-RX/TX PPDU, the initiator shall include, for each selected transmit sector, TRN subfields in the TRN field of the PPDU for the responder to perform receive AWV training. For each EDMG BRP-RX/TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0, and the parameters RX_TRN_PER_TX_TRN and EDMG_TRN_M shall be set to the values of the L-TX-RX and Requested EDMG TRN-Unit M fields in the MIMO BF Setup frame received from the responder, respectively. The TX Antenna Mask field of each EDMG BRP-RX/TX PPDU shall indicate the TX DMG antenna(s) that is being used by the initiator to transmit the EDMG BRP-RX/TX PPDU. The BRP CDOWN field of each EDMG BRP-RX/TX PPDU shall indicate the number of remaining EDMG BRP-RX/TX PPDUs to be transmitted by the initiator in the initiator SMBT subphase.

In the MIMO phase performed outside of a TDD SP, the responder shall initiate the responder SMBT subphase an MBIFS following the reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the initiator. In the MIMO phase performed in a TDD SP, upon reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the initiator, the responder shall initiate the responder SMBT subphase within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

In the responder SMBT subphase, the responder shall transmit EDMG BRP-RX/TX PPDUs to the initiator. Each EDMG BRP-RX/TX PPDU shall be separated by SIFS. When performed within a TDD SP and there is not enough time within a TDD slot to transmit all EDMG BRP-RX/TX PPDUs, the remaining EDMG BRP-RX/TX PPDUs are transmitted within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element. For each EDMG BRP-RX/TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0, and the parameters RX_TRN_PER_TX_TRN and EDMG_TRN_M shall be set to the values of the L-TX-RX and Requested EDMG TRN-Unit M fields in the MIMO BF Setup frame received from the initiator, respectively. The TX Antenna Mask field of each EDMG BRP-RX/TX PPDU shall indicate the TX DMG antenna(s) that is being used by the responder to transmit the EDMG BRP-RX/TX PPDU. The BRP CDOWN field of each EDMG BRP-RX/TX PPDU shall indicate the number of remaining EDMG BRP-RX/TX PPDUs to be transmitted by the responder in the responder SMBT subphase.

When the MIMO phase is performed outside of a TDD SP, the initiator shall initiate the SU-MIMO BF feedback subphase an MBIFS following the reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the responder. When the MIMO phase is performed in a TDD SP, upon reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the responder, the initiator shall initiate the SU-MIMO BF feedback subphase within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

In the SU-MIMO BF feedback subphase, the initiator shall send to the responder a MIMO BF Feedback frame with the TA field set to the MAC address of the initiator and the RA field set to the MAC address of the responder. The MIMO BF Feedback frame shall carry the dialog token in the Dialog Token field that identifies the SU-MIMO BF training. In the MIMO Feedback Control element of the MIMO BF Feedback frame, the SU/MU field shall be set to 0 and the Link Type field shall be set to 1. If the MIMO BF Feedback frame contains SU-MIMO BF feedback for responder link, the ComeBack Delay field shall be set to 0. Otherwise, the ComeBack Delay field shall be set to a nonzero value that indicates when the initiator is ready with SU-MIMO BF feedback for responder link. If the ComeBack Delay field is set to 0 and for a 2.16+2.16 GHz or 4.32+4.32 GHz channel, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field should be set to 1. If the ComeBack Delay field is set to a nonzero value, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field shall be set to 0. The Number of TX Sector Combinations Present subfield of the MIMO FBCK-TYPE field shall indicate the number of best transmit sector combinations, $N_{tsc}^{(R)}$, recommended by the initiator for responder link.

The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N_{tsc}^{(R)}$ best transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are determined based on channel measurement data captured from the responder SMBT subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain SNRs corresponding to the $N_{tsc}^{(R)}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the responder in the preceding SU-MIMO BF setup subphase is 1, the Channel Measurement Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the Channel Measurement Feedback element shall contain channel measurements corresponding to the $N_{tsc}^{(R)}$ transmit sector combinations in the Channel Measurement field. If the Tap Delay Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the responder in the preceding SU-MIMO BF setup subphase is 1, the Tap Delay Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the EDMG Channel Measurement Feedback element shall contain relative tap delays for the measurements in the Tap Delay field.

In the MIMO phase outside of a TDD SP, the responder shall send a MIMO BF Feedback frame to the initiator a SIFS following reception of a MIMO BF Feedback frame from the initiator. In the MIMO phase in a TDD SP, upon reception of a MIMO BF Feedback frame from the initiator, the responder shall send a MIMO BF Feedback frame to the initiator within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

The TA field of the MIMO BF Feedback shall be set to the MAC address of the responder and the RA field shall be set to the MAC address of the initiator. The MIMO BF Feedback frame shall carry the dialog token in the Dialog Token field that identifies the SU-MIMO BF training. In the MIMO Feedback Control element of the MIMO BF Feedback frame, the SU/MU and Link Type fields shall be set to 0. If the MIMO BF Feedback frame contains SU-MIMO BF feedback for initiator link, the ComeBack Delay field shall be set to 0. Otherwise, the ComeBack Delay field shall be set to a nonzero value that indicates when the responder is ready with SU-MIMO BF feedback for initiator link. If the ComeBack Delay field is set to 0 and for 2.16+2.16 or 4.32+4.32 GHz channels, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field should be set to 1. If the ComeBack Delay field is set to a nonzero value, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field shall be set to 0. The Number of TX Sector Combinations Present subfield of the MIMO FBCK-TYPE field shall indicate the number of best transmit sector combinations, $N_{tsc}^{(I)}$, recommended by the responder for initiator link.

If the ComeBack Delay field of the MIMO BF Feedback frame received from the initiator is nonzero, the responder shall send a MIMO BF Poll frame with the SU/MU and Poll Type fields set to 0 to the initiator after the initiator's comeback delay has elapsed subject to the DMG channel access rules in a DTI. The initiator shall send a MIMO BF Feedback frame that contains the SU-MIMO BF feedback for the responder link a SIFS following the reception of the MIMO BF Poll frame. If the ComeBack Delay field of the MIMO BF Feedback frame received from the responder is nonzero, the initiator shall send a MIMO BF Poll frame to the responder with the SU/MU and Poll Type fields set to 0 after the responder's comeback delay has elapsed subject to the DMG channel access rules in a DTI. The responder shall respond with a MIMO BF Feedback frame that contains the SU-MIMO BF feedback for the initiator link a SIFS following the reception of the MIMO BF Poll frame.

The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N_{tsc}^{(I)}$ best transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are determined based on channel measurement data captured from the initiator SMBT subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain SNRs corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding SU-MIMO BF setup subphase is 1, the Channel Measurement Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the Channel Measurement Feedback element shall contain channel measurements corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the Channel Measurement field. If the Tap Delay Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding SU-MIMO BF setup subphase is 1, the Tap Delay Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the EDMG Channel Measurement Feedback element shall contain tap delays corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the Tap Delay field.

The $N_{tsc}^{(I)}$ best transmit sector combinations (or equivalently $N_{tsc}^{(I)}$ best TX-RX AWV configurations) for the initiator link and the $N_{tsc}^{(R)}$ best transmit sector combinations (or equivalently $N_{tsc}^{(R)}$ best TX-RX AWV configurations) for the responder link shall be determined in such a way that no transmit or receive AWV come from the same DMG antenna (i.e., a transmit sector combination indicated by a specific SISO ID subset in the EDMG Channel Measurement Feedback element comprises a single transmit sector for each of $N_{TX}$ TX DMG antennas and the corresponding receive sector combination comprises a single receive sector for each of $N_{RX}$ RX DMG antennas). The algorithms for determining the $N_{tsc}^{(I)}$ best transmit sector combinations for the initiator link and for determining the $N_{tsc}^{(R)}$ best transmit sector combinations for the responder link are implementation dependent. The transmit sector combinations to be used for the initiator link and the responder link are indicated using either RTS/DMG CTS frames with a control trailer or a DMG CTS-to-self frame with a control trailer at the beginning of a SU-MIMO channel access procedure (see 10.39.12.4.3).

#### 10.42.10.2.2.5 MIMO phase–reciprocal

The reciprocal MIMO phase might shorten the SU-MIMO BF training time. The initiator may initiate a reciprocal MIMO phase if the following conditions are met:

— The SU-MIMO Supported field in initiator's and responder's EDMG Capabilities element equals one; and

— The Antenna Pattern Reciprocity field in initiator's and responder's DMG Capabilities element equals one

The reciprocal MIMO phase is shown in Figure 10-94b and consists of three subphases: an SU-MIMO BF setup subphase, an initiator SMBT subphase and an SU-MIMO BF feedback subphase.

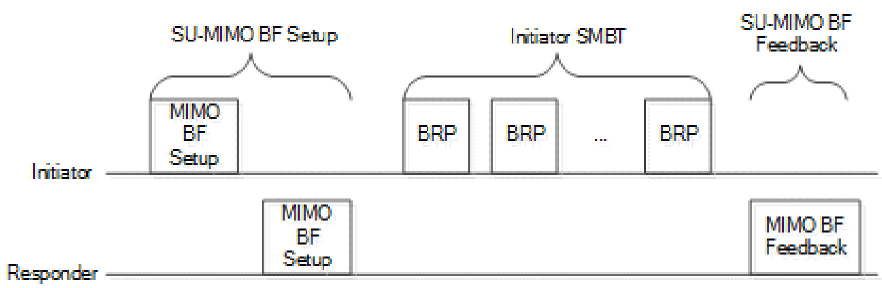


**Figure 10-94b—Reciprocal MIMO phase of SU-MIMO beamforming**

It is mandatory to perform the SU-MIMO BF setup subphase.

In the SU-MIMO BF setup subphase, the initiator shall send a MIMO BF Setup frame with the TA field and the RA field of the MIMO BF Setup frame set to the MAC addresses of the initiator and the responder, respectively. The MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying SU-MIMO BF training. In the MIMO Setup Control element of the MIMO BF Setup frame, the SU/MU field shall be set to 0, and both the Nonreciprocal/Reciprocal MIMO Phase and Initiator field shall be set to 1. The number of transmit sector combinations requested for the initiator link ($N_{tsc}^{(I)}$) shall be indicated in the Number of TX Sector Combinations Requested subfield of the MIMO FBCK-REQ field. Whether time domain channel response is requested as part of SU-MIMO BF feedback shall be indicated in the Channel Measurement Requested subfield of the MIMO FBCK-REQ field. If the time domain channel response is requested as part of SU-MIMO BF feedback, the Channel Measurement Requested subfield of the MIMO FBCK-REQ field shall be set to 1 and the Number of Taps Requested subfield of the MIMO FBCK-REQ field shall indicate the number of channel taps requested in time domain channel response. For channel aggregation, the Channel Aggregation Requested subfield of the MIMO FBCK-REQ field should be set to 1. Additionally, based on the SNRs of the transmit sectors collected from the responder in the SISO phase, the initiator may select a subset of candidate transmit sectors per DMG antenna to reduce the initiator SMBT training time. Each DMG antenna should have the similar number of candidate transmit sectors in order to avoid biasing a DMG antenna.

In the MIMO phase performed outside of a TDD SP, the responder shall send a MIMO BF Setup frame a SIFS following the reception of the MIMO BF Setup frame from the initiator. In the MIMO phase performed in a TDD SP, upon reception of the MIMO BF Setup frame from the initiator, the responder shall send a MIMO BF Setup frame within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

The TA field and the RA field of the MIMO BF Setup frame shall be set to the MAC address of the responder and the initiator, respectively. The MIMO BF Setup frame shall indicate the same dialog token value in the Dialog Token field as in the MIMO BF Setup frame received from the initiator. In the MIMO Setup Control element of the MIMO BF Setup frame, the SU/MU and Initiator fields shall be set to 0, and the Nonreciprocal/Reciprocal MIMO Phase field shall be set to 1. The L-TX-RX field and the Requested EDMG TRN-Unit M field shall indicate the number of TRN subfields requested for receive AWV training in the following initiator SMBT subphase. Based on the SNRs of the transmit sectors collected from the initiator in the SISO phase, the responder may select a subset of candidate receive sectors per DMG antenna to reduce the initiator SMBT training time. Each DMG antenna should have the similar number of candidate receive sectors in order to avoid biasing a DMG antenna.

When the MIMO phase is performed outside of a TDD SP, the initiator shall initiate the initiator SMBT subphase an MBIFS following the reception of the MIMO BF Setup frame from the responder. When the MIMO phase is performed in a TDD SP, upon reception of the MIMO BF Setup frame from the responder, the initiator shall initiate the initiator SMBT subphase within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

In the initiator SMBT subphase, the initiator shall transmit EDMG BRP-RX/TX PPDUs to the responder. Each EDMG BRP-RX/TX PPDU shall be separated by SIFS. When performed within a TDD SP and there is not enough time within a TDD slot to transmit all EDMG BRP-RX/TX PPDUs, the remaining EDMG BRP-RX/TX PPDUs are transmitted within the earliest occurring TDD slot the initiator is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element. Each transmitted EDMG BRP-RX/TX PPDU is used to train one or more transmit sectors and, for each transmit sector, a number of receive AWVs. In each EDMG BRP-RX/TX PPDU, the initiator shall include, for each selected transmit sector, TRN subfields in the TRN field of the PPDU for the responder to perform receive AWV training. For each EDMG BRP-RX/TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0, and the parameters RX_TRN_PER_TX_TRN and EDMG_TRN_M shall be set to the values of the L-TX-RX and Requested EDMG TRN-Unit M fields in the MIMO BF Setup frame received from the responder, respectively. The TX Antenna Mask field of each EDMG BRP-RX/TX PPDU shall indicate the TX DMG antenna(s) that is being used by the initiator to transmit the EDMG BRP-RX/TX PPDU. The BRP CDOWN field of each EDMG BRP-RX/TX PPDU shall indicate the number of remaining EDMG BRP-RX/TX PPDUs to be transmitted by the initiator in the initiator SMBT subphase.

When the MIMO phase is performed outside of a TDD SP, the responder shall initiate the SU-MIMO BF feedback subphase an MBIFS following the reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the initiator. When the MIMO phase is performed in a TDD SP, upon reception of an EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0 from the initiator, the responder shall initiate the SU-MIMO BF feedback subphase within the earliest occurring TDD slot the responder is assigned to and with slot category of the TDD slot set to Basic TDD slot as indicated in the TDD Slot Schedule element.

In the SU-MIMO BF feedback subphase, the responder shall send a MIMO BF Feedback frame to the initiator with the TA field set to the MAC address of the responder and the RA field set to the MAC address of the initiator. The MIMO BF Feedback frame shall carry the dialog token in the Dialog Token field that identifies the SU-MIMO BF training. In the MIMO Feedback Control element of the MIMO BF Feedback frame, the SU/MU and Link Type field shall be set to 0. If the MIMO BF Feedback frame contains

SU-MIMO BF feedback for the initiator link, the ComeBack Delay field shall be set to 0. Otherwise, the ComeBack Delay field shall be set to a nonzero value that indicates when the responder is ready with SU-MIMO BF feedback for initiator link. If the ComeBack Delay field is set to 0 and for 2.16+2.16 GHz or 4.32+4.32 GHz channels, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field should be set to 1. If the ComeBack Delay field is set to a nonzero value, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field shall be set to 0. The Number of TX Sector Combinations Present subfield of the MIMO FBCK-TYPE field shall indicate the number of best transmit sector combinations, $N_{tsc}^{(I)}$, recommended by the responder for initiator link.

If the ComeBack Delay field of the MIMO BF Feedback frame received from the responder is nonzero, the initiator shall send a MIMO BF Poll frame with the SU/MU and Poll Type fields set to 0 to the responder immediately after the responder's comeback delay has elapsed subject to the DMG channel access rules in a DTI. In this case, the responder shall respond with a MIMO BF Feedback frame that contains SU-MIMO BF feedback for the initiator link a SIFS following the reception of the MIMO BF Poll frame.

The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N_{tsc}^{(I)}$ best transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are determined based on channel measurement data captured from the initiator SMBT subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain SNRs corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding SU-MIMO BF setup subphase is 1, the Channel Measurement Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the Channel Measurement Feedback element shall contain channel measurements corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the Channel Measurement field. If the Tap Delay Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding SU-MIMO BF setup subphase is 1, the Tap Delay Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the EDMG Channel Measurement Feedback element shall contain tap delays corresponding to the $N_{tsc}^{(I)}$ transmit sector combinations in the Tap Delay field.

The $N_{tsc}^{(I)}$ best transmit sector combinations (or equivalently $N_{tsc}^{(I)}$ best TX-RX AWV configurations) for the initiator link shall be determined in such a way that no transmit or receive AWV come from the same DMG antenna (i.e., a transmit sector combination indicated by a specific SISO ID subset in the EDMG Channel Measurement Feedback element comprises a single transmit sector for each of $N_{TX}$ TX DMG antennas and the corresponding receive sector combination comprises a single receive sector for each of $N_{RX}$ RX DMG antennas). The determined $N_{tsc}^{(I)}$ best transmit and receive sector combinations for the initiator link shall be treated as the $N_{tsc}^{(R)}$ best receive and transmit sector combinations for the responder link, respectively, where $N_{tsc}^{(I)} = N_{tsc}^{(R)}$. The algorithm for determining the $N_{tsc}^{(I)}$ best transmit sector combinations for the initiator link is implementation dependent. The transmit sector combinations to be used for the initiator link and the responder link are indicated using either RTS/DMG CTS frames with a control trailer or a DMG CTS-to-self frame with a control trailer at the beginning of a SU-MIMO channel access procedure (see 10.39.12.4.3).

### 10.42.10.2.3 MU-MIMO beamforming

#### 10.42.10.2.3.1 General

An EDMG STA is MU-MIMO capable if the MU-MIMO Supported subfield of the Beamforming Capability subelement in the STA's EDMG Capabilities element is 1. The MU-MIMO beamforming protocol enables an MU-MIMO capable initiator and one or more MU-MIMO capable responders in an MU group to establish an antenna configuration that allows the initiator to transmit an EDMG MU PPDU to the responders in the MU group, such that the mutual interference among the streams transmitted in the MU PPDU is minimized. In this context, the method of minimizing interference is implementation dependent.

MU-MIMO beamforming shall not be performed within a TDD SP.

The MU-MIMO beamforming protocol is started and controlled by the initiator, and comprises the following consecutive phases:

— SISO phase
— MIMO phase

The MU-MIMO beamforming protocol uses the EDMG Group ID Set element transmitted by the AP or PCP of the BSS. The AP or PCP shall transmit an EDMG Group ID Set element prior to performing MU-MIMO beamforming protocol. The EDMG Group ID Set element shall include all existent groups in a BSS. An MU-MIMO capable EDMG STA shall store the groups in the last received EDMG Group ID Set element transmitted by the AP or PCP. If an AP or PCP needs to change the STAs in an MU group associated with an existing EDMG group ID, it shall send an individually addressed Announce frame including the updated EDMG Group ID Set element to each of the STAs that are affected by the change to notify of the update.

MIMO BF Setup frames, MIMO BF Poll frames and MIMO BF Selection frames sent by the initiator in the MIMO phase of an MU-MIMO beamforming shall be transmitted by applying spatial expansion and mapping a single space-time stream to all $N_{TX}$ transmit chains to be trained in the procedure. The AWVs used by such chains in the transmission of MIMO BF Setup frames and MIMO BF Selection frames should be selected in an implementation dependent manner. If an implementation has not yet determined AWVs to use in some of its transmit chains for the transmission of MIMO BF Poll frame, the AWVs used by such chains should be selected in an implementation dependent manner. MIMO BF Setup frames, MIMO BF Poll frames and MIMO BF Selection frames should be sent using the EDMG control mode.

In the nonreciprocal MU-MIMO BF feedback subphase, MIMO BF Feedback frame sent by each responder shall be transmitted by applying spatial expansion and mapping a single space-time stream to all $N_{TX}$ transmit chains. If an implementation has not yet determined AWVs to use in some of its transmit chains for the transmission of MIMO BF Feedback frame, the AWVs used by such chains should be selected in an implementation dependent manner. MIMO BF Feedback frame should be sent using the EDMG control mode.

BRP frames sent in the MIMO phase of an MU-MIMO beamforming shall be transmitted using EDMG PPDUs by applying spatial expansion and mapping a single space-time stream to all $N_{TX}$ transmit chains to be trained in the procedure. The TRN field of each EDMG BRP-RX/TX PPDU used in MU-MIMO beamforming shall consist of $N_{TX}$ orthogonal waveforms, as defined in 28.9.2. In the nonreciprocal MU-MIMO BF training subphase, the AWVs used by such chains in the transmission of all fields except for the TRN field of each EDMG BRP-RX/TX PPDU should be selected in an implementation dependent manner.

In the reciprocal MU-MIMO BF training subphase, if an implementation has not yet determined AWVs to use in some of its transmit chains for the transmission of all fields except for the TRN field of each EDMG BRP-RX/TX PPDU, the AWVs used by such chains should be selected in an implementation dependent manner.

#### 10.42.10.2.3.2 SISO phase

The goal of the SISO phase is to collect feedback on one or more suitable initiator's TX and responder's RX DMG antennas and sectors between the initiator and each responder in the MU group. This information is then used to perform the following MIMO phase. All transmissions during the SISO phase should use the DMG control mode.

Figure 10-94c depicts the SISO phase, which consists of two subphases, namely, an Initiator TXSS subphase and a SISO Feedback subphase. The initiator may perform the Initiator TXSS subphase. The

Initiator TXSS subphase enables the initiator to obtain feedback from the responders in the MU group on one or more sectors for each of the initiator's TX DMG antenna.

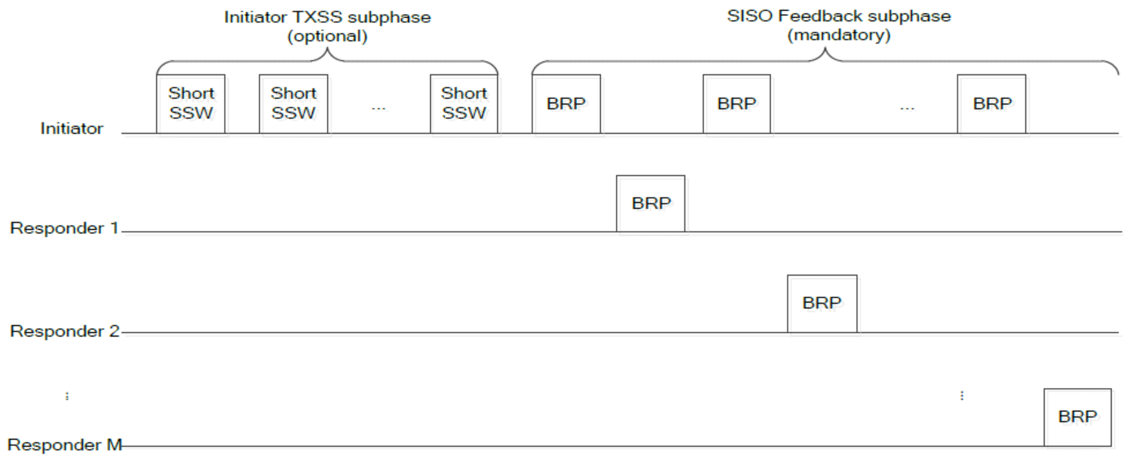


**Figure 10-94c—SISO phase of MU-MIMO beamforming**

The initiator performs the Initiator TXSS subphase through the use of the Short SSW PPDU (see 28.9.1). In each Short SSW PPDU transmitted as part of the Initiator TXSS, the initiator shall set the TXVECTOR parameter SSSW_DIR to indicate Initiator, shall set the TXVECTOR parameter SSSW_ADD_MODE to indicate GroupAddr and shall set the TXVECTOR parameter SSSW_DESTINATION_AID to contain a group ID announced by the PCP or AP in the last transmitted EDMG Group ID Set element. In addition, the TXVECTOR parameter SSSW_CDOWN shall be set to the number of Short SSW PPDUs remaining until the end of the Initiator TXSS subphase and the TXVECTOR parameter SSSW_SISO_FEEDBACK_DURATION shall be set to the duration of the following SISO Feedback subphase.

An MU-MIMO capable EDMG STA that receives a Short SSW PPDU indicating MU-MIMO transmission determines that it is an intended recipient of the PPDU by matching the value of the RXVECTOR parameter SSSW_DESTINATION_AID in the PPDU with a value of the EDMG Group ID subfield contained in the last received EDMG Group ID Set element. In case a match is found, the EDMG STA is an intended recipient of the PPDU if its AID is included in the EDMG Group ID subfield of the corresponding group. Otherwise, the EDMG STA is not an intended recipient of the PPDU and can ignore the remaining of the Initiator TXSS and SISO Feedback subphase, which can be done through the use of the value of the RXVECTOR parameters SSSW_CDOWN and SSSW_SISO_FEEDBACK_DURATION of the received Short SSW PPDU.

The initiator shall perform the SISO Feedback subphase. If the Initiator TXSS is present, the SISO Feedback subphase shall start MBIFS following the end of the Initiator TXSS subphase. During the SISO Feedback subphase, the initiator transmits a BRP frame to poll each responder in the MU group. The DMG Beam Refinement element of the BRP frame shall have the BF Training Type field set to 2, the TXSS-FBCK-REQ field set to 1, the SNR Requested subfield within the FBCK-REQ field set to 1, the Sector ID Order Requested field within the FBCK-REQ field set to 1, the Channel Measurement Requested subfield within the FBCK-REQ field set to 0, all the subfields within the FBCK-TYPE field set to 0 and the EDMG Channel Measurement Present field set to 0. A responder shall respond with a BRP frame within an MBIFS following the reception of the corresponding BRP frame. The DMG Beam Refinement element of the BRP frame shall have the BF Training Type field set to 2, all the subfields within the FBCK-REQ field set to 0, the SNR Present subfield within the FBCK-TYPE field set to 1, the Sector ID Order Present subfield within the FBCK-TYPE field set to 1, the Channel Measurement Present subfield within the FBCK-TYPE field set to 0, the Tap Delay Present subfield within the FBCK-TYPE field set to 0, the Link Type subfield within the FBCK-TYPE field set to 0, the EDMG Extension Flag field set to 1 and the EDMG Channel Measurement Present field set to 1. The BRP frame shall include an EDMG BRP Request element, in which the L-TX-RX and Requested EDMG TRN-Unit M fields indicate the number of TRN subfields requested for receive AWV training in the following nonreciprocal MU-MIMO BF training.

The last initiator TXSS may have been performed using DMG Beacon frames, SSW frames, Short SSW PPDUs or EDMG BRP-TX PPDUs.

— If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 0, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the sector IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last initiator TXSS.
— If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 1, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates the CDOWNs and RX antennas of all or a subset of sectors that were received in the last initiator TXSS.
— If the Sector Sweep Frame Type field in the DMG Beam Refinement element is 2, the EDMG Sector ID Order field in the EDMG Channel Measurement Feedback element indicates AWV feedback IDs, TX antennas and RX antennas of all or a subset of sectors that were received in the last Initiator TXSS.

The BRP CDOWN field in the EDMG Channel Measurement Feedback element indicates the BRP CDOWNs of the PPDUs in which these sectors were received. The SNR field in the Channel Measurement Feedback element indicates the SNRs with which these sectors were received. If the number of sectors for a pair of TX and RX DMG antennas that were received in the last initiator TXSS is larger than aMinTXSSSectorFBCnt, the BRP frame shall contain feedback for at least aMinTXSSSectorFBCnt received sectors for the pair of TX and RX DMG antennas. Otherwise, the BRP frame shall contain feedback for all the received sectors for the pair of TX and RX DMG antennas.

#### 10.42.10.2.3.3 MIMO phase—general

The MIMO phase consists of a nonreciprocal MIMO phase (see 10.42.10.2.3.4) or a reciprocal MIMO phase (see 10.42.10.2.3.5).

The nonreciprocal MIMO phase shall be supported by all EDMG STAs that are MU-MIMO capable. The reciprocal MIMO phase may be supported by EDMG STAs that are MU-MIMO capable.

#### 10.42.10.2.3.4 MIMO phase–nonreciprocal

The initiator shall start the MIMO phase MBIFS following the end of the SISO phase. The nonreciprocal MIMO phase is shown in Figure 10-94d and consists of four subphases, namely, an MU-MIMO BF setup subphase, an MU-MIMO BF training subphase, an MU-MIMO BF feedback subphase, and an MU-MIMO BF selection subphase. Each subphase shall be separated by MBIFS.

Based on the feedback from the SISO phase, in the MU-MIMO BF setup subphase the initiator may exclude some responders from the following MU-MIMO BF training subphase and MU-MIMO BF feedback subphase if the multiuser interference the responders are expected to suffer due to MU-MIMO transmission is negligible. If all of the responders are excluded from the following MU-MIMO BF training subphase and MU-MIMO BF feedback subphase, these two subphases are not present in the MIMO phase.

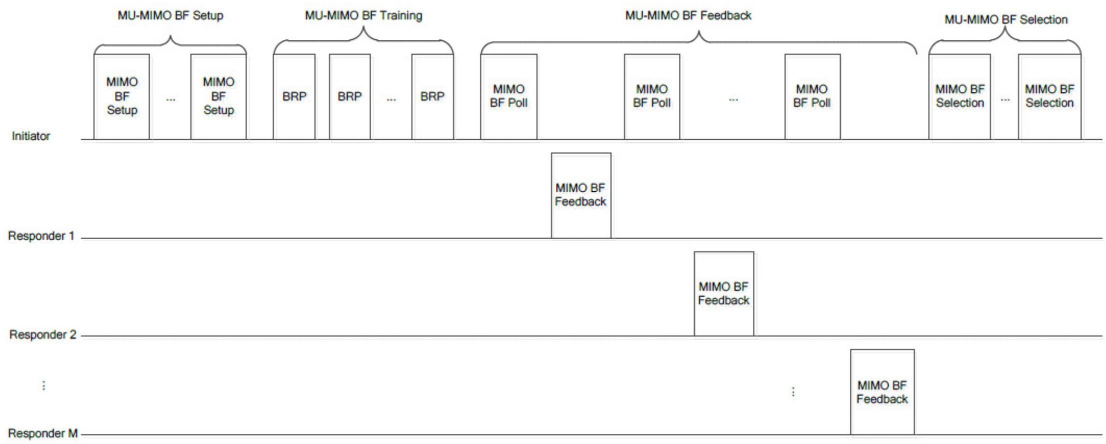


**Figure 10-94d—Nonreciprocal MIMO phase of MU-MIMO beamforming**

In the MU-MIMO BF setup subphase, the initiator shall transmit one or more MIMO BF Setup frame to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Setup frames to reach all responders in the MU group. The TA field of each MIMO BF Setup frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. Each MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying MU-MIMO BF training. In the MIMO Setup Control element of each MIMO BF Setup frame, the SU/MU field shall be set to 1, the Nonreciprocal/Reciprocal MIMO Phase field shall be set to 0, and the Initiator field shall be set to 1. The EDMG group ID of the MU group shall be indicated in the EDMG Group ID field and each remaining responder shall be indicated in the Group User Mask field. Whether time domain channel response is requested as part of MU-MIMO BF feedback shall be indicated in the Channel Measurement Requested subfield of the MIMO FBCK-REQ field. If the time domain channel response is requested as part of MU-MIMO BF feedback, the Channel Measurement Requested subfield of the MIMO FBCK-REQ field shall be set to 1 and the Number of Taps Requested subfield of the MIMO FBCK-REQ field shall indicate the number of channel taps requested in time domain channel response. For channel aggregation, the Channel Aggregation Requested subfield of the MIMO FBCK-REQ field should be set to 1. To reduce the MU-MIMO BF training time, the initiator may select a subset of TX sectors for each DMG antenna. The number of TRN subfields required for receive AWV training is based on the L-TX-RX field and the Requested EDMG TRN-Unit M field of the EDMG BRP Request element included in the BRP frame received from each responder during the SISO feedback subphase. A responder whose corresponding bit in the Group User Mask field of the MIMO Setup Control element included in the received MIMO BF Setup frame is equal to 0 can ignore frames transmitted in the following MU-MIMO BF training subphase and MU-MIMO BF feedback subphase.

The initiator shall initiate the MU-MIMO BF training subphase an MBIFS following the transmission of the MIMO BF Setup frame. In the MU-MIMO BF training subphase, the initiator shall transmit one or more EDMG BRP-RX/TX PPDUs to the remaining responders in the MU group. Each EDMG BRP-RX/TX PPDU shall be separated by SIFS. Both the TA and RA fields of each transmitted EDMG BRP-RX/TX PPDU shall be set to the MAC address of the initiator. If a responder whose corresponding bit in the Group User Mask field within the last received MIMO BF Setup frame from the initiator was equal to 1 receives an EDMG BRP-RX/TX PPDU with both the TA and RA fields equal to the MAC address of the initiator, the responder should perform receive AWV training. For each EDMG BRP-RX/TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0. The parameters RX_TRN_PER_TX_TRN and EDMG_TRN_M shall be set in such a manner that the number of TRN subfields included in the TRN field used for receive AWV training is the maximum number of receive sectors across all the remaining responders based on the L-TX-RX subfields and the Requested EDMG

TRN-Unit M subfields in the feedback from all the remaining responders in the SISO phase. The TX Antenna Mask field of each EDMG BRP-RX/TX PPDU shall indicate the TX DMG antenna(s) that is being used by the initiator to transmit the EDMG BRP-RX/TX PPDU. The BRP CDOWN field of each EDMG BRP-RX/TX PPDU shall indicate the number of remaining EDMG BRP-RX/TX PPDUs to be transmitted by the initiator in the MU-MIMO BF training subphase.

The initiator shall initiate the MU-MIMO BF feedback subphase an MBIFS following the transmission of the EDMG BRP-RX/TX PPDU with the BRP CDOWN field set to 0. In the MU-MIMO BF feedback subphase, the initiator shall transmit a MIMO BF Poll frame to poll each remaining responder to collect MU-MIMO BF feedback from the preceding MU-MIMO BF training subphase. The TA field of each MIMO BF Poll frame shall be set to the BSSID of the initiator and the RA field shall be set to the MAC address of the corresponding responder. Each MIMO BF Poll frame carries the dialog token in the Dialog Token field that identifies the MU-MIMO BF training. In the MIMO Poll Control element of each MIMO BF Poll frame, the SU/MU field shall be set to 1 and the Poll Type field shall be set to 0. Upon receiving a MIMO BF Poll frame for which a remaining responder is the addressed recipient, the responder shall transmit a MIMO BF Feedback frame to the initiator. The RA field of the MIMO BF Feedback frame shall be set to the BSSID of the initiator and the TA field shall be set to the MAC address of the responder. The MIMO BF Feedback frame carries the dialog token in the Dialog Token field that identifies the MU-MIMO BF training. In the MIMO Feedback Control element of the MIMO BF Feedback frame, the SU/MU field shall be set to 1 and the Link Type field shall be set to 0. If the MIMO BF Feedback frame contains MU-MIMO BF feedback, the ComeBack Delay field shall be set to 0. Otherwise, the ComeBack Delay field shall be set to a nonzero value that indicates when the responder is ready with MU-MIMO BF feedback.

If the ComeBack Delay field is set to 0 and for a 2.16+2.16 GHz or 4.32+4.32 GHz channel, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field should be set to 1. The Number of TX Sector Combinations Present subfield of the MIMO FBCK-TYPE field shall indicate the number of transmit sector combinations, $N_{tsc}$.

The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N_{tsc}$ transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are obtained through the channel measurement data captured from the MU-MIMO BF training subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate SNRs corresponding to $N_{tsc}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding MU-MIMO BF setup subphase is 1, the Channel Measurement Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the Channel Measurement Feedback element shall contain the channel measurements corresponding to $N_{tsc}$ transmit sector combinations in the Channel Measurement field. If the Tap Delay Requested subfield of the MIMO FBCK-REQ field in the MIMO BF Setup frame received from the initiator in the preceding MU-MIMO BF setup subphase is 1, the Tap Delay Present subfield of the MIMO FBCK-TYPE field in the MIMO Feedback Control element shall be set to 1 and the EDMG Channel Measurement Feedback element shall contain tap delays corresponding to the $N_{tsc}$ transmit sector combinations in the Tap Delay field.

If the ComeBack Delay field of the MIMO BF Feedback frame received from the responder is nonzero, the initiator shall send a MIMO BF Poll frame with the SU/MU field set to 1 and the Poll Type field set to 0 to the responder immediately after the responder’s comeback delay has elapsed subject to the DMG channel access rules in a DTI. In this case, the responder shall respond with a MIMO BF Feedback frame that contains the MU-MIMO BF feedback.

Each MIMO BF Poll frame and MIMO BF Feedback frame shall be separated by SIFS, except in the case that a MIMO BF Feedback frame includes a ComeBack Delay field set to a nonzero value.

The initiator shall initiate the MU-MIMO BF selection subphase an MBIFS following reception of the MIMO BF Feedback frame from the last remaining responder. In the MU-MIMO BF selection subphase, the initiator shall transmit one or more MIMO BF Selection frames to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Selection frames to reach all responders in the MU group. The MIMO BF Selection frames should be sent using the DMG control mode. The TA field of the MIMO BF Selection frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. Each MIMO BF Selection frame contains the dialog token in the Dialog Token field for identifying the MU-MIMO BF training. In the MIMO Selection Control element of each MIMO BF Selection frame, the MU-MIMO Transmission Configuration Type field shall be set to 0 and the Reciprocal MU-MIMO BF Training Based Transmission Configuration field shall not be present. The EDMG group ID corresponding to the MU group, which is the same as that is used in the MU-MIMO BF setup subphase, shall be indicated in the EDMG Group ID field and the number of MU-MIMO transmission configurations, $N_{conf}$, shall be indicated in the Number of MU-MIMO Transmission Configurations field.

Which responder(s) in the MU group is associated with each of $N_{TX}$ TX DMG antennas for each of $N_{conf}$ MU-MIMO transmission configurations shall be indicated in the Configuration *i* Group User Mask for Antenna *j* subfield ($i = 1, 2, \ldots, N_{conf}$ and $j = 1, 2, \ldots, N_{TX}$) of the Nonreciprocal MU-MIMO BF Training Based Transmission Configuration field. The TX sector of each of $N_{TX}$ TX DMG antennas and the corresponding RX AWVs or RX DMG antennas of all associated responders used in each of $N_{conf}$ MU-MIMO transmission configurations shall be indicated in the Configuration *i* User *k* SISO ID Subset Index/RX Antenna ID for Antenna *j* subfields ($k = 1, 2, \ldots, N_{i,j}^{(u)}$, $i = 1, 2, \ldots, N_{conf}$ and $j = 1, 2, \ldots, N_{TX}$) of the Nonreciprocal MU-MIMO BF Training Based Transmission Configuration field. In more details, if User *k* in Configuration *i* participated in the nonreciprocal MU-MIMO BF training, the Configuration *i* User *k* SISO ID Subset Index/RX Antenna ID for Antenna *j* subfield indicates the RX AWV of User *k* corresponding to TX DMG Antenna *j* in Configuration *i* from a receiver's perspective. Otherwise, the Configuration *i* User *k* SISO ID Subset Index/RX Antenna ID for Antenna *j* subfield indicates the RX DMG antenna of User *k* corresponding to TX DMG Antenna *j* in Configuration *i*.

Each MIMO BF Selection frame may include an EDMG Group ID Set element to update the MU group corresponding to the EDMG group ID indicated in the EDMG Group ID field of the MIMO Selection Control element or other MU groups.

The MU-MIMO transmission configuration to be used for MU-MIMO transmission is indicated using either a RTS frame with a control trailer or a DMG CTS-to-self frame with a control trailer at the beginning of a MU-MIMO channel access procedure (see 10.39.12.4.4).

#### 10.42.10.2.3.5 MIMO phase—reciprocal

The reciprocal MIMO procedure might shorten the MU-MIMO BF training duration. The initiator may initiate a reciprocal MIMO phase procedure if the following conditions are met:

— The Reciprocal MU-MIMO Supported field in initiator's and intended recipients' EDMG Capabilities element equals one, and
— The Antenna Pattern Reciprocity field in the initiator's DMG Capabilities element equals one.

The reciprocal MIMO phase is shown in Figure 10-94e and consists of three subphases, namely, an MU-MIMO BF setup subphase, an MU-MIMO BF training subphase and an MU-MIMO selection subphase. Each subphase shall be separated by MBIFS.

Based on the feedback from the SISO phase, in the reciprocal MU-MIMO BF setup subphase the initiator may exclude some responders from the following reciprocal MU-MIMO BF training subphase. This might happen if the multiuser interference the responders are expected to suffer due to MU-MIMO transmission is negligible or if they do not support the reciprocal MU-MIMO BF training subphase. If all of the responders are excluded from the following reciprocal MU-MIMO BF training subphase, this subphase is not present in the reciprocal MIMO phase.

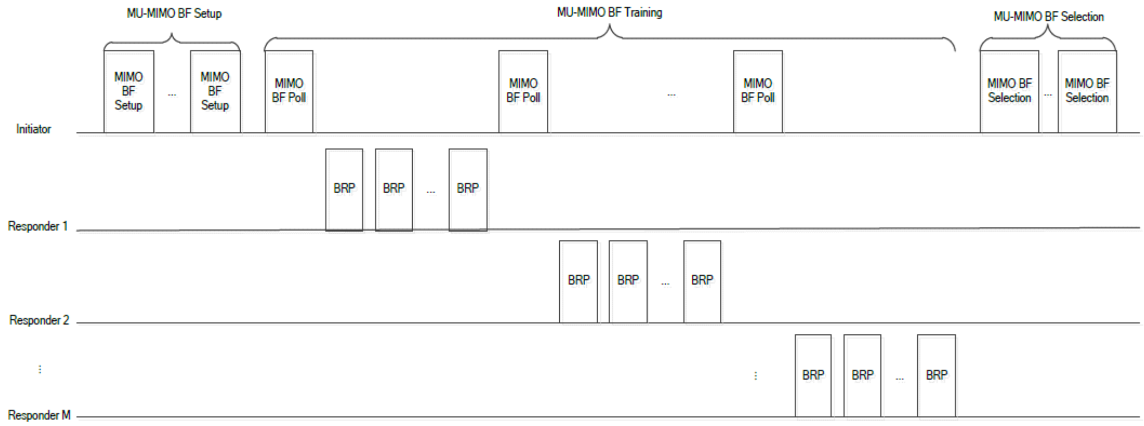


**Figure 10-94e—Reciprocal MIMO phase of MU-MIMO beamforming**

In the MU-MIMO BF setup subphase, the initiator shall transmit one or more MIMO BF Setup frame to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Setup frames to reach all responders in the MU group. The TA field of each MIMO BF Setup frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. Each MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying MU-MIMO BF training. In the MIMO Setup Control element of each MIMO BF Setup frame, all the SU/MU, Nonreciprocal/ Reciprocal MIMO Phase and Initiator fields shall be set to 1. The EDMG group ID of the MU group shall be indicated in the EDMG Group ID field and each remaining responder shall be indicated in the Group User Mask field. For channel aggregation, the Channel Aggregation Requested subfield of the MIMO FBCK-REQ field should be set to 1. A responder whose corresponding bit in the Group User Mask field of the MIMO Setup Control element included in the received MIMO BF Setup frame is equal to 0 can ignore the subsequent MU-MIMO BF training subphase.

The initiator shall initiate an MU-MIMO BF training subphase an MBIFS following the transmission of the MIMO BF Setup frame. In the MU-MIMO BF training subphase, the initiator shall transmit a MIMO BF Poll frame to each remaining responder in the MU group. The TA field of each MIMO BF Poll frame shall be set to the BSSID of the initiator and the RA field shall be set to the MAC address of the corresponding responder. Each MIMO BF Poll frame carries the dialog token in the Dialog Token field that identifies the MU-MIMO BF training. In the MIMO Poll Control element (see 9.4.2.260) of each MIMO BF Poll frame, the SU/MU and Poll Type fields shall be set to 1. The Training Duration field shall be set to the maximum duration during which EDMG BRP-RX/TX PPDUs can be transmitted by the polled responder. Additionally, in order to reduce training time, the initiator may reduce the number of TRN subfields used for receive AWV training in the following EDMG BRP-RX/TX PPDUs transmitted by each remaining responder based on the SNRs of transmit sectors collected from each remaining responder in the SISO phase. The L-TX-RX field and the Requested EDMG TRN-Unit M field shall indicate the number of TRN subfields required for receive AWV training in the following EDMG BRP-RX/TX PPDUs to be transmitted by the corresponding responder. The Requested EDMG TRN-Unit P field shall indicate the number of TRN subfields in a TRN-Unit that need to be transmitted with the same AWV as the preamble and Data fields in the following EDMG BRP-RX/TX PPDUs to be transmitted by the corresponding responder.

Upon receiving a MIMO BF Poll frame for which a remaining responder is the addressed recipient, the responder shall transmit one or more EDMG BRP-RX/TX PPDU to the initiator, where the TXVECTOR parameter EDMG_TRN_LEN is set to a value larger than zero, and the parameters RX_TRN_PER_TX_TRN, EDMG_TRN_M and EDMG_TRN_P are set to the values of the L-TX-RX field, the Requested EDMG TRN-Unit M field and the Requested EDMG TRN-Unit P field in the corresponding MIMO BF Poll frame received from the initiator, respectively. The TX Antenna Mask field of each EDMG BRP-RX/TX PPDU shall indicate the TX DMG antenna(s) that is being used by the responder to transmit the EDMG BRP-RX/TX PPDU. The BRP CDOWN field of each EDMG BRP-RX/TX PPDU shall indicate the number of remaining EDMG BRP-RX/TX PPDUs to be transmitted by the responder.

Each MIMO BF Poll frame and each EDMG BRP-RX/TX PPDU shall be separated by SIFS.

The initiator shall initiate the MU-MIMO BF selection subphase an MBIFS following reception of the EDMG BRP-RX/TX PPDU with the BRP CDOWN field equal to 0 from the last responder in the MU group. In the MU-MIMO BF selection subphase, the initiator shall transmit one or more MIMO BF Selection frame to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Selection frames to reach all responders in the MU group. The TA field of the MIMO BF Selection frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. Each MIMO BF Selection frame contains the dialog token in the Dialog Token field for identifying the MU-MIMO training. In the MIMO Selection Control element of each MIMO BF Selection frame, the MU-MIMO Transmission Configuration Type field shall be set to 1 and the Nonreciprocal MU-MIMO BF Training Based Transmission Configuration field shall not be present. The EDMG group ID corresponding to the MU group shall be indicated in the EDMG Group ID field and the number of MU-MIMO transmission configurations, $N_{conf}$, shall be indicated in the Number of MU-MIMO Transmission Configurations field.

Which responder(s) in the MU group is associated with each of $N_{TX}$ TX DMG antennas for each of $N_{conf}$ MU-MIMO transmission configurations shall be indicated in the Configuration *i* Group User Mask for Antenna *j* subfields ($i = 1, 2, \ldots, N_{conf}$ and $j = 1, 2, \ldots, N_{TX}$) of the Reciprocal MU-MIMO BF Training Based Transmission Configuration field. The RX AWVs or RX DMG antennas of all responders associated with each of $N_{TX}$ TX DMG antennas used in each of $N_{conf}$ MU-MIMO transmission configurations shall be indicated in the Configuration *i* User *k* AWV feedback ID for Antenna *j* subfields, the Configuration *i* User *k* BRP CDOWN for Antenna *j* subfield and the Configuration *i* User *k* RX Antenna ID for Antenna *j* subfields ($k = 1,2, \ldots, N_{i,j}^{(u)}$, $i = 1, 2, \ldots, N_{conf}$ and $j = 1, 2, \ldots, N_{TX}$) of the Reciprocal MU-MIMO BF Training Based Transmission Configuration field. In more details, if User *k* in Configuration *i* participated in the reciprocal MU-MIMO BF training, the Configuration *i* User *k* AWV feedback ID for Antenna *j* subfield, the Configuration *i* User *k* BRP CDOWN for Antenna *j* subfield and the Configuration *i* User *k* RX Antenna ID for Antenna *j* subfield indicate the RX AWV of User *k* corresponding to TX DMG Antenna *j* in Configuration *i* from a receiver's perspective. Otherwise, the Configuration *i* User *k* AWV feedback ID for Antenna *j* subfield and the Configuration *i* User *k* BRP CDOWN for Antenna *j* subfield are reserved and the Configuration *i* User *k* RX Antenna ID for Antenna *j* subfield indicates the RX DMG antenna of User *k* corresponding to TX DMG Antenna *j* in Configuration *i*.

### 10.42.10.2.4 Hybrid beamforming for SU-MIMO and MU-MIMO

#### 10.42.10.2.4.1 General

An EDMG STA is hybrid beamforming capable if either (or both) of the Hybrid Beamforming and SU-MIMO Supported subfield or the Hybrid Beamforming and MU-MIMO Supported subfield in the STA's EDMG Capabilities element is equal to 1. A hybrid beamforming capable STA is hybrid beamforming and SU-MIMO capable if the Hybrid Beamforming and SU-MIMO Supported subfield in the STA's EDMG Capability element is equal to 1. A hybrid beamforming capable STA is hybrid beamforming and MU-MIMO capable if the Hybrid Beamforming and MU-MIMO Supported subfield in the STA's EDMG Capability element is equal to 1. A hybrid beamforming capable STA may be hybrid beamforming and SU-MIMO capable, hybrid beamforming and MU-MIMO capable or both. A hybrid beamforming capable STA supports the hybrid beamforming protocol described in this subclause.

Hybrid beamforming is the transmission and reception of multiple spatial streams using a combination of analog beamforming (by determining appropriate AWVs) and digital beamforming (by determining appropriate spatial mapping matrices) between an SU-MIMO capable initiator and an SU-MIMO capable responder or between an MU-MIMO capable initiator and one or more MU-MIMO capable responders. The spatial mapping matrices are determined based on the DMG antenna configuration selected as a result of the SU-MIMO or MU-MIMO beamforming protocol.

The hybrid beamforming protocol supports digital baseband training and hybrid beamforming information feedback for subsequent hybrid beamforming transmission.

The hybrid beamforming protocol can also be used to support the transmission of a single spatial stream using multiple DMG antennas with a combination of analog beamforming and digital beamforming between an SU-MIMO capable initiator and an SU-MIMO capable responder.

The AWVs of the DMG antennas may be selected using the SU-MIMO beamforming protocol (10.42.10.2.2) or MU-MIMO beamforming protocol (10.42.10.2.3), which enable the determination of the antenna configuration for the simultaneous transmission of single or multiple spatial streams from an initiator to responder(s) (or vice versa in the case of SU-MIMO).

The relationship between a transmitted signal, $\boldsymbol{x}$, and a received signal, $\boldsymbol{Y}$, in a hybrid beamforming transmission (in a flat channel or single frequency bin) can be represented as follows:

$$\boldsymbol{Y}_{i,j} = \boldsymbol{Q}_{Br,i,j}\, \boldsymbol{H}_{BB,i,j}\boldsymbol{Q}_{Bt,i}\boldsymbol{x}_i + \boldsymbol{Q}_{Br,i,j}\boldsymbol{Q}_{Ar,j}\boldsymbol{n}_{i,j}\ ;\ \boldsymbol{H}_{BB,i,j} = \boldsymbol{Q}_{Ar,j}\boldsymbol{H}_{i,j}\ \boldsymbol{Q}_{At}$$

where

| | |
|---|---|
| $\boldsymbol{H}_{i,j}$ | is the channel between the transmit DMG antennas and receive DMG antennas of the $j^{th}$ STA in an MU-MIMO transmission |
| $\boldsymbol{n}_{i,j}$ | is additive white noise at the receiver of the $j^{th}$ STA in an MU-MIMO transmission |
| $\boldsymbol{H}_{BB,i,j}$ | is the effective baseband channel at the receiver of the $j^{th}$ STA in an MU-MIMO transmission, i.e., the channel observed by the baseband processor of the receiver when including the effect of their DMG antennas at the transmitter and receiver |
| $\boldsymbol{Q}_{At}$ | is the $N_{TX,A} \times N_{TX}$ response of the DMG antennas of the transmitter |
| $\boldsymbol{Q}_{Ar,j}$ | is the $N_{RX,j} \times N_{RX,j,A}$ response of the DMG antennas at the receiver of the $j^{th}$ STA in an MU-MIMO transmission |
| $\boldsymbol{Q}_{Bt,i}$ | is the $N_{TX} \times N_{STS}$ transmit spatial mapping matrix |
| $\boldsymbol{Q}_{Br,i,j}$ | is the $N_{STS,j} \times N_{RX,j}$ receive equalizer at the receiver of the $j^{th}$ STA in an MU-MIMO transmission |
| $\boldsymbol{x}_i$ | is the transmitted SU-MIMO or MU-MIMO signal |
| $\boldsymbol{i}$ | is the subcarrier index; for an EDMG SC mode PPDU transmission, $i = 0$; for an EDMG OFDM mode PPDU transmission, $-N_{SR} \le i \le N_{SR}$ |
| $\boldsymbol{j}$ | is index of $j^{th}$ STA in an MU-MIMO transmission; for an SU-MIMO transmission, $j = 0$ |

In the hybrid beamforming protocol, the transmitter acquires hybrid beamforming information based on feedback from the receiver derived from the channel in the direction between the transmitter and receiver.

The hybrid beamforming protocol comprises the following phases:

— Announcement phase: optional if the configuration has been previously set
— Sounding phase
— Feedback phase

On completion of the hybrid beamforming protocol, a hybrid beamforming transmission may take place.

For an EDMG SU PPDU to which hybrid beamforming is applied, $\boldsymbol{Q}_{Bt,i}$ is a transmit spatial mapping matrix and is derived from the TXVECTOR parameter EXPANSION_MAT with enumerated type NON_COMPRESSED_SV or CSI_MATRICES. For an EDMG MU PPDU to which hybrid beamforming is applied, $\boldsymbol{Q}_{Bt,i}$ is a transmit spatial mapping matrix and is derived from the TXVECTOR parameter EXPANSION_MAT with enumerated type COMPRESSED_SV. The transmit spatial mapping matrices are implementation dependent.

#### 10.42.10.2.4.2 Announcement phase—general

The hybrid beamforming protocol announcement phase uses an announcement and optional announcement acknowledgment frame exchange to enable the initiator and responder(s) to set up their DMG antenna configurations to the desired transmit and receive antenna sectors and to indicate the start of the hybrid beamforming protocol.

If the initiator and responder are already in the correct configuration and have previously set up their hybrid beamforming protocol information, the announcement phase is optional.

The parameters governing the hybrid beamforming protocol, such as feedback type and the hybrid beamforming protocol feedback parameters, are signaled during the sounding phase.

For more specifics about the announcement phase, see 10.42.10.2.4.3 for SU-MIMO and 10.42.10.2.4.4 for MU-MIMO.

#### 10.42.10.2.4.3 Announcement phase for SU-MIMO

For SU-MIMO, the announcement and announcement acknowledgment for the hybrid beamforming protocol may use

- A Grant frame as the announcement frame and a Grant Ack frame as the announcement acknowledgment frame with a control trailer for signaling the transmission configuration to be used or
- An RTS frame as the announcement and a DMG CTS frame as the announcement acknowledgment frame with a control trailer for signaling the transmission configuration to be used.

The procedure is detailed in 10.39.12.4.3.

#### 10.42.10.2.4.4 Announcement phase for MU-MIMO

Prior to the start of hybrid beamforming training with a set of responder STAs within an MU group, the initiator shall

- Indicate the MU group within the EDMG Group ID Set element and communicate the resulting element to the STAs in the BSS (see 10.42.10.2.3.1) and
- Perform MU-MIMO beamforming with the responders of the MU group (see 10.42.10.2.3).

For MU-MIMO, the announcement and announcement acknowledgment for the hybrid beamforming protocol may use

- An RTS as the announcement frame and simultaneous DMG CTS frames as the announcement acknowledgment frame with a control trailer for signaling the transmission configuration or
- A DMG CTS-to-self frame as the announcement frame with a control trailer for signaling the transmission configuration.

The procedure is detailed in 10.39.12.4.4.

#### 10.42.10.2.4.5 Sounding phase

In the sounding phase of the hybrid beamforming training protocol, the initiator (or responder) may send TRN fields to the responder (initiator) to measure the baseband channel. The TRN fields may be sent during the BRP phase (see 10.42.3) or during the beam tracking phase (see 10.42.7). A transmitter (initiator or responder) that desires to sound the baseband channel shall initiate initiator transmit beam refinement (see 10.42.3) or initiator transmit beam tracking (see 10.42.7). For more information about hybrid beamforming sounding with BRP frames, see 10.42.10.2.4.6. For more information about hybrid beamforming sounding with tracking, see 10.42.10.2.4.7.

The spatial mapping matrix, $Q$, for transmission that uses digital beamforming should be computed using the last analog combination decided between a pair of STAs (that is, on the current AWVs used by the STAs).

The transmitter shall use BRP sounding immediately after the hybrid beamforming protocol announcement or when the DMG antenna configuration or the digital beamforming feedback may need to be modified. The transmitter may use BRP or digital baseband beam tracking when DMG antenna configuration and the digital beamforming feedback are unchanged.

NOTE—The transmitter described above is the STA that sends the TRN field and can be the initiator or the responder.

For transmit beam refinement, the BRP frames indicate the TRN configuration and the type of feedback requested, and TRN fields are appended to the BRP frames to enable sounding.

For digital beam tracking, the TRN fields to enable sounding are appended to the initiator frames based on indications in the PHY header. The feedback for the digital beam tracking procedure should be the feedback negotiated in the most recent BRP sounding.

The Digital BF Request field in the EDMG BRP Request element shall be set to 1 to indicate that sounding for digital BF is requested.

For the EDMG SC mode, the DBF FBCK REQ field in the DMG Beam Refinement element shall be set to 0 to indicate MIMO channel measurement feedback, and set to 1 to indicate digital beamforming matrix feedback. For the EDMG OFDM mode, the DBF FBCK REQ field shall always be set to 1 to indicate digital beamforming matrix feedback.

For the EDMG SC mode, the number of taps requested during MIMO channel measurement or digital beamforming matrix feedback shall be set in the Number of Taps Requested field in the DMG Beam Refinement element.

#### 10.42.10.2.4.6 Hybrid beamforming sounding with BRP frame(s)

The hybrid beamforming sounding with BRP frames is performed as follows:

a) **SU-MIMO sounding (for both initiator and responder).** The initiator shall initiate the sounding phase a SIFS following reception of the announcement acknowledgment frame (see 10.42.10.2.4.3) from the responder. In the initiator sounding subphase, the initiator shall transmit an EDMG BRP-TX PPDU to the responder. The EDMG BRP-TX PPDU shall include a BRP frame with an EDMG BRP Request element with the Digital BF Request field set to 1 indicating a request for performing digital beamforming, and the Feedback Type field set to 0 for SU transmission. The Nc Index field is reserved. The EDMG BRP-TX PPDU shall use the TX sector combination selected in the announcement phase in the transmission of the TRN subfield. In the EDMG BRP-TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0, the parameter RX_TRN_PER_TX_TRN shall be set to 0, the parameter NUM_TX_CHAINS shall be set to the number of TX antennas in the TX sector combination and the parameter EDMG_TRN_M shall be set to values based on the desired configuration. The TX Antenna Mask field within the EDMG BRP-TX PPDU shall indicate the transmit DMG antenna(s) that is being used by the initiator to transmit the EDMG BRP-TX PPDU. The same AWV combination shall be maintained during the transmission of the PPDU, including the TRN field.

If the responder indicates that it is going to use SU-MIMO in the opposite direction (from the responder to the initiator) and requests hybrid beamforming training during the announcement phase, the initiator and responder shall delay sending feedback until after the responder completes the sounding phase. The responder shall initiate the responder sounding subphase a SIFS following the reception of an EDMG BRP-TX PPDU from the initiator. In the responder sounding subphase, the responder shall transmit an EDMG BRP-TX PPDU to the initiator. The EDMG BRP-TX PPDU shall include a BRP frame with an EDMG BRP Request element with the Digital BF Request field set to 1 indicating a request for performing digital beamforming, and the Feedback Type field set to 0 for SU transmission. The Nc Index field is reserved. The EDMG BRP-TX PPDU shall use the TX sector combination selected in the announcement phase in the transmission of the TRN subfield. In the EDMG BRP-TX PPDU, the TXVECTOR parameter EDMG_TRN_LEN shall be set to a value greater than 0, the parameter RX_TRN_PER_TX_TRN shall be set to 0, the parameter NUM_TX_CHAINS shall be set to the number of TX antennas in the TX sector combination and the parameter EDMG_TRN_M shall be set to values based on the desired configuration. The TX Antenna Mask field within the EDMG BRP-TX PPDU shall indicate the transmit DMG antenna(s) that is being used by the responder to transmit the EDMG BRP-TX PPDU. The same AWV combination shall be maintained during the transmission of the PPDU, including the TRN field.

In the case that only the initiator requested sounding, the responder shall not send the EDMG BRP-TX PPDU.

Figure 10-94f illustrates an example of a frame exchange sequence using the SU-MIMO hybrid beamforming protocol.

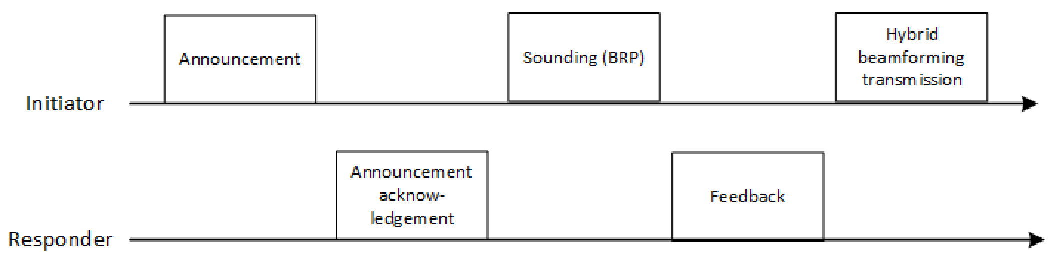


**Figure 10-94f—Example of frame exchange using SU-MIMO hybrid beamforming protocol**

b) **MU-MIMO sounding (for initiator).** The initiator shall initiate the hybrid beamforming sounding subphase a SIFS following the reception of the announcement acknowledgment frame(s) from the responder(s), if required, or immediately following the transmission of the DMG CTS-to-self frame from the initiator. In the hybrid beamforming sounding subphase, the initiator shall transmit an EDMG BRP-TX PPDU to the responders in the MU group. The EDMG BRP-TX PPDU shall include a BRP frame with an EDMG BRP Request element with the Digital BF Request field set to 1 indicating a request for performing digital beamforming, and the Feedback Type field set to 1 for MU transmission. For digital beamforming feedback in the EDMG OFDM mode, the Nc Index field is set to the number of columns, *Nc*, in the compressed beamforming feedback matrix minus 1. The RA field in the BRP frame shall be set to the broadcast address. The EDMG BRP-TX PPDU shall use the TX sector combination selected in the announcement phase in the transmission of the whole TRN subfield. In the EDMG BRP-TX PPDU, the TXVECTOR parameter

EDMG_TRN_LEN shall be set to a value greater than 0. The TXVECTOR parameter RX_TRN_PER_TX_TRN shall be set to 0 and the parameter EDMG_TRN_M shall be set to a value based on the desired configuration. The TX Antenna Mask field within the EDMG BRP-TX PPDU shall indicate the TX DMG antenna(s) that is being used by the initiator to transmit the EDMG BRP-TX PPDU.

#### 10.42.10.2.4.7 Hybrid beamforming sounding with tracking

SU-MIMO tracking may take place after the establishment of a hybrid beamforming link. The combination of an announcement with BRP sounding is used to establish the antenna configuration and feedback parameters to perform tracking.

To perform tracking, the initiator shall transmit an EDMG PPDU setting up an EDMG initiator transmit beam tracking (see 10.42.7) to the responder(s). The antenna configuration and feedback parameters used shall be based on the most recent BRP sounding parameters.

#### 10.42.10.2.4.8 Feedback phase

The feedback phase is used by the hybrid beamforming protocol to feed back the hybrid beamforming information to the transmitter for use in a subsequent hybrid beamforming transmission.

The feedback is carried in the MIMO BF Feedback frame and its contents are as follows:

- For the EDMG SC mode, when the BRP frame used during the sounding phase has the DBF FBCK REQ field equal to 1 within the DMG Refinement element, the MIMO BF Feedback frame contains the Digital BF Feedback element carrying the digital beamforming matrix information. When DBF FBCK REQ field equal to 0, the MIMO BF Feedback frame contains the Channel Measurement Feedback element and the EDMG Channel Measurement Feedback element.
- For the EDMG OFDM mode, the MIMO BF Feedback frame contains the Digital BF Feedback element carrying the digital beamforming matrix information.

The feedback may be based on fixed grouping of the subcarriers with $Ng$ = 2, 4 or 8 or the feedback may be based on dynamic grouping of the subcarriers in which the distance between the subcarriers may vary based on the characteristics of the channel fed back. These are illustrated in Figure 10-94g.

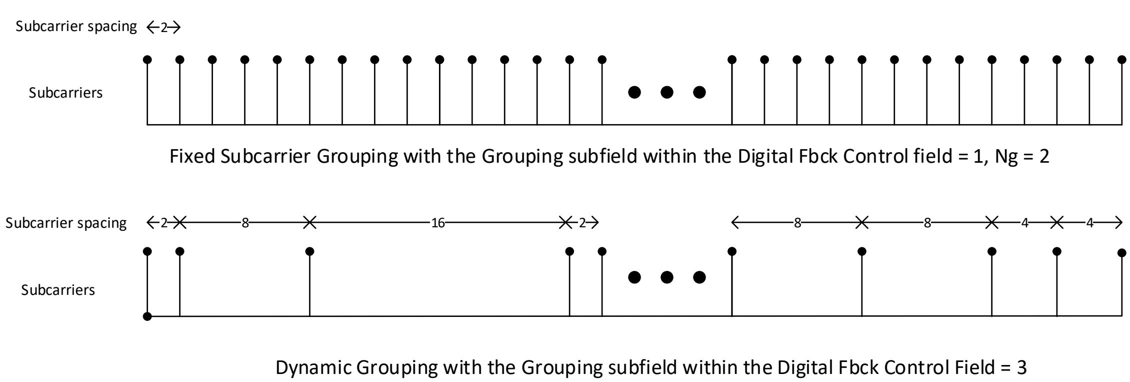


**Figure 10-94g—Example of EDMG OFDM mode dynamic feedback**

The capabilities governing the subcarrier grouping of an EDMG STA whose feedback is in the EDMG OFDM mode are contained in the Largest Ng Supported field and the Dynamic Grouping Supported field in the Beamforming Capability subelement of a STA's EDMG Capabilities element.

An EDMG STA shall not transmit digital BF feedback with a subcarrier grouping value larger than that in the Largest Ng Supported field indicated by the STA receiving the feedback. An EDMG STA shall not transmit digital BF feedback using dynamic grouping if the STA receiving the feedback indicates that it does not support dynamic grouping.

The SU-MIMO feedback and MU-MIMO feedback are performed as follows:

a) **SU-MIMO feedback.** If hybrid beamforming training is requested from the initiator to the responder only, the responder shall initiate the feedback phase a SIFS following the reception of an EDMG BRP-TX PPDU from the initiator with the BRP CDOWN field equal to 0.

   If hybrid beamforming training is requested from the initiator to the responder and from the responder to the initiator during the announcement phase, the initiator shall commence feedback to the responder a SIFS following the reception of an EDMG BRP-TX PPDU from the initiator with the BRP CDOWN field equal to 0. The responder shall then commence feedback to the initiator a SIFS following the reception of the feedback from the initiator.

   An exemplary procedure is shown in Figure 10-94h.

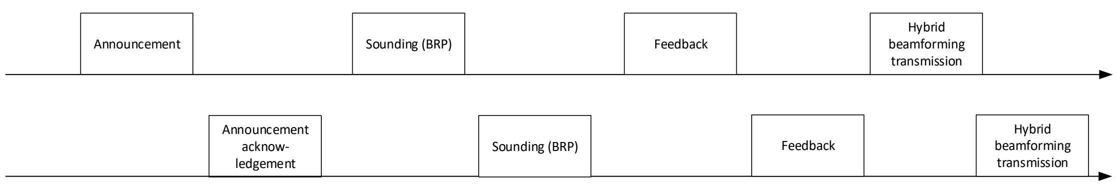


**Figure 10-94h—Example of frame exchange using SU-MIMO hybrid beamforming protocol**

b) **MU-MIMO feedback.** The initiator shall initiate the MU-MIMO beamforming feedback subphase an MBIFS following the transmission of an EDMG BRP-TX PPDU with the BRP CDOWN field set to 0. In the MU-MIMO beamforming feedback subphase, the initiator shall transmit a MIMO BF Poll frame to poll each remaining responder to collect hybrid beamforming MU-MIMO feedback from the preceding MU-MIMO sounding subphase. The TA field of each MIMO BF Poll frame shall be set to the MAC address of the initiator and the RA field shall be set to the MAC address of the corresponding responder. Each MIMO BF Poll frame carries the dialog token in the Dialog Token field that identifies the MU-MIMO BF sounding. In the MIMO Poll Control element of each MIMO BF Poll frame, the SU/MU field shall be set to 1 and the Poll Type field shall be set to 0.

   Upon receiving a MIMO BF Poll frame for which a responder is the addressed recipient, the responder shall transmit a MIMO BF Feedback frame which contains a Digital BF Feedback element to the initiator. The RA field of the MIMO BF Feedback frame shall be set to the MAC address of the initiator and the TA field shall be set to the MAC address of the responder. The MIMO BF Feedback frame carries the dialog token in the Dialog Token field that identifies the MU-MIMO sounding. In the MIMO Feedback Control element of the MIMO BF Feedback frame, the SU/MU field shall be set to 1 and the Link Type field shall be set to 0. If the MIMO BF Feedback frame contains a Digital BF Feedback element, the ComeBack Delay field shall be set to 0. Otherwise, the ComeBack Delay field shall be set to a nonzero value that indicates when the responder is ready with the Digital BF Feedback. If the ComeBack Delay field is set to 0 and for a 2.16+2.16 GHz or 4.32+4.32 GHz channel, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field shall be set to 1. If the ComeBack Delay field is set to a nonzero value, the Channel Aggregation Present subfield of the MIMO FBCK-TYPE field shall be set to 0.

   An exemplary procedure is shown in Figure 10-94i.

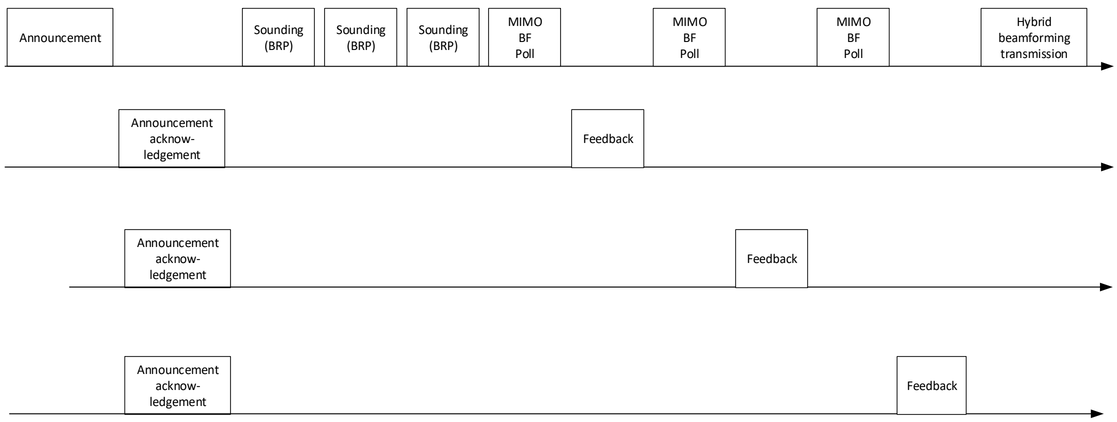


**Figure 10-94i—Example of frame exchange using MU-MIMO hybrid beamforming protocol**

### 10.42.10.3 Beamforming for asymmetric links

#### 10.42.10.3.1 General

An asymmetric link is present between a pair of STAs when in one STA the difference between the maximum receive antenna gain and the quasi-omni receive antenna gain is higher than 15 dB, while for the other STA this difference is at most 15 dB.

NOTE—As specified in 20.9.1, 15 dB is the sensitivity difference between the DMG control mode and the DMG SC mode for a PHY data rate greater than 1 Gb/s. When the difference between the full gain receive antenna setting and the quasi-omni receive antenna setting is higher than 15 dB, a STA might be able to receive a PPDU at full gain using the DMG SC mode at a range higher than in a quasi-antenna receive setting using the DMG control mode when the same antenna setting is used by the STA that transmits the PPDU.

The procedure defined in this subclause enables an initiator and a responder that would otherwise have an asymmetric link if a quasi-omni antenna configuration were to be used for communication between them, to perform beamforming according to the procedure described in this subclause. Following the successful establishment of the beamformed link, all frame exchanges between the STAs take place using the established beamformed link. STAs may determine whether to perform asymmetric beamforming according to the “Near-Far” self classification described in 10.39.12.6.

The procedure defined in this subclause requires that the DMG Antenna Reciprocity and Antenna Pattern Reciprocity subfields within the DMG STA Capability Information field of the initiator and responder are both set to 1.

#### 10.42.10.3.2 Scheduling during the BTI

To enable beamforming for asymmetric links, a PCP or AP shall

— In the PPDU containing a DMG Beacon frame transmitted in a BTI through the sector for which the asymmetric beamforming training is considered to be performed, include TRN-R subfields within the TRN field of the PPDU as specified in 10.42.4.
— Include an EDMG Extended Schedule element in each DMG Beacon frame that is transmitted in the step above. The EDMG Extended Schedule element shall include at least one allocation that has the Asymmetric Beamforming Training subfield for the allocation set to 1. The duration of this allocation shall be at least

$$N_{STS} \times aSTSTime + MBIFS + aAirPropagationTime + TXTIME(Sector\ Ack)$$

where

| | |
|---|---|
| $N_{STS}$ | is the value of the Number of Space-time Slots subfield in the EDMG Extended Schedule element describing this allocation. |
| *aSTSTime* | is the duration a space-time slot defined in 10.42.10.3.3. |
| *TXTIME*(*Sector Ack*) | is the transmission time of a Sector Ack frame, assuming there are $N_{STS}$ Sector Ack subfields in the Sector Ack frame. |

A PCP or AP shall not include in a DMG Beacon frame an EDMG Extended Schedule element including an allocation that has the Asymmetric Beamforming Training subfield for the allocation equal to 1 without inserting TRN-R subfields in the TRN field of the PPDU containing the DMG Beacon.

A non-PCP and non-AP STA receiving a DMG Beacon frame with appended TRN-R fields and that executes the beamforming procedure described in this subclause shall use the TRN-R fields to perform receive beamforming as specified in 10.42.2. The STA may then use one or more of the allocations announced in the EDMG Extended Schedule element that have the Asymmetric Beamforming Training subfield equal to 1 (see 9.4.2.267) to perform the procedure specified in 10.42.10.3.3. The STA should select the asymmetric beamforming allocation which corresponds to the DMG Beacon frame received with the best quality in the BTI. The determination of which DMG Beacon frame was received with the best quality is implementation dependent.

#### 10.42.10.3.3 Beamforming training allocation in DTI

A beamforming training allocation in the DTI is scheduled through the EDMG Extended Schedule element. A beamforming training allocation has the Asymmetric Beamforming Training subfield for the allocation equal to 1. Channel access during a beamforming training allocation is as follows:

- The PCP or AP (i.e., the initiator) shall listen on the combination of sector and DMG antenna that was used for transmission of the DMG Beacon frame describing this allocation during the last BTI. The PCP or AP shall listen for $N_{STS}$ space-time slots for any responder's transmission, where $N_{STS}$ is the value of the Number of Space-time Slots subfield describing the allocation. A space-time slot has a duration of aAirPropagationTime + TXTIME(SSW) + aSIFSTime, where aAirPropagationTime accounts for the propagation delay between the initiator and the responder.
- At the start of the allocation, the responder(s) shall invoke a random backoff procedure to transmit an SSW frame. The random backoff procedure begins at the start of the beamforming training allocation with the responder selecting a backoff count as a random integer drawn from a uniform distribution [0, $N_{STS}$), i.e., 0 to $N_{STS} – 1$. The responder shall decrement the backoff count by one at the end of each space-time slot, even if the CS function at the responder indicates the medium busy condition for that space-time slot. The responder may transmit the SSW frame only at the start of the space-time slot for which the backoff count is 0 at the beginning of the space-time slot. The responder's transmission is performed in directional mode using a transmit DMG antenna and sector corresponding to the receive DMG antenna and sector trained by the TRN-R subfields received in the last BTI.
- A responder may transmit more than one consecutive SSW frame within one beamforming training allocation, but shall not exceed the maximum number of space-time slots a responder can occupy as given by $2^{Nmax\ STS}$, where *Nmax STS* is the value of the Nmax STS subfield describing the allocation.
- After transmitting the SSW frame(s), the responder switches to directional receive in the sector trained by TRN-R in the last BTI.
- MBIFS after the PCP or AP completes listening for $N_{STS}$ space-time slots, the initiator shall transmit a Sector Ack frame on the same combination of sector and DMG antenna that was used for listening. The Sector Ack frame contains the information about the STAs that have been identified during the allocation. In case several SSW frames have been received from a STA, the Sector Ack refers to the

SSW frame that was received with the best quality. The determination of which frame was received with the best quality is implementation dependent.

— A responder that transmits an SSW frame during a beamforming training allocation, but that does not receive a Sector Ack frame in response, may repeat the attempt to perform asymmetric beamforming training during the next beamforming training allocation.

An example of beamforming training for asymmetric links of three EDMG STAs and an EDMG PCP or EDMG AP is shown in Figure 10-94j. In the example, the AP or PCP allocates a dedicated SP to perform the asymmetric beamforming training, which consists of sequential listening on each sector, followed by the Sector Ack transmissions by the PCP or AP. STA#1 selects the second (out of four) space-time slot and transmits the SSW frame with a beamforming link determined by the TRN-R appended during the last BTI. STAs #2 and #3 choose the same third space-time slot and transmit SSW frames, which results in a collision. MBIFS after the fourth space-time slot, the AP transmits a Sector Ack frame that includes information about all STAs which SSW frames were received correctly: STA#1 and either one of STAs #2 or #3 or none of them. If after the reception of the Sector Ack frame a STA cannot find itself in the list of identified STAs, it may retry to perform asymmetric beamforming training during the next beamforming training allocation for this sector. A STA can attempt to receive the Sector Ack frame using either a directional or a quasi-omni antenna pattern.

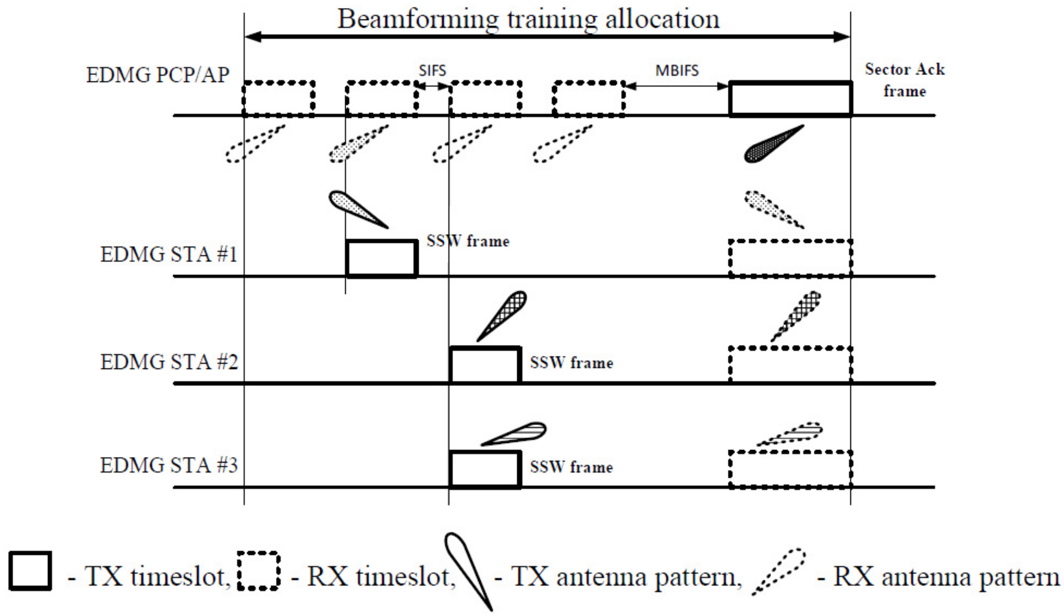


**Figure 10-94j—Example of beamforming training for asymmetric links in beamforming training allocation**

Following the successful completion of the beamforming training, the AP or PCP can schedule directional allocations for data exchange with the non-PCP and non-AP STA (see 10.39.12.3).

### 10.42.10.4 Group beamforming

An initiator that is an AP or PCP may simultaneously train a group of responder STAs that have antenna pattern reciprocity. This is referred to as group beamforming and, if performed, takes place in the BTI of a beacon interval. In group beamforming, the initiator trains its transmit antennas and sectors while a group of responders train their receive antennas and sectors. A DMG STA supports antenna pattern reciprocity if the value of the Antenna Pattern Reciprocity field in the STA’s DMG Capabilities element is 1.

To perform group beamforming, an AP or PCP shall, as specified in 10.42.4, include TRN-R subfields within the TRN field of each PPDU containing a DMG Beacon frame transmitted in a BTI. This is done by

- Setting the TXVECTOR parameter EDMG_TRN_LEN to a value greater than 0. The value of this parameter should be based on the maximum number of receive sectors and antennas across all intended responders; and
- Setting the TXVECTOR parameter EDMG_PPDU_TYPE to EDMG-TRN-R.

If the number of TRN-R subfield is smaller than a responder(s)' receive sectors and antennas, the responder(s) may train selected receive sectors and antennas with the available TRN-R subfields and may continue to train the other receive sectors and antennas with a subsequent DMG Beacon frame transmitted by the same transmit sector and with TRN-R subfields appended. Through reception of these TRN-R subfields, responders can determine the initiator's transmit antenna(s) and sector(s) that were received with the best quality and, given antenna pattern reciprocity, the responders can also determine their corresponding transmit antenna(s) and sector(s) with the best quality.

If the responder detects a change in the initiator's best TX antenna and sector, the responder may inform the AP or PCP of the change by transmitting an unsolicited Information Response frame to the AP or PCP containing an EDMG Channel Measurement Feedback element with an updated list of antenna and sector pairs.

### 10.42.10.5 BRP transmit sector sweep (BRP TXSS)

#### 10.42.10.5.1 General

Beam refinement protocol transmit sector sweep (BRP TXSS) is a procedure that allows EDMG STAs to determine improved antenna configurations for transmission and reception. The procedure is performed with the use of BRP frames, and consists of various phases of transmit sector sweep and receive training.

In BRP TXSS, the STA that initiates the procedure through the transmission of a BRP frame is referred to as the initiator, and the recipient STA of the BRP frame that participates in a BRP TXSS with the initiator is referred to as the responder.

In the BRP TXSS procedure, a BRP frame with acknowledgment is defined as a BRP frame that has the TX-TRN-OK field within the DMG Beam refinement element set to 1.

BRP TXSS may include as many as six phases: setup phase, transmit training phase by the initiator with feedback (referred to as Initiator BRP TXSS), receive training phase of the responder, transmit training phase by the responder with feedback (referred to as Responder BRP TXSS), receive training phase of the initiator, and acknowledgment phase. A BRP TXSS shall include a setup phase, an Initiator BRP TXSS, and an acknowledgment phase. As defined in 10.42.10.5.2, receive training for responder, Responder BRP TXSS, and receive training for initiator are included in a BRP TXSS depending on whether the procedure is a SISO BRP TXSS or a MIMO BRP TXSS and, for a SISO BRP TXSS, on reciprocity characteristics of the initiator and the responder.

An example of BRP TXSS is shown in Figure 10-94k for the case when the procedure is comprised of all six phases. In Figure 10-94k and in the remainder of 10.42.10.5:

- $N_{init}$ is the value of the TXSS-PPDUs subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the BRP TXSS.
- $R_{init}$ is the value of the TXSS-REPEAT subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the BRP TXSS.
- $N_{resp}$ is the value of the TXSS-PPDUs subfield within the EDMG BRP Request element in the BRP frame sent by the responder to confirm the procedure.
- Rresp is the value of the TXSS-REPEAT subfield within the EDMG BRP Request element in the BRP frame sent by the responder to confirm the procedure.

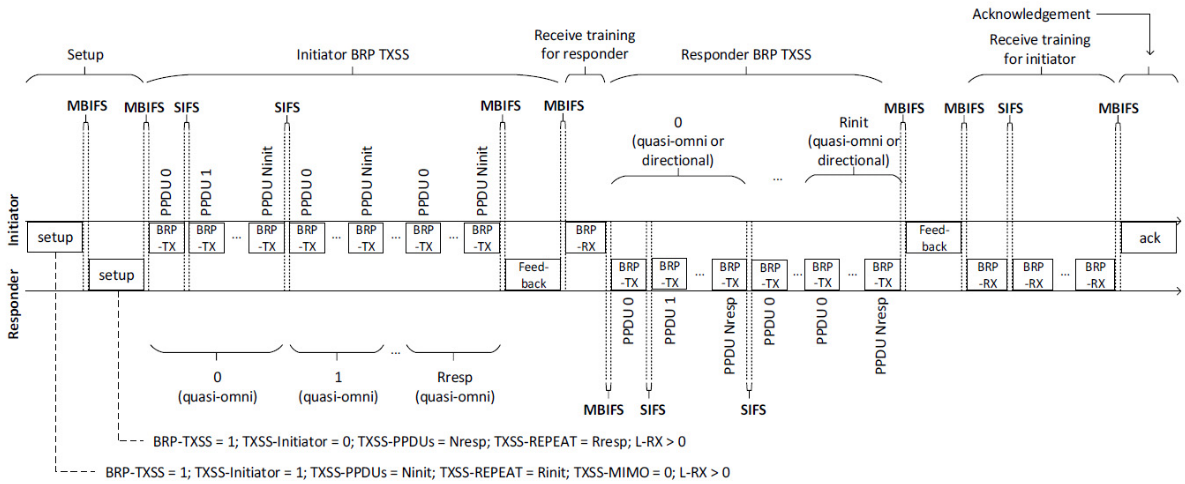


**Figure 10-94k—BRP TXSS when comprising all six phases**

As shown in Figure 10-94k and as defined in 10.42.10.5.3, the setup phase consists of the transmission of a BRP frame that requests BRP TXSS by the initiator followed by the transmission of a BRP frame that confirms the procedure by the responder. After receiving confirmation of the BRP TXSS request from the responder, the initiator performs an Initiator BRP TXSS. As defined in 10.42.10.5.2, in an Initiator BRP TXSS the initiator transmits $N_{init}$ + 1 EDMG BRP-TX PPDUs consecutively $R_{resp}$ + 1 times, and the same DMG antenna or set of DMG antennas is used by the responder when receiving the TRN field of all $N_{init}$ + 1 EDMG BRP-TX PPDUs within one of the $R_{resp}$ + 1 repetitions. The feedback sent by the responder within the Initiator BRP TXSS consists of a BRP frame with feedback of the measurements it performed during the reception of EDMG BRP-TX PPDUs. If receive training of the responder is included in the procedure, the TRN field of the EDMG BRP-RX PPDU sent immediately after the Initiator BRP TXSS is transmitted by the initiator and received by the responder using antenna configurations determined in the preceding Initiator BRP TXSS. In a Responder BRP TXSS, if present, the responder transmits $N_{resp}$ + 1 EDMG BRP-TX PPDUs consecutively $R_{init}$ + 1 times, and the same DMG antenna or set of DMG antennas is used by the initiator when receiving the TRN field of all $N_{resp}$ +1 EDMG BRP-TX PPDUs within one of the $R_{init}$ +1 repetitions. The feedback sent by the initiator within the Responder BRP TXSS consists of a BRP frame with feedback of the measurements it performed during the reception of EDMG BRP-TX PPDUs transmitted by the responder. If receive training of the initiator is included in the procedure, the TRN field of the one or more EDMG BRP-RX PPDUs sent immediately after the Responder BRP TXSS are transmitted by the responder and received by the initiator using antenna configurations determined in the preceding phases of the procedure. As defined in 10.42.10.5.2.3, the number of EDMG BRP-RX PPDUs transmitted in the receive training of the initiator depends on reciprocity characteristics of the initiator and the responder. The BRP TXSS is concluded with the transmission of a BRP frame with acknowledgment.

The TRN field of EDMG BRP-TX and EDMG BRP-RX PPDUs sent in a BRP TXSS may be transmitted with different DMG antennas than the ones used in the setup phase. Also, the TRN field of EDMG BRP-TX and EDMG BRP-RX PPDUs used in the procedure may be received with DMG antennas that are not the same ones used in the setup phase.

If both initiator and responder of a BRP TXSS are SU-MIMO capable (as defined in 10.42.10.2.2.1), EDMG BRP-TX PPDUs used in a BRP TXSS may be sent using multiple transmit chains simultaneously. As described in 10.42.10.2.2, the procedure in this case corresponds to the SISO phase of SU-MIMO beamforming training, and the MIMO phase of SU-MIMO beamforming training shall be performed after completion of the BRP TXSS.

As defined in 28.9.2.2.2, the TRN field in EDMG BRP PPDUs sent as part of BRP TXSS is transmitted over the entire channel bandwidth. Therefore, the BRP TXSS allows for transmit sector sweep over the entire channel bandwidth when the initiator and responder operate on a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel.

Similar to as specified in 10.42.6.4.2, all the PPDUs in a BRP-TXSS are transmitted with the same TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION values as those of the PPDU that initiated the BRP-TXSS.

#### 10.42.10.5.2 BRP TXSS configuration

##### 10.42.10.5.2.1 General

A SISO BRP TXSS is a BRP TXSS in which EDMG BRP PPDUs used in the procedure are transmitted using a single transmit chain. A MIMO BRP TXSS is a BRP TXSS in which EDMG BRP PPDUs used in the procedure are transmitted using multiple transmit chains.

##### 10.42.10.5.2.2 SISO BRP TXSS configuration—general

BRP frames transmitted in a BRP TXSS with feedback within an Initiator BRP TXSS or a Responder BRP TXSS and with acknowledgment at the end of the procedure shall be transmitted and received with the same DMG antennas and AWVs used in the setup phase. Also, these frames shall not include a TRN field.

All fields except for the TRN field of EDMG BRP-TX and EDMG BRP-RX PPDUs used in SISO BRP TXSS shall be transmitted with the same DMG antenna and AWV used in the setup phase. The TRN field of EDMG BRP-TX and EDMG BRP-RX PPDUs used in SISO BRP TXSS may be transmitted with a different DMG antenna than the one used in the transmission of the remaining fields of the same PPDU.

All fields of EDMG BRP-TX and EDMG BRP-RX PPDUs used in SISO BRP TXSS except for the TRN field shall be received with the same DMG antenna and AWV used in the setup phase. The TRN field of EDMG BRP-TX and EDMG BRP-RX PPDUs used in SISO BRP TXSS may be received with a DMG antenna that is not the same one used in the reception of the remaining fields of the same PPDU.

The Initiator BRP TXSS shall consist of the transmission of $N_{init}$ + 1 EDMG BRP-TX PPDUs consecutively repeated $R_{resp}$ + 1 times by the initiator followed by the transmission of a BRP frame with feedback by the responder. The EDMG BRP-TX PPDUs transmitted in an Initiator BRP TXSS shall be configured as follows:

— The TXVECTOR parameter TRN_RX_PATTERN of the PPDU shall be set to QUASI_OMNI.
— The TXVECTOR of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{resp}$ + 1 repetitions, where $1 \leq i \leq N_{init} + 1$, shall have the same value for the parameters EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N.
— The TRN field of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{resp}$ + 1 repetitions, where $1 \leq i \leq N_{init} + 1$, shall be transmitted using the same DMG antenna.
— The $j^{th}$ TRN subfield of the $k^{th}$ TRN-Unit of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{resp}$ + 1 repetitions, where $1 \leq j \leq M + 1$, $2 \leq k \leq L + 1$, and $1 \leq i \leq N_{init} + 1$, where $M$ and $L$ are the values of the TXVECTOR parameters EDMG_TRN_M and EDMG_TRN_LEN, shall be transmitted using the same AWV.
— The initiator should transmit the TRN field of each of the $N_{init}$ + 1 EDMG BRP-TX PPDUs within one of the $R_{resp}$ + 1 repetitions in an Initiator BRP TXSS using a different DMG antenna.

Similarly, the Responder BRP TXSS, if present, shall consist of the transmission of $N_{resp}$ +1 EDMG BRP-TX PPDUs consecutively repeated $R_{init}$ + 1 times by the responder followed by the transmission of a BRP frame with feedback by the initiator. The EDMG BRP-TX PPDUs transmitted in a Responder BRP TXSS shall be configured as follows:

— The value of the TXVECTOR parameter TRN_RX_PATTERN shall be set according to the Antenna Pattern Reciprocity and the DMG Antenna Reciprocity subfields within the DMG STA Capability Information field of both initiator and responder, as defined in 10.42.10.5.2.3.
— The TXVECTOR of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{init}$ + 1 repetitions, where $1 \leq i \leq N_{resp} + 1$, shall have the same value for the parameters EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N.
— The TRN field of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{init}$ + 1 repetitions, where $1 \leq i \leq N_{resp} + 1$, shall be transmitted using the same DMG antenna.
— The $j^{th}$ TRN subfield of the $k^{th}$ TRN-Unit of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{init}$ + 1 repetitions, where $1 \leq j \leq M + 1$, $2 \leq k \leq L + 1$, and $1 \leq i \leq N_{resp} + 1$, where $M$ and $L$ are the values of the TXVECTOR parameters EDMG_TRN_M and EDMG_TRN_LEN, respectively, shall be transmitted using the same AWV.
— The responder should transmit the TRN field of each of the $N_{resp}$ + 1 EDMG BRP-TX PPDUs within one of the $R_{init}$ + 1 repetitions in a Responder BRP TXSS using a different DMG antenna.

Receive training of the responder after the Initiator BRP TXSS is mandatory in SISO BRP TXSS, and it consists of the transmission of one EDMG BRP-RX PPDU by the initiator that allows for the responder to determine its receive configuration for the transmit configuration determined in the preceding Initiator BRP TXSS. The TRN field of the EDMG BRP-RX PPDU used for receive training of the responder

— Shall be transmitted with the best AWV identified in the preceding Initiator BRP TXSS.
— Shall be received with the DMG antenna corresponding to the best AWV configuration identified in the preceding Initiator BRP TXSS.
— Shall have a length that shall be equal to the value of the L-RX field in the BRP frame sent by the responder to confirm the procedure plus one.

Receive training of the initiator shall be performed if the value of the L-RX field in the BRP frame sent by the initiator to start the BRP TXSS is greater than 0. If the L-RX field in the BRP frame sent to start the BRP TXSS is equal to 0, receive training of the initiator shall not be performed. Receive training of the initiator consists of the transmission of one or more EDMG BRP-RX PPDUs by the responder that allows for the initiator to determine its receive configuration for the transmit configuration determined in the preceding Responder BRP TXSS or in the preceding receive training of the responder. The TRN field of the EDMG BRP-RX PPDUs used for receive training of the initiator

— Shall be transmitted with the best AWV identified in the preceding Responder BRP TXSS or in the receive training of the responder, as defined in 10.42.10.5.2.3.
— Shall be received with the DMG antenna corresponding to the best AWV identified in the Responder BRP TXSS or in the Initiator BRP TXSS, or with multiple DMG antennas, as defined in 10.42.10.5.2.3.
— Shall have a length that shall be equal to the value of the L-RX field in the BRP frame sent by the initiator to start the procedure plus one.

An example of a BRP TXSS is shown in Figure 10-94l for a scenario in which the initiator and the responder have two DMG antennas, and both the initiator and responder use one DMG antenna when performing measurements. It is assumed in this example that the best AWV configuration identified in the Initiator BRP TXSS was obtained when the initiator used DMG antenna 0 and the responder used DMG antenna 1, and that the best AWV configuration identified in the Responder BRP TXSS was obtained when the responder used DMG antenna 0 and the initiator used DMG antenna 0. If the responder in this example was capable of processing all of its antennas simultaneously, the duration of the BRP TXSS could be shortened as shown in Figure 10-94m.

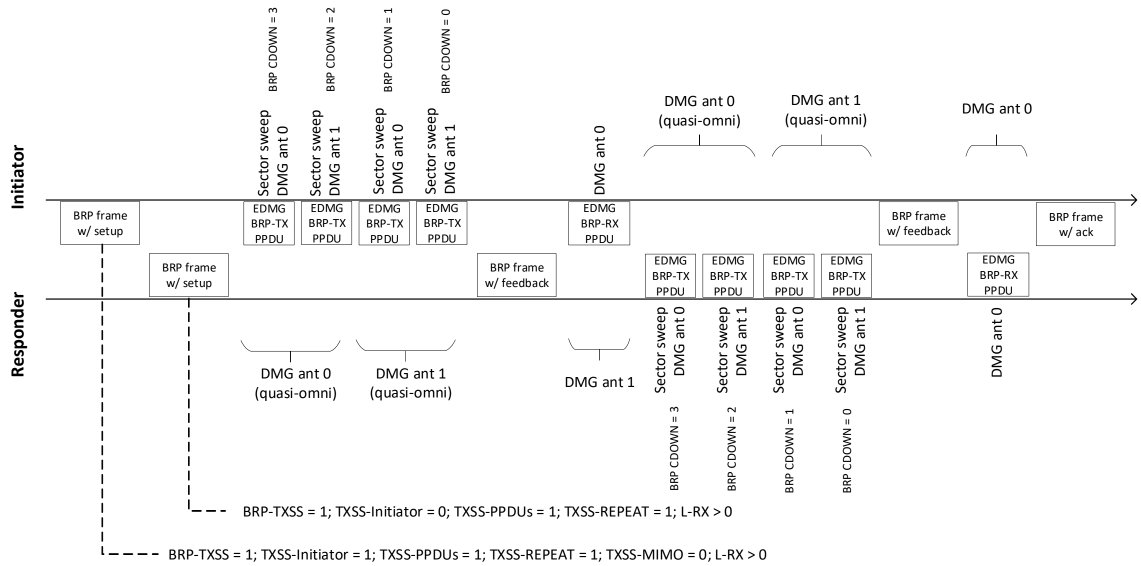


**Figure 10-94l—Example of BRP TXSS: responder performs measurements using one DMG antenna**

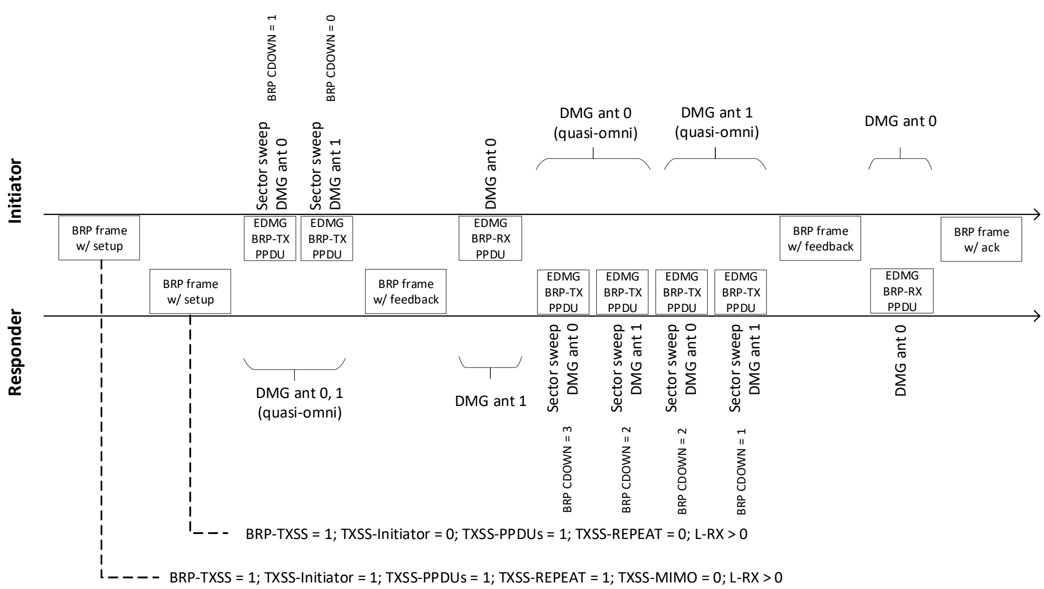


**Figure 10-94m—Example of BRP TXSS: responder performs measurements using multiple DMG antennas simultaneously**

The first TRN-Unit in an EDMG BRP PPDU used in a SISO BRP TXSS may be used for the initiator and responder to switch DMG antennas and shall not be processed by the receiver. Therefore, for EDMG BRP-TX and EDMG BRP-RX PPDUs transmitted during SISO BRP TXSS, the value of the TXVECTOR parameter EDMG_TRN_LEN shall be set to $k + 1$, where

— For the EDMG BRP-RX PPDU sent in the receive training for the responder, $k$ is equal to the value of the L-RX field in the BRP frame sent by the responder to confirm the procedure.
— If present, for the one or more EDMG BRP-RX PPDUs sent in the receive training for the initiator, $k$ is equal to the value of the L-RX field in the BRP frame sent by the initiator to start the BRP TXSS.

The TRN subfields that comprise the first TRN-Unit in EDMG BRP-TX PPDUs used as part of a BRP TXSS shall not be included in the TRN subfield and AWV feedback ID indexing procedures described in 28.9.2.2.5.

When transmitting an EDMG BRP-TX or an EDMG BRP-RX PPDU as part of a SISO BRP TXSS, an EDMG STA may change the DMG antenna used in the transmission of its TRN field during the first TRN-Unit and shall not change DMG antenna during the remaining TRN-Units.

When receiving an EDMG BRP-TX or an EDMG BRP-RX PPDU as part of SISO BRP TXSS, an EDMG STA may change the DMG antenna used in the reception of the TRN field during the first TRN-Unit and shall not change DMG antenna during the remaining TRN-Units.

For EDMG BRP-TX PPDUs used in a BRP TXSS, the AWV used in the transmission of the first $P$ TRN subfields of each TRN-Unit depends on whether the DMG antenna used in the transmission of an EDMG BRP-TX PPDU changes at the beginning of the TRN field. As defined in 28.9.2.2.5, if the TRN field of an EDMG BRP-TX PPDU is transmitted with the same DMG antenna as the remaining fields of the PPDU, the first $P$ TRN subfields of each TRN-Unit shall be transmitted using the same AWV as the remaining fields of the PPDU. If the DMG antenna used in the transmission of an EDMG BRP-TX PPDU changes at the beginning of the TRN field, the AWV used in the transmission of the first $P$ TRN subfields of each TRN-Unit is selected in an implementation dependent manner and should be the same for all TRN-Units.

#### 10.42.10.5.2.3 SISO BRP TXSS configuration—with reciprocity

A STA, responder or initiator, is antenna pattern reciprocal if the Antenna Pattern Reciprocity subfield in the DMG STA Capability Information field of the STA’s DMG Capabilities element is 1. Otherwise, the STA is not antenna pattern reciprocal.

A STA, responder or initiator, is DMG antenna reciprocal if the DMG Antenna Reciprocity subfield in the DMG STA Capability Information field of the STA’s DMG Capabilities element is 1. Otherwise, the STA is not DMG antenna reciprocal.

Responder BRP TXSS and receive training for the initiator are included in a SISO BRP TXSS depending on the reciprocity characteristics of the initiator and responder (see 10.42.10.5.2). Specifically, each of these two phases shall or shall not be included in a SISO BRP TXSS as defined in Table 10-31a.

If a SISO BRP TXSS includes receive training for the initiator, the L-RX field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS shall be set to a value greater than 0. If a SISO BRP TXSS does not include receive training for the initiator, the L-RX field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS shall be set to 0.

**Table 10-31a—Definition of whether Responder BRP TXSS and receive training for initiator are included in a SISO BRP TXSS**

("Yes" defines that the phase shall be included, and "No" defines that the phase shall not be included)

| Initiator | Responder | Phase: Responder BRP TXSS | Phase: Receive training for the initiator |
|---|---|---|---|
| Antenna pattern reciprocal | Antenna pattern reciprocal | No | No |
| Antenna pattern reciprocal | DMG antenna reciprocal | Yes | No |
| Antenna pattern reciprocal | Not antenna pattern reciprocal and not DMG antenna reciprocal | Yes | Yes |
| DMG antenna reciprocal | Antenna pattern reciprocal | No | Yes |
| DMG antenna reciprocal | DMG antenna reciprocal | Yes | Yes |
| DMG antenna reciprocal | Not antenna pattern reciprocal and not DMG antenna reciprocal | Yes | Yes |
| Not antenna pattern reciprocal and not DMG antenna reciprocal | Antenna pattern reciprocal | No | Yes |
| Not antenna pattern reciprocal and not DMG antenna reciprocal | DMG antenna reciprocal | Yes | Yes |
| Not antenna pattern reciprocal and not DMG antenna reciprocal | Not antenna pattern reciprocal and not DMG antenna reciprocal | Yes | Yes |

If the initiator is antenna pattern reciprocal and the responder is DMG antenna reciprocal, then

— The TXSS-REPEAT field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS shall be set to 0.
— The TXVECTOR parameter TRN_RX_PATTERN of EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be set to DIRECTIONAL.
— The TRN field of the EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be received with the RX AWV configuration corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the initiator is antenna pattern reciprocal and the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal, then

— The TXSS-REPEAT field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS shall be set to 0.
— The TXVECTOR parameter TRN_RX_PATTERN of EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be set to QUASI_OMNI.
— The TRN field of the EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be received with the DMG antenna corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the initiator is DMG antenna reciprocal and the SISO BRP TXSS includes a Responder BRP TXSS, then

— The TXSS-REPEAT field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS shall be set to 0.
— The TXVECTOR parameter TRN_RX_PATTERN of EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be set to QUASI_OMNI.

— The TRN field of the EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be received with the DMG antenna corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the initiator is not antenna pattern reciprocal and is not DMG antenna reciprocal and the SISO BRP TXSS includes a Responder BRP TXSS, then

— The TXSS-REPEAT field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the initiator to start the BRP TXSS may be set to a value greater than 0.
— The TXVECTOR parameter TRN_RX_PATTERN of EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be set to QUASI_OMNI.

If the responder is DMG antenna reciprocal, then

— The TXSS-PPDUs field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the responder to acknowledge the BRP TXSS request shall be set to 0.
— The TRN field of the EDMG BRP-TX PPDUs used in the Responder BRP TXSS shall be transmitted using the DMG antenna corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal, the TXSS-PPDUs field in the EDMG BRP Request element or EDMG BRP field within the BRP frame sent by the responder to acknowledge the BRP TXSS request may be set to a value greater than 0.

If the initiator is not antenna pattern reciprocal and is not DMG antenna reciprocal, and the responder is antenna pattern reciprocal, the receive training of the initiator consist of the transmission of $R_{init}$ + 1 EDMG BRP-RX PPDUs. For all other cases, the receive training of the initiator consists of the transmission of one EDMG BRP-RX PPDU.

If the initiator is DMG antenna reciprocal, the EDMG BRP-RX PPDU sent in the receive training of the initiator is received using the DMG antenna corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the initiator is antenna pattern reciprocal and the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal, the EDMG BRP-RX PPDU sent in the receive training of the initiator is received using the DMG antenna corresponding to the best AWV configuration identified in the Initiator BRP TXSS.

If the initiator is not antenna pattern reciprocal and is not DMG antenna reciprocal, and the responder is not antenna pattern reciprocal, the EDMG BRP-RX PPDU sent in the receive training of the initiator is received by the initiator with the DMG antenna corresponding to the best transmit AWV of the responder as identified in the Responder BRP TXSS.

The AWV configuration used in the transmission of the TRN field of the one or more EDMG BRP-RX PPDUs by the responder corresponds to the best AWV configuration identified in the receive training for the responder for the following cases:

— If the initiator is DMG antenna reciprocal and the responder is antenna pattern reciprocal.
— If the initiator is not antenna pattern reciprocal and is not DMG antenna reciprocal, and the responder is antenna pattern reciprocal.

The AWV configuration used in the transmission of the TRN field of the one or more EDMG BRP-RX PPDUs by the responder corresponds to the best AWV configuration identified in the Responder BRP TXSS for the following cases:

— If the initiator is antenna pattern reciprocal, and the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal.

— If both the initiator and responder are DMG antenna reciprocal.
— If the initiator is DMG antenna reciprocal, and the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal.
— If the initiator is not antenna pattern reciprocal and is not DMG antenna reciprocal, and the responder is DMG antenna reciprocal.
— If both the initiator and the responder are not antenna pattern reciprocal and are not DMG antenna reciprocal.

The examples given in Figure 10-94l and Figure 10-94m correspond to a scenario in which the initiator and responder are not antenna pattern reciprocal and are not DMG antenna reciprocal.

An example BRP TXSS for the case when the initiator is antenna pattern reciprocal, and the responder is not antenna pattern reciprocal and is not DMG antenna reciprocal is shown in Figure 10-94n.

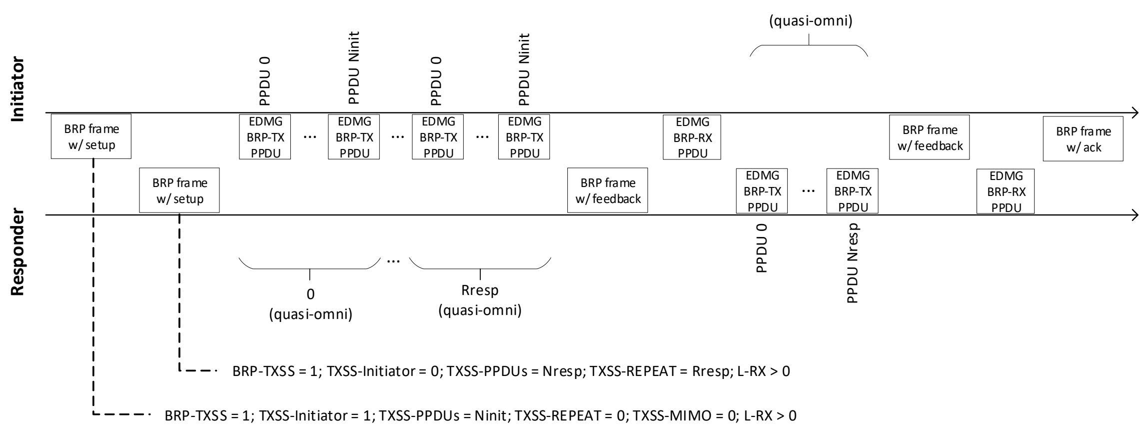


**Figure 10-94n—Example of BRP TXSS: initiator is antenna pattern reciprocal, and responder is not antenna pattern reciprocal and is not DMG antenna reciprocal**

An example BRP TXSS for the case when the initiator is DMG antenna reciprocal, and the responder is antenna pattern reciprocal is shown in Figure 10-94o.

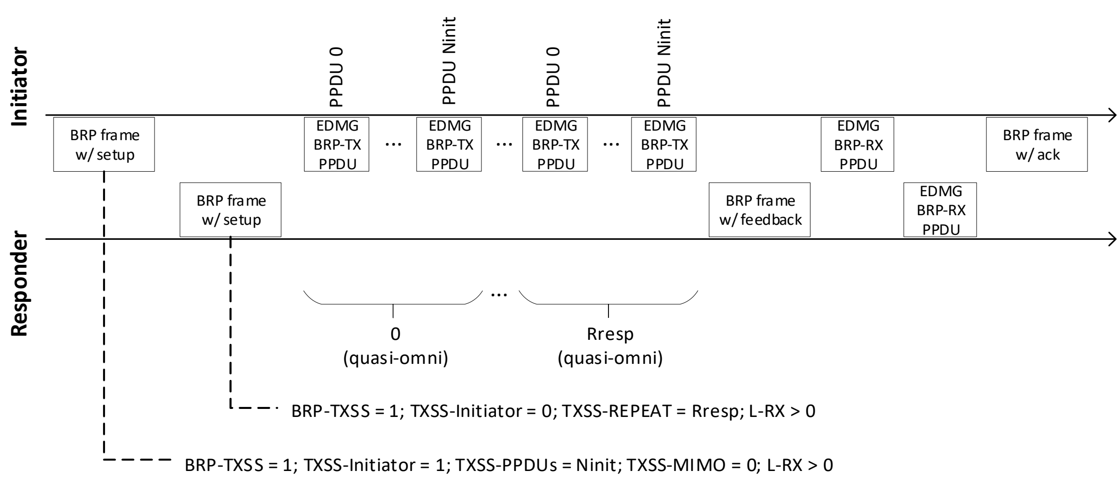


**Figure 10-94o—Example of BRP TXSS: initiator is DMG antenna reciprocal, and responder is antenna pattern reciprocal**

#### 10.42.10.5.2.4 MIMO BRP TXSS configuration

Receive training of the responder and receive training of the initiator shall not be performed in a MIMO BRP TXSS procedure. The L-RX field within the EDMG BRP Request element or EDMG BRP field in the BRP frames transmitted during the setup phase of a MIMO BRP TXSS shall be set to 0.

Responder BRP TXSS is mandatory in MIMO BRP TXSS.

An example of a MIMO BRP TXSS is shown in Figure 10-94p.

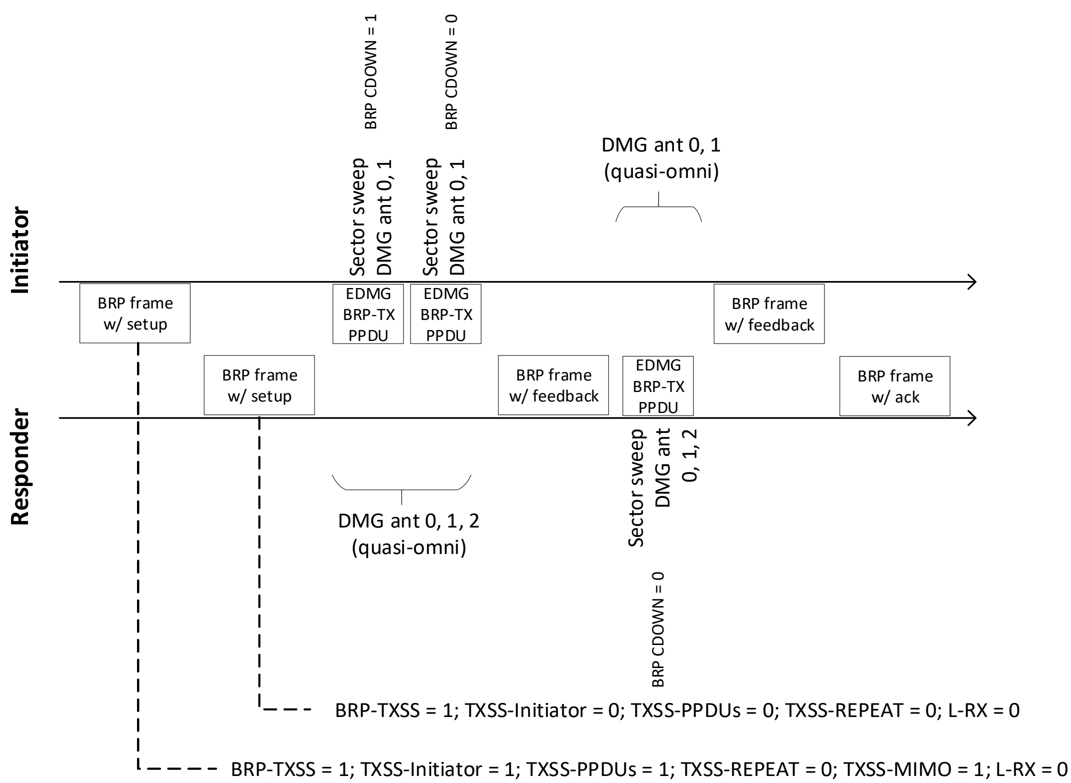


**Figure 10-94p—Example of MIMO BRP TXSS**

BRP frames sent in a MIMO BRP TXSS shall be transmitted by applying spatial expansion and mapping a single space-time stream to all *N* transmit chains to be trained in the procedure. The TRN field of EDMG BRP-TX PPDUs sent in a MIMO BRP TXSS shall consist of *N* orthogonal waveforms, as defined in 28.9.2.

BRP frames transmitted in a MIMO BRP TXSS during the setup phase, with feedback within an Initiator BRP TXSS, with feedback within a Responder BRP TXSS, and with acknowledgment at the end of the procedure shall not include a TRN field.

In the setup phase of a MIMO BRP TXSS, if an implementation has not yet determined AWVs to use in some of its transmit chains (for example, if a station has been using a single transmit chain before the setup phase), the AWVs used by such chains should be selected in an implementation dependent manner.

The DMG antennas and AWVs used in the transmission of all fields, except for the TRN field of EDMG BRP-TX PPDUs sent in the Initiator BRP TXSS, the Responder BRP TXSS, and with acknowledgment, shall be the same ones used in the setup phase. The TRN field of EDMG BRP-TX PPDUs sent in a MIMO

BRP TXSS may be transmitted with a different set of DMG antennas than the one used in the transmission of the remaining fields of the same PPDU.

Similarly, the DMG antennas and AWVs used in the reception of all fields, except for the TRN field of BRP frames sent in the Initiator BRP TXSS, the Responder BRP TXSS, and with acknowledgment, shall be the same ones used in the setup phase. The TRN field of EDMG BRP-TX PPDUs sent in a MIMO BRP TXSS may be received with a set of DMG antennas that is not the same one used in the reception of the remaining fields of the same PPDU.

The Initiator BRP TXSS shall consist of the transmission of $N_{init}$ + 1 EDMG BRP-TX PPDUs consecutively repeated $R_{resp}$ + 1 times by the initiator followed by the transmission of a BRP frame with feedback by the responder. The EDMG BRP-TX PPDUs transmitted in an Initiator BRP TXSS shall be configured as follows:

— The TXVECTOR parameter TRN_RX_PATTERN of the PPDU shall be set to QUASI_OMNI.
— The TXVECTOR of the $i^{\text{th}}$ EDMG BRP-TX PPDU within each of the $R_{resp}$ + 1 repetitions, where $1 \leq i \leq N_{init} + 1$, shall have the same value for the parameters EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N.
— The TRN subfields of the $i^{th}$ EDMG BRP-TX PPDU within each of the $R_{resp}$ + 1 repetitions, where $1 \leq i \leq N_{init}+1$, shall be transmitted using the same set of DMG antennas and the same AWVs.
— The set of DMG antennas used when transmitting the TRN field of the $N_{init}$ + 1 EDMG BRP-TX PPDUs within one of the $R_{resp}$ + 1 repetitions in an Initiator BRP TXSS should be different.

Similarly, the Responder BRP TXSS shall consist of the transmission of $N_{resp}$ + 1 EDMG BRP-TX PPDUs consecutively repeated $R_{init}$ + 1 times by the responder followed by the transmission of a BRP frame with feedback by the initiator. The EDMG BRP-TX PPDUs transmitted in a Responder BRP TXSS shall be configured as follows:

— The TXVECTOR parameter TRN_RX_PATTERN of the PPDU shall be set to QUASI_OMNI.
— The TXVECTOR of the $i^{\text{th}}$ EDMG BRP-TX PPDU within each of the $R_{init}$ + 1 repetitions, where $1 \leq i \leq N_{resp} + 1$, shall have the same value for the parameters EDMG_TRN_LEN, EDMG_TRN_P, EDMG_TRN_M, and EDMG_TRN_N.
— The TRN subfields of the $i^{\text{th}}$ EDMG BRP-TX PPDU within each of the $R_{init}$ + 1 repetitions, where $1 \leq \mathrm{i} \leq N_{resp} + 1$, shall be transmitted using the same set of DMG antennas and the same AWVs.
— The set of DMG antennas used when transmitting the TRN field of the $N_{resp}$ + 1 EDMG BRP-TX PPDUs within one of the $R_{init}$ + 1 repetitions in a Responder BRP TXSS should be different.

In both Initiator BRP TXSS and Responder BRP TXSS of a MIMO BRP TXSS, the set of DMG antennas used when receiving the TRN subfields of EDMG BRP-TX PPDUs of different repetitions should be different.

A STA that is part of a MIMO BRP TXSS shall provide feedback for each of the DMG antennas trained in the procedure, as defined in 10.42.10.5.3.

The first TRN-Unit in an EDMG BRP PPDU used in a MIMO BRP TXSS may be used for the initiator and responder to switch one or more DMG antennas used and shall not be processed by the receiver. Therefore, for EDMG BRP-TX PPDUs transmitted in a MIMO BRP TXSS, the value of the TXVECTOR parameter EDMG_TRN_LEN shall be set to $k + 1$, where $k$ is the number of TRN-Units used for transmit training. The TRN subfields that comprise the first TRN-Unit in EDMG BRP-TX PPDUs used as part of a MIMO BRP TXSS shall not be included in the TRN subfield and AWV feedback ID indexing procedures described in 28.9.2.2.5.

When transmitting an EDMG BRP-TX PPDU as part of a MIMO BRP TXSS, an EDMG STA may change the set of DMG antennas used in the transmission of its TRN field during the first TRN-Unit and shall not change DMG antennas during the remaining TRN-Units.

When receiving an EDMG BRP-TX PPDU as part of MIMO BRP TXSS, an EDMG STA may change the set of DMG antennas used in the reception of the TRN field during the first TRN-Unit and shall not change DMG antennas during the remaining TRN-Units.

For EDMG BRP-TX PPDUs used in a MIMO BRP TXSS, the AWVs used in the transmission of the first $P$ TRN subfields of each TRN-Unit depends on whether the set of DMG antennas used in the transmission of the EDMG BRP-TX PPDU changes at the beginning of the TRN field. If the TRN field of an EDMG BRP-TX PPDU is transmitted with the same set of DMG antennas as the remaining fields of the PPDU, the first $P$ TRN subfields of each TRN-Unit shall be transmitted using the same DMG Antennas and AWVs as the remaining fields of the PPDU. If the set of DMG antennas used in the transmission of an EDMG BRP-TX PPDU changes at the beginning of the TRN field, the AWVs used in the transmission of the first $P$ TRN subfields of each TRN-Unit are selected in an implementation dependent manner and should be the same for all TRN-Units.

#### 10.42.10.5.2.5 Configuration of BRP TXSS for 2.16+2.16 GHz and 4.32+4.32 GHz channels

The initiator of a BRP TXSS requests to perform BRP TXSS over a 2.16+2.16 GHz or a 4.32+4.32 GHz channel by sending a BRP frame with setup that has the Channel Aggregation Requested field in the DMG Beam Refinement element set to 1 and with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE. If the responder accepts the request by sending a BRP frame with setup with the Channel Aggregation Requested field set to 1 and the value of the TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION equal to the value of the RXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION of the BRP frame sent by the initiator, all BRP frames sent as part of the BRP TXSS shall have the same TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION.

BRP frames sent in a BRP TXSS performed in a 2.16+2.16 GHz or a 4.32+4.32 GHz channel during the setup phase or with the TXVECTOR parameter EDMG_TRN_LEN greater than 0 shall be sent using the EDMG control mode. BRP frames sent in a BRP TXSS with feedback or with acknowledgment shall be transmitted using an EDMG PPDU or a non-EDMG duplicate PPDU. As defined in 28.3.3.3.2.2, the total number of transmit chains, $N_{TX}$, is an even number, and the first $N_{TX}/2$ transmit chains are used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains are used for transmission on the secondary channel. In the setup phase, if an implementation has not yet determined AWVs to use in the secondary channel, the AWVs used by the $N_{TX}/2$ transmit chains used for transmission on the secondary channel is selected in an implementation dependent manner. If a BRP frame sent in a BRP TXSS performed in a 2.16+2.16 GHz or a 4.32+4.32 GHz includes a TRN field, the TXVECTOR parameter TRN_AGGREGATION shall be set to AggregationTRN.

If the TXSS-MIMO field within the EDMG BRP Request element or EDMG BRP field in a BRP frame with setup sent by the initiator is equal to 0, the BRP TXSS shall be configured as described in 10.42.10.5.2.2. If the TXSS-MIMO field is equal to 1, the BRP TXSS shall be configured as described in 10.42.10.5.2.4. In both cases, the values of the TXSS-PPDUs and TXSS-REPEAT fields exchanged during the setup correspond to the number of PPDUs and of repetitions, respectively, in each of the two aggregated channels.

A STA that is part of a BRP TXSS that is performed over a 2.16+2.16 GHz or a 4.32+4.32 GHz channel shall provide feedback for each of the two aggregated channels. BRP frames with feedback in this case shall have the Channel Aggregation Present field within the DMG Beam Refinement element set to 1.

#### 10.42.10.5.3 BRP TXSS execution

A BRP TXSS shall complete within the CBAP or SP in which it was initiated.

The FBCK-REQ subfield in the DMG Beam Refinement element carried within the BRP frame that initiates a BRP TXSS shall be set to 10001 (binary).

To request a BRP TXSS, the initiator sends a BRP frame with both the BRP-TXSS field and the TXSS-INITIATOR field within the EDMG BRP Request element or EDMG BRP field set to 1 and the TXSS-PPDUs field set to indicate the number of EDMG BRP-TX PPDUs necessary for the initiator to perform transmit training. To confirm the BRP TXSS execution, the responder shall respond with a BRP frame MBIFS after the reception of the BRP frame sent by the initiator with the BRP-TXSS field within the EDMG BRP Request element or EDMG BRP field set to 1, the TXSS-INITIATOR field set to 0, and the TXSS-REPEAT field set to indicate the number of requested repetitions of the EDMG BRP-TX PPDUs sent by the initiator.

If the procedure includes a Responder BRP TXSS, the TXSS-REPEAT field in the BRP frame sent by the initiator shall be set to indicate the number of requested repetitions of the EDMG BRP-TX PPDUs sent by the responder, and the TXSS-PPDUs field in the BRP frame sent by the responder shall be set to indicate the number of EDMG BRP-TX PPDUs necessary for the responder to perform transmit training. If the procedure does not include a Responder BRP TXSS, the TXSS-REPEAT field in the BRP frame sent by the initiator shall be set to 0 and the TXSS-PPDUs field in the BRP frame sent by the responder shall be set to 0.

The TXSS-MIMO subfield in the EDMG BRP Request element or EDMG BRP field of the BRP frame that initiates the BRP TXSS shall be set to 1 when the procedure is a MIMO BRP TXSS. If the procedure is a SISO BRP TXSS, the TXSS-MIMO subfield shall be set to 0. Both initiator and responder of a BRP TXSS shall be SU-MIMO capable (as defined in 10.42.10.2.2.1) for the TXSS-MIMO subfield to be set to 1.

The initiator shall transmit the first EDMG BRP-TX PPDU MBIFS after the reception of the BRP frame sent by the responder confirming the BRP TXSS execution.

The EDMG BRP-TX PPDUs sent by the initiator in a BRP TXSS procedure shall be separated by SIFS. The responder shall then send a BRP frame to the initiator containing feedback based on measurements it performed during the Initiator BRP TXSS. The BRP frame with feedback transmitted by the responder is separated from the last EDMG BRP-TX PPDU transmitted by the initiator by an MBIFS.

A BRP frame with feedback transmitted in a BRP TXSS may have the EDMG-SHORT-FBCK field set to 0 or 1. If the EDMG-SHORT-FBCK field is 0, the BRP frame shall have the SNR Present subfield within the FBCK-TYPE field set to 1, the Sector ID Order subfield set to 1, the EDMG Extension Flag set to 1 and the EDMG Channel Measurement Present set to 1. The EDMG Sector ID Order field indicates the AWV IDs, TX antennas and RX antennas of sectors that were received in the procedure. If the EDMG-SHORT-FBCK field is 1, the Sector ID/CDOWN/AWV ID subfield indicates the Sector ID of a PPDU received in the sector sweep. For both cases, when the EDMG-SHORT-FBCK field is 0 or 1, the SNR subfields indicate the SNRs with which the BRP PPDUs received through the corresponding sectors were received and the BRP-CDOWN subfields associated with each SISO ID indicate the BRP-CDOWN values within the BRP PPDUs received from the corresponding sector.

In an Initiator BRP TXSS, the BRP CDOWN field within the EDMG BRP Request element or EDMG BRP field in each transmitted EDMG BRP-TX PPDU shall contain the total number of transmissions remaining until the end of the Initiator BRP TXSS, such that the first EDMG BRP-TX PPDU transmitted in the Initiator BRP TXSS has the BRP CDOWN field set to $(N_{init} + 1) \times (R_{resp} + 1) - 1$ and the last PPDU has the BRP CDOWN field set to 0. The use of BRP CDOWN is illustrated in Figure 10-94l and Figure 10-94m.

If the BRP TXSS includes receive training of the responder, the initiator shall transmit one EDMG BRP-RX PPDU MBIFS after the reception of the BRP frame sent by the responder with feedback of the Initiator BRP TXSS.

If the procedure includes a Responder BRP TXSS, the responder shall send the first EDMG BRP-TX PPDU MBIFS after the EDMG BRP-RX PPDU sent by the initiator or, if receive training of the responder is not performed, the BRP frame with feedback transmitted by the responder within the Initiator BRP TXSS. The EDMG BRP-TX PPDUs sent by the responder in a BRP TXSS procedure shall be separated by SIFS.

The BRP CDOWN field within the EDMG BRP Request element or EDMG BRP field in each transmitted EDMG BRP-TX PPDU shall contain the total number of transmissions remaining until the end of the Responder BRP TXSS, such that the first EDMG BRP-TX PPDU transmitted in the Responder BRP TXSS has the BRP CDOWN field set to $(N_{resp} + 1) \times (R_{init} + 1) – 1$, and the last PPDU has the BRP CDOWN field set to 0.

If the BRP TXSS includes a Responder BRP TXSS, the initiator shall send a BRP frame to the responder containing feedback based on measurements it performed. The BRP frame with feedback transmitted by the initiator is separated from the last EDMG BRP-TX PPDU transmitted by the responder by an MBIFS.

If the BRP TXSS includes receive training of the initiator, the responder shall transmit the first EDMG BRP-RX PPDU MBIFS after the reception of the BRP frame sent by the initiator with feedback of the Responder BRP TXSS or, if Responder BRP TXSS is not performed, of the EDMG BRP-RX PPDU transmitted by the initiator. The EDMG BRP-RX PPDUs sent by the responder shall be separated by SIFS.

If the BRP TXSS includes receive training of the initiator, the initiator shall transmit a BRP frame with acknowledgment MBIFS after the reception of the last EDMG BRP-RX PPDU transmitted by the responder if it was successfully received. If the BRP TXSS does not include receive training of the initiator, the responder shall transmit a BRP frame with acknowledgment if the last BRP frame sent by the initiator was successfully received.

The responder and initiator of a SISO BRP TXSS shall start using the AWV configurations identified in the procedure immediately after the transmission of the BRP frame with acknowledgment.

If the TXSS-MIMO subfield in the EDMG BRP Request element or EDMG BRP field of the BRP frame that initiated the BRP TXSS was set to 1, the initiator shall start the MIMO phase of SU-MIMO beamforming training an MBIFS following the completion of the BRP TXSS.

#### 10.42.10.6 First path beamforming training

An EDMG STA that has the First Path Training Supported subfield in the STA's EDMG Capabilities element equal to 1 is first path beamforming capable.

An EDMG STA shall not initiate first path beamforming training with a peer EDMG STA that is not first path beamforming capable.

An EDMG STA requests first path beamforming training by initiating a BRP transaction with a BRP frame containing a training request that has the First Path Training subfield set to 1. An EDMG STA that is first path beamforming capable and that receives a BRP frame with the First Path Training subfield equal to 1 shall set the First Path Training subfield to 1 in the frame that it sends in response to the reception of the BRP frame.

In a BRP transaction that is part of a first path beamforming training, all transmitted BRP frames shall have the First Path Training subfield set to 1. EDMG BRP-TX, BRP-RX and BRP-RX/TX PPDUs may be used in first path beamforming transaction. In such a transaction, all the PPDUs that have the TXVECTOR parameter EDMG_TRN_LEN > 0 shall have the FIRST_PATH_TRAINING parameter in the TXVECTOR set to 1. All TX and RX beamforming training are used to find the AWV of the first path and not the best path. The first path is defined to be the propagation path between TX and RX that is estimated to have shortest time of flight. In line of sight (LOS) conditions, the first path corresponds to the LOS path. If several AWVs have the same estimated shortest time of flight, the beamforming training shall select the first path as the one with the best quality. The method a STA uses to determine the first path and the first path with the best quality is implementation dependent and beyond the scope of this standard. At the end of a first path beamforming transaction, both the initiator and responder shall return to the AWV of the prior established best path, which might not necessarily be the first path.

NOTE—First path beamforming training can be employed for positioning applications where it is desired that range and direction measurements are performed with beamforming in favor of the LOS path.

### 10.42.10.7 Dual polarization TRN beamforming training

Dual polarization TRN beamforming training may be used to assist a pair of EDMG STAs to determine if a beamformed link between them uses line-of-sight or non-line-of-sight propagation.

An EDMG STA supports dual polarization TRN beamforming training if the Dual Polarization TRN Supported subfield in the STA’s EDMG Capabilities element is 1.

An EDMG STA may initiate dual polarization TRN beamforming training with a peer EDMG STA if the peer STA

- Supports dual polarization TRN beamforming training and
- Indicates that it is capable of sending channel measurement feedback by setting the Chan-FBCK-CAP subfield to 1 in the last BRP Request field transmitted by the peer STA to the initiating STA.

Dual polarization TRN beamforming shall include at least a setup phase that consists of BRP frame from the initiator followed by a BRP frame from the responder, which is followed by a TRN training phase and the responder’s channel measurement feedback as shown in Figure 10-94q.

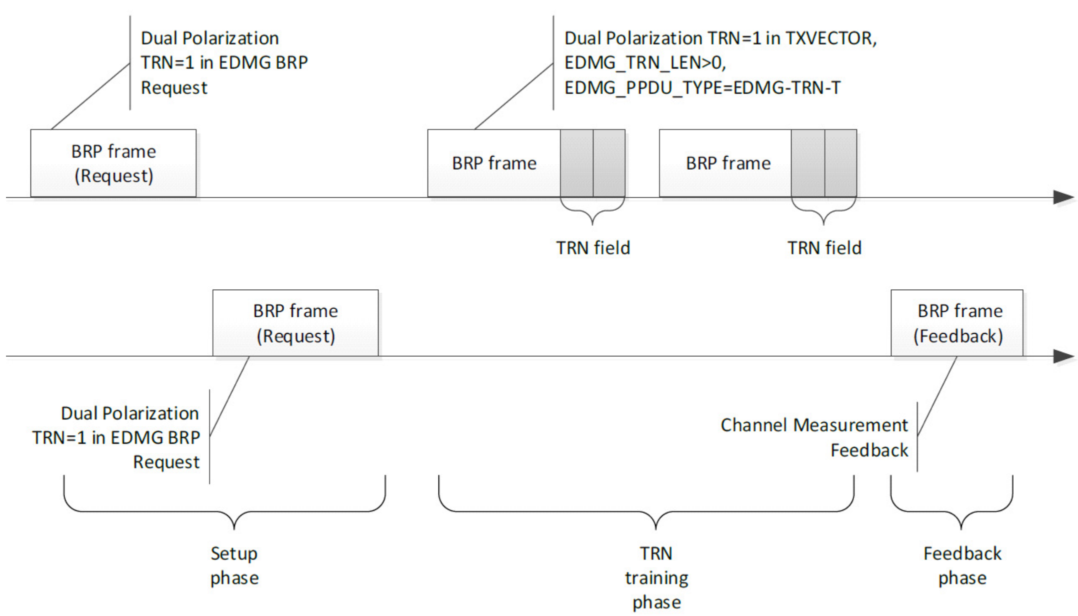


**Figure 10-94q—Dual polarization TRN beamforming training procedure**

In the setup phase, to request dual polarization TRN beamforming training, an intiating STA shall transmit a BRP frame to a responding STA that includes an EDMG BRP Request element with the following field setting:

— Dual PolarizationTraining set to 1
— TXSS-initiator set to 1
— TXSS-Repeat > 0

To conclude the setup phase, the responder shall repond, in a SIFS following the reception of the BRP frame from the initiator, with a BRP frame that contains an EDMG BRP Request element with the following field setting:

— Dual PolarizationTraining set to 1
— TXSS-initiator set to 0

During the dual polarization transmit training phase, the initiator sends PPDUs with TRN subfields within the TRN field switching polarization as described in 28.9.2.2.5, with the following TXVECTOR parameter setting:

— DUAL_POL_TRAINING set to 1.
— EDMG_PPDU_TYPE set to either EDMG-TRN-T or EDMG-TRN-R/T.
— EDMG_TRN_LEN set to a value greater than 0.
— EDMG_TRN_N set to either 1 or 3 (for EDMG_TRN_N=1, two consecutive TRN subfields have alternate polarization, e.g., horizontal vertical (HV) or vertical horizontal (VH); for EDMG_TRN_N=3, the polarization changes after two consecutive TRN subfields, e.g., HHVV or VVHH).

In the TRN training phase, when changing polarizations, the initiator shall change the TRN subfields polarizations with a 90 degrees rotation in a clockwise direction. For example for HV, the polarization changes from TRN horizontal polarization direction to vertical polarization direction via a 90 degrees clockwise rotation. As the responder receives the PPDUs in the dual polarization transmit training phase, it measures the signal strength of the dual polarized received TRN subfield as described in 28.9.2.2.5. This might require the responder to switch the receive polarization.

In the feedback phase, the responder responds with a BRP frame with the Channel Measurement Feedback element and EDMG Channel Measurement Feedback element that includes the Dual Polarization TRN Measurement field.

The initiator may use the received feedback to estimate if the communication link with the responder is NLOS or LOS.

If, in addition to the TXVECTOR parameters specified above in this subclause, the initiator sets the FIRST_PATH_TRAINING parameter to 1 and the First Path Training field of the EDMG BRP Request element to 1, the responder shall perform the measurement on the first arrival path and respond with a BRP frame with Channel Measurement Feedback element and EDMG Channel Measurement Feedback element with the Dual Polarization TRN field and First Path Training fields in the EDMG BRP Request element set to 1.

### 10.42.11 TDD beamforming

#### 10.42.11.1 General

The following TDD beamforming procedures are defined in this subclause:

— TDD individual beamforming: a single STA (initiator) transmits a series of TDD SSW frames through its sectors while a target STA (responder) sweeps the receive sectors specified by MLME-SCAN.request or MLME-TDD-BEAM-MEASUREMENT.request primitives. If the responder receives at least one TDD SSW frame, by exchanging additional frames both initiator and responder are made aware of one or more combinations of transmit beam on the initiator side and receive beam on the responder side that enable communication between the two STAs.

— TDD group beamforming: a single STA (initiator) transmits a series of TDD SSW frames through its sectors while two or more target STAs (responders) sweep the receive sectors specified by MLME-SCAN.request or MLME-TDD-BEAM-MEASUREMENT.request primitives at each target STA. For each responder that receives at least one TDD SSW frame, by exchanging additional frames both initiator and responder are made aware of one or more combinations of transmit beam on the initiator side and receive beam on the responder side.

— TDD beam measurement: a single STA (initiator) transmits a series of TDD SSW frames while a single target STA (responder), or alternatively a group of target STAs (responders), sweep their respective receive sectors. The primary difference between TDD beam measurement and other TDD beamforming procedures is that in TDD beam measurement responders transmit an Announce frame with a TDD Route element to the initiator during the procedure only upon request, and additionally, report the measurement results to the SME.

As specified in 11.54.2, unscheduled TDD beamforming is referred to as the TDD beamforming scheduled via the Transmit Period field within a TDD SSW frames. If TDD beamforming is scheduled via the TDD Slot Schedule element, it is referred to as scheduled TDD beamforming.

After the completion of the TDD beamforming procedure, the responder shall send to the initiator Announce frames containing TDD Route element with the results of the TDD beamforming. For unscheduled TDD beamforming, the initiator and responder may perform the authentication and association procedure described in 11.54.3.

All TDD beamforming procedures shall be performed during a TDD SP.

The TDD individual and group beamforming procedures assume antenna reciprocity for both the initiator and responder STAs. A TDD Beamforming frame is a TDD SSW frame, a TDD SSW Feedback frame or a TDD SSW Ack frame.

Figure 10-94r gives an example of the TDD individual beamforming training procedure.

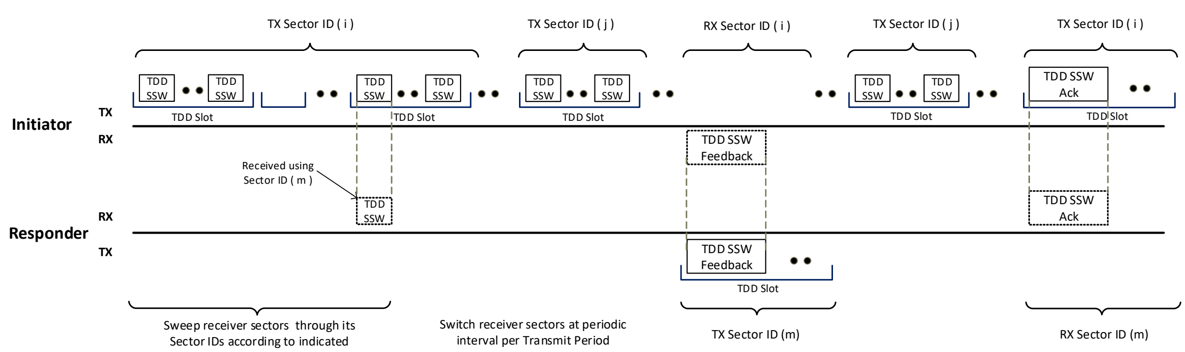


**Figure 10-94r—Example of TDD individual beamforming training**

During TDD individual beamforming training, a STA that has not established a DMG control mode connection with an intended peer switches its antenna configuration through all its receive sectors. In order to establish a DMG control mode connection, an initiator sends multiple TDD SSW frames during its assigned TDD slots. A TDD SSW frame indicates to the responder the TX Sector ID used by the initiator for the transmission of the TDD SSW frame and, in case of unscheduled TDD beamforming, the frame also includes the time offset for which the responder should send its TDD SSW Feedback frame as response and the time offset the responder shall be ready to receive one or more TDD SSW Ack frames sent to increase robustness. The responder sends its TDD SSW Feedback frame with the same sector it received the TDD SSW frame with the best quality. Following the reception of a TDD SSW Feedback frame, the initiator sends a TDD SSW Ack frame that acknowledges the received configuration.

During TDD individual BF training, the TDD SSW frame is sent periodically and is repeated multiple times for each TX Sector ID. The TDD individual BF training sequence continues until the initiator sets the End of Training subfield in the TDD SSW Ack frame to 1. In unscheduled TDD beamforming, the TDD SSW Ack frame includes also a time offset indication in the Initiator Transmit Offset subfield on when the responder obtains the network configuration parameters and time offset indication in the Responder Transmit Offset subfield on when the responder reports the results of the TDD individual BF procedure.

Figure 10-94s gives an example of the TDD group beamforming training procedure.

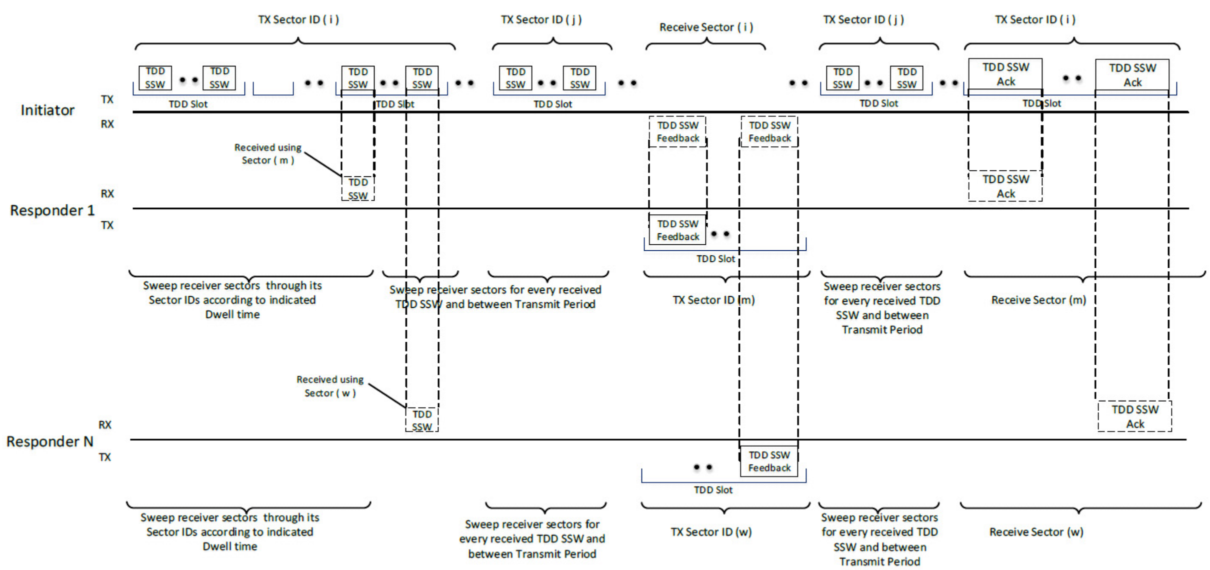


**Figure 10-94s—Example of TDD group beamforming training**

A STA participating in TDD group beamforming training and that has not established a DMG control mode connection with an intended peer switches its antenna configuration through all its receive sectors. In order to establish a DMG control mode connection, an initiator sends multiple TDD SSW frames during its assigned TDD slots. A TDD SSW frame indicates to the responders the TX Sector ID used by the initiator for the transmission of the TDD SSW frames and, in case of unscheduled TDD beamforming, the frame also includes the time offset for which each responder should send its TDD SSW Feedback frame as response and the time offset each responder shall be ready to receive a TDD SSW Ack frame. Each responder sends its TDD SSW Feedback frame with the same sector it received the TDD SSW frame with the best quality. Following the reception of a TDD SSW Feedback frame, the initiator sends a TDD SSW Ack frame to each responder that acknowledges the received configuration.

During the TDD group BF training, the TDD SSW frame is sent periodically and is repeated multiple times for each TX Sector ID. The TDD group BF training sequence for each responder continues until the initiator sets the End of Training subfield in the TDD SSW Ack frame to 1 for the corresponding responder. For unscheduled TDD beamforming, the initiator also indicates in the Initiator Transmit Offset subfield the time offsets on when the corresponding responder obtains the TDD Slot Schedule element for allocated TDD slots for further TDD link access operation and in the Responder Transmit Offset subfield the time offset on when the corresponding responder reports the results of the TDD group BF procedure. The initiator can end a TDD group BF training with the responders simultaneously or individually. This is implementation dependent and beyond the scope of this standard.

### 10.42.11.2 Initiator operation for TDD individual beamforming

For TDD individual beamforming, the BFType parameter is set to TDD Individual BF in the MLME-TDD-BF-TRAINING.request primitive.

To initiate TDD individual beamforming with a known responder, the initiator shall send multiple TDD SSW frames with the RA field set to the Responder STA's MAC address as indicated by the PeerSTAAddress parameter of the MLME-TDD-BF-TRAINING.request primitive.

To initiate TDD individual beamforming with an unknown responder, the initiator shall send TDD SSW frames with the RA field set to the broadcast address. The initiator should switch the RA field in a transmitted TDD SSW frame to responder's MAC address after receiving a TDD SSW Feedback frame from the intended responder.

TDD SSW frames that are sent from the same transmit DMG antenna shall have the same TX Antenna ID subfield value. TDD SSW frames that are sent from the same transmit antenna sector shall have the same TX Sector ID, Beamforming Time Unit, Transmit Period, Responder Feedback Offset, Initiator Ack Offset and Number of Requested Feedback subfield values. These frames shall be transmitted with the same transmit power and the PPDUs carrying these frames shall not include TRN fields.

The initiator shall send TDD SSW frames through all the DMG antennas and all the sectors indicated by the TX antenna index and TX sector index values as indicated in the TXAntennaSectorIDList parameter of the MLME-TDD-BF-TRAINING.request primitive. Moreover, for each DMG antenna and for each sector, the initiator shall send TDD SSW frames with the same TX Antenna ID and TX Sector ID subfields values for the number of times indicated in the NumOfTDDSlotPerTXSector parameter multiplied by NumOfSSWPerTDDSlot parameter of the MLME-TDD-BF-TRAINING.request primitive. If the initiator transmits a TDD SSW Ack frame, the initiator shall send as many TDD SSW Ack frames as the number indicated in the NumOfAckPerTDDSlot parameter of the MLME-TDD-BF-TRAINING.request primitive.

The Transmit Period subfield value within TDD SSW frames shall remain the same throughout a TDD beamforming training. If the value of the Transmit Period subfield is nonzero, at the time offset equal to the Transmit Period subfield value the initiator shall transmit a TDD SSW frame of the TDD beamforming training with the same Count Index value.

If the link between the initiator and responder is in the active state (see 11.54), and the initiator has sent the responder at least one frame with a TDD Slot Structure element and a TDD Slot Schedule element, then the initiator should use BF TDD slots to send TDD SSW and TDD SSW Ack frames to the responder. In this case, the Transmit Period, Responder Feedback Offset, Initiator Ack Offset, Initiator Transmit Offset and Responder Transmit Offset subfields shall be set to 0.

TDD SSW and TDD SSW Ack frames transmitted in the same TDD slot shall be separated with SBIFS and shall have a strictly increasing Count Index subfield value. The first TDD SSW frame or TDD SSW Ack frame transmitted in a TDD slot shall have the Count Index subfield set to 0. The Responder Feedback Offset subfield shall be equal in all TDD SSW frames transmitted in the same TDD slot. The Initiator Ack

Offset subfield shall be equal in all TDD SSW frames transmitted in the same TDD slot. The Initiator Transmit Offset subfield shall be equal in all TDD SSW Ack frames transmitted in the same TDD slot. The Responder Transmit Offset subfield shall be equal in all TDD SSW Ack frames transmitted in the same TDD slot.

To receive a TDD SSW Feedback frame from the responder, the initiator shall set its receive antenna to the same DMG antenna and sector that were indicated, respectively, in the TX Antenna ID and TX Sector ID subfield of the corresponding TDD SSW frame, at the following offset calculated as a spacing from the end of the transmitted TDD SSW frame to the start of the expected transmission of the TDD SSW Feedback frame by the responder:

$$\mathit{ResponderFeedbackOffset} - [(\mathit{CountIndex} + 1) \times \mathrm{TXTIME(TDD\ SSW)} + (\mathit{CountIndex} \times \mathrm{SBIFS})] \tag{10-19}$$

where

*ResponderFeedbackOffset* is the value of the Responder Feedback Offset subfield in the TDD SSW frame with the same TX Sector ID within the same TDD slot

*CountIndex* is the value of the Count Index subfield in the transmitted TDD SSW frame

Figure 10-94t depicts the timing to transmit the TDD SSW Feedback frame for unscheduled TDD individual BF.

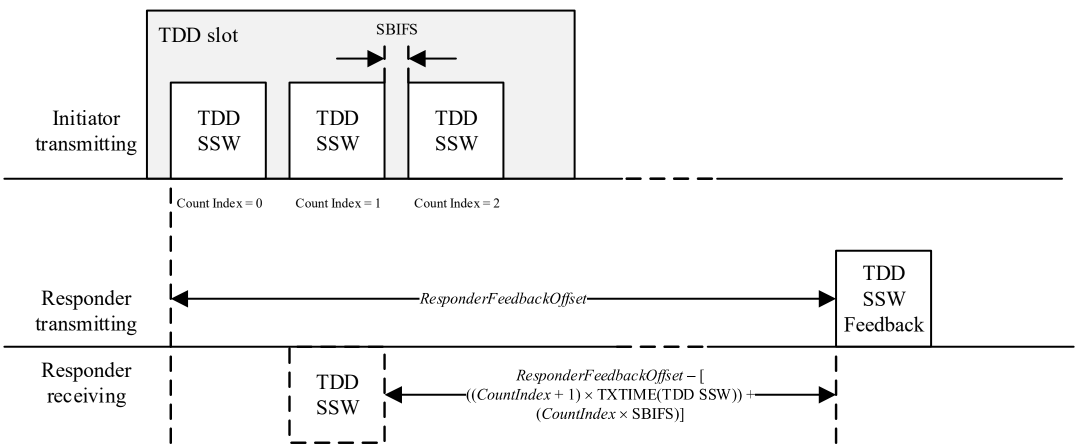


**Figure 10-94t—TDD SSW Feedback frame transmit time for unscheduled TDD individual BF**

If the initiator received a TDD SSW Feedback frame, it shall transmit one or more TDD SSW Ack frames to the responder. To transmit these frames, the initiator shall set its DMG antenna and sector to the Decoded TX Antenna ID and the Decoded TX Sector ID from the last received TDD SSW Feedback frame. The transmission of the first TDD SSW Ack frame shall start at the following offset calculated as a spacing from the end of the transmitted TDD SSW frame to the start of the transmission of the first TDD SSW Ack frame:

$$\mathit{InitiatorAckOffset} - [(\mathit{CountIndex} + 1) \times \mathrm{TXTIME(TDD\ SSW)} + (\mathit{CountIndex} \times \mathrm{SBIFS})] \tag{10-20}$$

where

*InitiatorAckOffset* is the value of the Initiator Ack Offset subfield in the TDD SSW frame with the same TX Sector ID within the same TDD slot

*CountIndex* is the value of the Count Index subfield in the transmitted TDD SSW frame

The TDD SSW Ack frame shall include in the Decoded TX Sector ID subfield the sector indicated by the responder in the TX Sector ID subfield, in the Decoded TX Antenna ID subfield the sector indicated by the responder in the TX Antenna ID subfield of the TDD SSW Feedback frame last received by the initiator, the measured SNR of the decoded TDD SSW Feedback frame in the SNR Report subfield and, when performing unscheduled TDD beamforming, the time offsets to exchange frames containing TDD Route, TDD Slot Structure and TDD Slot Schedule elements.

For TDD individual BF, an initiator may request the responder to stop its receive sector sweeping by setting the End of Training subfield to 1 in transmitted TDD SSW frames. Upon reception of a TDD SSW Feedback frame with the End of Training subfield equal to 1, the initiator shall send one or more TDD SSW Ack frames to the responder with End of Training subfield set to 1 at the time offset indicated by Equation (10-20) or, alternatively, during assigned BF TDD slots. After sending a TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall configure its receive and transmit DMG antenna and sector index as indicated, respectively, in the Decoded TX Antenna ID and Decoded TX Sector ID subfields of the TDD SSW Feedback frame received from the responder in which its End of Training subfield was set to 1. The initiator shall use this DMG antenna and sector for its subsequent transmissions and receptions with the responder, until another sector is negotiated.

After the initiator has sent the TDD SSW Ack frame with the End of Training subfield set to 1 to the responder, it may transmit a single PPDU other than a TDD Beamforming frame to the responder. To transmit the frame, the initiator shall set its antennas to the Decoded TX Sector ID and the Decoded TX Antenna ID from the last received TDD SSW Feedback frame. The transmission of the frame shall start at the following offset calculated as a spacing from the end of the transmitted TDD SSW Ack frame with the End of Training subfield set to 1 to the start of the expected transmission:

$$\mathit{InitiatorTransmitOffset} - [(\mathit{CountIndex} + 1) \times \mathrm{TXTIME}(\mathrm{TDD\ SSW\ Ack}) + (\mathit{CountIndex} \times \mathrm{SBIFS})] \tag{10-21}$$

where

| | |
|---|---|
| *InitiatorTransmitOffset* | is the value of the Initiator Transmit Offset subfield in the TDD SSW Ack frame with the End of Training subfield set to 1 |
| *CountIndex* | is the value of the Count Index subfield in the transmitted TDD SSW Ack frame with the End of Training subfield set to 1 |

Subsequent opportunities for the initiator to transmit to the responder are separated by the value of the Transmit Period subfield in the TDD SSW Ack frame with the End of Training subfield set to 1.

After the initiator has sent the last TDD SSW Ack frame with the End of Training subfield set to 1 to the responder, it shall be ready to receive a single PPDU other than a TDD Beamforming frame from the responder by setting its receive DMG antenna and sector to the Decoded TX Antenna ID and the Decoded TX Sector ID from the last received TDD SSW Feedback frame, at the following offset calculated as a spacing from the end of the transmitted TDD SSW Ack frame with the End of Training subfield set to 1 to the start of the expected reception of the frame:

$$\mathit{ResponderTransmitOffset} - [(\mathit{CountIndex} + 1) \times \mathrm{TXTIME}(\mathrm{TDD\ SSW\ Ack}) + (\mathit{CountIndex} \times \mathrm{SBIFS})] \tag{10-22}$$

where

| | |
|---|---|
| *ResponderTransmitOffset* | is the value of the Responder Transmit Offset subfield in the TDD SSW Ack frame with the End of Training subfield equal to 1 |
| *CountIndex* | is the value of the Count Index subfield in the transmitted TDD SSW Ack frame with the End of Training subfield equal to 1 |

Subsequent opportunities for the responder to transmit to the initiator are separated by the value of the Transmit Period subfield in the TDD SSW Ack frame with the End of Training subfield set to 1.

For the unscheduled TDD beamforming procedure, Equation (10-19) and Equation (10-20) establish transmit opportunities to exchange TDD Beamforming frames, and Equation (10-21) and Equation (10-22) establish transmit opportunities to exchange frames other than TDD Beamforming frames after TDD beamforming training completion with the responder.

In the unscheduled TDD beamforming procedure, upon transmission of the last TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall transmit an Announce frame to the responder, at the time offset indicated by Equation (10-21). The Announce frame shall include a TDD Slot Structure element. The initiator shall then, at the time offset indicated by Equation (10-22), be ready to receive a frame from the responder. If necessary, the initiator shall transmit additional frames at the periodic transmit opportunities following the time offset indicated by Equation (10-21), and shall be ready to receive additional frames at the periodic opportunities following the offset indicated by Equation (10-22).

In the scheduled TDD beamforming procedure, the initiator shall send TDD SSW and TDD SSW Ack frames during BF TDD slots assigned to transmit from the initiator to the responder. The exchange of TDD Route elements takes place during Basic or Data TDD slots available to the initiator and to the responder after completion of the TDD beamforming training with the responder.

### 10.42.11.3 Responder operation for TDD individual beamforming

A responder STA that has is in inactive state (see 11.54), or has not yet received a TDD SSW frame, or has not yet acquired the TDD Slot Structure element used by the BSS shall sweep its receiver antenna through all its receive sectors while dwelling on each sector for a time equal to SectorDwellTime as indicated by the MLME-TDD-BF-SCAN.request primitive.

NOTE 1—To increase the likelihood of detecting the initiator’s TDD SSW frame, the responder SME can set SectorDwellTime to at least [2 × TXTIME (TDD SSW) + SBIFS].

Figure 10-94u gives an example of the responder’s receiver sweeping procedure for unscheduled TDD individual BF.

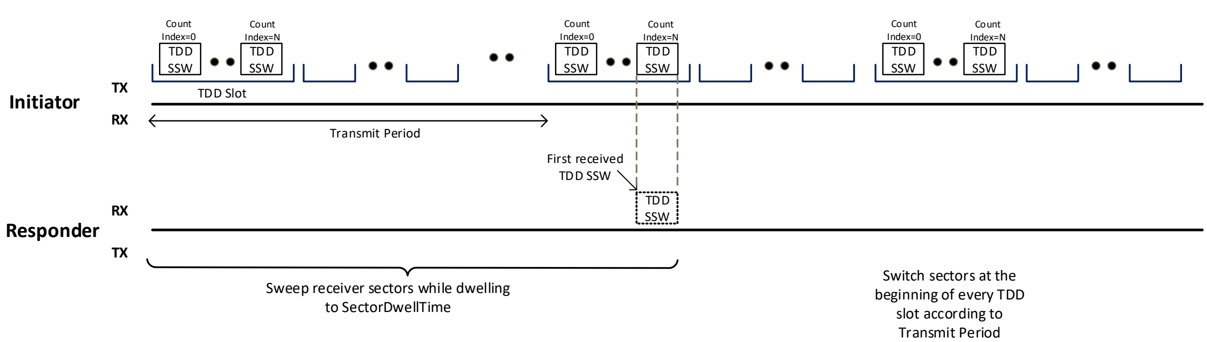


**Figure 10-94u—Responder’s receiver sweeping for unscheduled TDD individual BF**

Once the first TDD SSW frame is received, the responder proceeds with the following operation.

Upon reception on a receive sector of a TDD SSW frame with the RA field set to its MAC address or to the broadcast address, a responder shall switch within the TDD slot to its next receive sector to be ready to receive the next TDD SSW frame transmission within SBIFS. The responder shall switch its receive sector at the beginning of every TDD slot used for BF training at the time specified by a nonzero Transmit Period subfield in the received TDD SSW frame. While sweeping through its receive sectors, the responder shall continue decoding all the received TDD SSW frames.

NOTE 2—Switching the receive sectors after reception of each TDD SSW frame increases the number of trained receive sectors at the expense of receive sector measurement quality.

The responder shall transmit a TDD SSW Feedback frame using the DMG antenna and sector from which the responder received the TDD SSW with the best link quality at the time indicated by Equation (10-19) or, alternatively, during an assigned BF TDD slot. The TDD SSW Feedback frame shall include the DMG antenna index and sector index used by the initiator to transmit the TDD SSW frame in the, respectively, Decoded TX Antenna ID and Decoded TX Sector ID subfields, the DMG antenna index and sector index used by the responder to transmit the TDD SSW Feedback frame in the, respectively, TX Antenna ID and TX Sector ID subfields, and the SNR of the TDD SSW frame received with the best quality in the SNR Report subfield. The number of transmitted TDD SSW Feedback frames shall be equal to the value indicated in the Number of Requested Feedback subfield plus one of the received TDD SSW frame. The Feedback Count Index subfield in each transmitted TDD SSW Feedback frame shall contain the index of the TDD SSW Feedback frame transmitted in the same TDD slot, with the first TDD SSW Feedback frame having an index equal to 0. Except for the value of the Feedback Count Index subfield, all subfields of TDD SSW Feedback frames transmitted in a TDD slot shall have the same value of the corresponding field transmitted in the first TDD SSW Feedback frame within the TDD slot.

At the time offset indicated by Equation (10-20) of the decoded TDD SSW frame or, alternatively, during an assigned BF TDD slot, the responder shall set its receiver to the same DMG antenna and to the same sector that was indicated in the, respectively, TX Antenna ID and TX Sector ID subfields of the TDD SSW Feedback frame in order to be ready to receive a TDD SSW Ack frame from the initiator.

The responder shall continue sweeping through its receive sectors until successfully receiving and decoding a TDD SSW Ack frame with End of Training subfield equal to 1. Upon the reception of TDD SSW Ack frame with End of Training subfield equal to 1, the responder shall stop its receive sweeping and shall configure its DMG antenna as indicated in the Decoded TX Antenna ID subfield and its sector as indicated in the Decoded TX Sector ID subfield of the TDD SSW Ack frame received from the initiator that has the End of Training subfield equal to 1. The responder shall use this DMG antenna and sector for its subsequent frame exchanges with the initiator, until another sector is negotiated.

A responder that transmits a TDD SSW Feedback frame in response to a TDD SSW frame sent with End of Training subfield equal to 1 shall set the End of Training subfield in the TDD SSW Feedback frame to 1.

In the unscheduled TDD beamforming procedure, upon reception of a TDD SSW Ack frame with End of Training subfield equal to 1, the responder shall be ready to receive an Announce frame from the initiator at the time offset indicated by Equation (10-21). The responder shall then, at the time offset indicated by Equation (10-22), transmit an Announce or (Re)Association Request frame that includes a TDD Route element listing the ordered pairs of transmit sectors and decoded receive sectors obtained during the TDD beamforming training with the initiator. If necessary, the responder shall transmit additional frames at the periodic transmit opportunities following the time offset indicated by Equation (10-22), and shall be ready to receive additional frames at the periodic opportunities following the offset indicated by Equation (10-21).

In the scheduled TDD beamforming procedure, the responder shall send TDD SSW Feedback frames during BF TDD slots assigned to transmit from the responder to the initiator. The exchange of TDD Route elements takes place during Basic or Data TDD slots available to the initiator and the responder after completion of the TDD beamforming training.

A STA that has started to sweep its receive DMG antenna configuration in response to a TDD SSW frame with RA field set to the broadcast address and, during the same beamforming process, receives a TDD SSW frames with RA field set to an individual address different from the STA's MAC address shall stop its receive sweeping and shall configure its DMG antenna to the sector as indicated in the last successful TDD beamforming or TDD sector switch procedure and shall use this sector for its subsequent frame exchanges with the initiator, until another sector is negotiated.

NOTE 3—Switching from group addressed to individual addressed TDD beamforming can be used as method to discover a new STA in vicinity. In this case, other responders remain connected and revert to previously negotiated sectors.

A non-AP and non-PCP responder that has a link in active state with the initiator and that has received a frame with a TDD Slot Structure element and a TDD Slot Schedule element shall sweep its receiver antenna configuration through its received sectors in BF TDD slots. The responder shall resume the sweep from the previous configuration (used in the preceding BF TDD slot, if any) at the beginning of each BF TDD slot regardless of the value of the Transmit Period subfield within a received TDD SSW frame. In this case, the SectorDwellTime should be set to TXTIME(TDD SSW)+SBIFS. Such a responder shall use a BF TDD slot assigned for transmission from the responder to the initiator to trasnsmit a TDD SSW Feedback frame using the best DMG antenna when receiving TDD SSW frames of the current BF TDD sector training. The responder may set the End of Training subfield in the TDD SSW Feedback frame to indicate that it has received enough repetitions from the current transmit sector, so that the initiator may proceed to the next transmit sector. In this case, the initiator shall not set the End of Training subfield in the following TDD SSW Ack frame to 1.

#### 10.42.11.4 Initiator operation for TDD group beamforming

For TDD group beamforming, the BFType parameter is set to TDD group BF in the MLME-TDD-BF-TRAINING.request primitive.

To initiate TDD group beamforming, the initiator shall send multiple TDD SSW frames. For each TDD SSW frame, the RA field shall be set to the broadcast address. The Responder ID subfield of each responder included in a transmitted TDD SSW frame is set to be the value derived from the responder's MAC address following the scheme depicted in Figure 10-94v. The MAC address of each responder is indicated by the PeerSTAAddress parameter of the MLME-TDD-BF-TRAINING-START.request primitive.

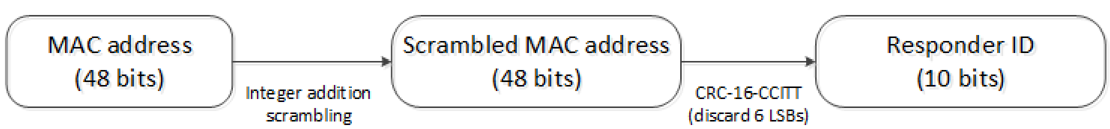


**Figure 10-94v—Generation of Responder ID subfield**

The process starts by using the MAC address of the responder to generate the scrambled MAC address. The MAC address is divided into three words, $word_i$ ($0 \leq i \leq 2$), of 16 bits each, where $word_0$ is the 16 MSB of the MAC address and $word_2$ is the 16 LSB of the MAC address. For each $word_i$, a $scrambled\_word_i$ is created as follows:

$$scrambled\_word_i = (word_i + scramble\_pattern) \bmod 2^{16}$$

where

| | |
|---|---|
| $word_i$ | is the corresponding 16 bit word from the MAC address |
| $scramble\_pattern$ | is $((0x5795 \times seed\_value) \bmod 2^{15})$, where $seed\_value$ is the value of the Scrambler Initialization field in the L-Header of the PPDU carrying the TDD SSW frame |

The scrambled MAC address is generated by the consecutive concatenation of $scrambled\_word_0$, $scrambled\_word_1$, and $scrambled\_word_2$.

Finally, the Responder ID subfield is generated by taking the 10 MSBs of CRC-16-CCITT computed over the scrambled MAC address. The CRC-16 is computed as defined in 20.3.7.

TDD SSW frames that are sent from the same transmit DMG antenna shall have the same TX Antenna ID subfield value. TDD SSW frames that are sent from the same transmit sector shall have the same TX Sector ID subfield value. TDD SSW frames shall be transmitted at the same transmit power and shall not include BRP training fields.

An initiator shall send TDD SSW frames through all the DMG antennas and all the sectors indicated by the TX antenna index and TX sector index values contained in the TXAntennaSectorIDList parameter of the MLME-TDD-BF-TRAINING.request primitive. For each DMG antenna and each sector, the initiator shall send TDD SSW frames with the same TX Antenna ID and TX Sector ID subfield values for the number of times indicated in the NumOfTDDSlotPerTXSector parameter multiplied by the NumOfSSWPerTDDSlot parameter of the MLME-TDD-BF-TRAINING.request primitive. If the initiator transmits a TDD SSW Ack frame, the initiator shall send as many TDD SSW Ack frames as the number indicated in the NumOfAckPerTDDSlot parameter of the MLME-TDD-BF-TRAINING.request primitive.

The Transmit Period subfield value within TDD SSW frames shall remain the same throughout a TDD beamforming training. If the value of the Transmit Period subfield is nonzero, at the time offset equal to the Transmit Period subfield value the initiator shall transmit a TDD SSW frame or a TDD SSW Ack frame of the TDD beamforming training with the same Count Index value.

TDD SSW and TDD SSW Ack frames transmitted in the same TDD slot shall be be separated with SBIFS and shall have a strictly increasing Count Index subfield value, with the first transmitted TDD SSW frame or TDD SSW Ack frame in a TDD slot having this subfield equal to 0.

To receive a TDD SSW Feedback frame from the responder, the initiator shall set its receive DMG antenna to the same DMG antenna and sector as was indicated, respectively, in the TX Antenna ID and TX Sector ID subfields of the respective TDD SSW frame, at the following offset from the end of the last transmitted TDD SSW frame:

$$\begin{aligned}&ResponderFeedbackOffset_n - [AckCountIndex \times \mathrm{TXTIME(TDD\ SSW\ Ack)} + \\ &(CountIndex + 1 - AckCountIndex) \times \mathrm{TXTIME(TDD\ SSW)} + (CountIndex \times \mathrm{SBIFS})]\end{aligned} \tag{10-23}$$

where

| | |
|---|---|
| $ResponderFeedbackOffset_n$ | is the value of the Responder Feedback Offset subfield in the $n^{th}$ responder's Responder Info subfield of the TDD SSW frame with the same TX Sector ID within the same TDD slot |
| *CountIndex* and *AckCountIndex* | are, respectively, the values of the Count Index and Ack Count Index subfields in the transmitted TDD SSW frame |

In order to avoid collision of TDD SSW Feedback frames, different Responder Feedback Offset subfield values in the Responder Info subfield of the TDD SSW frame should be used for different responders.

Figure 10-94w depicts the calculation of time to transmit a TDD SSW Feedback frame for unscheduled TDD group BF.

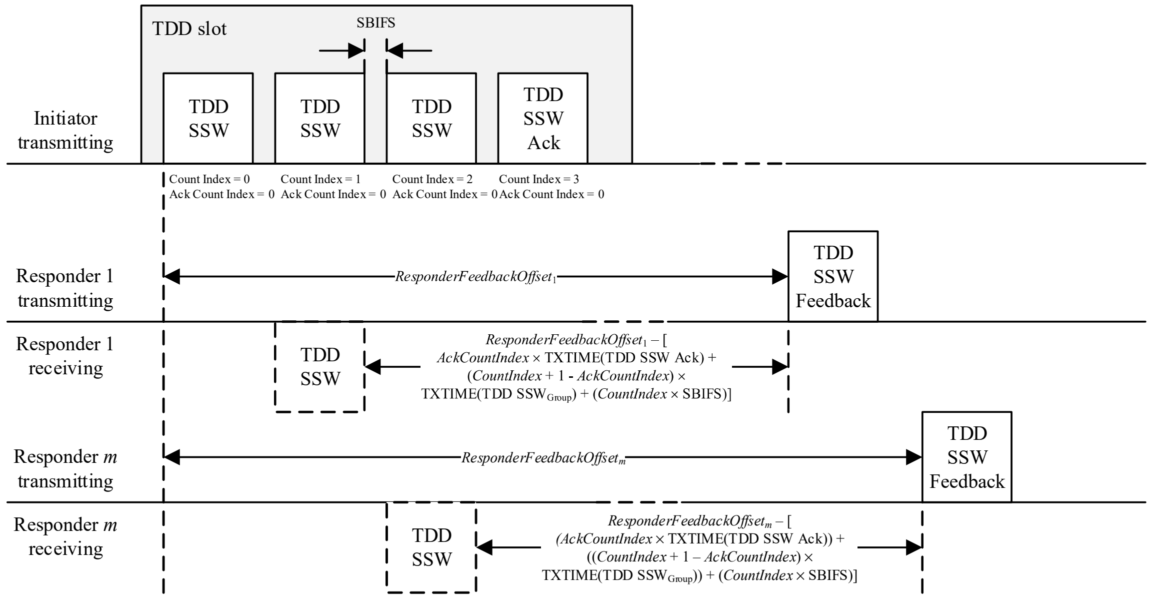


**Figure 10-94w—TDD SSW Feedback frame transmit time for unscheduled TDD group BF**

If the initiator received a TDD SSW Feedback frame, it shall transmit one or more TDD SSW Ack frames to the responder that sent the TDD SSW Feedback frame. To transmit the frames to this responder the initiator shall set its antennas to the Decoded TX Sector ID and the Decoded TX Antenna ID from the last TDD SSW Feedback frame received from this responder. The transmission of the first TDD SSW Ack frame shall start at the following offset calculated as a spacing from the end of the transmitted TDD SSW frame to the start of the transmission of the first TDD SSW Ack frame to the responder that sent the TDD SSW Feedback frame:

$$InitiatorAckOffset_n - [AckCountIndex \times \text{TXTIME(TDD SSW Ack)} + (CountIndex + 1 - AckCountIndex) \times \text{TXTIME(TDD SSW)} + (Count\ Index \times \text{SBIFS})] \quad (10\text{-}24)$$

where

| | |
|---|---|
| $InitiatorAckOffset_n$ | is the value of the Initiator Ack Offset subfield in the $n^{\text{th}}$ responder's Responder Info subfield of the TDD SSW frame with the same TX Sector ID within the same TDD slot |
| *CountIndex* and *AckCountIndex* | are, respectively, the values of the Count Index and Ack Count Index subfields in the transmitted TDD SSW frame |

The TDD SSW Ack frame shall include the DMG antenna and sector used by the responder to transmit the TDD SSW Feedback frame in, respectively, the Decoded TX Antenna ID and Decoded TX Sector ID subfields, the measured SNR of the decoded TDD SSW Feedback frame in the SNR Report subfield and, when performing unscheduled TDD beamforming, time offsets to exchange frames containing TDD Route, TDD Slot Structure, and TDD Slot Schedule elements.

For TDD group BF, an initiator may request one or more responders to stop their receive sector sweeping by setting the End of Training subfield to 1 in the Responder Info subfield corresponding to each responder in a transmitted TDD SSW frame. Upon reception of a TDD SSW Feedback frame with the End of Training subfield equal to 1 from a responder, the initiator shall send one or more TDD SSW Ack frames to the corresponding responder with the End of Training subfield set to 1 at the time offset indicated by Equation (10-24) or, alternatively, at a TDD slot allocated via the TDD Slot Schedule element. The initiator may also set the End of Training subfield in SSW Ack frames to 1 even if the End of Training subfield in a received TDD SSW Feedback frame was not set to 1. After sending a TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall configure its receive and transmit DMG antenna and sector index as indicated in the Decoded TX Antenna ID and Decoded TX Sector ID subfields of the TDD SSW Feedback frame received from the corresponding responder in which its End of Training subfield was set to 1. The initiator shall use this DMG antenna and sector for its subsequent transmissions and receptions with the corresponding responder, until another sector is negotiated.

The length of a TDD SSW frame shall remain the same during TDD group beamforming. For each target responder that has completed TDD beamforming training, the corresponding Responder Info Valid subfield shall be set to 0 to indicate an invalid Responder Info subfield.

Once the initiator sends a TDD SSW Ack frame with the End of Training subfield equal to 1 to a target responder, it may transmit a single PPDU other than a TDD Beamforming frame to the target responder. To transmit this frame, the initiator shall set its transmit DMG antenna and sector to the Decoded TX Antenna ID and the Decoded TX Sector ID from the TDD SSW Feedback frame last received from the target responder. The transmission of the frame shall start at the following offset calculated as a spacing from the end of the last transmitted SSW Ack frame with the End of Training subfield set to 1 to the start of the expected transmission:

$$\begin{aligned}&InitiatorTransmitOffset - [(AckCountIndex + 1) \times \mathrm{TXTIME(TDD\ SSW\ Ack)} + \\ &(CountIndex - AckCountIndex) \times \mathrm{TXTIME(TDD\ SSW)} + (Count\ Index \times \mathrm{SBIFS})]\end{aligned} \tag{10-25}$$

where

| | |
|---|---|
| *InitiatorTransmitOffset* | is the value of the Initiator Transmit Offset subfield in the TDD SSW Ack frame with the End of Training subfield set to 1 |
| *CountIndex* | is the value of the Count Index subfield in the received TDD SSW or TDD SSW Ack frame |
| *AckCountIndex* | is the value of the Ack Count Index subfield in the transmitted TDD SSW Ack frame |

Subsequent opportunities for the initiator to transmit to the responder are separated by the value of the Transmit Period subfield in the TDD SSW Ack frame with the End of Training subfield set to 1.

After the initiator has sent the last TDD SSW Ack frame with the End of Training subfield equal to 1 to a target responder, it shall be ready to receive a single PPDU other than a TDD Beamforming frame from the responder, by setting its receive DMG antenna and sector to the Decoded TX Antenna ID and the Decoded TX Sector ID and from the TDD SSW Feedback frame last received from the responder, and at the following offset calculated as a spacing from the end of the transmitted TDD SSW Ack frame with the End of Training subfield set to 1 to the start of the expected reception:

$$\begin{aligned}&ResponderTransmitOffset - [(AckCountIndex + 1) \times \mathrm{TXTIME(TDD\ SSW\ Ack)} + \\ &(CountIndex - AckCountIndex) \times \mathrm{TXTIME(TDD\ SSW)} + (Count\ Index \times \mathrm{SBIFS})]\end{aligned} \tag{10-26}$$

where

| | |
|---|---|
| *ResponderTransmitOffset* | is the value of the Responder Transmit Offset subfield in the TDD SSW Ack frame with the End of Training subfield set to 1 |
| *CountIndex* | is the value of the Count Index subfield in the respective TDD SSW or TDD SSW Ack frame |
| *AckCountIndex* | is the value of the Ack Count Index subfield in the transmitted TDD SSW Ack frame |

Subsequent opportunities for the responder to transmit to the initiator are separated by the value of the Transmit Period subfield in the TDD SSW Ack frame with the End of Training subfield set to 1.

For the unscheduled TDD beamforming procedure, Equation (10-23) and Equation (10-24) establish transmit opportunities to exchange TDD Beamforming frames, and Equation (10-25) and Equation (10-26) establish transmit opportunities to exchange frames other than TDD Beamforming frames after TDD beamforming training completion with the target responder.

In the unscheduled TDD beamforming procedure, upon transmission of the last TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall follow the same procedure as the initiator in 10.42.11.2 with *InitiatorTransmitOffset* and *ResponderTransmitOffset* parameters given by Equation (10-25) and Equation (10-26) instead of Equation (10-21) and Equation (10-22).

In the scheduled TDD beamforming procedure, the initiator shall send TDD SSW and TDD SSW Ack frames during BF TDD slots assigned to transmit from the initiator to the responder. The exchange of TDD Route elements takes place during non-beamforming TDD slots available to the initiator and the target responder after completion of the TDD beamforming training with the target responder.

### 10.42.11.5 Responder operation for TDD group beamforming

A responder STA that is in inactive state (see 11.54) or has not yet received a TDD SSW frame or has not yet acquired a TDD Slot Structure element used by the BSS shall sweep its receiver antenna through all its receive sectors while dwelling on each sector for a time equal to SectorDwellTime as indicated by the MLME-TDD-BF-SCAN.request primitive.

NOTE—To increase the likelihood of detecting an initiator's TDD SSW frame, the responder SME can set SectorDwellTime to at least [2 × TXTIME (TDD SSW) + SBIFS].

A responder STA that receives a TDD SSW frame with a Responder ID subfield that matches its ID shall sweep its receiver antenna configuration through its receive sectors between TDD beamforming frames received in a TDD slot and shall switch its receive sectors at the beginning of every TDD slot used for BF training according to the time interval indicated by a nonzero Transmit Period subfield value of the received TDD SSW frame.

Figure 10-94x gives an example of the responder's receiver sweeping procedure for TDD group BF.

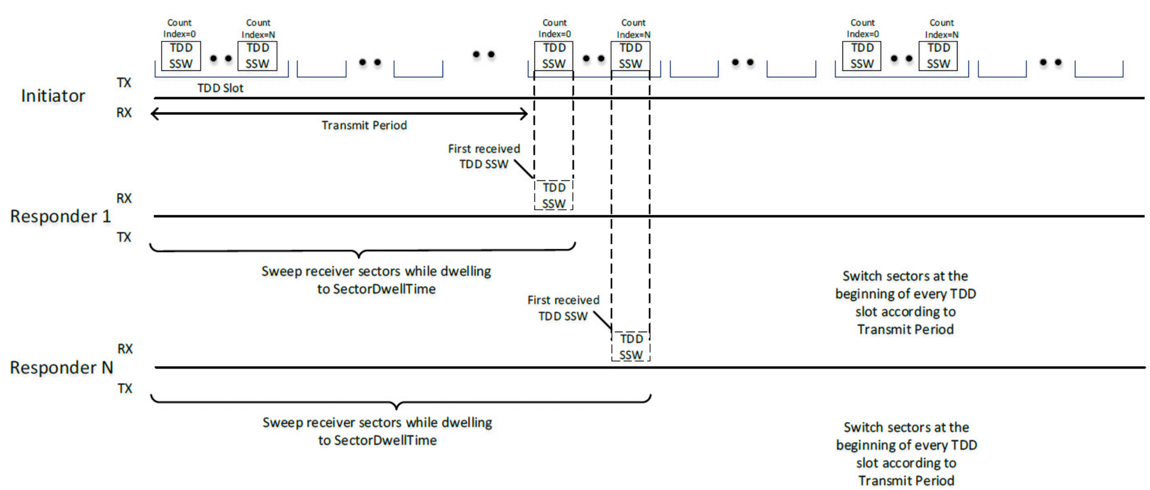


**Figure 10-94x—Responder's receiver sweeping for TDD group BF**

Once the first TDD SSW frame is received, the responder proceeds with the following operation.

Upon reception of one or more TDD SSW frames on a receive sector, the responder may switch, within the TDD slot, to its next receive sector to be ready to receive the next TDD SSW frame transmission within SBIFS. The responder shall switch its receive sector at the beginning of every TDD slot used for BF training at the time specified by the Transmit Period subfield value in the received TDD SSW frame. While sweeping through its receive sectors, the responder shall continue decoding all the received TDD SSW frames.

The responder shall transmit a TDD SSW Feedback frame using the DMG antenna and sector from which the responder received the TDD SSW with the best link quality at the time indicated by Equation (10-23) in case of unscheduled TDD beamforming or, alternatively, at an assigned BF TDD slot. The TDD SSW Feedback frame shall include the DMG antenna and sector index used by the initiator to transmit the TDD SSW frame in, respectively, the Decoded TX Antenna ID and Decoded TX Sector ID subfields, the antenna index and sector index used by the responder to transmit the TDD SSW Feedback frame in, respectively, the TX Antenna ID and TX Sector ID subfields, and the SNR of the TDD SSW frame received with the best quality in the SNR Report subfield.

At the time offset indicated by Equation (10-24) of the decoded TDD SSW frame or, alternatively, at an assigned BF TDD slot, the responder shall set its receiver to the same DMG antenna index and to the same sector that was indicated in, respectively, the TX Antenna ID and TX Sector ID subfields of the TDD SSW Feedback in order to be ready to receive a TDD SSW Ack frame from the initiator.

The responder shall continue sweeping through its receive sectors until successfully receiving and decoding a TDD SSW Ack frame with End of Training subfield equal to 1. Upon the reception of a TDD SSW Ack frame with End of Training subfield equal to 1, the responder shall stop its receive sweeping and shall configure its DMG antenna and sector as indicated in, respectively, the Decoded TX Antenna ID and Decoded TX Sector ID subfields of the TDD SSW Ack frame received from the initiator that has the End of Training subfield equal to 1. The responder shall use this DMG antenna and sector for its subsequent frame exchanges with the initiator, until another sector is negotiated.

A responder that transmits a TDD SSW Feedback frame in response to a TDD SSW frame sent with End of Training subfield equal to 1 shall set the End of Training subfield in the TDD SSW Feedback frame to 1.

In the unscheduled TDD beamforming procedure, upon reception of a TDD SSW Ack frame with End of Training subfield equal to 1, the responder, at the time offset indicated by Equation (10-26), shall follow the same procedure as the responder in 10.42.11.3 with *InitiatorTransmitOffset* and *ResponderTransmitOffset* parameters given by Equation (10-25) and Equation (10-26) instead of Equation (10-21) and Equation (10-22).

In the scheduled TDD beamforming procedure, the responder shall send TDD SSW Feedback frames during BF TDD slots assigned to transmit from the responder to the initiator. The exchange of TDD Route elements takes place during Basic or Data TDD slots available to the initiator and the responder after completion of the TDD beamforming training.

#### 10.42.11.6 Initiator operation for TDD beam measurement

The initiator operation during a TDD beam measurement is the same as the initiator operation for TDD individual BF, with the following differences:

— TDD beam measurement is started upon receiving an MLME-TDD-BEAM-MEASUREMENT.request primitive with BFRole parameter set to Initiator.

— The Initiator may send an Announce frame to a responder containing a TDD Route element with a TDD Sector Config subelement indicating the RX Sectors ID and RX Antenna ID to be used by the responder in the TDD beam measurement.
— During a TDD beam measurement, the TDD Slot CDOWN field in each transmitted frame shall contain the total number of BF TDD slots remaining until the end of the initiator TDD beam measurement, such that the last TDD SSW frame transmission by the initiator has the TDD Slot CDOWN field equal to 0.
— The initiator may set the Feedback Requested subfield in the TDD Beamforming Information field to 1 to request that the responder(s) send, following the completion of the TDD beam measurement, an Announce frame with a TDD Route element containing the measurement results.
— No TDD SSW Ack frame shall be transmitted.

#### 10.42.11.7 Responder operation for TDD beam measurement

The responder operation during a TDD beam measurement procedure is the same as the responder operation for TDD individual BF, with the following differences:

— TDD beam measurement is started upon receiving an MLME-TDD-BEAM-MEASUREMENT.request primitive with BFRole parameter set to Responder, or by receiving a TDD SSW frame with the RA field equal to STA's MAC address or the broadcast address, and with the TDD Beam Measurement field set to 1.
— If a TDD Sector Config subelement was received for this TDD beam measurement, the responder shall utilize the RX Sectors ID and RX Antenna ID configurations as indicated in the TDD Sector Config subelement.
— If the Feedback Requested subfield in a TDD SSW frame received by the responder is 0, the responder shall not transmit any frames to the initiator and shall report the measurement results to the SME instead.
— If the Feedback Requested subfield in a TDD SSW frame received by the responder is 1, the responder shall send an Announce frame with a TDD Route element containing the results of the TDD beam measurement on all received sectors. The Announce frame shall be sent in the first TDD slot allocated for transmission from the responder to the initiator.
— TDD beam measurement ends at the end of the TDD slot during which the initiator transmits the last TDD SSW frames with the TDD Slot CDOWN field equal to 0.

## 10.43 DMG link adaptation

### 10.43.1 General

***Change 10.43.1 as follows:***

A STA may transmit a Link Measurement Request frame to request a STA indicated in the RA field of the frame to respond with a single Link Measurement Report frame or periodic Link Measurement Report frames (9.6.6.5). If the Link Measurement Request frame is sent within a PPDU defined in Clause 20 or Clause 28, the Link Measurement Report frame shall contain the DMG Link Margin element. ~~The requesting STA may use values of the MCS, of the SNR and of the Link Margin to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame.~~ If the DMG Link Margin element does not include the PPDU Statistics field, nor the LDPC Statistics field and nor the SC/OFDM Statistics field, the requesting STA may use values of the MCS, SNR and Link Margin fields in a received DMG Link Margin element to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame. Otherwise, the requesting STA may use values of the MCS, SNR and Link Margin field(s) in the received PPDU Statistics field to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame.

The Number of Space-Time Streams Reported (NSTS) field in a DMG Link Margin element shall be set to the number of space-time streams received.

If the Link Measurement Request frame is sent within a PPDU defined in Clause 28, the Number of Transmit Chains Reported (NTX) field in the DMG Link Margin element within the Link Measurement Report frame shall be set to the same value indicated in the Extended TPC Configuration subelement within the Link Measurement Request frame. In this case, the requesting STA may use the reported MCS, SNR, and link margin values when transmitting frames to the STA indicated in the RA field of the Link Measurement Request frame using multiple transmit chains.

The requesting STA may aggregate a Link Measurement Request frame in an A-MPDU as defined in Table 9-530 and Table 9-533.

To initiate a periodic link measurement with a peer STA, the requesting STA shall transmit a Link Measurement Request frame to the peer STA that includes the Periodic Report Request subelement. The requesting STA should transmit at least one Management or Data frame (e.g., a QoS Null frame) to the peer STA, preferably requiring acknowledgment, every interval of time indicated by the value of the Report Interval field within the Periodic Report Request subelement to keep the statistics reported in the periodic Link Measurement Report frames transmitted by the peer STA updated.

If the Dialog Token field in the Link Measurement Request frame is nonzero, the responding STA shall perform the measurement on the next frame received from the requesting STA and shall send back a Link Measurement Report frame corresponding to the received frame. If the Link Measurement Request frame includes the Periodic Report Request subelement and the responding STA accepts a periodic link measurement request, at the time indicated by the value of the Report Start Time subfield, the responding STA shall send at least one Link Measurement Report frame including the Periodic Report subelement to the requesting STA for each report interval. The transmission of at least one unsolicited Link Measurement Report frame should be as close as possible to the start of each consecutive report interval subject to channel access rules. The total number of report intervals shall be equal or smaller than the value of the Report Count subfield in the Link Measurement Request frame. If the Link Measurement Request frame includes the Periodic Report Request subelement and the responding STA rejects a periodic link measurement request, the responding STA shall transmit a Link Measurement Report frame and set the Accept/Reject Periodic Report subfield within the Periodic Report Control field of the Periodic Report subelement to 0.

The responding STA may aggregate a Link Measurement Request frame in an A-MPDU as defined in Table 9-530 and Table 9-533.

The DMG STA whose MAC address equals the value of the Link Measurement Request frame RA field shall transmit ~~a~~ one or more Link Measurement Report frames addressed to the requesting STA. The RA field of the Link Measurement Report frame shall be equal to the TA field of the Link Measurement Request frame.

If the Dialog Token field in the Link Measurement Report frame is equal to the nonzero Dialog Token field of the Link Measurement Request frame, then the MCS, SNR, and Link Margin fields of the Link Measurement Report frame shall be computed using the measurements of the PPDU that is the next PPDU ~~frame~~ received from the requesting STA, or the PPDUs received from the requesting STA within the corresponding report interval and subject to the reset condition rules (see 9.4.2.142.6). The DMG Link Margin element within the Link Measurement Report frame shall include the following:

— The RX Chain Statistics field if the Number of RX Chains Reported (NRX) subfield in the Rate Adaptation Control/Extended TPC field is greater than 0.
— The PPDU Statistics field if the PPDU Statistics Present subfield in the Rate Adaptation Control/Extended TPC field is 1.

- The LDPC Statistics field if the LDPC Statistics Present subfield in the Rate Adaptation Control/Extended TPC field is 1.
- The SC/OFDM Statistics field if the SC/OFDM Present subfield in the Rate Adaptation Control/Extended TPC field is 1.

The DMG Link Margin element should not include the RX Chain Statistics, PPDU Statistics, LDPC Statistics and SC/OFDM Statistics fields if the Number of PPDUs subfield in the Rate Adaptation Control/Extended TPC field is 0.

NOTE—The MCS, SNR, and link margin values can be carried in either the three similarly named fields in the Link Measurement Report frame, or as part of the PPDU Statistics field in the same frame.

If the Dialog Token field in the Link Measurement Request frame is equal to 0, the responding STA may set the MCS field in the Link Measurement Report frame to the MCS value computed based on any of the received frames from the requesting STA.

The SNR field and Link Margin field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the same Link Measurement Report frame. If the Link Measurement Report frame contains measurements of more than one STS, the SNR subfield in the PPDU Statistics field and the Link Margin subfield in the Extended TPC field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the PPDU Statistics field within the same Link Measurement Report frame, or the corresponding measurements of PPDUs received from the requesting STA within the corresponding report interval and subject to the reset condition rules (see 9.4.2.142.6).

The Link Measurement Request and Report frames can be used to obtain link margin information, which can be used to determine appropriate action by the requesting STA (e.g., change MCS or control transmit power or initiate FST).

A STA may send an unsolicited Link Measurement Report frame with the Dialog Token field set to 0.

### 10.43.2 DMG TPC

***Change the first paragraph in 10.43.2 as follows:***

A DMG STA that receives a Link Measurement Report frame containing a DMG Link Margin element that indicates increase or decrease transmit power behaves according to the following rules:

- If the STA implements the recommendation indicated in the Activity field of the Link Measurement Report frame that does not include a Rate Adaptation Control/Extended TPC field, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Activity field in the received DMG Link Margin ~~Sub~~element.
- If the STA does not implement the recommendation indicated in the Activity field of the Link Measurement Report frame that does not include a Rate Adaptation Control/Extended TPC field, it may send a Link Measurement report containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0~~, indicating that the STA did not change its transmit power~~.
- A STA shall not send a Link Measurement Report later than 2×aPPDUMaxTime after it acknowledged the reception of the link measurement report.
- If the STA implements the recommendation indicated in the Extended Activity field of a Link Measurement Report frame that includes a Rate Adaptation Control/Extended TPC field for one or

more STS, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The value of the Number of STS Reported field within the DMG Link Adaptation Acknowledgment element shall be set to the same value of the Number of STS Reported field in the DMG Link Margin element within the Link Measurement Report frame. If the STA implements the recommendation for an STS, the Extended Activity acknowledgment field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Extended Activity field in the received DMG Link Margin element of the same STS. If the STA does not implement the recommendation for an STS, the Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0. In addition, the Extended Activity acknowledgment Parameter value shall be set to the actual transmit power change that the STA implements, using the same encoding as the transmit power change request (see 9.4.2.142.8).

***Insert the following subclauses (10.43.4, 10.43.5, and 10.43.6) after 10.43.3:***

### 10.43.4 EDMG spatial stream feedback

An EDMG STA may provide feedback on individual transmitted spatial streams by appending a control trailer (see 10.39.12.5) to SSW-Feedback, BlockAck or Ack frames. Spatial stream feedback information may be used for MCS selection or to trigger beamforming between STAs.

To do this, the STA shall set the TXVECTOR parameter SCRAMBLER_INIT_SETTING to CONTROL_TRAILER, shall set the TXVECTOR parameter CT_TYPE to SSW_FEEDBACK in case of transmitting an SSW-Feedback frame, to BLOCK_ACK in case of transmitting a BlockAck frame, or to ACK in case of transmitting an Ack frame. The STA shall set the TXVECTOR parameter STREAM_FBCK to contain the per spatial stream feedback.

The per stream SNR and RSSI information in the control trailer shall be measured by the STA during the reception of the PPDU immediately before the corresponding SSW-Feedback, BlockAck or Ack frame is transmitted.

### 10.43.5 TDD link maintenance

A STA indicates support for TDD link maintenance by setting the TDD Link Maintenance Statistics field within the STA's DMG Capabilities element to a nonzero value. A STA that supports TDD link maintenance shall not initiate TDD link maintenance, as specified below, with a peer STA that does not support TDD link maintenance.

The SME of the STA that supports TDD link maintenance shall use the PLME-MINPAYLOADSTAT.request primitive to request the PHY to initiate measurement of signal power of received PPDUs and to compute the receiver statistics as described below. Upon receiving a PLME-MINPAYLOADSTAT.request primitive, the PHY shall use the parameter PSDU_MIN_LENGTH of the primitive to start the measurements and shall respond to the MAC with a PLME-MINPAYLOADSTAT.confirm primitive.

A STA that supports TDD link maintenance and that receives a Link Measurement Request frame shall include a DMG Link Margin element in a transmitted Link Measurement Report frame. The STA shall perform the link statistics measurements and set the DMG Link Margin element according to the following rules:

— In the RX Chain Statistics field, the RCPI shall be measured during the reception of the L-STF or EDMG-STF field of the PPDU. The measurement shall be performed on the same bandwidth as the PSDU.

- The value of the PPDU Statistics field is computed as follows:
  - For a SC mode PPDU, the SNR per stream is found by computing the SNR of the DMG or EDMG preambles. If EDMG preambles are present, it shall be used to compute the SNR. The measurement shall be on the same bandwidth as the PSDU.
  - For an OFDM mode PPDU, the average SNR per stream is found by computing the SNR per subcarrier in decibels for all the pilot and data subcarriers, and then computing the arithmetic mean of those values. Each SNR value per subcarrier and per stream (before being averaged) corresponds to the SNR of one of the pilot or data subcarrier. The SNR value per subcarrier per stream shall be based on measurement of EDMG-STF and/or EDMG-CEF using the same bandwidth as the PSDU.
- To compute the value of the LDPC Statistics field, the PPDUs used for computing the Average Iterations, Max Iteration, Nonzero Syndromes and Number of LDPC Codewords subfields are those PPDUs that have the payload length greater or equal to PSDU_MIN_LENGTH. All reported LDPC statistics shall be measured over the PSDU of a PPDU.
- To compute the value of the SC/OFDM Statistics field, the PPDUs used for computing the EVM and Number of SC Blocks/OFDM Symbols subfields are those PPDUs that have the payload length greater or equal to PSDU_MIN_LENGTH. The EVM is computed by averaging, in power units, the estimated EVM of SC data symbols or OFDM data subcarriers across PSDUs of PPDUs transmitted with an MCS different from MCS 0. The average is performed per space-time stream. The EVM estimation per SC symbol or OFDM carrier should be as close as possible to the value computed when the estimator has full knowledge of the transmitted signal.

When the following reset condition is met, the statistics specified in 9.4.2.142.4, 9.4.2.142.5, 9.4.2.142.6, and 9.4.2.142.7 shall be reset:

- Any change of modulation (SC or OFDM), MCS, constellation, LDPC mode, GI/CP length, number of space-time streams, or MIMO type, or
- The number of reports sent reaches the value of the Report Count subfield in the Periodic Report Request subelement (see 9.4.2.289.2) associated with this measurement.

To cause the PHY to stop performing measurements over received PPDUs, the SME shall invoke the PLME-MINPAYLOADSTATSTOP.request primitive.

### 10.43.6 Extended TPC

A DMG STA supports the extended TPC mechanism specified in this subclause if the Extended TPC Rx Supported subfield in the STA’s last transmitted DMG Capabilities element is 1. A STA that supports the extended TPC shall support TDD link maintenance as defined in 10.43.5 and periodic link measurement as defined in 10.43.1.

A STA that has dot11ExtendedTPCActivated set to Rx and that receives a Link Measurement Report frame shall adjust its transmit power according to the values indicated by the Extended TPC field within the DMG Link Margin element carried in the received Link Measurement Report frame. A STA is not required to adjust its transmit power if the value exceeds the STA capabilities.

NOTE 1—A STA that has dot11ExtendedTPCActivated set to Rx sends a Link Measurement Request frame to a peer STA with an Extended Link Measurement element that includes a Periodic Report Request subelement. As such, the STA periodically receives a Link Measurement Report frame that includes the Extended TPC subfield with a transmit power update. The STA uses the received values to update its transmitter power. The peer STA, which responds with a Link Measurement Report frame, continuously evaluates the link based on the information it receives from the STA and computes the transmit power update for the STA.

A STA that has dot11ExtendedTPCActivated set to Tx and that receives s Link Measurement Report frame shall adjust its transmit power. The algorithm to determine the transmit power adjustment is beyond the scope of this standard. The STA may use any part of received measurements and any additional information available to the STA.

NOTE 2—A STA that has dot11ExtendedTPCActivated set to Tx sends a Link Measurement Request frame to a peer STA with an Extended Link Measurement element that includes a Periodic Report Request subelement. As such, the STA periodically receives a Link Measurement Report frame that includes at least one of the RX Chain Statistics, PPDU Statistics, LDPC Statistics, or SC/OFDM Statistics fields. The STA uses the received values to update its transmitter power. The STA might also receive an Extended TPC subfield, including a transmit power update. When dot11ExtendedTPCActivated is equal to Tx, the STA is not required to adopt the values in Extended TPC subfield; the STA can use these values as additional information to update its transmitter power.

An AP or PCP that has dot11ExtendedTPCActivated set to Tx or Rx shall have Extended TPC Rx Supported subfield in its DMG Capabilities element set to 1, as well as support the computation and report of the Extended TPC field defined in 9.4.2.142.8.

***Insert the following subclauses (10.67 through 10.70.2, including Figure 10-121) after 10.66:***

## 10.67 EDMG phase hopping and open loop precoding operation

An EDMG STA supports phase hopping modulation defined in 28.6.9.3.8 if the Phase Hopping Supported field in the STA's EDMG Capabilities element is 1. A phase hopping capable STA may transmit to a peer STA an EDMG OFDM mode SU PPDU with with the TXVEXTOR parameter PHASE_HOPPING set to PH_APPLIED only if the peer STA has set the Phase Hopping Supported subfield in the peer STA's EDMG Capabilities element to 1 and the NUM_STS parameter in the TXVECTOR is set to 2.

An EDMG STA supports open loop precoding defined in 28.6.9.3.8 if the Open Loop Precoding Supported subfield in the STA's EDMG Capabilities element is 1. An open loop precoding capable STA is also phase hopping capable. An open loop precoding capable STA may transmit to a peer STA an EDMG OFDM mode SU PPDU with the TXVECTOR parameter OPEN_LOOP_PC set to OL_APPLIED only if the peer STA has set the Open Loop Precoding Supported subfield in the peer STA's EDMG Capabilities element to 1, and the NUM_ STS parameter in the TXVECTOR is set to 2 and the PHASE_HOPPING parameter in the TXVECTOR is set to PH_APPLIED.

## 10.68 EDMG AP or EDMG PCP distributed scheduling protocol operation

### 10.68.1 General

An EDMG PCP or EDMG AP may use the distributed scheduling protocol to improve spatial sharing and interference mitigation with other BSSs that use one or more of the same channels. An EDMG PCP or EDMG AP with dot11EDMGDistributedSchedulingProtocolActivated equal to true shall enable the distributed scheduling protocol by setting the Distributed Scheduling Enabled subfield to 1 in a transmitted EDMG Extended Schedule element. An EDMG PCP or EDMG AP shall follow the distributed scheduling protocol as described in this subclause during any beacon interval in which the PCP or AP transmits an EDMG Extended Schedule element with the Distributed Scheduling Enabled subfield equal to 1. In such cases, the PCP or AP is distributed scheduling enabled for this beacon interval.

### 10.68.2 Distributed scheduling initialization

When an EDMG PCP or EDMG AP first enables the distributed scheduling protocol, it shall listen for the maximum permitted beacon interval duration for DMG Beacons frames from neighboring PCPs or APs to determine the location (in terms of time and channel) and periodicity of their DMG Beacon frame transmissions as well as whether these PCPs or APs have the distributed scheduling protocol enabled.

### 10.68.3 Distributed scheduling protocol

While not engaged in communication within its BSS, a distributed scheduling enabled EDMG PCP or EDMG AP shall listen for DMG Beacon frames from neighboring PCPs or APs to determine their upcoming transmission schedules by parsing the Extended Schedule elements and EDMG Extended Schedule elements contained in received DMG Beacon frames. This may require listening on different channels, since neighbor PCPs or APs may operate in different primary channels.

If an AP or PCP determines that the BTI of a neighbor AP or PCP is overlapping or getting close to overlapping its own BTI in time, the AP or PCP may use the procedure in 11.30.2 to move the TBTT of its BSS to remove or avoid the overlap. The procedure to determine when two BTIs are overlapping or drifting too close to overlapping in time is implementation dependent.

To distribute channel resources among PCPs or APs in the same coverage area, the PCP or AP shall determine how much of each beacon interval it can occupy on any given channel by dividing its beacon interval duration by the number of detected neighboring PCPs or APs that are using that channel. Thus, for each channel $i$ that the PCP or AP is using, the PCP or AP shall not schedule allocations covering more than $1/(N_i + 1)$ of the beacon interval, where $N_i$ is the number of detected neighboring PCPs or APs using channel $i$. Both the BHI and SPs shall count toward a PCP or AP's beacon interval usage, whereas CBAPs shall not count towards this total since CBAPs do not provide guaranteed transmissions.

When creating the Extended Schedule element and EDMG Extended Schedule elements, a distributed scheduling enabled PCP or AP shall do the following on each channel it is using. The PCP or AP shall randomly schedule its SPs over unoccupied time periods first. If after scheduling its SPs over unoccupied time periods the PCP or AP has not yet used its share of the channel, it may randomly schedule remaining SPs over time periods with no neighbor SPs. Finally, if after scheduling its SPs over time periods with no neighbor SPs the PCP or AP has not yet used its share of the channel, it may randomly schedule its remaining SPs over time periods with no SPs of distributed scheduling enabled PCPs or APs (i.e., the PCP or AP is allowed to schedule over SPs of neighbors that have not enabled the distributed scheduling protocol).

A distributed scheduling enabled PCP or AP may schedule CBAPs anywhere in the DTI except during periods when the PCP or AP needs to listen for neighbor beacons. Allocated CBAPs should not traverse the start of SPs belonging to neighboring BSSs.

## 10.69 DMG segmentation and reassembly operation

### 10.69.1 General

A STA supports segmentation and reassembly if dot11SAROptionImplemented is true and, as a consequence, the Segmentation and Reassembly Support subfield in the STA's DMG Capabilities element is 1. A STA that supports segmentation and reassembly may employ this mechanism with a peer STA if the peer STA also supports segmentation and reassembly.

A DMG STA that supports segmentation and reassembly may segment large MSDUs received at the MAC SAP or A-MSDUs received at the A-MSDU aggregation function into MSDU or A-MSDU segments, respectively, that are transmitted into MPDUs (see 10.69.2). These MSDU or A-MSDU segments are reassembled at the recipient STA to recreate the original MSDU or A-MSDU (see 10.69.3). MSDU or A-MSDU segments shall be carried in individually addressed MPDUs.

The segmentation and reassembly mechanism allows a STA to receive at the MAC SAP an MSDU with a size that is optimal for an upper layer, or to aggregate MSDUs into A-MSDU, and that is not limited to the maximum transmission unit. The MSDU is delivered to the MAC SAP and the A-MSDU is delivered to the

A-MSDU de-aggregation function of the recipient STA through, respectively, MSDU or A-MSDU segments carried within MPDUs transmitted over the wireless link using the HT-Immediate BlockAck mechanism (see 10.25.6). The recipient STA is responsible to reassemble the segmented MSDUs or A-MSDUs into their original size MSDU or A-MSDU and forward it to, respectively, the MAC SAP or A-MSDU de-aggregation function. This mechanism allows sending a large MSDU or A-MSDU over the wireless link without the need for any upper layer fragmentation or segmentation processing. The maximum segmented MSDU or A-MSDU size is negotiated between communicating peers during SAR establishment (see 10.25.2).

Segmentation and reassembly is established for a particular TID through the use of an ADDBA Request and ADDBA Response frame exchange that includes the SAR Configuration element. Segmentation and reassembly shall not be used under an unsolicited block ack agreement.

A pair of STAs that use segmentation and reassembly for a particular TID shall not employ MSDU fragmentation, as defined in 10.5, for this TID.

A STA that supports segmentation and reassembly shall be capable of reception of MPDUs carrying segments of different MSDUs or A-MSDU, plus any security encapsulation overhead, MAC header and FCS and to reassemble it back to the original MSDU or A-MSDU size.

Figure 10-121 depicts an example of the transmission of MSDUs using the segmentation and reassembly procedure. In this example, the upper layer of the originator uses the MA-UNITDTA.request primitive to pass MSDUs to the MAC layer for delivery to the recipient. MAC level acknowledgments are not depicted in the figure. Delivered MPDUs reside in the recipient's reordering buffer. A MA-UNITDATA.indication primitive is used to deliver the complete MSDU to the recipient's upper layer. Moreover, in this example, MSDU $K-1$ contains one segment delivered in the MPDU with $SN = N-1$, which is successfully delivered to the recipient's reordering buffer and then released to the recipient's upper layer. MSDU $K$ comprises four MSDU segments that are transmitted to the recipient by MPDUs with $SN = N$, $N+1$, $N+2$, and $N+3$. The first transmission attempt of MPDU $SN = N+2$ fails and is retransmitted. The entire MSDU $K$ is released to the recipient's upper layer upon arrival of all MSDU segments at the recipient's reordering buffer.

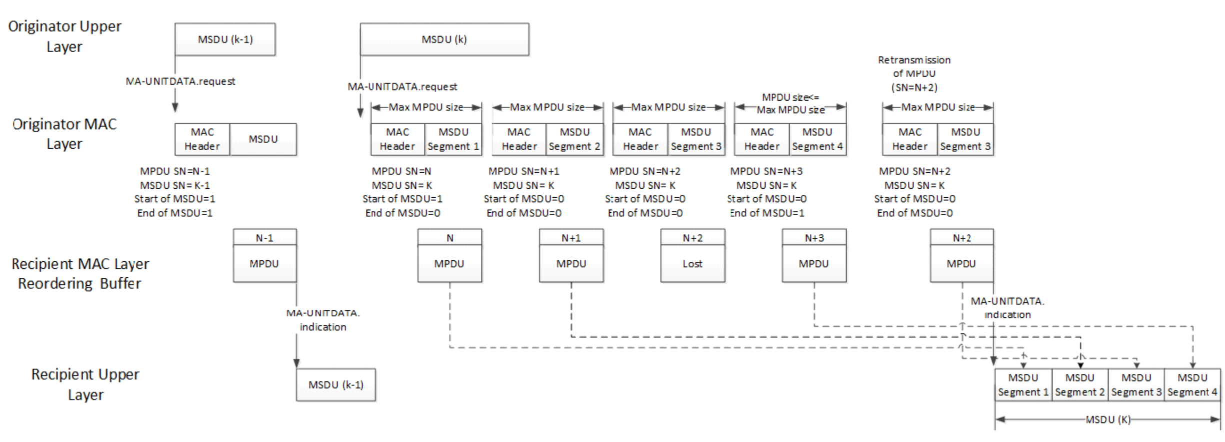


**Figure 10-121—Example of segmentation and reassembly procedure**

### 10.69.2 Segmentation operation

An MSDU or A-MSDU segment is carried within an MPDU. An MSDU or A-MSDU segment may comprise all or a portion of an MSDU or A-MSDU. Once an MSDU or A-MSDU segment is transmitted for the first time, its frame body content and length shall remain unchanged until it is successfully delivered to the recipient STA or the MSDU or A-MSDU is discarded.

An MPDU that contains the first segment of an MSDU or A-MSDU shall be assigned with a value of the Start of MSDU subfield equal to 1; otherwise, Start of MSDU shall be set to 0. An MPDU that contains the last segment of an MSDU or A-MSDU shall be assigned with a value of the End of MSDU subfield equal to 1; otherwise, the End of MSDU subfield shall be set to 0. An MPDU that has the End of MSDU subfield equal to 1 and the Start of MSDU subfield equal to 1 contains an entire single MSDU or A-MSDU. An MPDU that has the End of MSDU subfield equal to 0 and the Start of MSDU subfield equal to 1 shall have a size given by the maximum MPDU size as defined in 9.4.2.280. All MSDU Sequence Number and MPDU Sequence Number values assigned to an MPDU shall be set with continuously increasing sequential values.

### 10.69.3 Reassembly operation

A recipient STA reassembles an MSDU or A-MSDU comprising, respectively, one or more MSDU or A-MSDU segments according to the Start of MSDU, End of MSDU, MSDU Sequence Number, and MPDU Sequence Number indications of the MPDU of which the MSDU or A-MSDU segment is a part, as described in 10.25.6.6.2. The recipient MAC entity shall reassemble the MSDU or A-MSDU by concatenating, in increasing order of MPDU SN, the MSDU, or A-MSDU segments contained in the decrypted frame body of MPDUs with equal sequence numbers starting from the MPDU with Start of MSDU subfield equal to 1 and ending with the MPDU with End of MSDU subfield equal to 1.

The MA-UNITDATA.indication primitive is used by a recipient MAC to release a reassembled MSDU to its MAC SAP.

## 10.70 EDMG A-MPDU with multiple TIDs

### 10.70.1 General

A multi-TID A-MPDU is an A-MPDU that contains QoS Data frames where at least two of the QoS Data frames have different TID values.

An EDMG STA with dot11EDMGAMPDUwithMultipleTIDOptionImplemented set to true shall set the EDMG Multi-TID Aggregation Support subfield of the EDMG Capabilities element it transmits to a nonzero value. An EDMG STA with dot11EDMGAMPDUwithMultipleTIDOptionImplemented equal to false shall set the Multi-TID Aggregation Support subfield of the EDMG Capabilities element it transmits to zero.

An EDMG STA with dot11EDMGAMPDUwithMultipleTIDOptionImplemented set to true and that supports unsolicited block ack may set the Multi-TID Supported subfield of the Unsolicited Block Ack Extension Parameters field within the Unsolicited Block Ack Extension elements it transmits to 1. Otherwise, the EDMG STA shall set the Multi-TID Supported subfield to 0 to indicate that multi-TID is not supported under an unsolicited block ack agreement.

An EDMG STA may transmit a multi-TID A-MPDU to a peer EDMG STA if the EDMG STA has received from the peer STA an EDMG Capabilities element where the EDMG Multi-TID Aggregation Support subfield is nonzero. Otherwise, the EDMG STA shall not transmit a multi-TID A-MPDU to the peer EDMG STA.

An EDMG STA may transmit a multi-TID A-MPDU to a peer EDMG STA with a number of TIDs that does not exceed $MT + 1$, where $MT$ is the value indicated in the EDMG Multi-TID Aggregation Support subfield within the EDMG Capabilities element transmitted by the peer EDMG STA.

An EDMG STA shall construct a multi-TID A-MPDU as defined in 9.7 and 10.12.

The sum of all block ack bitmap fields, negotiated as specified in 10.25.2, of all block ack agreements identified by TIDs included in a Multi-TID A-MPDU shall be less than or equal to 2048.

An EDMG STA may aggregate in a multi-TID A-MPDU QoS Data frames with multiple TIDs as defined in Table 9-530 or Table 9-531.

An EDMG STA may aggregate MPDUs from any TID in a multi-TID A-MPDU to be transmitted in an SP.

A multi-TID A-MPDU shall not be transmitted in a TXOP, except when the TXOP limit is nonzero for the AC that is used to gain access to the medium. This AC is defined as the primary AC. When the TXOP limit is nonzero, the STA may aggregate QoS Data frames from one or more TIDs in the A-MPDU under the following conditions:

- The A-MPDU is transmitted by the STA within the TXOP.
- The A-MPDU contains MPDUs with TIDs that correspond to the primary AC.
- When no more MPDUs can be aggregated in the A-MPDU from any of the TIDs that correspond to the primary AC, then the A-MPDU may additionally contain one or more MPDUs with TIDs that do not correspond to the primary AC if
  - The TIDs correspond to an AC that has a higher priority with respect to the primary AC.
  - The addition of these MPDUs does not cause the STA to exceed the current TXOP duration.

A Multi-TID BlockAck frame shall be used to acknowledge MPDUs in a received multi-TID A-MPDU. The rules for Multi-TID BlockAck are defined in 10.25.5.

When a multi-TID A-MPDU is sent in response to an MPDU, received within an SU PPDU, with the RD Grant field set to 1 and the AC Constraint field set to 1 as specified in 10.29.3, the lowest priority AC indicated in the MPDU that solicited the A-MPDU is defined as the primary AC. The recipient EDMG STA with dot11EDMGAMPDUwithMultipleTIDOptionImplemented equal to true may transmit a multi-TID A-MPDU and aggregate QoS Data frames from one or more TIDs in the A-MPDU under the following conditions:

- The A-MPDU is transmitted by the STA within the same TXOP or SP where the A-MPDU is solicited.
- The A-MPDU contains one or more MPDUs with any of the TIDs that correspond to the primary AC.
- When no more MPDUs can be aggregated in the A-MPDU from any of the TIDs that correspond to the primary AC, then the A-MPDU may additionally contain one or more MPDUs with TIDs that do not correspond to the primary AC if
  - The TIDs correspond to an AC that has a higher priority with respect to the primary AC.
  - The addition of these MPDUs does not cause the STA to exceed the current TXOP or SP duration.

### 10.70.2 Acknowledgment context in a Multi-TID BlockAck frame

A recipient of a multi-TID A-MPDU or of an EDMG MU-MIMO PPDU sets the Ack Type subfield in the Multi-TID BlockAck frame sent as a response depending on the acknowledgment context. The following acknowledgment contexts are defined as follows:

— **All Ack context:** If the originator has the EDMG All Ack Support subfield in its EDMG Capabilities element equal to 1, the recipient may set the Ack Type field to 2 to indicate the successful reception of all the MPDUs carried in the multi-TID A-MPDU. Otherwise, the recipient shall not set the Ack Type field to 2. The Multi- STA BlockAck frame shall contain only one Per-TID Info subfield field in the Multi-TID BlockAck frame.

— **BlockAck context:** The recipient shall set the Ack Type subfield to 0 and the TID field of each Per-TID Info subfield to a TID value of an MPDU contained in the multi-TID A-MPDU. The Block Ack Starting Sequence Control and Block Ack Bitmap fields shall be set according to 10.25.6 for each block ack agreement.

— **Ack context:** The recipient of an EDMG MU-MIMO PPDU shall set the Ack Type subfield to 1 and the TID field of the Per-TID Info subfield to the TID value of the MPDU with no block ack agreement contained in the EDMG MU-MIMO PPDU.

If all MPDUs in the multi-TID A-MPDU are received successfully, the recipient may follow the procedure described in the All Ack context. Otherwise, the recipient shall use the procedure defined in the BlockAck and Ack context.

# 11. MLME

## 11.1 Synchronization

### 11.1.1 General

***Insert the following paragraph at the end of 11.1.1:***

A DMG STA that operates under TDD channel access (see 10.39.6.2.2) and that has the TDD Synchronization Mode subfield in the DMG Capabilities element equal to 1 shall maintain a local TSF timer as specified in 11.1.7.

### 11.1.3 Maintaining synchronization

#### 11.1.3.3 Beacon generation in a DMG infrastructure BSS and in a PBSS

##### 11.1.3.3.1 General

***Insert the following paragraph into 11.1.3.3.1 after the sixth paragraph ("A PCP and a DMG AP ...."):***

A PCP or an AP that schedules a TDD SP that occupies the entire beacon interval shall transmit DMG Beacons frames according to the procedure specified in 11.1.3.3.4. In all other cases, the following procedures shall apply.

***Insert the following paragraph and note into 11.1.3.3.1 after the now ninth paragraph ("An AP or PCP may ...."), and change the subsequent note in this subclause to "NOTE 2":***

An EDMG AP or EDMG PCP can transmit a DMG Beacon frame using a quasi-omni antenna pattern as described in 10.42.4.

NOTE 1—The reception of a DMG Beacon frame transmitted using a quasi-omni antenna pattern indicates to the receiving STA a possibility of communicating with the AP or PCP (e.g., Probe Request, Probe Response) using a quasi-omni transmit antenna pattern.

***Insert the following subclause (11.1.3.3.4) after 11.1.3.3.3:***

##### 11.1.3.3.4 Beacon generation under TDD channel access

If a TDD SP occupies the entire beacon interval, the DMG Beacon frame fields shall be set as follows:
- Next A-BFT subfield: set to a nonzero value
- Duration field: bits 0–13 set to 0, and bit 14 and bit 15 set to 1

#### 11.1.3.4 DMG Beacon generation before establishment of a BSS

***Insert the following paragraph and note into 11.1.3.4 after the sixth paragraph ("A STA that transmits ...."):***

An EDMG STA can transmit a DMG Beacon using a quasi-omni antenna pattern as described in 10.42.4.

NOTE—The reception of a DMG Beacon frame transmitted using a quasi-omni antenna pattern indicates to the receiving STA a possibility of communicating with the transmitting STA (e.g. Probe Request, Probe Response) using a quasi-omni transmit antenna pattern.

### 11.1.4 Acquiring synchronization, scanning

#### 11.1.4.3 Active scanning and probing procedures

##### 11.1.4.3.3 Active scanning procedure for a DMG STA

***Change item g) in the lettered list of 11.1.4.3.3 as follows:***

g) If an SSW-Feedback frame is neither transmitted nor received in step d), then:
   1) Optionally send a probe request to the broadcast destination address. The probe request is sent with the SSID and BSSID from the received MLME-SCAN.request primitive and includes the DMG Capabilities element. <u>An EDMG STA may transmit the probe request using a quasi-omni antenna pattern and, in this case, may send the probe request using an EDMG BRP-RX PPDU.</u> The basic access procedure (10.3.4.2) is performed prior to the probe request transmission.
   2) When the SSID List is present in the invocation of the MLME-SCAN.request primitive, send zero or more probe requests to the broadcast destination address. Each probe request is sent with an SSID indicated in the SSID List and the BSSID from the MLME-SCAN.request primitive and includes the DMG Capabilities element. <u>An EDMG STA may transmit the probe request using a quasi-omni antenna pattern and, in this case, may send the probe request using an EDMG BRP-RX PPDU.</u> The basic access procedure (10.3.4.2) is performed prior to each probe request transmission.

##### 11.1.4.3.4 Criteria for sending a response

***Insert the following paragraph into 11.1.4.3.4 after the first paragraph ("If a STA that received ...."):***

An EDMG STA that receives a probe request before performing transmit antenna training may use a quasi-omni antenna pattern for transmission of the Probe Response. An EDMG STA that receives a probe request transmitted using an EDMG BRP-RX PPDU may perform receive training and select a transmit sector if the STA supports antenna reciprocity or antenna pattern reciprocity as indicated by setting the DMG Antenna Reciprocity field or Antenna Pattern Reciprocity field in the DMG Capabilities element to 1 respectively, for transmission to the transmitter of the probe request based on the result of the receive training.

***Change item k) in the lettered list of 11.1.4.3.4 as follows:***

k) The STA is a DMG STA<u>,</u> ~~and~~ the transmit antenna of the DMG STA is not trained to transmit to the STA from which the Probe Request frame was received<u>, and the STA is not an EDMG STA that intends to transmit the response using a quasi-omni antenna pattern</u>.

### 11.1.4.4 Initializing a BSS

#### 11.1.4.4.2 Initializing a DMG BSS

***Insert the following sentence at the end of the second paragraph ("When a STA's MAC ...."):***

For an EDMG BSS, an AP or PCP shall set the Channel BW Configuration subfield within the EDMG Operation element it transmits to a valid value as defined in Table 11-1a.

***Insert Table 11-1a after the second paragraph:***

**Table 11-1a—Valid Channel BW Configuration subfield values**

| EDMG Operation element configuration | | | |
|---|---|---|---|
| BSS Operating Channel subfield in EDMG Operation element | | Valid Channel BW Configuration subfield values when primary channel is not adjacent to secondary channel | Valid Channel BW Configuration subfield values when primary channel is adjacent to secondary channel |
| Total number of subfields set to 1 in BSS Operating Channels field | Total number of adjacent channels indicated by BSS Operating Channels field | | |
| 1 | No adjacent channels | 4 | — |
| 2, 3, or 4 | No adjacent channels | 8 | — |
| 2, 3, or 4 | Two adjacent channels | 8 | 5, 8, 9 |
| 4 | Pair of two adjacent channels | — | 8, 9, 12, 13 |
| 3 or 4 | Three adjacent channels | 8 | 6, 8, 9, 10 |
| 4 | Four adjacent channels | — | 7, 11, 12, 13, 14, 15 |

***Insert the following subclause (11.1.7) after 11.1.6:***

### 11.1.7 TDD time synchronization

This subclause applies to DMG STAs that are operating under TDD channel access (see 10.39.6.2.2) and that have the TDD Synchronization Mode subfield in their DMG Capabilities element equal to 1.

All STAs shall include a TDD Synchronization element, at least once per beacon interval, in transmitted Announce frames. An AP or PCP may include a TDD Synchronization element in DMG Beacon frames.

NOTE 1—A STA is not required to transmit the TDD Synchronization element during a beacon interval where it does not have transmit opportunity, subject to TDD channel access rules, to transmit an Announce frame.

A STA with dot11DMGTDDLocalClockModeActivated set to true shall not update its TSF timer based on the Timestamp field of a received DMG Beacon or Announce frame.

A STA with dot11DMGTDDLocalClockModeActivated set to false shall update its TSF timer based on the Timestamp field of each received DMG Beacon or Announce frame that includes a TDD Synchronization element with the Sync Mode field set to 0, unless both of the following are true:

- The last frame the STA used to update its TSF timer was a frame received in the same beacon interval as the new frame.
- The Clock Attributes field in the TDD Synchronization element of that last frame scores better than the Clock Attributes field in the TDD Synchronization element of the new frame. The logic to compare two Clock Attributes field values is the same as the logic to compare two IEEE 802.1AS systemIdentity attributes, as defined in 8.6.2 in IEEE Std 802.1AS-Rev/D8.0.

NOTE 2—While the comparison metric and logic are defined the same as IEEE 802.1AS for flexibility, using the IEEE 802.1AS protocol for TDD time synchronization is not required and is beyond the scope of this standard. The logic to compare two Clock Attributes field values is a hierarchical comparison of the Clock Attributes subfields in this order: Priority 1, Clock Class, Clock Accuracy, Offset Scaled Log Variance, and Priority 2, with a lower numerical value for each subfield indicating a better clock.

If a STA with dot11DMGTDDLocalClockModeActivated set to false receives an Announce frame that has the Sync Mode field in the TDD Synchronization element equal to 1, then the SME of the STA shall issue an MLME-DISASSOCIATE.request primitive with ReasonCode parameter set to TIME_SYNC_LOST and PeerSTAAddress parameter set to the TA of the received Announce.

## 11.2 Power management

### 11.2.6 SM power save

***Change the first paragraph in 11.2.6 as follows:***

A STA consumes power on all active receive chains, even though they are not necessarily required for the actual frame exchange. The SM power save feature allows a non-AP HT STA or a non-AP and non-PCP EDMG STA in an infrastructure BSS or PBSS to operate with only one active receive chain for a significant portion of time.

***Change the fourth paragraph and note in 11.2.6 as follows:***

In dynamic SM power save mode, the HT STA enables its multiple receive chains when it receives the start of a frame exchange sequence addressed to it, while the EDMG STA enables its multiple receive chains only when the frame it receives indicates that the following transmission requires the activation of multiple receive chains. Such a frame exchange sequence shall start with a single-spatial stream individually addressed frame that is not a Trigger frame, that requires an immediate response, and that is addressed to the STA in dynamic SM power save mode. For an HT STA, a~~A~~n RTS/CTS sequence may be used for this purpose. For an EDMG STA in dynamic SM power save mode, a Grant/Grant Ack sequence shall be used for this purpose (see 10.39.12.4.2). The STA shall, subject to its spatial stream capabilities (see 9.4.2.55.4, 9.4.2.265, and 9.4.2.157.3) and operating mode (see 11.40), be capable of receiving a PPDU that is sent using more than one spatial stream a SIFS after the end of its response frame transmission. The HT STA may switch back to the single receive chain mode immediately after the end of the frame exchange sequence. The EDMG STA switches to the multiple receive chain mode when it receives a frame addressed to it and the frame indicates the following transmission requires multiple receive chains (see 10.39.12.4); the EDMG STA switches back immediately when the frame exchange sequence ends.

NOTE—An HT STA in dynamic SM power save mode cannot distinguish between an RTS/CTS sequence that precedes a MIMO transmission and any other RTS/CTS and, therefore, always enables its multiple receive chains if it responds to the RTS addressed to it.

***Change the seventh paragraph in 11.2.6 as follows:***

The STA may use the SM Power Save frame to communicate its SM power save state. The STA may also use the SM Power Save subfield in the HT Capabilities element or EDMG Capabilities element of its (Re)Association Request frame or the SM Power Save subfield in the HE 6 GHz Band Capabilities element of its (Re)Association Request frame to achieve the same purpose. Using the (Re)Association Request frame allows the STA to use only a single receive chain immediately after (re)association.

***Change the ninth paragraph in 11.2.6 as follows:***

Changes to the number of active receive chains are made only after the SM power save mode indication has been successfully delivered (i.e., by acknowledgment of a frame carrying the HT Capabilities element or EDMG Capabilities element, by acknowledgment of a frame carrying the HE 6 GHz Band Capabilities element, or by acknowledgment of an SM Power Save frame). The SM power save mode indication shall be transmitted using an individually addressed frame.

### 11.2.7 Power management in a PBSS and DMG infrastructure BSS

#### 11.2.7.1 General

***Insert the following rows at the end of Table 11-3:***

**Table 11-3—Power states for an A-BI**

| Portion of the beacon interval | | PPS PCP | PS non-AP and non-PCP STA |
|---|---|---|---|
| | Unassigned TDD slot | Awake or doze | Doze |
| | Assigned simplex RX TDD slot | Awake | Awake |
| | Assigned simplex TX TDD slot | Awake | Awake or doze |

***Change the 15th paragraph in 11.2.7.1 as follows:***

The source DMG STA and the destination DMG STA of a nontruncatable SP, ~~or~~ allocated CBAP, or TDD slot with a destination AID that is not the broadcast AID may go to doze state within the SP, ~~or~~ within the CBAP, or within the TDD slot, respectively, after the source DMG STA transmitted a frame to the destination DMG STA of the SP, ~~or~~ the CBAP, or the TDD slot, respectively, with the EOSP subfield set to 1 and received the following response frame from the destination DMG STA of the SP, ~~or~~ the CBAP, or the TDD slot, respectively.

#### 11.2.7.2 Non-AP and non-PCP STA power management mode

##### 11.2.7.2.2 Non-AP and non-PCP STA operation without a wakeup schedule

***Change the third paragraph in 11.2.7.2.2 as follows:***

As long as there is at least one STA that has entered doze state through the unscheduled power save mechanism, the AP or PCP shall establish at least one ~~an~~ awake window by transmitting an Awake Window element, and shall include a UPSIM element in every DMG Beacon and Announce frame it transmits. The

AP or PCP may establish ~~an~~ awake windows and/or include a UPSIM element in a DMG Beacon or Announce frame it transmits even if no STA is in doze state. The absence of a UPSIM element in a DMG Beacon or Announce frame is equivalent to presence of the UPSIM element in the frame with all bits of the Power Save Indication Bitmap field in the UPSIM element set to 0. The UPSIM element in every DMG Beacon or Announce frame transmitted by the AP or PCP shall indicate the power state of all STAs at the time of frame transmission.

***Insert the following paragraphs at the end of 11.2.7.2.2:***

An EDMG AP shall set the Triggered Unscheduled PS subfield to one in any transmitted Capability Information field. A non-AP EDMG STA may set the Triggered Unscheduled PS subfield to one in any transmitted Capability Information field. An EDMG STA is QoS triggered enabled if it transmits a Triggered Unscheduled PS subfield equal to 1.

An EDMG STA may include the QoS Triggered Unscheduled element in a PSC-REQ or Association Request frame transmitted to an QoS triggered enabled EDMG AP or EDMG PCP to indicate an explicit request for a QoS triggered unscheduled power save on specific ACs. A QoS triggered enabled EDMG AP or EDMG PCP shall include a QoS Triggered Unscheduled element in the PSC-RSP or Association Response frame, respectively, sent as response with the same QoS-TU AC flag fields set to 1 as those that were set to 1 in the received PSC-REQ or Association Request frame. An EDMG STA may clear the QoS triggered unscheduled power save on a specific AC by sending a successful PSC-REQ frame with the relevant QoS-TU AC flag field set to 0.

When QoS triggered unscheduled power save is enabled on a specific AC, an EDMG PCP and an EDMG AP shall deliver the available buffered BU on the AC immediately following a trigger frame that grants the RDG to the EDMG PCP or EDMG AP. The EDMG PCP or EDMG AP shall not deliver to the triggering STA an A-MPDU with a size greater than indicated by the QoS-TU Max A-MPDU Length Exponent field and the A-MPDU shall not contain more MPDUs than the number of MPDUs indicated by the QoS-TU Max MPDU Size field, where both of these fields are indicated in the last QoS Triggered Unscheduled element sent in the PSC-REQ frame or Association Request frame, whichever came later, that established the QoS triggered unscheduled power save.

#### 11.2.7.2.3 Non-AP and non-PCP STA operation with a wakeup schedule

***Change the fourth paragraph in 11.2.7.2.3 as follows:***

If a non-AP and non-PCP STA has established a WS with the AP or PCP and the non-AP and non-PCP STA is in PS mode, the non-AP and non-PCP STA shall have *m* successive A-BIs repeating every *n* beacon interval, where *n* is the Sleep Cycle field of the DMG Wakeup Schedule element contained in the PSC-RSP frame received from the AP or PCP during the frame exchange that established the WS, and *m* is the Number of A-BIs field in the DMG Wakeup Schedule element contained in that PSC-RSP frame. During each of its A-BIs, the non-AP and non-PCP STA shall be awake during the awake windows that are ~~if it is~~ present, and during all allocated SPs in which it is either the source or destination DMG STA.

### 11.2.7.4 ATIM frame usage for power management of non-AP STAs

***Change the first paragraph in 11.2.7.4 as follows:***

An awake window is present within the first CBAP of a beacon interval that is scheduled through the Extended Schedule element and has the Source AID and Destination AID fields in that Extended Schedule element equal to the broadcast AID, or in a CBAP that is scheduled through the CBAP Only field in the

DMG Parameters field (9.4.1.46) set to 1, for dot11MaxLostBeacons beacon intervals following the most recent transmission of the Awake Window element (9.4.2.137) by the AP or PCP with the Awake Window Duration field set to a nonzero value. If present in the first CBAP, the awake window starts from the beginning of a CBAP and has a duration that is defined by the value of the Awake Window Duration field in the Awake Window element or the CBAP duration, whichever is smaller.

***Insert the following paragraphs into 11.2.7.4 after the first paragraph:***

If the value of the EDMG Awake Window Duration field within the transmitted Awake Window element is nonzero, an awake window is present within a CBAP allocation of a beacon interval if all of the following conditions are met:

- The CBAP allocation is scheduled in the beacon interval through the EDMG Extended Schedule element
- The CBAP allocation has the Source AID field equal to the broadcast AID

If all these conditions are met, the awake window is present in the CBAP allocation for dot11MaxLostBeacons beacon intervals following the most recent transmission of the Awake Window element by the AP or PCP. The awake window starts from the beginning of the CBAP and has a duration equal to the value of the EDMG Awake Window Duration field within the Awake Window element or the CBAP allocation duration, whichever is smaller.

***Change the now fifth paragraph in 11.2.7.4 as follows:***

~~If present, the awake window starts from the beginning of a CBAP and has a duration that is defined by the Awake Window Duration field in the Awake Window element or the CBAP duration, whichever is smaller.~~ During the awake window, a STA shall transmit only ATIM frames and, if the ATIM frame is individually addressed, Ack frames. A DMG STA in PS mode shall be in the awake state during each awake window that lies within each A-BI for that STA.

***Change the now seventh paragraph in 11.2.7.4 as follows:***

A STA that is in PS mode and following a wakeup schedule and is in awake state and receives an ATIM frame during the awake window shall be awake during allocations within the current beacon interval that have the Source AID equal to broadcast AID or have a Source AID that identifies a STA whose MAC address is equal to the TA field of the received ATIM frame, or during any DTI that is scheduled through the CBAP Only field in the DMG Parameters field (9.4.1.46) set to 1. If a STA transmits an ATIM frame during the awake window, it shall attempt to deliver its BUs during allocations within the current beacon interval that have a Destination AID equal to broadcast AID or have a Destination AID that identifies a STA whose MAC address is equal to the RA field of the transmitted ATIM frame, or during any DTI that is scheduled through the CBAP Only field in the DMG Parameters field (9.4.1.46) set to 1. A STA that receives from, or transmits to, a peer STA that is not an EDMG STA an ATIM frame during the awake window may enter the doze state when it has successfully transmitted to and received from all corresponding peer STAs for this beacon interval a QoS Data frame with the EOSP subfield set to 1; otherwise, it shall stay active until the end of the current beacon interval. An EDMG STA that receives from, or transmits to, a peer EDMG STA an ATIM frame during an awake window may enter the doze state when it has successfully transmitted to and received from all corresponding peer STAs for this allocation a QoS Data frame with the EOSP subfield set to 1; otherwise, it shall remain active until the end of the allocation. ATIM frame transmissions and MSDU transmissions follow the rules defined in 11.2.8.

***Change the now eighth paragraph in 11.2.7.4 as follows (Figure 11-16 remains unchanged):***

Figure 11-16 illustrates an example of a DMG STA response to an ATIM frame. For illustration purposes the 5 beacon intervals shown in the figure are numbered from 0 to 4. The PCP is following a wakeup schedule, with 1 A-BI out of every 4 beacon intervals. The non-PCP STA A is also following a wakeup schedule, with 1 A-BI out of every 2 beacon intervals. In addition, STA A performs unscheduled power save during beacon interval 0, and also during beacon interval 2 through beacon interval 4. The PCP ~~STA A~~ is required to remain ~~stay~~ awake during the following CBAP after receiving an ATIM frame in beacon interval 2. An ATIM frame received during beacon interval 4, however, serves as a traffic indication and PCP will transmit frames to STA A only after STA A is in the awake state.

***Insert the following subclause (11.2.7.5) after 11.2.7.4:***

#### 11.2.7.5 MU-MIMO power save

The MU-MIMO power save mechanism allows a non-AP and non-PCP EDMG STA in an infrastructure BSS or PBSS to go to PS mode during a TXOP where the STA is involved in an MU-MIMO transmission and acknowledgment procedures.

An EDMG STA that receives A-MPDUs within an EDMG MU PPDU may go to PS mode during the following two periods:

- First period: from the end of its individual A-MPDU within the EDMG MU PPDU to the time it needs to transmit its BA or RD response burst to the initiator (see 10.3.2.13 and 10.29.5).
- Second period: from the time of sending back the BA or RD response burst to the time indicated in Next PPDU Start Offset subfield in the Block Ack Schedule frame starting from the end of EDMG MU PPDU.

A STA that did not receive a Block Ack Schedule frame within a received MU PPDU shall remain awake in receive mode until it receives a BlockAckReq or Block Ack Schedule frame from the initiator or until the end of the TXOP, whichever comes first.

Once awake at the end of the second period, the EDMG STA shall stay in awake state until it receives the next EDMG MU PPDU from the initiator or until the end of the current TXOP, whichever comes first.

Figure 11-16a illustrates an example of MU-MIMO power save performed in an MU group with three EDMG STAs.

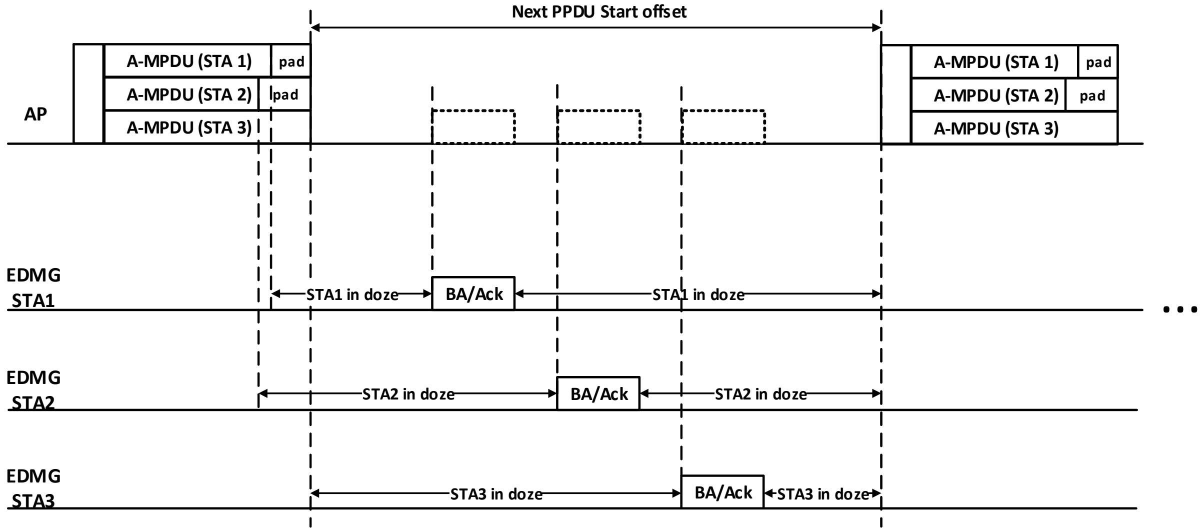


**Figure 11-16a—Example of MU-MIMO power save performed in MU group with three EDMG STAs**

## 11.4 TS operation

### 11.4.13 DMG allocation formats

#### 11.4.13.1 General

***Change 11.4.13.1 as follows:***

A DMG STA manages allocations and TSs as described in 11.4.1 to 11.4.14. Using the DMG TSPEC element, a DMG STA can indicate two types of allocation scheduling: isochronous and asynchronous. It should establish an isochronous allocation if it needs periodic access to the channel and does not expect to change the amount of time allocated frequently. It should establish an asynchronous allocation if it expects to make requests for channel time and wishes to reserve a minimum amount of channel time to satisfy for those requests when they occur.

#### 11.4.13.2 Isochronous allocations

***Insert the following paragraph into 11.4.13.2 after the first paragraph ("In order to ...."):***

An EDMG STA may request an SP allocation by using the BW, Channel Aggregation and Is Channel Number subfields in the DMG TSPEC element. To request a specific channel, the STA shall set the Is Channel Number subfield to 1 and set the BW subfield to the value of the requested channel; otherwise, the STA shall set the Is Channel Number subfield to 0 and set the BW subfield to the value of requested channel width. Upon reception of a DMG ADDTS Request frame that is admitted, an EDMG AP or EDMG PCP sets the Channel Aggregation subfield in the DMG ADDTS Response frame to the value of the Channel Aggregation subfield in the received DMG TSPEC element for the allocated channel, and sets the value of the BW field in the DMG TSPEC element of the DMG ADDTS Response frame sent in response to the ADDTS Request frame such that it meets the following requirements:

- If the Is Channel Number subfield in the received ADDTS Request frame is equal to 0, the AP or PCP may allocate a channel with channel width less than or equal to the value of the BW subfield in the received ADDTS Request frame.
- If the Is Channel Number subfield in the received ADDTS Request frame is equal to 1, the AP or PCP should allocate the channel as indicated by the BW subfield in the received ADDTS Request frame.

***Change the now third paragraph in 11.4.13.2 as follows:***

Following the successful admittance of a DMG TSPEC with an isochronous allocation, the AP or PCP should allocate time in the beacon interval to meet the periodicity and minimum allocation requirements specified in the DMG TSPEC element. If the PCP or AP is an EDMG STA and both the source and destination STAs of the DMG TSPEC are also EDMG STAs, the allocation time created by the AP or PCP should meet the bandwidth requirements specified in the DMG TSPEC element.

### 11.4.13.3 Asynchronous allocations

***Insert the following paragraphs at the end of 11.4.13.3:***

An EDMG STA may request an SP allocation by transmitting an SPR frame with the CONTROL_TRAILER parameter in the TXVECTOR set to Present, CT_TYPE parameter in the TXVECTOR set to SPR, and then using the BW, Channel Aggregation and Is Channel Number subfields in the control trailer. To request a specific channel, the STA shall set the Is Channel Number subfield to 1 and set the BW subfield to the value of the requested channel; otherwise, the STA shall set the Is Channel Number subfield to 0 and set the BW subfield to the value of requested channel width. Upon reception of the SPR frame, an EDMG AP or EDMG PCP responds with a Grant frame that has the CONTROL_TRAILER parameter in the TXVECTOR set to Present and CT_TYPE parameter in the TXVECTOR set to GRANT_RTS_CTS2self. The EDMG AP or EDMG PCP sets the Channel Aggregation subfield in the Grant frame to the value of the Channel Aggregation subfield in the received SPR frame for the allocated channel, and sets the value of the BW field in the control trailer of the Grant frame such that the following requirements are met:

- If the Is Channel Number subfield in the control trailer of the received SPR frame is equal to 0, the AP or PCP may allocate a channel with channel width less than or equal to the value of the BW subfield in the received ADDTS Request frame.
- If the Is Channel Number subfield in the control trailer of the received SPR frame is equal to 1, the AP or PCP should allocate the channel as indicated by the BW subfield in the received ADDTS Request frame.

If the source DMG STA, destination DMG STA and the PCP or AP are all EDMG STAs, the allocation time created by the AP or PCP should meet the bandwidth requirements specified in the DMG TSPEC element or SPR frame, as appropriate, received by the AP or PCP.

## 11.5 Block ack operation

### 11.5.2 Setup and modification of the block ack parameters

#### 11.5.2.4 Procedure common to both originator and recipient

***Change the first paragraph in 11.5.2.4 as follows (Table 11-5 and Table 11-6 remain unchanged):***

Once a block ack agreement has been successfully established between two STAs, the type of agreement thus established is dependent on the capabilities of the STAs and the contents of the ADDBA Request and ADDBA Response frames used to establish this agreement as defined in Table 11-5 for non-DMG STAs, ~~and~~ in Table 11-6 for DMG STAs that are not EDMG STAs, and in Table 11-6a for EDMG STAs.

***Insert Table 11-6a at the end of 11.5.2.4:***

**Table 11-6a—Types of block ack agreement based on capabilities and ADDBA conditions for EDMG STAs**

| Capabilities conditions | ADDBA condition | Type of BlockAckReq and BlockAck variant | Type of block ack agreement |
|---|---|---|---|
| One of the STAs is a non-EDMG STA | Per Table 11-6 | Per Table 11-6 | Per Table 11-6 |
| Both STAs are EDMG STAs | At least one STA indicates no support for EDMG flow control | Compressed BlockAckReq, EDMG Compressed BlockAck, and EDMG Multi-TID BlockAck | HT-Immediate + EDMG flow control (RBUFCAP with values Receiver Buffer Full, Receiver Buffer Empty, and No Memory Kept) |
| Both STAs are EDMG STAs | Both STAs indicate support for EDMG flow control | Compressed BlockAckReq, EDMG Compressed BlockAck, and EDMG Multi-TID BlockAck | HT-Immediate + EDMG flow control (RBUFCAP with values Receiver Buffer Full, Receiver Buffer Empty, and No Memory Kept) + EDMG flow control per Recipient Memory Capabilities field |

## 11.7 TPC procedures

### 11.7.1 General

***Insert the following paragraph at the end of 11.7.1:***

A DMG STA that has dot11ExtendedTPCActivated defined and with a value different from none shall support the Extended TPC as defined in 10.43.6.

## 11.8 DFS procedures

### 11.8.8 Selecting and advertising a new channel

***Insert the following subclause (11.8.8.7) after 11.8.8.6:***

#### 11.8.8.7 Selecting and advertising new channels in an EDMG BSS

A change in the BSS operating channels or operating channel width as announced by the EDMG Operation element is referred to as a change of operating channels.

The decision to switch to new operating channels in an EDMG BSS shall be made only by an AP or PCP. An AP or PCP may make use of the information it received in EDMG Capabilities elements and the results of measurements undertaken by the AP or PCP and other STAs in the BSS to assist the selection of the new operating channels. The algorithm to choose the new operating channels is beyond the scope of this standard.

An AP or PCP shall inform associated STAs that the AP or PCP is changing operating channels and shall maintain the association by advertising the switch using the Extended Channel Switch Announcement element and EDMG Wide Bandwidth Channel Switch element in its transmitted DMG Beacon frames, Announce frames, or Information Response frames until the intended channel switch time. The channel switch should be scheduled so that all non-AP and non-PCP STAs in the BSS, including STAs in power save mode, have the opportunity to receive at least one Extended Channel Switch Announcement element and EDMG Wide Bandwidth Channel Switch element before the switch. A STA may ignore the Channel Switch Mode field and either cease transmissions or attempt new transmission in the operating channel until the channel change occurs.

A STA that receives an Extended Channel Switch Announcement element and EDMG Wide Bandwidth Channel Switch element chooses whether to perform the specified switch. If a STA that receives an Extended Channel Switch Announcement element and EDMG Wide Bandwidth Channel Switch element chooses to perform the specified switch, it shall operate on the channels indicated in the EDMG Wide Bandwidth Channel Switch element. If a STA that receives an Extended Channel Switch Announcement element and an EDMG Wide Bandwidth Channel Switch element chooses not to perform the specified switch, it may take alternative action. For example, it may choose to move to a different BSS.

A non-AP and non-PCP STA in an infrastructure BSS or PBSS shall not transmit the Extended Channel Switch Announcement element or the EDMG Wide Bandwidth Channel Switch element.

## 11.19 Timing advertisement

### 11.19.3 UTC TSF Offset procedures

***Change the first paragraph in 11.19.3 as follows:***

When dot11UTCTSFOffsetActivated is true, the Time Advertisement and Time Zone elements shall be included in all Probe Response frames, ~~and~~ the Time Advertisement element shall be included in the Beacon frame every dot11TimeAdvertisementDTIMInterval DTIMs<u>, and the Time Advertisement element shall be included in the DMG Beacon frame or in the Announce frame at least every dot11DMGTimeAdvertisementBeaconInterval</u>. When dot11UTCTSFOffsetActivated is false, the Time Advertisement and Time Zone elements shall not be included in Beacon<u>,</u> ~~and~~ Probe Response<u>, and Announce</u> frames.

## 11.24 Quality-of-service Management frame (QMF)

### 11.24.1 General

#### 11.24.1.2 Default QMF policy

***Change Table 11-16 as follows (not all rows are shown):***

**Table 11-16—Default QMF policy**

| Description | Management Frame Subtype value from Table 9-1 | Category value from Table 9-51 | Action field | QMF access category |
|---|---|---|---|---|
| ... | | | | |
| DMG | 1101 | 16 | 0–22 | AC_BE |
| DMG | 1101 | 16 | 23 | AC_VO |
| ... | | | | |
| Unprotected DMG | 1101 | 20 | 0–5 ~~1~~ | AC_VO |

## 11.27 DMG beamformed link and BSS maintenance

### 11.27.1 Beamformed link maintenance

***Insert the following subclause heading for 11.27.1.1 immediately after the heading for 11.27.1 (the original text of 11.27.1 as published in IEEE Std 802.11-2020, including Figure 11-46, becomes the text of 11.27.1.1):***

#### 11.27.1.1 General

***Insert the following subclause (11.27.1.2) after 11.27.1.1:***

#### 11.27.1.2 EDMG partial SLS

An initiator and responder that are EDMG STAs are partial SLS ready if

— Either the initiator or the responder, or both the initiator and the responder, have more than one DMG antenna, and
— The initiator and responder have successfully exchanged an EDMG Partial Sector Level Sweep element (see 10.42.6.4.1)

When the beam link maintenance timer expires on a link between an initiator and a responder that are partial SLS ready,

1) The responder shall configure its receive DMG antenna to a quasi-omni pattern and switch its receive DMG antennas at a rate of once per a time interval equal to MBIFS plus the number of sectors indicated in the Partial Number of Sectors field of the last EDMG Partial Sector Level Sweep element received from the initiator multiplied by (TXTIME(SSW frame)+SBIFS).

2) The initiator shall initiate an ISS with the number of sectors indicated in the Partial Number of Sectors field of the last EDMG Partial Sector Level Sweep element it sent to the responder. The initiator shall repeat this set of sectors for one plus the number indicated in the Partial Number of RX Antennas field in the last EDMG Partial Sector Level Sweep element received from the responder.
3) When the initiator finishes the ISS, it shall configure its receive antennas to a quasi-omni pattern and switch its receive DMG antennas at a rate of once per a time interval equal to MBIFS plus the number of sectors indicated in the Partial Number of Sectors field of the last EDMG Partial Sector Level Sweep element received from the responder multiplied by (TXTIME(SSW frame)+SBIFS).
4) If the responder received at least one SSW frame from the initiator during step 1, it shall wait for the time indicated in the Duration field of that frame and initiate an RSS with the number of sectors indicated in the Partial Number of Sectors field of the last EDMG Partial Sectors Level Sweep element it has sent to the initiator. The responder shall repeat the RSS to each DMG antenna of the initiator according to the number indicated in the Partial Number of RX Antennas field in the last EDMG Partial Sectors Level Sweep element received from the initiator.

If the time indicated in the Time to Switch to Full Sweep field sent by the initiator to the responder in the last EDMG Partial Sectors Level Sweep element following the expiration of the dot11BeamLinkMaintenanceTime has passed and the initiator and responder have not completed a succsesfull SLS, the initiator and responder shall perform the following steps:

5) The responder shall configure its receive antenna to a quasi-omni pattern and switch its receive DMG antennas at a rate of once per a time interval equal to MBIFS plus the number of sectors indicated in the Total Number of Sectors field of the last EDMG Partial Sector Level Sweep element received from the initiator multiplied by (TXTIME(SSW frame)+SBIFS).
6) The initiator shall initiate an ISS with the number of sectors indicated in the Total Number of Sectors field of the last EDMG Partial Sector Level Sweep element sent to the responder. The initiator shall repeat the ISS for one plus the number indicated in the Total Number of RX Antennas field in the last EDMG Partial Sector Level Sweep element received from the responder.
7) When the initiator finishes the ISS, it shall configure its receive DMG antennas to a quasi-omni patterm and switch its receive DMG antennas at a rate of once per a time interval equal to MBIFS plus the number of sectors indicated in the Total Number of Sectors field of the last EDMG Partial Sector Level Sweep element received from the responder multiplied by (TXTIME(SSW frame)+SBIFS).
8) If the responder received at least one SSW frame from the initiator during step 5, it shall wait until the time indicated in the Duration field of that frame and initiate an RSS with the number of sectors indicated in the Partial Number of Sectors field of the last EDMG Partial Sector Level Sweep element it has sent to the initiator. The responder shall repeat this RSS for each DMG antenna of the initiator according to the number indicated in the Total Number of RX Antennas field in the last EDMG Partial Sector Level Sweep element received from the initiator.

If the initiator and responder agreed to change roles according to the procedure described in 10.42.6.4.1, the initiator and responder in step 1 through step 8 shall become, respectively, the responder and initiator of the EDMG Partial Sector Level Sweep element exchange.

If the procedure in step 1 through step 8 does not complete before the end of the allocation (SP or TXOP) in which the procedure started is reached, the initiator and responder shall resume the procedure at step 5 at the next available allocation.

## 11.30 Spatial sharing and interference mitigation for DMG STAs

### 11.30.1 General

***Change the first and second paragraphs in 11.30.1 as follows:***

This subclause describes mechanisms to enable spatial sharing and interference mitigation within a PBSS/infrastructure BSS and in an uncoordinated OBSS environment. The mechanisms specified can operate on one or more channels.

Spatial sharing mechanisms allow SPs belonging to different STAs in the same spatial vicinity to be scheduled concurrently over ~~the same~~ one or more channels, and for interference mitigation. Alternatively, the AP or PCP can use CBAPs to mitigate interference.

### 11.30.2 Spatial sharing and interference assessment

***Change the second paragraph in 11.30.2 as follows:***

The AP or PCP should use the directional channel quality described in 9.4.2.20.16 and 9.4.2.21.15 to assess the possibility for spatial sharing of SPs over one or more channels.

***Change the fifth, sixth, and seventh paragraphs in 11.30.2 as follows:***

For the purpose of spatial sharing with one or more existing SPs allocated on the same channel, t~~T~~he AP or PCP should request the source DMG STA and the destination DMG STA involved in a candidate SP to perform measurements ~~for the purpose of spatial sharing with an existing SP~~ only after the STAs have beamforming trained with each other. For the purpose of spatial sharing with one or more existing SPs allocated in different channels, the EDMG AP or EDMG PCP should request each source DMG STA and each destination DMG STA involved in each candidate SP to perform measurements only after the STAs have beamforming trained with each other. The AP or PCP can infer that the STAs in a candidate SP have a beamformed link with each other if the Beamforming Training field within the DMG TSPEC used to set up the candidate SP was set to 1 and at least one beacon interval has elapsed since the candidate SP was first scheduled.

If the AP or PCP transmits a Directional Channel Quality request to a STA involved in a candidate SP to assess the possibility for spatial sharing with one or more ~~another~~ existing SPs, it shall set the Target STA to the corresponding peer STA's MAC address involved in the candidate SP and shall set the Measurement Method field to indicate ANIPI. Additionally, the AP or PCP may include a Measurement Configuration subelement in the Directional Channel Quality request where the Measurement Channel Bitmap subfield indicates one or more 2.16 GHz channels for which the measurement request applies; in this case, it may set the Channel Measurement Report Method subfield to 0 to indicate the results of measurements over all the requested 2.16 GHz channels during each measurement time block are reported per 2.16 GHz channel or may set this subfield to 1 to indicate the averaged results of concurrent measurements over all the requested 2.16 GHz channels during each measurement time block are reported, and may set the Antenna Measurement Report Method subfield to 0 to indicate the results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported per DMG antenna or may set this subfield to 1 to indicate the averaged results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported, and may set the RX Antenna Configuration Type subfield to 0 to indicate the RX antenna configuration for SISO communication is requested to be used for measurements or may set this subfield to 1 to indicate the RX antenna configuration for SU-MIMO communication is requested to be used for measurements. Together with the Measurement Configuration subelement, the AP or PCP may also include an Extended Measurement Configuration subelement in the Directional Channel Quality request, where measurement timing information for the first requested channel is indicated in the Measurement Request field and measurement timing information for the remaining requested channels is indicated in the Extended Measurement Configuration subelement.

If the candidate SP has already been allocated channel time, the AP or PCP should additionally transmit a Directional Channel Quality request to the STAs involved in each of the one or more existing SPs to assess the possibility for spatial sharing with the candidate SP. In the Directional Channel Quality request, the AP or PCP shall set the Target STA to the corresponding peer STA involved in the existing SP and shall set the Measurement Method field to indicate ANIPI. Additionally, the PCP or AP may include a Measurement Configuration subelement in the Directional Channel Quality request where the Measurement Channel Bitmap subfield indicates one or more 2.16 GHz channels for which the measurement request applies; in this case, it may set the Channel Measurement Report Method subfield to 0 to indicate the results of measurements over all the requested 2.16 GHz channels during each measurement time block are reported per 2.16 GHz channel or may set this subfield to 1 to indicate the averaged results of concurrent measurements over all the requested 2.16 GHz channels during each measurement time block are reported, and may set the Antenna Measurement Report Method subfield to 0 to indicate the results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported per DMG antenna or may set this subfield to 1 to indicate the averaged results of concurrent measurements over each requested 2.16 GHz channel using multiple RX DMG antennas during a measurement time block are reported, and may set the RX Antenna Configuration Type subfield to 0 to indicate the RX antenna configuration for SISO communication is requested to be used for measurements or may set this subfield to 1 to indicate the RX antenna configuration for SU-MIMO communication is requested to be used for measurements. Together with the Measurement Configuration subelement, the AP or PCP may also include an Extended Measurement Configuration subelement in the Directional Channel Quality request, where measurement timing information for the first requested channel is indicated in the Measurement Request field and measurement timing information for the remaining requested channels is indicated in the Extended Measurement Configuration subelement.

***Change the eighth paragraph in 11.30.2 as follows (the note before this paragraph remains unchanged):***

If a recipient STA that receives a Directional Channel Quality request frame is already beamformed trained with the target STA specified by the AID field within the frame, then the recipient STA shall carry out the measurement employing the same receive antenna configuration as is used by the recipient STA when receiving frames from the target STA using a SISO antenna setting or shall carry out the measurements concurrently employing the same receive antenna configuration as is used by the recipient STA when receiving frames from the target STA using an SU-MIMO antenna setting. If the AID field is set to the broadcast AID or an unknown AID, then the recipient STA shall perform the measurements using a quasi-omni antenna pattern.

### 11.30.3 Achieving spatial sharing and interference mitigation

***Change the second and third paragraphs in 11.30.3 as follows:***

An AP or PCP should schedule a candidate SP that overlaps with an existing SP in its beacon interval only after it receives a Directional Channel Quality report from the STAs involved in the candidate SP. When an EDMG AP or EDMG PCP schedules a candidate SP that overlaps with an existing SP in its beacon interval, it may also recommend whether SISO transmission or SU-MIMO transmission is applied in the candidate SP by using the Recommended Transmission Scheme subfield in the EDMG Extended Schedule element.

If a candidate SP is already scheduled in the beacon interval, the AP or PCP should schedule this candidate SP time overlapping with an existing SP in its beacon interval only after it receives a Directional Channel

Quality report from the STAs involved in the existing SP. When an EDMG AP or EDMG PCP schedules this candidate SP time overlapping with an existing SP in its beacon interval, it may also recommend whether SISO transmission or SU-MIMO transmission is applied in this candidate SP by using the Recommended Transmission Scheme subfield in the EDMG Extended Schedule element.

***Insert the following subclause (11.30.5) after 11.30.4:***

### 11.30.5 Directional transmit activity report

DMG STAs for which dot11DMGSTATxActivityReportImplemented is true are capable of transmitting DMG STA Directional Transmit Activity Report frames which, for a given receiving STA (or group of receiving STAs as defined below) and a given 2.16 GHz channel, include information that helps the receiving STAs unintentionally affected by the radiation pattern (more precisely, STAs that receive energy when the transmitting STA uses the given antenna pattern to communicate with its intended targets) to mitigate the interference caused by the transmitting STA, as well as the interference these receiving STAs cause to the transmitting STA.

A STA with both dot11DMGSTATxActivityReportImplemented and dot11DMGSTATxActivityReportActivated equal to true regularly transmits DMG STA Directional Transmit Activity Report frames (activity report frames, for short) as follows.

For each receiver (or group of receivers always transmitted data through a common transmit antenna pattern and transmit power) and each 2.16 GHz channel that the transmitting STA is using to communicate with the receiver(s), the STA monitors its transmit activity in terms of number of active time units, contiguous or non-contiguous, during a sliding window comprising a given number of time units. An active time unit is a period during which the STA has been in transmit mode for a percentage of the time unit greater than or equal to aDMGActiveThresholdPercentage, excluding any time spent towards transmitting a DMG Beacon frame or a PPDU that contains only activity report frames, using the common antenna pattern and the transmit power, and using the 2.16 GHz channels. The time unit duration, in microseconds, is dot11DMGSTATxActivityReportTimeUnit.

As long as the STA has observed at least dot11DMGSTATxActivityReportMinActiveTimeUnits active time units over the last dot11DMGSTATxActivityReportActiveMonitoringTime time units, it shall transmit a PPDU containing one activity report MMPDU, using the common antenna pattern, and on each of the 2.16 GHz channels used for data transmission, at least once during every dot11DMGSTATxActivityReportInterval microseconds, provided that the STA has a transmit opportunity longer than SIFS plus the duration of a PPDU that only includes one activity report frame. The interval between the start of transmission of consecutive Directional Transmit Activity Report frames shall not exceed aDMGSTATxActivityReportingtLimit. If the STA does not have the transmit opportunity to transmit the activity report frame during this time, it shall transmit the frame at the first opportunity.

NOTE 1—For example, the following settings require a capable DMG STA to transmit a DMG STA Directional Transmit Activity Report frame at least once during every second, as long as the STA has had at least 10 active seconds of transmission using a given antenna pattern over the last 60 seconds: dot11DMGSTATxActivityReportActivated = true, dot11DMGSTATxActivityReportTimeUnit = 1000000, dot11DMGSTATxActivityReportMinActiveTimeUnits = 10, dot11DMGSTATxActivityReportActiveMonitoringTime = 60, and dot11DMGSTATxActivityReportInterval = 1000000.

All transmitted activity report frames shall include the Country and DMG STA Directional Transmit Activity Report elements. The DMG STA Directional Transmit Activity Report element shall include the Directional Transmit Activity and Transceiver Parameters subelements.

The PPDUs containing an activity report frame should use the average effective TRP that the transmitting STA expects to apply when it communicates with other STAs using the common antenna pattern and occupying channels that are the same as, or include the channels used for the data transfer.

NOTE 2—For example, when the STA is communicating over a 4.32 GHz channel, it transmits the PPDUs that contain a transmit activity report frame at about half the power on each of the two 2.16 GHz channels in the 4.32 GHz channel.

A DMG STA that has the EDMG Supported subfield equal to 1 in the transmitted DMG Parameters field shall include DMG TRN-R subfields within its TRN field of the PPDU containing an activity report frame to enable receive training. Specifically, the STA transmitting such PPDU shall set the TRN-LEN parameter of the TXVECTOR of the PPDU to a value not less than 2 and shall set the PPDU_TYPE parameter of the TXVECTOR to TRN-R. The PPDU_TYPE parameter of the TXVECTOR of such PPDU shall not be set to TRN-T.

A STA may transmit individually addressed activity report frames to a target STA. When transmitting the activity report frame to a target STA in the same BSS, and when management frame protection is negotiated, the transmitting STA shall use individually addressed Protected Dual of Public Action frames instead of Public Action frames.

## 11.31 Multi-band operation

### 11.31.1 General

***Insert the following paragraph at the end of 11.31.1:***

The multi-band discovery assistance request is managed by the FST setup protocol and is used in conjunction with a session transfer. State transition of the discovery assistance request is described in 11.31.3 and details of the multi-band discovery assistance procedure are described in 11.31.7. A STA may include a DMG Discovery Assistance element in an FST Setup Request frame only if the recipient STA sets the Discovery Assistance Enabled subfield in the recipient STA's Multi-band element to 1. When a DMG Discovery Assistance element is present in the frame, it indicates a request for a discovery assistance to a recipient STA. A STA that supports the discovery assistance procedure and that receives a discovery assistance request shall include the DMG Discovery Assistance element in the FST Setup Response frame transmitted in response to a received FST Setup Response frame containing the multi-band discovery assistance request. If the Discovery Assistance Type subfield in a received DMG Discovery Assistance element is 1, the recipient STA shall include also an Extended Schedule element in the FST Setup Response frame and may include a TDD Slot Structure and TDD Slot Schedule elements.

***Insert the following subclauses (11.31.7, 11.31.7.1, and 11.31.7.2, including Figure 11-55a) after 11.31.6:***

### 11.31.7 Multi-band discovery assistance procedure

#### 11.31.7.1 Multi-band discovery assistance request procedure

The multi-band discovery assistance procedure allows discovery of DMG BSSs using a STA of a multi-band capable device that operates on a band other than its intended band of communication.

A device is multi-band discovery assistance capable if the value of both dot11MultibandImplemented and dot11DiscoveryAssistanceActivated are true for all discovery assistance cooperating STAs in the device. A STA that is part of a multi-band discovery assistance capable device shall advertise the capability of multi-band discovery assistance by setting the Discovery Assistance Enabled subfield in the Multi-band Control field of its Multi-band element to 1.

Figure 11-55a depicts an example of the overall multi-band discovery assistance procedure.

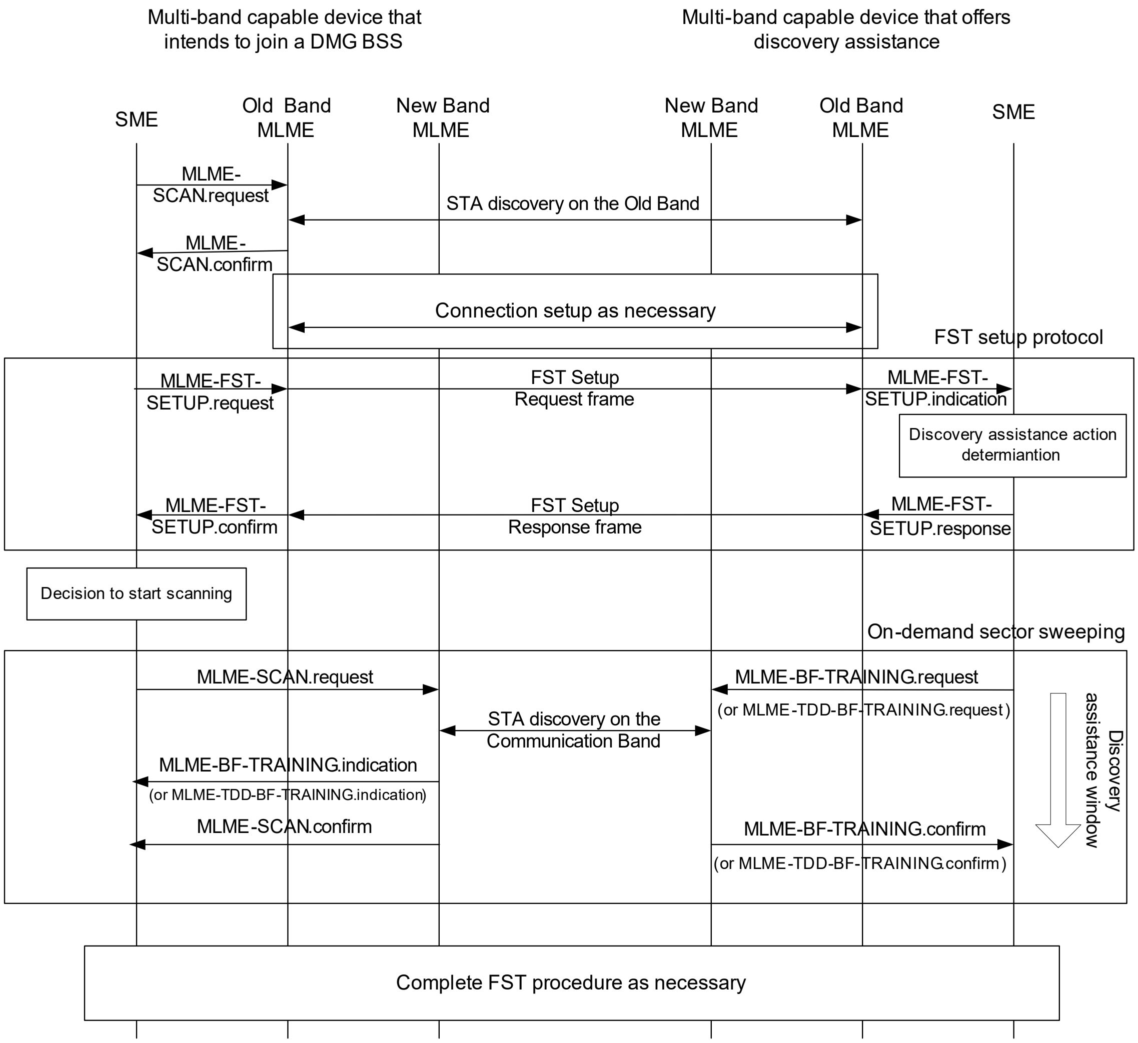


**Figure 11-55a—Multi-band discovery assistance procedure**

The SME of a STA of a multi-band capable device that intends to join a DMG BSS issues an MLME-SCAN.request primitive to the *Old Band MLME* of the device. After the scanning procedure completes, the *Old Band MLME* issues an MLME-SCAN.confirm primitive to the SME of the STA. The MLME-SCAN.confirm primitive contains information indicating which STAs support multi-band discovery assistance and for which band, i.e., the Discovery Assistance Enabled subfield in the Multi-band Control field of the Multi-band element.

If a multi-band discovery assistance capable device is found and a STA of the device operates a DMG BSS or an EDMG BSS, the SME of the STA that performed scanning may issue MLME-FST-SETUP.request primitive to the *Old Band MLME* of the STA to request the discovered STA to start the discovery assistance procedure with its DMG STA. The *Old Band MLME* receiving the MLME-FST-SETUP.request primitive shall transmit an FST Setup Request frame.

NOTE—If the recipient of an FST Setup Request frame is an AP, the STA transmitting the FST Setup Request frame needs to complete the association and authentication process before transmitting the frame.

The two multi-band capable devices exchange FST Setup Request frame and FST Setup Response frames, as described in 11.31.3, containing the DMG Discovery Assistance element.

Upon reception of the MLME-FST-SETUP.indication primitive, the SME of the STA that received the discovery assistance request determines if it accepts the requested discovery assistance. The SME shall encode the determination results in the DMG Discovery Assistance element, and issue an MLME-FST-SETUP.response primitive to the *Old Band MLME* to send back discovery assistance response.

The SME that received the MLME-FST-SETUP.confirm primitive including the DMG Discovery Assistance element shall determine if the discovery assistance response indicates that the discovery assistance is accepted. If it has been accepted, the device shall start its DMG STA on the channel specified in the Multi-band element. Further, the SME of the DMG STA shall issue an MLME-SCAN.request primitive to its *New Band MLME* in accordance with the parameters contained in the elements in the received frame.

Upon the successful completion of the on demand sector sweeping, the two multi-band devices may complete the FST procedure as described in 11.31.3.

#### 11.31.7.2 Discovery assistance action determination and on demand sector sweeping

When the SME receiving the discovery assistance request accepts the request, it shall set the Discovery Assistance Request Status Code field of the DMG Discovery Assistance element transmitted in the FST Setup Response frame containing the discovery assistance response to SUCCESS and take one of the following actions with the corresponding DMG STA.

If the DMG STA operates non-TDD channel access, the DMG STA shall provide discovery assistance through one of the following two options:

- Option 1: The DMG STA schedules DMG Beacon frame transmissions sweeping all of its sectors so that the STA requesting discovery assistance can attempt to receive it. The STA sets fields in the DMG Discovery Assistance element as follows and includes it in transmitting response:
  - Sets the Discovery Assistance Type subfield in the Discovery Assistance Control field to 0.
  - Sets the Sector Sweep Start Time field to the TSF value indicating its TBTT when the discovery assistance starts.
  - Sets the Discovery Assistance Window Length to the time duration of the discovery assistance, i.e., DMG Beacon sweeping. The number of transmit antenna sectors in the STA requesting discovery assistance is used to determine the exact number of slots needed in the A-BFT period for the responder TXSS. The DMG STA might use multiple beacon intervals to complete full DMG Beacon sweeping. The Discovery Assistance Window Length might include one or more complete full DMG Beacon Sweep.
- Option 2: The DMG STA schedules a beamforming training period with the discovery assistance requesting DMG STA. The DMG STA adds the beamforming training period allocation to the Extended Schedule element and includes this element in its response. The total duration of the beamforming period shall at least cover the initiator TXSS and the responder TXSS. The DMG STA shall assign a temporary AID to the DMG STA that is requesting discovery assistance, in order to identify the STA in the element. The DMG STA sets fields in the Extended Schedule element sent in its response as follows:
  - Sets the Beamforming Training field, the IsInitiatorTXSS and IsResponderTXSS subfields in the BF Control subfield in the Allocation field to 1 to indicate that beamforming training is initiated at the start of the allocation.
  - If the DMG STA is offering discovery assistance with active scanning, it sets the Source AID subfield in the Allocation field to the temporary AID value that is assigned to the requesting DMG STA. If the DMG STA is offering discovery assistance with passive scanning, it sets the Destination AID subfield in the Allocation field to the temporary AID value that is assigned to the requesting DMG STA.

The DMG STA sets the fields in the DMG Discovery Assistance element sent in its response as follows:

- Sets the Discovery Assistance Type subfield in the Discovery Assistance Control field to 1.
- Sets the Temporary AID field to the temporary value that is assigned to the requesting DMG STA.
- Sets the Discovery Assistance Window Length to the time duration of the beamforming period, including all time blocks if more than one time block is scheduled.

If the DMG STA operates TDD channel access, the DMG STA shall provide discovery assistance through one of the following two options:

- Option 1: The DMG STA initiates TDD beamforming, as specified in 10.42.11, with the STA that requested discovery assistance. The STA sets fields in the DMG Discovery Assistance element sent in the response as follows:
  - Sets the Discovery Assistance Type subfield in the Discovery Assistance Control field to 0.
  - Sets the Sector Sweep Start Time field to the TSF value when the STA starts TDD beamforming procedure.
  - Sets the Dwelling Time field to the recommended time to sweep the receive antenna pattern during the scanning.
  - Sets the Discovery Assistance Window Length to the time duration for the TDD beamforming. The number of DMG STA transmit antenna sectors, the number of receive antenna sectors in the STA requesting discovery assistance and the dwelling time are used to calculate the time required for TDD beamforming as described in 10.42.11.
- Option 2: The DMG STA schedules TDD beamforming with the STA that requested discovery assistance. The DMG STA schedules the allocation as part of an Extended Schedule element and includes this element in its response. The TDD Applicable SP subfield in the Allocation Control subfield of the Allocation field in the Extended Schedule field is set to 1 and either the Source AID or the Destination AID subfields in the Allocation field in the Extended schedule element is set to the DMG STA requesting a temporary AID. The DMG STA may include a TDD Slot Structure element and a TDD Slot Schedule element in its response. The DMG STA sets fields in the DMG Discovery Assistance element sent its response as follows:
  - Sets the Discovery Assistance Type subfield in the Discovery Assistance Control field to 1.
  - Sets the Temporary AID field to a temporary value that is assigned to the requesting DMG STA. This temporary AID value is used to identify the requesting DMG STA in the Extended Schedule element.
  - Sets the Dwelling Time field to the recommended time to sweep the receive antenna pattern during the scanning.
  - Sets the Discovery Assistance Window Length to the time duration of the TDD beamforming period, including all time blocks if more than one time block is scheduled.

When a STA that is a part of a multi-band capable device receives an FST Setup Response frame with a Discovery Assistance Response element indicating SUCCESS in the Discovery Assistance Request Status Code field in the received DMG Discovery Assistance element, the STA shall take the following actions with the corresponding peer DMG STA:

The SME shall issue an MLME-SCAN.request primitive to its New Band MLME, set the BSSID and ChannelList parameters according to the BSSID, Band ID, Operating Class and Channel Number field values captured from the Multi-band element and set the MinChannelTime parameter to the Discovery Assistance Window Length field in the received DMG Discovery Assistance element.

Depending on the values contained in the Discovery Assistance Control field in the received DMG Discovery Assistance element, the MLME-SCAN.request primitive is issued in one of the following manners:

— If the Dwelling Time Present subfield is 0 and the Discovery Assistance Type subfield is 0, the MLME-SCAN.request primitive is issued before the time specified in the Sector Sweep Start Time field in the received DMG Discovery Assistance element and the ScanType is set to passive scanning.
— If the Dwelling Time Present subfield is 0 and the Discovery Assistance Type subfield is 1, the MLME-SCAN.request primitive is issued before the time of the scheduled beamforming period specified by the Allocation field in the received Extended Schedule element. The ScanType is set to active scanning if the Source AID subfield in the Allocation field in the received Extended Scheduled element is equal to the Temporary AID field in the received DMG Discovery Assistance element. The ScanType is set to passive scanning otherwise. The DMG STA shall perform the initiator TXSS and the responder TXSS within the allocated time specified in the received Extended Schedule element.
— If the Dwelling Time Present subfield is 1 and the Discovery Assistance Type subfield is 0, the MLME-SCAN.request primitive is issued before the time specified in the Sector Sweep Start Time field in the received DMG Discovery Assistance element. The ScanType is set to TDD passive scanning, and SectorDwellTime is set to the value specified in the Dwelling Time field in the received DMG Discovery Assistance element.
— If the Dwelling Time Present subfield is 1 and the Discovery Assistance Type subfield is 1, the MLME-SCAN.request primitive is issued before the time of the scheduled beamforming period specified by the Allocation field in the received Extended Schedule element. The ScanType is set to TDD passive scanning.

The New Band MLME reports the results of the beamforming training procedure by sending an MLME-BF-TRAINING.indication primitive or MLME-TDD-BF-TRAINING.indication primitive to its SME (see 11.36). After the scanning procedure, the New Band MLME responds back with an MLME-SCAN.confirm primitive to its SME notifying the completion of the scanning on the New Band.

## 11.33 DMG coexistence with non-IEEE-802.11 systems

***Change the first and second paragraphs in 11.33 as follows:***

This subclause describes the features available in this standard to improve coexistence with other ~~DMG~~ systems that operate in the 60 GHz band, including IEEE ~~Std~~ 802.15~~.3™-2016 [B21]~~ systems.

The same common channelization that is defined in other ~~DMG standards and~~ specifications for systems that operate in the 60 GHz band is adopted by the DMG PHY specifications (20.3.1 and 28.3.4) for 2.16 GHz channels. In regulatory domains where 2 or more channels are defined, a DMG STA should support at least 2 channels.

***Insert the following list item into 11.33 at the end of the dashed list of the fifth paragraph ("If a DMG STA detects ...:"):***

— In an EDMG BSS, when operating over multiple channels, the occupied bandwidth of a PPDU transmitted by a TXOP holder may be smaller than the occupied bandwidth of the last PPDU transmitted by the TXOP holder within the same TXOP (10.6.7.6).

## 11.36 DMG beamforming

***Insert the following subclause heading for 11.36.1 immediately after the heading for 11.36 (the original text of 11.36 as published in IEEE Std 802.11-2020, including Figure 11-57 and Figure 58, becomes the text of 11.36.1):***

### 11.36.1 Non-TDD beamforming

***Change the text of 11.36.1 as follows (Figure 11-57 and Figure 11-58 remain unchanged):***

Upon receipt of an MLME-BF-TRAINING.request primitive, a STA shall undertake beamforming training with the STA indicated by the PeerSTAAddress parameter according to the procedures defined in 10.42. ~~This training shall start with the SLS and shall include the BRP if and only if the RequestBRP parameter of the MLME-BF-TRAINING.request primitive is true.~~ Beamforming training may consist of an SLS not followed by a BRP, an SLS followed by a BRP, or a BRP as defined by the MLME-BF-TRAINING.request primitive. An SLS shall include a BRP if and only if the RequestBRP parameter of the MLME-BF-TRAINING.request primitive is true.

If the MLME-BF-TRAINING.request primitive is used to request a BRP, the parameter BRPRequest parameter shall be included. The information subfields within BRPRequest are used to request and configure DMG beamforming procedures. The indication of whether the requested BRP procedure shall use short BRP frames is also defined in BRPRequest. If the primitive is used to request an EDMG beamforming procedure, the MLME-BF-TRAINING.request primitive shall also include the parameter EDMGBRPRequest. The MLME-BF-TRAINING.request primitive may also include the parameter DMGBeamRefinement that may be used to request and configure both DMG and EDMG beamforming procedures. If the primitive is used to request a partial sector level sweep, it shall also contain the parameter EDMGPartialSLS.

A STA receiving MLME-BF-TRAINING.request primitive may act as either initiator or responder in the beamforming training.

If the STA indicated by the PeerSTAAddress parameter of a received MLME-BF-TRAINING.request primitive is an AP or PCP of a BSS in which a STA is a member, the STA receiving the MLME-BF-TRAINING.request primitive may perform beamforming training during the A-BFT as described in 10.42.5. Alternatively, the STA receiving the MLME-BF-TRAINING.request primitive may use an SP or a TXOP to perform ISS as described in 10.42.2.2.

A STA receiving the MLME-BF-TRAINING.request primitive shall issue an MLME-BF-TRAINING.confirm primitive on completion of the requested beamforming training or on timeout as specified in 10.42.

A STA that performs beamforming training with a peer STA at the request of the peer STA shall issue an MLME-BF-TRAINING.indication primitive on completion of that beamforming training, or on timeout as specified in 10.42.

Both MLME-BF-TRAINING.confirm and MLME-BF-TRAINING.indication primitives shall include one or more of the following feedback related parameters if the ResultCode is equal to SUCCESS: DMGBeamRefinement, MeasFeedback, and EDMGMeasFeedback. The presence of these elements in the primitive depends on the specific DMG or EDMG beamforming procedure that was executed.

Figure 11-57 illustrates an example of the beamforming training procedure in the DTI for a case where the STA receiving the MLME-BF-TRAINING.request primitive acts as initiator.

Figure 11-58 illustrates an example of the beamforming training procedure in the context of a non-AP and non-PCP STA joining an infrastructure BSS or PBSS. In this scenario, the MLME-BF-TRAINING.request primitive is issued by the STA attempting to associate in order that the link be trained to a degree that allows the over-the-air exchanges necessary for association to succeed.

***Insert the following subclauses (11.36.2, 11.36.3, and 11.36.4, including Figure 11-58a, Figure 11-58b, and Figure 11-58c) after 11.36.1:***

### 11.36.2 TDD beamforming

Upon receipt of an MLME-TDD-BF-TRAINING.request primitive, a DMG STA shall assume the role of TDD beamforming initiator and, based on the BFType parameter, shall perform TDD individual BF or TDD group BF training with the STA indicated by the PeerSTAAddress parameter according to the procedures defined in 10.42.11. This beamforming training shall start at the time indicated by the BeamformingStartTimestamp parameter.

Upon receipt of the MLME-SCAN.request primitive with the ScanType parameter equal to TDD passive, a DMG STA shall passively scan for TDD SSW frames by sweeping its receiver antenna through all the receive sectors specified in ScanSectorIDList parameter while dwelling on each sector for a time equal to SectorDwellTime according to procedure described in 10.42.11.3. This passive scan shall be performed through all channels specified within the ChannelList parameter.

A STA that successfully performed scan and TDD beamforming training with a peer STA in response to an MLME-SCAN.request primitive shall issue an MLME-SCAN.confirm primitive containing all successfully received DMG Beacon frames that match the desired SSID in the BSSDescriptionSet parameters of the corresponding MLME-SCAN.confirm primitive as described in 11.1.4.

A STA that receives a MLME-TDD-BF-TRAINING.request primitive with BFType parameter set to TDD individual BF or TDD group BF shall assume the initiator role and perform the TDD individual BF or TDD group BF procedure, respectively, defined in 10.42.11. The STA shall issue an MLME-TDD-BF-TRAINING.confirm primitive on completion of the requested TDD beamforming procedure after transmitting the last TDD SSW Ack frame with End of Training subfield set to 1. In the primitive, the STA shall set the parameters NumberOfTDDFeedbackPeers and TDDFeedbackResults according to the TDD Route element received from the responder.

A STA that performs TDD beamforming training with a peer STA at the request of the peer STA shall issue an MLME-TDD-BF-TRAINING.indication primitive on completion of the TDD beamforming training procedure as specified in 10.42.11, following the reception of a TDD SSW Ack frame with the RA field set to the STA MAC address and with the End of Training subfield equal to 1.

Figure 11-58a illustrates an example of the TDD individual beamforming training procedure.

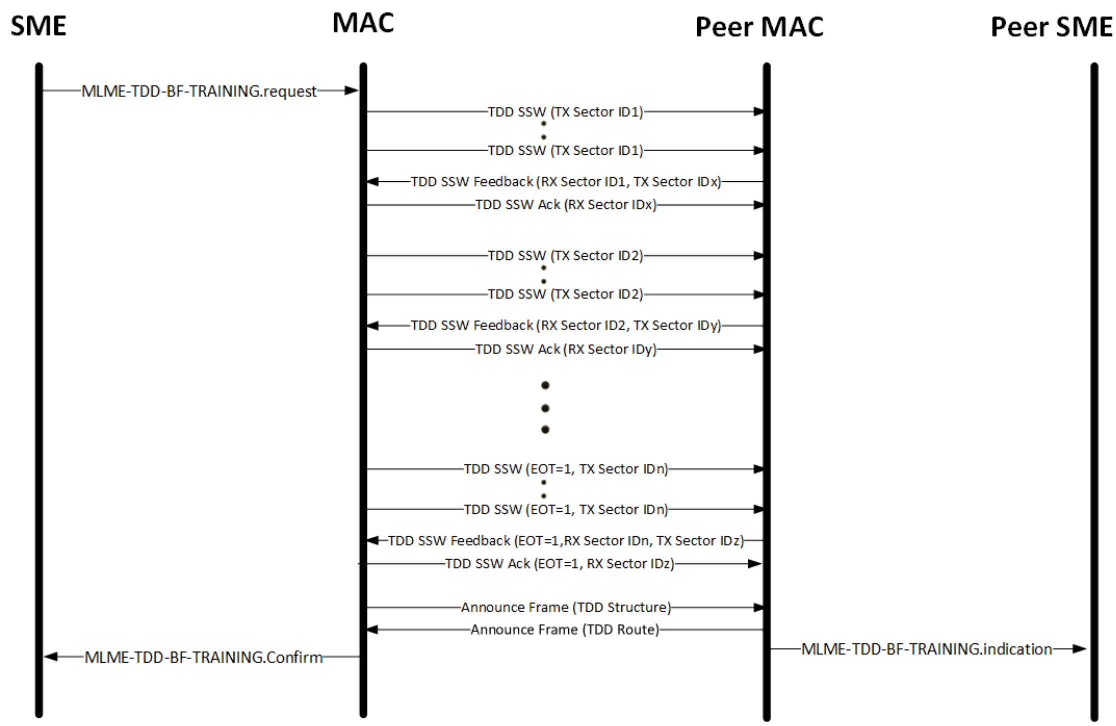


**Figure 11-58a—TDD individual beamforming training procedure**

Figure 11-58b illustrates an example of the TDD group beamforming training procedure.

### 11.36.3 TDD sector switch procedure

The TDD sector switch procedure allows a pair of DMG STAs operating in an SP with TDD channel access to synchronize the switch of transmit and receive sectors for communication between them. Only a PCP or AP shall initiate the TDD sector switch procedure. An AP or PCP can make use of the information in TDD Sector Feedback subelement and the results of measurements undertaken by STAs in the BSS to determine when to invoke a TDD sector switch procedure.

Upon receipt of an MLME-TDD-SECTOR-SWITCH.request primitive, a DMG STA shall send to the peer STA indicated by the PeerSTAAddress parameter an Announce frame of subtype Action with a TDD Route element that includes a TDD Sector Setting subelement with the Set Sector Request subfield set to 1. This is referred to as a TDD sector switch request message. Messages with Set Sector Response subfield set to 1 and messages with Set Sector Acknowledge subfield set to 1 are referred to as TDD sector switch response and TDD sector switch acknowledge messages, respectively. A STA shall not set to 1 more than one subfield of the TDD Sector Setting Control field in a given transmitted element.

The Responder TX Antenna ID, Responder RX Antenna ID, Initiator TX Antenna ID and Initiator RX Antenna ID subfields in the TDD Sector Setting subelement shall be set to, respectively, the ResponderTXAntennaID, ResponderRXAntennaID, InitiatorTXAntennaID and InitiatorRXAntennaID parameters of the request primitive. The Responder TX Sector ID, Responder RX Sector ID, Initiator TX Sector ID and Initiator RX Sector ID subfields in the TDD Sector Setting subelement shall be set to, respectively, the ResponderTXSectorID, ResponderRXSectorID, InitiatorTXSectorID and InitiatorRXSectorID parameters of the request primitive. The Set Sector Request subfield in the TDD Sector Setting subelement shall be set to 1.

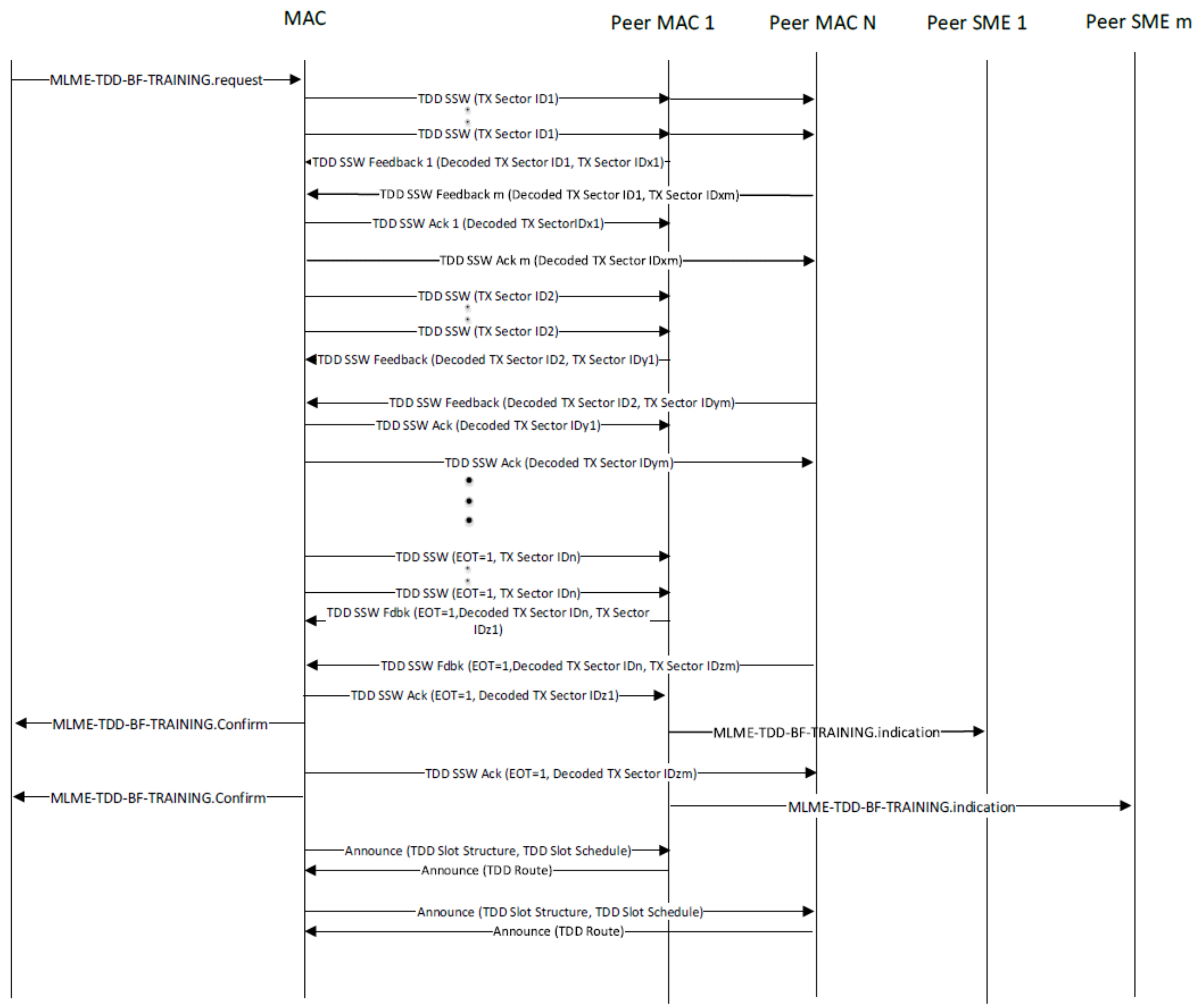


**Figure 11-58b—TDD group beamforming training procedure**

The Switch Timestamp subfield in the TDD Sector Setting subelement shall be set to the value of the SectorSwitchTimestamp parameter of the request primitive. The Switch Timestamp subfield value shall be set to a time value that allows at least three retransmissions of the Announce frame and the corresponding Ack frame sent in response.

The Revert Timestamp subfield in the TDD Sector Setting subelement shall be set to the value of the SectorRevertTimestamp parameter of the request primitive. The Revert Timestamp subfield value shall be set to a time value that allows the responder at least three retransmissions of a TDD sector switch response message, for the case the responder does not receive the TDD sector switch acknowledge message from the initiator, plus time to allow the initiator at least three retransmissions of a TDD sector switch acknowledge message, for the case the initiator does not receive the Ack frame from the responder.

An initiator STA that does not receive an Ack frame in response to a TDD sector switch request message should retransmit the message until the time indicated by the Switch Timestamp subfield.

A MLME-TDD-SECTOR-SWITCH.request primitive incorporating a new SectorSwitchTimestamp value shall not be issued until the SectorRevertTimestamp of the previous request primitive has elapsed.

A responder that receives a TDD sector switch request message shall perform the following:

— Issue an MLME-TDD-SECTOR-SWITCH.indication primitive with the PeerSTAAddress parameter set to the TA of the received message, the ResponderTXAntennaID, ResponderRXAntennaID, InitiatorTXAntennaID, InitiatorRXAntennaID, ResponderTXSectorID, ResponderRXSectorID, InitiatorTXSectorID and InitiatorRXSectorID parameters of the primitive set to, respectively, the Responder TX Antenna ID, Responder RX Antenna ID, Initiator TX Antenna ID, Initiator RX Antenna ID, Responder TX Sector ID, Responder RX Sector ID, Initiator TX Sector ID and Initiator RX Sector ID subfields of the TDD Sector Setting subelement within the received message.
— Respond with an Ack frame to any TDD sector switch request messages that arrive before the time indicated by the Switch Timestamp subfield value within the message.
— Set its receive and transmit antenna configuration corresponding to the Responder RX Antenna ID, Responder RX Sector ID, Responder TX Antenna ID and Responder TX Sector ID subfield values in the TDD sector switch request message, respectively, at the time indicated by the Switch Timestamp subfield.
— Send to the initiator a TDD sector switch response message by transmitting an Announce frame of subtype Action No Ack with the same Sector Setting subelement that was received by the responder, except that the Set Sector Request subfield shall be set to 0 and the Set Sector Response subfield shall be set to 1. The TDD sector switch response message should be sent at the earliest TDD slot occurring after the time indicated by the value of the Switch Timestamp subfield.

An initiator transmitting a TDD sector switch request message shall set its receive and transmit antenna configuration corresponding to the Initiator TX Antenna ID, Initiator TX Sector ID, Initiator RX Antenna ID and Initiator RX Sector ID subfield values, respectively, at the time indicated by the value of the Switch Timestamp subfield.

An initiator receiving a TDD sector switch response message shall send the responder a TDD sector switch acknowledge message by transmitting an Announce frame of subtype Action with the same Sector Setting subelement that was received by the initiator, except that the Set Sector Response subfield shall be set to 0 and the Set Sector Acknowledge subfield shall be set to 1. The TDD sector switch acknowledge message should be sent at the earliest TDD slot occurring after the time indicated by the value of the Switch Timestamp subfield.

A responder receiving a TDD sector switch acknowledge message before the time indicated by the Revert Timestamp value shall issue an MLME-TDD-SECTOR-SWITCH.confirm primitive. The TXAntennaID, RXAntennaID, TXSectorID and RXSectorID parameters of the primitive shall be set to the new transmit DMG antenna and sector index and to the receive DMG antenna and sector indexes, respectively, and the ResultCode parameter shall be set to SUCCESS.

An initiator transmitting a TDD sector switch acknowledge message before the time indicated by the Revert Timestamp value shall issue MLME-TDD-SECTOR-SWITCH.confirm primitive. The TXAntennaID, RXAntennaID, TXSectorID and RXSectorID parameters of the primitive shall be set to the new transmit DMG antenna and sector index and to the receive DMG antenna and sector indexes, respectively, and the ResultCode parameter shall be set to SUCCESS.

A responder that did not receive a TDD sector switch acknowledge message in response to a transmitted TDD sector switch response message should retransmit the TDD sector switch response message before the time indicated by the Revert Timestamp subfield value.

An initiator STA that did not receive an Ack frame in response to a transmitted TDD sector switch acknowledge message should retransmit the TDD sector switch acknowledge message before the time indicated by the Revert Timestamp subfield value.

A responder that did not receive a TDD sector switch acknowledge message by the time indicated by the Revert Timestamp subfield value shall issue an MLME-TDD-SECTOR-SWITCH.confirm primitive with the ResultCode parameter set to FAILURE and shall revert to the antenna configuration used at the start of the TDD sector switch procedure.

An initiator STA that did not receive a TDD sector switch response message by the time indicated by the Revert Timestamp subfield value shall issue an MLME-TDD-SECTOR-SWITCH.confirm primitive with the ResultCode parameter shall be set to FAILURE and shall revert to the antenna configuration used at the start of the TDD sector switch procedure.

An initiator STA that reverted to the previous antenna configuration at the time indicated by the Revert Timestamp subfield value shall send a PPDU that requires Ack frame at the earliest TDD slots occurring after the Revert Timestamp subfield value. An initiator STA receiving a PPDU after the time indicated by the Revert Timestamp subfield shall issue an MLME-TDD-SECTOR-SWITCH.confirm primitive. The TXSectorID and RXSectorID parameters of the primitive shall be set to the sectors used at the start of the TDD sector switch procedure and the ResultCode parameter shall be set to SUCCESS.

A responder receiving a PPDU after the time indicated by the Revert Timestamp subfield value shall issue an MLME-TDD-SECTOR-SWITCH.confirm primitive. The TXSectorID and RXSectorID parameters of the primitive shall be set to the sectors used at the start of the TDD sector switch procedure and the ResultCode parameter shall be set to SUCCESS.

A TDD initiator that did not receive an Ack frame in response to a transmitted PPDU shall initiate the TDD beamforming procedure as described in 10.42.11.

A responder that reverted to the antenna configuration at the time indicated by the Revert Timestamp subfield value and that did not receive a PPDU from the initiator at a TDD slot occurring after the Revert Timestamp subfield value shall start the TDD beamforming procedure as a responder as described in 10.42.11.

Figure 11-58c illustrates an example of a successful TDD sector switch procedure.

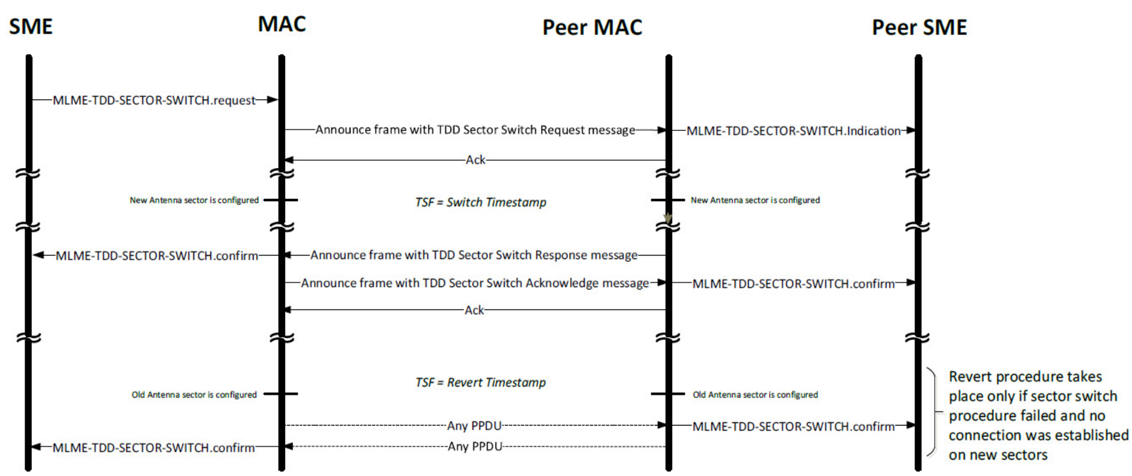


**Figure 11-58c—TDD sector switch procedure**

### 11.36.4 TDD beam measurement

Upon receipt of an MLME-TDD-BEAM-MEASUREMENT.request primitive, a DMG STA shall assume the role of initiator or responder, as specified by the BFRole parameter, and shall perform the beam measurement procedure with the STA(s) indicated by the PeerSTAAddress parameter according to the procedures defined in 10.42.11. The beam measurement procedure shall start at the time indicated by the BeamMeasurementStartTimestamp parameter.

A STA that receives an MLME-TDD-BEAM-MEASUREMENT.request primitive with BFRole parameter set to initiator shall issue an MLME-TDD-BEAM-MEASUREMENT.confirm primitive on completion of the beam measurement procedure, as specified in 10.42.11.

A STA that performs the TDD beam measurement procedure with a peer STA (the initiator) at the request of the peer STA shall issue an MLME-TDD-BEAM-MEASUREMENT.indication primitive on completion of the TDD beam measurement procedure as specified in 10.42.11. The STA shall set the parameters DecodedRXAntennaID, DecodedRXSectorID and SNR Report according to the TDD SSW frames received from the initiator.

## 11.37 DMG MAC sublayer attributes

***Insert the following rows at the end of Table 11-22:***

**Table 11-22—DMG MAC sublayer attribute values**

| Attribute | Value |
|---|---|
| aMinTXSSSectorFBCnt | 16 |
| aDMGSTATxActivityReportingtLimit | 2000 ms |

***Insert the following subclauses (11.54 through 11.54.4, including Figure 11-62 through Figure 11-66) after 11.53:***

## 11.54 TDD channel access operation

### 11.54.1 General

In a TDD SP, co-channel interference mitigation requires managing the TDD schedule in each stage of the TDD channel access life cycle. The TDD schedule may change during the TDD channel access life cycle. If a device uses co-channel coordinated management operation (see 4.9.5), different STAs in the device may coordinate the configuration of the DMG antennas and the TDD schedule to mitigate the co-channel interference.

### 11.54.2 TDD channel access life cycle

Figure 11-62 summarizes an exemplary TDD channel access life cycle.

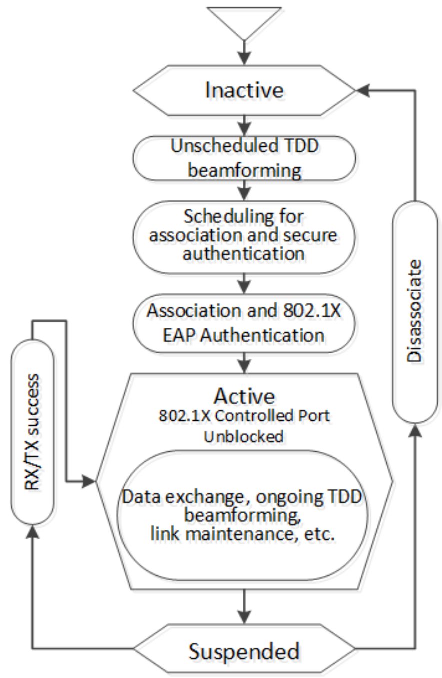


**Figure 11-62—Example of TDD channel access life cycle**

Initially, a STA is inactive and not performing any TDD channel access. In this phase, the STA shall not transmit any MPDUs.

The TDD channel access life cycle includes the following phases:

- Unscheduled TDD beamforming
- Scheduling of the TDD channel access for association and secure authentication
- Association and secure authentication
- Scheduling of the TDD channel access for data traffic, ongoing beamforming and link maintenance
- Data exchange accompanied by beamforming and link maintenance

The term *unscheduled TDD beamforming* is used in this subclause to refer to the TDD beamforming scheduled via the Transmit Period field within a TDD SSW frame. TDD beamforming is defined in 11.36.2, 11.36.3, 11.36.4, and 10.42.10. Scheduling for association, secure authentication, and relevant operations are defined in 11.54.3. TDD channel access becomes active for data transfer (i.e., an MSDU may be transmitted) after successful completion of a secure authentication. Scheduling for data traffic is defined in 11.54.4. Data traffic transfer under TDD channel access is defined in 10.39.6.2.2 and link maintenance is defined in 10.43.5.

TDD channel access becomes inactive when an implementation dependent number of frames can no longer be successfully delivered.

An AP (or PCP) shall transmit at least one MPDU with Ack Policy Indicator subfield set to Normal Ack or Implicit BAR in the first TDD slot assigned to each non-AP (or non-PCP) STA following a DMG Beacon transmission. TDD channel access is suspended if an expected MPDU transmission does not succeed within the AckTimeout (see 10.3.2.11). A beamformed link is considered lost if no successful MPDU transmission takes place during dot11MaxLostBeacons beacon intervals starting at the beacon interval containing the TDD slot where the AP's (or PCP's) MPDU transmission with Ack Policy Indicator subfield set to Normal Ack or Implicit BAR is expected to take place. A STA shall initiate the dissociation procedure at the indication of a link loss. To do that, the AP (or PCP) shall proceed as defined in 11.3.5.8 and 11.3.5.9, and use Reason Code field equal to MISSING_ACKS; the non-AP (or non-PCP) STA shall proceed as defined in 11.3.5.6 and 11.3.5.7, and use Reason Code field equal to REASON_INACTIVITY. As part of the disassociation procedure, the STA may optionally transmit the Disassociation frame at the first assigned TDD slot following the link loss indication.

### 11.54.3 Scheduling for association and secure authentication

The schedule for the association and secure authentication is delivered by an AP STA (or PCP STA) via the transmission of an Announce frame at the completion of the unscheduled TDD beamforming as defined in 10.42.11.2, 10.42.11.4, and 11.36.2. The Announce frame shall use the category Unprotected DMG. The Announce frame conveys the TDD Slot Structure element and the TDD Slot Schedule element (see 10.39.6.2.2). The message diagram is shown in Figure 11-63.

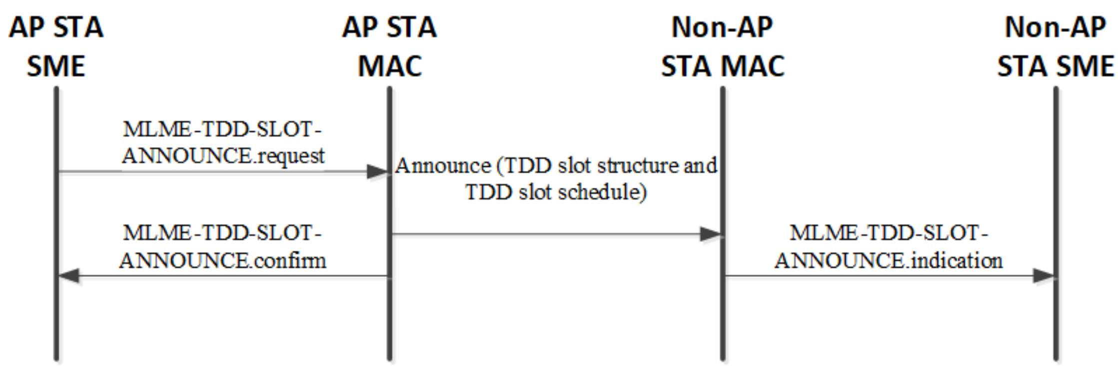


**Figure 11-63—Scheduling for association and secure authentication**

Association shall be performed as defined in 11.3.5 according to DMG infrastructure BSS, in case of an AP STA, or PBSS, in case of a PCP STA. Secure authentication shall be performed as defined in 12.5 through 12.9.

Prior to performing association and authentication, the SME of the non-AP may issue an MLME-SCAN.request primitive with ScanType parameter set to ACTIVE to transmit an individually addressed Probe Request frame to the AP STA (or PCP STA) and, as a result, solicit a Probe Response frame from the AP STA (or PCP STA).

Transmission and acknowledgment of Management and Data frames shall follow rules defined in 10.39.6.2.2.

The 802.1X controlled port is unblocked after completion of the 802.1X EAP Authentication, after which time the TDD channel access becomes active for data transmission (see 12.6.9).

### 11.54.4 Scheduling for data traffic

There are a few options to deliver the TDD schedule for data transmission and related functionality. Figure 11-64 illustrates an option that assumes co-channel coordinated management operation (see 4.9.5), where both STAs belong to the same device. In this case, the SME delivers the TDD schedule to a STA and the MLME primitives are local and do not cause a frame to be transmitted.

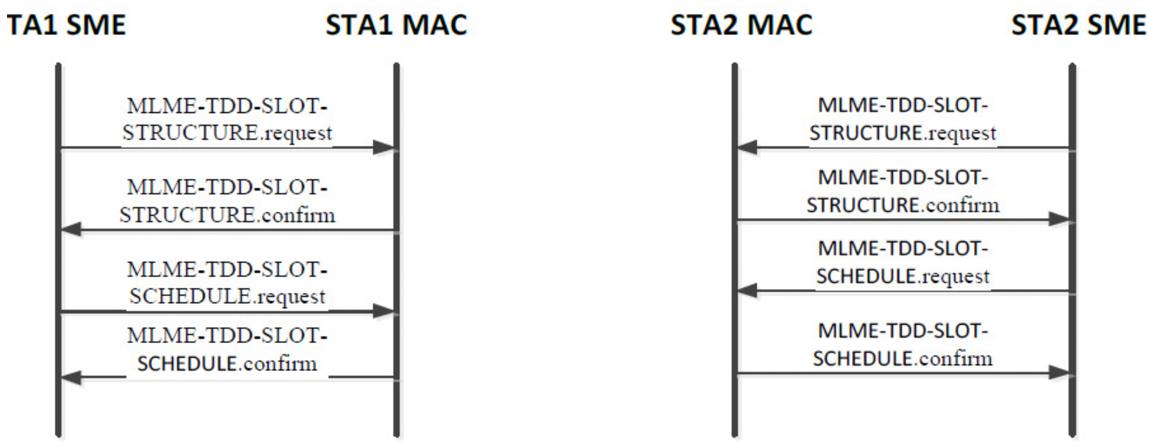


**Figure 11-64—Local delivery of TDD schedule**

Figure 11-65 illustrates an option where an AP (or PCP) delivers the schedule to a non-AP STA (or non-PCP STA). The AP may choose to reserve an amount of time to satisfy the bandwidth request contained in a TDD Bandwidth Request element received from the non-AP STA. The schedule delivered by the AP may be a response to a bandwidth request from the non-AP STA or initiated by the AP without receiving a request from the non-AP STA. Announce frames of a category equal to DMG Action shall be used to deliver the elements for the case defined in 12.6.20; otherwise, the category equal to Unprotected DMG Action shall be used.

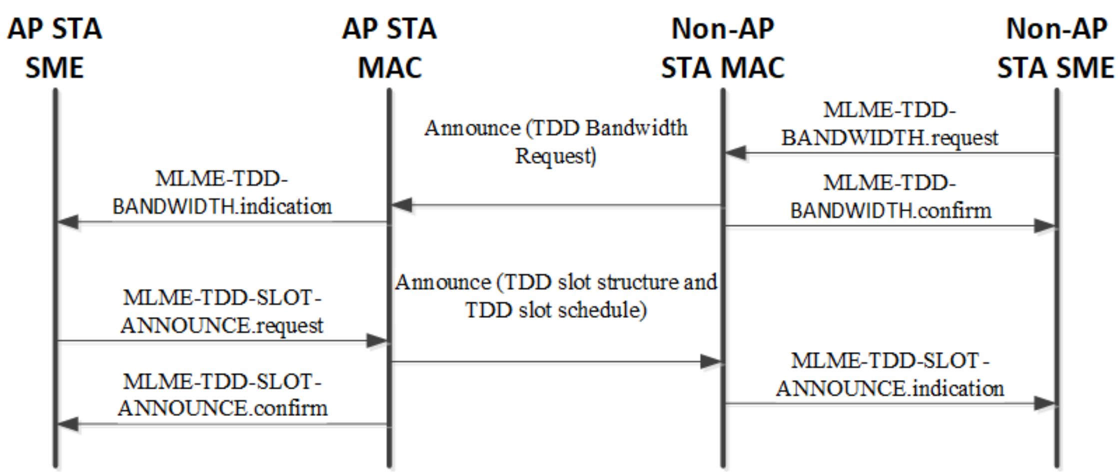


**Figure 11-65—Delivery of TDD schedule by an AP**

An AP (or PCP) and non-AP STA (or non-PCP STA) that belong to different devices may exchange TDD Slot Schedule elements to notify each other of the use of TDD slots. The non-AP STA (or non-PCP STA) may indicate that it is not able to use a TDD slot by specifying the TDD slot as unavailable (see 10.39.6.2.2). Figure 11-66 illustrates this case. Announce frames of a category equal to DMG Action shall be used to deliver the elements for the case defined in 12.6.20; otherwise, the category equal to Unprotected DMG Action shall be used.

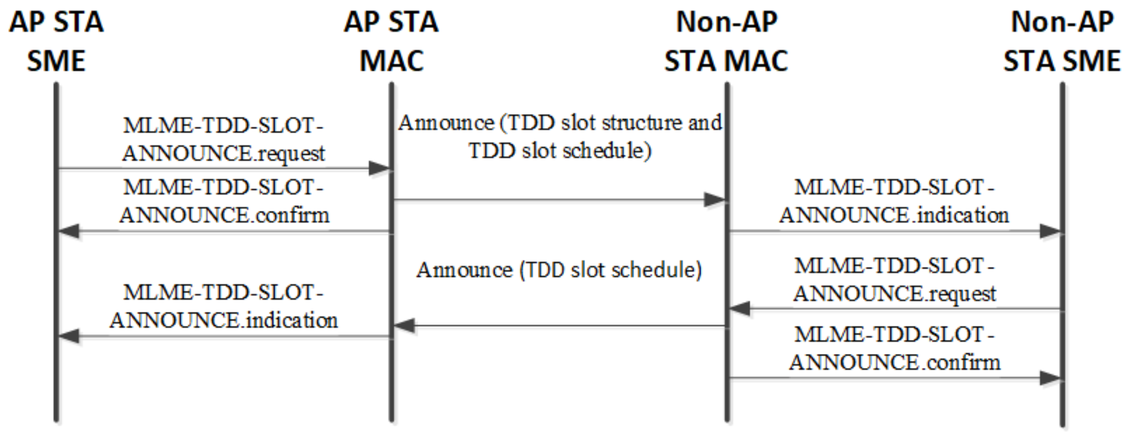


**Figure 11-66—Mutual delivery of TDD schedule**

# 12. Security

## 12.6 RSNA security association management

### 12.6.20 Robust management frame selection procedure

***Insert the following paragraphs at the end of 12.6.20:***

If a Protected Announce Action frame exists to allow robust STA-STA communications of the same information that is conveyed in the corresponding Announce Action frame, the protected variant shall be transmitted between a pair of communicating DMG STAs when dot11ProtectedAnnounceImplemented equals true for both of these STAs.

Otherwise, Protected Announce Action frames of the category DMG Action shall not be used.

A DMG STA shall not set dot11ProtectedAnnounceImplemented to true if dot11RSNAProtectedManagementFramesActivated equals false.

A non-EDMG STA shall transmit the RSNXE with the Protected Announce Support field set to 1 when the dot11ProtectedAnnounceImplemented equals true.

An EDMG STA shall set dot11ProtectedAnnounceImplemented to true if dot11RSNAProtectedManagementFramesActivated equals true. An EDMG STA shall set the Protected Announce Support field in the RSNXE to 0.

The Unprotected DMG Action frames are listed in 9.6.21.1 and the DMG Action frames are listed in 9.6.19.

# 20. Directional multi-gigabit (DMG) PHY specification

## 20.2 DMG PHY service interface

### 20.2.2 TXVECTOR and RXVECTOR parameters

***Insert the following row at the end of Table 20-1:***

**Table 20-1—TXVECTOR and RXVECTOR parameters**

| Parameter | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|
| SCRAMBLER_RESET | Indicates that the scrambler should be reset before the start of the PPDU.<br><br>Enumerated Type:<br>RESET_SCRAMBLER: The scrambler should be reset.<br>NO_SCRAMBLER_RESET: The scrambler should not be reset. | Y | N |

## 20.3 Common parameters

### 20.3.9 Scrambler

***Change the second paragraph in 20.3.9 as follows:***

For each PPDU, the transmitter shall select a nonzero seed value for the scrambler (bits $x_1$ to $x_7$). The seed value should be selected in a pseudorandom fashion. <u>If the SCRAMBLER_RESET parameter is set to RESET_SCRAMBLER, the seed value should be set to a nonzero random value not based on the scrambler value at the end of the last transmitted PPDU, before changes required to indicate MCSs in the set {9.1, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6} are applied.</u> The seed value is sent in the Scrambler Initialization field of the PHY header. Each data bit in the data field of the PPDU is then XORed with the scrambler output ($x_4 \oplus x_7$) and then the scrambler content is shifted once.

## 20.9 Beamforming

### 20.9.1 Beamforming concept

***Change the second paragraph in 20.9.1 as follows:***

DMG STAs use a quasi-omni antenna pattern. <u>For a STA that is not operating in a TDD SP (see 10.39.6.2.2), t</u>~~T~~he antenna gain of the main beam of a quasi-omni antenna pattern ~~shall~~ <u>should</u> be at most 15 dB lower than the antenna gain in the main beam for a directional pattern<u>, unless the STA is an EDMG STA that supports beamforming for asymmetric links (see 10.42.10.3). In this case, the difference in antenna gain may be greater than 15 dB</u>.

## 20.11 DMG PLME

### 20.11.4 DMG PHY

***Insert the following rows at the end of Table 20-30:***

**Table 20-30—DMG PHY characteristics**

| PHY parameter | Value |
|---|---|
| aTDDAirPropagationTime | 1 µs |
| aDMGActiveThresholdPercentage | 10% |

*Insert the following text (Clause 28) after Clause 27:*

# 28. Enhanced directional multi-gigabit (EDMG) PHY specification

## 28.1 Introduction

### 28.1.1 Introduction to EDMG PHY

This clause specifies the PHY entity for the enhanced directional multi-gigabit (EDMG) control, single carrier (SC) and orthogonal frequency division multiplexing (OFDM) modes.

The EDMG PHY is based on the DMG PHY defined in Clause 20. In addition to the requirements in this clause, an EDMG STA shall be capable of transmitting and receiving PPDUs that are compliant with the mandatory PHY specifications defined in Clause 20.

The EDMG PHY adds support for multiple space-time streams, downlink multi-user (MU) transmissions and PPDU transmissions with multiple channel widths, including 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz. The channels making up a 2.16+2.16 GHz and 4.32+4.32 GHz PPDU transmission may be contiguous or noncontiguous. The maximum number of spatial streams per STA is eight. An MU PPDU transmission supports up to eight STAs. For 2.16+2.16 GHz and 4.32+4.32 GHz transmissions, the maximum number of spatial streams in each 2.16 GHz channel and 4.32 GHz channel, respectively, is four.

An EDMG STA shall support the following features:

— EDMG format (transmit and receive)
— 2.16 GHz PPDU using EDMG control mode MCS 0 and SC mode MCSs 1 to 5 and 7 to 10 (transmit and receive)
— 4.32 GHz PPDU using EDMG control mode MCS 0 and SC mode MCSs 1 to 5 and 7 to 10 (transmit and receive)
— Single spatial stream (transmit and receive) in all channel widths that the EDMG STA supports
— Normal GI type
— 2.16 GHz PPDU using non-EDMG control mode MCS 0 and SC mode MCSs 1 to 4 (transmit and receive)
— 4.32 GHz PPDU using non-EDMG duplicate control mode MCS 0 and SC mode MCSs 1 to 4 (transmit and receive)

An EDMG STA may support the following features:

— 2.16 GHz PPDU using EDMG SC mode MCSs 6 and 11 to 21 and OFDM mode all MCSs (transmit and receive)
— 4.32 GHz PPDU using EDMG SC mode MCSs 6 and 11 to 21 and OFDM mode all MCSs (transmit and receive)
— Two or more spatial streams using EDMG SC and OFDM modes (transmit and receive)
— EDMG MU PPDUs using EDMG SC and OFDM modes (transmit and receive)
— 2.16+2.16 GHz PPDU using EDMG control mode MCS 0, SC and OFDM mode all MCSs (transmit and receive)
— 4.32+4.32 GHz PPDU using EDMG control mode MCS 0, SC and OFDM mode all MCSs (transmit and receive)

- 6.48 GHz PPDU using EDMG control mode MCS 0, SC and OFDM mode all MCSs (transmit and receive)
- 8.64 GHz PPDU using EDMG control mode MCS 0, SC and OFDM mode all MCSs (transmit and receive)
- 2.16+2.16 GHz PPDU using non-EDMG duplicate control mode MCS 0 and SC mode all MCSs (transmit and receive)
- 4.32+4.32 GHz PPDU using non-EDMG duplicate control mode MCS 0 and SC mode all MCSs (transmit and receive)
- 6.48 GHz PPDU using non-EDMG duplicate control mode MCS 0 and SC mode all MCSs (transmit and receive)
- 8.64 GHz PPDU using non-EDMG duplicate control mode MCS 0 and SC mode all MCSs (transmit and receive)
- Short GI type, long GI type, or both
- SU A-PPDU (transmit and receive)
- STBC (transmit and receive)
- DCM π/2-BPSK using EDMG SC mode (transmit and receive)
- π/2-64-NUC using EDMG SC mode (transmit and receive)
- π/2-8-PSK using EDMG SC mode (transmit and receive)

### 28.1.2 Scope

The services provided to the MAC by the EDMG PHY consist of the following protocol functions:

- A function that defines a method of mapping the PSDUs into a framing format (PPDU) suitable for sending and receiving PSDUs between two or more STAs.
- A function that defines the characteristics and method of transmitting and receiving data through a wireless medium between two or more STAs. Depending on the PPDU format, these STAs support a mixture of EDMG and Clause 20 PHYs.

### 28.1.3 EDMG PHY functions

#### 28.1.3.1 General

The EDMG PHY contains two functional entities: the PHY function and the physical layer management function (i.e., the PLME). These functions are described in detail in 28.4, 28.5, and 28.6.

The EDMG PHY service is provided to the MAC through the PHY service primitives defined in Clause 8. The EDMG PHY service interface is described in 28.2.

#### 28.1.3.2 PHY management entity (PLME)

The PLME performs management of the local PHY functions in conjunction with the MLME.

#### 28.1.3.3 Service specification method

The models represented by figures and state diagrams are intended to be illustrations of the functions provided. It is important to distinguish between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, but do not necessarily reflect any particular implementation.

The service of a layer is the set of capabilities that it offers to a user in the next higher layer. Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition is independent of any particular implementation.

### 28.1.4 PPDU formats

The structure of the PPDU transmitted by an EDMG STA is determined by the TXVECTOR parameters as defined in Table 28-1 (in 28.2.2).

For an EDMG STA, the FORMAT parameter determines the overall structure of the PPDU and includes the following:

— Non-EDMG format (NON_EDMG) based on Clause 20.

— EDMG format (EDMG). PPDUs of this format contain a preamble compatible with Clause 20 STAs. The non-EDMG portion of the EDMG format preamble (the parts of EDMG preamble preceding the EDMG-Header-A field) is defined so that it can be decoded by these STAs. An EDMG PPDU can be further categorized as an EDMG SU PPDU or an EDMG MU PPDU. An EDMG SU PPDU shall not contain the EDMG-Header-B field. An EDMG MU PPDU shall contain the EDMG-Header-B field.

## 28.2 EDMG PHY service interface

### 28.2.1 General

The PHY provides an interface to the MAC through an extension of the generic PHY service interface defined in 8.3.4. The interface includes TXVECTOR, RXVECTOR, and PHYCONFIG_VECTOR.

The TXVECTOR supplies the PHY with per-PPDU transmit parameters. Using the RXVECTOR, the PHY informs the MAC of the received PPDU parameters. Using the PHYCONFIG_VECTOR, the MAC configures the PHY for operation, independent of frame transmission or reception.

### 28.2.2 TXVECTOR and RXVECTOR parameters

The parameters in Table 28-1 are defined as part of the TXVECTOR parameter list in the PHY-TXSTART.request primitive and/or as part of the RXVECTOR parameter list in the PHY-RXSTART.indication primitive.

The $N_{CB}$ parameter represents the number of contiguous (i.e., bonded) 2.16 GHz channels used for a transmission. The value of the CH_BANDWIDTH and CHANNEL_AGGREGATION parameters in the TXVECTOR and RXVECTOR define the value of the $N_{CB}$ parameter in the EDMG PHY definition throughout this clause as follows:

— If the CH_BANDWIDTH parameter has a single bit equal to 1 (e.g., “01000000” or “01001000”), then $N_{CB}$ is set to 1.

— If the CH_BANDWIDTH parameter has two contiguous bits each of which is equal to 1 (e.g., “01100000”) and the CHANNEL_AGGREGATION parameter is set to AGGREGATE, then $N_{CB}$ is set to 1. Otherwise, if the CHANNEL_AGGREGATION parameter is set to NOT_AGGREGATE, then $N_{CB}$ is set to 2.

— If the CH_BANDWIDTH parameter has three contiguous bits each of which is equal to 1 (e.g., “00111000”), then $N_{CB}$ is set to 3.

— If the CH_BANDWIDTH parameter has four contiguous bits each of which is equal to 1 (e.g., “01111000”) and the CHANNEL_AGGREGATION parameter is set to AGGREGATE, then $N_{CB}$ is set to 2. Otherwise, if CHANNEL_AGGREGATION parameter is set to NOT_AGGREGATE, then $N_{CB}$ is set to 4.

The parameter TIME_OF_DEPARTURE_REQUESTED is common for both NON_EDMG and EDMG formats. The parameter RX_START_OF_FRAME_OFFSET is common for both NON_EDMG and EDMG formats.

**Table 28-1—TXVECTOR and RXVECTOR parameters**

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| FORMAT | | Determines the format of the PPDU.<br><br>Enumerated type:<br>NON_EDMG indicates Clause 20 or non-EDMG duplicate format. In this case, the modulation is determined by the NON_EDMG_MODULATION parameter.<br>EDMG indicates EDMG format. In this case, the modulation is determined by the EDMG_MODULATION parameter. | Y | Y |
| NON_EDMG_MODULATION | FORMAT is NON_EDMG. | In TXVECTOR, indicates the format type of the transmitted non-EDMG PPDU.<br>In RXVECTOR, indicates the estimated format type of the received non-EDMG PPDU.<br><br>Enumerated type:<br>DMG_C_MODE indicates Clause 20 control mode format.<br>DMG_SC_MODE indicates Clause 20 SC mode format.<br>NON_EDMG_DUP_C_MODE indicates non-EDMG duplicate format of the Clause 20 control mode format.<br>NON_EDMG_DUP_SC_MODE indicates non-EDMG duplicate format of the Clause 20 SC mode format. | Y | Y |
| L_LENGTH | FORMAT is NON_EDMG. | See LENGTH entry in Table 20-1. | Y | Y |
| L_MCS | FORMAT is NON_EDMG. | See MCS entry in Table 20-1. | Y | Y |
| L_ADD_PPDU | FORMAT is NON_EDMG. | See ADD-PPDU entry in Table 20-1. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| L_PPDU_ TYPE | FORMAT is NON_EDMG. | See PPDU_TYPE entry in Table 20-1. | Y | Y |
| L_TRN_LEN | FORMAT is NON_EDMG. | See TRN-LEN entry in Table 20-1. | Y | Y |
| L_ AGGREGATION | FORMAT is NON_EDMG. | See AGGREGATION entry in Table 20-1. | Y | Y |
| L_ RSSI | FORMAT is NON_EDMG. | See RSSI entry in Table 20-1. | N | Y |
| L_ SNR | FORMAT is NON_EDMG. | See SNR entry in Table 20-1. | N | Y |
| L_ RCPI | FORMAT is NON_EDMG. | See RCPI entry in Table 20-1. | N | Y |
| L_ ANT_ CONFIG | FORMAT is NON_EDMG. | See ANT_CONFIG entry in Table 20-1. | Y | N |
| L_ CHAN_ MEASUREMENT | FORMAT is NON_EDMG. | See CHAN_MEASUREMENT entry in Table 20-1. | N | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| L_BEAM_TRACKING_REQUEST | FORMAT is NON_EDMG. | See BEAM_TRACKING_REQUEST entry in Table 20-1. | Y | Y |
| L_LAST_RSSI | FORMAT is NON_EDMG. | See LAST_RSSI entry in Table 20-1. | Y | Y |
| L_TURNAROUND | FORMAT is NON_EDMG. | See TURNAROUND entry in Table 20-1. | Y | Y |
| RX_START_OF_FRAME_OFFSET | | 0 to $2^{32}$–1. An estimate of the offset (in 0.1 nanosecond units) from the point in time at which the start of the preamble corresponding to the incoming frame arrived at the receive antenna connector to the point in time at which this primitive is issued to the MAC. | N | See NOTE 3 |
| EDMG_MODULATION | FORMAT is EDMG. | Indicates the EDMG modulation type.<br><br>Enumerated type:<br>EDMG_C_MODE indicates EDMG control mode (28.4).<br>EDMG_SC_MODE indicates EDMG SC mode (28.5).<br>EDMG_OFDM_MODE indicates EDMG OFDM mode (28.6). | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| EDMG_MCS | FORMAT is EDMG. | In the TXVECTOR, indicates the modulation and coding scheme applied for the transmission of the PPDU. In the RXVECTOR, indicates the modulation and coding scheme of the received PPDU. Values are integers in the range 0 to 21.<br>— If EDMG_MODULATION is EDMG_C_MODE, valid EDMG_MCS value is 0.<br>— If EDMG_MODULATION is EDMG_SC_MODE, valid EDMG_MCS values are 1 to 21.<br>— If EDMG_MODULATION is EDMG_OFDM_MODE, valid EDMG_MCS values are 1 to 20. | SU+ MU | Y |
| EDMG_LENGTH | FORMAT is EDMG. | Indicates the length of the PSDU in octets in the range of 14 to 1023 for the Control mode and of 1 to 4 194 303 for the EDMG SC and OFDM modes. This value is used by the PHY to determine the number of octet transfers that occur between the MAC and the PHY. | MU | Y |
| LDPC_CW_TYPE | FORMAT is EDMG. | Indicates the LDPC codeword type in terms of code word length.<br><br>Enumerated type:<br>SHORT: LDPC codeword length 672, 624, 504, or 468.<br>LONG: LDPC codeword length 1344, 1248, 1008, or 936. | MU | Y |
| LDPC_SUPERIMPOSED | FORMAT is EDMG. | Indicates whether punctured or superimposed LDPC code is used for code rate 7/8 encoding.<br>0 indicates that punctured LDPC code is applied as described in 20.5.3.2.3 and 28.5.9.4.3.<br>1 indicates that superimposed LDPC code is applied as described in 28.5.9.4.3.<br><br>If the EDMG_MCS parameter is 13 and the PSK_APPLIED parameter is PSK_APPLIED, then this parameter indicates the 7/8 code employed in the encoding procedure with codeword shortening to achieve the effective code rate of 5/6 as defined in 28.5.9.4.3. | MU | Y |
| STBC | FORMAT is EDMG. | Indicates whether STBC is used.<br>0 indicates no STBC ($N_{STS} = N_{SS}$ in the Data field).<br>1 indicates STBC is used ($N_{STS} = 2 \times N_{SS}$ and $N_{SS}$ in the Data field). | MU | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| DCM_BPSK | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_SC_MODE,<br>CHANNEL_AGGREGATION is AGGREGATE,<br>STBC is 0,<br>NUM_STS is 2. | Indicates whether DCM BPSK modulation is applied.<br><br>Enumerated type:<br>DCM_BPSK_Not_Applied indicates that DCM π/2-BPSK is not applied.<br>DCM_BPSK_Applied indicates that DCM π/2-BPSK is applied and that $N_{SS} = N_{STS} = 2$. | Y | Y |
| | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_OFDM_MODE,<br>STBC is 0,<br>NUM_STS is 2. | Enumerated type:<br>DCM_BPSK_Not_Applied indicates that Dual Stream DCM BPSK is not applied.<br>DCM_BPSK_Applied indicates that Dual Stream DCM BPSK is applied and that $N_{SS} = N_{STS} = 2$. | Y | Y |
| NUC_MOD | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_SC_MODE. | Indicates whether NUC modulation is applied.<br><br>Enumerated type:<br>NUCNotApplied indicates that NUC modulation is not applied.<br>NUCApplied indicates that NUC modulation is applied. | MU | Y |
| PSK_APPLIED | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_SC_MODE. | Indicates if π/2-8-PSK is applied for MCS 12 or MCS 13.<br><br>Enumerated Type:<br>PSK_APPLIED indicates that π/2-8-PSK is applied.<br>PSK_NOT_APPLIED indicates that π/2-8-PSK is not applied. | MU | Y |
| PHASE_HOPPING | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_OFDM_MODE. | Indicates whether phase hopping modulation is applied when $N_{STS} = N_{SS} = 2$.<br><br>Enumerated type:<br>PH_NOT_APPLIED indicates that phase hopping modulation is not applied.<br>PH_APPLIED indicates that phase hopping modulation is applied. | Y | Y |
| OPEN_LOOP_PC | FORMAT is EDMG,<br>EDMG_MODULATION is EDMG_OFDM_MODE. | Indicates whether open loop precoding is applied when $N_{STS} = N_{SS} = 2$.<br><br>Enumerated type:<br>OL_NOT_APPLIED indicates that open loop precoding is not applied.<br>OL_APPLIED indicates that open loop precoding is applied. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| NUM_STS | FORMAT is EDMG, STBC is 0. | Indicates the number of space-time streams.<br><br>Value is an integer in the range 1 to 8 for an SU PPDU. For an MU PPDU, values are integers in the range 1 to 2 per user in the TXVECTOR, and 0 to 2 per user in the RXVECTOR.<br><br>The sum of NUM_STS over all users is in the range of 1 to 8. | MU | Y |
| | FORMAT is EDMG, STBC is 1. | Indicates the number of space-time streams. The value of this parameter shall be an even number.<br><br>Value is an even integer in the range 2 to 8 for an SU PPDU. For an MU PPDU, the value is 2 for each user in the TXVECTOR, and 0 or 2 for each user in the RXVECTOR.<br><br>The sum of NUM_STS over all users is in the range of 1 to 8. | MU | Y |
| NUM_USERS | FORMAT is EDMG. | Indicates the number of users with nonzero space-time streams.<br><br>Integer: range 1 to 8. Range restrictions apply for SU PPDU or MU PPDU if at least one user employs STBC. | Y | N |
| MU_AID | FORMAT is EDMG. | Indicates the AID of each intended recipient addressed in an MU PPDU. | MU | O |
| EDMG_PPDU_TYPE | FORMAT is EDMG, EDMG_TRN_LEN > 0. | Enumerated type:<br>EDMG-TRN-R indicates either a PPDU whose Data field is followed by one or more TRN subfields, all of which are transmitted with the same AWV, or a PPDU that is requesting TRN subfields to be appended to a future response PPDU, all of which are transmitted with the same AWV.<br>EDMG-TRN-T indicates a PPDU whose Data field is followed by a TRN field. As defined in 28.9.2.2, the transmitter may change the AWV at the beginning of each set of *N* TRN subfields present in the last *M* TRN subfields of each TRN-Unit in the TRN field.<br>EDMG-TRN-R/T indicates a PPDU whose Data field is followed by one or more TRN subfields. The transmitter sends a number of consecutive TRN-Units in which the same AWV is used in the transmission of the last *M* TRN subfields of each TRN-Unit. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| EDMG_TRN_LEN | FORMAT is EDMG. | Indicates the number of TRN-Units in the TRN field of a PPDU or, as defined in 10.42.7, a requested number of TRN-Units for receive beam tracking. Values are in the range 0 to 255 (see 28.9.2.2.5). | Y | Y |
| RX_TRN_PER_TX_TRN | FORMAT is EDMG, EDMG_PPDU_TYPE is EDMG-TRN-R/T, EDMG_TRN_LEN > 0. | Indicates the number of consecutive TRN-Units in which the same AWV is used in the transmission of the last EDMG_TRN_M TRN subfields of each TRN-Unit. Values are in the range 2 to 255, and divisors of the value of EDMG_TRN_LEN including EDMG_TRN_LEN but excluding 1. | Y | Y |
| EDMG_TRN_P | FORMAT is EDMG, EDMG_PPDU_TYPE is EDMG-TRN-T or EDMG-TRN-R/T. | Indicates the number of TRN subfields at the beginning of a TRN-Unit that are transmitted with the same AWV. Values are in the range 0 to 3. | Y | Y |
| EDMG_TRN_M | FORMAT is EDMG, EDMG_PPDU_TYPE is EDMG-TRN-T or EDMG-TRN-R/T. | If EDMG_PPDU_TYPE is EDMG-TRN-T or EDMG-TRN-R/T, indicates the number of TRN subfields in a TRN-Unit that may be used for transmit training, as defined in 28.9.2.2. Values are in the range 0 to 15. The parameter is reserved if TRN-LEN is 0. The parameter is reserved if EDMG_PPDU_TYPE is EDMG-TRN-R. | Y | Y |
| EDMG_TRN_N | FORMAT is EDMG, EDMG_PPDU_TYPE is EDMG-TRN-T. | Indicates the number of consecutive TRN subfields within the EDMG TRN-Unit M of a TRN-Unit that are transmitted using the same AWV. Values are in the range 0 to 3. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| TRN_SEQ_LENGTH | FORMAT is EDMG. | Indicates the length of the Golay sequence to be used to transmit the TRN subfields present in the TRN field of the PPDU.<br><br>Enumerated type:<br>Normal: The Golay sequence has a length of $128 \times N_{CB}$.<br>Long: The Golay sequence has a length of $256 \times N_{CB}$.<br>Short: The Golay sequence has a length of $64 \times N_{CB}$.<br><br>$N_{CB}$ represents the integer number of contiguous 2.16 GHz channels over which the TRN subfield is transmitted and $1 \leq N_{CB} \leq 4$. | Y | Y |
| TRN_RX_PATTERN | FORMAT is EDMG, EDMG_PPDU_TYPE is EDMG-TRN-T or EDMG-TRN-R/T. | Indicates the receive antenna pattern to be used when measuring TRN-Units present in a received PPDU.<br><br>Enumerated type:<br>QUASI_OMNI indicates that quasi-omni AWV should be used.<br>DIRECTIONAL indicates that directed AWV should be used. | Y | Y |
| EDMG_BEAM_TRACKING_REQUEST | FORMAT is EDMG. | This parameter indicates whether beam tracking (see 10.42.7) is requested.<br><br>Enumerated type:<br>BEAM-TRACKING-REQUESTED<br>BEAM-TRACKING-NOT-REQUESTED | Y | Y |
| EDMG_BEAM_TRACKING_TYPE | FORMAT is EDMG. | This parameter indicates if analog beam tracking or baseband beam tracking is requested.<br><br>Enumerated type:<br>Analog Beam Tracking<br>Baseband Beam Tracking | Y | Y |
| EDMG_BRP_MIN_SC_BLOCKS | FORMAT is EDMG, EDMG_TRN_LEN > 0. | Indicates the minimum duration of the Data field in units of SC IDFT/DFT period. | Y | N |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| SCRAMBLER_INIT_SETTING | FORMAT is EDMG. | Indicates that the PPDU is an EDMG control mode PPDU carrying the EDMG-Header-A.<br><br>Enumerated type:<br>EDMG-Header-A | Y | Y |
| | FORMAT is NON_EDMG. | Indicates the configuration of the Scrambler Initialization field of a control mode PPDU.<br><br>Enumerated type:<br>Channel_BW<br>CONTROL_TRAILER | Y | Y |
| CT_TYPE | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Indicates the content of the control trailer:<br><br>Enumerated type:<br>CTS_DTS<br>GRANT_RTS_CTS2self<br>SPR<br>SSW_FEEDBACK<br>BLOCK_ACK<br>ACK | Y | Y |
| CH_BANDWIDTH | FORMAT is EDMG. | In the TXVECTOR, indicates the set of channels on which the PPDU is transmitted and the value of the BW field in the EDMG Header-A. In the RXVECTOR, indicates the value of the BW field in the EDMG Header-A of a received PPDU.<br><br>This parameter is a bitmap. Valid values for this parameter and the CHANNEL_AGGREGATION parameter are indicated in Table 28-21, Table 28-22, and Table 28-23. | Y | Y |
| | FORMAT is NON_EDMG. | In the TXVECTOR, indicates the set of channels on which the PPDU is transmitted. In the RXVECTOR, indicates the estimated set of channels on which PPDU was received.<br><br>This parameter is a bitmap. Valid values for this parameter and the CHANNEL_AGGREGATION parameter are indicated in Table 28-21, Table 28-22, and Table 28-23. | Y | Y |
| CH_BANDWIDTH_SIGNALING | FORMAT is NON_EDMG, NON_EDMG_MODULATION is NON_EDMG_DUP_C_MODE. | Indicates the value of the Scrambler Initialization field, as defined in Table 28-6, of the PPDU transmitted in NON_EDMG_DUP_C_MODE. | O | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| CHANNEL_ AGGREGATION | FORMAT is EDMG. | Indicates the transmission and reception type of the PPDU in case the number of bits equal to 1 in the CH_BANDWIDTH parameter is greater than 1.<br><br>Enumerated type:<br>AGGREGATE<br>NOT_AGGREGATE | Y | Y |
| EDMG_ADD_PPDU | FORMAT is EDMG. | Enumerated type:<br>ADD-PPDU indicates that this EDMG PPDU is immediately followed by another EDMG PPDU with no IFS or preamble on the subsequent EDMG PPDU.<br>NO-ADD-PPDU indicates no additional EDMG PPDU follows this EDMG PPDU. | Y | Y |
| NUM_TX_CHAINS | | The value of this field indicates the number of transmit chains used in the transmission of the PPDU.<br><br>Integer: range 1 to 8. | Y | Y |
| DMG_TRN | FORMAT is EDMG, NUM_TX_CHAINS = 1, $N_{CB}$ = 1. | Indicates the configuration of the DMG TRN field (see Table 28-12). Possible values are 0 and 1.<br><br>When set to 1, indicates that the TRN field appended to this PPDU has the structure of a DMG training field containing an AGC training field and a TRN field as defined in 20.9.2.2.2. In this case, the RX_TRN_PER_TX_TRN, EDMG_TRN_P, EDMG_TRN_M, EDMG_TRN_N and TRN_SEQ_LENGTH parameters are reserved. The EDMG_TRN_LEN parameter has a value greater than 0 and less than 32. | Y | Y |
| TIME_OF_DEPARTURE_ REQUESTED | | Enumerated type:<br>True indicates that the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first frame energy is sent by the transmitting port. False indicates that the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters. | O | N |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| RSSI | FORMAT is EDMG. | The allowed values for the RSSI parameter are in the range 0 through 255. This parameter is a measure by the PHY of the power observed at the input of the antennas plus the antenna gain, or equivalent antenna gain for a phased array antenna, used to receive the current PPDU.<br><br>The RSSI shall be measured during the reception of the L-STF or EDMG-STF field. RSSI is intended to be used in a relative manner, and it shall be a monotonically increasing function of the received power with equidistant step equal to 0.25 dB. | N | Y |
| RCPI | FORMAT is EDMG. | Is a measure of the received RF power (in dBm) measured over the preamble of a received PPDU. Refer to 28.3.9.2 for the definition of RCPI. | N | Y |
| FIRST_PATH_ TRAINING | FORMAT is EDMG. | When set to 1, indicates that the TRN field appended to this PPDU, if any, is used for first path beamforming training. Set to 0 otherwise. | Y | Y |
| DUAL_POL_TRAINING | FORMAT is EDMG. | When set to 1, indicates that the TRN subfields in the TRN field appended to this PPDU have different polarizations for the same AWV. When set to 0, indicates that the TRN field appended to this PPDU does not change polarization. | Y | Y |
| GI_TYPE | FORMAT is EDMG. | Indicates the length of the guard interval.<br><br>Enumerated type:<br>SHORT<br>NORMAL<br>LONG | Y | Y |
| PRIMARY_ CHANNEL | FORMAT is EDMG. | Indicates the primary channel number for the transmission. Values are 1 to 8. | Y | Y |
| BEAMFORMED | FORMAT is EDMG or FORMAT is NON_EDMG and NON_EDMG_ MODULATION is NON_EDMG_DUP_SC_ MODE. | Enumerated type:<br>Beamformed<br>Not_Beamformed<br><br>If set to Beamformed, indicates that digital beamforming is applied. Set to Not_Beamformed otherwise. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| CSD_APPLIED | BEAMFORMED is Not_Beamformed. | Enumerated type:<br>CSD_Applied<br>CSD_Not_Applied<br><br>If set to CSD_Applied, indicates that CSD is applied over different transmit chains. Set to CSD_Not_Applied otherwise. | Y | Y |
| TRN_AGGREGATION | FORMAT is EDMG and EDMG_TRN_LEN > 0. | Enumerated type:<br>WidebandTRN: The BW field specifies that the TRN field of the PPDU is appended on a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel.<br>AggregationTRN: The BW field specifies that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel. | Y | Y |
| NEXT_TX_SISO | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Indicates whether the following transmission from this STA is performed with a single DMG antenna or multiple DMG antennas.<br><br>Enumerated type:<br>NextTxSingleAntenna<br>NextTxMultiAntenna | Y | Y |
| MU_MIMO_NEXT | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Indicates whether the following transmission from this STA is performed in MU-MIMO.<br><br>Enumerated type:<br>NextMUMIMO<br>NextNotMUMIMO | Y | Y |
| HBF_TRAINING | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Indicates whether the following transmission from this STA is for hybrid beamforming training.<br><br>Enumerated type:<br>NextHBF<br>NextNotHBF | Y | Y |
| TX_SECTOR_CONFIG_INDEX | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | An integer identifying the TX sector combination index.<br><br>Integer: range 0 to 63. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| EDMG_GROUP_ID | MU_MIMO_NEXT is NextMUMIMO. | Indicates the identification of the MU-MIMO group of STAs that are involved in the following MU-MIMO transmission.<br><br>Integer: range 0 to 255. | Y | Y |
| MU_MIMO_TX_CONFIG_TYPE | MU_MIMO_NEXT is NextMUMIMO. | Indicates whether the MIMO phase of MU-MIMO beamforming training consisted of a nonreciprocal MIMO phase or a reciprocal MIMO phase.<br><br>Enumerated type:<br>Non_reciprocal_MU_MIMO_BF<br>Reciprocal_MU_MIMO_BF | Y | Y |
| MU_MIMO_TX_CONFIG_INDEX | MU_MIMO_NEXT is NextMUMIMO. | An integer identifying the MU-MIMO configuration.<br><br>Integer: range 0 to 7. | Y | Y |
| IS_CHANNEL_NUMBER | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Indicates whether the value in the BW_IN_CT parameter represents a channel width or a channel number.<br><br>Enumerated type:<br>ChannelWidth<br>ChannelNumber | Y | Y |
| BW_IN_CT | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | If the IS_CHANNEL_NUMBER is ChannelWidth, indicates a channel width. In this case, the format of this parameter is the same as the CH_BANDWIDTH parameter.<br><br>Otherwise, indicates a channel number. In this case, the format of this parameter is the same as the PRIMARY_CHANNEL parameter. | Y | Y |
| STREAM_FBCK | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER. | Contains up to 8 pairs of spatial stream feedback. Each pair spatial stream feedback comprises an SNR and an RSSI and is defined as follows:<br>— STREAM_SNR: as defined in Table 28-39.<br>— STREAM_RSSI: as defined in Table 28-39. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| NUM_SECTORS_MSB | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER, CT_TYPE is GRANT_RTS_CTS2self. | Indicates the value of the Total Number of Sectors MSB field in the control trailer of a Grant or Grant Ack frame.<br><br>Integer: range 0 to 15. | Y | Y |
| NUM_ANT_MSB | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER, CT_TYPE is GRANT_RTS_CTS2self. | Indicates the value of the Number of RX DMG Antennas MSB field in the control trailer of a Grant or Grant Ack frame. | Y | Y |
| NUM_SECTORS | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER, CT_TYPE is SPR. | Indicates the value of the Total Number of Sectors field in the control trailer of an SPR frame. | Y | Y |
| NUM_ANT | SCRAMBLER_INIT_SETTING is CONTROL_TRAILER, CT_TYPE is SPR. | Indicates the value of the Number of RX DMG Antennas field in the control trailer of an SPR frame. | Y | Y |
| SSSW_DIR | FORMAT is NON_EDMG, NON_EDMG_MODULATION is DMG_C_MODE, L_LENGTH is 6. | Indicates the direction of the transmission of a Short SSW PPDU.<br><br>Enumerated type:<br>Initiator indicates the frame is transmitted by the initiator.<br>Responder indicates the frame is transmitted by the responder. | Y | Y |
| SSSW_ADD_MODE | SSSW_DIR is Initiator. | Indicates the interpretation of the destination AID.<br><br>Enumerated type:<br>IndividualAddr: The destination AID field contains an individual address.<br>GroupAddr: The destination AID field contains a group address. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| SSSW_SOURCE_AID | FORMAT is NON_EDMG, NON_EDMG_ MODULATION is DMG_C_MODE, L_LENGTH is 6. | When the SSSW_DIR is set to Initiator, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID or the transmitting STA is not associated to intended recipient in which case this field contains a random value in the range 0 to 255.<br><br>When the SSSW_DIR is set to Responder, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID or the transmitting STA is not associated to the intended recipient in which case this field contains the value contained in the Source AID field in the received Short SSW PPDU during the preceding ISS. | Y | Y |
| SSSW_DESTINATION_AID | FORMAT is NON_EDMG, NON_EDMG_ MODULATION is DMG_C_MODE, L_LENGTH is 6. | When the SSSW_DIR is set to Initiator, contains the AID of the STA addressed by the Short SSW PPDU, except if the addressed STA is a PCP or an AP in which case this field contains the BSS AID or the transmitting STA is not associated to the intended recipient in which case this field contains a random value in the range 0 to 255.<br><br>When the SSSW_DIR is set to Responder, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID or the transmitting STA is not associated to the intended recipient in which case this field contains the value contained in the Destination AID field in the received Short SSW PPDU during the preceding ISS. | Y | Y |
| SSSW_CDOWN | FORMAT is NON_EDMG, NON_EDMG_ MODULATION is DMG_C_MODE, L_LENGTH is 6. | A down counter indicating the number of remaining Short SSW PPDU transmissions and LBIFSs to the end of the TXSS/RXSS across all DMG antennas. This parameter is set to 0 in the last Short SSW PPDU transmission. | Y | Y |
| SSSW_RF_CHAIN_ID | FORMAT is NON_EDMG, NON_EDMG_ MODULATION is DMG_C_MODE, L_LENGTH is 6. | Identifies the transmit chain currently being used for the transmission. Can take the values in the range 1 to 8. | Y | Y |

**Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)***

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| SSSW_BSSID | SSSW_DIR is Initiator, SSSW_ADD_MODE is IndividualAddr. | Contains the BSSID of the BSS. | Y | Y |
| SSSW_UNASSOCIATED | SSSW_DIR is Initiator, SSSW_ADD_MODE is IndividualAddr. | Indicates whether the transmitting STA is associated to the intended recipient.<br><br>Enumerated type:<br>Associated: if the transmitting STA is associated to the intended recipient.<br>Unassociated: if the transmitting STA is not associated to the intended recipient. | Y | Y |
| SSSW_SISO_FEEDBACK_DURATION | SSSW_DIR is Initiator. | Specifies the duration, in microseconds, of the SISO Feedback subphase that starts following the Short SSW PPDU transmission with CDOWN field equal to 0. | Y | Y |
| SSSW_FEEDBACK | SSSW_DIR is Responder. | Contains the value of the CDOWN field of the Short SSW PPDU that was received with the best quality in the immediately preceding sector sweep. The determination of which PPDU was received with the best quality is implementation dependent. | Y | Y |
| EXPANSION_MAT | FORMAT is EDMG and EXPANSION_MAT_TYPE is COMPRESSED_SV. | Contains a set of compressed digital beamforming feedback matrices as defined in 9.4.2.284. The number of elements depends on the number of subcarriers, the number of spatial streams and the number of transmit chains. | Y | N |
| | FORMAT is EDMG and EXPANSION_MAT_TYPE is NON_COMPRESSED_SV. | Contains a set of noncompressed beamforming feedback matrices as defined in 9.4.2.284. The number of complex elements depends on the number of feedback taps per element of the SC feedback matrix, the number of columns, and the number of rows in each matrix. | Y | N |
| | FORMAT is EDMG and EXPANSION_MAT_TYPE is CSI_MATRICES. | Contains a set of CSI matrices as defined in 9.4.2.268. The number of complex elements depends on the number of feedback taps per element of the SC feedback matrix, the number of columns, and the number of rows in each matrix. | Y | N |
| | Otherwise | Not present | N | N |

### Table 28-1—TXVECTOR and RXVECTOR parameters *(continued)*

| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
|---|---|---|---|---|
| EXPANSION_MAT_TYPE | EXPANSION_MAT is present. | Enumerated type:<br>COMPRESSED_SV indicates that EXPANSION_MAT is a set of compressed beamforming feedback matrices.<br>NON_COMPRESSED_SV indicates that EXPANSION_MAT is a set of noncompressed beamforming feedback matrices.<br>CSI_MATRICES indicates that EXPANSION_MAT is a set of channel state matrices. | Y | N |
| CHANNEL_ MEASUREMENT | FORMAT is EDMG. | Channel measurement, including real and imaginary parts, based on measurements performed on received TRN field. | N | Y |
| SCRAMBLER_RESET | FORMAT is EDMG or FORMAT is NON_EDMG. | Indicates that the scrambler has to be reset before the start of the PPDU.<br><br>Enumerated Type:<br>RESET_SCRAMBLER: The scrambler has to be reset.<br>NO_SCRAMBLER_RESET: The scrambler does not have to be reset. | Y | N |
| NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply: Y = Present; N = Not present: O = Optional; SU = indicates that the parameter is present for each spatial stream. Those parameters are conceptually supplied as an array of values indexed by values 0 to NUM_STS – 1 if STBC is not applied or indexed by 0 to (NUM_STS/2 – 1) if STBC is applied; MU = indicates that the parameter is present once for an EDMG SU PPDU and present per user for an EDMG MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by values 0 to NUM_USERS – 1; SU+MU = indicates that the parameter is present for each spatial stream and each user. Those parameters are conceptually supplied as a two dimensional array of values indexed by values 0 to NUM_STS – 1 if STBC is not applied or 0 to (NUM_STS/2 – 1) if STBC is applied by 0 to NUM_USERS – 1.<br>NOTE 2—If the condition specified in the “Condition” is not satisfied, the parameter is not present in either the TXVECTOR or RXVECTOR.<br>NOTE 3—“Y” if dot11TimingMsmtActivated is true; otherwise, “N”. | | | | |

### 28.2.3 PHYCONFIG_VECTOR parameters

The PHYCONFIG_VECTOR carried in a PHY-CONFIG.request primitive for an EDMG PHY contains a CHANNEL_WIDTH parameter, which identifies the operating channel width and takes one of the values 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz. The PHY shall set dot11EDMGCurrentChannelWidth to the value of this parameter.

The PHYCONFIG_VECTOR carried in a PHY-CONFIG.request primitive for an EDMG PHY contains a CENTER_FREQUENCY_INDEX_0 parameter, which identifies the center frequency of the 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channel. For 2.16+2.16 GHz channel configuration, it identifies the center frequency of the primary channel. For 4.32+4.32 GHz channel configuration, it identifies the center frequency of the 4.32 GHz channel containing the primary 2.16 GHz channel. The PHY shall set dot11EDMGCurrentChannelCenterFrequencyIndex0 to the value of this parameter defined in the range 1 to 15 (see Table 28-20).

The PHYCONFIG_VECTOR carried in a PHY-CONFIG.request primitive for an EDMG PHY contains a CENTER_FREQUENCY_INDEX_1 parameter, which for 2.16+2.16 GHz channel configuration identifies the center frequency of the secondary channel. For 4.32+4.32 GHz channel configuration, it identifies the center frequency of the 4.32 GHz channel that contains the secondary 2.16 GHz channels only. The PHY shall set dot11EDMGCurrentChannelCenterFrequencyIndex1 to the value of this parameter defined in the range 1 to 15 (see Table 28-20).

The PHYCONFIG_VECTOR carried in a PHY-CONFIG.request primitive for an EDMG PHY contains an OPERATING_CHANNEL parameter, which identifies the operating or primary 2.16 GHz channel. The PHY shall set dot11EDMGCurrentPrimaryChannel to the value of this parameter defined in the range 1 to 15 (see Table 28-20).

The PHYCONFIG_VECTOR carried in a PHY-CONFIG.request primitive for an EDMG PHY contains a set of up to 8 RX_CHAIN_ID_ASSIGNMENT parameters, each taking values from the set {DMG_ANT1, DMG_ANT2, DMG_ANT3, DMG_ANT4, DMG_ANT5, DMG_ANT6, DMG_ANT7, DMG_ANT8}.

The valid channel configurations for an EDMG STA and configuration rules are defined in 28.3.4.

### 28.2.4 Support for NON_EDMG formats

#### 28.2.4.1 General

An EDMG STA logically encompasses Clause 20 and Clause 28 PHYs. The MAC interfaces to the PHY via the Clause Enhanced directional multi-gigabit (EDMG) PHY specification PHY service interface, which in turn interacts with Clause 20 PHY service interface. The EDMG PHY TXVECTOR and RXVECTOR defined in 28.2.2 structurally include all fields of the DMG TXVECTOR and RXVECTOR accordingly defined in 20.2.2. The EDMG PHY TXSTATUS vector is identical to the TXSTATUS vector defined for DMG PHY in 20.2.3. The EDMG PHYCONFIG_VECTOR defined in 28.2.3 structurally includes all fields of the DMG PHYCONFIG_VECTOR.

#### 28.2.4.2 EDMG STA PHY entity configuration for transmission

Figure 28-1 shows an EDMG STA PHY SAP interactions on transmit for different PPDU formats.

The selection of the PHY type is based on the FORMAT parameter included into the TXVECTOR and transferred from MAC to PHY entity using PHY-TXSTART.request(TXVECTOR) primitive.

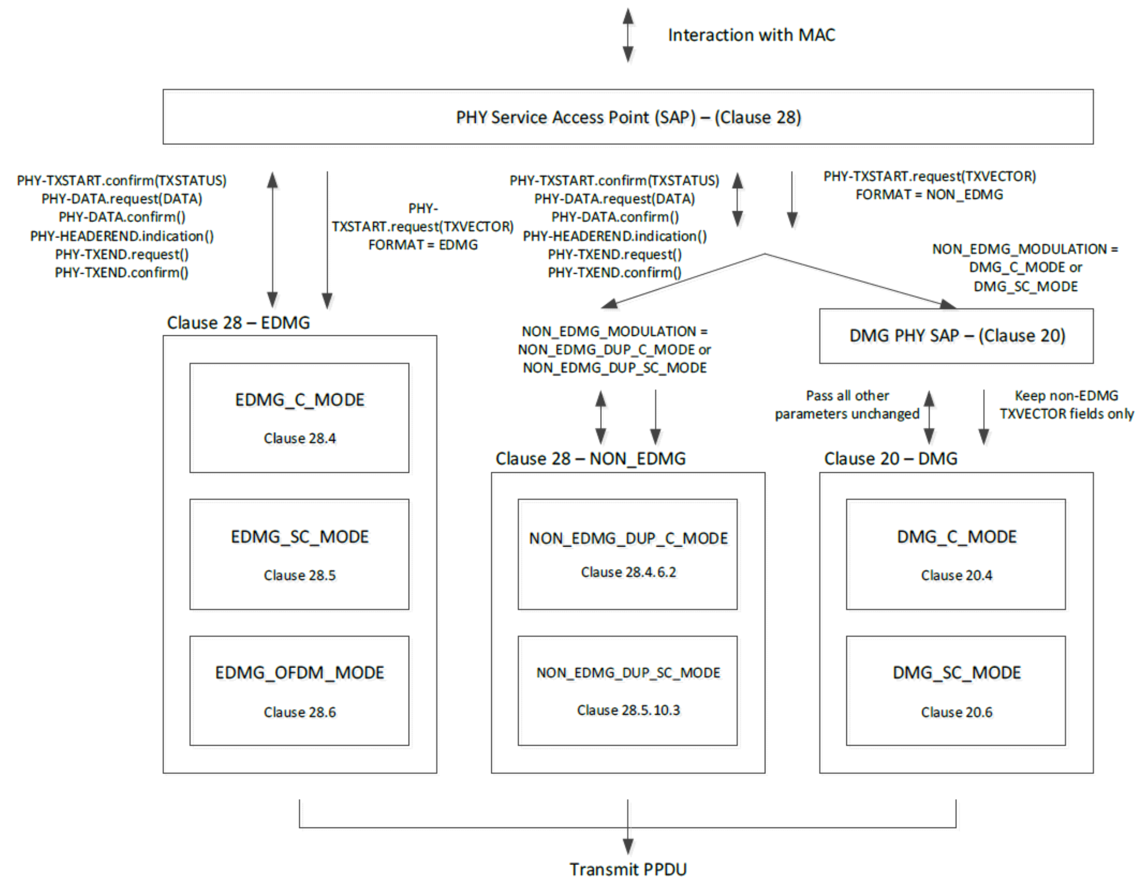


**Figure 28-1—EDMG STA PHY interaction on transmit for various PPDU formats**

If the FORMAT parameter is set to EDMG, then Clause 28 PHY entity is used for transmission. The transmission mode is selected based on the TXVECTOR EDMG_MODULATION parameter and it can be set to EDMG_C_MODE for the EDMG control mode (28.4), EDMG_SC_MODE for the EDMG SC mode (28.5), and EDMG_OFDM for EDMG OFDM mode (28.6).

If the FORMAT parameter is set to NON_EDMG and the TXVECTOR NON_EDMG_MODULATION parameter is set to either NON_EDMG_DUP_C_MODE or NON_EDMG_DUP_SC_MODE, then Clause 28 PHY entity is used for transmission. If NON_EDMG_MODULATION parameter is set to the NON_EDMG_DUP_C_MODE, then the non-EDMG control mode transmission defined in 28.4.7.2 is selected. If NON_EDMG_MODULATION parameter is set to the NON_EDMG_DUP_SC_MODE, then the non-EDMG SC mode defined in 28.5.10.3 is selected.

If the FORMAT parameter is set to NON_EDMG and NON_EDMG_MODULATION is set to either DMG_C_MODE or DMG_SC_MODE, then Clause 20 PHY entity is used for transmission. The TXVECTOR content is filtered out while transferring to the Clause 20 PHY entity to keep the DMG fields only to define the TXVECTOR in accordance with DMG PHY SAP interface (see 20.2.2). If NON_EDMG_MODULATION is set to the DMG_C_MODE, then the DMG control mode defined in 20.4 is selected. If NON_EDMG_MODULATION is set to the DMG_SC_MODE, then the DMG SC mode defined in 20.6 is selected.

### 28.2.4.3 EDMG STA PHY entity configuration for reception

Figure 28-2 shows an EDMG STA PHY SAP interactions on receive for different PPDU formats.

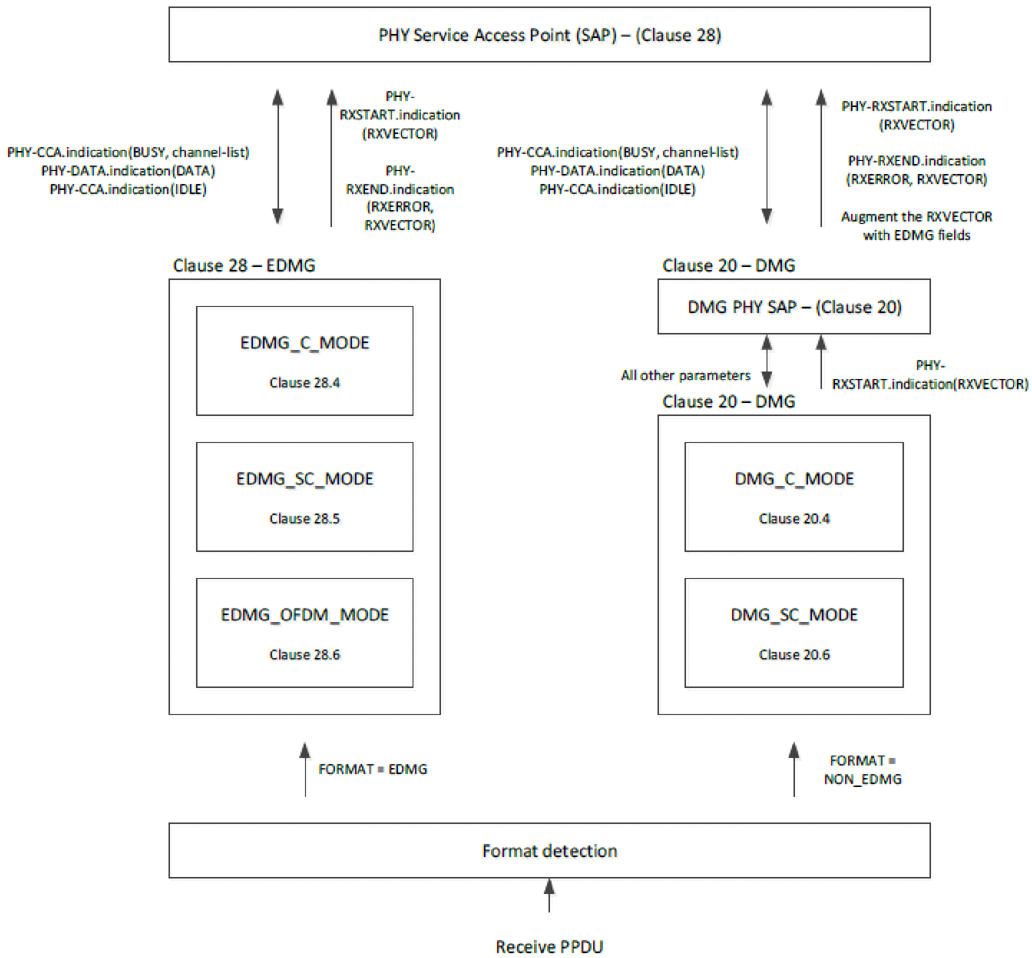


**Figure 28-2—EDMG STA PHY interaction on receive for various PPDU formats**

The selection of the PHY type at the reception is based on the FORMAT detection. For a control mode PPDU, if bits 22 and 23 of the L-Header are both 1, the Scrambler Initialization field B0 is 0, B1 is 1, B2 and B3 are reserved, and the Turnaround field is 0, then the FORMAT parameter is set to the EDMG. Otherwise, the FORMAT parameter is set to the NON_EDMG.

For a SC and an OFDM mode PPDU, if bit 46 of the L-Header is 1, then the FORMAT parameter is set to the EDMG. Otherwise, the FORMAT parameter is set to the NON_EDMG.

If the FORMAT is EDMG, then Clause 28 PHY entity is used for reception. If the FORMAT is EDMG and the PHY entity detects the Gb Golay sequence in the L-STF field, then the EDMG_MODULATION parameter is set to the EDMG_C_MODE. If the FORMAT is EDMG and the PHY entity detects the Ga Golay sequence in the L-STF field and the IsSC field of L-Header is set to 1, then the EDMG_MODULATION parameter is set to the EDMG_SC_MODE. If the FORMAT is EDMG and the PHY entity detects the Ga Golay sequence in the L-STF field and the IsSC field of L-Header is set to 0, then the EDMG_MODULATION parameter is set to the EDMG_OFDM_MODE.

If the FORMAT is NON_EDMG, then Clause 20 PHY entity is used for reception. If the FORMAT is NON_EDMG and PHY entity detects the Gb Golay sequence in the L-STF field, then the NON_EDMG_MODULATION parameter is set to the DMG_C_MODE. If the FORMAT is NON_EDMG and the PHY entity detects the Ga Golay sequence in the L-STF field, then the NON_EDMG_MODULATION parameter is set to the DMG_SC_MODE. The RXVECTOR content is augmented with the EDMG fields to define the RXVECTOR in accordance with EDMG PHY SAP interface (see 28.2.2). The augmented RXVECTOR is passed to the EDMG PHY SAP interface.

The EDMG STA performs the non-EDMG PPDU detection and reception in the primary 2.16 GHz channel only.

#### 28.2.4.4 EDMG STA PHY entity channel bandwidth configuration

Figure 28-3 shows an EDMG STA PHY SAP operating channel bandwidth configuration using the PHYCONFIG_VECTOR parameters.

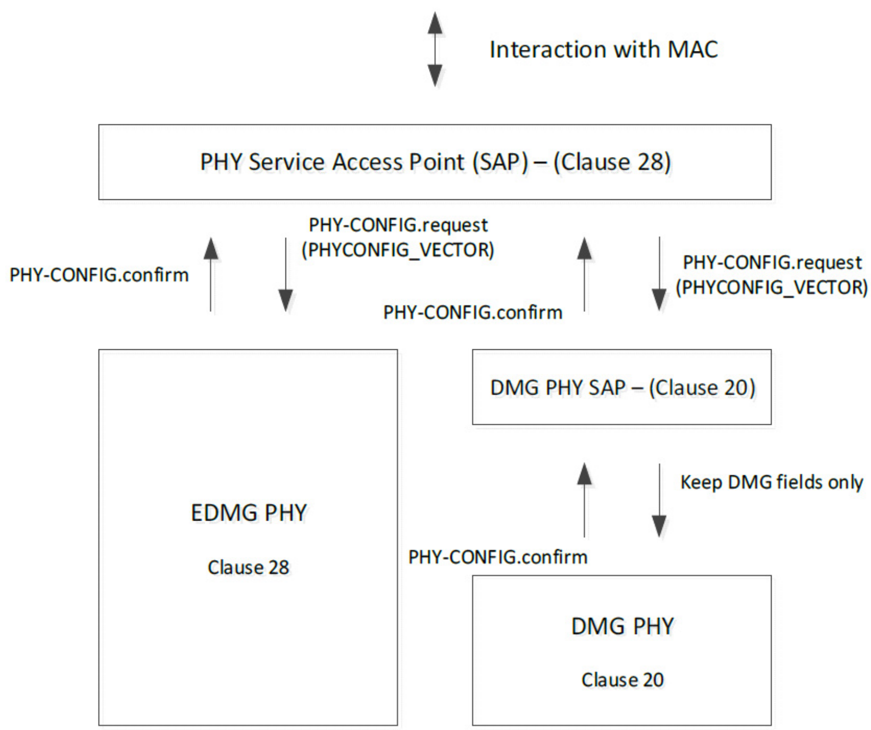


**Figure 28-3—EDMG STA PHY interaction on channel bandwidth configuration for Clause 28 and Clause 20 PHYs**

The EDMG STA PHY entity configuration is performed using the PHYCONFIG_VECTOR parameters defined in 28.2.3. The configuration of the Clause 28 PHY entity shall follow the rules defined in 28.3.4 for the configuration of the following PLME MIB parameters:

- dot11EDMGCurrentChannelWidth
- dot11ChannelCenterFrequencyIndex
- dot11EDMGCurrentChannelCenterFrequencyIndex0
- dot11EDMGCurrentChannelCenterFrequencyIndex1
- dot11EDMGCurrentPrimaryChannel

The configuration of Clause 20 PHY entity by an EDMG STA is performed by setting the OPERATING_CHANNEL parameter, which identifies the operating or primary 2.16 GHz channel. The PHY shall set dot11EDMGCurrentPrimaryChannel to the value of this parameter defined in the range 1 to 15 (see Table 28-20). The configuration of OPERATING_CHANNEL parameter (dot11EDMGCurrentPrimaryChannel) shall follow the rules defined in 28.3.4. All other parameters of the EDMG PHYCONFIG_VECTOR are filtered out while transferring to the Clause 20 PHY entity to keep the DMG fields only to define the PHYCONFIG_VECTOR in accordance with the DMG PHY SAP interface.

#### 28.2.4.5 EDMG STA PHY CCA

The EDMG STA shall follow the CCA requirements defined in 28.3.8 for both Clause 28 and Clause 20 PHY entities.

### 28.2.5 TXSTATUS parameters

The parameters listed in Table 20-2 (in 28.3.1) are defined as part of the TXSTATUS parameter list in the PHY-TXSTART.confirm(TXSTATUS) primitive.

## 28.3 Common parameters

### 28.3.1 Introduction

Subclauses 28.4, 28.5, and 28.6 provide a procedure for converting PSDUs to PPDUs. During transmission, the PSDU is processed (i.e., scrambled, coded and modulated) and appended to the PHY preamble to create the PPDU. At the receiver, the PHY preamble is processed to aid in demodulation and delivery of the PSDU.

Two preamble formats are defined. For EDMG format operation, the preamble has a non-EDMG portion and an EDMG portion. The non-EDMG portion of the EDMG format preamble enables detection of the PPDU and acquisition of carrier frequency and timing by both non-EDMG and EDMG STAs. To be decodable by non-EDMG and EDMG STAs compliant with Clause 20, the following applies:

— If the Short Training field and Channel Estimation field of the non-EDMG portion indicate a control mode transmission, the non-EDMG portion of the EDMG format preamble includes the Header field defined in Clause 20 for the control mode (see 20.4).
— In all other cases, the non-EDMG portion of the EDMG format preamble includes the Header field defined in Clause 20 for the SC mode (see 20.6).

The EDMG portion of the EDMG format preamble enables estimation of the channel to support demodulation of the PSDU transmitted over 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz channels with single and multiple spatial streams. The EDMG portion of the EDMG format preamble includes the EDMG-Header-A field and may include EDMG-Header-B field.

Table 28-2 defines the symbol notations used throughout this clause.

**Table 28-2—Frequently used parameters**

| Symbol | Explanation |
|---|---|
| $i_{SS}$ | Spatial stream number. |
| $N_{SS}$ | Total number of spatial streams. |
| $N_{SS\,i_{user}}$ | Total number of spatial streams for $i_{user}{}^{\text{th}}$ user. |

**Table 28-2—Frequently used parameters *(continued)***

| Symbol | Explanation |
|---|---|
| $i_{STS}$ | Space-time stream number. |
| $N_{STS}$ | Total number of space-time streams. |
| $N_{STS\ i_{user}}$ | Total number of space-time streams for $i_{user}{}^{th}$ user. |
| $i_{STS\ i_{user}}$ | Space-time stream number for $i_{user}{}^{th}$ user. |
| $i_{user}$ | User number. |
| $N_{user}$ | Total number of users. |
| $i_{TX}$ | Transmit chain number. |
| $N_{TX}$ | Total number of transmit chains. |
| $N_{up}$ | Upsampling factor. |
| $N_{CB}$ | Number of contiguous 2.16 GHz channels, $N_{CB}$ = 1 for 2.16 GHz and 2.16+2.16 GHz, $N_{CB}$ = 2 for 4.32 GHz and 4.32+4.32 GHz, $N_{CB}$ = 3 for 6.48 GHz, and $N_{CB}$ = 4 for 8.64 GHz channel. |
| $i_{PPDU}$ | PPDU number aggregated into the EDMG A-PPDU. |
| $N_{PPDU}$ | Total number of PPDUs aggregated into the EDMG A-PPDU. |
| $h_{SCCB}$ | Shaping filter impulse response defined at the $N_{up} \times F_c$ sampling rate, where $F_c$ is defined in 28.5.2.2. |
| $Q$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, independent of subcarrier index. |
| $Q_{non-EDMG}$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, applied to a non-EDMG PPDU transmission and independent of subcarrier index. |
| $Q_{pre-EDMG}$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, applied to the pre-EDMG fields of an EDMG PPDU transmission and independent of subcarrier index. |
| $Q_{EDMG}$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, applied to the EDMG fields of an EDMG PPDU transmission and independent of subcarrier index. |
| $Q_k$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, defined for $k^{th}$ subcarrier. |
| $Q_{EDMG\ k}$ | Spatial mapping matrix of size $N_{TX}$ by $N_{STS}$, applied to the EDMG fields of an EDMG PPDU transmission and defined for the $k^{th}$ subcarrier. |
| $Length_{i_{user}}$ | PSDU length in octets for $i_{user}{}^{th}$ user. |
| $L_{CW}$ | LDPC codeword length in bits, it can be equal to 468, 504, 624, 672, 936, 1008, 1248, and 1344. |
| $L_{CW\ i_{user}}$ | LDPC codeword length for the $i_{user}{}^{th}$ user. |
| $L_{CWD}$ | Number of systematic data bits per LDPC codeword. |
| $L_{CWP}$ | Number of parity bits per LDPC codeword. |
| $R_{i_{user}}$ | LDPC code rate for the $i_{user}{}^{th}$ user and can be equal to1/2, 5/8, 2/3, 3/4, 13/16, 5/6, 7/8. |
| $\rho_{i_{user}}$ | Repetition factor for $i_{user}{}^{th}$ user; is equal to 2 for MCS 1 and equal to 1 for all other MCSs, applied for EDMG SC mode only. |
| $N_{CW\ i_{user}}$ | Total number of LDPC codewords for the $i_{user}{}^{th}$ user. |
| $N_{DATA\_PADi_{user}}$ | Number of pad bits for $i_{user}{}^{th}$ user to get integer number of LDPC codewords. |

**Table 28-2—Frequently used parameters *(continued)***

| Symbol | Explanation |
|---|---|
| $N_{BLKS\ i_{user}}$ | Total number of SC symbol blocks for the $i_{user}$<sup></sup>th user, applied for EDMG SC mode only. |
| $N_{SYMS\ i_{user}}$ | Total number of OFDM symbols for $i_{user}$th user, applied for EDMG OFDM mode only. |
| $N_{BLKS\min}$ | Minimum number of total SC symbol blocks for a PPDU carrying a BRP frame transmission, applied for EDMG SC mode only. |
| $N_{SYMS\min}$ | Minimum number of total OFDM symbols for PPDU carrying a BRP frame transmission, applied for EDMG OFDM mode only. |
| $N_{BLK\_PAD i_{user}}$ | Number of pad bits for the $i_{user}$th user to reach an integer number of SC symbol blocks, applied for EDMG SC mode only. |
| $N_{SYM\_PAD i_{user}}$ | Number of pad bits for the $i_{user}$th user to get integer number of OFDM symbols, applied for EDMG OFDM mode only. |
| $N_{CBPB}$ | Total number of coded bits per SC symbol block, applied for EDMG SC mode only. |
| $N_{CBPS}$ | Number of coded bits per symbol (constellation point) for EDMG SC mode and per OFDM symbol for EDMG OFDM mode. |
| $N_{CBPS\ i_{user} i_{SS}}$ | Number of coded bits per symbol (constellation point) for the $i_{user}$th user and $i_{SS}$th spatial stream, applied for EDMG SC mode only. |
| $N_{SPB}$ | Total number of symbols (constellation points) per SC symbol block, applied for EDMG SC mode only. |
| $N_{BPSC}$ | Number of coded bits per constellation point, applied for EDMG OFDM mode only. |
| $N_{BPSC\ i_{user} i_{SS}}$ | Number of coded bits per constellation point for the $i_{user}$th user and $i_{SS}$th spatial stream, applied for EDMG OFDM mode only. |
| $N_{BLKS\max}$ | Maximum total number of SC symbol blocks over all users, applied for EDMG SC mode only. |
| $N_{SYMS\max}$ | Maximum total number of OFDM symbols over all users, applied for EDMG OFDM mode only. |
| $N_{PAD\_BLKS\ i_{user}}$ | The number of pad SC symbol blocks for the $i_{user}$th user that is required to align PPDUs over different users in time, applied for EDMG SC mode only. |
| $N_{PAD\_SYMS\ i_{user}}$ | The number of pad OFDM symbols for the $i_{user}$th user required to align PPDUs over different users in time, applied for EDMG OFDM mode only. |
| $N_{BLKSspoof}$ | Number of SC symbol blocks for the last PPDU in an EDMG A-PPDU to reach the spoofing EDMG A-PPDU duration, applied for EDMG SC mode only. |
| $N_{SYMSspoof}$ | Number of OFDM symbols for the last PPDU in an EDMG A-PPDU to reach the spoofing EDMG A-PPDU duration, applied for EDMG OFDM mode only. |

### 28.3.2 EDMG PPDU format

#### 28.3.2.1 General

A single PPDU format is defined for all EDMG PHYs: the EDMG PPDU format. Figure 28-4 shows the EDMG PPDU format and all possible fields. Not all fields are transmitted in an EDMG PPDU. Fields are included depending on whether the PPDU is an SU PPDU, an MU PPDU, or a part of an A-PPDU.

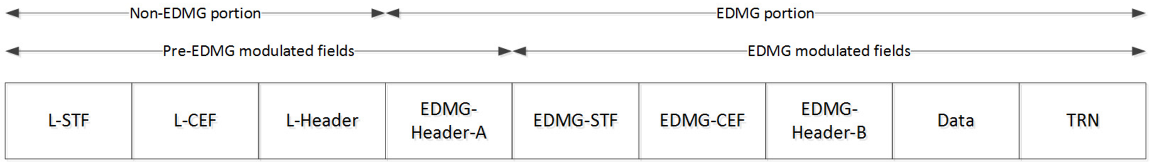


**Figure 28-4—EDMG PPDU format**

The fields of the EDMG PPDU format are summarized in Table 28-3.

**Table 28-3—Fields of the EDMG PPDU**

| Field | Description |
|---|---|
| L-STF | Non-EDMG Short Training field |
| L-CEF | Non-EDMG Channel Estimation field |
| L-Header | Non-EDMG Header field |
| EDMG-Header-A | EDMG Header A field |
| EDMG-STF | EDMG Short Training field |
| EDMG-CEF | EDMG Channel Estimation field |
| EDMG-Header-B | EDMG Header B field |
| Data | The Data field carries the PSDU(s) |
| TRN | Training sequence field |

The EDMG-Header-A, EDMG-STF, EDMG-CEF, and EDMG-Header-B fields exist only in EDMG PPDUs.

Table 28-4 describes the content of the Data field of a PPDU depending on values of specific bits in the L-Header.

**Table 28-4—Data field content based on the values of B46 and B37 in the L-Header field**

| B46 | B37 | Data field content |
|---|---|---|
| 0 | 0 | DMG MPDU |
| 0 | 1 | DMG A-MPDU |
| 1 | 0 | EDMG MPDU |
| 1 | 1 | EDMG A-MPDU |

### 28.3.2.2 EDMG A-PPDU format

An EDMG A-PPDU is defined as a concatenation of EDMG PPDUs defined in 28.3.2.1. An EDMG A-PPDU shall be transmitted to a single user and shall not be transmitted to multiple users. Figure 28-5 shows the EDMG A-PPDU format and all possible fields. The first PPDU of an EDMG A-PPDU includes L-STF, L-CEF, L-Header, EDMG-Header-A, EDMG-STF, EDMG-CEF, and Data fields, and each subsequent PPDU includes EDMG-Header-A and Data fields only. The TRN field, if present, is appended only once at the end of an EDMG A-PPDU. Not all fields are transmitted in an EDMG A-PPDU. Fields are included depending on the values of $N_{CB}$ and $N_{STS}$. The EDMG-Header-A field preceding a Data field defines the parameters of the PSDU transmitted in the Data field.

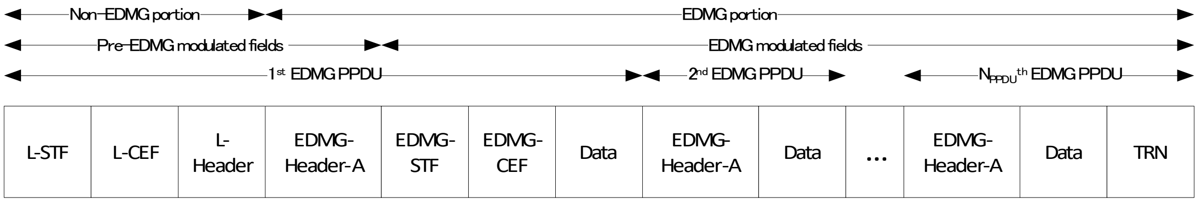


**Figure 28-5—EDMG A-PPDU format**

### 28.3.3 EDMG preamble

#### 28.3.3.1 General

This subclause defines the EDMG format preamble, which includes a non-EDMG portion and an EDMG portion.

For a single PPDU transmission, the fields of the non-EDMG portion of the EDMG format preamble and the EDMG-Header-A field of the EDMG portion of the EDMG format preamble form the pre-EDMG modulated fields. The subsequent fields in the PPDU are referred to as EDMG modulated fields (see Figure 28-4).

For an EDMG A-PPDU transmission, the fields of the non-EDMG portion of the EDMG format preamble and the EDMG-Header-A field of the EDMG portion of the EDMG format preamble of the first EDMG PPDU form the pre-EDMG modulated fields, and subsequent fields in the EDMG A-PPDU are referred to as EDMG modulated fields (see Figure 28-5).

For 4.32 GHz, 6.48 GHz and 8.64 GHz EDMG PPDU transmissions, the pre-EDMG modulated fields shall be transmitted using the non-EDMG duplicate format (28.5.10.4.4.2).

The pre-EDMG modulated fields when transmitted on each secondary channel shall have a relative delay with respect to the corresponding fields transmitted over the primary channel that is between zero (inclusive) and $T_c$ (inclusive), where $T_c$ is defined in Table 28-47. The relative delay applicable to each secondary channel transmission may be different from each other, so long as it follows this rule.

#### 28.3.3.2 Non-EDMG portion of EDMG format preamble

##### 28.3.3.2.1 General

The non-EDMG portion of the EDMG format preamble includes the L-STF, L-CEF and L-Header fields. These fields are defined at the DMG SC chip rate $F_c$ in 20.4.3.1.2, 20.3.6.2, 20.3.6.3, 20.4.3.2, and 20.5.3.1.

##### 28.3.3.2.2 L-STF definition

For an EDMG control mode PPDU, the L-STF is defined in 20.4.3.1.2. For other types of EDMG PPDUs, the L-STF is defined in 20.3.6.2.

#### 28.3.3.2.3 L-CEF definition

The L-CEF for all types of EDMG PPDUs is the same as the Channel Estimation field used by DMG SC PPDUs defined in 20.3.6.3.

#### 28.3.3.2.4 L-Header definition

##### 28.3.3.2.4.1 General

For EDMG and non-EDMG PPDUs, spoofing error is defined as the difference between the PPDU duration calculated based on L-Header and the actual PPDU duration.

The structure of the L-Header field is defined as follows:

- For an EDMG control mode PPDU and a non-EDMG control mode PPDU transmitted with the control trailer or carrying bandwidth signaling information, the L-Header field is the same as the DMG control mode header field (see Table 20-11) except that the reserved bits 22 and 23 shall be both set to 1. In this case, the combination of the Turnaround field and the Scrambler Initialization field in the L-Header indicates the transmission mode:
    - If Turnaround field is 0, then the interpretation of the Scrambler Initialization field is defined in Table 28-5.
    - If Turnaround field is 1 and the PPDU contains an RTS, a DMG CTS, a DMG DTS, or a CF-End frame, then the interpretation of the Scrambler Initialization field is defined in Table 28-6 and indicates the channel bandwidth of the PPDU (corresponds to the TXVECTOR parameter SCRAMBLER_INIT_SETTING equal to Channel_BW). Otherwise, the Scrambler Initialization field is reserved.
- For an EDMG control mode PPDU and a non-EDMG control mode PPDU, the Length field and the Training Length field shall be set so that the spoofing error is non-negative and less than or equal to 150 ns, except for PPDU durations between 347.56 µs and 347.93 µs and between 349.10 µs and 350.76 µs where the maximum spoofing error shall be 0.37 µs and 1.66 µs, respectively.
- For an EDMG SC mode PPDU or an EDMG OFDM mode PPDU, the L-Header field is the same as the DMG SC mode PHY header (see Table 20-13) with the following changes:
    - The reserved bit 46 shall be set to 1 to indicate the presence of the EDMG-Header-A field. This implies that the PPDU is an EDMG PPDU.
    - The Last RSSI field shall be redefined as shown in Table 28-7.
    - The 5 LSBs of the Length field shall be redefined as shown in Table 28-8. Moreover, the remaining bits of the Length field together with the values of the Training Length field and of the MCS field shall be set so that the spoofing error is smaller than one SC symbol block ($512 \times T_c$) and non-negative.
    - The Additional PPDU field and the Beam Tracking Request field shall both be set to 0.
- For an EDMG SC mode A-PPDU or an EDMG OFDM mode A-PPDU, the definition of the L-Header field is the same as for the EDMG SC mode PPDU and the EDMG OFDM mode PPDU defined above with the following change:
    - If the actual A-PPDU duration is unknown at the point in time of L-Header transmission, the remaining bits of the Length field shall be set such that the PPDU duration calculated based on the L-Header shall be within the range of the actual PPDU duration of the first PPDU in the A-PPDU to the smaller of aPPDUMaxTime and remaining TXOP duration. Padding shall be applied such that the spoofing error requirements are fulfilled. The padding for EDMG SC mode A-PPDU is defined in 28.5.9.4.3. The padding for EDMG OFDM mode A-PPDU is defined in 28.6.9.2.3.

— For a non-EDMG SC mode PPDU that has the TXVECTOR parameter NON_EDMG_MODULATION equal to NON_EDMG_DUP_SC_MODE, the L-Header field is the same as the DMG SC mode PHY header (see Table 20-13) with the following changes:
  — The Additional PPDU field shall be set to 0.

### Table 28-5—Definition of Scrambler Initialization field when transmitted using the control mode and the Turnaround field is 0

| Scrambler Initialization field | | | | Definition |
|---|---|---|---|---|
| **B0** | **B1** | **B2** | **B3** | |
| 0 | 0 | R | R | Corresponds to the TXVECTOR parameter SCRAMBLER_INIT_SETTING equal to CONTROL_TRAILER.<br><br>Indicates the presence of the control trailer in the PPDU. The content of the control trailer depends on the type of frame contained in the PPDU (see 28.3.7). |
| 0 | 1 | R | R | Corresponds to the TXVECTOR parameter SCRAMBLER_INIT_SETTING equal to EDMG-Header-A.<br><br>Indicates the presence of the EDMG-Header-A field. This implies that the PPDU is an EDMG control mode PPDU. |
| 1 | 0 | R | R | Reserved |
| 1 | 1 | R | R | Reserved |
| NOTE—“R” indicates that this bit field is reserved. | | | | |

### Table 28-6—Definition of Scrambler Initialization field when transmitted using the control mode and the Turnaround field is 1

| Scrambler Initialization field | | | | Requested channel bandwidth | 2.16 GHz channel number(s) making up the requested channelization |
|---|---|---|---|---|---|
| **B0** | **B1** | **B2** | **B3** | | |
| 0 | 0 | 0 | 0 | 2.16 GHz | Any one of 1, 2, 3, 4, 5, 6, 7, 8 |
| 1 | 0 | 0 | 0 | 4.32 GHz or<br>2.16+2.16 GHz | Any one of (1 and 2), (3 and 4), (5 and 6), or (7 and 8) |
| 0 | 1 | 0 | 0 | 4.32 GHz or<br>2.16+2.16 GHz | Any one of (2 and 3), (4 and 5), or (1 and 6) |
| 1 | 1 | 0 | 0 | 6.48 GHz | (1–3) or (4–6) |
| 0 | 0 | 1 | 0 | 6.48 GHz | (2–4) or (5–7) |
| 1 | 0 | 1 | 0 | 6.48 GHz | (3–5) or (6–8) |
| 0 | 1 | 1 | 0 | 8.64 GHz or<br>4.32+4.32 GHz | 1–4 |
| 1 | 1 | 1 | 0 | 8.64 GHz or<br>4.32+4.32 GHz | 2–5 |

### Table 28-6—Definition of Scrambler Initialization field when transmitted using the control mode and the Turnaround field is 1 *(continued)*

| Scrambler Initialization field | | | | Requested channel bandwidth | 2.16 GHz channel number(s) making up the requested channelization |
|---|---|---|---|---|---|
| B0 | B1 | B2 | B3 | | |
| 0 | 0 | 0 | 1 | 8.64 GHz or 4.32+4.32 GHz | 3–6 |
| 1 | 0 | 0 | 1 | 2.16+2.16 GHz | (1 and 3) or (4 and 6) |
| 0 | 1 | 0 | 1 | 2.16+2.16 GHz | (2 and 4) or (3 and 5) |
| 1 | 1 | 0 | 1 | 2.16+2.16 GHz | Any one of (1 and 4), (2 and 5), or (3 and 6) |
| 0 | 0 | 1 | 1 | 2.16+2.16 GHz | Any one of (1 and 5), (2 and 6), (3 and 7), or (4 and 8) |
| 1 | 0 | 1 | 1 | 4.32+4.32 GHz | 1–2 and 4–5 |
| 0 | 1 | 1 | 1 | 4.32+4.32 GHz | 2–3 and 5–6 |
| 1 | 1 | 1 | 1 | 4.32+4.32 GHz | 3–4 and 6–7 |

### Table 28-7—Definition of bit allocation of Last RSSI field when transmitted using the EDMG SC or EDMG OFDM mode

| Bit number | Field name | Definition |
|---|---|---|
| B0 | IsSC | If set to 1, this field indicates that the PSDU is modulated using SC (see 28.5). Otherwise, if set to 0, this field indicates that the PSDU is modulated using OFDM (see 28.6). If modulated using SC, the PPDU is termed as EDMG SC (mode) PPDU. If modulated using OFDM, the PPDU is termed as EDMG OFDM (mode) PPDU. |
| B1 | IsSISO | If set to 1, this field indicates that the PPDU is a single space-time stream PPDU. Otherwise, the PPDU encodes more than one space-time stream. |
| B2–B3 | GI Length | This field indicates the type of GI used in the PPDU and is set as follows: set to 0 for short GI, set to 1 for normal GI, and set to 2 for long GI. Value of 3 is reserved. |

### Table 28-8—Definition of the 5 LSBs of the Length field when transmitted using the EDMG SC or EDMG OFDM mode

| Bit number | Field name | Definition |
|---|---|---|
| B0–B4 | Compressed BW | The Compressed BW field indicates the bandwidth over which the PPDU is transmitted. Possible values for this field are defined in Table 28-9. Values not listed in Table 28-9 are reserved. |

### Table 28-9—Compressed BW field definition

| Bandwidth of PPDU | 2.16 GHz channel number(s) over which PPDU is transmitted | | | | | | | | Compressed BW field value |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 2.16 GHz | x | — | — | — | — | — | — | — | 0 |
| | — | x | — | — | — | — | — | — | |
| | — | — | x | — | — | — | — | — | |
| | — | — | — | x | — | — | — | — | |
| | — | — | — | — | x | — | — | — | |
| | — | — | — | — | — | x | — | — | |
| | — | — | — | — | — | — | x | — | |
| | — | — | — | — | — | — | — | x | |
| 4.32 GHz or 2.16+2.16 GHz | x | x | — | — | — | — | — | — | 1 |
| | — | — | x | x | — | — | — | — | |
| | — | — | — | — | x | x | — | — | |
| | — | — | — | — | — | — | x | x | |
| 4.32 GHz or 2.16+2.16 GHz | — | x | x | — | — | — | — | — | 2 |
| | — | — | — | x | x | — | — | — | |
| | — | — | — | — | — | x | x | — | |
| | x | — | — | — | — | — | — | x | |
| 6.48 GHz | x | x | x | — | — | — | — | — | 3 |
| | — | — | — | x | x | x | — | — | |
| 6.48 GHz | — | x | x | x | — | — | — | — | 4 |
| | — | — | — | — | x | x | x | — | |
| 6.48 GHz | — | — | x | x | x | — | — | — | 5 |
| | — | — | — | — | — | x | x | x | |
| 8.64 GHz or 4.32+4.32 GHz | x | x | x | x | — | — | — | — | 6 |
| | — | — | — | — | x | x | x | x | |
| 8.64 GHz or 4.32+4.32 GHz | — | x | x | x | x | — | — | — | 7 |
| 8.64 GHz or 4.32+4.32 GHz | — | — | x | x | x | x | — | — | 8 |
| 8.64 GHz or 4.32+4.32 GHz | — | — | — | x | x | x | x | — | 9 |

**Table 28-9—Compressed BW field definition *(continued)***

| Bandwidth of PPDU | 2.16 GHz channel number(s) over which PPDU is transmitted | | | | | | | | Compressed BW field value |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 2.16+2.16 GHz | x | — | x | — | — | — | — | — | 10 |
| | — | x | — | x | — | — | — | — | |
| | — | — | — | — | x | — | x | — | |
| | — | — | — | — | — | x | — | x | |
| 2.16+2.16 GHz | — | — | x | — | x | — | — | — | 11 |
| | — | — | — | x | — | x | — | — | |
| 2.16+2.16 GHz | x | — | — | x | — | — | — | — | 12 |
| | — | x | — | — | x | — | — | — | |
| | — | — | x | — | — | x | — | — | |
| 2.16+2.16 GHz | — | — | — | x | — | — | x | — | 13 |
| | — | — | — | — | x | — | — | x | |
| 2.16+2.16 GHz | x | — | — | — | x | — | — | — | 14 |
| | — | x | — | — | — | x | — | — | |
| | — | — | x | — | — | — | x | — | |
| | — | — | — | x | — | — | — | x | |
| 4.32+4.32 GHz | x | x | — | x | x | — | — | — | 15 |
| 4.32+4.32 GHz | — | x | x | — | x | x | — | — | 16 |
| 4.32+4.32 GHz | — | — | x | x | — | x | x | — | 17 |
| 4.32+4.32 GHz | — | — | — | x | x | — | x | x | 18 |
| 4.32+4.32 GHz | x | x | — | — | x | x | — | — | 19 |
| | — | — | x | x | — | — | x | x | |
| 4.32+4.32 GHz | — | x | x | — | — | x | x | — | 20 |
| Legend: “x” indicates that the channel is used; “—” indicates that the channel is not used. | | | | | | | | | |

### 28.3.3.2.4.2 Example of spoofing algorithm for EDMG SC PPDUs

The following is an informative algorithm for calculating the value of the Length field (referred to in this subclause as Length), the Training Length field, and the MCS field (referred to in this subclause as Base MCS) used in items a), b), c), d), and e) in the L-Header of an EDMG SC mode PPDU.

a) The tentative number of SC symbol blocks, $N_{BLKS}'$, is calculated as $$N_{BLKS}' = \left\lceil \frac{TXTIME - \left(T_{L-STF} + T_{L-CEF} + T_{L-Header}\right) - \left(64 \times T_c\right)}{512 \times T_c} \right\rceil$$ where *TXTIME* is defined in 28.12.3 and $T_{L\text{-}STF}$, $T_{L\text{-}CEF}$, and $T_{L\text{-}Header}$ are defined in 28.5.10.4.4.2.

b) The Base MCS field in the L-Header is set to the value such that the following conditions are met:

1) $N_{BLKS}' \leq \left\lceil \left(2^{18}-1\right)\times 8 / \left(N_{CBPB} \times \frac{R}{\rho}\right) \right\rceil - 1$ where $N_{CBPB}$, $R$, and $\rho$ are the parameters chosen based on the value of the Base MCS field as described in 20.5.3. If this condition is fulfilled, the Length to be calculated in steps d) and e) does not exceed the maximum value of the Length field in the L-Header, $2^{18} - 1$.

2) If $N_{BLKS}'$ mod 3 = 1 and $N_{BLKS}' < 38$, the Base MCS field should be set to the value that is greater than 5 to apply algorithm in step c).

c) One of the combinations of the parameters $N_{BLKS}$ and $N_{TRN}$, which denote, respectively, the number of SC symbol blocks and the Training Length in a DMG SC mode PPDU with the spoofed TXTIME of the EDMG PPDU, is calculated as follows:

**If** the Base MCS > 5 (π/2-QPSK, π/2-16-QAM and π/2- 64-QAM) **then**

$$N_{BLKS} = N_{BLKS}'$$

$$N_{TRN} = 0$$

**Endif**

**If** the Base MCS ≤ 5 (π/2-BPSK) **then**

**If** $N_{BLKS}' \bmod 3 \neq 1$ **then**

$$N_{BLKS} = N_{BLKS}'$$

$$N_{TRN} = 0$$

**else if** $N_{BLKS}' \geq 38$ **then**

$$N_{TRN} = 2$$

**If** $0 < \frac{TXTIME - \left(T_{L-STF} + T_{L-CE} + T_{L-Header}\right) - \left(64 \times T_c\right)}{T_c} \bmod 512 \leq 256$ **then**

$$N_{BLKS} = N_{BLKS}' - 20$$

**else**

$$N_{BLKS} = N_{BLKS}' - 19$$

**endif**

**endif**

**endif**

d) The maximum *Length* value that fulfills the requirement for the spoofing error specified in 28.3.3.2.4.1, $Length_{max}$, is calculated as $Length_{max} = \left\lfloor \left\lfloor N_{BLKS} \cdot \frac{N_{CBPB}}{L_{CW}} \right\rfloor \cdot \frac{L_{CW}}{8} \cdot \frac{R}{\rho} \right\rfloor$, where $L_{CW}$ is the parameter defined in 20.5.3.2.3, and the value is chosen based on the value of the Base MCS field as described in 20.5.3.

e) The spoofed values of the Length and Training Length fields of the EDMG PPDU are calculated as follows:

$$Length = \begin{cases} \left\lfloor \dfrac{Length_{max}}{32} \right\rfloor \cdot 32 + compressed\_bw, \text{ if } Length_{max} \; mod \; 32 \geq compressed\_bw \\ \left( \left\lfloor \dfrac{Length_{max}}{32} \right\rfloor - 1 \right) \cdot 32 + compressed\_bw, \text{ otherwise} \end{cases}$$

$$Training\ Length = N_{TRN}$$

where

*compressed_bw* is the value of the Compressed BW field in the L-Header as described in 28.3.3.2.4.1

When the Base MCS field is equal to 1, the calculated length might not satisfy the requirement for the spoofing error defined in 28.3.3.2.4.1. In that case, the Base MCS field shall be set to a value different from 1, and the Length and the Training Length fields shall be calculated by repeating steps c) to e).

### 28.3.3.3 EDMG portion of EDMG format preamble

#### 28.3.3.3.1 General

The EDMG portion of the EDMG format preamble includes the EDMG-Header-A, EDMG-STF, EDMG-CEF and EDMG-Header-B fields. The EDMG-Header-A field is defined at the DMG SC chip rate $F_c$. The EDMG-STF, EDMG-CEF and EDMG-Header-B fields are not always transmitted as part of an EDMG PPDU transmission.

#### 28.3.3.3.2 EDMG-Header-A definition

##### 28.3.3.3.2.1 General

The EDMG-Header-A field carries information required to demodulate EDMG PPDUs. The definition of the EDMG-Header-A is the same for an EDMG SC mode and an EDMG OFDM mode PPDU, but is different from the definition for an EDMG control mode PPDU.

Reserved bits in the EDMG-Header-A field shall be set to 0 by the transmitter and shall be ignored by the receiver.

##### 28.3.3.3.2.2 Definition for EDMG control mode PPDU

The contents of the EDMG-Header-A field are partitioned between the first and second LDPC codeword of an EDMG control mode PPDU as shown in Figure 28-6. The contents included in the first LDPC codeword are referred to as the EDMG-Header-$A_1$ subfield, which is defined in Table 28-10. The contents included in the second LDPC codeword are referred to as the EDMG-Header-$A_2$ subfield, which is defined in Table 28-11.

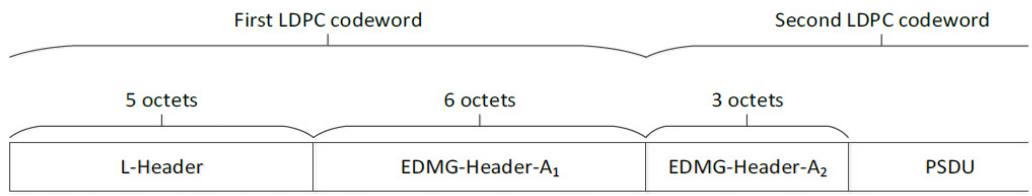


**Figure 28-6—Structure of EDMG-Header-A in an EDMG control mode PPDU**

**Table 28-10—EDMG-Header-A$_1$ subfield definition**

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| BW | 8 | 0 | See Table 28-12 (in 28.3.3.3.2.3). |
| Primary Channel Number | 3 | 8 | See Table 28-12. |
| PSDU Length | 10 | 11 | Length of the PSDU field in octets in the range 14 to 1023. |
| EDMG TRN Length | 8 | 21 | See Table 28-12. |
| RX TRN-Units per Each TX TRN-Unit | 8 | 29 | See Table 28-12. |
| EDMG TRN-Unit P | 2 | 37 | See Table 28-12. |
| EDMG TRN-Unit M | 4 | 39 | See Table 28-12. |
| EDMG TRN-Unit N | 2 | 43 | See Table 28-12. |
| TRN Subfield Sequence Length | 2 | 45 | See Table 28-12. |
| TRN-Unit RX Pattern | 1 | 47 | See Table 28-12. |

**Table 28-11—EDMG-Header-A$_2$ subfield definition**

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| TRN Aggregation | 1 | 0 | Corresponds to the TXVECTOR parameter TRN_AGGREGATION.<br><br>If this field set to 0, the BW field specifies that the TRN field of the PPDU is appended on a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel. If this field set to 1, the BW field specifies that the TRN field is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel.<br><br>This field is reserved if the value of the EDMG TRN Length field is 0. |
| Number of Transmit Chains | 3 | 1 | See Table 28-12. |
| DMG TRN | 1 | 4 | See Table 28-12. |

**Table 28-11—EDMG-Header-A$_2$ subfield definition *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| First Path Training | 1 | 5 | See Table 28-13 (in 28.3.3.3.2.3). |
| Dual Polarization TRN Training | 1 | 6 | See Table 28-13. |
| Reserved | 1 | 7 | Set to 0 by the transmitter and ignored by the receiver. |
| CRC | 16 | 8 | Header Check sequence. Calculation of the header check sequence is defined in 20.3.7. |

For 2.16+2.16 GHz and 4.32+4.32 GHz PPDU transmission, the total number of transmit chains, $N_{TX}$, is an even number. For 2.16+2.16 GHz PPDU transmission, the first $N_{TX}/2$ transmit chains are used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains are used for transmission on the secondary channel. For 4.32+4.32 GHz PPDU transmission, the first $N_{TX}/2$ transmit chains are used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains are used for transmission on the secondary1 and secondary2 channels. See also 28.3.3.4.2.

The knowledge of the number of transmit chains to receive the preamble and Data fields of a PPDU is not required, because the data is duplicated over all transmit chains with CSD. The knowledge of the number of transmit chains is needed to perform beamforming training using TRN units included in the TRN field of a PPDU. The TRN units are defined using orthogonal sequences and allow channel estimation between $N_{TX}$ transmit chains and $N_{RX}$ receive chains. The receiver needs to know the number of TRN units (corresponding to $N_{TX}$ chains) that were transmitted in order to perform channel measurements. Based on this information, the receiver can run the appropriate number of correlators for each receive chain.

### 28.3.3.3.2.3 Definition for EDMG SC mode and EDMG OFDM mode PPDUs

The EDMG-Header-A field has a fixed size of two DMG SC symbol blocks (see Clause 20) comprising 112 data bits followed by a 16 bit CRC.

Two types of EDMG-Header-A structures are defined, namely, one for EDMG SU PPDU and one for EDMG MU PPDU. The type of EDMG-Header-A structure used in an EDMG PPDU is indicated by the value of the SU/MU Format field.

The structure of the EDMG-Header-A field for an EDMG SU PPDU is shown in Table 28-12. The structure of the EDMG-Header-A field for an EDMG MU PPDU is shown in Table 28-17.

For multiple stream transmission, each spatial stream has an identical bandwidth configuration as defined in the EDMG-Header-A.

For 2.16+2.16 GHz and 4.32+4.32 GHz PPDU transmission, the total number of transmit chains, $N_{TX}$, is an even number. For 2.16+2.16 GHz PPDU transmission, the first $N_{TX}/2$ transmit chains are used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains are used for transmission on the secondary channel. For 4.32+4.32 GHz PPDU transmission, the first $N_{TX}/2$ transmit chains are used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains are used for transmission on the secondary1 and secondary2 channels. See also 28.3.3.4.2.

For an EDMG A-PPDU, the following apply:

— The SU/MU Format field shall be set to 0 for all EDMG PPDUs comprising the EDMG A-PPDU.

— The PSDU Length and EDMG-MCS fields may be set to different values for EDMG PPDUs comprising the EDMG A-PPDU.
— The Additional EDMG PPDU field shall be set to 1 for all EDMG PPDUs, except for the last EDMG PPDU where it shall be set to 0.
— The EDMG TRN Length field shall be set to 0 for all EDMG PPDUs, except for the last EDMG PPDU where it may be set to a nonzero value.
— The RX TRN-Units per Each TX TRN-Unit, EDMG TRN-Unit P, EDMG TRN-Unit M, EDMG TRN-Unit N, TRN Subfield Sequence Length, TRN-Unit RX Pattern, EDMG Beam Tracking Request, EDMG Beam Tracking Request Type, DMG TRN, First Path Training and Dual Polarization TRN Training fields are reserved for all EDMG PPDUs, except the last EDMG PPDU. For the last EDMG PPDU in the EDMG A-PPDU, the values of these fields may be set based on the TRN field parameters and EDMG TRN Length field value.
— The Channel Aggregation, BW, Primary Channel Number, Beamformed, Short/Long LDPC, STBC Applied, Number of SS, Number of Transmit Chains, and NUC Applied fields shall have the same value for all EDMG PPDUs comprising the EDMG A-PPDU.
— The DCM BPSK Applied field shall have the same value for all EDMG PPDUs comprising the EDMG A-PPDU. The conditions on DCM BPSK modulation usage shall be met as defined in 28.5.9.5.3 and 28.6.9.3.4 for the EDMG SC and EDMG OFDM modes, respectively. If conditions are not met, then the DCM BPSK Applied field is reserved for all EDMG PPDUs comprising the EDMG A-PPDU.
— The Phase Hopping and Open Loop Precoding fields shall have the same value for all EDMG PPDUs comprising the OFDM EDMG A-PPDU. The conditions on phase hopping modulation usage shall be met as defined in 28.6.9.3.8. If conditions are not met, the Phase Hopping and Open Loop Precoding fields are reserved for all EDMG PPDUs comprising the EDMG A-PPDU.
— The Superimposed Code Applied field shall have the same value for all EDMG PPDUs comprising the EDMG A-PPDU. The receiver shall ignore the Superimposed Code Applied field if the EDMG-MCS field does not indicate the LDPC code rate-7/8.
— The π/2-8-PSK Applied field shall have the same value for all EDMG PPDUs comprising the EDMG A-PPDU. The receiver shall ignore the π/2-8-PSK Applied field if the EDMG-MCS field does not indicate EDMG-MCS 12 or 13.
— The Reserved field is reserved for all EDMG PPDUs comprising the EDMG A-PPDU.
— The CRC field is computed based on the EDMG-Header-A content for a given EDMG PPDU and may have different values for EDMG PPDUs comprising the EDMG A-PPDU.

### Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| SU/MU Format | 1 | 0 | Generated from the NUM_USERS parameter in the TXVECTOR. Indicates whether the PPDU is an SU PPDU or an MU PPDU. Set to 0 to indicate an SU PPDU and set to 1 otherwise. |
| Channel Aggregation | 1 | 1 | Generated from the CHANNEL_AGGREGATION parameter in the TXVECTOR. Set to 0 if the parameter is equal to NOT_AGGREGATE. Set to 1 if the parameter is equal to AGGREGATE. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| BW | 8 | 2 | A bitmap as indicated by the CH_BANDWIDTH parameter in the TXVECTOR that indicates the 2.16 GHz channel(s) over which the PPDU is transmitted on. If a bit is set to 1, it indicates that the corresponding channel is used for the PPDU transmission; otherwise, if the bit is set to 0, the channel is not used. Bit 0 corresponds to channel 1, bit 1 corresponds to channel 2, and so on. |
| Primary Channel Number | 3 | 10 | Corresponds to the TXVECTOR parameter PRIMARY_CHANNEL. Contains the primary 2.16 GHz channel number of the BSS minus one. |
| Beamformed | 1 | 13 | Corresponds to the TXVECTOR parameter BEAMFORMED. Set to 1 to indicate that digital beamforming is applied. Set to 0 otherwise. |
| Short/Long LDPC | 1 | 14 | Corresponds to the TXVECTOR parameter LDPC_CW_LENGTH. Indicates the LDPC codeword length used in the PSDU. Set to 0 for LDPC codeword of length 672, 624, 504, or 468. Set to 1 for LDPC codeword of length 1344, 1248, 1008, or 936. |
| STBC Applied | 1 | 15 | Corresponds to the TXVECTOR parameter STBC. If set to 1, indicates that STBC was applied at the transmitter. Otherwise, set to 0.<br><br>If set to 1, the DCM BPSK Applied and the Phase Hopping fields shall be set to 0. |
| PSDU Length | 22 | 16 | Length of the PSDU field in octets. |
| Number of SS | 3 | 38 | Generated from the TXVECTOR parameters NUM_STS and STBC. The value of this field plus one indicates the number of SSs transmitted in the PPDU. |
| EDMG-MCS | 21 | 41 | Generated from TXVECTOR parameter EDMG_MCS. If the Number of SS field is 0, the EDMG-MCS field is as defined in Table 28-13. Otherwise, the EDMG-MCS field is as defined in Table 28-14. |
| DCM BPSK Applied | 1 | 62 | Corresponds to the TXVECTOR parameter DCM_BPSK. If set to 1 and the PSDU is encoded using the EDMG SC mode, it indicates that DCM $\pi$/2-BPSK modulation defined in 28.5.9.5.3 was applied at the transmitter.<br><br>If set to 1 and the PSDU is encoded using the EDMG OFDM mode with two spatial streams, it indicates that Dual Stream DCM BPSK modulation defined in 28.6.9.3.4 was applied at the transmitter.<br><br>If set to 1, the STBC Applied and the Phase Hopping fields shall be set to 0.<br><br>In all other cases, this field is set to 0. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| NUC Applied | 1 | 63 | Corresponds to the TXVECTOR parameter NUC_MOD. If this field is set to 1, π/2-64-NUC is applied at the transmitter for all MCSs indicated within the EDMG-MCS field, if supported. If a Differential EDMG-MCS indicated within the EDMG-MCS field does not support π/2-64-NUC, then π/2-64-QAM uniform constellation is applied for this particular MCS.<br><br>If set to 0, π/2-64-QAM uniform constellation is applied for all MCSs signaled in the EDMG-MCS field. |
| EDMG TRN Length | 8 | 64 | Corresponds to the TXVECTOR parameter EDMG_TRN_LEN. Indicates the number of TRN-Units present in the TRN field of the PPDU or, as defined in 10.42.7, a requested number of TRN-Units for receive beam tracking. |
| RX TRN-Units per Each TX TRN-Unit | 8 | 72 | Corresponds to TXVECTOR parameter RX_TRN_PER_TX_TRN. This field is reserved if the value of the EDMG TRN Length field is 0. Otherwise, the value of this field plus one indicates the number of consecutive TRN-Units in the TRN field for which the transmitter remains with the same transmit AWV (see 28.9.2.2.5). |
| EDMG TRN-Unit P | 2 | 80 | Corresponds to TXVECTOR parameter EDMG_TRN_P. For EDMG BRP-TX and EDMG BRP-RX/TX PPDUs, the value of this field describes the number of TRN subfields in a TRN-Unit that are transmitted using the same AWV used in the transmission of the preamble and Data fields, except for the case when the DMG antenna used in the transmission of the PPDU changes at the beginning of the TRN field, as defined in 28.9.2.2.5. Possible values for this field are as follows:<br>0 indicates zero TRN subfields.<br>1 indicates one TRN subfield.<br>2 indicates two TRN subfields.<br>3 indicates four TRN subfields.<br><br>For EDMG BRP-RX PPDUs, this field is reserved. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU** ***(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| EDMG TRN-Unit M | 4 | 82 | Corresponds to TXVECTOR parameter EDMG_TRN_M. For EDMG BRP-TX PPDUs, as defined in 28.9.2.2, the transmitter may change the AWV at the beginning of each set of *N* TRN subfields present in the last *M* TRN subfields of each TRN-Unit in the TRN field, where *M* is the value of this field plus one and the value of *N* is indicated by the TXVECTOR parameter EDMG_TRN_N. For EDMG BRP-RX/TX PPDUs, the value of this field plus one indicates the number of TRN subfields in a TRN-Unit transmitted with the same AWV following a possible AWV change, as defined in 28.9.2.2.5.<br><br>For EDMG BRP-RX PPDUs, this field is reserved. For EDMG BRP-TX PPDUs transmitted with EDMG Beam Tracking Request Type field set to 1, this field is reserved. |
| EDMG TRN-Unit N | 2 | 86 | Corresponds to TXVECTOR parameter EDMG_TRN_N. For EDMG BRP-TX PPDUs, the value of this field indicates the number of consecutive TRN subfields within EDMG TRN-Unit M that are transmitted using the same AWV, as defined in 28.9.2.2.5. Possible values for this field are as follows:<br>0 indicates one TRN subfield.<br>1 indicates two TRN subfields.<br>2 indicates three TRN subfields if EDMG TRN-Unit M is equal to 2, 5, 8, 11 or 14; indicates eight TRN subfields if EDMG TRN-Unit M is equal to 7 or 15.<br>3 indicates four TRN subfields.<br><br>For EDMG BRP-RX and EDMG BRP-RX/TX PPDUs, this field is reserved. For EDMG BRP-TX PPDUs transmitted with EDMG Beam Tracking Request Type field set to 1, this field is reserved. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| TRN Subfield Sequence Length | 2 | 88 | Corresponds to TXVECTOR parameter TRN_SEQ_LENGTH.<br><br>For an EDMG SC mode PPDU, this field is reserved if the value of the EDMG TRN Length field is 0. Otherwise, this field indicates the length of the Golay sequence used to transmit the TRN subfields present in the TRN field of the PPDU and is set as follows:<br>— Set to 0 to indicate normal sequence length of $128 \times N_{CB}$.<br>— Set to 1 to indicate long sequence length of $256 \times N_{CB}$.<br>— Set to 2 to indicate short sequence length of $64 \times N_{CB}$.<br>— Value of 3 is reserved.<br><br>$N_{CB}$ is defined in Table 28-2 and, in this case, represents the integer number of contiguous 2.16 GHz channels over which the TRN subfield is transmitted.<br><br>For an EDMG OFDM mode PPDU, this field is reserved if the value of the EDMG TRN Length field is 0. Otherwise, this field indicates the number of basic TRN subfield repetitions used to transmit the TRN subfields present in the TRN field of the PPDU and is set as follows:<br>— Set to 0 to indicate normal TRN subfield composed of 2 repetitions of the basic TRN subfield.<br>— Set to 1 to indicate long TRN subfield composed of 4 repetitions of the basic TRN subfield.<br>— Set to 2 to indicate short TRN subfield composed of 1 repetition of the basic TRN subfield.<br>— Value of 3 is reserved. |
| TRN-Unit RX Pattern | 1 | 90 | Corresponds to TXVECTOR parameter TRN_RX_PATTERN. If set to 1 in a BRP-TX PPDU, indicates that the measurements of the TRN-Units is to be done using a quasi-omni antenna pattern. Otherwise, if set to 0 in a BRP-TX PPDU, indicates that the measurements of the TRN-Units is to be done using a directional AWV receive antenna configuration. For all other cases, this field is reserved. |
| EDMG Beam Tracking Request | 1 | 91 | Corresponds to the TXVECTOR parameter EDMG_BEAM_TRACKING_REQUEST.<br><br>Set to 1 to indicate the need for beam tracking (10.42.7); otherwise, set to 0.<br><br>The EDMG Beam Tracking Request field is reserved when the EDMG TRN Length field is 0. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| EDMG Beam Tracking Request Type | 1 | 92 | Corresponds to the TXVECTOR parameter EDMG_BEAM_TRACKING_TYPE.<br><br>Set to 0 to indicate analog beam tracking (10.42.7); set to 1 to indicate baseband beam tracking (10.42.7).<br><br>This field is reserved when the EDMG Beam Tracking Request field is reserved or 0. |
| Phase Hopping | 1 | 93 | Corresponds to TXVECTOR parameter PHASE_HOPPING. If set to 1 in an EDMG OFDM mode PPDU, this field indicates that phase hopping modulation (see 28.6.9.3.8) is used. Otherwise, this field is set to 0.<br><br>If set to 1, the STBC Applied and the DCM BPSK Applied fields shall be set to 0.<br><br>This field is reserved in an EDMG SC mode PPDU, or if the transmitter or receiver do not support phase hopping. |
| Open Loop Precoding | 1 | 94 | Corresponds to TXVECTOR parameter OPEN_LOOP_PC. If the Phase Hopping field is set to 1, this field indicates if open loop precoding is used. If this field is 1, open loop precoding (see 28.6.9.3.8) is used. Otherwise, open loop precoding is not used. If the Phase Hopping field is reserved, this field is also reserved. |
| Additional EDMG PPDU | 1 | 95 | Corresponds to TXVECTOR parameter EDMG-ADD-PPDU. A value of 1 indicates that this EDMG PPDU is immediately followed by another EDMG PPDU with no IFS or preamble in between the PPDUs. A value of 0 indicates that no additional EDMG PPDU follows this EDMG PPDU. |
| Superimposed Code Applied | 1 | 96 | Corresponds to TXVECTOR parameter LDPC_SUPERIMPOSED. If the LDPC code rate is 7/8 and this field is set to 0, it indicates puncturing code with codeword length 624 or 1248 is applied (see 28.5.9.4.3 and 28.6.9.2.3).<br><br>If the LDPC code rate is 7/8 and this field is set to 1, it indicates that superimposed code with codeword length 672 or 1344 is applied (see 28.3.6.2 and 28.3.6.7).<br><br>If the EDMG-MCS field indicates a value of 13 and the $\pi/2$-8-PSK Applied field is 1, then this field indicates the 7/8 code employed in the encoding procedure with codeword shortening to achieve the effective code rate of 5/6 as defined in 28.5.9.4.3.<br><br>In all other cases, this field is reserved. |

**Table 28-12—EDMG-Header-A field structure and definition for an SU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| π/2-8-PSK Applied | 1 | 97 | Corresponds to TXVECTOR parameter PSK_APPLIED. If this field is set to 1, π/2-8-PSK with corresponding LDPC shortening code with rates 2/3 or 5/6 is applied at the transmitter for MCS 12 or 13, respectively, as indicated within the EDMG-MCS field.<br><br>If set to 0, π/2-16-QAM constellation with regular LDPC code with rates 1/2 or 5/8 is applied at the transmitter for MCS 12 or 13, respectively, as indicated in the EDMG-MCS field. |
| Number of Transmit Chains | 3 | 98 | Corresponds to TXVECTOR parameter NUM_TX_CHAINS. The value of this field plus 1 indicates the number of transmit chains used in the transmission of the PPDU. The value of the field plus 1 also indicates the total number of orthogonal sequences in a TRN field (see 28.9.2.2.5). This field is reserved when the EDMG TRN Length field is 0, or when the EDMG Beam Tracking Request field is 1 and the PPDU is an EDMG BRP-RX PPDU. |
| DMG TRN | 1 | 101 | Corresponds to TXVECTOR parameter DMG_TRN. When set to 1, indicates that the TRN field appended to this PPDU has the structure of a DMG training field containing an AGC training field and a TRN field as defined in 20.9.2.2.2. In this case, the RX TRN-Units per Each TX TRN-Unit, the EDMG TRN-Unit P, the EDMG TRN-Unit M, the EDMG TRN-Unit N, and the TRN Subfield Sequence Length fields are reserved. This field is reserved when the EDMG TRN Length field is equal to 0. |
| Reserved | 10 | 102 | Set to 0 by the transmitter and ignored by the receiver. |
| CRC | 16 | 112 | Header Check sequence. Calculation of the header check sequence is defined in 20.3.7. |

**Table 28-13—EDMG-MCS field definition when the Number of SS field is 0**

| Subfield | Number of bits | Start bit | Description |
|---|---|---|---|
| Base MCS | 5 | 0 | Indicates the index of the modulation and coding scheme that is used to define the modulation and coding scheme of the spatial stream. |
| First Path Training | 1 | 5 | Corresponds to the TXVECTOR parameter FIRST_PATH_TRAINING. When set to 1, indicates that the TRN field appended to this PPDU is used for first path beamforming training (see 10.42.10.6). Set to 0 otherwise. This field is reserved when the EDMG TRN Length field is equal to 0. |
| Dual Polarization TRN Training | 1 | 6 | Corresponds to the TXVECTOR parameter DUAL_POL_TRAINING. If set to 1, indicates that the TRN subfields appended to this PPDU have different polarization for the same AWV (see 28.9.2.2.5). If set to 0, indicates that the TRN field appended to this PPDU does not change polarization. |
| Reserved | 14 | 7 | |

**Table 28-14—EDMG-MCS field definition when the Number of SS field is greater than 0**

<table>
<tr><th>Subfield</th><th>Number of bits</th><th>Start bit</th><th>Description</th></tr>
<tr><td>Base MCS</td><td>5</td><td>0</td><td>Indicates the lowest index of the modulation and coding scheme that is used to define the modulation and coding scheme of the spatial streams.</td></tr>
<tr><td>Differential EDMG-MCS1</td><td>2</td><td>5</td><td rowspan="8">Generated from TXVECTOR parameter EDMG_MCS.<br><br>Each Differential EDMG-MCSi subfield, 1 ≤ i ≤ 8, defines the modulation and coding scheme for spatial stream i, respectively. All spatial streams have the same code rate and repetition factor defined by the Base MCS subfield. A Differential EDMG-MCSi subfield is reserved if spatial stream i is not defined.<br><br>The rules for setting each Differential EDMG-MCS subfield are defined in Table 28-15 and Table 28-16 for the EDMG SC and the EDMG OFDM modes, respectively. Each Differential EDMG-MCS subfield indicates a possible modulation change relative to one defined by the Base MCS subfield.</td></tr>
<tr><td>Differential EDMG-MCS2</td><td>2</td><td>7</td></tr>
<tr><td>Differential EDMG-MCS3</td><td>2</td><td>9</td></tr>
<tr><td>Differential EDMG-MCS4</td><td>2</td><td>11</td></tr>
<tr><td>Differential EDMG-MCS5</td><td>2</td><td>13</td></tr>
<tr><td>Differential EDMG-MCS6</td><td>2</td><td>15</td></tr>
<tr><td>Differential EDMG-MCS7</td><td>2</td><td>17</td></tr>
<tr><td>Differential EDMG-MCS8</td><td>2</td><td>19</td></tr>
</table>

### Table 28-15—Rules for differential EDMG-MCS signaling for the EDMG SC mode

| Base MCS modulation type | Differential EDMG-MCS = 0 | Differential EDMG-MCS = 1 | Differential EDMG-MCS = 2 | Differential EDMG-MCS = 3 |
|---|---|---|---|---|
| π/2-BPSK with repetition factor 2 | π/2-BPSK | N/A | N/A | N/A |
| π/2-BPSK with repetition factor 1 | π/2-BPSK | π/2-QPSK | π/2-16-QAM | π/2-64-QAM or π/2-64-NUC |
| π/2-QPSK | π/2-QPSK | π/2-16-QAM | π/2-64-QAM or π/2-64-NUC | N/A |
| π/2-8-PSK | π/2-8-PSK | N/A | N/A | N/A |
| DCM π/2-BPSK | DCM π/2-BPSK | N/A | N/A | N/A |
| π/2-16-QAM | π/2-16-QAM | π/2-64-QAM or π/2-64-NUC | N/A | N/A |
| π/2-64-QAM | π/2-64-QAM | N/A | N/A | N/A |
| π/2-64-NUC | π/2-64-NUC | N/A | N/A | N/A |

NOTE 1—The π/2-64-QAM or π/2-64-NUC modulation type is selected based on the NUC Applied field in the EDMG-Header-A.

NOTE 2—An “N/A” entry denotes a disallowed mode of transmission.

NOTE 3—The DCM π/2-BPSK modulation type is selected by setting the Base MCS modulation type to π/2-BPSK and the DCM BPSK Applied field to 1 in the EDMG-Header-A. This type of modulation can only be applied to SU PPDUs.

### Table 28-16—Rules for differential EDMG-MCS signaling for the EDMG OFDM mode

| Base MCS modulation type | Differential EDMG-MCS = 0 | Differential EDMG-MCS = 1 | Differential EDMG-MCS = 2 | Differential EDMG-MCS = 3 |
|---|---|---|---|---|
| DCM BPSK | DCM BPSK | DCM QPSK | 16-QAM | 64-QAM |
| DCM QPSK | DCM QPSK | 16-QAM | 64-QAM | N/A |
| 16-QAM | 16-QAM | 64-QAM | N/A | N/A |
| 64-QAM | 64-QAM | N/A | N/A | N/A |

NOTE—An “N/A” entry denotes a disallowed mode of transmission.

### Table 28-17—EDMG-Header-A field structure and definition for an MU PPDU

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| SU/MU Format | 1 | 0 | See Table 28-12. |
| Channel Aggregation | 1 | 1 | See Table 28-12. |
| BW | 8 | 2 | See Table 28-12. |
| Primary Channel Number | 3 | 10 | See Table 28-12. |

**Table 28-17—EDMG-Header-A field structure and definition for an MU PPDU *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| SS Descriptor Set 0 | 9 | 13 | Describes the SS assignment to the first STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 1 | 9 | 22 | Describes the SS assignment to the second STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 2 | 9 | 31 | Describes the SS assignment to the third STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 3 | 9 | 40 | Describes the SS assignment to the fourth STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 4 | 9 | 49 | Describes the SS assignment to the fifth STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 5 | 9 | 58 | Describes the SS assignment to the sixth STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 6 | 9 | 67 | Describes the SS assignment to the seventh STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| SS Descriptor Set 7 | 9 | 76 | Describes the SS assignment to the eighth STA addressed within the MU PPDU. This field is formatted as described in Table 28-18. |
| EDMG TRN Length | 8 | 85 | See Table 28-12. |
| RX TRN-Units per Each TX TRN-Unit | 8 | 93 | See Table 28-12. |
| EDMG TRN-Unit P | 2 | 101 | See Table 28-12. |
| EDMG TRN-Unit M | 4 | 103 | See Table 28-12. |
| EDMG TRN-Unit N | 2 | 107 | See Table 28-12. |
| TRN Subfield Sequence Length | 2 | 109 | See Table 28-12. |
| Reserved | 1 | 111 | |
| CRC | 16 | 112 | Header Check sequence. Calculation of the header check sequence is defined in 20.3.7. |

The SS Descriptor Set field is defined in Table 28-18.

**Table 28-18—SS Descriptor Set field**

| | AID | Number of SS |
|---|---|---|
| Bits | 8 | 1 |

The AID subfield indicates the AID of a STA addressed by an MPDU contained within the MU PPDU and corresponds to TXVECTOR parameter MU_AID. The AID of a STA shall not appear more than once across all SS Descriptor Set fields included in the EDMG-Header-A. The SS Descriptor Set field is reserved if the value of the AID subfield is 0.

The value of the Number of SS subfield plus one indicates the number of SSs transmitted to the STA indicated by the AID subfield. This subfield value is generated from the TXVECTOR parameters NUM_STS and STBC. SSs are assigned sequentially across all STAs addressed by the MU PPDU.

### 28.3.3.3.2.4 Encoding and modulation

For an EDMG SC mode PPDU or an EDMG OFDM mode PPDU, the EDMG-Header-A field is encoded and modulated using two SC blocks of 448 chips with 64 guard symbols. The bits are scrambled and encoded as follows:

- The input 112 header bits are appended with 16 HCS bits calculated as defined in 20.3.7.
- The resulting 128 bits (including CRC) are scrambled as described in 20.3.9, starting from the first bit using a continuation of the scrambler bit sequence from the L-Header.
- The scrambled bits are divided into two parts $\mathbf{b1} = (B_1, B_2, ..., B_{64})$ and $\mathbf{b2} = (B_{65}, B_{66}, ..., B_{128})$ of 64 bits each. Each part is encoded taking the following steps:
  - For each data word $\mathbf{b} = \mathbf{b1}$ or $\mathbf{b} = \mathbf{b2}$, append 440 zero bits $\mathbf{0} = (0_1, 0_2, ..., 0_{440})$ and generate 168 parity bits $\mathbf{p} = (p_1, p_2, ..., p_{168})$ to create a codeword $\mathbf{c} = (\mathbf{b}, \mathbf{0}, \mathbf{p})$, such that $\mathbf{H} \cdot (\mathbf{c})^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 672, $R$ = 3/4 LDPC matrix defined in 20.5.3.2.3.2.
  - Remove zero-valued bits and discard (puncture) the last 8 parity bits to create a codeword $\mathbf{cs1} = (b_1, b_2, ..., b_{64}, p_1, p_2, ..., p_{160})$ of length 224 bits.
  - Remove zero-valued bits and discard (puncture) the second to last 8 parity bits to create a codeword $\mathbf{cs2} = (b_1, b_2, ..., b_{64}, p_1, p_2, ..., p_{152}, p_{161}, p_{162}, ..., p_{168})$ of length 224 bits and then XOR with a PN sequence that is generated from the LFSR used for data scrambling defined in 20.3.9. The LFSR is initialized to the all 1s vector.
  - Concatenate **cs1** and **cs2** to create the output codeword $\mathbf{cs} = (\mathbf{cs1}, \mathbf{cs2})$ of length 448 bits.
- The resulting codewords **cs** for **b1** and **b2** of 448 bits each are then modulated applying π/2-BPSK modulation as defined in 20.5.3.2.4.2. This creates two SC data blocks EDMG-Header-$A_1$ and EDMG-Header-$A_2$, respectively.
- Each of the resulting two SC data blocks is prepended with 64 guard symbols to create SC symbol blocks. The second SC data block, EDMG-Header-$A_2$, is appended with the appropriate number of guard symbols as described in 28.5.9.2.

The EDMG-Header-A encoding and modulation for an EDMG SC mode and an EDMG OFDM mode A-PPDU is defined in 28.5.7 and 28.6.7, respectively.

The EDMG-Header-A encoding and modulation for an EDMG control mode PPDU is defined in 28.4.5.

### 28.3.3.3.3 EDMG-STF definition

For EDMG SC mode PPDU transmissions, the EDMG-STF field is defined in 28.5.4. For EDMG OFDM mode PPDU transmissions, the EDMG-STF field is defined in 28.6.4. The EDMG-STF field is not present in EDMG control mode PPDUs.

#### 28.3.3.3.4 EDMG-CEF definition

For EDMG SC mode PPDU transmissions, the EDMG-CEF field is defined in 28.5.5. For EDMG OFDM mode PPDU transmissions, the EDMG-CEF field is defined in 28.6.5. The EDMG-CEF field is not present in EDMG control mode PPDUs.

#### 28.3.3.3.5 EDMG-Header-B definition

##### 28.3.3.3.5.1 General

The EDMG-Header-B is transmitted only in EDMG MU PPDUs and on a per STA basis. The EDMG-Header-B field is defined in Table 28-19.

**Table 28-19—EDMG-Header-B field structure and definition**

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| Scrambler Seed | 7 | 0 | |
| PSDU Length | 22 | 7 | Length of the PSDU field in octets in the range 1 to 4 194 303. |
| Base MCS | 5 | 29 | Generated from TXVECTOR parameter EDMG_MCS. Indicates the lowest index of the modulation and coding scheme that is used to define the modulation and coding scheme of the spatial streams. |
| Differential EDMG-MCS | 2 | 34 | Generated from TXVECTOR parameter EDMG_MCS.<br><br>The Base MCS field defines the modulation and coding scheme for the spatial stream 1.<br><br>The Differential EDMG-MCS field defines a possible modulation level change for the spatial stream 2 relative to the modulation level of spatial stream 1. The rules for setting the Differential EDMG-MCS field are defined in Table 28-15 and Table 28-16 for the EDMG SC and the EDMG OFDM modes, respectively.<br><br>All spatial streams have the same code rate defined by the Base MCS field.<br><br>If the number of spatial streams is 1 (per user), then the Differential EDMG-MCS field is reserved. |
| Superimposed Code Applied | 1 | 36 | See Table 28-12. |
| Short/Long LDPC | 1 | 37 | See Table 28-12. |
| STBC Applied | 1 | 38 | See Table 28-12. |

**Table 28-19—EDMG-Header-B field structure and definition *(continued)***

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| NUC Applied | 1 | 39 | Corresponds to the TXVECTOR parameter NUC_MOD. If this field is set to 1, π/2-64-NUC is applied at the transmitter for the MCSs indicated by the Base MCS and Differential EDMG-MCS fields, if supported. If an indicated MCS does not support π/2-64-NUC, then π/2-64-QAM uniform constellation is applied for this particular MCS.<br><br>If set to 0, π/2-64-QAM uniform constellation is applied for MCSs signaled in the Base MCS and Differential EDMG-MCS fields. |
| π/2-8-PSK Applied | 1 | 40 | See Table 28-12. |
| Spoofing Error Length Indicator | 1 | 41 | If set to 0 in an EDMG OFDM PPDU, indicates that the spoofing error, defined as the difference between the PPDU duration calculated based on L-Header and the actual PPDU duration, is smaller than $T_{OFDM\text{-}SYM}$, where $T_{OFDM\text{-}SYM} = T_{DFT} + T_{GI}$, $T_{DFT}$ is the OFDM IDFT/DFT period and $T_{GI}$ is the guard interval duration, which is determined by bits B2 and B3 of the Last RSSI field within the L-Header of the PPDU. Otherwise, if set to 1 in an EDMG OFDM PPDU, indicates that the spoofing error is greater than or equal to $T_{OFDM\text{-}SYM}$. For an EDMG SC PPDU, this field is reserved. |
| Beamformed | 1 | 42 | See Table 28-12. |
| Number of Transmit Chains | 3 | 43 | See Table 28-12. |
| Reserved | 2 | 46 | |
| CRC | 16 | 48 | Header Check sequence. Calculation of the header check sequence is defined in 20.3.7. |

The value of the Spoofing Error Length Indicator subfield within all EDMG-Header-B fields present in an EDMG MU PPDU shall be the same.

Reserved bits in the EDMG-Header-B field shall be set to 0 by the transmitter and shall be ignored by the receiver.

#### 28.3.3.3.5.2 Transmission

The encoding of EDMG-Header-B in an EDMG SC mode PPDU is specified in 28.5.6. The encoding of EDMG-Header-B in an EDMG OFDM mode PPDU is specified in 28.6.6.

### 28.3.3.4 Mathematical description of signals

#### 28.3.3.4.1 General

The transmitted signal is described in complex baseband signal notation. The actual transmitted signal in the $i_{TX}$ transmit chain is related to the complex baseband signal $r^{i_{TX}}(t)$ by the following relation:

$$r_{RF}^{i_{TX}}(t) = Re\left\{r_{PPDU}^{i_{TX}}(t)\exp\left(j2\pi f_c(t)\right)\right\}$$

where

$f_c$ is the carrier center frequency

The transmitted signal is generated by modulating the complex baseband signal, which consists of the fields defined in 28.3.2.1 and 28.3.2.2. The waveform $r_{PPDU}^{i_{TX}}(nT_c)$ is defined for various control and SC mode PPDU formats in 28.4.7.2, 28.4.7.3, 28.5.3.3.1, 28.5.3.3.2, and 28.5.3.3.3. The waveform $r_{PPDU}^{i_{TX}}(nT_s)$ is defined in 28.6.10.3 and 28.6.10.4 for OFDM mode PPDU formats.

#### 28.3.3.4.2 Channel aggregation

For a PPDU with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE, the following shall apply:

— The number of transmit chains $N_{TX}$ is even.
— The lower half $N_{TX}/2$ transmit chains (i.e., those with lower indices) are used in the primary channel for a 2.16+2.16 GHz PPDU transmission, or in the primary and secondary channels for a 4.32+4.32 GHz PPDU transmission.
— The upper half $N_{TX}/2$ transmit chains (i.e., those with higher indices) are used in the secondary channel for a 2.16+2.16 GHz PPDU transmission, or in the secondary1 and secondary2 channels for a 4.32+4.32 GHz PPDU transmission.

In this case, the transmitted signal is as follows:

$$r_{RF}^{i_{TX}}(t) = \begin{cases} Re\left\{r_{PPDU}^{i_{TX}}(t)\exp\left(j2\pi f_{c_p}(t)\right)\right\} & i_{TX} \le \dfrac{N_{TX}}{2} \\ Re\left\{r_{PPDU}^{i_{TX}}(t)\exp\left(j2\pi f_{c_s}(t)\right)\right\} & i_{TX} > \dfrac{N_{TX}}{2} \end{cases}$$

where

$f_{c_p}$ is the carrier center frequency of the primary channel for a 2.16+2.16 GHz PPDU transmission, or of the primary and secondary channels for a 4.32+4.32 GHz PPDU transmission

$f_{c_s}$ is the carrier center frequency of the secondary channel for a 2.16+2.16 GHz PPDU transmission, or of the secondary1 and secondary2 channels for a 4.32+4.32 GHz PPDU transmission

### 28.3.4 Channelization

A channel used by an EDMG STA is specified by the four PLME MIB fields defined in Table 28-20.

**Table 28-20—Parameters that specify a channel used by an EDMG STA**

| Field | Meaning |
|---|---|
| dot11EDMGCurrentChannelWidth | Channel width. Possible values represent 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz. |

**Table 28-20—Parameters that specify a channel used by an EDMG STA *(continued)***

| Field | Meaning |
|---|---|
| dot11EDMGCurrentChannelCenterFrequencyIndex0 | For a 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channel, denotes the channel center frequency.<br><br>For a 2.16+2.16 GHz channel, denotes the center frequency of the primary channel.<br><br>For a 4.32+4.32 GHz channel, denotes the center frequency of the 4.32 GHz channel containing the primary 2.16 GHz channel.<br><br>Value range is 1 to 15 (see 28.3.4). |
| dot11EDMGCurrentChannelCenterFrequencyIndex1 | For a 2.16+2.16 GHz channel, denotes the center frequency of the secondary channel.<br><br>For a 4.32+4.32 GHz channel, denotes the center frequency of the 4.32 GHz channel that contains the secondary 2.16 GHz channels only.<br><br>For a 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channel, it is undefined.<br><br>Value range is 1 to 15. |
| dot11EDMGCurrentPrimaryChannel | Denotes the location of the primary 2.16 GHz channel. Value range is 1 to 15. |

The channelization used by an EDMG STAs is shown in Figure 28-7.

An EDMG STA can use any one of the channels shown in Figure 28-7. The channel number is shown in the center of the trapezoid defining the particular channel location.

The support of the 2.16 GHz channel number 2, and the 4.32 GHz channel number 10 with channel number 2 as a primary channel is mandatory. The support of other channels is optional.

Table 28-21 defines the valid configurations for 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels. Table 28-22 defines the valid configurations for 2.16+2.16 GHz channel. Table 28-23 defines the valid configurations for 4.32+4.32 GHz channel.

An entry in Table 28-21, Table 28-22, and Table 28-23 denoted as *Idx* defines the channel index value *Idx*. The definition of the channel index and channel number is shown in Figure 28-7. The channel index is defined in the range 0 to 16 and is shown near the vertical dotted lines. The increment of the channel index by 1 corresponds to the frequency step equal to the half of channel spacing $\Delta f$ = 1.08 GHz depicted in the horizontal axis corresponding to the frequency in GHz.

The current center frequency for the channel containing the primary 2.16 GHz channel is defined as follows:

$$\textit{Channel center frequency0}\ [\text{GHz}] = (\textit{Channel starting frequency} + \Delta f) + \Delta f \times \textit{dot11EDMGCurrentChannelCenterFrequencyIndex0}$$

where
*Channel starting frequency* is given by the operating class (see Annex E)

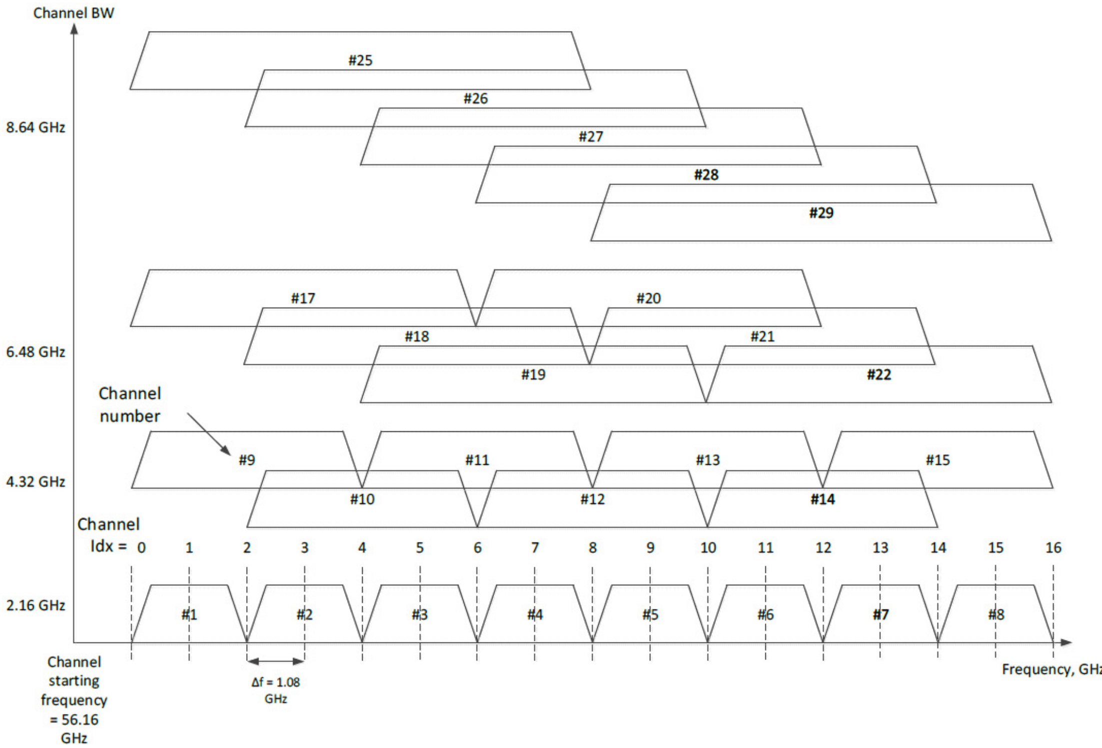


**Figure 28-7—Channelization used by EDMG STAs**

For 2.16+2.16 GHz and 4.32+4.32 GHz channel configurations, the current center frequency for the channel containing the secondary 2.16 GHz channels only is defined as follows:

*Channel center frequency1* [GHz] = (*Channel starting frequency* + *Δf*) + *Δf* × *dot11EDMGCurrentChannelCenterFrequencyIndex1*

For 4.32 GHz, 6.48 GHz, and 8.64 GHz channels, the dot11EDMGCurrentChannelCenterFrequencyIndex1 is not defined and is marked as N/A in Table 28-21.

The center frequency of the primary 2.16 GHz channel is given as follows:

*Primary 2.16 GHz channel center frequency* [GHz] = (*Channel starting frequency* + *Δf*) + *Δf* × *dot11EDMGCurrentPrimaryChannel*

The circumstances in which a channel can be used in a regulatory domain is determined by local regulatory rules and any additional rules prescribed by this standard.

**Table 28-21—2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels used by an EDMG STA**

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB…MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 1 | 10000000 | NOT_AGGREGATE | 1 | 2.16 GHz | 1 | 1 | N/A |
| 2 | 01000000 | | 2 | | 3 | 3 | |
| 3 | 00100000 | | 3 | | 5 | 5 | |
| 4 | 00010000 | | 4 | | 7 | 7 | |
| 5 | 00001000 | | 5 | | 9 | 9 | |
| 6 | 00000100 | | 6 | | 11 | 11 | |
| 7 | 00000010 | | 7 | | 13 | 13 | |
| 8 | 00000001 | | 8 | | 15 | 15 | |
| 9 | 11000000 | | 1 | 4.32 GHz | 2 | 1 | |
| 10 | | | 2 | | | 3 | |
| 11 | 01100000 | | 2 | | 4 | 3 | |
| 12 | | | 3 | | | 5 | |
| 13 | 00110000 | | 3 | | 6 | 5 | |
| 14 | | | 4 | | | 7 | |
| 15 | 00011000 | | 4 | | 8 | 7 | |
| 16 | | | 5 | | | 9 | |
| 17 | 00001100 | | 5 | | 10 | 9 | |
| 18 | | | 6 | | | 11 | |
| 19 | 00000110 | | 6 | | 12 | 11 | |
| 20 | | | 7 | | | 13 | |
| 21 | 00000011 | | 7 | | 14 | 13 | |
| 22 | | | 8 | | | 15 | |

**Table 28-21—2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB...MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 23 | 11100000 | NOT_AGGREGATE | 1 | 6.48 GHz | 3 | 1 | N/A |
| 24 | | | 2 | | | 3 | |
| 25 | | | 3 | | | 5 | |
| 26 | 01110000 | | 2 | | 5 | 3 | |
| 27 | | | 3 | | | 5 | |
| 28 | | | 4 | | | 7 | |
| 29 | 00111000 | | 3 | | 7 | 5 | |
| 30 | | | 4 | | | 7 | |
| 31 | | | 5 | | | 9 | |
| 32 | 00011100 | | 4 | | 9 | 7 | |
| 33 | | | 5 | | | 9 | |
| 34 | | | 6 | | | 11 | |
| 35 | 00001110 | | 5 | | 11 | 9 | |
| 36 | | | 6 | | | 11 | |
| 37 | | | 7 | | | 13 | |
| 38 | 00000111 | | 6 | | 13 | 11 | |
| 39 | | | 7 | | | 13 | |
| 40 | | | 8 | | | 15 | |

**Table 28-21—2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB...MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 41 | 11110000 | NOT_AGGREGATE | 1 | 8.64 GHz | 4 | 1 | N/A |
| 42 | | | 2 | | | 3 | |
| 43 | | | 3 | | | 5 | |
| 44 | | | 4 | | | 7 | |
| 45 | 01111000 | | 2 | | 6 | 3 | |
| 46 | | | 3 | | | 5 | |
| 47 | | | 4 | | | 7 | |
| 48 | | | 5 | | | 9 | |
| 49 | 00111100 | | 3 | | 8 | 5 | |
| 50 | | | 4 | | | 7 | |
| 51 | | | 5 | | | 9 | |
| 52 | | | 6 | | | 11 | |
| 53 | 00011110 | | 4 | | 10 | 7 | |
| 54 | | | 5 | | | 9 | |
| 55 | | | 6 | | | 11 | |
| 56 | | | 7 | | | 13 | |
| 57 | 00001111 | | 5 | | 12 | 9 | |
| 58 | | | 6 | | | 11 | |
| 59 | | | 7 | | | 13 | |
| 60 | | | 8 | | | 15 | |

**Table 28-22—2.16+2.16 GHz channel used by an EDMG STA**

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB...MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 61 | 11000000 | AGGREGATE | 1 | 2.16+2.16 GHz | 1 | 1 | 3 |
| 62 | 10100000 | | 1 | | | | 5 |
| 63 | 10010000 | | 1 | | | | 7 |
| 64 | 10001000 | | 1 | | | | 9 |
| 65 | 10000100 | | 1 | | | | 11 |
| 66 | 10000010 | | 1 | | | | 13 |
| 67 | 10000001 | | 1 | | | | 15 |
| 68 | 11000000 | | 2 | | 3 | 3 | 1 |
| 69 | 01100000 | | 2 | | | | 5 |
| 70 | 01010000 | | 2 | | | | 7 |
| 71 | 01001000 | | 2 | | | | 9 |
| 72 | 01000100 | | 2 | | | | 11 |
| 73 | 01000010 | | 2 | | | | 13 |
| 74 | 01000001 | | 2 | | | | 15 |
| 75 | 10100000 | | 3 | | 5 | 5 | 1 |
| 76 | 01100000 | | 3 | | | | 3 |
| 77 | 00110000 | | 3 | | | | 7 |
| 78 | 00101000 | | 3 | | | | 9 |
| 79 | 00100100 | | 3 | | | | 11 |
| 80 | 00100010 | | 3 | | | | 13 |
| 81 | 00100001 | | 3 | | | | 15 |

**Table 28-22—2.16+2.16 GHz channel used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB…MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 82 | 10010000 | AGGREGATE | 4 | 2.16+2.16 GHz *(continued)* | 7 | 7 | 1 |
| 83 | 01010000 | | 4 | | | | 3 |
| 84 | 00110000 | | 4 | | | | 5 |
| 85 | 00011000 | | 4 | | | | 9 |
| 86 | 00010100 | | 4 | | | | 11 |
| 87 | 00010010 | | 4 | | | | 13 |
| 88 | 00010001 | | 4 | | | | 15 |
| 89 | 10001000 | | 5 | | 9 | 9 | 1 |
| 90 | 01001000 | | 5 | | | | 3 |
| 91 | 00101000 | | 5 | | | | 5 |
| 92 | 00011000 | | 5 | | | | 7 |
| 93 | 00001100 | | 5 | | | | 11 |
| 94 | 00001010 | | 5 | | | | 13 |
| 95 | 00001001 | | 5 | | | | 15 |
| 96 | 10000100 | | 6 | | 11 | 11 | 1 |
| 97 | 01000100 | | 6 | | | | 3 |
| 98 | 00100100 | | 6 | | | | 5 |
| 99 | 00010100 | | 6 | | | | 7 |
| 100 | 00001100 | | 6 | | | | 9 |
| 101 | 00000110 | | 6 | | | | 13 |
| 102 | 00000011 | | 6 | | | | 15 |

**Table 28-22—2.16+2.16 GHz channel used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | **CH_BANDWIDTH [LSB…MSB]** | **CHANNEL_AGGREGATION** | **PRIMARY_CHANNEL** | **dot11 Current Channel Width** | **dot11 Current Channel Center Frequency Index0** | **dot11 Current Primary Channel** | **dot11 Current Channel Center Frequency Index1** |
| 103 | 10000010 | AGGREGATE | 7 | 2.16+2.16 GHz *(continued)* | 13 | 13 | 1 |
| 104 | 01000010 | | 7 | | | | 3 |
| 105 | 00100010 | | 7 | | | | 5 |
| 106 | 00010010 | | 7 | | | | 7 |
| 107 | 00001010 | | 7 | | | | 9 |
| 108 | 00000110 | | 7 | | | | 11 |
| 109 | 00000011 | | 7 | | | | 15 |
| 110 | 10000001 | | 8 | | 15 | 15 | 1 |
| 111 | 01000001 | | 8 | | | | 3 |
| 112 | 00100001 | | 8 | | | | 5 |
| 113 | 00010001 | | 8 | | | | 7 |
| 114 | 00001001 | | 8 | | | | 9 |
| 115 | 00000101 | | 8 | | | | 11 |
| 116 | 00000011 | | 8 | | | | 13 |

**Table 28-23—4.32+4.32 GHz channel used by an EDMG STA**

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB…MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 117 | 11110000 | AGGREGATE | 1 | 4.32+4.32 GHz | 2 | 1 | 6 |
| 118 | | | 2 | | | 3 | |
| 119 | 11011000 | | 1 | | | 1 | 8 |
| 120 | | | 2 | | | 3 | |
| 121 | 11001100 | | 1 | | | 1 | 10 |
| 122 | | | 2 | | | 3 | |
| 123 | 11000110 | | 1 | | | 1 | 12 |
| 124 | | | 2 | | | 3 | |
| 125 | 11000011 | | 1 | | | 1 | 14 |
| 126 | | | 2 | | | 3 | |
| 127 | 01111000 | | 2 | | 4 | 3 | 8 |
| 128 | | | 3 | | | 5 | |
| 129 | 01101100 | | 2 | | | 3 | 10 |
| 130 | | | 3 | | | 5 | |
| 131 | 01100110 | | 2 | | | 3 | 12 |
| 132 | | | 3 | | | 5 | |
| 133 | 01100011 | | 2 | | | 3 | 14 |
| 134 | | | 3 | | | 5 | |

**Table 28-23—4.32+4.32 GHz channel used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR CH_BANDWIDTH [LSB...MSB] | TXVECTOR CHANNEL_AGGREGATION | TXVECTOR PRIMARY_CHANNEL | PLME MIB variables (PHYCONFIG_VECTOR) dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
|---|---|---|---|---|---|---|---|
| 135 | 11110000 | AGGREGATE | 3 | 4.32+4.32 GHz *(continued)* | 6 | 5 | 2 |
| 136 | | | 4 | | | 7 | |
| 137 | 00111100 | | 3 | | | 5 | 10 |
| 138 | | | 4 | | | 7 | |
| 139 | 00110110 | | 3 | | | 5 | 12 |
| 140 | | | 4 | | | 7 | |
| 141 | 00110011 | | 3 | | | 5 | 14 |
| 142 | | | 4 | | | 7 | |
| 143 | 11011000 | | 4 | | 8 | 7 | 2 |
| 144 | | | 5 | | | 9 | |
| 145 | 01111000 | | 4 | | | 7 | 4 |
| 146 | | | 5 | | | 9 | |
| 147 | 00011110 | | 4 | | | 7 | 12 |
| 148 | | | 5 | | | 9 | |
| 149 | 00011011 | | 4 | | | 7 | 14 |
| 150 | | | 5 | | | 9 | |
| 151 | 11001100 | | 5 | | 10 | 9 | 2 |
| 152 | | | 6 | | | 11 | |
| 153 | 01101100 | | 5 | | | 9 | 4 |
| 154 | | | 6 | | | 11 | |
| 155 | 00111100 | | 5 | | | 9 | 6 |
| 156 | | | 6 | | | 11 | |
| 157 | 00001111 | | 5 | | | 9 | 14 |
| 158 | | | 6 | | | 11 | |

**Table 28-23—4.32+4.32 GHz channel used by an EDMG STA *(continued)***

| Channel configuration # | TXVECTOR | | | PLME MIB variables (PHYCONFIG_VECTOR) | | | |
|---|---|---|---|---|---|---|---|
| | CH_BANDWIDTH [LSB…MSB] | CHANNEL_AGGREGATION | PRIMARY_CHANNEL | dot11 Current Channel Width | dot11 Current Channel Center Frequency Index0 | dot11 Current Primary Channel | dot11 Current Channel Center Frequency Index1 |
| 159 | 11000110 | AGGREGATE | 6 | 4.32+4.32 GHz *(continued)* | 12 | 11 | 2 |
| 160 | | | 7 | | | 13 | |
| 161 | 01100110 | | 6 | | | 11 | 4 |
| 162 | | | 7 | | | 13 | |
| 163 | 00110110 | | 6 | | | 11 | 6 |
| 164 | | | 7 | | | 13 | |
| 165 | 00011110 | | 6 | | | 11 | 8 |
| 166 | | | 7 | | | 13 | |
| 167 | 11000011 | | 7 | | 14 | 13 | 2 |
| 168 | | | 8 | | | 15 | |
| 169 | 01100011 | | 7 | | | 13 | 4 |
| 170 | | | 8 | | | 15 | |
| 171 | 00110011 | | 7 | | | 13 | 6 |
| 172 | | | 8 | | | 15 | |
| 173 | 00011011 | | 7 | | | 13 | 8 |
| 174 | | | 8 | | | 15 | |
| 175 | 00001111 | | 7 | | | 13 | 10 |
| 176 | | | 8 | | | 15 | |

### 28.3.5 Transmit mask

NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause.

NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale.

NOTE 3—For rules regarding TX center frequency leakage levels, see 28.3.9.4. The spectral mask requirements in this subclause do not apply to the RF LO leakage and its harmonics.

An EDMG PPDU transmission shall comply with the TX masks defined in this subclause. An EDMG PPDU transmission that partially occupies a channel shall comply with the TX mask defined for the wider channel. For example, a 2.16 GHz PPDU transmission that partially occupies a 4.32 GHz channel shall not exceed the 4.32 GHz channel mask.

A 2.16 GHz PPDU of EDMG and non-EDMG format shall adhere to the transmit spectrum mask shown in Figure 20-1.

For a 4.32 GHz mask PPDU or a 2.16+2.16 GHz mask PPDU spanning adjacent channels, the transmit spectral mask shall have a 0 dBr bandwidth of 4.04 GHz, –17 dBr at 2.40 GHz frequency offset, –22 dBr at 5.40 GHz frequency offset, and –30 dBr at 6.12 GHz frequency offset and above. The transmit spectral mask for frequency offsets in between 2.02 and 2.40 GHz, 2.40 and 5.40 GHz, and 5.40 and 6.12 GHz shall be linearly interpolated in decibels from the requirements for 2.02 GHz, 2.40 GHz, 5.40 GHz, and 6.12 GHz frequency offsets. Figure 28-8 shows an example of the resulting overall spectral mask.

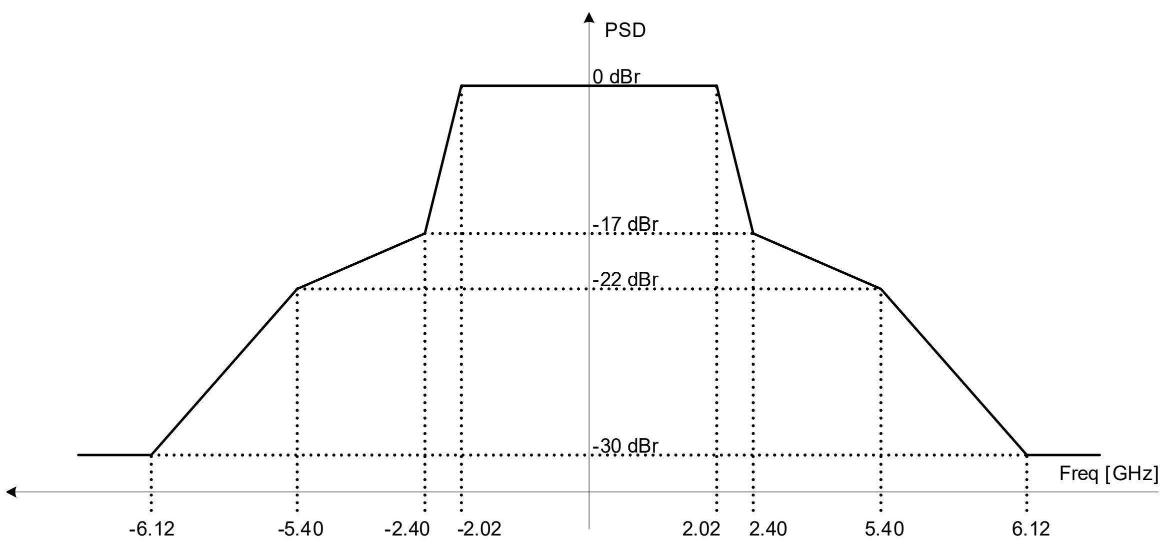


**Figure 28-8—Example transmit spectral mask for a 4.32 GHz mask PPDU**

For a 6.48 GHz mask PPDU, the transmit spectral mask shall have a 0 dBr bandwidth of 6.20 GHz, –17 dBr at 3.60 GHz frequency offset, –22 dBr at 8.10 GHz frequency offset, and –30 dBr at 9.18 GHz frequency offset and above. The transmit spectral mask for frequency offsets in between 3.10 and 3.60 GHz, 3.60 and 8.10 GHz, and 8.10 and 9.18 GHz shall be linearly interpolated in decibels from the requirements for 3.10 GHz, 3.60 GHz, 8.10 GHz, and 9.18 GHz frequency offsets. Figure 28-9 shows an example of the resulting overall spectral mask.

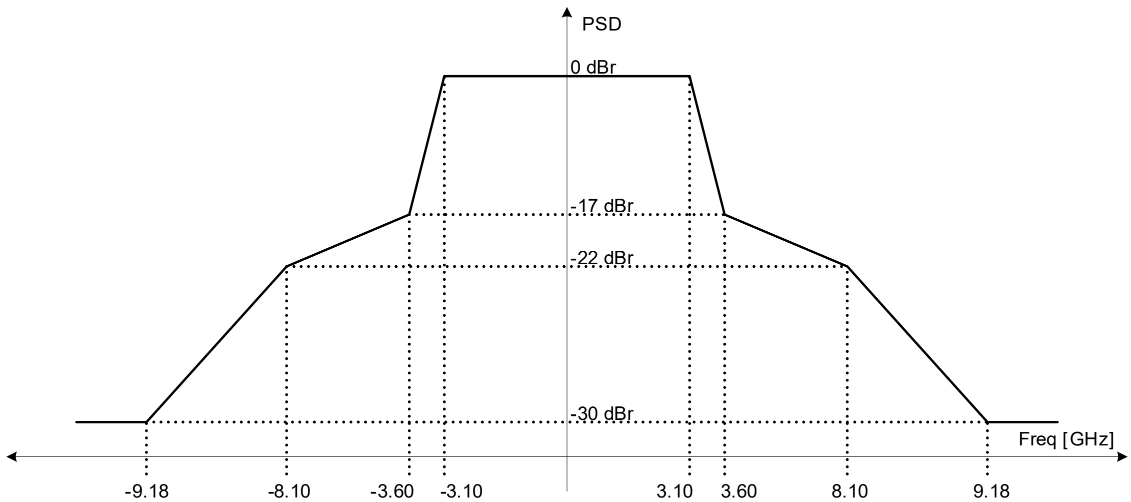


**Figure 28-9—Example transmit spectral mask for a 6.48 GHz mask PPDU**

For an 8.64 GHz mask PPDU or a 4.32+4.32 GHz mask PPDU spanning adjacent channels, the transmit spectral mask shall have a 0 dBr bandwidth of 8.36 GHz, –17 dBr at 4.80 GHz frequency offset, –22 dBr at 10.80 GHz frequency offset, and –30 dBr at 12.24 GHz frequency offset and above. The transmit spectral mask for frequency offsets in between 4.18 and 4.80 GHz, 4.80 and 10.80 GHz, and 10.80 and 12.24 GHz shall be linearly interpolated in decibels from the requirements for 4.18 GHz, 4.80 GHz, 10.80 GHz, and 12.24 GHz frequency offsets. Figure 28-10 shows an example of the resulting overall spectral mask.

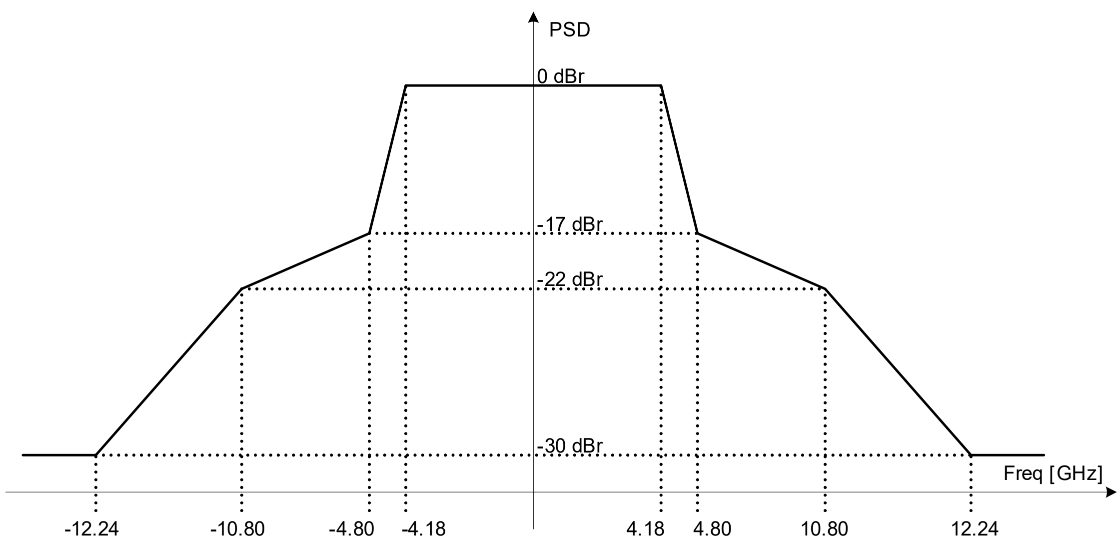


**Figure 28-10—Example transmit spectral mask for an 8.64 GHz mask PPDU**

For 2.16+2.16 GHz or 4.32+4.32 GHz mask PPDUs spanning non-adjacent channels, the overall transmit spectral mask is constructed in the following manner. First, the 2.16 (or 4.32) GHz spectral mask is placed on each of the two 2.16 (or 4.32) GHz segments. Then, for each frequency at which both of the 2.16 (or 4.32) GHz spectral masks have values greater than –30 dBr and less than –17 dBr, the sum of the two mask values (summed in power) shall be taken as the overall spectral mask value. Next, for each frequency at which neither of the two 2.16 (or 4.32) GHz masks have values greater than or equal to –17 dBr and less than or equal to 0 dBr, the higher value of the two masks shall be taken as the overall spectral value. Finally, for any frequency region where the mask value has not been defined yet, linear interpolation (in decibels) between the nearest two frequency points with the spectral mask value defined shall be used to define the spectral mask value.

Different center frequency separation between the two 2.16 GHz frequency segments of the spectral mask as well as different peak levels of each 2.16 GHz frequency segment of the spectral mask are possible, in which case a similar procedure in determining the spectral mask as in Figure 28-11 is followed.

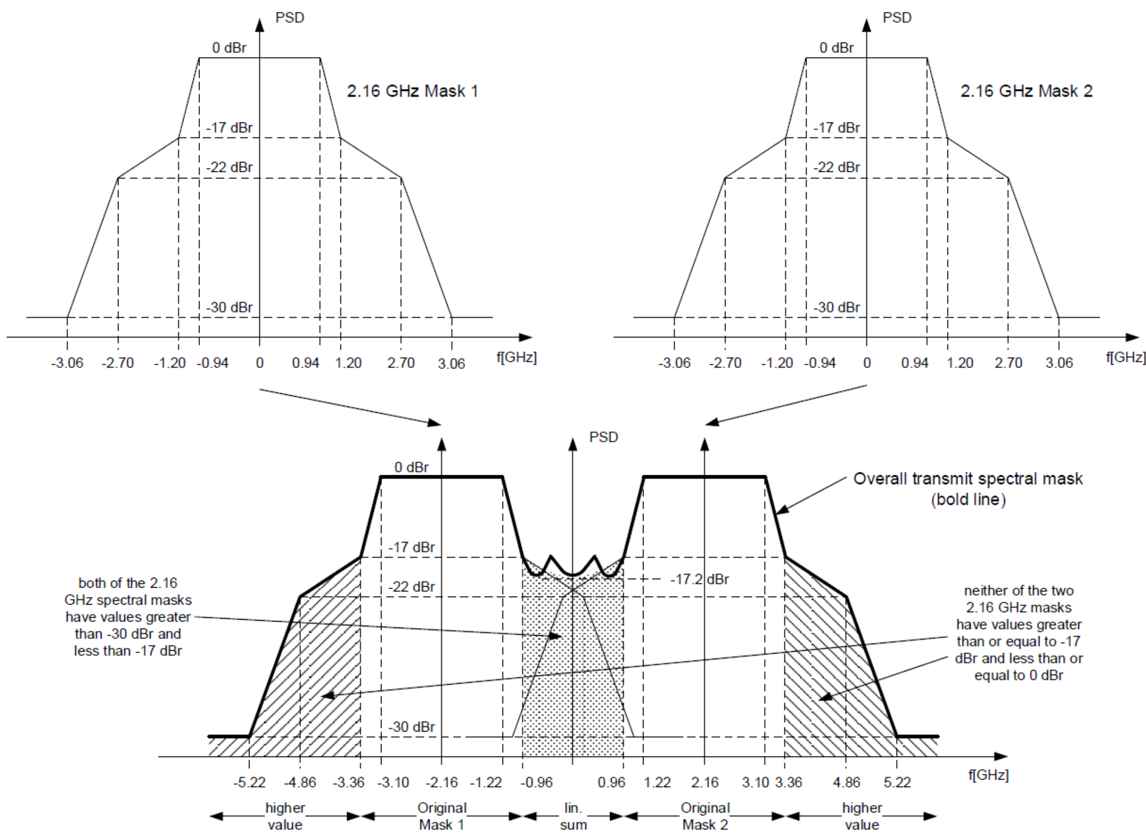


**Figure 28-11—Example transmit spectral mask for a 2.16+2.16 GHz mask PPDU**

The transmit spectral mask for noncontiguous transmissions using two nonadjacent channels is applicable only in regulatory domains that allow for such transmissions.

Measurements shall be made using a 1 MHz resolution bandwidth and a 300 kHz video bandwidth.

### 28.3.6 LDPC parity matrices

#### 28.3.6.1 General

The EDMG PHY shall support the LDPC parity matrices specified in 20.3.8 and may support the additional matrices described in this subclause.

The EDMG PHY defines an additional rate-7/8 LDPC code matrix for a codeword of size equal to 672 bits, which is the same codeword size used in the DMG PHY. The definition of this LDPC code matrix follows the approach specified in 20.3.8.

In addition, the EDMG PHY also defines an LDPC codeword of size equal to 1344 bits through the use of lifting matrices. A lifting matrix acts on the code matrix to generate a larger matrix as follows:

— A nonblank ‘0’ element in the lifting matrix acts on the $Z{\times}Z$ cyclic permutation matrix $P_i$ in the code matrix (at the same location) to create the $2Z{\times}2Z$ matrix:

$$\begin{array}{|c|c|}\hline i & \\ \hline & i \\ \hline\end{array}$$

— A nonblank ‘1’ element in the lifting matrix acts on the $Z{\times}Z$ cyclic permutation matrix $P_i$ in the code matrix (at the same location) to create the $2Z{\times}2Z$ matrix:

$$\begin{array}{|c|c|}\hline & i \\ \hline i & \\ \hline\end{array}$$

— A blank entry in the lifting matrix acts on the blank entry in the code matrix representing the $Z{\times}Z$ zero matrix (at the same location) to create the blank entry representing the $2Z{\times}2Z$ zero matrix:

$$\begin{array}{|c|c|}\hline \phantom{i} & \phantom{i} \\ \hline \phantom{i} & \phantom{i} \\ \hline\end{array}$$

NOTE—Each element $i$ in the matrices represents the cyclic permutation matrix $P_i$, and a blank entry represents the zero matrix of size $Z{\times}Z$. The cyclic permutation matrix $P_i$ is defined in 20.3.8.

#### 28.3.6.2 Rate-7/8 LDPC code matrix H = 84 rows x 672 columns, $Z$ = 42

The rate-7/8 LDPC code matrix with codeword length 672 is defined in Table 28-24. It is derived using the rate-3/4 LDPC code matrix specified in Table 20-8 by rows 1 and 3, 2 and 4 modulo-2 addition of the original rate-3/4 LDPC matrix.

**Table 28-24—Rate 7/8 LDPC code matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37⊕35 | 31⊕19 | 18⊕41 | 23⊕22 | 11⊕40 | 21⊕41 | 6⊕39 | 20⊕6 | 32⊕28 | 9⊕18 | 12⊕17 | 29⊕3 | 28 | 0 | 13 | |
| 25⊕29 | 22⊕30 | 4⊕0 | 34⊕8 | 31⊕33 | 3⊕22 | 14⊕17 | 15⊕4 | 4⊕27 | 28 | 14⊕20 | 18⊕27 | 13⊕24 | 13⊕23 | 22 | 24 |

NOTE—Each nonblank element $i$ or $i \oplus j$ is the cyclic permutation matrix $P_i$ of size $Z{\times}Z$ or the modulo-2 addition of the cyclic permutation matrices $P_i$ and $P_j$ of size $Z{\times}Z$ (denoted by $P_i \oplus P_j$), respectively; blank entries represent the zero matrix of size $Z{\times}Z$.

### 28.3.6.3 Rate-1/2 LDPC code matrix H = 672 rows x 1344 columns, *Z* = 42

The rate-1/2 LDPC code matrix with codeword length 1344 is defined in Table 28-25. It is derived using rate-1/2 LDPC code matrix specified in Table 20-6 by application of the lifting matrix specified in Table 28-26.

**Table 28-25—Rate-1/2 LDPC code matrix**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | | | | 38 | | | 13 | | | | | 5 | | | 18 | | | | | | | | | | | | | | | |
| | 40 | | | 38 | | | | | 13 | | | 5 | | | | | 18 | | | | | | | | | | | | | | |
| 34 | | | | 35 | | | | | 27 | | | | | | 30 | 2 | | 1 | | | | | | | | | | | | | |
| | 34 | | | | 35 | | | 27 | | | | | | 30 | | | 2 | | 1 | | | | | | | | | | | | |
| | | 36 | | | | | 31 | | | 7 | | | | | 34 | | | | 10 | 41 | | | | | | | | | | | |
| | | | 36 | | | 31 | | | | | 7 | | | 34 | | | | 10 | | | 41 | | | | | | | | | | |
| | | | 27 | | | | 18 | | | | 12 | 20 | | | | | | | | 15 | | 6 | | | | | | | | | |
| | | 27 | | | | 18 | | | | 12 | | | 20 | | | | | | | | 15 | | 6 | | | | | | | | |
| 35 | | | | | 41 | | | | 40 | | | 39 | | | | 28 | | | | | | | 3 | 28 | | | | | | | |
| | 35 | | | 41 | | | | 40 | | | | | 39 | | | | 28 | | | | | 3 | | | 28 | | | | | | |
| | 29 | | | | 0 | | | | | | 22 | | | 4 | | | | | 28 | | | | 27 | | | 23 | | | | | |
| 29 | | | | 0 | | | | | | 22 | | | | | 4 | | | 28 | | | | 27 | | | | | 23 | | | | |
| | | 31 | | | | 23 | | | | | 21 | | | 20 | | | | | | 12 | | | | | | | 0 | 13 | | | |
| | | | 31 | | | | 23 | | | 21 | | | | | 20 | | | | | | 12 | | | | | 0 | | | 13 | | |
| | | 22 | | | | | 34 | 31 | | | | 14 | | | | 4 | | | | | | | | | 13 | | | 22 | | 24 | |
| | | | 22 | | | 34 | | | 31 | | | | 14 | | | | 4 | | | | | | | 13 | | | | | 22 | | 24 |

NOTE—Each nonblank element *i* in the table is the cyclic permutation matrix $P_i$ of size $Z \times Z$; blank entries represent the zero matrix of size $Z \times Z$.

**Table 28-26—Rate-1/2 lifting matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 1 | | 0 | | 1 | | 0 | | | | | | | |
| 0 | | 0 | | 1 | | | 1 | 0 | 0 | | | | | | |
| | 0 | | 1 | | 0 | | 1 | | 1 | 0 | | | | | |
| | 1 | | 1 | | 1 | 0 | | | | 0 | 0 | | | | |
| 0 | | 1 | | 1 | | 0 | | 0 | | | 1 | 0 | | | |
| 1 | | 1 | | | 1 | | 0 | | 1 | | 1 | | 0 | | |
| | 0 | | 0 | | 1 | | 0 | | | 0 | | | 1 | 0 | |
| | 0 | | 1 | 0 | | 0 | | 0 | | | | 1 | | 0 | 0 |

### 28.3.6.4 Rate-5/8 LDPC code matrix H = 504 rows x 1344 columns, *Z* = 42

The rate-5/8 LDPC code matrix with codeword length 1344 is defined in Table 28-27. It is derived using rate-5/8 LDPC code matrix specified in Table 20-7 by application of the lifting matrix specified in Table 28-28.

**Table 28-27—Rate-5/8 LDPC code matrix**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | | 36 | | | 34 | | 31 | 20 | | 7 | | | 41 | | 34 | | | | 10 | 41 | | | | | | | | | | | |
| | 20 | | 36 | 34 | | 31 | | | 20 | | 7 | 41 | | 34 | | | | 10 | | | 41 | | | | | | | | | | |
| 30 | | | 27 | | | | 18 | | | | 12 | 20 | | 14 | | | 2 | | 25 | 15 | | 6 | | | | | | | | | |
| | 30 | 27 | | | | 18 | | | | 12 | | | 20 | | 14 | 2 | | 25 | | | 15 | | 6 | | | | | | | | |
| 35 | | | | | 41 | | | | 40 | | | 39 | | | | 28 | | | | | | | 3 | 28 | | | | | | | |
| | 35 | | | 41 | | | | 40 | | | | | 39 | | | | 28 | | | | | 3 | | | 28 | | | | | | |
| | 29 | | | | 0 | | | | | | 22 | | | 4 | | | | | 28 | | | | 27 | | 24 | 23 | | | | | |
| 29 | | | | 0 | | | | | | 22 | | | | | 4 | | | 28 | | | | 27 | | 24 | | | 23 | | | | |
| | | 31 | | | | 23 | | | | | 21 | | | 20 | | | | 9 | | 12 | | | | | | | 0 | 13 | | | |
| | | | 31 | | | | 23 | | | 21 | | | | | 20 | | | | 9 | | 12 | | | | | 0 | | | 13 | | |
| | | 22 | | | | | 34 | 31 | | | | 14 | | | | 4 | | | | | | | | | | | | 22 | | 24 | |
| | | | 22 | | | 34 | | | 31 | | | | 14 | | | | 4 | | | | | | | | | | | | 22 | | 24 |

NOTE—Each nonblank element *i* in the table is the cyclic permutation matrix $P_i$ of size $Z×Z$; blank entries represent the zero matrix of size $Z×Z$.

**Table 28-28—Rate-5/8 lifting matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | | 1 | 0 | | | | | |
| 0 | 1 | | 1 | | 1 | 0 | 0 | 1 | 1 | 0 | 0 | | | | |
| 0 | | 1 | | 1 | | 0 | | 0 | | | 1 | 0 | | | |
| 1 | | 1 | | | 1 | | 0 | | 1 | | 1 | 1 | 0 | | |
| | 0 | | 0 | | 1 | | 0 | | 0 | 0 | | | 1 | 0 | |
| | 0 | | 1 | 0 | | 0 | | 0 | | | | | | 0 | 0 |

### 28.3.6.5 Rate-3/4 LDPC code matrix H = 336 rows x 1344 columns, *Z* = 42

The rate-3/4 LDPC code matrix with codeword length 1344 is defined in Table 28-29. It is derived using rate-3/4 LDPC code matrix specified in Table 20-8 by application of the lifting matrix specified in Table 28-30.

**Table 28-29—Rate-3/4 LDPC code matrix**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | | 19 | | | 41 | | 22 | | 40 | 41 | | 39 | | | 6 | 28 | | 18 | | | 17 | | 3 | 28 | | | | | | | |
| | 35 | | 19 | 41 | | 22 | | 40 | | | 41 | | 39 | 6 | | | 28 | | 18 | 17 | | 3 | | | 28 | | | | | | |
| | 29 | 30 | | | 0 | | 8 | | 33 | | 22 | 17 | | 4 | | | 27 | | 28 | 20 | | | 27 | | 24 | 23 | | | | | |
| 29 | | | 30 | 0 | | 8 | | 33 | | 22 | | | 17 | | 4 | 27 | | 28 | | | 20 | 27 | | 24 | | | 23 | | | | |
| 37 | | 31 | | 18 | | 23 | | 11 | | | 21 | 6 | | 20 | | 32 | | 9 | | 12 | | | 29 | | | | 0 | 13 | | | |
| | 37 | | 31 | | 18 | | 23 | | 11 | 21 | | | 6 | | 20 | | 32 | | 9 | | 12 | 29 | | | | 0 | | | 13 | | |
| | 25 | 22 | | | 4 | | 34 | 31 | | | 3 | 14 | | | 15 | 4 | | | | | 14 | 18 | | | 13 | 13 | | 22 | | 24 | |
| 25 | | | 22 | 4 | | 34 | | | 31 | 3 | | | 14 | 15 | | | 4 | | | 14 | | | 18 | 13 | | | 13 | | 22 | | 24 |

NOTE—Each nonblank element $i$ in the table is the cyclic permutation matrix $P_i$ of size $Z \times Z$; blank entries represent the zero matrix of size $Z \times Z$.

**Table 28-30—Rate-3/4 lifting matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | | | |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | | 1 | 0 | |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | | 1 | 0 | 1 | 0 | 0 | 0 |

### 28.3.6.6 Rate-13/16 LDPC code matrix H = 252 rows x 1344 columns, $Z$ = 42

The rate-13/16 LDPC code matrix with codeword length 1344 is defined in Table 28-31. It is derived using rate-13/16 LDPC code matrix specified in Table 20-9 by application of the lifting matrix specified in Table 28-32.

**Table 28-31—Rate-13/16 LDPC code matrix**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 29 | 30 | | | 0 | | 8 | | 33 | | 22 | 17 | | 4 | | | 27 | | 28 | 20 | | | 27 | | 24 | 23 | | | | | |
| 29 | | | 30 | 0 | | 8 | | 33 | | 22 | | | 17 | | 4 | 27 | | 28 | | | 20 | 27 | | 24 | | | 23 | | | | |
| 37 | | 31 | | 18 | | 23 | | 11 | | | 21 | 6 | | 20 | | 32 | | 9 | | 12 | | | 29 | | 10 | | 0 | 13 | | | |
| | 37 | | 31 | | 18 | | 23 | | 11 | 21 | | | 6 | | 20 | | 32 | | 9 | | 12 | 29 | | 10 | | 0 | | | 13 | | |
| | 25 | 22 | | | 4 | | 34 | 31 | | | 3 | 14 | | | 15 | 4 | | 2 | | | 14 | 18 | | | 13 | 13 | | 22 | | 24 | |
| 25 | | | 22 | 4 | | 34 | | | 31 | 3 | | | 14 | 15 | | | 4 | | 2 | 14 | | | 18 | 13 | | | 13 | | 22 | | 24 |

NOTE—Each nonblank element $i$ in the table is the cyclic permutation matrix $P_i$ of size $Z \times Z$; blank entries represent the zero matrix of size $Z \times Z$.

**Table 28-32—Rate-13/16 lifting matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | | |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

### 28.3.6.7 Rate-7/8 LDPC code matrix H = 168 rows x 1344 columns, *Z* = 42

The rate-7/8 LDPC code matrix with codeword length 1344 is defined in Table 28-33. This code matrix is derived using rate-3/4 LDPC code matrix specified in Table 20-8 by applying two steps. In the first step, the lifting matrix in Table 28-34 is applied to the rate-3/4 LDPC code matrix. In the second step, rows 1 and 5, 2 and 6, 3 and 7, and 4 and 8 modulo-2 addition of the lifted matrix is performed to produce the resulting rate-7/8 LDPC code matrix specified in Table 28-33.

**Table 28-33—Rate-7/8 LDPC code matrix**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 35 | 31 | 19 | 41 | 18 | 22 | 23 | 40 | 11 | 41 | 21 | 39 | 6 | 20 | 6 | 32 | 28 | 18 | 9 | 12 | 17 | 3 | 29 | 28 | | 0 | | | 13 | | |
| 35 | 37 | 19 | 31 | 18 | 41 | 23 | 22 | 11 | 40 | 21 | 41 | 6 | 39 | 6 | 20 | 28 | 32 | 9 | 18 | 17 | 12 | 29 | 3 | | 28 | | 0 | 13 | | | |
| 25 | 29 | 30 | 22 | 0 | 4 | 34 | 8 | 31 | 33 | 3 | 22 | 14 | 17 | 15 | 4 | 4 | 27 | | 28 | 14 | 20 | 27 | 18 | 13 | 24 | 13 | 23 | 22 | | 24 | |
| 29 | 25 | 22 | 30 | 4 | 0 | 8 | 34 | 33 | 31 | 22 | 3 | 17 | 14 | 4 | 15 | 27 | 4 | 28 | | 20 | 14 | 18 | 27 | 24 | 13 | 23 | 13 | | 22 | | 24 |

NOTE—Each nonblank element *i* in the table is the cyclic permutation matrix $P_i$ of size $Z \times Z$; blank entries represent the zero matrix of size $Z \times Z$.

**Table 28-34—Rate-7/8 lifting matrix**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | | | |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | | |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | | 0 | 1 | |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | 0 |

### 28.3.7 Control trailer

If the TXVECTOR parameter SCRAMBLER_INIT_SETTING is set to CONTROL_TRAILER for a non-EDMG control mode PPDU, a control trailer shall be inserted in the PPDU immediately following the Data field of the PPDU. The control trailer is one LDPC codeword with 18 data octets and 21 parity octets. The control trailer is added after the Data field of a non-EDMG control mode PPDU, using and continuing the control mode modulation and encoding. The scrambler is used to generate the control trailer and its initial state is the final state of the scrambler from the Data field of the PPDU.

To indicate the presence of a control trailer in a non-EDMG control mode PPDU, the Scrambler Initialization field in the L-Header shall be set as indicated in Table 28-5 and the value of the Training Length field in the L-Header shall be incremented by 2 to account for the presence of the control trailer. If the value of the Training Length field is equal to 2, the control trailer takes the place of the AGC and TRN fields following the Data field. If the value of the Training Length field is greater than 2, the AGC and TRN fields are appended after the control trailer.

The format of the control trailer depends on the value of the TXVECTOR parameter CT_TYPE. Each control trailer starts with a CT Format Type field, whose value depends on the value of the CT_TYPE parameter as shown in Table 28-35. Table 28-36 defines the control trailer format when the CT_TYPE parameter is equal to CTS_DTS. Table 28-37 defines the control trailer format when the CT_TYPE parameter is equal to GRANT_RTS_CTS2self. Table 28-38 defines the control trailer format when the CT_TYPE parameter is equal to SPR. Table 28-39 defines the control trailer format when the CT_TYPE parameter is equal to SSW_FEEDBACK, BLOCK_ACK or ACK.

### Table 28-35—CT Format Type field value

| CT_TYPE parameter value | CT Format Type field value |
|---|---|
| CTS_DTS | 0 |
| GRANT_RTS_CTS2self | 1 |
| SPR | 2 |
| SSW_FEEDBACK, BLOCK_ACK or ACK | 3 |
| Reserved | 4–15 |

### Table 28-36—Control trailer definition when CT_TYPE is CTS_DTS

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| CT Format Type | 4 | 0 | Indicates the format of the control trailer. This field takes the value defined in Table 28-35 for CT_TYPE = CTS_DTS. |
| Channel Aggregation | 1 | 4 | See Table 28-12. |
| BW | 8 | 5 | See Table 28-12. |
| Primary Channel Number | 3 | 13 | See Table 28-12. |
| SISO/MIMO | 1 | 16 | Corresponds to the TXVECTOR parameter NEXT_TX_SISO. Set to 0 to indicate that the following transmission from this STA is performed with a single antenna. Set to 1 to indicate that the following transmission from this STA is performed with multiple antennas. |
| SU/MU MIMO | 1 | 17 | Corresponds to the TXVECTOR parameter MU_MIMO_NEXT. Set to 0 to indicate SU-MIMO, and set to 1 to indicate MU-MIMO. Reserved when the SISO/MIMO field is set to 0. |
| EDMG Group ID | 8 | 18 | Corresponds to the TXVECTOR parameter EDMG_GROUP_ID. This field indicates the group of STAs that are involved in the following MU-MIMO transmission. Reserved when the SU/MU MIMO field is set to 0. |
| TX Sector Combination Index | 6 | 26 | Indicates the TX sector combination (as defined in 9.4.2.268) and the corresponding RX AWVs to be used in the SU-MIMO transmission from the EDMG STA transmitting the CTS to the EDMG STA that transmitted the RTS. Reserved if the SISO/MIMO field is set to 0, if the SU/MU MIMO field is set to 1 or if the control trailer is sent with a DMG DTS frame. |
| HBF | 1 | 32 | Corresponds to the TXVECTOR parameter HBF_TRAINING. Set to 0 to indicate that the following transmission from this STA is not hybrid beamforming training. Set to 1 to indicate that the following transmission from this STA is hybrid beamforming training. Reserved when the SISO/MIMO field is 0. |
| Reserved | 95 | 33 | Set to 0 by the transmitter and ignored by the receiver. |
| CTCS | 16 | 128 | Control Trailer Check Sequence (CTCS) is a CRC-16 computed over the content of the control trailer. The CRC-16 is computed as defined in 20.3.7. |

### Table 28-37—Control trailer definition when CT_TYPE is GRANT_RTS_CTS2self

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| CT Format Type | 4 | 0 | Indicates the format of the control trailer. This field takes the value defined in Table 28-35 for CT_TYPE = GRANT_RTS_CTS2self. |
| Channel Aggregation | 1 | 4 | See Table 28-12. |
| BW | 8 | 5 | See Table 28-12. |
| Primary Channel Number | 3 | 13 | See Table 28-12. |
| SISO/MIMO | 1 | 16 | See Table 28-36. |
| SU/MU MIMO | 1 | 17 | See Table 28-36. |
| TX Sector Combination Index | 6 | 18 | Indicates the TX sector combination (as defined in 9.4.2.268) and the corresponding RX AWVs to be used in the following SU-MIMO transmission. Reserved if the SISO/MIMO field is 0 or the SU/MU MIMO field is 1. |
| EDMG Group ID | 8 | 24 | See Table 28-36. |
| MU-MIMO Transmission Configuration Type | 1 | 32 | Corresponds to the TXVECTOR parameter MU_MIMO_TX_CONFIG_TYPE. Set to 1 to indicate that the MU-MIMO transmission configuration was obtained from the reciprocal MU-MIMO BF training; set to 0 to indicate that the MU-MIMO transmission configuration was obtained from the nonreciprocal MU-MIMO BF training. Reserved if the SISO/MIMO field is 0 or the SU/MU MIMO field is 0. |
| MU-MIMO Transmission Configuration Index | 3 | 33 | Corresponds to the TXVECTOR parameter MU_MIMO_TX_CONFIG_INDEX. Indicates the MU-MIMO transmission configuration (as defined in 9.4.2.276) to be used in the following MU-MIMO transmission. Reserved if the SISO/MIMO field is 0 or the SU/MU MIMO field is 0. |
| Total Number of Sectors MSB | 4 | 36 | This field is prepended to the Total Number of Sectors subfield in the BF Control field to form a single 11-bit field indicating the total number of sectors the initiator or the responder uses during an SLS. This field is reserved and set to 0 when the PPDU does not carry a Grant or Grant Ack frame with the Beamforming Training field equal to 1. |
| Number of RX DMG Antennas MSB | 1 | 40 | This field is prepended to the Number of RX DMG Antennas subfield in the BF Control field to form a single 3-bit field indicating the total number of repetitions of the TXSS that the initiator or the responder uses during the SLS. This field is reserved and set to 0 when the PPDU does not carry a Grant or Grant Ack frame with the Beamforming Training field equal to 1. |
| HBF | 1 | 41 | See Table 28-36. |
| Reserved | 86 | 42 | Set to 0 by the transmitter and ignored by the receiver. |
| CTCS | 16 | 128 | Control Trailer Check Sequence (CTCS) is a CRC-16 computed over the content of the control trailer. The CRC-16 is computed as defined in 20.3.7. |

### Table 28-38—Control trailer definition when CT_TYPE is SPR

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| CT Format Type | 4 | 0 | Indicates the format of the control trailer. This field takes the value defined in Table 28-35 for CT_TYPE = SPR. |
| Channel Aggregation | 1 | 4 | See Table 28-12. |
| BW | 8 | 5 | Corresponds to the TXVECTOR parameter BW_IN_CT. Indicates the requested channel width or channel number of the allocation.<br><br>If the Is Channel Number field is set to 1, the BW field indicates the requested channel number for the allocation per the channel numbers defined in Annex E.<br><br>If the Is Channel Number field is set to 0, the BW field indicates a channel width using the bitmap format of the BW field defined in Table 28-12. In this case, the channel width can be allocated on any channel number. |
| Primary Channel Number | 3 | 13 | See Table 28-12. |
| Is Channel Number | 1 | 16 | Corresponds to the TXVECTOR parameter IS_CHANNEL_NUMBER. Indicates whether the value in the BW subfield represents a channel width or a channel number (see 11.4.13.3). |
| Total Number of Sectors | 11 | 17 | Corresponds to the TXVECTOR parameter NUM_SECTORS. This field indicates the total number of sectors the initiator or the unsolicited RSS responder uses during an SLS. This field is reserved and set to 0 when the PPDU does not carry an SPR frame with the Beamforming Training field equal to 1. |
| Number of RX DMG Antennas | 3 | 28 | Corresponds to the TXVECTOR parameter NUM_ANT. This field indicates the total number of repetitions of the TXSS that the responder uses during the SLS. This field is reserved and set to 0 when the PPDU does not carry an SPR frame with the Beamforming Training field equal to 1. |
| Reserved | 97 | 31 | Set to 0 by the transmitter and ignored by the receiver. |
| CTCS | 16 | 128 | Control Trailer Check Sequence (CTCS) is a CRC-16 computed over the content of the control trailer. The CRC-16 is computed as defined in 20.3.7. |

**Table 28-39—Control trailer definition when CT_TYPE is SSW_FEEDBACK, BLOCK_ACK, or ACK**

| Field | Number of bits | Start bit | Description |
|---|---|---|---|
| CT Format Type | 4 | 0 | Indicates the format of the control trailer. This field takes the value defined in Table 28-35 for CT_TYPE = SSW_FEEDBACK, BLOCK_ACK or ACK. |
| Number of reported Streams | 3 | 4 | Indicates the total number of reported streams minus one. This value should match the Number of SS field in the PHY header of the PPDU to which this Control frame is responding. |
| Stream 1 SNR | 4 | 7 | Range 0 to 30 dB in 2 dB steps. |
| Stream 1 RSSI | 3 | 11 | Range –70 dBm to –42 dBm in 4 dB steps. |
| Stream 2 SNR | 4 | 14 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 2 RSSI | 3 | 18 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 3 SNR | 4 | 21 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 3 RSSI | 3 | 25 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 4 SNR | 4 | 28 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 4 RSSI | 3 | 32 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 5 SNR | 4 | 35 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 5 RSSI | 3 | 39 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 6 SNR | 4 | 42 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 6 RSSI | 3 | 46 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 7 SNR | 4 | 49 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 7 RSSI | 3 | 53 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Stream 8 SNR | 4 | 56 | Range 0 to 30 dB in 2 dB steps.<br>If unused, these bits are reserved. |
| Stream 8 RSSI | 3 | 60 | Range –70 dBm to –42 dBm in 4 dB steps.<br>If unused, these bits are reserved. |
| Reserved | 65 | 63 | Set to 0 by the transmitter and ignored by the receiver. |
| CTCS | 16 | 128 | Contains the CRC-16 computed over the content of the control trailer. This field is computed as defined in 20.3.7. |

### 28.3.8 CCA sensitivity

The start of a valid 2.16 GHz EDMG PPDU and of a valid 2.16 GHz non-EDMG PPDU at a receive power level greater than the minimum sensitivity for a 2.16 GHz SC PPDU using MCS 1 shall cause the receiver to issue a PHY-CCA.indication(BUSY) primitive with a probability > 90% within aCCAtime. The PHY-CCA.indication(BUSY) primitive shall be maintained for the duration of the PPDU. The receiver shall issue the PHY-CCA.indication(BUSY) primitive for any signal 20 dB above the minimum sensitivity for a 2.16 GHz PPDU using SC MCS 1 for at least aDMGCCAEDDetectTime.

For a receiver using a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel, the start of a valid EDMG PPDU and of a valid non-EDMG PPDU at a receive power level greater than the minimum sensitivity for a 2.16 GHz SC PPDU using MCS 1 at the primary channel shall cause the receiver to issue a PHY-CCA.indication(BUSY) primitive with a probability > 90% within aCCAtime. The PHY-CCA.indication(BUSY) primitive shall be maintained for the duration of the PPDU. The receiver shall issue the PHY-CCA.indication(BUSY, primary/secondary/secondary1/secondary2) primitive for any signal 20 dB above the minimum sensitivity for a 2.16 GHz PPDU using SC MCS 1 at any of the channels (primary/secondary/secondary1/secondary2) the receiver is open to receive in for at least aDMGCCAEDDetectTime.

A receiver that has more than one active RX chain shall issue PHY-CCA.indication(BUSY, RX-Antenna-ID, primary/secondary/secondary1/secondary2) primitive if the condition above applies to any DMG antenna connected to an active receive chain.

### 28.3.9 Common requirements

#### 28.3.9.1 Introduction

This subclause describes common requirement to all EDMG and non-EDMG modes, specifically EDMG and non-EDMG control mode, EDMG and non-EDMG SC mode, and EDMG OFDM mode.

#### 28.3.9.2 Received channel power indicator (RCPI) measurement

The RCPI is a measure of the received RF power (in dBm) in the selected channel as measured at the DMG antenna output, including the antenna gain that is used to receive the PPDU. This parameter shall be measured by the PHY over the preamble of a received PPDU, that is, L-STF or L-CEF, or both, or, if present, EDMG-STF or EDMG-CEF. The measurement shall be done over the same bandwidth as the PSDU of the PPDU. When multiple RF chains are used to receive the PPDU, RCPI is measured per each RF chain.

The RCPI encoding is defined in 9.4.2.37.

The RCPI for each RF chain shall be equal to the received RF power at each RF chain with an accuracy of ± 5 dB with 95% confidence interval within the specified dynamic range of the receiver. The received RF power at each RF chain shall be determined assuming a receiver noise equivalent bandwidth equal to the channel width multiplied by 1.1. The relative error between RCPI measurements made per RF chain within a 1 second interval should be less than ± 1 dB.

#### 28.3.9.3 Transmit center frequency and symbol clock frequency tolerance

The requirements defined in 20.3.3.2 for the center frequency tolerance and center frequency convergence and in 20.3.3.3 for the symbol clock tolerance apply for all EDMG and non-EDMG modes. The transmit center frequency and the symbol clock frequency for all transmit chains and channels shall be derived from the same reference oscillator. Transmit signals with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE may be generated using two separate RF LOs, one for each channel, with the constraint that all RF LOs shall be locked to a common source.

#### 28.3.9.4 Transmit center frequency leakage

The transmit center frequency leakage is specified per transmit chain.

For transmissions with TXVECTOR parameter CHANNEL_AGGREGATION set to NOT_AGGREGATE, the transmitter center frequency leakage shall not exceed –23 dB relative to the transmit power per transmit chain regardless of the relationship between the RF LO and center of the transmitted PPDU BW. Equivalently, for the EDMG OFDM mode, the transmitter center frequency leakage shall not exceed $\left(P+2.5-10\log_{10}\left(N_{SD}+N_{SP}\right)\right)$ measured over a subcarrier spacing bandwidth regardless of the relationship between the RF LO and center of the transmitted PPDU bandwidth, where $P$ is the transmit power per transmit chain in dBm and $N_{SD}$ and $N_{SP}$ are defined in Table 28-62.

For transmissions with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE, the transmitter center frequency leakage shall meet the following requirements for all EDMG and non-EDMG formats:

- When the RF LO falls within one of the two frequency segments, the transmitter center frequency leakage requirement is the same as the one for transmissions with TXVECTOR parameter CHANNEL_AGGREGATION set to NOT_AGGREGATE.
- When the RF LO falls outside both frequency segments, the RF LO shall follow the spectral mask requirements as defined in 28.3.5.

#### 28.3.9.5 Transmit rampup and rampdown

The requirements defined in 20.3.3.5 for transmit power on ramp and power down ramp apply for all EDMG and non-EDMG modes.

#### 28.3.9.6 Antenna setting

Antenna setting shall remain constant for the transmission of the entire PPDU, except for the case of transmission of EDMG BRP-TX PPDUs, EDMG BRP-RX/TX PPDUs and, when transmitted during a SISO BRP TXSS (see 10.42.10.5), EDMG BRP-RX PPDUs. In these cases, the antenna setting shall remain constant for the transmission of all fields up to the TRN field. The transmission of the TRN field is defined in 28.9.2.2.5.

#### 28.3.9.7 Maximum input requirement

The requirement defined in 20.3.3.7 for the receiver maximum input level apply for all EDMG and non-EDMG modes.

#### 28.3.9.8 Receiver minimum input sensitivity

For the EDMG control mode and non-EDMG control mode, the PER shall be less than 5% for a PSDU length of 256 octets and with the input level listed in Table 28-40 defined at the antenna connector(s). If the TXVECTOR parameter NON_EDMG_MODULATION is set to NON_EDMG_DUP_SC_MODE, the minimum sensitivity listed in Table 28-40 shall be met in the reception of each 2.16 GHz channel.

For the non-EDMG SC mode, EDMG SC mode, and EDMG OFDM mode, the PER shall be less than 1% for a PSDU length of 4096 octets with the MCS and mode dependent input levels listed in Table 28-41 through Table 28-45 defined at the antenna connector(s).

When an EDMG STA has multiple DMG RX antennas, each DMG antenna shall be tested in SISO non-STBC mode, using a spatial expansion matrix that directs the single spatial stream to the tested DMG antenna. All other DMG antennas shall be covered with absorptive material. If covering a DMG antenna with absorptive material is not possible, the STA shall disable all DMG antennas besides the one being tested.

For transmissions with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE, the minimum sensitivity listed in Table 28-41 through Table 28-45 (values corresponding to 2.16 GHz PPDU or 4.32+4.32 GHz PPDU) shall be met in the reception of each channel. For transmissions with TXVECTOR parameter NON_EDMG_MODULATION set to NON_EDMG_DUP_SC_MODE, the minimum sensitivity listed in Table 28-41 through Table 28-45 (values corresponding to 2.16 GHz PPDU) shall be met in the reception of each channel.

NOTE—For RF power measurements performed over the air, the input level has to be corrected to compensate for the antenna gain in the implementation. The gain of the antenna is the maximum estimated gain by the manufacturer. In the case of the phased array antenna, the gain of the phased array antenna is the maximum sum of estimated element gain minus 3 dB implementation loss.

Table 28-40 through Table 28-45 assume 5 dB implementation loss and 10 dB noise factor (noise figure).

**Table 28-40—Receiver minimum input level sensitivity for the EDMG and non-EDMG control mode**

| MCS | Minimum sensitivity (dBm) |
|---|---|
| 0 | –78 |

**Table 28-41—Receiver minimum input level sensitivity for the EDMG and non-EDMG SC mode**

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 1 | –68 | –65 | –63 | –62 |
| 2 | –66 | –63 | –61 | –60 |
| 3 | –65 | –62 | –60 | –59 |
| 4 | –64 | –61 | –59 | –58 |
| 5 | –62 | –59 | –57 | –56 |
| 6 | –61 | –58 | –56 | –55 |
| 7 | –63 | –60 | –58 | –57 |
| 8 | –62 | –59 | –57 | –56 |
| 9 | –61 | –58 | –56 | –55 |
| 10 | –59 | –56 | –54 | –53 |
| 11 | –57 | –54 | –52 | –51 |

### Table 28-41—Receiver minimum input level sensitivity for the EDMG and non-EDMG SC mode *(continued)*

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 12 | –55 | –52 | –50 | –49 |
| 13 | –54 | –51 | –49 | –48 |
| 14 | –53 | –50 | –48 | –47 |
| 15 | –51 | –48 | –46 | –45 |
| 16 | –50 | –47 | –45 | –44 |
| 17 | –49 | –46 | –44 | –43 |
| 18 | –48 | –45 | –43 | –42 |
| 19 | –46 | –43 | –41 | –40 |
| 20 | –45 | –42 | –40 | –39 |
| 21 | –44 | –41 | –39 | –38 |

### Table 28-42—Receiver minimum input level sensitivity for the EDMG SC mode if the π/2-8-PSK Applied field is 1

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 12 | –56 | –53 | –51 | –50 |
| 13 | –54 | –51 | –49 | –48 |

### Table 28-43—Receiver minimum input level sensitivity for the EDMG SC mode if the π/2-64-NUC Applied field is 1

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 17 | –49 | –46 | –44 | –43 |
| 18 | –48 | –45 | –43 | –42 |
| 19 | –46 | –43 | –41 | –40 |
| 20 | –45 | –42 | –40 | –39 |
| 21 | –44 | –41 | –39 | –38 |

### Table 28-44—Receiver minimum input level sensitivity for the EDMG SC mode if the DCM π/2-BPSK Applied field is 1

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 2 | –66 | –63 | –61 | –60 |
| 3 | –65 | –62 | –60 | –59 |
| 4 | –64 | –61 | –59 | –58 |
| 5 | –62 | –59 | –57 | –56 |
| 6 | –61 | –58 | –56 | –55 |

### Table 28-45—Receiver minimum input level sensitivity for the EDMG OFDM mode

| MCS | Minimum sensitivity (2.16 GHz PPDU or 2.16+2.16 GHz PPDU) (dBm) | Minimum sensitivity (4.32 GHz PPDU or 4.32+4.32 GHz PPDU) (dBm) | Minimum sensitivity (6.48 GHz PPDU) (dBm) | Minimum sensitivity (8.64 GHz PPDU) (dBm) |
|---|---|---|---|---|
| 1 | –66 | –63 | –61 | –60 |
| 2 | –64 | –61 | –59 | –58 |
| 3 | –63 | –60 | –58 | –57 |
| 4 | –61 | –58 | –56 | –55 |
| 5 | –60 | –57 | –55 | –54 |
| 6 | –63 | –60 | –58 | –57 |
| 7 | –62 | –59 | –57 | –56 |
| 8 | –61 | –57 | –55 | –54 |
| 9 | –59 | –55 | –53 | –52 |
| 10 | –58 | –54 | –52 | –51 |
| 11 | –58 | –54 | –52 | –51 |
| 12 | –57 | –52 | –50 | –49 |
| 13 | –56 | –50 | –48 | –47 |
| 14 | –55 | –48 | –46 | –45 |
| 15 | –54 | –47 | –45 | –44 |
| 16 | –52 | –49 | –47 | –46 |
| 17 | –51 | –47 | –45 | –44 |
| 18 | –50 | –45 | –43 | –42 |
| 19 | –48 | –43 | –41 | –40 |
| 20 | –46 | –41 | –39 | –38 |

The receiver sensitivity for the EDMG OFDM mode if the DCM BPSK Applied field is 1 and the number of spatial streams is 2 is the same one defined in Table 28-45 for the coding scheme used (MCSs 1 to 5). Similarly, the receiver sensitivity for the EDMG OFDM mode if the Phase Hopping field in the EDMG-Header-A is equal to 1 and the number of spatial streams is 2 is the same one defined in Table 28-45 for the coding scheme used (MCSs 1 to 20).

### 28.3.9.9 Spectral flatness test for the EDMG OFDM mode

Spectral flatness measurements shall be conducted using DCM BPSK modulated EDMG OFDM PPDUs only while transmitting OFDM symbols. See 28.6.11.1.1 for the demodulation procedure and the number of PPDUs and OFDM symbols to be used for testing. Spectral flatness shall be evaluated using the subcarrier received values or the magnitude of channel estimates obtained with the EDMG-CEF field.

Let $E_{i,avg}$ denote the magnitude of the channel estimation on subcarrier $i$ or the average constellation energy of a DCM BPSK modulated subcarrier $i$. In an EDMG OFDM PPDU having TXVECTOR parameter CH_BANDWIDTH listed in Table 28-46, $E_{i,avg}$ of each of the subcarriers with indices listed as tested subcarrier indices shall not deviate by more than the specified maximum deviation in Table 28-46 from the average of $E_{i,avg}$ over subcarrier indices listed as averaging subcarrier indices. Averaging of $E_{i,avg}$ is done in the linear domain.

**Table 28-46—Maximum transmit spectral flatness deviations**

| TXVECTOR parameter CH_BANDWIDTH (CHANNEL_AGGREGATION = NOT_AGGREGATE) | Average subcarrier indices (inclusive) | Tested subcarrier indices (inclusive) | Maximum deviation (dB) |
|---|---|---|---|
| One bit set to 1 | –146 to –2 and 2 to 146 | –146 to –2 and 2 to 146 | ± 2 |
| | | –177 to –147 and 147 to 177 | +2/–4 |
| Two bits set to 1 | –355 to –2 and 2 to 355 | –325 to –2 and 2 to 325 | ± 2 |
| | | –386 to –326 and 326 to 386 | +2/–4 |
| Three bits set to 1 | –565 to –2 and 2 to 565 | –505 to –2 and 2 to 505 | ± 2 |
| | | –596 to –506 and 506 to 596 | +2/–4 |
| Four bits set to 1 | –774 to –2 and 2 to 774 | –684 to –2 and 2 to 684 | ± 2 |
| | | –805 to –685 and 685 to 805 | +2/–4 |

For transmit signals with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE and CH_BANDWIDTH parameter with two bits set to 1, each frequency segment shall meet the spectral flatness requirement for a transmission with TXVECTOR parameter CH_BANDWIDTH with one bit set to 1. For transmit signals with TXVECTOR parameter CHANNEL_AGGREGATION set to AGGREGATE and CH_BANDWIDTH parameter with four bits set to 1, each frequency segment shall meet the spectral flatness requirement for a transmission with TXVECTOR parameter CH_BANDWIDTH with two bits set to 1.

For the spectral flatness test, the transmitting STA shall be configured to use a spatial mapping matrix $Q_k$ (see 28.6.10) with flat frequency response. Each output port under test of the transmitting STA shall be connected through a cable to one input port of the testing instrumentation.

#### 28.3.9.10 Receiver co-channel interference (CCI) resilience

Co-channel interference resilience is defined as the ability of a STA to correctly receive an intended PPDU in the presence of an interfering transmission on the same channel and overlapping in time.

In the presence of CCI originating from a DMG PPDU transmission, a DMG STA operating in a TDD SP should decode an intended PPDU as long as all of the following conditions hold:

— The RCPI of the intended PPDU is at least 3 dB above actual receiver sensitivity.
— The RCPI of the CCI is at least 6 dB below the RCPI of the intended PPDU.
— The intended PPDU has sufficient signal to noise plus interference ratio to be decodable.

NOTE—An intended PPDU is a PPDU that contains at least one MPDU with the RA field set to the MAC address of the receiving STA.

In addition, a DMG STA operating in a TDD SP may abort a PPDU reception (see 8.3.5.17) at the trailing boundary of any TDD slot after which the STA is scheduled to receive from a different transmitting STA.

## 28.4 EDMG and non-EDMG control mode

### 28.4.1 General

Transmission and reception of 2.16 GHz PPDU using EDMG and non-EDMG control mode and 4.32 GHz PPDU using EDMG duplicate and non-EDMG duplicate control mode is mandatory.

Transmission and reception of a 2.16+2.16 GHz PPDU using EDMG and non-EDMG control mode is optional. Transmission and reception of a 6.48 GHz PPDU, 8.64 GHz PPDU, and 4.32+4.32 GHz PPDU using EDMG duplicate and non-EDMG duplicate control mode is optional.

The transmission block diagrams for non-EDMG and EDMG control modes are illustrated in 28.4.2.2 and 28.4.2.3, respectively. The PPDU format, non-EDMG portion and EDMG portion of the EDMG control mode PPDU are defined in 28.4.3, 28.4.4, and 28.4.5, respectively.

The non-EDMG and EDMG PPDU transmissions are defined in 28.4.7.2 and 28.4.7.3, respectively.

The non-EDMG control trailer encoding and modulation is defined in 28.4.6.

The non-EDMG and EDMG control mode PPDUs are transmitted using MCS 0 and EDMG-MCS 0 modulation and coding schemes, respectively.

The performance requirements are defined in 28.4.8.

### 28.4.2 Transmitter block diagram

#### 28.4.2.1 General

EDMG and non-EDMG control mode PPDU transmissions may be generated using a transmitter consisting of the following blocks:

- Scrambler scrambles the data to reduce the probability of long sequences of 0s and 1s; see 28.4.5.2.2.
- LDPC encoder encodes the data to enable error correction; see 28.4.5.2.3.
- Constellation mapper maps the sequence of bits to constellation points; see 28.4.5.2.4.
- Spreader spreads out a single constellation point to 32 chips applying the Ga Golay sequence of length 32; see 28.4.5.2.4.
- Golay builder builds π/2-BPSK modulated Ga and Gb Golay sequences comprising the L-STF, L-CEF, and TRN units; see 28.10.
- Cyclic shift diversity (CSD) prevents the signal from unintentional beamforming. CSD is specified per transmitter chain for EDMG and non-EDMG duplicate PPDU transmissions.
- Pulse shaping performs convolution of constellation points with shape filter impulse response with possible sampling rate change. For duplicate transmissions, pulse shaping may include a relative time delay between the primary and secondary channels. The exact definition of shape filter impulse response is implementation dependent.

#### 28.4.2.2 Non-EDMG PPDU transmission

Figure 28-12 shows the transmitter blocks used to generate a non-EDMG PPDU. The L-STF, L-CEF, and TRN units of the PPDU are generated using the Golay builder block. The L-Header and Data fields of the PPDU are generated using the scrambler, LDPC encoder, constellation mapper, and spreader. The encoded and modulated bit stream is mapped to $N_{TX}$ transmit chains applying spatial expansion with relative cyclic shift over the chains as defined in 28.4.7.2.

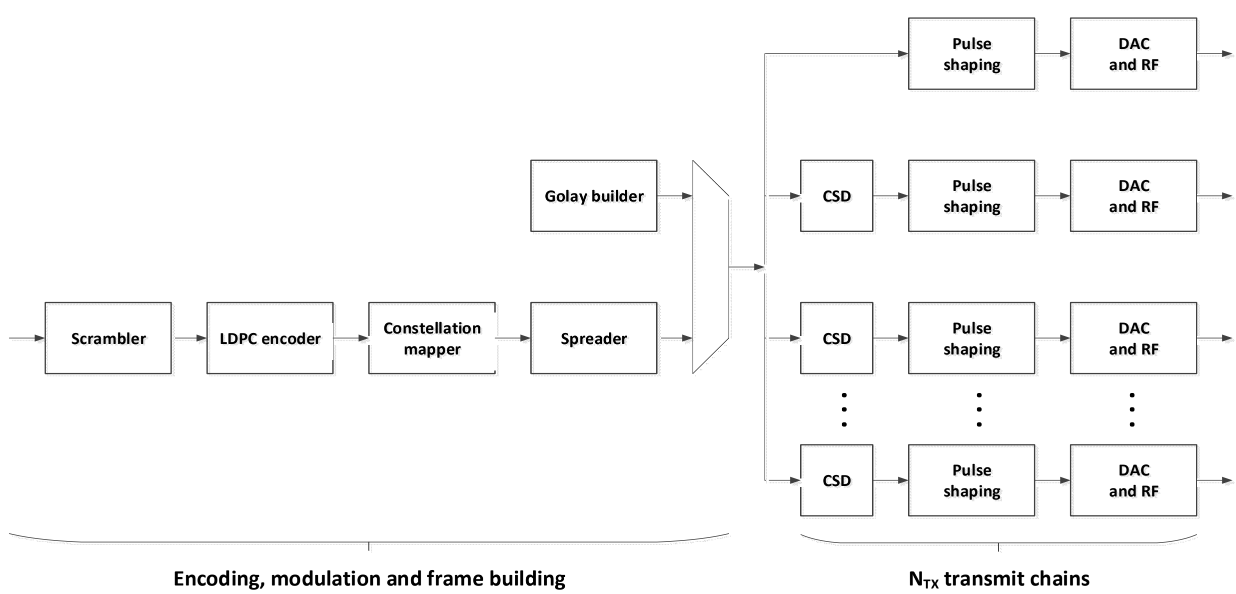


**Figure 28-12—Control mode transmitter block diagram for a non-EDMG PPDU transmission**

#### 28.4.2.3 EDMG PPDU transmission

Figure 28-13 shows the transmitter blocks used to generate an EDMG PPDU. The L-STF, L-CEF, and TRN units of the PPDU are generated using the Golay builder block. The L-Header, EDMG-Header-A, and Data fields of PPDU are generated using the scrambler, LDPC encoder, constellation mapper, and spreader. The encoded and modulated bit stream is mapped to the $N_{TX}$ transmit chains applying spatial expansion with relative cyclic shift over the transmit chains as defined in 28.4.7.3. The cyclic shift is not applied to TRN units included in the TRN field and each transmit chain transmits its own TRN field as defined in 28.9.2.2.6.

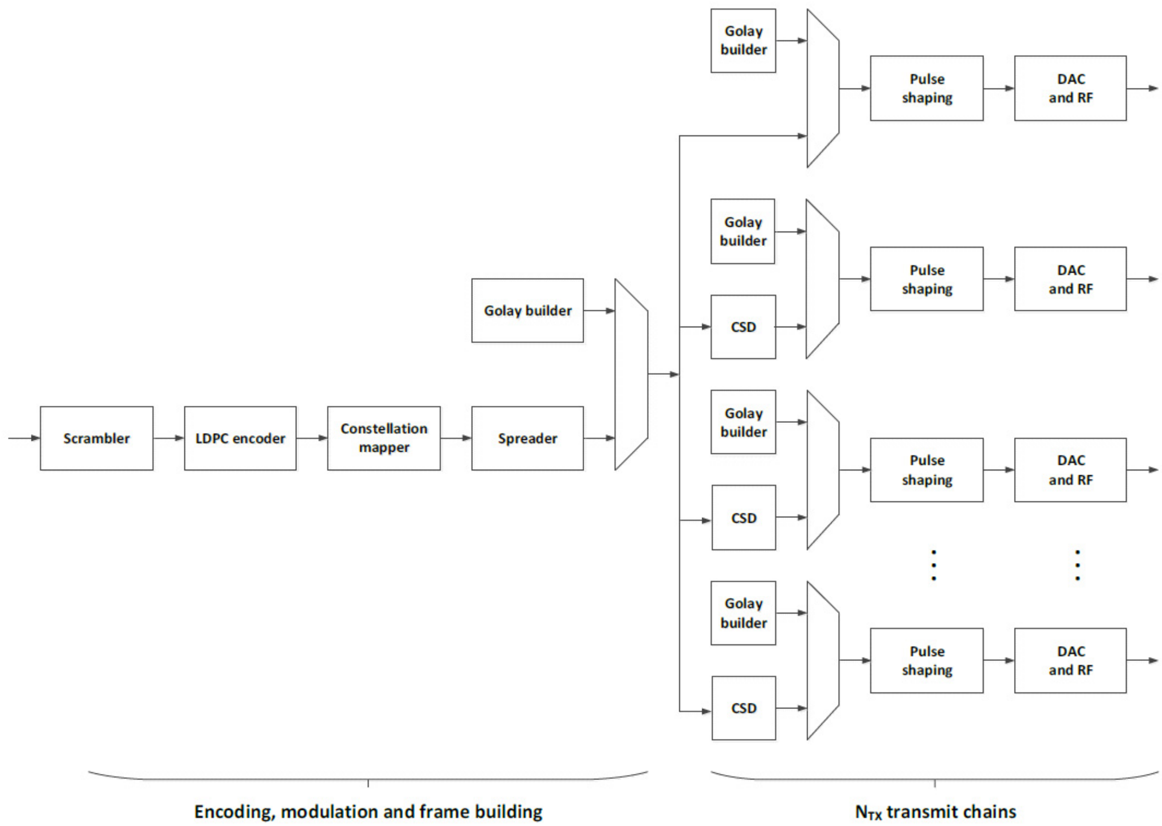


**Figure 28-13—Control mode transmitter block diagram for an EDMG PPDU transmission**

### 28.4.3 PPDU format

An EDMG control mode PPDU shall contain the L-STF, L-CEF, L-Header, and EDMG-Header-A fields, but shall not contain the EDMG-STF, EDMG-CEF or EDMG-Header-B fields.

An EDMG control mode PPDU may contain a TRN field as defined in 28.9.2.2.5.

An EDMG control mode PPDU may contain the DMG AGC and TRN fields defined in 20.9.2.2.5 and 20.9.2.2.6, respectively, indicated by the DMG TRN field in the EDMG-Header-A. In this case, the TRN field defined in 28.9.2.2.5 shall not be transmitted.

A non-EDMG PPDU format shall be as defined in 20.4.2.

### 28.4.4 Non-EDMG portion of the EDMG control mode PPDU

The non-EDMG portion of the EDMG control mode PPDU is composed of the L-STF, the L-CEF, and the L-Header. These fields are defined at the DMG SC chip rate $F_c$ and transmitted in the EDMG control mode for 2.16 GHz and 2.16+2.16 GHz channels, and in the EDMG duplicate control mode for 4.32 GHz, 6.48 GHz, 8.64 GHz, and 4.32+4.32 GHz channels as defined in 28.4.7.3.2 and 28.4.7.3.3.

The L-STF, L-CEF and L-Header fields of an EDMG control mode PPDU are defined in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively.

### 28.4.5 EDMG portion of the EDMG control mode PPDU

#### 28.4.5.1 General

The EDMG portion of the EDMG control mode PPDU is composed of the EDMG-Header-A field, the Data field, and the TRN field.

The EDMG-Header-A and the Data fields are defined at the DMG SC chip rate $F_c$ and transmitted in the EDMG control mode for 2.16 GHz and 2.16+2.16 GHz channels, and in the EDMG duplicate control mode for 4.32 GHz, 6.48 GHz, 8.64 GHz, and 4.32+4.32 GHz channels as defined in 28.4.7.3.2 and 28.4.7.3.3.

The TRN field, if present, is transmitted at the EDMG SC chip rate $F_{c\ EDMG}$ as defined in 28.4.7.3.4.

The EDMG control mode PPDU transmission with TRN field is defined in 28.4.7.3.5.

The case of an EDMG control mode PPDU transmission with DMG AGC and TRN fields is defined in 28.4.7.3.6.

#### 28.4.5.2 Data field

##### 28.4.5.2.1 General

The Data field contains the PSDU. The PSDU shall be scrambled, encoded, modulated and spread as described in the following subclauses.

##### 28.4.5.2.2 Scrambler

The operation of the scrambler is defined in 20.3.9. Bits x1, x2, x3, x4 of the scrambler shift register shall be initialized using the bits in the scrambler initialization bits from the L-Header and bits x5, x6, x7 shall be set to 1. The L-Header is scrambled starting from bit 5. The scrambling of the EDMG-Header-A shall continue the scrambling of the L-Header with no reset. The scrambling of the Data field shall continue the scrambling of the EDMG-Header-A with no reset.

##### 28.4.5.2.3 Encoder

The L-Header, EDMG-Header-A, and Data field are encoded using an effective LDPC code rate less than or equal to 1/2, generated from the data PHY rate 3/4 LDPC parity check matrix, with shortening. The maximum number of data bits in each LDPC codeword is $L_{CWD} = 168$. The following steps are used for the encoding:

— $L_{L\text{-}Header} = 5$ is the length of L-Header in octets. $L_{EDMG\text{-}Header\text{-}A1} = 6$ is the length of EDMG-Header-$A_1$ subfield in octets. Therefore, the total number of bits in the first LDPC codeword is $L_{DPFCW} = (L_{L\text{-}Header} + L_{EDMG\text{-}Header\text{-}A1}) \times 8 = 88$ bits.

- $L_{EDMG\text{-}Header\text{-}A2} = 3$ is the length of EDMG-Header-$A_2$ subfield in octets. The EDMG-Header-$A_2$ subfield is transmitted in the second LDPC codeword.
- The number of LDPC codewords is $N_{CW} = 1 + \left\lceil \frac{(Length + L_{EDMG-Header-A2}) \times 8}{L_{CWD}} \right\rceil$, where Length is the value of the PSDU Length subfield in the EDMG-Header-A field.
- The number of bits in the second and, if present, any subsequent LDPC codeword except the last one is $L_{DPCW} = \left\lceil \frac{(Length + L_{EDMG-Header-A2}) \times 8}{N_{CW} - 1} \right\rceil$.
- The number of bits in the last LDPC codeword is $L_{DPLCW} = (Length + L_{EDMG\text{-}Header\text{-}A2}) \times 8 - (N_{CW} - 2) \times L_{DPCW}$.

NOTE—For example, if Length is 128 octets, then $N_{CW} = 8$, $L_{DPCW} = 150$, and $L_{DPLCW} = 148$. In the first LDPC block, the $L_{DPFCW} = 88$ bits consist of 40 bits from the L-Header field along with 48 bits from the EDMG-Header-$A_1$ subfield. In the second LDPC block, the $L_{DPCW} = 150$ bits consist of 24 bits from the EDMG-Header-$A_2$ subfield along with 126 data bits.

### 28.4.5.2.4 Modulation and spreading

The scrambled and coded bit stream shall be converted into a stream of complex constellation points by using the procedure defined in 20.4.3.3.4. The constellation points shall then be spread using the sequence $Ga^3{}_2(n)$, as defined in 20.4.3.3.5.

### 28.4.6 Non-EDMG control trailer encoding and modulation

If a control trailer is present in a transmitted PPDU (see 28.3.7), the control trailer has a length of 18 data octets. The control trailer continues scrambling of the Data field with no seed reset as defined in 20.4.3.3.2. The control trailer is encoded using the rate 3/4 LDPC parity check matrix defined in 20.3.8.4 with shortening to achieve the effective LDPC code rate of 6/13.

The encoding procedure includes the following steps:

- The input 144 data bits (18 octets) are padded with 360 0s to get an LDPC codeword length of 504 bits.
- Compute the 168 parity bits applying the rate-3/4 LDPC parity check matrix.
- Discard the padded 360 zero bits and form the output LDPC codeword of length 312 bits.

The control trailer LDPC codeword continues the DBPSK modulation as defined in 20.4.3.3.4 and then applies the spreading as defined in 20.4.3.3.5.

### 28.4.7 PPDU transmission

#### 28.4.7.1 General

This subclause defines the waveform for a control mode PPDU transmitted using the non-EDMG format and EDMG format over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz channel using $N_{TX}$ transmit chains. The non-EDMG PPDU transmission shall be as defined in 28.4.7.2. The EDMG PPDU transmission shall be as defined in 28.4.7.3.

### 28.4.7.2 Non-EDMG PPDU transmission

#### 28.4.7.2.1 Non-EDMG PPDU transmission over a 2.16 GHz and 2.16+2.16 GHz channel

The non-EDMG control mode PPDU waveform shall be defined at the DMG SC chip rate $F_c$ and include the following modulated fields:

$$r_{non\text{-}EDMG}\left(nT_c\right) = r_{L\text{-}STF}\left(nT_c\right) + r_{L\text{-}CEF}\left(nT_c - t_{L\text{-}CEF}\right) + r_{L\text{-}Header}\left(nT_c - t_{L\text{-}Header}\right)$$
$$+ r_{Data}\left(nT_c - t_{Data}\right) + r_{AGC\ TRN}\left(nT_c - t_{AGC\ TRN}\right)$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{Data} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of the L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{AGC\ TRN} = t_{Data} + T_{Data}$ | is the total duration of the L-STF, L-CEF, L-Header, and Data fields of the PPDU |

In the non-EDMG control mode PPDU waveform, the AGC and TRN fields may be present in a 2.16 GHz non-EDMG PPDU transmission and shall not be present in a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz non-EDMG PPDU transmission.

In a 2.16 GHz non-EDMG PPDU transmission, a control trailer can be present in place of the AGC and TRN fields (see 28.3.7).

In a 4.32 GHz, 6.48 GHz, 8.64 GHz 2.16+2.16 GHz, or 4.32+4.32 GHz non-EDMG PPDU transmission, the Training Length field in the L-Header of the non-EDMG PPDU shall not have a value that is different from 0 or 2. If the Training Length field is equal to 2, a control trailer is present in place of the AGC and TRN fields as defined in 28.3.7.

Unless specified, the chip index $n$ is defined in the range [0, $N_{Field} - 1$], where $N_{Field}$ defines the total number of samples for a given signal field. The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively. The definition of the AGC and TRN fields is provided in 20.9.2.2.5 and 20.9.2.2.6, respectively. The L-Header and Data fields encoding and modulation is provided in 20.4.3.2.3 and 20.4.3.3, respectively.

To transmit a non-EDMG waveform using multiple transmit chains, a spatial expansion with cyclic shift diversity (CSD) is applied. The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain includes a CSD, $T_{SC}^{i_{TX}}$, that is dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c\right) = \begin{cases} r_{non\text{-}EDMG}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\ldots,N-1-T_{SC}^{i_{TX}}/T_c \\ r_{non\text{-}EDMG}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}/T_c,\ldots,N-1 \end{cases}, \quad 1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $N$ | is the total number of chips in the non-EDMG PPDU waveform $r_{non\text{-}EDMG}$ |
| $T_c$ | is the chip time duration |

The non-EDMG PPDU waveform for $i_{TX}$th transmit chain is obtained by upsampling and filtering and then appropriate carrier frequency shift of the $r_{non-EDMG}^{i_{TX}\ (1)}(nT_c)$ waveform, if required. The upsampling procedure is applied using a factor of $N_{up}$. The filtering procedure is performed with a pulse shaping filter, $h_{SC\ CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = \begin{cases} r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n = 0, N_{up}, 2 * N_{up} \ldots \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

$$r_{non\text{-}EDMG}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right) = \sum_{k=0}^{K-1} r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{N_{up}}\right) h_{SC\ CB}(k), n = 0, 1, \ldots$$

$$r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right) = r_{non\text{-}EDMG}^{i_{TX}\ (3)}\left(\left(n+\frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n = 0, 1, \ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = 0$, for $n < 0$ and $n \geq N \times N_{up}$

$N$ is the total number of chips in the non-EDMG PPDU waveform $r_{non\text{-}EDMG}^{i_{TX}\ (1)}$

$T_c$ is the chip time duration

The pulse shaping filter impulse response, $h_{SC\ CB}$, and the $N_{up}$ parameter definition are implementation dependent.

The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain with transmission over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right), 1 \leq i_{TX} \leq N_{TX}$$

For a 2.16+2.16 GHz PPDU transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary channel (see 28.3.4).

#### 28.4.7.2.2 Non-EDMG duplicate PPDU transmission over a 4.32 GHz, 6.48 GHz, 8.64 GHz, and 4.32+4.32 GHz channel

The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain with duplicate transmission over a 4.32 GHz or 4.32+4.32 GHz channel shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}} + \Delta t_1\right) \cdot \frac{1}{\sqrt{2}} \exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)$$
$$+ r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}} + \Delta t_2\right) \cdot \frac{1}{\sqrt{2}} \exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right), 1 \leq i_{TX} \leq N_{TX}$$

where

| | |
|---|---|
| $\Delta F$ | defines the channel spacing and is equal to 2.16 GHz |
| $\Delta t_1$ and $\Delta t_2$ | are in the range $[0, T_c]$ |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

For 4.32+4.32 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary1 and secondary2 channels (see 28.3.4).

The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain with duplicate transmission over a 6.48 GHz channel shall be defined as follows:

$$
\begin{aligned}
r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) &= r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{3}}\exp\left(-j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{3}}\\
&+r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{3}}\exp\left(+j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right), 1 \le i_{TX} \le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, and $\Delta t_3$ | are in the range $[0, T_c]$ |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain with duplicate transmission over an 8.64 GHz channel shall be defined as follows:

$$
\begin{aligned}
r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) &= r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_4\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right), 1 \le i_{TX} \le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, $\Delta t_3$, and $\Delta t_4$ | are in the range $[0, T_c]$ |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

### 28.4.7.3 EDMG PPDU transmission

#### 28.4.7.3.1 General

The EDMG control mode PPDU is composed of a preamble, a Data field and a TRN field. The total number of transmit chains, $N_{TX}$, used for transmission shall be constant over the different fields of EDMG PPDU.

For the case of DMG AGC and TRN fields transmission over a 2.16 GHz channel, indicated by the DMG TRN field in the EDMG-Header-A, the EDMG control mode PPDU is composed of a preamble, a Data field, and DMG AGC and TRN fields.

#### 28.4.7.3.2 EDMG preamble and Data field transmission over a 2.16 GHz and 2.16+2.16 GHz channel

The preamble and Data fields shall be defined at the DMG SC chip rate $F_c$ and include the following modulated fields:

$$r_{EDMG\text{-}Pream,\,Data}(nT_c) = r_{L\text{-}STF}(nT_c) + r_{L\text{-}CEF}(nT_c - t_{L\text{-}CEF}) + r_{L\text{-}Header}(nT_c - t_{L\text{-}Header})$$
$$+ r_{EDMG\text{-}Header\text{-}A}(nT_c - t_{EDMG\text{-}Header\text{-}A}) + r_{Data}(nT_c - t_{Data})$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ | is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU |

The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively. The definition of EDMG-Header-A is provided in 28.3.3.3.2.2 and 28.3.3.3.2.4. The definition of the Data field is provided in 28.4.5.2.

To transmit the preamble and Data fields using multiple transmit chains, a spatial expansion with cyclic shift diversity (CSD) is applied. The preamble and Data fields of the PPDU waveform for the $i_{TX}$th transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{EDMG\text{-}Pream,\,Data}^{i_{TX}\ (1)}(nT_c) = \begin{cases} r_{EDMG\text{-}Pream,\,Data}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\ldots,N-1-T_{SC}^{i_{TX}}/T_c \\ r_{EDMG\text{-}Pream,\,Data}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}/T_c,\ldots,N-1 \end{cases},\quad 1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $N$ | is the total number of chips in the EDMG preamble and Data fields $r_{EDMG\text{-}Pream,\,Data}$ of the EDMG PPDU waveform |
| $T_c$ | is a chip time duration |

The EDMG PPDU waveform for the $i_{TX}$th transmit chain is obtained by upsampling and filtering and then appropriate carrier frequency shift of the $r_{EDMG\text{-}Pream,\,Data}^{i_{TX}\ (1)}(nT_c)$ waveform, if required. The upsampling procedure is applied using a factor of $N_{up}$. The filtering procedure is performed with a pulse shaping filter, $h_{SC\ CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right)=\begin{cases} r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n=0, N_{up}, 2*N_{up}\ldots \\ 0 \qquad \text{otherwise} \end{cases}$$

$$r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right)=\sum_{k=0}^{K-1} r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{N_{up}}\right)h_{SC\,CB}(k), n=0,1,\ldots$$

$$r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right)=r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (3)}\left(\left(n+\frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n=0,1,\ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right)=0,$ for $n<0$ and $n\geq N\times N_{up}$

$N$ is the total number of chips in the EDMG preamble and Data fields $r_{EDMG\text{-}Pream,\ Data}^{i_{TX}\ (1)}$ of the EDMG PPDU waveform

$T_c$ is a chip time duration

The pulse shaping filter impulse response, $h_{SC\ CB}$, and $N_{up}$ parameter definition is implementation dependent.

The preamble and Data fields of the EDMG PPDU waveform for the $i_{TX}{}^{\text{th}}$ transmit chain with transmission over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined as follows:

$$r_{EDMG-Pream,\ Data}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right)=r_{EDMG-Pream,\ Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right), 1\leq i_{TX}\leq N_{TX}$$

For a 2.16+2.16 GHz PPDU transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary channel (see 28.3.4).

#### 28.4.7.3.3 EDMG duplicate preamble and Data field transmission over a 4.32 GHz, 6.48 GHz, 8.64 GHz, and 4.32+4.32 GHz channel

The preamble and Data fields of the EDMG PPDU waveform for the $i_{TX}{}^{\text{th}}$ transmit chain with duplicate transmission over a 4.32 GHz or 4.32+4.32 GHz channel shall be defined as follows:

$$\begin{aligned} r_{EDMG-Pream,\ Data}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) &= r_{EDMG-Pream,\ Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{2}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right) \\ &+ r_{EDMG-Pream,\ Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{2}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right), 1\leq i_{TX}\leq N_{TX} \end{aligned}$$

where

$\Delta F$ defines the channel spacing and is equal to 2.16 GHz

$\Delta t_1$ and $\Delta t_2$ are in the range $[0, T_c]$

$\Delta t_i$ equal to 0 corresponds to the primary channel

For 4.32+4.32 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary1 and secondary2 channels (see 28.3.4).

The preamble and Data fields of the EDMG PPDU waveform for the $i_{TX}^{\text{th}}$ transmit chain with duplicate transmission over a 6.48 GHz channel shall be defined as follows:

$$
\begin{aligned}
r_{EDMG-Pream,\, Data}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) &= r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{3}}\exp\left(-j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{3}}\\
&+r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{3}}\exp\left(+j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right),1\le i_{TX}\le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, and $\Delta t_3$ | are in the range [0, $T_c$] |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The preamble and Data fields of the EDMG PPDU waveform for the $i_{TX}^{\text{th}}$ transmit chain with duplicate transmission over an 8.64 GHz channel shall be defined as follows:

$$
\begin{aligned}
r_{EDMG-Pream,\, Data}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) &= r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r_{EDMG-Pream,\, Data}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}+\Delta t_4\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right),1\le i_{TX}\le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, $\Delta t_3$, and $\Delta t_4$ | are in the range [0, $T_c$] |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

### 28.4.7.3.4 TRN field transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz channel

The TRN field, $r_{TRN}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{CB}}\right)$, shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ per $i_{TX}{}^{\text{th}}$ transmit chain as defined in 28.9.2.2.6. The TRN field is defined using $N_{TX}$ orthogonal waveforms and transmitted over the entire channel bandwidth.

The TRN field is filtered and resampled with conversion rate ratio $N_{up}/N_{CB}$. For example, the resampling procedure for the ratio $N_{up}/N_{CB}$ equal to 3/2 can be defined as follows:

$$r_{TRN}^{i_{TX}\ (2)}\left(n\frac{T_c}{3N_{CB}}\right)=\begin{cases} r_{TRN}^{i_{TX}\ (1)}\left(n\frac{T_c}{3N_{CB}}\right), n=0,3,6... \\ \qquad\qquad\qquad \text{otherwise} \\ 0 \end{cases}$$

$$r_{TRN}^{i_{TX}\ (3)}\left(n\frac{T_c}{3N_{CB}}\right)=\sum_{k=0}^{K-1} r_{TRN}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{3N_{CB}}\right)h_{SC\,CB}(k), n=0,1,...$$

$$r_{TRN}^{i_{TX}}\left(n\frac{2T_c}{3N_{CB}}\right)=r_{TRN}^{i_{TX}\ (3)}\left(\left(2n+\frac{K-1}{2}\right)\frac{T_c}{3N_{CB}}\right), n=0,1,...$$

where

| | |
|---|---|
| $K$ | is the length of $h_{SC\ CB}$ in samples |
| $r_{TRN}^{i_{TX}\ (2)}\left(n\frac{T_c}{3N_{CB}}\right)=0$, for $n<0$ and $n\geq N\times 3$ | |
| $N$ | is the total number of chips in the TRN field $r_{TRN}^{i_{TX}\ (1)}$ |
| $T_c/N_{CB}$ | is the chip time duration |

### 28.4.7.3.5 EDMG PPDU transmission with TRN field transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, and 4.32+4.32 GHz channel

The EDMG control mode PPDU waveform for the $i_{TX}{}^{\text{th}}$ transmit chain concatenates the preamble and Data fields defined in 28.4.7.3.2 and 28.4.7.3.3 with the TRN field defined in 28.4.7.3.4 and shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right)=r_{EDMG\text{-}Pream,\ Data}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right)+r_{TRN}^{i_{TX}}\left(n\frac{T_c}{N_{up}}-t_{TRN}\right), 1\leq i_{TX}\leq N_{TX}$$

where

| | |
|---|---|
| $t_{TRN}=t_{Data}+T_{Data}$ | is the total duration of the L-STF, L-CEF, L-Header, EDMG-Header-A, and Data fields of the PPDU |

### 28.4.7.3.6 EDMG PPDU transmission with DMG AGC and TRN fields over a 2.16 GHz channel

For the case of DMG AGC and TRN fields transmission over a 2.16 GHz channel, indicated by the DMG TRN field in the EDMG-Header-A, the EDMG control mode PPDU is composed of a preamble, a Data field and DMG AGC and TRN fields.

The EDMG control mode PPDU shall be defined at the DMG SC chip rate $F_c$ and include the following modulated fields:

$$\begin{aligned} r_{EDMG\text{-}PPDU}(nT_c) &= r_{L\text{-}STF}(nT_c) + r_{L\text{-}CEF}(nT_c - t_{L\text{-}CEF}) + r_{L\text{-}Header}(nT_c - t_{L\text{-}Header}) \\ &+ r_{EDMG\text{-}Header\text{-}A}(nT_c - t_{EDMG\text{-}Header\text{-}A}) + r_{Data}(nT_c - t_{Data}) + r_{AGC\ TRN}(nT_c - t_{AGC\ TRN}) \end{aligned}$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ | is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU |
| $t_{AGC\ TRN} = t_{Data} + T_{Data}$ | is the total duration of the L-STF, L-CEF, L-Header, EDMG-Header-A, and Data fields of the PPDU |

The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively. The definition of EDMG-Header-A is provided in 28.3.3.3.2.2 and 28.3.3.3.2.4. The definition of the Data field is provided in 28.4.5.2. The definition of the DMG AGC and TRN fields is provided in 20.9.2.2.5 and 20.9.2.2.6, respectively.

To transmit an EDMG PPDU using multiple transmit chains, a spatial expansion with cyclic shift diversity (CSD) is applied. The EDMG PPDU waveform for the $i_{TX}$th transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{EDMG\text{-}PPDU}^{i_{TX}\ (1)}(nT_c) = \begin{cases} r_{EDMG\text{-}PPDU}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\ldots,N-1-T_{SC}^{i_{TX}}\ /T_c \\ r_{EDMG\text{-}PPDU}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}\ /T_c,\ldots,N-1 \end{cases},\quad 1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $N$ | is the total number of chips in the EDMG PPDU waveform $r_{EDMG\text{-}PPDU}$ |
| $T_c$ | is a chip time duration |

The EDMG PPDU waveform for the $i_{TX}$th transmit chain is obtained by upsampling and filtering. The upsampling procedure is applied using a factor of $N_{up}$. The filtering procedure is performed with a pulse shaping filter, $h_{SC\ CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{EDMG\text{-}PPDU}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right)=\begin{cases} r_{EDMG\text{-}PPDU}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n=0, N_{up}, 2*N_{up}\ldots \\ 0 \qquad \text{otherwise}\end{cases}$$

$$r_{EDMG\text{-}PPDU}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right)=\sum_{k=0}^{K-1} r_{EDMG\text{-}PPDU}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{N_{up}}\right)h_{SC\,CB}(k), n=0,1,\ldots$$

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right)=r_{EDMG\text{-}PPDU}^{i_{TX}\ (3)}\left(\left(n+\frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n=0,1,\ldots$$

where

$K$ is the length of $h_{SC\,CB}$ in samples

$r_{EDMG\text{-}PPDU}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right)=0$, for $n<0$ and $n\geq N\times N_{up}$

$N$ is the total number of chips in the EDMG PPDU waveform $r_{EDMG\text{-}PPDU}^{i_{TX}\ (1)}$

$T_c$ is a chip time duration

The pulse shaping filter impulse response, $h_{SC\,CB}$, and the $N_{up}$ parameter definition are implementation dependent.

### 28.4.8 Performance requirements

The transmit EVM performance requirement of EDMG and non-EDMG control mode PPDUs shall be the same as that of DMG control mode PPDUs defined in 20.4.4.1.2.

In the transmit EVM accuracy test, each transmit chain of the transmitting STA shall be connected through a cable to one input port of the testing instrumentation. If the TXVECTOR parameter CH_BANDWIDTH has more than one bit set to 1, the duplicate transmission in the two or more 2.16 GHz channels may be tested independently. In this case, the transmit EVM accuracy of each 2.16 GHz channel shall meet the required value defined in 20.4.4.1.2 using only the signal within the corresponding channel.

Receive requirement of EDMG and non-EDMG control mode PPDUs are defined in 28.3.8.

## 28.5 EDMG and non-EDMG SC mode

### 28.5.1 General

Transmission and reception of the following modes are mandatory:

— 2.16 GHz SU PPDU using the EDMG SC mode MCSs 1 to 5 and 7 to 10 with single spatial stream
— 2.16 GHz PPDU using the non-EDMG SC mode MCSs 1 to 4
— 4.32 GHz SU PPDU using the EDMG SC mode MCSs 1 to 5 and 7 to 10 with single spatial stream
— 4.32 GHz PPDU using the non-EDMG duplicate SC mode MCSs 1 to 4

Transmission and reception of all other modes are optional.

### 28.5.2 Signal parameters

#### 28.5.2.1 General

This subclause defines the main EDMG SC signal parameters for 2.16 GHz ($N_{CB}$ = 1), 4.32 GHz ($N_{CB}$ = 2), 6.48 GHz ($N_{CB}$ = 3), 8.64 GHz ($N_{CB}$ = 4), 2.16+2.16 GHz ($N_{CB}$ = 1), and 4.32+4.32 GHz ($N_{CB}$ = 2) PPDU transmissions.

#### 28.5.2.2 Timing-related parameters

Table 28-47 provides a summary of the EDMG SC mode timing-related parameters.

**Table 28-47—EDMG SC mode timing-related parameters**

| Parameter | Value | | | |
|---|---|---|---|---|
| | $N_{CB}$ = 1 | $N_{CB}$ = 2 | $N_{CB}$ = 3 | $N_{CB}$ = 4 |
| $N_{SPB}$: number of symbols per SC symbol block for short GI length | 480 | 960 | 1440 | 1920 |
| $N_{SPB}$: number of symbols per SC symbol block for normal GI length | 448 | 896 | 1344 | 1792 |
| $N_{SPB}$: number of symbols per SC symbol block for long GI length | 384 | 768 | 1152 | 1536 |
| $N_{GI\ short}$: short guard interval length | 32 | 64 | 96 | 128 |
| $N_{GI\ normal}$: normal guard interval length | 64 | 128 | 192 | 256 |
| $N_{GI\ long}$: long guard interval length | 128 | 256 | 384 | 512 |
| $F_c$: DMG SC chip rate | 1.76 GHz | 1.76 GHz | 1.76 GHz | 1.76 GHz |
| $F_{c\ EDMG}$: EDMG SC chip rate | 1.76 GHz | 3.52 GHz | 5.28 GHz | 7.04 GHz |
| $T_c$: DMG SC chip time duration | 0.57 ns | 0.57 ns | 0.57 ns | 0.57 ns |
| $T_{c\ EDMG}$: EDMG SC chip time duration | 0.57 ns | 0.28 ns | 0.19 ns | 0.14 ns |
| $N_{DFT}$: DFT size | 512 | 1024 | 1536 | 2048 |
| $T_{DFT}$: SC IDFT/DFT period | 0.291 µs | 0.291 µs | 0.291 µs | 0.291 µs |
| $T_{GI\ short}$: short guard interval duration | 18.18 ns | 18.18 ns | 18.18 ns | 18.18 ns |
| $T_{GI\ normal}$: normal guard interval duration | 36.36 ns | 36.36 ns | 36.36 ns | 36.36 ns |
| $T_{GI\ long}$: long guard interval duration | 72.72 ns | 72.72 ns | 72.72 ns | 72.72 ns |

NOTE 1—The non-EDMG and pre-EDMG modulated fields are defined at the DMG SC chip rate $F_c$ and the corresponding chip time duration $T_c$. The EDMG modulated fields are defined at the EDMG SC chip rate $F_{c\ EDMG} = F_c \times N_{CB}$ and the corresponding chip time duration $T_{c\ EDMG} = T_c/N_{CB}$.

NOTE 2—The values given for parameters $N_{GI\ short}$, $N_{GI\ normal}$, and $N_{GI\ long}$ correspond to the number of elements in the GI for each GI length and $N_{CB}$ value.

### 28.5.3 Transmitter block diagram

#### 28.5.3.1 General

EDMG and non-EDMG SC PPDU transmissions can be generated using a transmitter consisting of the following blocks:

- Scrambler scrambles the data to reduce the probability of long sequences of 0s and 1s; see 28.5.9.3.
- LDPC encoder encodes the data to enable error correction. It pads the data with 0s to get an integer number of codewords and SC symbol blocks; see 28.5.9.4.
- Stream parser divides the output of the LDPC encoder into the groups of bits that are sent to different mapping devices. The sequence of the bits sent to different mapping devices is called a spatial stream; see 28.5.9.4.
- Constellation mapper and π/2-rotation block map the sequence of bits in each spatial stream to constellation points (complex numbers); see 28.5.9.5.
- Interleaver performs interleaving inside a SC symbol block; see 28.5.9.5.5.
- STBC encoder spreads constellation points from $N_{SS}$ spatial streams into $N_{STS}$ space-time streams using a space-time block code. SC mode defines STBC schemes with $N_{STS} = 2 \times N_{SS}$; see 28.5.9.5.4.
- GI insertion prepends the SC symbol block with guard interval defined as a π/2-BPSK modulated Golay sequence; see 28.5.9.2.
- Preamble builder builds π/2-BPSK modulated Ga and Gb Golay sequences comprising the L-STF, L-CEF, EDMG-STF, and EDMG-CEF fields; see 28.10.
- Spatial mapper maps space-time streams to transmit chains. This may include one of the following, see 28.5.10.2:
  - Direct mapping: constellation points from each space-time stream are mapped directly to the transmit chains.
  - Indirect mapping: constellation points from each space-time stream are mapped to each transmit chain.
  - Digital beamforming: each vector of constellation points from all of the space-time streams is multiplied by a matrix of steering vectors to produce the input to the transmit chains.
- Cyclic shift diversity (CSD) prevents the signal transmission from unintentional beamforming. A cyclic shift is specified per transmitter chain for non-EDMG duplicate PPDU transmission; see 28.5.3.2 and 28.5.3.3.1.
- Pulse shaping performs convolution of constellation points with shape filter impulse response with possible sampling rate change. For duplicate channel transmission, pulse shaping may include a relative time delay between the primary and secondary channels. The exact definition of shape filter impulse response is beyond the scope of this standard and is implementation specific.

#### 28.5.3.2 Non-EDMG PPDU transmission

Figure 28-14 shows the transmitter blocks used to generate the non-EDMG PPDU. The L-STF, L-CEF fields and TRN units of PPDU are generated using Golay builder block. The L-Header and data part of PPDU are generated using scrambler, LDPC encoder, constellation mapper, and GI insertion blocks. A single spatial stream is mapped to the $N_{TX}$ transmit chains applying relative cyclic shift over the chains as defined in 28.5.9.

#### 28.5.3.3 EDMG PPDU transmission

##### 28.5.3.3.1 Pre-EDMG modulated fields of PPDU transmission

Figure 28-14 shows the transmitter blocks used to generate the pre-EDMG modulated fields of the EDMG PPDU preamble. The L-STF and L-CEF fields are generated using Golay builder block. The L-Header and EDMG-Header-A are generated using scrambler, LDPC encoder, constellation mapper, and GI insertion blocks. A single spatial stream is mapped to the $N_{TX}$ transmit chains applying relative cyclic shift over the chains as defined in 28.5.10.

##### 28.5.3.3.2 EDMG modulated fields of SU PPDU transmission

Figure 28-15 shows the transmitter blocks used to generate the EDMG modulated fields of an SU PPDU. The EDMG-STF and EDMG-CEF fields are generated using the Preamble builder block. The TRN field is generated using TRN builder block. The Data field of the PPDU is generated using the scrambler, LDPC encoder, constellation mapper, interleaver, and GI insertion blocks. If STBC encoder is applied, then $N_{SS}$ spatial streams are mapped to $2 \times N_{SS}$ space-time streams as defined in 28.5.9.5.4. The $N_{STS}$ space-time streams are further mapped to $N_{TX}$ transmit chains, where $N_{STS} \le N_{TX}$.

NOTE—Interleaver is applied to π/2-64-QAM and π/2-64-NUC modulations only. π/2-rotation is applied to the 64-QAM and 64-NUC symbols at the output of the interleaver block.

##### 28.5.3.3.3 EDMG modulated fields of MU PPDU transmission

Figure 28-16 shows the transmitter blocks used to generate the EDMG modulated fields of an MU PPDU. The EDMG-STF and EDMG-CEF fields are generated using the Preamble builder block. The TRN field is generated using TRN builder block. The EDMG-Header-B and Data field of the PPDU are generated using scrambler, LDPC encoder, constellation mapper, interleaver, and GI insertion blocks. The PPDU encoding uses seed value defined in the EDMG-Header-B and has independent flows per user. The EDMG-Header-B encoding is defined in 28.5.6. The space-time streams mapping is defined in 28.5.9.4.4. The total number of space-time streams per user shall be less than or equal to 2. If STBC encoder is applied, then a single spatial stream is mapped to two space-time streams as defined in 28.5.9.5.4. The $N_{STS}$ space-time streams are further mapped to $N_{TX}$ transmit chains, where $N_{STS} \le N_{TX}$.

NOTE—Interleaver is applied to π/2-64-QAM and π/2-64-NUC modulations only. π/2-rotation is applied to the 64-QAM and 64-NUC symbols at the output of the interleaver block.

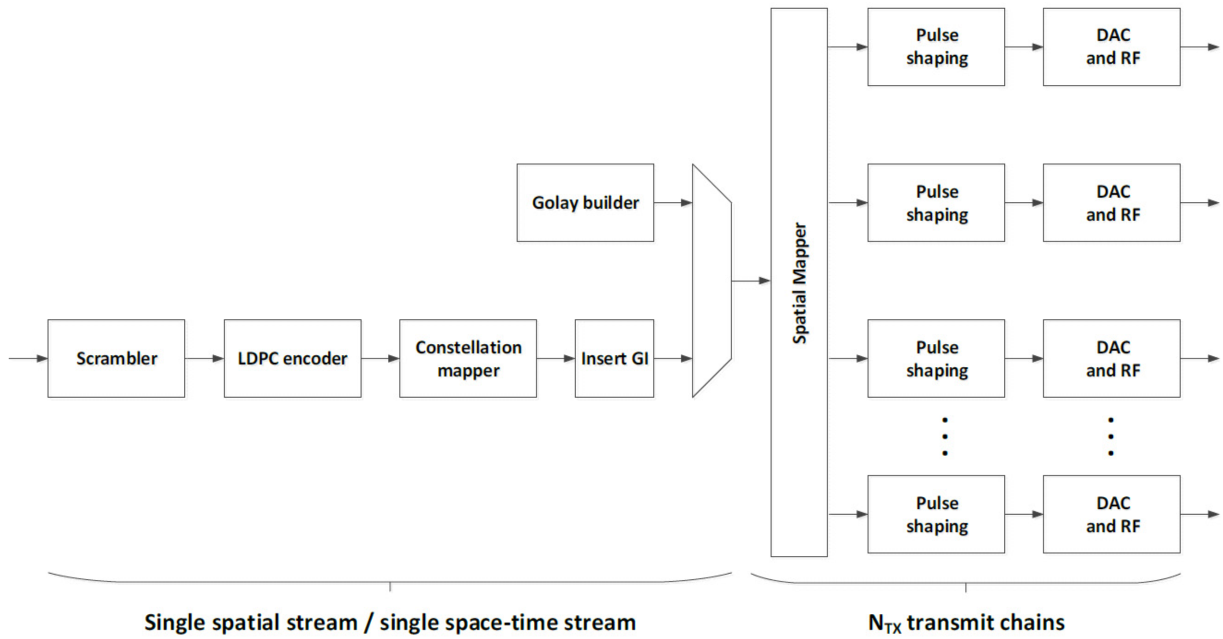


**Figure 28-14—Transmitter block diagram for non-EDMG PPDU transmission**

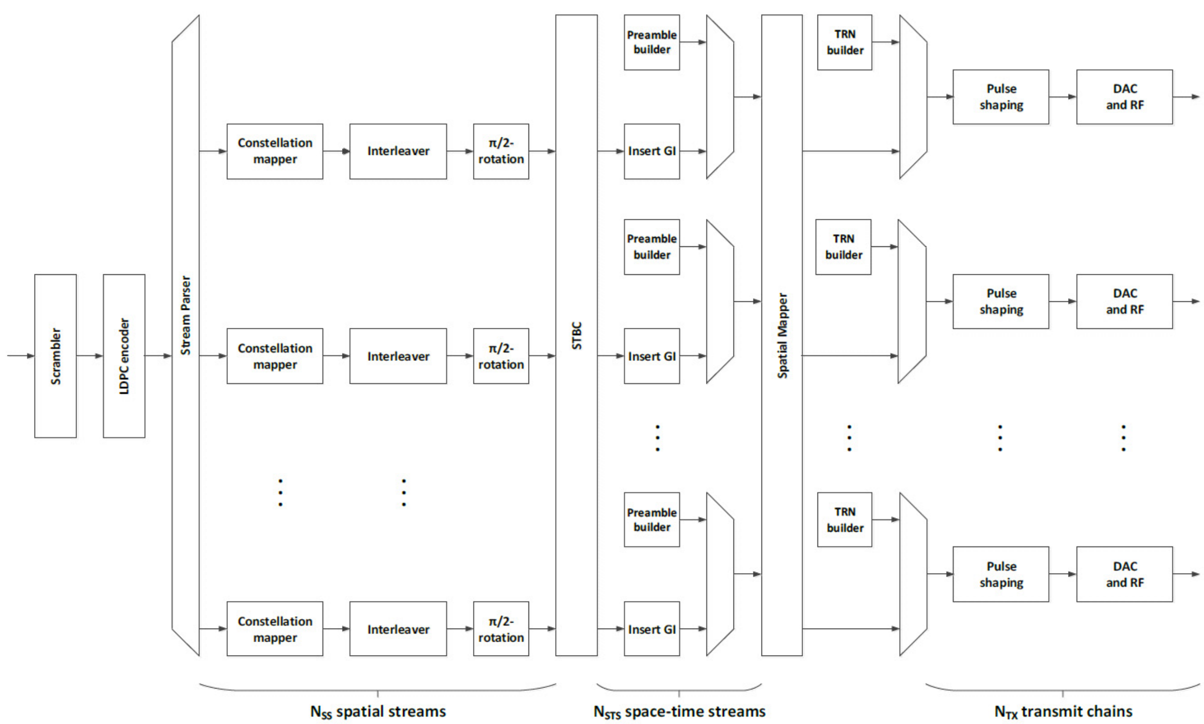


**Figure 28-15—Transmitter block diagram for the EDMG modulated fields of an SU PPDU transmission**

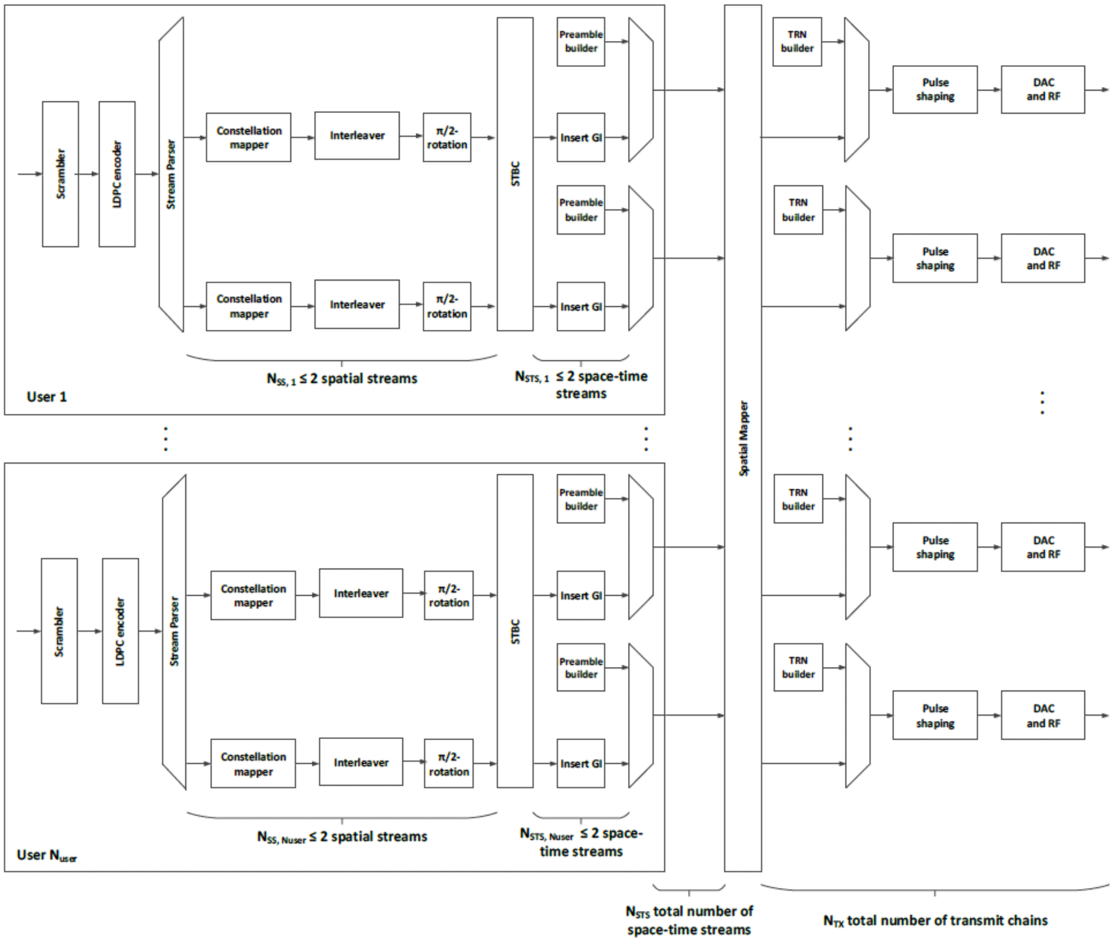


**Figure 28-16—Transmitter block diagram for the EDMG modulated fields of an MU PPDU transmission**

### 28.5.4 EDMG-STF definition

#### 28.5.4.1 General

The structure of the EDMG-STF field depends on the number of contiguous 2.16 GHz channels over which an EDMG PPDU is transmitted and the index $i_{STS}$ of the $i_{STS}$<sup></sup>th space-time stream.

For single space-time stream EDMG PPDU transmissions using the EDMG SC mode over a single 2.16 GHz channel, the EDMG-STF field is not present.

For EDMG SC transmissions, the EDMG-STF field shall be modulated using π/2-BPSK.

The Golay sequences used in the definition of the EDMG-STF are found in 28.10.

#### 28.5.4.2 Definition

The EDMG-STF field transmit waveform in time domain shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ and chip time duration $T_{c\ EDMG}$. The EDMG-STF field for the $i_{TX}$th transmit chain is defined as follows:

$$r_{EDMG\text{-}STF}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)=\frac{1}{\sqrt{N_{STS}}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{EDMG}\right]_{i_{TX},i_{STS}}r_{STF}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)$$

where

| | |
|---|---|
| $N_{STS}$ | is a total number of space-time streams |
| $r_{STF}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)$ | is the short training field definition for $i_{STS}$th space-time stream |
| $Q_{EDMG}$ | is a spatial mapping matrix |
| $[\ ]_{m,n}$ | is a matrix element from $m$th row and $n$th column |

For spatial expansion, $N_{STS} = 1 \leq N_{TX}$, the spatial mapping matrix $Q$ is defined as the column vector composed of all 1s of size $N_{TX}$ by 1. The spatial expansion is performed by application of CSD over different transmit chains as defined in 28.5.10.

The EDMG-STF field is composed of 18 repetitions of $Ga_{128\times N_{CB}}^{i_{STS}}$ followed by one with inverse sign $-Ga_{128\times N_{CB}}^{i_{STS}}$. The waveform for the EDMG-STF field, $r_{STF}^{i_{STS}}\left(qT_c\right)$, is defined as follows:

$$r_{STF}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)=\left(\sum_{n=1}^{18}Ga_{128\times N_{CB}}^{i_{STS}}\left(q-128\times(n-1)\times N_{CB}\right)-Ga_{128\times N_{CB}}^{i_{STS}}\left(q-128\times 18\times N_{CB}\right)\right)$$

Note that sequence $Ga_{128\times N_{CB}}^{i_{STS}}(n)$ is defined for $0 \leq n \leq 128 \times N_{CB} - 1$. For other values of $n$, $Ga_{128\times N_{CB}}^{i_{STS}}(n)$ is set to 0.

### 28.5.5 EDMG-CEF definition

#### 28.5.5.1 General

The structure of the EDMG-CEF field depends on the number of contiguous 2.16 GHz channels over which an EDMG PPDU is transmitted and the number, $i_{STS}$, of space-time streams.

For single space-time stream EDMG PPDU transmissions using the EDMG SC mode over a single 2.16 GHz channel, the EDMG-CEF field is not present.

For EDMG SC transmissions, the EDMG-CEF field shall be modulated using π/2-BPSK.

The pairs of Golay complementary sequences ($Ga^{iSTS}{}_{128}$, $Gb^{iSTS}{}_{128}$), ($Ga^{iSTS}{}_{256}$, $Gb^{iSTS}{}_{256}$), ($Ga^{iSTS}{}_{384}$, $Gb^{iSTS}{}_{384}$) and ($Ga^{iSTS}{}_{512}$, $Gb^{iSTS}{}_{512}$) used in the definition of the EDMG-CEF field for different space-time streams are specified in 28.10.

### 28.5.5.2 Definition

The EDMG-CEF field transmit waveform in time domain shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ and chip time duration $T_{c\ EDMG}$. The EDMG-CEF field is composed of $N_{EDMG\text{-}CEF}^{N_{STS}}$ subfields for the $i_{TX}$th transmit chain is defined as follows:

$$r_{EDMG\text{-}CEF}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)=\frac{1}{\sqrt{N_{STS}}}\sum_{n=1}^{N_{EDMG\text{-}CEF}^{N_{STS}}}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{EDMG}\right]_{i_{TX},i_{STS}}\left[P_{EDMG\text{-}CEF}\right]_{i_{STS},n} r_{CE,m}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}-nT_{EDMG\text{-}CEF,m}\right),$$

$$m=1\ for\ n=1;\ m=2\ for\ n>1$$

$$T_{EDMG\text{-}CEF,1}=1152\times T_c\ ,\ T_{EDMG\text{-}CEF,2}=1280\times T_c$$

where

| | |
|---|---|
| $N_{EDMG\text{-}CEF}^{N_{STS}}$ | is the total number of EDMG-CEF subfields, where index $n$ defines a subfield number |
| $N_{STS}$ | is a total number of space-time streams |
| $r_{CE,m}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)$ | is a channel estimation field definition for the $i_{STS}$th space-time stream, where $m$ = 1 for $n$ = 1 and $m$ = 2 for $n$ > 1 |
| $T_{EDMG\text{-}CEF}$ | is the EDMG-CEF subfield duration |
| $P_{EDMG\text{-}CEF}$ | is an EDMG-CEF mapping matrix |
| $Q_{EDMG}$ | is a spatial mapping matrix |
| $[\ ]_{m,n}$ | is a matrix element from $m$th row and $n$th column |

For spatial expansion, $N_{STS} = 1 \le N_{TX}$, the spatial mapping matrix $Q$ is defined as the column vector composed of all 1s of size $N_{TX}$ by 1. The spatial expansion is performed by application of CSD over different transmit chains as defined in 28.5.10.

The waveform for the channel estimation subfield, $r_{CE,1}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)$, is defined as follows:

$$r_{CE,1}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)=\left(Gu_{512\times N_{CB}}^{i_{STS}}(q)+Gv_{512\times N_{CB}}^{i_{STS}}\left(q-512\times N_{CB}\right)-Gb_{128\times N_{CB}}^{i_{STS}}\left(q-1024\times N_{CB}\right)\right)$$
$$\cdot\exp\left(j(\pi/2)q\right),q=0,1,...,1152\times N_{CB}-1$$

The waveform for the channel estimation subfield, $r_{CE,2}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)$, is defined as follows:

$$r_{CE,2}^{i_{STS}}\left(q\frac{T_c}{N_{CB}}\right)=\left(-Ga_{128\times N_{CB}}^{i_{STS}}(q)+Gu_{512\times N_{CB}}^{i_{STS}}\left(q-128\times N_{CB}\right)+Gv_{512\times N_{CB}}^{i_{STS}}\left(q-640\times N_{CB}\right)\right.$$
$$\left.-Gb_{128\times N_{CB}}^{i_{STS}}\left(q-1152\times N_{CB}\right)\right)\cdot\exp\left(j(\pi/2)q\right),q=0,1,...,1280\times N_{CB}-1$$

Note that sequences $Ga_{128\times N_{CB}}^{i_{STS}}(n)$ and $Gb_{128\times N_{CB}}^{i_{STS}}(n)$, $i_{STS}$ = 1, 2, …, 8, are defined for $0 \le n \le 128 \times N_{CB} - 1$.

For other values of $n$, $Ga_{128\times N_{CB}}^{i_{STS}}(n)$ and $Gb_{128\times N_{CB}}^{i_{STS}}(n)$ are set to 0.

The sequences $Gu_{512\times N_{CB}}^{i_{STS}}(n)$ and $Gv_{512\times N_{CB}}^{i_{STS}}(n)$ are defined as follows:

$$Gu_{512\times N_{CB}}^{i_{STS}} = \begin{bmatrix} -Gb_{128\times N_{CB}}^{i_{STS}} & -Ga_{128\times N_{CB}}^{i_{STS}} & +Gb_{128\times N_{CB}}^{i_{STS}} & -Ga_{128\times N_{CB}}^{i_{STS}} \end{bmatrix}, \text{ for } i_{STS} = 1, 2, 3, 4, 5, 6, 7, 8$$

$$Gv_{512\times N_{CB}}^{i_{STS}} = \begin{bmatrix} -Gb_{128\times N_{CB}}^{i_{STS}} & +Ga_{128\times N_{CB}}^{i_{STS}} & -Gb_{128\times N_{CB}}^{i_{STS}} & -Ga_{128\times N_{CB}}^{i_{STS}} \end{bmatrix}, \text{ for } i_{STS} = 1, 2, 3, 4, 5, 6, 7, 8$$

Note that sequences $Gu_{512\times N_{CB}}^{i_{STS}}(n)$ and $Gv_{512\times N_{CB}}^{i_{STS}}(n)$ are defined for $0 \le n \le 512 \times N_{CB} - 1$. For other values of $n$, $Gu_{512\times N_{CB}}^{i_{STS}}(n)$ and $Gv_{512\times N_{CB}}^{i_{STS}}(n)$ are set to 0.

The EDMG-CEF mapping matrix for $N_{STS} = 1, 2$ is defined as follows:

$$P_{EDMG-CEF} = \begin{bmatrix} +1 \\ +1 \end{bmatrix}, N_{EDMG-CEF}^{N_{STS}} = 1$$

The EDMG-CEF mapping matrix for $N_{STS} = 3, 4$ is defined as follows:

$$P_{EDMG-CEF} = \begin{bmatrix} +1 & +1 \\ +1 & +1 \\ +1 & -1 \\ +1 & -1 \end{bmatrix}, N_{EDMG-CEF}^{N_{STS}} = 2$$

The EDMG-CEF mapping matrix for $N_{STS} = 5, 6, 7$, and 8 is defined as follows:

$$P_{EDMG-CEF} = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \\ +1 & -1 & -1 & +1 \end{bmatrix}, N_{EDMG-CEF}^{N_{STS}} = 4$$

### 28.5.6 Encoding of EDMG-Header-B

The EDMG-Header-B for the $i_{user}{}^{th}$ user shall be encoded as follows:

- The input 64 bits of the EDMG-Header-B, $\mathbf{b} = (b_1, b_2, ..., b_{64})$, are scrambled with the PN sequence described in 20.3.9, starting from the eighth bit to create the $\mathbf{bq} = (bq_1, bq_2, ..., bq_{64})$ sequence. The scrambler seed value is initialized by the first seven bits of the EDMG-Header-B.
- The LDPC codeword of length 672 bits is created by concatenating the 440 0s to the scrambled header bits $\mathbf{bq} = (bq_1, bq_2, ..., bq_{64})$ and then computing 168 parity bits $\mathbf{p} = (p_1, p_2, ..., p_{168})$ using the LDPC matrix with $R = 3/4$ and $L_{CW} = 672$ defined in 20.3.8.4. The LDPC codeword is defined as $(bq_1, bq_2, ..., bq_{64}, 0_1, 0_2, ..., 0_{440}, p_1, p_2, ..., p_{168})$.

— The zero padded bits are discarded and the output codeword is defined as $\mathbf{c} = (\mathbf{c}_1, \mathbf{c}_2)$, where
  — $\mathbf{c}_1 = (bq_1, bq_2, ..., bq_{64}, p_1, p_2, ..., p_{160})$
  — $\mathbf{c}_2 = (bq_1, bq_2, ..., bq_{64}, p_1, p_2, ..., p_{152}, p_{161}, p_{162}, ..., p_{168})$

— For a PPDU transmitted over a $N_{CB}$ × 2.16 GHz channel, where $1 \le N_{CB} \le 4$, the data block is defined as a repetition of codeword **c** by $N_{CB}$ times:
  — **cb** = **c** for $N_{CB} = 1$
  — **cb** = (**c**, **c**) for $N_{CB} = 2$
  — **cb** = (**c**, **c**, **c**) for $N_{CB} = 3$
  — **cb** = (**c**, **c**, **c**, **c**) for $N_{CB} = 4$

— For a PPDU transmitted using $N_{STS}$ ($N_{STS}$ = 1, 2) space-time streams, the data block **cb** is repeated $N_{STS}$ times. Then, the $N_{STS}$ data blocks are scrambled continuously with the PN sequence defined in 28.5.9.3.2 without seed reset. The initial seed value is equal to all 1s $(1_1, 1_2, ..., 1_7)$. The scrambling starts at the 225$^{th}$ bit and ends at the $(N_{STS} \times 448 \times N_{CB})^{th}$ bit. The first scrambled **cb** block is mapped to the first space-time stream and the second scrambled **cb** block to the second space-time stream.

The SC data blocks shall be modulated using π/2-BPSK modulation as defined in 20.5.3.2.4. Each SC data block is prepended with a guard interval as defined in 28.5.9.2.

The EDMG-Header-B field is transmitted by applying EDMG transmission format defined in 28.5.9.5.2.

### 28.5.7 Encoding of EDMG-Header-A for EDMG A-PPDU transmission

The EDMG-Header-A field in the first EDMG PPDU in an EDMG SC mode A-PPDU (i.e., $i_{PPDU} = 1$, where $i_{PPDU}$ represents the index of the PPDU into the EDMG A-PPDU) is encoded and modulated as specified in 28.3.3.3.2.4.

For the $i_{PPDU}{}^{th}$ EDMG PPDU in the EDMG SC mode A-PPDU, $i_{PPDU} > 1$, the EDMG-Header-A field shall be encoded and modulated as follows:

— The input 112 header bits are appended with 16 HCS bits calculated as defined in 20.3.7.
— The resulting 128 bits including CRC, **b** = ($b_1$, $b_2$,…, $b_{128}$), are scrambled with the PN sequence as described in 20.3.9, starting from the first bit using a continuation of the scrambler bit sequence from the Data field of preceding EDMG PPDU in the EDMG SC mode A-PPDU to create the **bq** = ($bq_1$, $bq_2$,…, $bq_{128}$) sequence.
— The scrambled header bits, **bq**, are divided into two parts **bq1** = ($bq_1$, $bq_2$,…, $bq_{64}$) and **bq2** = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$) of 64 bits each.
— Two LDPC codewords of length 672 bits each are created by concatenating the 440 0s to each part, **bq1** and **bq2**, and then computing 168 parity bits **p1** = ($p1_1$, $p1_2$,…, $p1_{168}$) and **p2** = ($p2_1$, $p2_2$,…, $p2_{168}$) for **bq1** and **bq2**, respectively, using the LDPC matrix with $R$ = 3/4 and $L_{CW}$ = 672 defined in 20.3.8.4. The LDPC codewords are defined as follows:
  — **cw1** = ($bq_1$, $bq_2$,…, $bq_{64}$, $0_1$, $0_2$,…, $0_{440}$, $p1_1$, $p1_2$,…, $p1_{168}$)
  — **cw2** = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $0_1$, $0_2$,…, $0_{440}$, $p2_1$, $p2_2$,…, $p2_{168}$)
— The padded 0s are discarded and two output codewords are defined as **c1** = ($c1_1$, $c1_2$) and **c2** = ($c2_1$, $c2_2$), where
  — $\mathbf{c1_1}$ = ($bq_1$, $bq_2$,…, $bq_{64}$, $p1_1$, p$1_2$,…, $p1_{160}$)
  — $\mathbf{c1_2}$ = ($bq_1$, $bq_2$,…, $bq_{64}$, $p1_1$, $p1_2$,…, $p1_{152}$, $p1_{161}$, $p1_{162}$,…, $p1_{168}$)

- — **c2**$_1$ = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $p2_1$, $p2_2$,…, $p2_{160}$)
- — **c2**$_2$ = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $p2_1$, $p2_2$,…, $p2_{152}$, $p2_{161}$, $p2_{162}$,…, $p2_{168}$)

— For a PPDU transmitted over an $N_{CB}$ × 2.16 GHz channel, where 1 ≤ $N_{CB}$ ≤ 4, the data blocks are defined as a repetition of codeword **c1** and **c2** by $N_{CB}$ times:

- — **cb1** = c1, **cb2** = c2 for $N_{CB}$ = 1
- — **cb1** = (c1, c1), **cb2** = (c2, c2) for $N_{CB}$ = 2
- — **cb1** = (c1, c1, c1), **cb2** = (c2, c2, c2) for $N_{CB}$ = 3
- — **cb1** = (c1, c1, c1, c1), **cb2** = (c2, c2, c2, c2) for $N_{CB}$ = 4

— For a PPDU transmitted using $N_{STS}$ ($N_{STS}$ = 1, 2, …, 8) space-time streams, the data blocks **cb1** and **cb2** are concatenated as **cb** = (**cb1**, **cb2**) and the data block **cb** is repeated $N_{STS}$ times. Then, the $N_{STS}$ data blocks **cb** are scrambled continuously with the PN sequence defined in 28.5.9.3.2 without seed reset. The initial seed value is equal to all 1s ($1_1$, $1_2$,…, $1_7$). The scrambling starts at the 225$^{th}$ bit and ends at the ($N_{STS}$ × 896 × $N_{CB}$)$^{th}$ bit. The first scrambled **cb** block is mapped to the first space-time stream and the second scrambled **cb** block to the second space-time stream, and so on.

The data blocks shall be modulated using π/2-BPSK modulation as defined in 20.5.3.2.4. Each of the modulated data blocks **cb1** and **cb2** is prepended with 64 × $N_{CB}$ guard symbols, and the data block **cb2** is appended with appropriate number of guard symbols as described in 28.5.9.2.3.

The EDMG-Header-A field for $i_{PPDU}$ > 1 is transmitted by applying the EDMG transmission format defined in 28.5.9.5.2.

### 28.5.8 Modulation and coding scheme (MCS)

The MCS is a value that determines the modulation and coding. For an EDMG PPDU, the MCS value is carried in the EDMG-Header-A field and in the EDMG-Header-B field. The data rate provided by an MCS depends on the guard interval length, the number of spatial streams, $N_{SS}$ (1 ≤ $N_{SS}$ ≤ 8), and the number of contiguous 2.16 GHz channels, $N_{CB}$ (1 ≤ $N_{CB}$ ≤ 4), that make up the signal bandwidth of an EDMG PPDU.

The set of MCSs for an EDMG SC mode PPDU are defined in Table 28-48, where $N_{CB}$ is as defined above. If the π/2-8-PSK Applied field in the EDMG-Header-A of an SU PPDU is 1, then MCS 12 and 13 shall use π/2-8-PSK modulation as indicated in Table 28-49. If the π/2-64-NUC Applied field in the EDMG-Header-A or in the EDMG-Header-B is 1, then MCS 17 through 21 shall use π/2-64-NUC modulation as indicated in Table 28-50. If the DCM BPSK Applied field in the EDMG-Header-A of an SU PPDU is 1, then MCS 2 through 6 shall use DCM BPSK modulation as indicated in Table 28-51.

For a given type of guard interval used in the transmission of an EDMG SC mode PPDU, the total transmission data rate, ρ, provided by the PPDU is defined as follows:

$$\rho = \sum_{i_{ss}=1}^{N_{ss}} Data\_rate_{i_{ss}}$$

where

| | |
|---|---|
| $N_{SS}$ | is as defined above |
| $Data\_rate_{i_{ss}}$ | is the data rate provided by the MCS of spatial stream $i_{ss}$ as defined in Table 28-48 |

Transmit and receive support for MCSs 1 to 5 and 7 to 10 are mandatory. Other MCSs are optional. MCS indexes exceeding the largest MCS index defined in Table 28-48 are reserved.

NOTE 1—The LDPC code with rate 7/8 can use a superimposed or puncturing code selected by the Superimposed Code Applied field defined in the EDMG-Header-A or EDMG-Header-B, as appropriate. The encoding procedure for both cases is described in 28.5.9.4.3.

NOTE 2—The LDPC code with rate 2/3 is generated by employing the original LDPC code with rate 3/4 and applying the codeword shortening procedure to achieve the effective code rate. The LDPC code with rate 5/6 is generated by employing the original LDPC code with rate 7/8 and applying the codeword shortening procedure to achieve the effective code rate. Therefore, similar to the LDPC code with rate 7/8, the LDPC code with rate 5/6 is obtained by using a superimposed or puncturing code selected by the Superimposed Code Applied field defined in the EDMG-Header-A or EDMG-Header-B, as appropriate. The encoding procedure for both cases is described in 28.5.9.4.3.

### Table 28-48—EDMG-MCSs for the EDMG SC mode

| EDMG-MCS index | Modulation | $N_{CBPS}$ | Repetition | Code rate | Data rate per spatial stream (Mb/s) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Normal GI | Short GI | Long GI |
| 1 | π/2-BPSK | 1 | 2 | 1/2 | $N_{CB}$×385.00 | $N_{CB}$×412.50 | $N_{CB}$×330.00 |
| 2 | π/2-BPSK | 1 | 1 | 1/2 | $N_{CB}$×770.00 | $N_{CB}$×825.00 | $N_{CB}$×660.00 |
| 3 | π/2-BPSK | 1 | 1 | 5/8 | $N_{CB}$×962.50 | $N_{CB}$×1031.25 | $N_{CB}$×825.00 |
| 4 | π/2-BPSK | 1 | 1 | 3/4 | $N_{CB}$×1155.00 | $N_{CB}$×1237.50 | $N_{CB}$×990.00 |
| 5 | π/2-BPSK | 1 | 1 | 13/16 | $N_{CB}$×1251.25 | $N_{CB}$×1340.63 | $N_{CB}$×1072.50 |
| 6 | π/2-BPSK | 1 | 1 | 7/8 | $N_{CB}$×1347.50 | $N_{CB}$×1443.75 | $N_{CB}$×1155.00 |
| 7 | π/2-QPSK | 2 | 1 | 1/2 | $N_{CB}$×1540.00 | $N_{CB}$×1650.00 | $N_{CB}$×1320.00 |
| 8 | π/2-QPSK | 2 | 1 | 5/8 | $N_{CB}$×1925.00 | $N_{CB}$×2062.50 | $N_{CB}$×1650.00 |
| 9 | π/2-QPSK | 2 | 1 | 3/4 | $N_{CB}$×2310.00 | $N_{CB}$×2475.00 | $N_{CB}$×1980.00 |
| 10 | π/2-QPSK | 2 | 1 | 13/16 | $N_{CB}$×2502.50 | $N_{CB}$×2681.25 | $N_{CB}$×2145.00 |
| 11 | π/2-QPSK | 2 | 1 | 7/8 | $N_{CB}$×2695.00 | $N_{CB}$×2887.50 | $N_{CB}$×2310.00 |
| 12 | π/2-16-QAM | 4 | 1 | 1/2 | $N_{CB}$×3080.00 | $N_{CB}$×3300.00 | $N_{CB}$×2640.00 |
| 13 | π/2-16-QAM | 4 | 1 | 5/8 | $N_{CB}$×3850.00 | $N_{CB}$×4125.00 | $N_{CB}$×3300.00 |
| 14 | π/2-16-QAM | 4 | 1 | 3/4 | $N_{CB}$×4620.00 | $N_{CB}$×4950.00 | $N_{CB}$×3960.00 |
| 15 | π/2-16-QAM | 4 | 1 | 13/16 | $N_{CB}$×5005.00 | $N_{CB}$×5362.50 | $N_{CB}$×4290.00 |
| 16 | π/2-16-QAM | 4 | 1 | 7/8 | $N_{CB}$×5390.00 | $N_{CB}$×5775.00 | $N_{CB}$×4620.00 |
| 17 | π/2-64-QAM | 6 | 1 | 1/2 | $N_{CB}$×4620.00 | $N_{CB}$×4950.00 | $N_{CB}$×3960.00 |
| 18 | π/2-64-QAM | 6 | 1 | 5/8 | $N_{CB}$×5775.00 | $N_{CB}$×6187.50 | $N_{CB}$×4950.00 |
| 19 | π/2-64-QAM | 6 | 1 | 3/4 | $N_{CB}$×6930.00 | $N_{CB}$×7425.00 | $N_{CB}$×5940.00 |
| 20 | π/2-64-QAM | 6 | 1 | 13/16 | $N_{CB}$×7507.50 | $N_{CB}$×8043.75 | $N_{CB}$×6435.00 |
| 21 | π/2-64-QAM | 6 | 1 | 7/8 | $N_{CB}$×8085.00 | $N_{CB}$×8662.50 | $N_{CB}$×6930.00 |

### Table 28-49—EDMG-MCSs 12 and 13 for the EDMG SC mode if the π/2-8-PSK Applied field is 1

| EDMG-MCS index | Modulation | $N_{CBPS}$ | Repetition | Code rate | Data rate per spatial stream (Mb/s) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Normal GI | Short GI | Long GI |
| 12 | π/2-8-PSK | 3 | 1 | 2/3 | $N_{CB}$×3080.00 | $N_{CB}$×3300.00 | $N_{CB}$×2640.00 |
| 13 | π/2-8-PSK | 3 | 1 | 5/6 | $N_{CB}$×3850.00 | $N_{CB}$×4125.00 | $N_{CB}$×3300.00 |

### Table 28-50—EDMG-MCSs 17 to 21 for the EDMG SC mode if the π/2-64-NUC Applied field is 1

| EDMG-MCS index | Modulation | $N_{CBPS}$ | Repetition | Code rate | Data rate per spatial stream (Mb/s) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Normal GI | Short GI | Long GI |
| 17 | π/2-64-NUC | 6 | 1 | 1/2 | $N_{CB}$×4620.00 | $N_{CB}$×4950.00 | $N_{CB}$×3960.00 |
| 18 | π/2-64-NUC | 6 | 1 | 5/8 | $N_{CB}$×5775.00 | $N_{CB}$×6187.50 | $N_{CB}$×4950.00 |
| 19 | π/2-64-NUC | 6 | 1 | 3/4 | $N_{CB}$×6930.00 | $N_{CB}$×7425.00 | $N_{CB}$×5940.00 |
| 20 | π/2-64-NUC | 6 | 1 | 13/16 | $N_{CB}$×7507.50 | $N_{CB}$×8043.75 | $N_{CB}$×6435.00 |
| 21 | π/2-64-NUC | 6 | 1 | 7/8 | $N_{CB}$×8085.00 | $N_{CB}$×8662.50 | $N_{CB}$×6930.00 |

### Table 28-51—EDMG-MCSs 2 to 6 for the EDMG SC mode if the DCM BPSK Applied field is 1

| EDMG-MCS index | Modulation | $N_{CBPS}$ | Repetition | Code rate | Data rate per spatial stream (Mb/s) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Normal GI | Short GI | Long GI |
| 2 | DCM π/2-BPSK | 1 | 1 | 1/2 | $N_{CB}$×770.00 | $N_{CB}$×825.00 | $N_{CB}$×660.00 |
| 3 | DCM π/2-BPSK | 1 | 1 | 5/8 | $N_{CB}$×962.50 | $N_{CB}$×1031.25 | $N_{CB}$×825.00 |
| 4 | DCM π/2-BPSK | 1 | 1 | 3/4 | $N_{CB}$×1155.00 | $N_{CB}$×1237.50 | $N_{CB}$×990.00 |
| 5 | DCM π/2-BPSK | 1 | 1 | 13/16 | $N_{CB}$×1251.25 | $N_{CB}$×1340.63 | $N_{CB}$×1072.50 |
| 6 | DCM π/2-BPSK | 1 | 1 | 7/8 | $N_{CB}$×1347.50 | $N_{CB}$×1443.75 | $N_{CB}$×1155.00 |

### 28.5.9 Data field

#### 28.5.9.1 Guard interval definition

Three types of GIs are defined: short, normal and long. An EDMG STA shall support the normal GI for each combination of channel bandwidth and number of spatial streams supported by the EDMG STA. All GI sequences are defined at the $N_{CB} \times F_c$ sampling rate, where $N_{CB}$ is the integer number of 2.16 GHz channels that make up the channel bandwidth and $1 \le N_{CB} \le 4$.

The following GI nomenclature is used: $GI^{iSTS}{}_N$ and $GIe^{iSTS}{}_N$. Here, $i_{STS}$ represents the space-time stream number, and $N$ represents the sequence length.

The GIs definitions utilize $GI^{iSTS}{}_{64}$ and $GIe^{iSTS}{}_N$. $GI^{iSTS}{}_{64}$ shall be equal to $+Ga^{iSTS}{}_{64}$ for all cases. However, the definition of $GIe^{iSTS}{}_N$ depends on the value of $N_{CB}$. Table 28-52, Table 28-53, Table 28-54, and Table 28-55 define $GIe^{iSTS}{}_N$ for $N_{CB} = 1$, $N_{CB} = 2$, $N_{CB} = 3$, and $N_{CB} = 4$, respectively.

**Table 28-52—*GIe* definition for 2.16 GHz or 2.16+2.16 GHz ($N_{CB}$ = 1) channel**

| Space-time stream number ($i_{STS}$) | Short GI | Normal GI | Long GI |
|---|---|---|---|
| 1 | $GIe^1{}_{32} = -Gc^1{}_{32}$ | $GIe^1{}_{64} = +Ga^1{}_{64}$ | $GIe^1{}_{128} = -Gc^1{}_{128}$ |
| 2 | $GIe^2{}_{32} = -Gc^2{}_{32}$ | $GIe^2{}_{64} = +Ga^2{}_{64}$ | $GIe^2{}_{128} = -Gc^2{}_{128}$ |
| 3 | $GIe^3{}_{32} = -Gc^3{}_{32}$ | $GIe^3{}_{64} = +Ga^3{}_{64}$ | $GIe^3{}_{128} = -Gc^3{}_{128}$ |
| 4 | $GIe^4{}_{32} = -Gc^4{}_{32}$ | $GIe^4{}_{64} = +Ga^4{}_{64}$ | $GIe^4{}_{128} = -Gc^4{}_{128}$ |
| 5 | $GIe^5{}_{32} = -Gc^5{}_{32}$ | $GIe^5{}_{64} = +Ga^5{}_{64}$ | $GIe^5{}_{128} = -Gc^5{}_{128}$ |
| 6 | $GIe^6{}_{32} = -Gc^6{}_{32}$ | $GIe^6{}_{64} = +Ga^6{}_{64}$ | $GIe^6{}_{128} = -Gc^6{}_{128}$ |
| 7 | $GIe^7{}_{32} = -Gc^7{}_{32}$ | $GIe^7{}_{64} = +Ga^7{}_{64}$ | $GIe^7{}_{128} = -Gc^7{}_{128}$ |
| 8 | $GIe^8{}_{32} = -Gc^8{}_{32}$ | $GIe^8{}_{64} = +Ga^8{}_{64}$ | $GIe^8{}_{128} = -Gc^8{}_{128}$ |

**Table 28-53—*GIe* definition for 4.32 GHz or 4.32+4.32 GHz ($N_{CB}$ = 2) channel**

| Space-time stream number ($i_{STS}$) | Short GI | Normal GI | Long GI |
|---|---|---|---|
| 1 | $GIe^1{}_{64} = -Gc^1{}_{64}$ | $GIe^1{}_{128} = +Ga^1{}_{128}$ | $GIe^1{}_{256} = +Ga^1{}_{256}$ |
| 2 | $GIe^2{}_{64} = -Gc^2{}_{64}$ | $GIe^2{}_{128} = +Ga^2{}_{128}$ | $GIe^2{}_{256} = +Ga^2{}_{256}$ |
| 3 | $GIe^3{}_{64} = +Gc^3{}_{64}$ | $GIe^3{}_{128} = +Ga^3{}_{128}$ | $GIe^3{}_{256} = +Ga^3{}_{256}$ |
| 4 | $GIe^4{}_{64} = +Gc^4{}_{64}$ | $GIe^4{}_{128} = +Ga^4{}_{128}$ | $GIe^4{}_{256} = +Ga^4{}_{256}$ |
| 5 | $GIe^5{}_{64} = +Gc^5{}_{64}$ | $GIe^5{}_{128} = +Ga^5{}_{128}$ | $GIe^5{}_{256} = +Ga^5{}_{256}$ |
| 6 | $GIe^6{}_{64} = +Gc^6{}_{64}$ | $GIe^6{}_{128} = +Ga^6{}_{128}$ | $GIe^6{}_{256} = +Ga^6{}_{256}$ |
| 7 | $GIe^7{}_{64} = -Gc^7{}_{64}$ | $GIe^7{}_{128} = +Ga^7{}_{128}$ | $GIe^7{}_{256} = +Ga^7{}_{256}$ |
| 8 | $GIe^8{}_{64} = -Gc^8{}_{64}$ | $GIe^8{}_{128} = +Ga^8{}_{128}$ | $GIe^8{}_{256} = +Ga^8{}_{256}$ |

**Table 28-54—*GIe* definition for 6.48 GHz ($N_{CB}$ = 3) channel**

| Space-time stream number ($i_{STS}$) | Short GI | Normal GI | Long GI |
|---|---|---|---|
| 1 | $GIe^{1}96 = +Ga^{1}_{96}$ | $GIe^{1}_{192} = +Ga^{1}_{192}$ | $GIe^{1}_{384} = +Ga^{1}_{384}$ |
| 2 | $GIe^{2}_{96} = +Ga^{2}_{96}$ | $GIe^{2}_{192} = +Ga^{2}_{192}$ | $GIe^{2}_{384} = +Ga^{2}_{384}$ |
| 3 | $GIe^{3}_{96} = +Ga^{3}_{96}$ | $GIe^{3}_{192} = +Ga^{3}_{192}$ | $GIe^{3}_{384} = +Ga^{3}_{384}$ |
| 4 | $GIe^{4}_{96} = +Ga^{4}_{96}$ | $GIe^{4}_{192} = +Ga^{4}_{192}$ | $GIe^{4}_{384} = +Ga^{4}_{384}$ |
| 5 | $GIe^{5}_{96} = +Ga^{5}_{96}$ | $GIe^{5}_{192} = +Ga^{5}_{192}$ | $GIe^{5}_{384} = +Ga^{5}_{384}$ |
| 6 | $GIe^{6}_{96} = +Ga^{6}_{96}$ | $GIe^{6}_{192} = +Ga^{6}_{192}$ | $GIe^{6}_{384} = +Ga^{6}_{384}$ |
| 7 | $GIe^{7}_{96} = +Ga^{7}_{96}$ | $GIe^{7}_{192} = +Ga^{7}_{192}$ | $GIe^{7}_{384} = +Ga^{7}_{384}$ |
| 8 | $GIe^{8}_{96} = +Ga^{8}_{96}$ | $GIe^{8}_{192} = +Ga^{8}_{192}$ | $GIe^{8}_{384} = +Ga^{8}_{384}$ |

**Table 28-55—*GIe* definition for 8.64 GHz ($N_{CB}$ = 4) channel**

| Space-time stream number ($i_{STS}$) | Short GI | Normal GI | Long GI |
|---|---|---|---|
| 1 | $GIe^{1}_{128} = +Ga^{1}_{128}$ | $GIe^{1}_{256} = +Ga^{1}_{256}$ | $GIe^{1}_{512} = +Ga^{1}_{512}$ |
| 2 | $GIe^{2}_{128} = +Ga^{2}_{128}$ | $GIe^{2}_{256} = +Ga^{2}_{256}$ | $GIe^{2}_{512} = +Ga^{2}_{512}$ |
| 3 | $GIe^{3}_{128} = -Ga^{3}_{128}$ | $GIe^{3}_{256} = +Ga^{3}_{256}$ | $GIe^{3}_{512} = +Ga^{3}_{512}$ |
| 4 | $GIe^{4}_{128} = -Ga^{4}_{128}$ | $GIe^{4}_{256} = +Ga^{4}_{256}$ | $GIe^{4}_{512} = +Ga^{4}_{512}$ |
| 5 | $GIe^{5}_{128} = -Ga^{5}_{128}$ | $GIe^{5}_{256} = +Ga^{5}_{256}$ | $GIe^{5}_{512} = +Ga^{5}_{512}$ |
| 6 | $GIe^{6}_{128} = -Ga^{6}_{128}$ | $GIe^{6}_{256} = +Ga^{6}_{256}$ | $GIe^{6}_{512} = +Ga^{6}_{512}$ |
| 7 | $GIe^{7}_{128} = -Ga^{7}_{128}$ | $GIe^{7}_{256} = +Ga^{7}_{256}$ | $GIe^{7}_{512} = +Ga^{7}_{512}$ |
| 8 | $GIe^{8}_{128} = -Ga^{8}_{128}$ | $GIe^{8}_{256} = +Ga^{8}_{256}$ | $GIe^{8}_{512} = +Ga^{8}_{512}$ |

### 28.5.9.2 Symbol blocking and guard insertion

#### 28.5.9.2.1 General

This subclause defines the symbol blocking and guard interval structure for each type of EDMG SC mode PPDU. The GIs used to define symbol blocking structure for the pre-EDMG modulated fields, EDMG-Header-B and Data field are defined in 28.5.9.1.

The SU PPDU symbol blocking and guard interval structure shall be as defined in 28.5.9.2.2. The SU A-PPDU symbol blocking and guard interval structure shall be as defined in 28.5.9.2.3.

The MU PPDU symbol blocking and guard interval structure shall be as defined in 28.5.9.2.4.

### 28.5.9.2.2 SU PPDU transmission

#### 28.5.9.2.2.1 General

This subclause defines an SU PPDU transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel with one or more space-time streams.

The SU PPDU structure for a 2.16 GHz PPDU transmission and a single space-time stream transmission ($N_{STS}$ = 1) is defined in 28.5.9.2.2.2. The SU PPDU structure for a 2.16 GHz or a 2.16+2.16 GHz PPDU transmission with more than one space-time streams ($N_{STS}$ > 1) and 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz PPDU transmissions with one or more space-time streams ($N_{STS}$ ≥ 1) is defined in 28.5.9.2.2.3.

#### 28.5.9.2.2.2 SU PPDU transmission over a 2.16 GHz or a 2.16+2.16 GHz channel with $N_{STS}$ = 1

An SU PPDU transmitted over a 2.16 GHz or a 2.16+2.16 GHz channel with a single space-time stream ($N_{STS}$ = 1) shall be defined at the DMG SC chip rate $F_c$. The PPDU of this type does not include the EDMG-STF and EDMG-CEF fields and the symbol blocking structure defined for the Data field continues the symbol blocking structure of the pre-EDMG modulated fields.

The EDMG SC mode SU PPDU symbol blocking structure for the short, normal and long GI shall be as shown in Figure 28-17, Figure 28-18, and Figure 28-19, respectively. An EDMG STA shall support the SU PPDU structure with normal GI as shown in Figure 28-18.

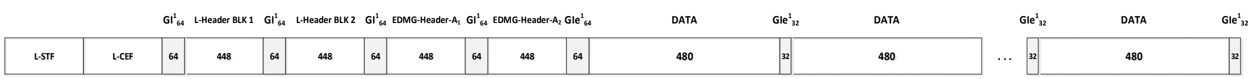


**Figure 28-17—SU PPDU structure: 2.16 GHz or 2.16+2.16 GHz channel, $N_{STS}$ = 1, short GI**

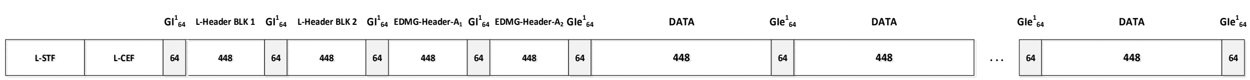


**Figure 28-18—SU PPDU structure: 2.16 GHz or 2.16+2.16 GHz channel, $N_{STS}$ = 1, normal GI**

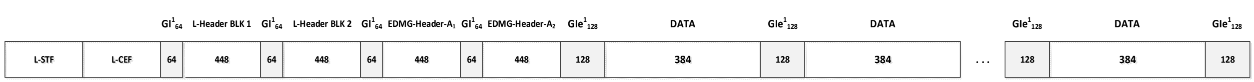


**Figure 28-19—SU PPDU structure: 2.16 GHz or 2.16+2.16 GHz channel, $N_{STS}$ = 1, long GI**

The single space-time stream of an SU PPDU may be mapped to $N_{TX}$ ≥ 1 transmit chains applying direct, indirect spatial mapping or digital beamforming as defined in 28.5.10.4.2. The single space-time stream may be mapped to $N_{TX}$ ≥ 1 transmit chains applying spatial expansion as defined in 28.5.10.4.4.

A TRN field per transmit chain (see 28.9.2.2.6) may be appended to an SU PPDU.

#### 28.5.9.2.2.3 SU PPDU transmission over a 2.16 GHz or 2.16+2.16 GHz channel with $N_{STS} > 1$ and over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channel with $N_{STS} \geq 1$

An SU PPDU transmitted over a 2.16 GHz or 2.16+2.16 GHz channel with more than one space-time stream ($N_{STS} > 1$) and an SU PPDU transmission over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channel with one or more space-time streams ($N_{STS} \geq 1$) shall have a sampling rate of $N_{CB} \times F_c$.

A PPDU of this type includes the EDMG-STF and EDMG-CEF fields separating the symbol blocking structure of the Data field and pre-EDMG modulated fields.

The symbol blocking structure for pre-EDMG modulated fields transmitted over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined at the DMG SC chip rate $F_c$ as shown in Figure 28-20.

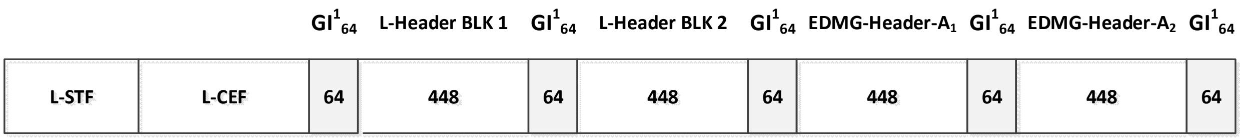


**Figure 28-20—SU PPDU structure: pre-EDMG modulated fields symbol blocking, 2.16 GHz or 2.16+2.16 GHz channel**

To transmit pre-EDMG modulated fields over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channel, the duplicate format defined in 28.5.10.4.4 shall be used.

To transmit pre-EDMG modulated fields using $N_{TX} > 1$ transmit chains, the format using cyclic shift diversity (CSD) defined in 28.5.10.4.4 shall be used.

The symbol blocking structure for the Data field of an SU PPDU for the short, normal and long GI shall be as shown in Figure 28-21, Figure 28-22, and Figure 28-23, respectively.

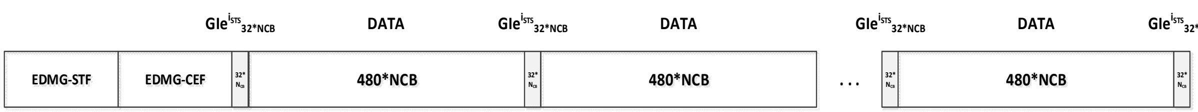


**Figure 28-21—SU PPDU structure: Data field symbol blocking, (2.16 GHz or 2.16+2.16 GHz, $N_{STS} > 1$) or (4.32 GHz, 6.48 GHz, 8.64 GHz or 4.32+4.32 GHz, $N_{STS} \geq 1$), short GI**

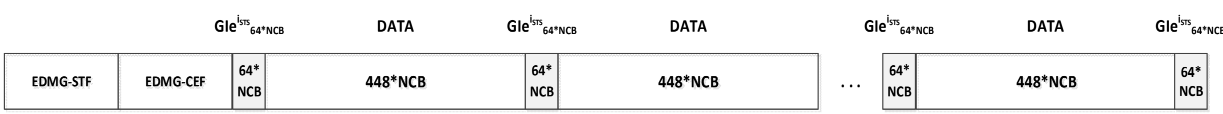


**Figure 28-22—SU PPDU structure: Data field symbol blocking, (2.16 GHz or 2.16+2.16 GHz, $N_{STS} > 1$) or (4.32 GHz, 6.48 GHz, 8.64 GHz or 4.32+4.32 GHz, $N_{STS} \geq 1$), normal GI**

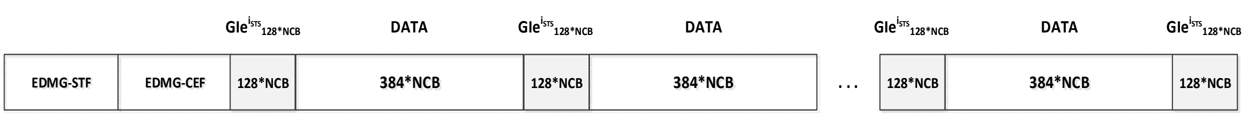


**Figure 28-23—SU PPDU structure: Data field symbol blocking, (2.16 GHz or 2.16+2.16 GHz, $N_{STS} > 1$) or (4.32 GHz, 6.48 GHz, 8.64 GHz or 4.32+4.32 GHz, $N_{STS} \geq 1$), long GI**

The $N_{STS}$ space-time streams of an SU PPDU may be mapped to $N_{TX}$ ($N_{STS} \le N_{TX}$) transmit chains applying direct, indirect spatial mapping or digital beamforming as defined in 28.5.10.4.2. The single space-time stream may be mapped to $N_{TX} \ge 1$ transmit chains applying spatial expansion as defined in 28.5.10.4.4.

A TRN field per transmit chain (see 28.9.2.2.6) may be appended to an SU PPDU.

### 28.5.9.2.3 SU A-PPDU transmission

The SU PPDU structures for EDMG A-PPDU transmission described in this subclause cover all the combination of channel bandwidth and number of spatial streams.

The SU PPDU structures for the first EDMG PPDU (i.e., $i_{PPDU} = 1$) within the EDMG A-PPDU are as shown in Figure 28-17 through Figure 28-23. The SU PPDU structure for the EDMG PPDUs following the first EDMG PPDU (i.e., $2 \le i_{PPDU} \le N_{PPDU}$) when using the short GI, normal GI and long GI shall be as shown in Figure 28-24, Figure 28-25, and Figure 28-26, respectively. The final block transmitted of each EDMG PPDU within the EDMG A-PPDU is followed by the same GI as the Data field regardless of the value of the Additional EDMG PPDU field within the EDMG-Header-A.

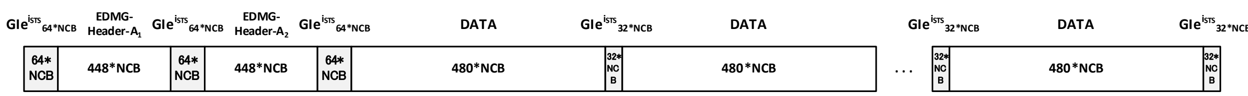


**Figure 28-24—SU PPDU structure: EDMG A-PPDU, $2 \le i_{PPDU} \le N_{PPDU}$, short GI**

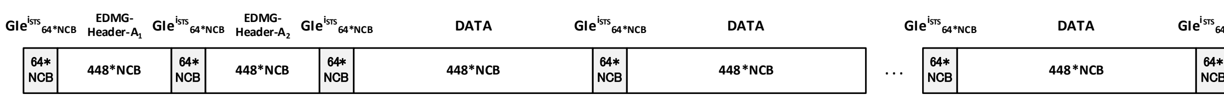


**Figure 28-25—SU PPDU structure: EDMG A-PPDU, $2 \le i_{PPDU} \le N_{PPDU}$, normal GI**

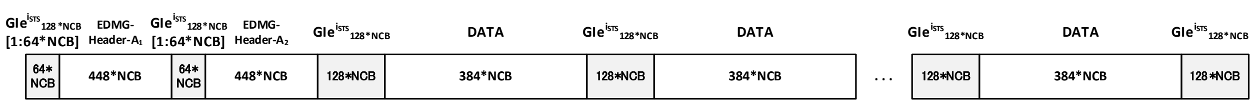


**Figure 28-26—SU PPDU structure: EDMG A-PPDU, $2 \le i_{PPDU} \le N_{PPDU}$, long GI**

### 28.5.9.2.4 MU PPDU transmission

#### 28.5.9.2.4.1 General

This subclause defines an MU PPDU transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel with more than one space-time stream ($N_{STS} > 1$) transmitted to two or more users ($N_{user} > 1$).

An MU PPDU transmission shall be as defined in 28.5.9.2.4.2.

### 28.5.9.2.4.2 MU PPDU transmission

As opposed to an SU PPDU, an MU PPDU includes the EDMG-Header-B. Similar to an SU PPDU transmission, the EDMG-Header-B and data symbol blocking structure is separated from the pre-EDMG modulated fields' symbol blocking structure by the EDMG-STF and EDMG-CEF fields.

The symbol blocking structure for pre-EDMG modulated fields transmitted over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined at the DMG SC chip rate $F_c$ as shown in Figure 28-20.

To transmit pre-EDMG modulated fields over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channel, the duplicate format defined in 28.5.10.4.4 shall be used.

To transmit pre-EDMG modulated fields using $N_{TX}$ > 1 transmit chains, the format using cyclic shift diversity (CSD) defined in 28.5.10.4.4 shall be used.

The symbol blocking structure for the EDMG-Header-B and Data field of an MU PPDU for the short, normal and long GI shall be as shown in Figure 28-27, Figure 28-28, and Figure 28-29, respectively.

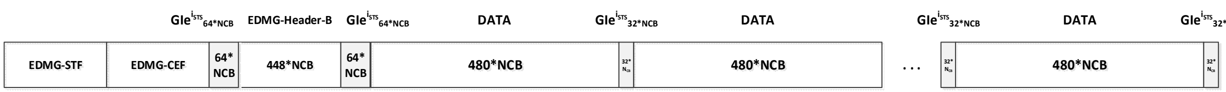


**Figure 28-27—MU PPDU structure: EDMG-Header-B and Data field symbol blocking, (2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz or 4.32+4.32 GHz, $N_{STS}$ > 1), short GI**

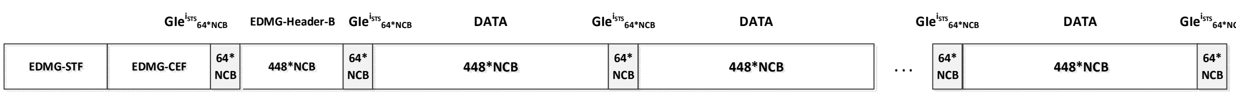


**Figure 28-28—MU PPDU structure: EDMG-Header-B and Data field symbol blocking, (2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz or 4.32+4.32 GHz, $N_{STS}$ > 1), normal GI**

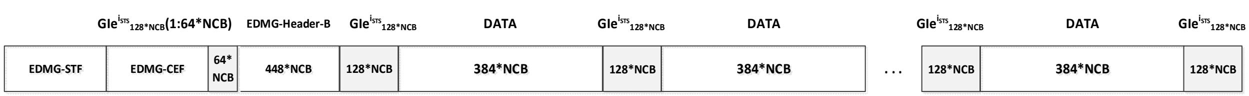


**Figure 28-29—MU PPDU structure: EDMG-Header-B and Data field symbol blocking, (2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz or 4.32+4.32 GHz, $N_{STS}$ > 1), long GI**

The $N_{STS}$ space-time streams of an MU PPDU may be mapped to $N_{TX}$ ($N_{STS} \le N_{TX}$) transmit chains applying direct, indirect spatial mapping or digital beamforming as defined in 28.5.10.4.2.

A TRN field per transmit chain (see 28.9.2.2.6) may be appended to an MU PPDU.

### 28.5.9.3 Scrambler

#### 28.5.9.3.1 Scrambler for the Data field, L-Header, EDMG-Header-A, and EDMG-Header-B data bits and non-EDMG SC MCS1 coded bits

The Data field, L-Header, EDMG-Header-A, and EDMG-Header-B data bits and non-EDMG SC MCS1 coded bits (see 20.5.3.2.3) shall be scrambled applying scrambler defined in 20.3.9.

The scrambling of the Data field of an SU PPDU continues the scrambling of the L-Header and the EDMG-Header-A fields. The initial seed value is defined in the L-Header field.

The scrambling of the Data field of an MU PPDU is performed on a per user basis and continues the scrambling of the EDMG-Header-B field with reset of the seed value. The initial seed value is defined in the EDMG-Header-B field on a per user basis.

For an SU EDMG A-PPDU, the initial seed value is defined in the L-Header field and the scrambling of the $i_{PPDU}^{\text{th}}$ PPDU continues the scrambling of $(i_{PPDU} - 1)^{\text{th}}$ PPDU with no seed reset.

For non-EDMG SC MCS1 with codeword length equal to 672 bits, the 168 repeated systematic bits shall be scrambled in turn starting from bit 1 and ending with bit 168 (see 20.5.3.2.3). For each codeword, the transmitter shall reload the seed value to all 1s (bits $x_1$ through $x_7$).

#### 28.5.9.3.2 Scrambler for EDMG-Header-A in SU EDMG A-PPDU, EDMG-Header-B, and EDMG SC MCS1 coded bits

The EDMG Header-A transmitted in an SU EDMG A-PPDU (excluding the first PPDU) coded bits, EDMG-Header-B coded bits, and repeated systematic part of an LDPC codeword using EDMG SC MCS1 encoding shall be scrambled by XORing each bit in turn with a length 127 periodic sequence generated by polynomial $S(x) = x^7 + x + 1$. The generation of the sequence and the XOR operation are shown in Figure 28-30. Each data or header bit is XORed with the scrambler output $(x_1 \oplus x_7)$ and the scrambler content is shifted once. The 127-bit sequence generated repeatedly by the scrambler shall be (leftmost used first), 01010100 11001110 11101001 01100011 01111011 01011011 00100100 01110000 10111110 01010111 00110100 01001111 00010100 00110000 01000000 1111111, when the all 1s (bits $x_1$ through $x_7$) initial state is used.

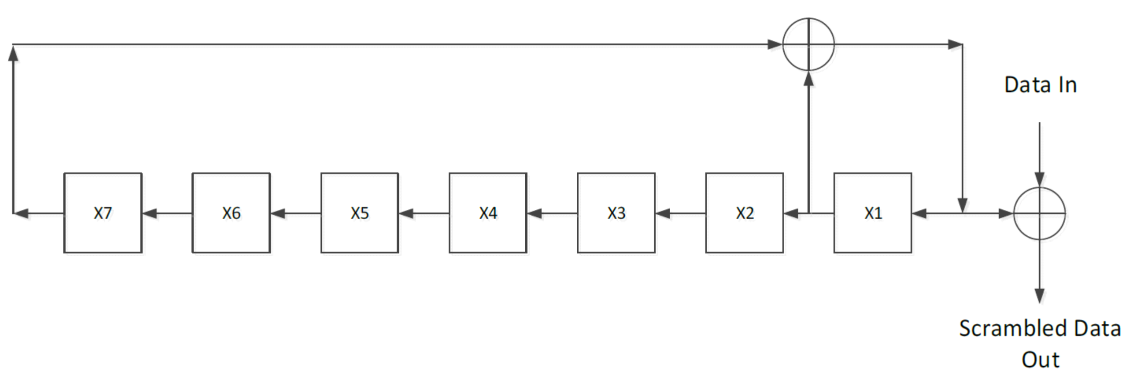


**Figure 28-30—EDMG-Header-A in SU EDMG A-PPDU, EDMG-Header-B, and EDMG SC MCS1 coded bits sequence scrambler**

For an EDMG-Header-A of an SU EDMG A-PPDU (excluding the first PPDU) using the EDMG SC mode, the scrambling of the coded bits starts at the 225th bit and ends at the $(N_{STS} \times 896 \times N_{CB})^{th}$ bit (see 28.5.7). The initial seed value is equal to all 1s (bits $x_1$ through $x_7$).

For an EDMG-Header-A of an SU EDMG A-PPDU (excluding the first PPDU) using the EDMG OFDM mode, the scrambling of the coded bits starts at the 225th bit and ends at the $(N_{STS} \times 4 \times N_{SD})^{th}$ bit (see 28.6.7). The initial seed value is equal to all 1s (bits $x_1$ through $x_7$).

In an MU PPDU transmission using the EDMG SC mode, the scrambling of the EDMG-Header-B coded bits starts at the 225th bit and ends at the $(N_{STS} \times 448 \times N_{CB})^{th}$ bit (see 28.5.6). The initial seed value is equal to all 1s (bits $x_1$ through $x_7$).

In an MU PPDU transmission using the EDMG OFDM mode, the scrambling of the EDMG-Header-B coded bits starts at the 225th bit and ends at the $(N_{STS} \times 2 \times N_{SD})^{th}$ bit (see 28.6.6). The initial seed value is equal to all 1s (bits $x_1$ through $x_7$).

For EDMG SC MCS1 with codeword length equal to 672 bits, the 168 repeated systematic bits shall be scrambled in turn starting from bit 1 and ending with bit 168. For EDMG SC MCS1 scrambling and codeword length equal to 1344 bits, the 336 repeated systematic bits shall be scrambled in turn starting from bit 1 and ending with bit 336. For each codeword, the transmitter shall reload the seed value to all 1s (bits $x_1$ through $x_7$).

### 28.5.9.4 Encoding

#### 28.5.9.4.1 General

An EDMG SC mode PSDU is encoded by a systematic LDPC block code. Each data word of $L_{CWD}$ information bits is concatenated with $L_{CWP}$ parity bits to create a codeword of total length $L_{CW} = L_{CWD} + L_{CWP}$ bits. The EDMG LDPC encoding can employ the codeword lengths $L_{CW}$ = 468, 504, 624, 672, 936, 1008, 1248, and 1344 and code rates $R$ = 1/2, 5/8, 2/3, 3/4, 13/16, 5/6, and 7/8. The set of code rates is defined in Table 28-56.

**Table 28-56—LDPC code rates**

| Code rate | Codeword size ($L_{CW}$) | | Number of data bits ($L_{CWD}$) | |
|---|---|---|---|---|
| | Short | Long | Short | Long |
| 1/2 | 672 | 1344 | 336 | 672 |
| 5/8 | 672 | 1344 | 420 | 840 |
| 2/3 | 504 | 1008 | 336 | 672 |
| 3/4 | 672 | 1344 | 504 | 1008 |
| 13/16 | 672 | 1344 | 546 | 1092 |
| 5/6 | 468 or 504 | 936 or 1008 | 390 or 420 | 780 or 840 |
| 7/8 | 624 or 672 | 1248 or 1344 | 546 or 588 | 1092 or 1176 |

The LDPC encoding with codeword length $L_{CW}$ = 672 and 1344 is performed by solving the linear system of equations $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$ defined by the parity matrix H of size $L_{CWP}$ by $L_{CW}$, where $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right)$ defines the $m^{\text{th}}$ LDPC codeword, $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{L_{CWD}}^{(m)}\right)$ defines the $m^{\text{th}}$ data word, and $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{L_{CWP}}^{(m)}\right)$ defines parity bits for $m^{\text{th}}$ LDPC codeword.

The LDPC encoding with codeword length $L_{CW}$ = 624 and 1248 employs the matrices H with $L_{CW}$ = 672 and 1344 for code rate $R$ = 13/16, and then applies a puncturing procedure to get to a desired code rate $R$ = 7/8. For $L_{CW}$ = 624, first 48 parity bits are discarded; for $L_{CW}$ = 1248, first 96 parity bits are discarded.

The LDPC encoding for code rate 2/3 with codeword length $L_{CW}$ = 504 and 1008 employs the matrices H with $L_{CW}$ = 672 and 1344 for code rate $R$ = 3/4, and then applies a shortening procedure to get to a desired code rate $R$ = 2/3. For $L_{CW}$ = 504, 168, 0s are appended to 336 data bits before encoding; for $L_{CW}$ = 1008, 336, 0s are appended to 672 data bits before encoding. After encoding the zero bits are discarded and not transmitted.

The LDPC encoding for code rate 5/6 with codeword length $L_{CW}$ = 504 and 1008 employs the matrices H with $L_{CW}$ = 672 and 1344 for code rate $R$ = 7/8. For $L_{CW}$ = 504, 168, 0s are appended to 420 data bits before encoding; for $L_{CW}$ = 1008, 336, 0s are appended to 840 data bits before encoding. After encoding, the zero bits are discarded and not transmitted.

The LDPC encoding for code rate 5/6 with codeword length $L_{CW}$ = 468 and 936 employs the matrices H with $L_{CW}$ = 672 and 1344 for code rate $R$ = 13/16. For $L_{CW}$ = 468, 156, 0s are appended to 390 data bits before encoding; for $L_{CW}$ = 936, 312, 0s are appended to 780 data bits before encoding. After encoding, the zero bits are discarded; for $L_{CW}$ = 468, the first 48 parity bits are discarded (punctured); for $L_{CW}$ = 936, the first 96 parity bits are discarded and not transmitted.

Table 28-57 defines the number of coded bits per SC symbol block, $N_{CBPB}$, for different types of GI.

**Table 28-57—Values of $N_{CBPB}$ for different types of GI**

| Symbol mapping | Short GI | Normal GI | Long GI |
|---|---|---|---|
| π/2-BPSK | 480 | 448 | 384 |
| π/2-QPSK | 960 | 896 | 768 |
| π/2-8-PSK | 1440 | 1344 | 1152 |
| π/2-16-QAM | 1920 | 1792 | 1536 |
| π/2-64-QAM/π/2-64-NUC | 2880 | 2688 | 2304 |

Table 28-47 defines the number of symbols (constellation points) per SC symbol block, $N_{SPB}$, for different types of GI.

### 28.5.9.4.2 Parity check matrices

See 28.3.6.

### 28.5.9.4.3 LDPC encoding

This subclause defines the PSDU encoding process for an SU PPDU and the PSDU per user basis encoding for an MU PPDU. The LDPC encoding may employ codeword lengths $L_{CW}$ = 468, 504, 624, 672, 936, 1008, 1248, or 1344 and code rates $R$ = 1/2, 5/8, 2/3, 3/4, 13/16, 5/6 or 7/8.

The LDPC encoding process for the $i_{user}{}^{th}$ user shall be as follows:

a) Compute the number of data pad bits, $N_{DATA\_PAD\,i_{user}}$, using the number of LDPC codewords, $N_{CW\,i_{user}}$, as follows:

$$N_{CW\ i_{user}} = \left\lceil \frac{Length_{i_{user}} \cdot 8}{L_{CW\ i_{user}} \cdot \frac{R_{i_{user}}}{\rho_{i_{user}}}} \right\rceil$$

$$N_{DATA\_PAD\ i_{user}} = N_{CW\ i_{user}} \cdot L_{CW\ i_{user}} \cdot \left( \frac{R_{i_{user}}}{\rho_{i_{user}}} \right) - Length_{i_{user}} \cdot 8$$

The scrambled PSDU is concatenated with $N_{DATA\_PAD\,i_{user}}$ zero bits. They are scrambled using the continuation of the scrambler sequence that scrambled the PSDU input bits.

b) Convert the scrambled PSDU bits to LDPC codewords as follows:

1) If $\rho$ = 1 and $L_{CW}$ = 672 or 1344, $R$ = 1/2, 5/8, 3/4, 13/16, or 7/8:

i) The output stream of scrambler is broken into the blocks of length $L_{CWD} = L_{CW} \times R$ bits such that the $m^{th}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{L_{CWD}}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{L_{CWP}}^{(m)}\right)$, $L_{CWP} = L_{CW} - L_{CWD}$, are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$.

2) If $\rho$ = 1 and $L_{CW}$ = 624, $R$ = 7/8:

i) The output stream of scrambler is broken into the blocks of length 546 bits such that the $m^{th}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{546}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{126}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 672, $R$ = 13/16 LDPC matrix.

iii) Finally, the first 48 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots., b_{546}^{(m)}, p_{49}^{(m)}, p_{50}^{(m)}, \ldots, p_{126}^{(m)}\right), m \le N_{CW\,i_{user}}$.

3) If $\rho$ = 1 and $L_{CW}$ = 1248, $R$ = 7/8:

i) The output stream of scrambler is broken into the blocks of length 1092 bits such that the $m^{th}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{1092}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, ..., p_{252}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 1344, $R$ = 13/16 LDPC matrix.

iii) Finally, the first 96 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ...., b_{1092}^{(m)}, p_{97}^{(m)}, p_{98}^{(m)}, ..., p_{252}^{(m)}\right), m \le N_{CW\,i_{user}}$.

4) If $\rho$ = 2 and $L_{CW}$ = 672, $R$ = 1/2:

i) The output stream of scrambler is broken into the blocks of length 168 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ..., b_{168}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, ..., 0_{168}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, ..., p_{336}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$.

iii) Finally, the zero bits are replaced with word $\mathbf{b}^{(m)}$ repetition XORed by PN sequence that is generated from the LFSR used for MCS 1 scrambling as defined in 28.5.9.3.2. The LFSR is initialized to all 1s initial seed value and reinitialized to the same seed after every codeword.

5) If $\rho$ = 2 and $L_{CW}$ = 1344, $R$ = 1/2:

i) The output stream of scrambler is broken into the blocks of length 336 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ..., b_{336}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, ..., 0_{336}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, ..., p_{672}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$.

iii) Finally, the zero bits are replaced with word $\mathbf{b}^{(m)}$ repetition XORed by PN sequence that is generated from the LFSR used for MCS 1 scrambling as defined in 28.5.9.3.2. The LFSR is initialized to all 1s initial seed value and reinitialized to the same seed after every codeword.

6) If $\rho$ = 1 and $L_{CW}$ = 504, $R$ = 2/3:

i) The output stream of scrambler is broken into the blocks of length 336 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ..., b_{336}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, ..., 0_{168}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, ..., p_{168}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 672, $R$ = 3/4 LDPC matrix.

iii) Finally, the zero bits are discarded to create the output codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$.

7) If $\rho = 1$ and $L_{CW} = 1008$, $R = 2/3$:
   i) The output stream of scrambler is broken into the blocks of length 672 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{672}^{(m)}\right), m \le N_{CW\, i_{user}}$.
   ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, \ldots, 0_{336}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{336}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW} = 1344$, $R = 3/4$ LDPC matrix.
   iii) Finally, the zero bits are discarded to create the output codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$.
8) If $\rho = 1$ and $L_{CW} = 504$, $R = 5/6$:
   i) The output stream of scrambler is broken into the blocks of length 420 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{420}^{(m)}\right), m \le N_{CW\, i_{user}}$.
   ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, \ldots, 0_{168}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{84}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying for $L_{CW} = 672$, $R = 7/8$ LDPC matrix.
   iii) Finally, the zero bits are discarded to create the output codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$.
9) If $\rho = 1$ and $L_{CW} = 1008$, $R = 5/6$:
   i) The output stream of scrambler is broken into the blocks of length 840 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{840}^{(m)}\right), m \le N_{CW\, i_{user}}$.
   ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, \ldots, 0_{336}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{168}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW} = 1344$, $R = 7/8$ LDPC matrix.
   iii) Finally, the zero bits are discarded to create the output codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\, i_{user}}$.
10) If $\rho = 1$ and $L_{CW} = 468$, $R = 5/6$:
   i) The output stream of scrambler is broken into the blocks of length 390 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{390}^{(m)}\right), m \le N_{CW\, i_{user}}$.
   ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, \ldots, 0_{156}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{126}^{(m)}\right)$ are added to create the codeword

$\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 672, $R$ = 13/16 LDPC matrix.

iii) Finally, the zero bits are discarded and the first 48 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ...., b_{390}^{(m)}, p_{49}^{(m)}, p_{50}^{(m)}, ..., p_{126}^{(m)}\right), m \le N_{CW\,i_{user}}$.

11) If $\rho$ = 1 and $L_{CW}$ = 936, $R$ = 5/6:

i) The output stream of scrambler is broken into the blocks of length 780 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ..., b_{780}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, zero bits $\mathbf{0}^{(m)} = \left(0_1^{(m)}, 0_2^{(m)}, ..., 0_{312}^{(m)}\right)$ and parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, ..., p_{252}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{0}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$, parity bits are computed applying $L_{CW}$ = 1344, $R$ = 13/16 LDPC matrix.

iii) Finally, the zero bits are discarded and the first 96 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, ...., b_{780}^{(m)}, p_{97}^{(m)}, p_{98}^{(m)}, ..., p_{252}^{(m)}\right), m \le N_{CW\,i_{user}}$.

c) Concatenate LDPC codewords one after the other to create the coded bits stream $\left(\mathbf{c}^{(1)}, \mathbf{c}^{(2)}, ..., \mathbf{c}^{\left(N_{CW\,i_{user}}\right)}\right)$.

d) Compute the number of coded pad bits, $N_{BLK\_PAD\,i_{user}}$, using the number of SC symbol blocks, $N_{BLKS\,i_{user}}$, as follows:

$$N_{BLKS\ i_{user}} = \left\lceil \frac{N_{CW\ i_{user}} \cdot L_{CW\ i_{user}}}{N_{SPB} \cdot \sum_{i_{SS}=1}^{N_{SS\ i_{user}}} N_{CBPS\ i_{user}\ i_{ss}}} \right\rceil$$

If (BRP PPDU) and $N_{BLKS\,i_{user}} < N_{BLKS\,\min}$, then $N_{BLKS\,i_{user}} = N_{BLKS\,\min}$.

If last PPDU in A-PPDU, then $N_{BLKS\,i_{user}} = N_{BLKSspoof}$.

If STBC applied and $N_{BLKS\,i_{user}}$ is odd, then $N_{BLKS\,i_{user}} = N_{BLKS\,i_{user}} + 1$.

$$N_{BLK\_PAD\,i_{user}} = N_{BLKS\ i_{user}} \cdot N_{SPB} \cdot \sum_{i_{SS}=1}^{N_{SS\ i_{user}}} N_{CBPS\ i_{user}\ i_{SS}} - N_{CW\ i_{user}} \cdot L_{CW\ i_{user}}$$

Concatenate coded bits with $N_{BLK\_PAD\,i_{user}}$ zero bits. They are scrambled using the continuation of the scrambler sequence that scrambled the PSDU bits and data pad bits in step a).

e) Distribute the encoded and padded bits over the $N_{SS\,i_{user}}$ spatial streams on a group basis with the number of $N_{CBPS\,i_{user}\ i_{ss}}$ bits in a group. The first group of bits goes to the first spatial stream, the second group of bits goes to the second spatial stream, and so on. The procedure is repeated when the maximum number of spatial streams, $N_{SS\,i_{user}}$, is reached. The procedure ends when all PSDU encoded bits, including $N_{BLK\_PAD\,i_{user}}$ pad bits, are distributed over the $N_{SS\,i_{user}}$ spatial streams.

For each user, if STBC coding is applied, then $N_{SS\,i_{user}}$ spatial streams are mapped to $N_{STS\,i_{user}} = 2N_{SS\,i_{user}}$ space-time streams as defined in 28.5.9.5.4. Otherwise, a one-to-one mapping of $N_{SS\,i_{user}}$ spatial streams to $N_{STS\,i_{user}}$ space-time streams shall be applied.

NOTE—For a PPDU carrying a BRP frame, the value of $N_{BLKS\,\min}$ is specified in 28.9.2.2.4.

### 28.5.9.4.4 MU PPDU padding and space-time streams mapping

For an MU PPDU transmission, all user PPDUs shall be aligned in time. If necessary, PSDUs within the MU PPDU shall be padded according to the following steps:

a) Compute the maximum number of SC symbol blocks over all users $N_{BLKS\,\max} = \max_{i_{user}}\left(N_{BLKS\,i_{user}}\right)$ for $i_{user} = 1, 2, \ldots, N_{user}$.
b) Update the number of SC symbol blocks at step e) in 28.5.9.4.3 as $N_{BLKS\,i_{user}} = N_{BLKS\,\max}$ for $i_{user} = 1, 2, \ldots, N_{user}$. Update the number of pad bits for the $i_{user}$th user accordingly.
c) The number of pad SC symbol blocks for the MU PPDU transmission for the $i_{user}$th user is defined as $N_{PAD\_BLKS\,i_{user}} = N_{BLKS\,\max} - N_{BLKS\,i_{user}}$.

The number of pad blocks $N_{PAD\_BLKS\,i_{user}}$ takes into account the MU PPDU padding only and does not include the regular padding described in 28.5.9.4.3.

The space-time stream index per user, $i_{STS\,i_{user}}$, is mapped to the space-time stream index over all users, $i_{STS}$, as follows:

$$i_{STS}\left(i_{user}, i_{STS\,i_{user}}\right) = \sum_{m=0}^{i_{user}-1} Num_m + i_{STS\,i_{user}},\ 1 \le i_{STS\,i_{user}} \le N_{STS\,i_{user}},\ 1 \le i_{user} \le N_{user}$$

$$Num_m = N_{STS\,m} \text{ for } m > 0 \text{ and } Num_m = 0 \text{ otherwise}$$

NOTE—$i_{STS}$ is a function of $i_{user}$ and $i_{STS\,i_{user}}$ indices. However, to simplify the notation, this dependence is not indicated explicitly in other equations.

### 28.5.9.4.5 SU A-PPDU padding

For the last PPDU in an EDMG A-PPDU, $N_{BLKSspoof}$ shall be set, at step d) in 28.5.9.4.3, so that the spoofing error is non-negative and smaller than one SC symbol block (i.e., $T_{DFT}$, defined in Table 28-47). If the last PPDU in an EDMG A-PPDU contains a BRP frame, $N_{BLKSspoof}$ shall be equal to or greater than $N_{BLKS\,\min}$. $N_{BLKSspoof}$ is calculated as follows:

$$\begin{aligned} T_{Data\,\max}^{(N_{PPDU})} = TXTIME_{spoof} - \Big( & T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + N_{PPDU} \cdot T_{EDMG\text{-}Header\text{-}A} \\ & + T_{EDMG\text{-}STF} + T_{EDMG\text{-}CEF} + \sum_{i_{PPDU}=1}^{N_{PPDU}-1} T_{Data}^{(i_{PPDU})} + T_{TRN} \Big) \end{aligned}$$

$$N_{BLKSspoof} = \left\lfloor \frac{T_{Data\,\max}^{(N_{PPDU})}}{T_{DFT}} \right\rfloor$$

where

| | |
|---|---|
| $i_{STS}$ | is the space-time stream number and $1 \le i_{STS} \le 8$ |
| $TXTIME_{spoof}$ | is the spoofed PPDU duration calculated based on L-Header |

$T_{L\text{-}STF}$, $T_{L\text{-}CEF}$, $T_{L\text{-}Header}$, $T_{EDMG\text{-}STF}$, $T_{EDMG\text{-}CEF}$, $T_{EDMG\text{-}Header\text{-}A}$, and $T_{TRN}$
: are the durations of the L-STF, L-CEF, L-Header, EDMG-STF, EDMG-CEF, EDMG-Header-A, and TRN fields as defined in 28.12.3.3

$T_{DFT}$
: is defined in Table 28-47

$T_{Data}^{(i_{PPDU})}$, for $i_{PPDU}$ =1, …, $N_{PPDU}$ – 1,
: is the duration of the Data field of the $i_{PPDU}$^th PPDU, except for the last PPDU, as defined in 28.12.3.3

$T_{Data\max}^{(N_{PPDU})}$
: is the maximum duration of the last PPDU that fulfills the spoofing error requirement

For an EDMG A-PPDU transmission, the spoofed values of the L-Header fields and the duration of the PPDUs except the last PPDU shall be determined so that $N_{BLKSspoof}$ is equal to or greater than $N_{BLKS\min}$.

### 28.5.9.5 Modulation mapping

#### 28.5.9.5.1 General

The coded and padded bit stream is converted into a stream of complex constellation points, following the rules defined in 20.5.3.2.4 for π/2-BPSK, π/2-QPSK, π/2-16-QAM, and π/2-64-QAM. The π/2-64-NUC nonuniform constellation (NUC) modulation is defined in 28.5.9.5.6. For π/2-8-PSK, follow the rules defined in 28.5.9.5.7.

#### 28.5.9.5.2 Transmission in EDMG format

The EDMG data transmit waveform for $i_{TX}^{\text{th}}$ transmit chain in time domain shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ as follows:

$$r_{Data}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)=\frac{1}{\sqrt{N_{STS}}}\sum_{n=0}^{N_{EDMG\text{-}DATA}-1}\sum_{i_{STS}=1}^{N_{STS}}\left[Q_{EDMG}\right]_{i_{TX},i_{STS}}d\left(i_{STS},n\right)\delta\left(\left(n-q\right)\frac{T_c}{N_{CB}}\right)$$

where

| | |
|---|---|
| $N_{EDMG\text{-}DATA}$ | is the total number of chips |
| $N_{STS}$ | is the total number of space-time streams |
| $Q_{EDMG}$ | is a spatial mapping matrix independent of the $n^{\text{th}}$ chip time index that is described in 28.5.10.2 |
| $[\ ]_{m,n}$ | is a matrix element from $m^{\text{th}}$ row and $n^{\text{th}}$ column |
| $d(i_{STS}, n)$ | is the data sequence, it includes data payload symbols as well as the guard interval symbols |
| $\delta\left(\left(n-q\right)\frac{T_c}{N_{CB}}\right)$ | is the delta function, which is equal to 1 if $n = q$, and is equal to 0 otherwise |
| $q$ | is a time sample index |

### 28.5.9.5.3 Dual carrier modulation (DCM) π/2-BPSK

A frequency domain diversity scheme based on DCM π/2-BPSK may be applied to an EDMG PPDU transmission over 2.16+2.16 GHz or 4.32+4.32 GHz channels. An EDMG STA shall only apply DCM π/2-BPSK to an EDMG PPDU transmitted to a peer EDMG STA if the DCM π/2-BPSK Supported field in the peer STA's EDMG Capabilities element is 1.

The DCM π/2-BPSK modulation is applied to an EDMG PPDU if, in the EDMG-Header-A, the BW field indicates a bandwidth configuration 2.16+2.16 GHz or 4.32+4.32 GHz, the Channel Aggregation field is set to 1, the Number of SS field indicates 2 spatial streams, and the DCM BPSK Applied field is set to 1. The value of the Differential EDMG-MCS1 and Differential EDMG-MCS2 fields in the EDMG-Header-A shall be the same. The resulting EDMG-MCS index shall be in the range from 2 to 6 as defined in Table 28-51.

The DCM π/2-BPSK modulation is defined as follows:

— After LDPC encoding, the bit stream of the first spatial stream ($i_{SS}$ = 1) and the second spatial stream ($i_{SS}$ = 2) is broken into two groups of $N_{CBPB} \times N_{CB}$ bits as $\left(c_0^{(i_{SS}=1,q)}, c_1^{(i_{SS}=1,q)}, \ldots, c_{N_{CBPB} \times N_{CB}-1}^{(i_{SS}=1,q)}\right)$ and $\left(c_0^{(i_{SS}=2,q)}, c_1^{(i_{SS}=2,q)}, \ldots, c_{N_{CBPB} \times N_{CB}-1}^{(i_{SS}=2,q)}\right)$, respectively, where $q$ denotes the SC symbol block number and $q$ =0,1,…$N_{BLKS}$ – 1. $N_{CBPB}$ is defined as in Table 28-57 for the π/2-BPSK case, $N_{CB}$ = 1 for a 2.16+2.16 GHz channel and $N_{CB}$ = 2 for a 4.32+4.32 GHz channel.

— Each pair of bits $\left(c_k^{(i_{SS}=1,q)}, c_k^{(i_{SS}=2,q)}\right)$ of the $q^{\text{th}}$ SC data block, $k$ = 0, 1, $N_{CBPB} \times N_{CB}$ – 1, is converted into a pair of constellation points $d_k^{(i_{SS}=1,q)} == \frac{1}{\sqrt{2}}\left(\left(2 \times c_k^{(i_{SS}=1,q)} - 1\right) + j\left(2 \times c_k^{(i_{SS}=2,q)} - 1\right)\right)e^{j\pi k/2}$ and $d_k^{(i_{SS}=2,q)} == \frac{1}{\sqrt{2}}\left(\left(2 \times c_k^{(i_{SS}=1,q)} - 1\right) - j\left(2 \times c_k^{(i_{SS}=2,q)} - 1\right)\right)e^{j\pi k/2}$.

— Finally, the $q^{\text{th}}$ SC data block of the first spatial stream $d_k^{(i_{SS}=1,q)}$, $k$ = 0, 1, …, $N_{CBPB} \times N_{CB}$ – 1, is assigned to the channel containing the primary 2.16 GHz channel and the second spatial stream $d_k^{(i_{SS}=2,q)}$, $k$ = 0, 1, …, $N_{CBPB} \times N_{CB}$ – 1, is assigned to the channel that does not contain the primary channel.

The DCM π/2-BPSK modulation uses the same symbol blocking structure as for an SU PPDU defined in 28.5.9.2.2.3.

### 28.5.9.5.4 Space-time block coding (STBC)

An EDMG STA shall only apply STBC to an EDMG PPDU transmitted to a peer EDMG STA if the STBC Type field in the peer STA's EDMG Capabilities element is nonzero.

STBC performs mapping of $N_{SS}$ spatial streams to 2 × $N_{SS}$ space-time streams. STBC is applied to an EDMG PPDU if, in the EDMG-Header-A of the PPDU, the STBC field is equal to 1. The number of STBC modulated spatial streams $N_{SS}$ is given by the Number of SS field in the EDMG-Header-A. $N_{SS}$ shall not exceed four for an SU PPDU and one per user for an MU PPDU.

The mapping of each spatial stream, $i_{SS} = 1, \ldots, N_{SS}$, includes the following steps:

— The input encoded bits stream of spatial stream $i_{SS}$ is broken into groups of $N_{CBPB\ i_{SS}} \times N_{CB}$ bits, $\left( c_0^{(i_{SS},q)}, c_1^{(i_{SS},q)}, \ldots, c_{N_{CBPB\ i_{SS}} \times N_{CB}-1}^{(i_{SS},q)} \right)$, where $q$ denotes the group number. The STBC applies the encoding procedure defined in 28.5.9.4.3. The padding procedure requires that the total number of groups of $N_{CBPB\ i_{SS}} \times N_{CB}$ bits shall be an even number.

— Each group of bits $\left( c_{N_{CBPS\ i_{SS}} \cdot k}^{(i_{SS},q)}, c_{N_{CBPS\ i_{SS}} \cdot k+1}^{(i_{SS},q)}, \ldots, c_{N_{CBPS\ i_{SS}} \cdot k+N_{CBPS\ i_{SS}}-1}^{(i_{SS},q)} \right)$, $k = 0, 1, \ldots, N_{SPB} - 1$, is converted to the constellation point $d_k^{(i_{SS},q)}$ following the rules defined in 20.5.3.2.4, 28.5.9.5.6, and 28.5.9.5.7.

— STBC operates with symbol blocks $d^{(i_{SS},q)} = \left( d_0^{(i_{SS},q)}, d_1^{(i_{SS},q)}, \ldots, d_{N_{SPB}-1}^{(i_{SS},q)} \right)$, $q = 0, 1, \ldots, N_{BLKS} - 1$, and with blocks with reversed symbols order $d_{inv}^{(i_{SS},q)} = \left( d_{N_{SPB}-1}^{(i_{SS},q)}, d_{N_{SPB}-2}^{(i_{SS},q)}, \ldots, d_0^{(i_{SS},q)} \right)$ of spatial stream $i_{SS}$ and assigns these blocks to two space-time streams.

— The modulated data symbols for the odd space-time stream are defined as follows:

$$s^{(i_{STS}=2\times i_{SS}-1)} = \left( d^{(i_{SS},0)}, d^{(i_{SS},1)}, d^{(i_{SS},2)}, d^{(i_{SS},3)}, \ldots, d^{(i_{SS},N_{BLKS}-2)}, d^{(i_{SS},N_{BLKS}-1)} \right)$$

— The modulated data symbols for the even space-time stream are defined as follows:

$$s^{(i_{STS}=2\times i_{SS})} = \left( \begin{array}{l} -conj\left( d_{inv}^{(i_{SS},1)} \right), conj\left( d_{inv}^{(i_{SS},0)} \right), -conj\left( d_{inv}^{(i_{SS},3)} \right), conj\left( d_{inv}^{(i_{SS},2)} \right), \ldots \\ \ldots, -conj\left( d_{inv}^{(i_{SS},N_{BLKS}-1)} \right), conj\left( d_{inv}^{(i_{SS},N_{BLKS}-2)} \right) \end{array} \right)$$

— STBC uses the same symbol blocking structure for an SU PPDU and an MU PPDU defined in 28.5.9.2.2.3 and 28.5.9.2.4, respectively.

### 28.5.9.5.5 Block interleaver

The block interleaver is defined for π/2-64-QAM and π/2-64-NUC modulations. The block interleaver performs modulated complex symbols interleaving inside a SC symbol block and its parameters depend on the $N_{SPB}$, $N_{CB}$, $N_{SS\ i_{user}}$, $L_{CW\ i_{user}}$, and $N_{CBPS\ i_{user}\ i_{SS}}$ parameters.

The input to the interleaver for the $i^{th}$ spatial stream is a SC symbol block $d_{in}^{(i_{SS},q)}$ of length $N_{SPB}$ and composed of 64-QAM or 64-NUC symbols (before application of π/2-rotation) $d_{in}^{(i_{SS},q)} = \left( d_0^{(i_{SS},q)}, d_1^{(i_{SS},q)}, \ldots, d_{N_{SPB}-1}^{(i_{SS},q)} \right)$, where $q$ denotes the SC symbol block number, $q = 0, 1, \ldots, N_{BLKS\ i_{user}} - 1$.

The output of the interleaver for the $i^{th}$ spatial stream is a permuted SC symbol block $d_{out}^{(i_{SS},q)}$ of length $N_{SPB}$ and defined as $d_{out}^{(i_{SS},q)} = \left( d_{idx(0)}^{(i_{SS},q)}, d_{idx(1)}^{(i_{SS},q)}, \ldots, d_{idx(N_{SPB}-1)}^{(i_{SS},q)} \right)$, where $idx()$ defines the array of permutation indexes.

The array of permutation indexes, *idx*(), is constructed as follows:

Let $x = \left( N_{SPB} \times \sum_{i_{SS}=1}^{N_{SS\ i_{user}}} N_{CBPS\ i_{user}\ i_{SS}} \right) / L_{CW\ i_{user}}$.

Moreover, for each $x$, let $N_x = \begin{cases} 2 \times N_{CB},\ \text{if } x \le 3 \times N_{CB} \\ 4 \times N_{CB},\ \text{if } 3 \times N_{CB} < x \le 6 \times N_{CB} \\ 8 \times N_{CB},\ \text{if } 6 \times N_{CB} < x \le 12 \times N_{CB} \\ 16 \times N_{CB},\ \text{if } 12 \times N_{CB} < x \le 24 \times N_{CB} \\ 32 \times N_{CB},\ \text{if } 24 \times N_{CB} < x \end{cases}$ and $N_y = N_{SPB} / N_x$.

Then, $idx\left(j \times N_x + i\right) = N_y \times i + j$, where $i = 0, 1, \ldots, N_x - 1$ and $j = 0, 1, \ldots, N_y - 1$.

The symbols of the output interleaver SC symbol block are then rotated by π/2 as defined in 20.5.3.2.4.5 and 28.5.9.5.6 to produce the π/2-64-QAM and π/2-64-NUC constellation points, respectively.

### 28.5.9.5.6 π/2-64-NUC nonuniform constellation modulation

An EDMG STA shall only apply nonuniform constellation (NUC) to an EDMG PPDU transmitted to a peer EDMG STA if the NUC RX Supported field in the peer STA's EDMG Capabilities element is nonzero.

In π/2-64-NUC NUC modulation, the input bit stream is grouped in sets of 6 bits and mapped according to the following equation:

$$
\begin{aligned}
\tilde{s}_k = \left(1-2c_{6k}\right) & \begin{pmatrix}
(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})1.0997+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})c_{6k+5}0.1440 \\
+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})c_{6k+4}(1\text{-}c_{6k+5})0.7484+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})c_{6k+4}c_{6k+5}0.4369 \\
+(1\text{-}c_{6k+2})c_{6k+3}(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})1.0414+(1\text{-}c_{6k+2})c_{6k+3}(1\text{-}c_{6k+4})c_{6k+5}0.1414+(1\text{-}c_{6k+2})c_{6k+3}c_{6k+4}(1\text{-}c_{6k+5})0.7230 \\
+(1\text{-}c_{6k+2})c_{6k+3}c_{6k+4}c_{6k+5}0.4272+c_{6k+2}(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})1.0691+c_{6k+2}(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})c_{6k+5}0.1426 \\
+c_{6k+2}(1\text{-}c_{6k+3})c_{6k+4}(1\text{-}c_{6k+5})0.7360+c_{6k+2}(1\text{-}c_{6k+3})c_{6k+4}c_{6k+5}0.4351+c_{6k+2}c_{6k+3}(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})1.4058 \\
+c_{6k+2}c_{6k+3}(1\text{-}c_{6k+4})c_{6k+5}0.1695+c_{6k+2}c_{6k+3}c_{6k+4}(1\text{-}c_{6k+5})0.5981+c_{6k+2}c_{6k+3}c_{6k+4}c_{6k+5}0.2236
\end{pmatrix} \\
+j\left(2c_{6k+1}-1\right) & \begin{pmatrix}
(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})0.5419+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})c_{6k+5}0.4167 \\
+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})c_{6k+4}(1\text{-}c_{6k+5})0.4663+(1\text{-}c_{6k+2})(1\text{-}c_{6k+3})c_{6k+4}c_{6k+5}0.4317 \\
+(1\text{-}c_{6k+2})c_{6k+3}(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})0.1712+(1\text{-}c_{6k+2})c_{6k+3}(1\text{-}c_{6k+4})c_{6k+5}0.1379+(1\text{-}c_{6k+2})c_{6k+3}c_{6k+4}(1\text{-}c_{6k+5})0.1517 \\
+(1\text{-}c_{6k+2})c_{6k+3}c_{6k+4}c_{6k+5}0.1421+c_{6k+2}(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})0.9443+c_{6k+2}(1\text{-}c_{6k+3})(1\text{-}c_{6k+4})c_{6k+5}0.7102 \\
+c_{6k+2}(1\text{-}c_{6k+3})c_{6k+4}(1\text{-}c_{6k+5})0.8042+c_{6k+2}(1\text{-}c_{6k+3})c_{6k+4}c_{6k+5}0.7394+c_{6k+2}c_{6k+3}(1\text{-}c_{6k+4})(1\text{-}c_{6k+5})0.2115 \\
+c_{6k+2}c_{6k+3}(1\text{-}c_{6k+4})c_{6k+5}1.0298+c_{6k+2}c_{6k+3}c_{6k+4}(1\text{-}c_{6k+5})1.1597+c_{6k+2}c_{6k+3}c_{6k+4}c_{6k+5}1.3784
\end{pmatrix}
\end{aligned}
$$

Each output symbol is then rotated according to the equation $s_k = \tilde{s}_k \cdot e^{\frac{j\pi k}{2}}$. The constellation bit encoding for the 64-NUC is depicted in Figure 28-31.

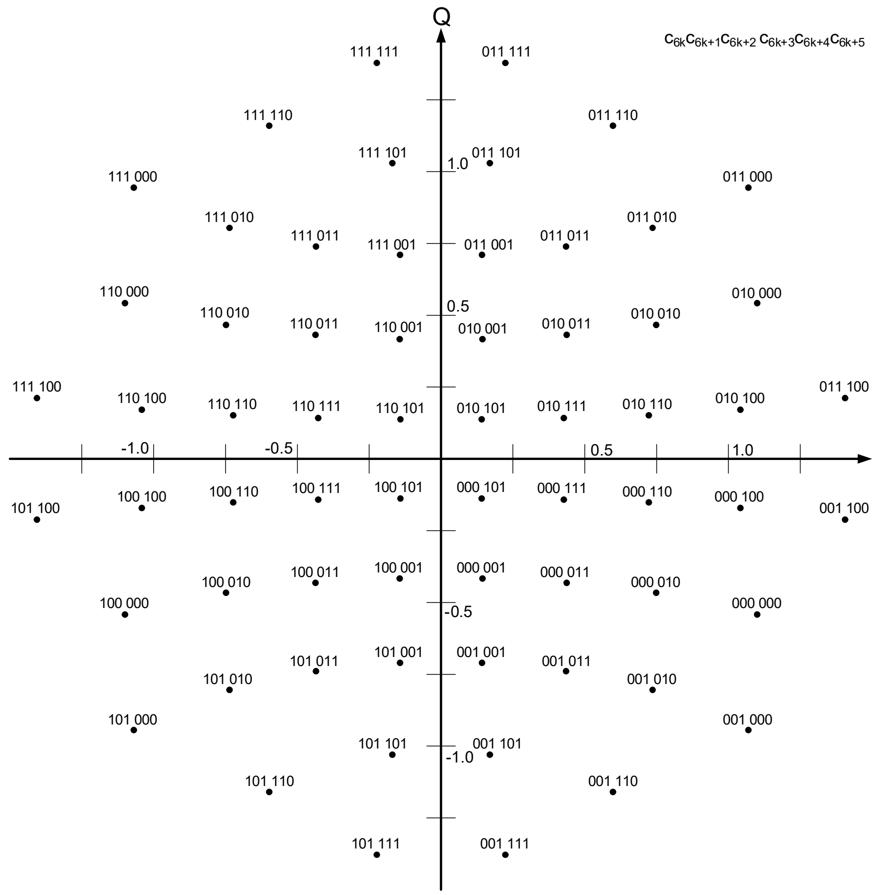

**Figure 28-31—64-NUC nonuniform constellation bit encoding**

NOTE—The π/2-64-NUC is quadrant symmetric and has an average power of one.

### 28.5.9.5.7 π/2-8-PSK modulation

An EDMG STA shall only apply π/2-8-PSK modulation to an EDMG PPDU transmitted to a peer EDMG STA if the π/2-8-PSK Supported field in the peer STA's EDMG Capabilities element is nonzero.

In π/2-8-PSK modulation, the input stream is grouped into sets of 3 bits and mapped according to the following equation:

$$\tilde{s}_k = \exp\left( j\frac{\pi}{4}\left(c_{3k} - 3c_{3k+1} - c_{3k+2} - 2c_{3k}c_{3k+1} + 2c_{3k+1}c_{3k+2} + 2c_{3k}c_{3k+2} + 4c_{3k}c_{3k+1}c_{3k+2} + 4\right)\right)$$

where
  $k$ is the symbol output index, $k = 0, 1, \ldots$.

Each output symbol is then rotated according to the equation $s_k = \tilde{s}_k \cdot e^{j \cdot \pi \cdot k/2}$. The constellation bit encoding for 8-PSK is depicted in Figure 28-32.

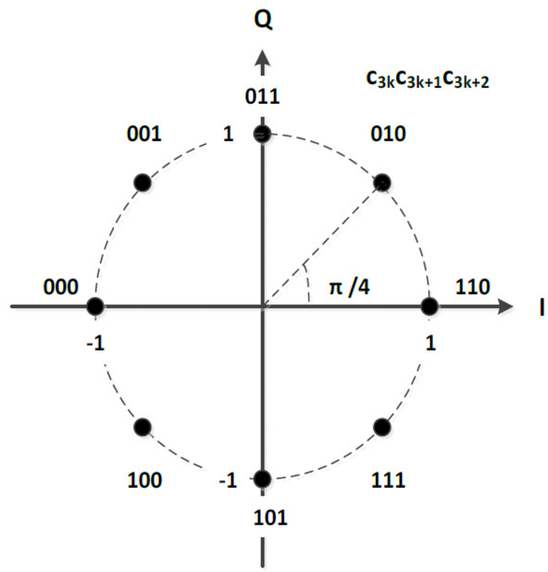


**Figure 28-32—8-PSK constellation bit encoding**

### 28.5.10 PPDU transmission

#### 28.5.10.1 General

This subclause defines the waveform for the EDMG SC mode and the non-EDMG PPDU transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel using $N_{TX}$ transmit chains.

The definition of the spatial mapping methods is provided in 28.5.10.2. The non-EDMG PPDU transmission shall be as defined in 28.5.10.3. The EDMG SU PPDU transmission shall be as defined in 28.5.10.4. The EDMG MU PPDU transmission shall be as defined in 28.5.10.5.

#### 28.5.10.2 Spatial mapping

Spatial mapping defines the method of $N_{STS}$ space-time streams to $N_{TX}$ transmit chains mapping, where $N_{STS} \leq N_{TX}$, which may be implemented by means of a spatial mapping matrix $Q$ of size $N_{TX}$ by $N_{STS}$ and by cyclic shift diversity (CSD), if applied. The spatial mapping matrix $Q$ is independent of the chip time index or subcarrier index and is constant in time.

This standard defines four basic mappings for the EDMG PHY, namely, direct mapping, indirect mapping, digital beamforming and spatial expansion. Provided below are examples of spatial mapping methods and $Q$ matrices that might be used in different cases.

— Direct mapping, $N_{STS} = N_{TX}$: the spatial mapping matrix $Q$ is a square diagonal complex value matrix of size $N_{TX}$ that might be defined as follows:
  — $[Q]_{i,i} = 1, i = 1, 2, ..., N_{TX}$, the identity matrix
  — $[Q]_{i,i} = \exp\left(j2\pi\phi_i\right), i = 1, 2, ..., N_{TX}$, exponential matrix

— Indirect mapping, $N_{STS} = N_{TX}$: the spatial mapping matrix $Q$ is a square matrix of size $N_{TX}$ composed of complex values that might be defined as follows:
  — Normalized discrete Fourier matrix
  — Normalized Hadamard matrix
  — Normalized direct mapping diagonal matrix with permutated rows and/or columns
— Digital beamforming, $N_{STS} \leq N_{TX}$: the spatial mapping matrix $Q$ is a rectangular matrix of size $N_{TX}$ by $N_{STS}$ composed of complex values that might be defined based on some knowledge of the channel.
— Spatial expansion, $N_{STS} = 1 < N_{TX}$: the spatial expansion is performed by multiplication by matrix $Q$, which is defined as a column vector of size $N_{TX}$ by 1 and composed of all 1s, and application of CSD over different transmit chains. The CSD is applied to the fields of PPDU with the exception of the TRN field. This enables duplication of the transmission of PPDU fields over the $N_{TX}$ transmit chains and avoids unintentional beamforming that exists with a coherent signal transmission. The spatial expansion technique is not applied to the TRN field, which is transmitted using an orthogonal sequence set.
— Channel aggregation, in this case $N_{TX}$ is an even number: the transmit chains 1 through $N_{TX}/2$ are assigned to the primary or primary and secondary channels and transmit chains $N_{TX}/2 + 1$ are assigned to the secondary or secondary1 and secondary2 channels. The mapping of space-time streams to the transmit chains is defined by the spatial mapping matrix $Q$, which is implementation specific.

The spatial mapping matrix $Q$ may be different for the pre-EDMG and EDMG modulated fields, except for the case of an EDMG SU PPDU transmitted over a 2.16 GHz or a 2.16+2.16 GHz channel with single space-time stream ($i_{STS} = 1$). The spatial mapping matrix $Q$ shall be normalized to have the same average power per transmit chain for pre-EDMG and EDMG modulated fields.

### 28.5.10.3 Non-EDMG PPDU transmission

#### 28.5.10.3.1 Non-EDMG PPDU transmission over a 2.16 GHz or 2.16+2.16 GHz channel

The non-EDMG PPDU waveform shall be defined at the DMG SC chip rate $F_c$ and include the following modulated fields:

$$r_{non\text{-}EDMG}(nT_c) = r_{L\text{-}STF}(nT_c) + r_{L\text{-}CEF}(nT_c - t_{L\text{-}CEF}) + r_{L\text{-}Header}(nT_c - t_{L\text{-}Header})$$
$$+ r_{Data}(nT_c - t_{Data}) + r_{AGC\ TRN}(nT_c - t_{AGC\ TRN})$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{Data} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of the L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{AGC\ TRN} = t_{Data} + T_{Data}$ | is the total duration of the L-STF, L-CEF, L-Header, and Data fields of the PPDU |

In the non-EDMG duplicate PPDU waveform, the AGC and TRN fields may be present in a 2.16 GHz non-EDMG PPDU transmission and shall not be present in a 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz non-EDMG PPDU transmission.

Unless specified, the chip index $n$ is defined in the range [0, $N_{Field} - 1$], where $N_{Field}$ defines the total number of samples for a given signal field. The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively. The definition of the AGC and TRN fields is provided in 20.9.2.2.5 and 20.9.2.2.6, respectively. The L-Header and Data fields encoding and modulation is provided in 20.5.3.1.4 and 20.5.3.2, respectively.

The non-EDMG PPDU waveform for the $i_{TX}$th transmit chain shall be defined as follows:

$$r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c\right) = \left[Q_{non\text{-}EDMG}\right]_{i_{TX},1} \cdot r_{non\text{-}EDMG}\left(nT_c\right), 1 \le i_{TX} \le N_{TX}$$

where

$Q_{non\text{-}EDMG}$ is a spatial mapping matrix

$[\ ]_{m,n}$ is a matrix element from $m$th row and $n$th column

For spatial expansion, the non-EDMG waveform for the $i_{TX}$th transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c\right) = \begin{cases} r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\ldots,N-1-T_{SC}^{i_{TX}}\ /\ T_c \\ r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}\ /\ T_c,\ldots,N-1 \end{cases}, \quad 1 \le i_{TX} \le N_{TX}$$

where

$N$ is the total number of chips in the non-EDMG PPDU waveform

The non-EDMG waveform for the $i_{TX}$th transmit chain is obtained by upsampling and filtering and then appropriate carrier frequency shift of the $r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c\right)$ waveform, if required. The upsampling procedure is applied using a factor of $N_{up}$. The filtering procedure is performed with a pulse shaping filter, $h_{SC\,CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = \begin{cases} r_{non\text{-}EDMG}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n = 0, N_{up}, 2*N_{up}\cdots \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

$$r_{non\text{-}EDMG}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right) = \sum_{k=0}^{K-1} r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(\left(n-k\right)\frac{T_c}{N_{up}}\right) h_{SC\,CB}\left(k\right), n = 0,1,\ldots$$

$$r_{non\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right) = r_{non\text{-}EDMG}^{i_{TX}\ (3)}\left(\left(n + \frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n = 0,1,\ldots$$

where

$K$ is the length of $h_{SC\,CB}$ in samples

$r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = 0$, for $n < 0$ and $n \ge N \times N_{up}$

$N$ is the total number of chips in the non-EDMG PPDU waveform

The non-EDMG waveform for the $i_{TX}^{\text{th}}$ transmit chain when transmitted over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}}\right), 1 \le i_{TX} \le N_{TX}$$

For a 2.16+2.16 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary channel (see 28.3.4).

#### 28.5.10.3.2 Non-EDMG duplicate PPDU transmission over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channel

The non-EDMG waveform for the $i_{TX}^{\text{th}}$ transmit chain when transmitted using duplicate transmission over a 4.32 GHz or 4.32+4.32 GHz channel shall be defined as follows:

$$\begin{aligned} r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = {} & r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}} + \Delta t_1\right)\cdot\frac{1}{\sqrt{2}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right) + r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}} + \Delta t_2\right) \\ & \cdot\frac{1}{\sqrt{2}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right), 1 \le i_{TX} \le N_{TX} \end{aligned}$$

where

| | |
|---|---|
| $\Delta F$ | defines the channel spacing and is equal to 2.16 GHz |
| $\Delta t_1$ and $\Delta t_2$ | are in the range $[0, T_c]$ |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

For 4.32+4.32 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary1 and secondary2 channels (see 28.3.4).

The non-EDMG waveform for the $i_{TX}^{\text{th}}$ transmit chain when transmitted using duplicate transmission over a 6.48 GHz channel shall be defined as follows:

$$\begin{aligned} r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = {} & r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}} + \Delta t_1\right)\cdot\frac{1}{\sqrt{3}}\exp\left(-j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right) + r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}} + \Delta t_2\right) \\ & \cdot\frac{1}{\sqrt{3}} + r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}} + \Delta t_3\right)\cdot\frac{1}{\sqrt{3}}\exp\left(+j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right), 1 \le i_{TX} \le N_{TX} \end{aligned}$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, and $\Delta t_3$ | are in the range $[0, T_c]$ |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The non-EDMG waveform for the $i_{TX}^{\text{th}}$ transmit chain when transmitted using duplicate transmission over an 8.64 GHz channel shall be defined as follows:

$$
\begin{aligned}
r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = {} & r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right) \\
& \cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)+r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right) \\
& \cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)+r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right) \\
& \cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)+r_{non\text{-}EDMG}^{i_{TX}(4)}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right) \\
& \cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right),1\le i_{TX}\le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, $\Delta t_3$, and $\Delta t_4$ | are in the range [0, $T_c$] |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The definition of the pulse shaping filter impulse response, $h_{SC\,CB}$, and the $N_{up}$ parameter are implementation dependent.

### 28.5.10.4 EDMG SU PPDU transmission

#### 28.5.10.4.1 General

An EDMG SC mode SU PPDU transmitted over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel with single and multiple space-time streams ($i_{STS} \geq 1$) is composed of pre-EDMG modulated fields, EDMG preamble, Data field and TRN field. The EDMG preamble and TRN field might not be present in a transmitted SU PPDU depending on particular transmission parameters. The total number of transmit chains, $N_{TX}$, shall be constant over the different fields of a transmitted EDMG SU PPDU.

#### 28.5.10.4.2 EDMG PPDU transmission over a 2.16 GHz or 2.16+2.16 GHz channel with $N_{STS}$ = 1

An EDMG SC mode SU PPDU transmitted over a 2.16 GHz or 2.16+2.16 GHz channel with single space-time stream ($N_{STS}$ = 1) is composed of pre-EDMG, Data, and TRN fields.

For a single PPDU transmission, the pre-EDMG and Data fields include the following modulated fields:

$$
\begin{aligned}
& r_{pre\text{-}EDMG,\,Data}\left(nT_c\right) = r_{L\text{-}STF}\left(nT_c\right)+r_{L\text{-}CEF}\left(nT_c - t_{L\text{-}CEF}\right)+r_{L\text{-}Header}\left(nT_c - t_{L\text{-}Header}\right) \\
& +r_{EDMG\text{-}Header\text{-}A}\left(nT_c - t_{EDMG\text{-}Header\text{-}A}\right)+r_{Data}\left(nT_c - t_{Data}\right)
\end{aligned}
$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of the L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ | is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU |

The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively.

For an EDMG A-PPDU transmission of $N_{PPDU}$ PPDUs, the pre-EDMG, the EDMG modulated field of the EDMG preamble, and Data fields include the following modulated fields:

$$
\begin{aligned}
r_{pre\text{-}EDMG,\,Data}(nT_c) &= r_{L\text{-}STF}(nT_c) + r_{L\text{-}CEF}(nT_c - t_{L\text{-}CEF}) + r_{L\text{-}Header}(nT_c - t_{L\text{-}Header}) \\
&+ r_{EDMG\text{-}Header\text{-}A_1}(nT_c - t_{EDMG\text{-}Header\text{-}A_1}) + r_{Data_1}(nT_c - t_{Data_1}) \\
&+ r_{EDMG\text{-}Header\text{-}A_2}(nT_c - t_{EDMG\text{-}Header\text{-}A_2}) + r_{Data_2}(nT_c - t_{Data_2}) \\
&+ \ldots \\
&+ r_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\left(nT_c - t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\right) + r_{Data_{N_{PPDU}}}\left(nT_c - t_{Data_{N_{PPDU}}}\right)
\end{aligned}
$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_1} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data_1} = t_{EDMG\text{-}Header\text{-}A_1} + T_{EDMG\text{-}Header\text{-}A_1}$ | is the total duration of L-STF, L-CEF, L-Header, and EDMG-Header-$A_1$ fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_2} = t_{Data_1} + T_{Data_1}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, and $Data_1$ fields of the PPDU |
| $t_{Data_2} = t_{EDMG\text{-}Header\text{-}A_2} + T_{EDMG\text{-}Header\text{-}A_2}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, and EDMG-Header-$A_2$ fields of the PPDU |
| … | |
| $t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} = t_{Data_{N_{PPDU}-1}} + T_{Data_{N_{PPDU}-1}}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, and $Data_{NPPDU-1}$ fields of the PPDU |
| $t_{Data_{N_{PPDU}}} = t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} + T_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU-1}$, and EDMG-Header-$A_{NPPDU}$ fields of the PPDU |

The PPDU waveform of the pre-EDMG and Data fields for the $i_{TX}{}^{th}$ transmit chain shall be defined as follows:

$$r^{i_{TX}}_{pre\text{-}EDMG,\,Data}\left(nT_c\right) = \left[Q_{EDMG}\right]_{i_{TX},1} \cdot r_{pre\text{-}EDMG,\,Data}\left(nT_c\right), 1 \le i_{TX} \le N_{TX}$$

where

$Q_{EDMG}$ is a spatial mapping matrix

$[\ ]_{m,n}$ is a matrix element from $m^{th}$ row and $n^{th}$ column

For spatial expansion, the PPDU waveform of the pre-EDMG and Data fields for the $i_{TX}{}^{th}$ transmit chain includes a cyclic shift, $T^{i_{TX}}_{SC}$, dependent on the particular transmit chain number. The cyclic shift, $T^{i_{TX}}_{SC}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r^{i_{TX}}_{pre\text{-}EDMG,\,Data}\left(nT_c\right) = \begin{cases} r^{i_{TX}}_{pre\text{-}EDMG,\,Data}\left(nT_c + T^{i_{TX}}_{SC}\right), & n = 0,1,\ldots,N-1-T^{i_{TX}}_{SC}/T_c \\ r^{i_{TX}}_{pre\text{-}EDMG,\,Data}\left(nT_c - \left(NT_c - T^{i_{TX}}_{SC}\right)\right), & n = N - T^{i_{TX}}_{SC}/T_c,\ldots,N-1 \end{cases}, \quad 1 \le i_{TX} \le N_{TX}$$

where

$N$ is the total number of chips in the pre-EDMG and Data fields of the EDMG PPDU

The TRN field, $r^{i_{TX}}_{TRN}\left(nT_c\right)$, shall be defined at the DMG SC chip rate $F_c$ per $i_{TX}{}^{th}$ transmit chain as defined in 28.9.2.2.6.

The resulting SU PPDU waveform for a 2.16 GHz or 2.16+2.16 GHz channel and single space-time stream ($N_{STS}$ = 1) for the $i_{TX}{}^{th}$ transmit chain concatenates the preamble and Data fields with the TRN field and shall be defined as follows:

$$r^{i_{TX}\ (1)}_{EDMG}\left(nT_c\right) = r^{i_{TX}}_{pre\text{-}EDMG,\,Data}\left(nT_c\right) + r^{i_{TX}}_{TRN}\left(nT_c - t_{TRN}\right), 1 \le i_{TX} \le N_{TX}$$

where

$t_{TRN} = t_{Data} + T_{Data}$ is the total duration of the L-STF, L-CEF, L-Header, EDMG-Header-A, and Data fields of the PPDU

For a 2.16+2.16 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary channel (see 28.3.4).

The filtering procedure is performed with a pulse shaping filter, $h_{SC\,CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r^{i_{TX}\ (2)}_{EDMG}\left(n\frac{T_c}{N_{up}}\right) = \begin{cases} r^{i_{TX}\ (1)}_{EDMG}\left(n\frac{T_c}{N_{up}}\right), n = 0, N_{up}, 2*N_{up}\ldots \\ 0 \qquad \text{otherwise} \end{cases}$$

$$r^{i_{TX}\ (3)}_{EDMG}\left(n\frac{T_c}{N_{up}}\right) = \sum_{k=0}^{K-1} r^{i_{TX}\ (2)}_{EDMG}\left((n-k)\frac{T_c}{N_{up}}\right) h_{SC\,CB}(k), n = 0,1,\ldots$$

$$r^{i_{TX}}_{EDMG}\left(n\frac{T_c}{N_{up}}\right) = r^{i_{TX}\ (3)}_{EDMG}\left(\left(n + \frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n = 0,1,\ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = 0$, for $n < 0$ and $n \geq N \times N_{up}$

$N$ is the total number of chips in the EDMG PPDU

The definition of the pulse shaping filter impulse response, $h_{SC\ CB}$, and the $N_{up}$ parameter are implementation dependent.

#### 28.5.10.4.3 EDMG PPDU transmission with DMG AGC and TRN fields over a 2.16 GHz channel with $N_{STS}$ = 1

For the case of DMG AGC and TRN field transmission over a 2.16 GHz channel, indicated by the DMG TRN field in the EDMG-Header-A, the EDMG SU PPDU is transmitted with a single space-time stream and composed of pre-EDMG, Data, DMG AGC and TRN fields.

For a single PPDU transmission, the pre-EDMG, Data, AGC, and TRN fields include the following modulated fields:

$$r_{pre\text{-}EDMG,\ Data, AGC\ \ TRN}\left(nT_c\right) = r_{L\text{-}STF}\left(nT_c\right) + r_{L\text{-}CEF}\left(nT_c - t_{L\text{-}CEF}\right) + r_{L\text{-}Header}\left(nT_c - t_{L\text{-}Header}\right)$$
$$+ r_{EDMG\text{-}Header\text{-}A}\left(nT_c - t_{EDMG\text{-}Header\text{-}A}\right) + r_{Data}\left(nT_c - t_{Data}\right) + r_{AGC\ \ TRN}\left(nT_c - t_{AGC\ \ TRN}\right)$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of the L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of the L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of the L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ | is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU |
| $t_{AGC\ \ TRN} = t_{Data} + T_{Data}$ | is the total duration of the L-STF, L-CEF, L-Header, EDMG-Header-A, and Data fields of the PPDU |

The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively. The definition of the AGC and TRN fields is provided in 20.9.2.2.5 and 20.9.2.2.6, respectively.

For an EDMG A-PPDU transmission of $N_{PPDU}$ PPDUs, the pre-EDMG, the EDMG modulated field of the EDMG preamble, Data AGC and TRN fields include the following modulated fields:

$$\begin{aligned}
& r_{pre\text{-}EDMG,\,Data,\,AGC\ TRN}\left(nT_c\right) = r_{L\text{-}STF}\left(nT_c\right) + r_{L\text{-}CEF}\left(nT_c - t_{L\text{-}CEF}\right) + r_{L\text{-}Header}\left(nT_c - t_{L\text{-}Header}\right) \\
& + r_{EDMG\text{-}Header\text{-}A_1}\left(nT_c - t_{EDMG\text{-}Header\text{-}A_1}\right) + r_{Data_1}\left(nT_c - t_{Data_1}\right) \\
& + r_{EDMG\text{-}Header\text{-}A_2}\left(nT_c - t_{EDMG\text{-}Header\text{-}A_2}\right) + r_{Data_2}\left(nT_c - t_{Data_2}\right) \\
& + \ldots \\
& + r_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\left(nT_c - t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\right) + r_{Data_{N_{PPDU}}}\left(nT_c - t_{Data_{N_{PPDU}}}\right) \\
& + r_{AGC\ TRN}\left(nT_c - t_{AGC\ TRN}\right)
\end{aligned}$$

where

| | |
|---|---|
| $t_{L\text{-}CEF} = T_{L\text{-}STF}$ | is the duration of L-STF field of the PPDU |
| $t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ | is the total duration of L-STF and L-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_1} = t_{L\text{-}Header} + T_{L\text{-}Header}$ | is the total duration of L-STF, L-CEF, and L-Header fields of the PPDU |
| $t_{Data_1} = t_{EDMG\text{-}Header\text{-}A_1} + T_{EDMG\text{-}Header\text{-}A_1}$ | is the total duration of L-STF, L-CEF, L-Header, and EDMG-Header-$A_1$ fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_2} = t_{Data_1} + T_{Data_1}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, and $Data_1$ fields of the PPDU |
| $t_{Data_2} = t_{EDMG\text{-}Header\text{-}A_2} + T_{EDMG\text{-}Header\text{-}A_2}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, and EDMG-Header-$A_2$ fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} = t_{Data_{N_{PPDU}-1}} + T_{Data_{N_{PPDU}-1}}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, and $Data_{NPPDU}$–1 fields of the PPDU |
| $t_{Data_{N_{PPDU}}} = t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} + T_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU}$–1, and EDMG-Header-$A_{NPPDU}$ fields of the PPDU |
| $t_{AGC\ TRN} = t_{Data_{N_{PPDU}}} + T_{Data_{N_{PPDU}}}$ | is the total duration of L-STF, L-CEF, L-Header, EDMG-Header-$A_1$, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU}$–1, EDMG-Header-$A_{NPPDU}$, and $Data_{NPPDU}$ fields of the PPDU |

The EDMG PPDU waveform for the $i_{TX}$th transmit chain shall be defined as follows:

$$r_{EDMG,}^{i_{TX}(1)}\left(nT_c\right) = \left[Q_{EDMG}\right]_{i_{TX},1} \cdot r_{pre-EDMG,\,Data,\,AGC\ TRN}\left(nT_c\right), 1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $Q_{EDMG}$ | is a spatial mapping matrix |
| $[\ ]_{m,n}$ | is a matrix element from $m$th row and $n$th column |

For spatial expansion, the EDMG PPDU waveform for the $i_{TX}{}^{\text{th}}$ transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration:

$$r_{EDMG}^{i_{TX}\,(1)}\left(nT_c\right) = \begin{cases} r_{pre\text{-}EDMG,\,Data,\,AGC\ \ TRN}^{i_{TX}\,(1)}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\ldots,N-1-T_{SC}^{i_{TX}}\,/\,T_c \\ r_{pre\text{-}EDMG,\,Data,\,AGC\ \ TRN}^{i_{TX}\,(1)}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}\,/\,T_c,\ldots,N-1 \end{cases},\quad 1 \le i_{TX} \le N_{TX}$$

where

$N$ is the total number of chips in the pre-EDMG, Data, AGC, and TRN fields

The filtering procedure is performed with a pulse shaping filter, $h_{SC\ CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = \begin{cases} r_{EDMG}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n = 0, N_{up}, 2 * N_{up} \ldots \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

$$r_{EDMG}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right) = \sum_{k=0}^{K-1} r_{EDMG}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{N_{up}}\right) h_{SC\,CB}(k), n = 0,1,\ldots$$

$$r_{EDMG}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{EDMG}^{i_{TX}\ (3)}\left(\left(n + \frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n = 0,1,\ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{non\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = 0$, for $n < 0$ and $n \ge N \times N_{up}$

$N$ is the total number of chips in the EDMG PPDU waveform

The definition of the pulse shaping filter impulse response, $h_{SC\ CB}$, and the $N_{up}$ parameter are implementation dependent.

### 28.5.10.4.4 EDMG PPDU transmission over a 2.16 GHz or 2.16+2.16 GHz channel with $N_{STS}$ > 1 and 4.32 GHz, 6.48 GHz, 8.64 GHz or 4.32+4.32 GHz channel with $N_{STS}$ ≥ 1

#### 28.5.10.4.4.1 General

An EDMG SC mode SU PPDU transmitted over a 2.16 GHz or 2.16+2.16 GHz channel with more than one stream ($N_{STS} > 1$) or over a 4.32 GHz, 6.48 GHz, 8.64 GHz, or 4.32+4.32 GHz channels with one or more space-time streams ($N_{STS} \ge 1$) is composed of pre-EDMG modulated fields, EDMG preamble, Data field and TRN field. The total number of transmit chains, $N_{TX}$, shall be constant over the different fields of the EDMG SU PPDU.

### 28.5.10.4.4.2 Pre-EDMG modulated fields transmission

The pre-EDMG modulated fields of the PPDU includes the following modulated fields:

$$r_{pre\text{-}EDMG}(nT_c) = r_{L\text{-}STF}(nT_c) + r_{L\text{-}CEF}(nT_c - t_{L\text{-}CEF}) + r_{L\text{-}Header}(nT_c - t_{L\text{-}Header})$$
$$+ r_{EDMG\text{-}Header\text{-}A}(nT_c - t_{EDMG\text{-}Header\text{-}A})$$

where

$t_{L\text{-}CEF} = T_{L\text{-}STF}$ is the duration of the L-STF field of the PPDU

$t_{L\text{-}Header} = t_{L\text{-}CEF} + T_{L\text{-}CEF}$ is the total duration of the L-STF and L-CEF fields of the PPDU

$t_{EDMG\text{-}Header\text{-}A} = t_{L\text{-}Header} + T_{L\text{-}Header}$ is the total duration of the L-STF, L-CEF, and L-Header fields of the PPDU

The definition of the L-STF, L-CEF, and L-Header fields is provided in 28.3.3.2.2, 28.3.3.2.3, and 28.3.3.2.4, respectively.

The PPDU waveform of the pre-EDMG modulated fields for the $i_{TX}$th transmit chain shall be defined as follows:

$$r_{pre\text{-}EDMG}^{i_{TX}\ (1)}(nT_c) = \left[Q_{pre\text{-}EDMG}\right]_{i_{TX},1} \cdot r_{pre\text{-}EDMG}(nT_c), 1 \le i_{TX} \le N_{TX}$$

where

$Q_{pre\text{-}EDMG}$ is a spatial mapping matrix

$[\ ]_{m,n}$ is a matrix element from $m$th row and $n$th column

For spatial expansion, the PPDU waveform of the pre-EDMG modulated fields for the $i_{TX}$th transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX} - 1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{pre\text{-}EDMG}^{i_{TX}\ (1)}(nT_c) = \begin{cases} r_{pre\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c + T_{SC}^{i_{TX}}\right), & n = 0,1,\dots,N-1-T_{SC}^{i_{TX}}/T_c \\ r_{pre\text{-}EDMG}^{i_{TX}\ (1)}\left(nT_c - \left(NT_c - T_{SC}^{i_{TX}}\right)\right), & n = N - T_{SC}^{i_{TX}}/T_c,\dots,N-1 \end{cases}, \quad 1 \le i_{TX} \le N_{TX}$$

where

$N$ is the total number of chips in the pre-EDMG field of the EDMG PPDU waveform

The waveform for the pre-EDMG modulated fields for $i_{TX}$th transmit chain is obtained by upsampling and filtering and then appropriate carrier frequency shift of the $r_{pre-EDMG}^{i_{TX}\ (1)}(nT_c)$ waveform, if required. The upsampling procedure is applied using a factor of $N_{up}$. The filtering procedure is performed with a pulse shaping filter, $h_{SC\ CB}$, defined at the $N_{up} \times F_c$ sampling rate as follows:

$$r_{pre-EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = \begin{cases} r_{pre-EDMG}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{up}}\right), n = 0, N_{up}, 2*N_{up}\ldots \\ 0 \qquad\qquad otherwise \end{cases}$$

$$r_{pre-EDMG}^{i_{TX}\ (3)}\left(n\frac{T_c}{N_{up}}\right) = \sum_{k=0}^{K-1} r_{pre-EDMG}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{N_{up}}\right)h_{SC\,CB}(k), n = 0,1,\ldots$$

$$r_{pre-EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right) = r_{pre-EDMG}^{i_{TX}\ (3)}\left(\left(n+\frac{K-1}{2}\right)\frac{T_c}{N_{up}}\right), n = 0,1,\ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{pre\text{-}EDMG}^{i_{TX}\ (2)}\left(n\frac{T_c}{N_{up}}\right) = 0$, for $n < 0$ and $n \geq N \times N_{up}$

$N$ is the total number of chips in the pre-EDMG field of the EDMG PPDU

The waveform of the pre-EDMG modulated fields for the $i_{TX}$th transmit chain when transmitted over a 2.16 GHz or 2.16+2.16 GHz channel shall be defined as follows:

$$r_{pre-EDMG}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{pre-EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}}\right), 1 \le i_{TX} \le N_{TX}$$

For a 2.16+2.16 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary channel and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary channel (see 28.3.4).

The waveform of the pre-EDMG modulated fields for the $i_{TX}$th transmit chain when transmitted using duplicate transmission over a 4.32 GHz or 4.32+4.32 GHz channel shall be defined as follows:

$$r_{pre\text{-}EDMG}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{pre\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}} + \Delta t_1\right) \cdot \frac{1}{\sqrt{2}} \exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)$$
$$+ r_{pre\text{-}EDMG}^{i_{TX}\ (4)}\left(n\frac{T_c}{N_{up}} + \Delta t_2\right) \cdot \frac{1}{\sqrt{2}} \exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right), 1 \le i_{TX} \le N_{TX}$$

where

$\Delta F$ defines the channel spacing and is equal to 2.16 GHz

$\Delta t_1$ and $\Delta t_2$ are in the range $[0, T_c]$

$\Delta t_i$ equal to 0 corresponds to the primary channel

For a 4.32+4.32 GHz transmission, the total number of transmit chains, $N_{TX}$, shall be an even number. The first $N_{TX}/2$ transmit chains shall be used for transmission on the primary and secondary channels and the second $N_{TX}/2$ transmit chains shall be used for transmission on the secondary1 and secondary2 channels (see 28.3.4).

The waveform of the pre-EDMG modulated fields for the $i_{TX}{}^{\text{th}}$ transmit chain when transmitted using duplicate transmission over a 6.48 GHz channel shall be defined as follows:

$$\begin{aligned}
r^{i_{TX}}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}\right) &= r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{3}}\exp\left(-j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{3}}\\
&+r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{3}}\exp\left(+j2\pi\Delta F\left(\frac{T_c}{N_{up}}\right)n\right),1\le i_{TX}\le N_{TX}
\end{aligned}$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, and $\Delta t_3$ | are in the range [0, $T_c$] |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The waveform of the pre-EDMG modulated fields for the $i_{TX}{}^{\text{th}}$ transmit chain when transmitted using duplicate transmission over an 8.64 GHz channel shall be defined as follows:

$$\begin{aligned}
r^{i_{TX}}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}\right) &= r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_1\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_2\right)\cdot\frac{1}{\sqrt{4}}\exp\left(-j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_3\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right)\\
&+r^{i_{TX}\,(4)}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}+\Delta t_4\right)\cdot\frac{1}{\sqrt{4}}\exp\left(+j2\pi\left(\frac{3\Delta F}{2}\right)\left(\frac{T_c}{N_{up}}\right)n\right),1\le i_{TX}\le N_{TX}
\end{aligned}$$

where

| | |
|---|---|
| $\Delta t_1$, $\Delta t_2$, $\Delta t_3$, and $\Delta t_4$ | are in the range [0, $T_c$] |
| $\Delta t_i$ equal to 0 | corresponds to the primary channel |

The definition of the pulse shaping filter impulse response, $h_{SC\ CB}$, and the $N_{up}$ parameter are implementation dependent.

### 28.5.10.4.4.3 EDMG preamble and Data field transmission

For a single PPDU transmission, the EDMG modulated field of the EDMG preamble and Data field of an SU PPDU is defined for the $i_{TX}{}^{\text{th}}$ transmit chain at the EDMG SC chip rate $F_{c\ EDMG}$ and includes the following modulated fields:

$$r^{i_{TX}}_{EDMG\text{-}Pream,\,Data}\left(n\frac{T_c}{N_{CB}}\right)=r^{i_{TX}}_{EDMG\text{-}STF}\left(n\frac{T_c}{N_{CB}}\right)+r^{i_{TX}}_{EDMG\text{-}CEF}\left(n\frac{T_c}{N_{CB}}-t_{EDMG\text{-}CEF}\right)$$
$$+r^{i_{TX}}_{Data}\left(n\frac{T_c}{N_{CB}}-t_{Data}\right),\ 1\le i_{TX}\le N_{TX}$$

where

| | |
|---|---|
| $t_{EDMG\text{-}CEF}=T_{EDMG\text{-}STF}$ | is the duration of the EDMG-STF field of the PPDU |
| $t_{Data}=t_{EDMG\text{-}CEF}+T_{EDMG-CEF}$ | is the total duration of the EDMG-STF and EDMG-CEF fields of the PPDU |

The EDMG-STF, EDMG-CEF, and Data field transmission is defined in 28.5.4, 28.5.5, and 28.5.9.5.2, respectively.

For an EDMG A-PPDU transmission of $N_{PPDU}$ PPDUs, the EDMG modulated field of the EDMG preamble and Data field of an SU PPDU is defined for $i_{TX}$th transmit chain at the $F_{c\ EDMG}$ and includes the following modulated fields:

$$r^{i_{TX}}_{EDMG\text{-}Pream,\,Data}\left(n\frac{T_c}{N_{CB}}\right)=r^{i_{TX}}_{EDMG\text{-}STF}\left(n\frac{T_c}{N_{CB}}\right)+r^{i_{TX}}_{EDMG\text{-}CEF}\left(n\frac{T_c}{N_{CB}}-t_{EDMG\text{-}CEF}\right)$$
$$+r^{i_{TX}}_{Data_1}\left(n\frac{T_c}{N_{CB}}-t_{Data_1}\right)$$
$$+r^{i_{TX}}_{EDMG\text{-}Header\text{-}A_2}\left(n\frac{T_c}{N_{CB}}-t_{EDMG\text{-}Header\text{-}A_2}\right)+r^{i_{TX}}_{Data_2}\left(n\frac{T_c}{N_{CB}}-t_{Data_2}\right)$$
$$+\ldots$$
$$+r^{i_{TX}}_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\left(n\frac{T_c}{N_{CB}}-t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\right)+r^{i_{TX}}_{Data_{N_{PPDU}}}\left(n\frac{T_c}{N_{CB}}-t_{Data_{N_{PPDU}}}\right),\ 1\le i_{TX}\le N_{TX}$$

where

| | |
|---|---|
| $t_{EDMG\text{-}CEF}=T_{EDMG\text{-}STF}$ | is the duration of the EDMG-STF field of the PPDU |
| $t_{Data_1}=t_{EDMG\text{-}CEF}+T_{EDMG\text{-}CEF}$ | is the total duration of the EDMG-STF and EDMG-CEF fields of the PPDU |
| $t_{EDMG\text{-}Header\text{-}A_2}=t_{Data_1}+T_{Data_1}$ | is the total duration of the EDMG-STF, EDMG-CEF, and $Data_1$ fields of the PPDU |
| $t_{Data_2}=t_{EDMG\text{-}Header\text{-}A_2}+T_{EDMG\text{-}Header\text{-}A_2}$ | is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, and EDMG-Header-$A_2$ fields of the PPDU |
| … | |
| $t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}=t_{Data_{N_{PPDU}-1}}+T_{Data_{N_{PPDU}-1}}$ | is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, and $Data_{NPPDU-1}$ fields of the PPDU |
| $t_{Data_{N_{PPDU}}}=t_{EDMG\text{-}Header-A_{N_{PPDU}}}+T_{EDMG\text{-}Header-A_{N_{PPDU}}}$ | is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU-1}$, and EDMG-Header-$A_{NPPDU}$ fields of the PPDU |

The EDMG-STF, EDMG-CEF, Data, and EDMG-Header-A field transmission is defined in 28.5.4, 28.5.5, 28.5.9.5.2, and 28.5.7, respectively.

For spatial expansion, the PPDU waveform of the EDMG preamble and Data field for the $i_{TX}$th transmit chain includes a cyclic shift, $T_{SC}^{i_{TX}}$, dependent on the particular transmit chain number. The cyclic shift, $T_{SC}^{i_{TX}}$, is defined in SC chip units as $(i_{TX}-1) \times N_c \times T_c$, where $N_c$ is equal to 4 chips and $T_c$ is a chip time duration.

$$r_{EDMG\text{-}Pream,\,Data}^{i_{TX}}\left(n\frac{T_c}{N_{CB}}\right)=$$

$$=\begin{cases} r_{EDMG\text{-}Pream,\,Data}^{i_{TX}}\left(n\left(\frac{T_c}{N_{CB}}\right)+T_{SC}^{i_{TX}}\right), & n=0,1,\ldots,N-1-T_{SC}^{i_{TX}}\ /\left(T_c\ /\ N_{CB}\right) \\ r_{EDMG\text{-}Pream,\,Data}^{i_{TX}}\left(n\left(\frac{T_c}{N_{CB}}\right)-\left(N\left(\frac{T_c}{N_{CB}}\right)-T_{SC}^{i_{TX}}\right)\right), & n=N-T_{SC}^{i_{TX}}\ /\left(T_c\ /\ N_{CB}\right),\ldots,N-1 \end{cases},\quad 1\le i_{TX}\le N_{TX}$$

where

$N$ is the total number of chips in the EDMG preamble and Data fields of the EDMG PPDU

### 28.5.10.4.4.4 TRN field transmission

The TRN field, $r_{TRN}^{i_{TX}}\left(n\frac{T_c}{N_{CB}}\right)$, shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ per $i_{TX}$th transmit chain as defined in 28.9.2.2.6.

### 28.5.10.4.4.5 Filtering procedure

The EDMG preamble, Data field, and TRN field for the $i_{TX}$th transmit chain are defined as follows:

$$r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{CB}}\right)=r_{EDMG\text{-}Pream,\,Data}^{i_{TX}}\left(n\frac{T_c}{N_{CB}}\right)$$
$$+r_{TRN}^{i_{TX}}\left(n\frac{T_c}{N_{CB}}-t_{TRN}\right),\ 1\le i_{TX}\le N_{TX}$$

where

$t_{TRN}=t_{Data}+T_{Data}$ is the total duration of the EDMG-STF, EDMG-CEF, and Data fields of the PPDU

The EDMG preamble, Data field, and TRN field are filtered and resampled with a conversion rate ratio $N_{up}/N_{CB}$. For example, the resampling procedure for a ratio $N_{up}/N_{CB}$ equal to 3/2 can be defined as follows:

$$r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (2)}\left(n\frac{T_c}{3N_{CB}}\right)=\begin{cases} r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (1)}\left(n\frac{T_c}{3N_{CB}}\right), & n=0,3,6\ldots \\ 0 & \text{otherwise} \end{cases}$$

$$r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (3)}\left(n\frac{T_c}{3N_{CB}}\right)=\sum_{k=0}^{K-1}r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (2)}\left(\left(n-k\right)\frac{T_c}{3N_{CB}}\right)h_{SC\,CB}\left(k\right),n=0,1,\ldots$$

$$r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}}\left(n\frac{2T_c}{3N_{CB}}\right)=r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}\ (3)}\left(\left(2n+\frac{K-1}{2}\right)\frac{T_c}{3N_{CB}}\right),n=0,1,\ldots$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r^{i_{TX}\ (2)}_{EDMG\text{-}Pream,Data,TRN}\left(n\dfrac{T_c}{3N_{CB}}\right) = 0$, for $n < 0$ and $n \geq N \times 3$

$N$ is the total number of chips in the EDMG preamble, Data field, and TRN field of the EDMG PPDU

The EDMG SC mode SU PPDU waveform for the $i_{TX}$th transmit chain concatenates the pre-EDMG modulated fields, EDMG preamble, Data field, and TRN field and shall be defined as follows:

$$r^{i_{TX}}_{PPDU}\left(n\frac{T_c}{N_{up}}\right) = r^{i_{TX}}_{pre\text{-}EDMG}\left(n\frac{T_c}{N_{up}}\right) + r^{i_{TX}}_{EDMG\text{-}Pream,\ Data,\ TRN}\left(n\frac{T_c}{N_{up}} - t_{EDMG\text{-}STF}\right), 1 \leq i_{TX} \leq N_{TX}$$

where

$t_{EDMG\text{-}STF} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU

The definition of the pulse shaping filter impulse response, $h_{SC\ CB}$, and the $N_{up}$ parameter are implementation dependent.

### 28.5.10.5 EDMG MU PPDU transmission

#### 28.5.10.5.1 General

The EDMG SC mode MU PPDU transmitted over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel with multiple space-time streams ($N_{STS} > 1$) for two or more users ($N_{user} > 1$) is composed of pre-EDMG modulated fields, EDMG preamble, EDMG-Header-B field, Data field and TRN field. The TRN field might not be present in a transmitted MU PPDU depending on particular transmission parameters. The total number of transmit chains, $N_{TX}$, shall be constant over the different fields of a transmitted EDMG MU PPDU.

#### 28.5.10.5.2 Pre-EDMG modulated fields transmission

The pre-EDMG modulated fields of the PPDU shall be transmitted as specified in 28.5.10.4.4.2.

#### 28.5.10.5.3 EDMG preamble, EDMG-Header-B, and Data field transmission

The EDMG preamble, EDMG-Header-B and Data field of an EDMG MU PPDU is defined for $i_{TX}$th transmit chain at the EDMG SC chip rate $F_{c\ EDMG}$ and includes the following modulated fields:

$$r^{i_{TX}}_{EDMG\text{-}Pream,\ EDMG\text{-}Header\text{-}B,\ Data}\left(n\frac{T_c}{N_{CB}}\right) = r^{i_{TX}}_{EDMG\text{-}STF}\left(n\frac{T_c}{N_{CB}}\right) + r^{i_{TX}}_{EDMG\text{-}CEF}\left(n\frac{T_c}{N_{CB}} - t_{EDMG\text{-}CEF}\right)$$
$$+ r^{i_{TX}}_{EDMG\text{-}Header\text{-}B}\left(n\frac{T_c}{N_{CB}} - t_{EDMG\text{-}Header\text{-}B}\right) + r^{i_{TX}}_{Data}\left(n\frac{T_c}{N_{CB}} - t_{Data}\right), 1 \leq i_{TX} \leq N_{TX}$$

where

$t_{EDMG\text{-}CEF} = T_{EDMG\text{-}STF}$ is the duration of the EDMG-STF field of the PPDU

$t_{EDMG\text{-}Header\text{-}B} = t_{EDMG\text{-}CEF} + T_{EDMG\text{-}CEF}$ is the total duration of the EDMG-STF and EDMG-CEF fields of the PPDU

$t_{Data} = t_{EDMG\text{-}Header\text{-}B} + T_{EDMG\text{-}Header\text{-}B}$ is the total duration of the EDMG-STF, EDMG-CEF, and EDMG-Header-B fields of the PPDU

The EDMG-STF, EDMG-CEF, Data, and EDMG-Header-B field transmission is defined in 28.5.4, 28.5.5, 28.5.9.5.2, and 28.5.6, respectively.

#### 28.5.10.5.4 TRN field transmission

The TRN field, $r_{TRN}^{i_{TX}}\left(n\dfrac{T_c}{N_{CB}}\right)$, shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ per $i_{TX}$th transmit chain as defined in 28.9.2.2.6.

#### 28.5.10.5.5 Filtering procedure

The EDMG preamble, EDMG-Header-B, Data field, and TRN field for the $i_{TX}$th transmit chain are defined as follows:

$$r_{EDMG\text{-}Pream,\ EDMG\text{-}Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (1)}\left(n\frac{T_c}{N_{CB}}\right) = r_{EDMG\text{-}Pream,\ EDMG\text{-}Header\text{-}B,\ Data}^{i_{TX}}\left(n\frac{T_c}{N_{CB}}\right)$$
$$+ r_{TRN}^{i_{TX}}\left(n\frac{T_c}{N_{CB}} - t_{TRN}\right),\ 1 \le i_{TX} \le N_{TX}$$

where

$t_{TRN} = t_{Data} + T_{Data}$ is the total duration of the EDMG-STF, EDMG-CEF, EDMG-Header-B, and Data fields of the PPDU

The EDMG preamble, EDMG-Header-B, Data field and TRN field are filtered and resampled with a conversion rate ratio $N_{up}/N_{CB}$. For example, the resampling procedure for a ratio $N_{up}/N_{CB}$ equal to 3/2 can be defined as follows:

$$r_{EDMG\text{-}Pream,\ Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (2)}\left(n\frac{T_c}{3N_{CB}}\right) = \begin{cases} r_{EDMG\text{-}Pream,\ EDMG\text{-}Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (1)}\left(n\dfrac{T_c}{3N_{CB}}\right), n = 0,3,6... \\ 0 \qquad \text{otherwise} \end{cases}$$

$$r_{EDMG\text{-}Pream,\ Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (3)}\left(n\frac{T_c}{3N_{CB}}\right) = \sum_{k=0}^{K-1} r_{EDMG\text{-}Pream,\ Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (2)}\left((n-k)\frac{T_c}{3N_{CB}}\right) h_{SC\,CB}(k), n = 0,1,...$$

$$r_{EDMG\text{-}Pream,\ Header\text{-}B,\ Data,\ TRN}^{i_{TX}}\left(n\frac{2T_c}{3N_{CB}}\right) = r_{EDMG\text{-}Pream,\ Header\text{-}B,\ Data,\ TRN}^{i_{TX}\ (3)}\left(\left(2n+\frac{K-1}{2}\right)\frac{T_c}{3N_{CB}}\right), n = 0,1,...$$

where

$K$ is the length of $h_{SC\ CB}$ in samples

$r_{EDMG\text{-}Pream,Header\text{-}B,Data,TRN}^{i_{TX}\ (2)}\left(n\dfrac{T_c}{3N_{CB}}\right) = 0$, for $n < 0$ and $n \ge N \times 3$

$N$ is the total number of chips in the EDMG preamble, EDMG-Header-B, Data, and TRN fields of the EDMG PPDU

The EDMG SC mode MU PPDU waveform for the $i_{TX}$^th^ transmit chain concatenates the pre-EDMG modulated fields, EDMG preamble, EDMG-Header-B, Data field, and TRN field and shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) = r_{pre\text{-}EDMG}^{i_{TX}}\left(n\frac{T_c}{N_{up}}\right) + r_{EDMG\text{-}Pream,\,Header\text{-}B,\,Data,\,TRN}^{i_{TX}}\left(n\frac{T_c}{N_{up}} - t_{EDMG\text{-}STF}\right), 1 \le i_{TX} \le N_{TX}$$

where

$t_{EDMG\text{-}STF} = t_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}Header\text{-}A}$ is the total duration of the L-STF, L-CEF, L-Header, and EDMG-Header-A fields of the PPDU

The definition of the pulse shaping filter impulse response, $h_{SC\,CB}$, and the $N_{up}$ parameter are implementation dependent.

### 28.5.11 Performance requirements

#### 28.5.11.1 Transmit requirements

##### 28.5.11.1.1 Transmit modulation accuracy (EVM) test and requirements

This subclause specifies the EVM test and corresponding requirements for the following:

- PPDUs transmitted with the TXVECTOR parameter EDMG_MODULATION equal to EDMG_SC_MODE and with TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION equal to any valid combination indicated in Table 28-21, Table 28-22, or Table 28-23.
- PPDUs transmitted with the TXVECTOR parameter NON_EDMG_MODULATION equal to NON_EDMG_DUP_SC_MODE and with TXVECTOR parameter CH_BANDWIDTH with at least 2 bits equal one.

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted signals into a stream of complex samples at sampling rate greater than or equal to the SC chip rate, with the following exceptions:

- If the TXVECTOR parameter NON_EDMG_MODULATION is set to NON_EDMG_DUP_SC_MODE, the transmission in the two or more 2.16 GHz channels may be tested independently.
- If the TXVECTOR parameter CHANNEL_AGGREGATION is set to AGGREGATE, the transmission in the two (adjacent or non-adjacent) 2.16 GHz channels or 4.32 GHz channels may be tested independently.

In the two cases indicated above, transmit modulation accuracy of each 2.16 GHz channel (when NON_EDMG_MODULATION is set to NON_EDMG_DUP_SC_MODE or when CHANNEL_AGGREGATION is set to AGGREGATE) or of each 4.32 GHz channel (when CHANNEL_AGGREGATION is set to AGGREGATE) shall meet the required value in Table 28-58 through Table 28-61 using only the signal within the corresponding channel.

If the TXVECTOR parameter EDMG_MODULATION is set to EDMG_SC_MODE, the TXVECTOR parameters NUM_STS and NUM_TX_CHAINS shall be equal, and the value of both parameters shall be equal to the number of utilized testing instrumentation input ports or antennas, if ports are not available on the STA under test. In the test, $N_{SS}$ = $N_{STS}$ (no STBC) shall be used. If the TXVECTOR parameter NUM_STS is set to a value greater than 1, the two or more space-time streams shall have the same modulation type. The identity matrix should be used as the expansion matrix. Each port or antenna of the transmitting STA, which is connected to a transmit chain, shall be assigned to a port or antenna of the testing instrumentation in a way that makes signal coupling between the different transmit signal paths negligible.

The instrumentation used in the transmit EVM accuracy test shall have sufficient accuracy in terms of I/Q arm amplitude and phase balance, DC offsets, phase noise, and analog-to-digital quantization noise, so as not to mask or degrade the true EVM measurement. A possible embodiment of such a setup is converting the signals to a low IF frequency with a microwave synthesizer, sampling the signal with a digital oscilloscope and decomposing it digitally into quadrature components. The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps, or equivalent procedure:

— Detect the start of the PPDU.
— Establish fine timing.
— Estimate the coarse and fine frequency offsets.
— De-rotate the frame according to the estimated frequency offset.
— Estimate the complex channel impulse response for each of the transmit chains using the EDMG-CEF field, if present. If not, channel estimation is performed using the L-CEF field.
— For each SC symbol block, estimate time-dependent phase variations using guard interval symbols (for example, by interpolating the phase between the prefix and postfix GI samples), and de-rotate the corresponding symbol samples accordingly.
— For each SC symbol block, perform demodulation and apply a minimum mean square error equalization matrix generated from the channel estimate. Group the demodulated symbols from each SC symbol block, and combine the demodulated data from each spatial stream into a vector.
— For each element of the vector, find the closest constellation point and compute the Euclidian distance from it.
— Compute the average relative constellation RMS error (EVM) across PPDUs according to the formula:

$$EVM =$$

$$20\log_{10}\left(\frac{1}{N_f}\sum_{f=1}^{N_f}\sqrt{\frac{\sum_{n=0}^{N_{BLKS}-1}\sum_{j=1}^{N_{ss}}\sum_{k=0}^{N_{SPB}-1}\left(I(f,n,j,k)-I^*(f,n,j,k)-I_0(f,j)\right)^2+\left(Q(f,n,j,k)-Q^*(f,n,j,k)-Q_0(f,j)\right)^2}{N_{BLKS}\times N_{SS}\times N_{SPB}\times P_0}}\right)$$

where

$N_f$ is the number of frames for the measurement

$N_{BLKS}$ is the number of SC symbol blocks within each frame

$N_{SS}$ is the number of spatial streams of each frame

$N_{SPB}$ is the number of data modulated symbols per SC symbol block

$P_0$ is the average power of the constellation

$I(f,n,j,k)$ and $Q(f,n,j,k)$
denote the observed symbol point in the complex plane for the $k^{th}$ symbol of the $n^{th}$ SC symbol block and $j^{th}$ spatial stream within the $f^{th}$ frame

$I^*(f,n,j,k)$ and $Q^*(f,n,j,k)$
denote the ideal symbol point in the complex plane for the $k^{th}$ symbol of the $n^{th}$ SC symbol block and $j^{th}$ spatial stream within the $f^{th}$ frame

$I_0(f,j)$ and $Q_0(f,j)$
are the complex DC term chosen to minimize the EVM, which may be dependent on the frame index (*f*) and spatial stream index (*j*)

The total number of symbols used in the test is equal to $N_f \times N_{BLKS} \times N_{SS} \times N_{SPB}$ with the constraint that $N_{BLKS}$ shall be at least 20 and that $N_f$ shall be at least 20. Random data shall be used for the symbols and frames.

The test equipment shall use a root-raised cosine filter with roll-off factor of 0.25 for the pulse shaping filter when conducting EVM measurements.

The transmit pulse shaping filter impulse response is implementation specific.

The EVM shall not exceed an MCS dependent value provided in Table 28-58 through Table 28-61.

Transmit requirements of PPDUs transmitted with TXVECTOR parameter NON_EDMG_MODULATION equal to DMG_SC_MODE are defined in 20.5.4.

**Table 28-58—EDMG-MCSs for the EDMG SC mode**

| MCS | EVM value (dB) |
|---|---|
| 1 | –6 |
| 2 | –7 |
| 3 | –9 |
| 4 | –10 |
| 5 | –12 |
| 6 | –13 |
| 7 | –11 |
| 8 | –12 |
| 9 | –13 |
| 10 | –15 |
| 11 | –16 |
| 12 | –19 |
| 13 | –20 |
| 14 | –21 |
| 15 | –22 |
| 16 | –23 |
| 17 | –24 |
| 18 | –25 |
| 19 | –27 |
| 20 | –28 |
| 21 | –29 |

### Table 28-59—EDMG-MCSs 12 and 13 for the EDMG SC mode if the π/2-8-PSK Applied field is 1

| MCS | EVM value (dB) |
|---|---|
| 12 | –17 |
| 13 | –20 |

### Table 28-60—EDMG-MCSs 17 to 21 for the EDMG SC mode if the π/2-64-NUC Applied field is 1

| MCS | EVM value (dB) |
|---|---|
| 17 | –24 |
| 18 | –25 |
| 19 | –27 |
| 20 | –28 |
| 21 | –29 |

### Table 28-61—EDMG-MCSs 2 to 6 for the EDMG SC mode if the DCM π/2-BPSK Applied field is 1

| MCS | EVM value (dB) |
|---|---|
| 2 | –7 |
| 3 | –9 |
| 4 | –10 |
| 5 | –12 |
| 6 | –13 |

#### 28.5.11.1.2 Time of Departure accuracy

The Time of Departure accuracy test evaluates TIME_OF_DEPARTURE against aTxPHYTxStartRMS and aTxPHYTxStartRMS against TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH as defined in Annex P with the following test parameters:

— MULTICHANNEL_SAMPLING_RATE is set to aDMGChipRate.
— FIRST_TRANSITION_FIELD is L-STF of the waveform transmitted in the primary channel.
— SECOND_TRANSITION_FIELD is L-CEF of the waveform transmitted in the primary channel.
— TRAINING_FIELD is L-CEF of the waveform transmitted in the primary channel.
— TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH is set to aDMGTimeOfDepartureAccuracyThresh.

#### 28.5.11.2 Receive requirements

CCA sensitivity requirements are defined in 28.3.8.

## 28.6 EDMG OFDM mode

### 28.6.1 General

Transmission and reception of 2.16 GHz PPDU, 4.32 GHz PPDU, 6.48 GHz PPDU, 8.64 GHz PPDU, 2.16+2.16 GHz PPDU, and 4.32+4.32 GHz PPDU using the EDMG OFDM mode are optional. This applies to SU and MU PPDUs with one or more spatial streams.

### 28.6.2 OFDM signal parameters

#### 28.6.2.1 General

This subclause defines main EDMG OFDM signal parameters for 2.16 GHz ($N_{CB}$ = 1), 4.32 GHz ($N_{CB}$ = 2), 6.48 GHz ($N_{CB}$ = 3), 8.64 GHz ($N_{CB}$ = 4), 2.16+2.16 GHz ($N_{CB}$ = 1), and 4.32+4.32 GHz ($N_{CB}$ = 2) transmissions.

#### 28.6.2.2 Timing related parameters

Table 28-62 provides a summary of the timing related parameters of the EDMG OFDM mode.

**Table 28-62—EDMG OFDM mode timing related parameters1**

| Parameter | Value | | | |
|---|---|---|---|---|
| | $N_{CB}$ = 1 | $N_{CB}$ = 2 | $N_{CB}$ = 3 | $N_{CB}$ = 4 |
| $N_{SD}$: Number of data subcarriers | 336 | 734 | 1134 | 1532 |
| $N_{SP}$: Number of pilot subcarriers | 16 | 36 | 56 | 76 |
| $N_{DC}$: Number of DC subcarriers | 3 | 3 | 3 | 3 |
| $N_{ST}$: Total number of subcarriers | 355 | 773 | 1193 | 1611 |
| $N_{SR}$: Number of subcarriers occupying half of the overall bandwidth | 177 | 386 | 596 | 805 |
| $N_{GI\ short}$: short guard interval length | 48 | 96 | 144 | 192 |

**Table 28-62—EDMG OFDM mode timing related parameters1** ***(continued)***

| Parameter | Value | | | |
|---|---|---|---|---|
| | $N_{CB} = 1$ | $N_{CB} = 2$ | $N_{CB} = 3$ | $N_{CB} = 4$ |
| $N_{GI\ normal}$: normal guard interval length | 96 | 192 | 288 | 384 |
| $N_{GI\ long}$: long guard interval length | 192 | 384 | 576 | 768 |
| $\Delta_F$: Subcarrier frequency spacing | 5.15625 MHz | 5.15625 MHz | 5.15625 MHz | 5.15625 MHz |
| $F_s$: EDMG OFDM sample rate | 2.64 GHz | 5.28 GHz | 7.92 GHz | 10.56 GHz |
| $T_s$: EDMG OFDM sample time duration | 0.38 ns | 0.19 ns | 0.13 ns | 0.09 ns |
| $N_{DFT}$: DFT size | 512 | 1024 | 1536 | 2048 |
| $T_{DFT}$: OFDM IDFT/DFT period | 0.194 µs | 0.194 µs | 0.194 µs | 0.194 µs |
| $T_{GI\ short}$: short guard interval duration | 18.18 ns | 18.18 ns | 18.18 ns | 18.18 ns |
| $T_{GI\ normal}$: normal guard interval duration | 36.36 ns | 36.36 ns | 36.36 ns | 36.36 ns |
| $T_{GI\ long}$: long guard interval duration | 72.72 ns | 72.72 ns | 72.72 ns | 72.72 ns |

NOTE—The values given for parameters $N_{GI\ short}$, $N_{GI\ normal}$, and $N_{GI\ long}$ correspond to the number of elements in the GI for each GI length and $N_{CB}$ value.

The pre-EDMG modulated fields are defined at the DMG SC chip rate $F_c$ and the corresponding chip time duration $T_c$ (see Table 28-47). Then, the resampling procedure is applied with 3/2 sample rate conversion ratio to achieve the effective sample rate of $(3/2) \times f_c$ and sample time duration of $(2/3) \times 1/f_c$.

The EDMG modulated fields are defined at the EDMG OFDM sample rate $F_s = 2.64 \times N_{CB}$ GHz and the corresponding sample time duration $T_s = 1 / (2.64 \times N_{CB})$ ns.

### 28.6.2.3 DC relative shift to carrier frequency

The DC relative frequency shift is applied in digital domain to the EDMG-STF, EDMG-CEF, Data, and TRN fields of an EDMG OFDM mode PPDU. The DC relative shift is frequency channel dependent, and denoted as $(f_{DC} - f_c)$, where $f_c$ is the center frequency of the carrier and $f_{DC}$ is the DC subcarrier frequency. $f_{DC}$ and the DC relative shift are defined in Table 28-63.

NOTE—By applying the DC relative shift, each of the subcarrier frequencies for any channel numbers can be denoted as $64.8 + \Delta_F \times n$ GHz, where $n$ is an integer. This makes the space between DC subcarrier frequencies of any two channels an integer multiple of the OFDM subcarrier spacing, and the subcarrier frequencies for 4.32 GHz or wider channels are aligned with the subcarriers in 2.16 GHz channels. In all cases, the relative shift between the DC subcarrier frequency and the center frequency of the carrier does not exceed half of the subcarrier spacing.

### Table 28-63—DC relative shift to carrier frequency

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Center frequency of the carrier, $f_c$ (GHz) | DC subcarrier frequency, $f_{DC}$ (GHz) | DC relative shift, ($f_{DC} - f_c$) (MHz) |
|---|---|---|---|---|
| 1 | 1 | 58.32 | $64.8 - \Delta_F \times 3 \times 419$ | –1.4063 |
| | 2 | 60.48 | $64.8 - \Delta_F \times 2 \times 419$ | –0.9375 |
| | 3 | 62.64 | $64.8 - \Delta_F \times 419$ | –0.4688 |
| | 4 | 64.8 | 64.8 | 0 |
| | 5 | 66.96 | $64.8 + \Delta_F \times 419$ | 0.4688 |
| | 6 | 69.12 | $64.8 + \Delta_F \times 2 \times 419$ | 0.9375 |
| | 7 | 71.28 | $64.8 + \Delta_F \times 3 \times 419$ | 1.4063 |
| | 8 | 73.44 | $64.8 + \Delta_F \times 4 \times 419$ | 1.8750 |
| 2 | 9 | 59.4 | $64.8 - \Delta_F \times 1047$ | 1.4062 |
| | 10 | 61.56 | $64.8 - \Delta_F \times 628$ | 1.8750 |
| | 11 | 63.72 | $64.8 - \Delta_F \times 209$ | 2.3438 |
| | 12 | 65.88 | $64.8 + \Delta_F \times 209$ | –2.3437 |
| | 13 | 68.04 | $64.8 + \Delta_F \times 628$ | –1.8750 |
| | 14 | 70.2 | $64.8 + \Delta_F \times 1047$ | –1.4063 |
| | 15 | 72.36 | $64.8 + \Delta_F \times 1466$ | –0.9375 |
| 3 | 17 | 60.48 | $64.8 - \Delta_F \times 2 \times 419$ | –0.9375 |
| | 18 | 62.64 | $64.8 - \Delta_F \times 419$ | –0.4688 |
| | 19 | 64.8 | 64.8 | 0 |
| | 20 | 66.96 | $64.8 + \Delta_F \times 419$ | 0.4688 |
| | 21 | 69.12 | $64.8 + \Delta_F \times 2 \times 419$ | 0.9375 |
| | 22 | 71.28 | $64.8 + \Delta_F \times 3 \times 419$ | 1.4063 |
| 4 | 25 | 61.56 | $64.8 - \Delta_F \times 628$ | 1.8750 |
| | 26 | 63.72 | $64.8 - \Delta_F \times 209$ | 2.3438 |
| | 27 | 65.88 | $64.8 + \Delta_F \times 209$ | –2.3437 |
| | 28 | 68.04 | $64.8 + \Delta_F \times 628$ | –1.8750 |
| | 29 | 70.2 | $64.8 + \Delta_F \times 1047$ | –1.4063 |

### 28.6.2.4 Pilot tones

Pilot tones $M_p(k)$ are frequency channel dependent and defined in Table 28-64.

**Table 28-64—Pilot tones definition**

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Pilot tones – $M_p(k)$ |
|---|---|---|
| 1 | 1 | [–162, –140, –118, –96, –74, –52, –30, –8, 14, 36, 58, 80, 102, 124, 146, 168] |
| | 2 | [–163, –141, –119, –97, –75, –53, –31, –9, 13, 35, 57, 79, 101, 123, 145, 167] |
| | 3 | [–164, –142, –120, –98, –76, –54, –32, –10, 12, 34, 56, 78, 100, 122, 144, 166] |
| | 4 | [–165, –143, –121, –99, –77, –55, –33, –11, 11, 33, 55, 77, 99, 121, 143, 165] |
| | 5 | [–166, –144, –122, –100, –78, –56, –34, –12, 10, 32, 54, 76, 98, 120, 142, 164] |
| | 6 | [–167, –145, –123, –101, –79, –57, –35, –13, 9, 31, 53, 75, 97, 119, 141, 163] |
| | 7 | [–168, –146, –124, –102, –80, –58, –36, –14, 8, 30, 52, 74, 96, 118, 140, 162] |
| | 8 | [–169, –147, –125, –103, –81, –59, –37, –15, 7, 29, 51, 73, 95, 117, 139, 161] |
| 2 | 9 | [–372, –350, –328, –306, –284, –262, –240, –218, –196, –174, –152, –130, –108, –86, –64, –42, –20, –3, 7, 24, 46, 68, 90, 112, 134, 156, 178, 200, 222, 244, 266, 288, 310, 332, 354, 376] |
| | 10 | [–373, –351, –329, –307, –285, –263, –241, –219, –197, –175, –153, –131, –109, –87, –65, –43, –21, –4, 6, 23, 45, 67, 89, 111, 133, 155, 177, 199, 221, 243, 265, 287, 309, 331, 353, 375] |
| | 11 | [–374, –352, –330, –308, –286, –264, –242, –220, –198, –176, –154, –132, –110, –88, –66, –44, –22, –5, 5, 22, 44, 66, 88, 110, 132, 154, 176, 198, 220, 242, 264, 286, 308, 330, 352, 374] |
| | 12 | [–374, –352, –330, –308, –286, –264, –242, –220, –198, –176, –154, –132, –110, –88, –66, –44, –22, –5, 5, 22, 44, 66, 88, 110, 132, 154, 176, 198, 220, 242, 264, 286, 308, 330, 352, 374] |
| | 13 | [–375, –353, –331, –309, –287, –265, –243, –221, –199, –177, –155, –133, –111, –89, –67, –45, –23, –6, 4, 21, 43, 65, 87, 109, 131, 153, 175, 197, 219, 241, 263, 285, 307, 329, 351, 373] |
| | 14 | [–376, –354, –332, –310, –288, –266, –244, –222, –200, –178, –156, –134, –112, –90, –68, –46, –24, –7, 3, 20, 42, 64, 86, 108, 130, 152, 174, 196, 218, 240, 262, 284, 306, 328, 350, 372] |
| | 15 | [–377, –355, –333, –311, –289, –267, –245, –223, –201, –179, –157, –135, –113, –91, –69, –47, –25, –8, 2, 19, 41, 63, 85, 107, 129, 151, 173, 195, 217, 239, 261, 283, 305, 327, 349, 371] |

**Table 28-64—Pilot tones definition *(continued)***

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Pilot tones – $M_p(k)$ |
|---|---|---|
| 3 | 17 | [–581, –559, –537, –515, –493, –471, –449, –427, –405, –383, –361, –339, –317, –295, –273, –251, –229, –212, –202, –185, –163, –141, –119, –97, –75, –53, –31, –9, 13, 35, 57, 79, 101, 123, 145, 167, 189, 206, 216, 233, 255, 277, 299, 321, 343, 365, 387, 409, 431, 453, 475, 497, 519, 541, 563, 585] |
| | 18 | [–582, –560, –538, –516, –494, –472, –450, –428, –406, –384, –362, –340, –318, –296, –274, –252, –230, –213, –203, –186, –164, –142, –120, –98, –76, –54, –32, –10, 12, 34, 56, 78, 100, 122, 144, 166, 188, 205, 215, 232, 254, 276, 298, 320, 342, 364, 386, 408, 430, 452, 474, 496, 518, 540, 562, 584] |
| | 19 | [–583, –561, –539, –517, –495, –473, –451, –429, –407, –385, –363, –341, –319, –297, –275, –253, –231, –214, –204, –187, –165, –143, –121, –99, –77, –55, –33, –11, 11, 33, 55, 77, 99, 121, 143, 165, 187, 204, 214, 231, 253, 275, 297, 319, 341, 363, 385, 407, 429, 451, 473, 495, 517, 539, 561, 583] |
| | 20 | [–584, –562, –540, –518, –496, –474, –452, –430, –408, –386, –364, –342, –320, –298, –276, –254, –232, –215, –205, –188, –166, –144, –122, –100, –78, –56, –34, –12, 10, 32, 54, 76, 98, 120, 142, 164, 186, 203, 213, 230, 252, 274, 296, 318, 340, 362, 384, 406, 428, 450, 472, 494, 516, 538, 560, 582] |
| | 21 | [–585, –563, –541, –519, –497, –475, –453, –431, –409, –387, –365, –343, –321, –299, –277, –255, –233, –216, –206, –189, –167, –145, –123, –101, –79, –57, –35, –13, 9, 31, 53, 75, 97, 119, 141, 163, 185, 202, 212, 229, 251, 273, 295, 317, 339, 361, 383, 405, 427, 449, 471, 493, 515, 537, 559, 581] |
| | 22 | [–586, –564, –542, –520, –498, –476, –454, –432, –410, –388, –366, –344, –322, –300, –278, –256, –234, –217, –207, –190, –168, –146, –124, –102, –80, –58, –36, –14, 8, 30, 52, 74, 96, 118, 140, 162, 184, 201, 211, 228, 250, 272, 294, 316, 338, 360, 382, 404, 426, 448, 470, 492, 514, 536, 558, 580] |

**Table 28-64—Pilot tones definition *(continued)***

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Pilot tones – $M_p(k)$ |
|---|---|---|
| 4 | 25 | [–791, –769, –747, –725, –703, –681, –659, –637, –615, –593, –571, –549, –527, –505, –483, –461, –439, –422, –412, –395, –373, –351, –329, –307, –285, –263, –241, –219, –197, –175, –153, –131, –109, –87, –65, –43, –21, –4, 6, 23, 45, 67, 89, 111, 133, 155, 177, 199, 221, 243, 265, 287, 309, 331, 353, 375, 397, 414, 424, 441, 463, 485, 507, 529, 551, 573, 595, 617, 639, 661, 683, 705, 727, 749, 771, 793] |
| | 26 | [–792, –770, –748, –726, –704, –682, –660, –638, –616, –594, –572, –550, –528, –506, –484, –462, –440, –423, –413, –396, –374, –352, –330, –308, –286, –264, –242, –220, –198, –176, –154, –132, –110, –88, –66, –44, –22, –5, 5, 22, 44, 66, 88, 110, 132, 154, 176, 198, 220, 242, 264, 286, 308, 330, 352, 374, 396, 413, 423, 440, 462, 484, 506, 528, 550, 572, 594, 616, 638, 660, 682, 704, 726, 748, 770, 792] |
| | 27 | [–792, –770, –748, –726, –704, –682, –660, –638, –616, –594, –572, –550, –528, –506, –484, –462, –440, –423, –413, –396, –374, –352, –330, –308, –286, –264, –242, –220, –198, –176, –154, –132, –110, –88, –66, –44, –22, –5, 5, 22, 44, 66, 88, 110, 132, 154, 176, 198, 220, 242, 264, 286, 308, 330, 352, 374, 396, 413, 423, 440, 462, 484, 506, 528, 550, 572, 594, 616, 638, 660, 682, 704, 726, 748, 770, 792] |
| | 28 | [–793, –771, –749, –727, –705, –683, –661, –639, –617, –595, –573, –551, –529, –507, –485, –463, –441, –424, –414, –397, –375, –353, –331, –309, –287, –265, –243, –221, –199, –177, –155, –133, –111, –89, –67, –45, –23, –6, 4, 21, 43, 65, 87, 109, 131, 153, 175, 197, 219, 241, 263, 285, 307, 329, 351, 373, 395, 412, 422, 439, 461, 483, 505, 527, 549, 571, 593, 615, 637, 659, 681, 703, 725, 747, 769, 791] |
| | 29 | [–794, –772, –750, –728, –706, –684, –662, –640, –618, –596, –574, –552, –530, –508, –486, –464, –442, –425, –415, –398, –376, –354, –332, –310, –288, –266, –244, –222, –200, –178, –156, –134, –112, –90, –68, –46, –24, –7, 3, 20, 42, 64, 86, 108, 130, 152, 174, 196, 218, 240, 262, 284, 306, 328, 350, 372, 394, 411, 421, 438, 460, 482, 504, 526, 548, 570, 592, 614, 636, 658, 680, 702, 724, 746, 768, 790] |

### 28.6.2.5 Data tones

Data tones $M_d(k)$ are frequency channel dependent and defined in Table 28-65. In the table, the notation *m*:*n* denotes an array of integer values starting with *m* (inclusive) and ending with *n* (inclusive), and with a step equal to 1.

**Table 28-65—Data tones definition**

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Data tones – $M_d(k)$ |
|---|---|---|
| 1 | 1 | [–177:–163,–161:–141,–139:–119,–117:–97,–95:–75,–73:–53,–51:–31,–29:–9, –7:–2,2:13,15:35,37:57,59:79,81:101,103:123,125:145,147:167,169:177] |
| | 2 | [–177:–164,–162:–142,–140:–120,–118:–98,–96:–76,–74:–54,–52:–32,–30: –10,–8:–2,2:12,14:34,36:56,58:78,80:100,102:122,124:144,146:166,168:177] |
| | 3 | [–177:–165,–163:–143,–141:–121,–119:–99,–97:–77,–75:–55,–53:–33,–31: –11,–9:–2,2:11,13:33,35:55,57:77,79:99,101:121,123:143,145:165,167:177] |
| | 4 | [–177:–166,–164:–144,–142:–122,–120:–100,–98:–78,–76:–56,–54:–34,–32: –12,–10:–2,2:10,12:32,34:54,56:76,78:98,100:120,122:142,144:164,166:177] |
| | 5 | [–177:–167,–165:–145,–143:–123,–121:–101,–99:–79,–77:–57,–55:–35,–33: –13,–11:–2,2:9,11:31,33:53,55:75,77:97,99:119,121:141,143:163,165:177] |
| | 6 | [–177:–168,–166:–146,–144:–124,–122:–102,–100:–80,–78:–58,–56:–36,–34: –14,–12:–2,2:8,10:30,32:52,54:74,76:96,98:118,120:140,142:162,164:177] |
| | 7 | [–177:–169,–167:–147,–145:–125,–123:–103,–101:–81,–79:–59,–57:–37,–35: –15,–13:–2,2:7,9:29,31:51,53:73,75:95,97:117,119:139,141:161,163:177] |
| | 8 | [–177:–170,–168:–148,–146:–126,–124:–104,–102:–82,–80:–60,–58:–38,–36: –16,–14:–2,2:6,8:28,30:50,52:72,74:94,96:116,118:138,140:160,162:177] |

### Table 28-65—Data tones definition *(continued)*

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Data tones – $M_d(k)$ |
|---|---|---|
| 2 | 9 | [–386:–373,–371:–351,–349:–329,–327:–307,–305:–285,–283:–263,–261:–241,–239:–219,–217:–197,–195:–175,–173:–153,–151:–131,–129:–109,–107:–87,–85:–65,–63:–43,–41:–21,–19:–4,–2,2:6,8:23,25:45,47:67,69:89,91:111,113:133,135:155,157:177,179:199,201:221,223:243,245:265,267:287,289:309,311:331,333:353,355:375,377:386] |
| | 10 | [–386:–374,–372:–352,–350:–330,–328:–308,–306:–286,–284:–264,–262:–242,–240:–220,–218:–198,–196:–176,–174:–154,–152:–132,–130:–110,–108:–88,–86:–66,–64:–44,–42:–22,–20:–5,–3:–2,2:5,7:22,24:44,46:66,68:88,90:110,112:132,134:154,156:176,178:198,200:220,222:242,244:264,266:286,288:308,310:330,332:352,354:374,376:386] |
| | 11 | [–386:–375,–373:–353,–351:–331,–329:–309,–307:–287,–285:–265,–263:–243,–241:–221,–219:–199,–197:–177,–175:–155,–153:–133,–131:–111,–109:–89,–87:–67,–65:–45,–43:–23,–21:–6,–4:–2,2:4,6:21,23:43,45:65,67:87,89:109,111:131,133:153,155:175,177:197,199:219,221:241,243:263,265:285,287:307,309:329,331:351,353:373,375:386] |
| | 12 | [–386:–375,–373:–353,–351:–331,–329:–309,–307:–287,–285:–265,–263:–243,–241:–221,–219:–199,–197:–177,–175:–155,–153:–133,–131:–111,–109:–89,–87:–67,–65:–45,–43:–23,–21:–6,–4:–2,2:4,6:21,23:43,45:65,67:87,89:109,111:131,133:153,155:175,177:197,199:219,221:241,243:263,265:285,287:307,309:329,331:351,353:373,375:386] |
| | 13 | [–386:–376,–374:–354,–352:–332,–330:–310,–308:–288,–286:–266,–264:–244,–242:–222,–220:–200,–198:–178,–176:–156,–154:–134,–132:–112,–110:–90,–88:–68,–66:–46,–44:–24,–22:–7,–5:–2,2:3,5:20,22:42,44:64,66:86,88:108,110:130,132:152,154:174,176:196,198:218,220:240,242:262,264:284,286:306,308:328,330:350,352:372,374:386] |
| | 14 | [–386:–377,–375:–355,–353:–333,–331:–311,–309:–289,–287:–267,–265:–245,–243:–223,–221:–201,–199:–179,–177:–157,–155:–135,–133:–113,–111:–91,–89:–69,–67:–47,–45:–25,–23:–8,–6:–2,2,4:19,21:41,43:63,65:85,87:107,109:129,131:151,153:173,175:195,197:217,219:239,241:261,263:283,285:305,307:327,329:349,351:371,373:386] |
| | 15 | [–386:–378,–376:–356,–354:–334,–332:–312,–310:–290,–288:–268,–266:–246,–244:–224,–222:–202,–200:–180,–178:–158,–156:–136,–134:–114,–112:–92,–90:–70,–68:–48,–46:–26,–24:–9,–7:–2,3:18,20:40,42:62,64:84,86:106,108:128,130:150,152:172,174:194,196:216,218:238,240:260,262:282,284:304,306:326,328:348,350:370,372:386] |

**Table 28-65—Data tones definition *(continued)***

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Data tones – $M_d(k)$ |
|---|---|---|
| 3 | 17 | [–596:–582,–580:–560,–558:–538,–536:–516,–514:–494,–492:–472,–470:–450,–448:–428,–426:–406,–404:–384,–382:–362,–360:–340,–338:–318,–316:–296,–294:–274,–272:–252,–250:–230,–228:–213,–211:–203,–201:–186,–184:–164,–162:–142,–140:–120,–118:–98,–96:–76,–74:–54,–52:–32,–30:–10,–8:–2,2:12,14:34,36:56,58:78,80:100,102:122,124:144,146:166,168:188,190:205,207:215,217:232,234:254,256:276,278:298,300:320,322:342,344:364,366:386,388:408,410:430,432:452,454:474,476:496,498:518,520:540,542:562,564:584,586:596] |
| | 18 | [–596:–583,–581:–561,–559:–539,–537:–517,–515:–495,–493:–473,–471:–451,–449:–429,–427:–407,–405:–385,–383:–363,–361:–341,–339:–319,–317:–297,–295:–275,–273:–253,–251:–231,–229:–214,–212:–204,–202:–187,–185:–165,–163:–143,–141:–121,–119:–99,–97:–77,–75:–55,–53:–33,–31:–11,–9:–2,2:11,13:33,35:55,57:77,79:99,101:121,123:143,145:165,167:187,189:204,206:214,216:231,233:253,255:275,277:297,299:319,321:341,343:363,365:385,387:407,409:429,431:451,453:473,475:495,497:517,519:539,541:561,563:583,585:596] |
| | 19 | [–596:–584,–582:–562,–560:–540,–538:–518,–516:–496,–494:–474,–472:–452,–450:–430,–428:–408,–406:–386,–384:–364,–362:–342,–340:–320,–318:–298,–296:–276,–274:–254,–252:–232,–230:–215,–213:–205,–203:–188,–186:–166,–164:–144,–142:–122,–120:–100,–98:–78,–76:–56,–54:–34,–32:–12,–10:–2,2:10,12:32,34:54,56:76,78:98,100:120,122:142,144:164,166:186,188:203,205:213,215:230,232:252,254:274,276:296,298:318,320:340,342:362,364:384,386:406,408:428,430:450,452:472,474:494,496:516,518:538,540:560,562:582,584:596] |
| | 20 | [–596:–585,–583:–563,–561:–541,–539:–519,–517:–497,–495:–475,–473:–453,–451:–431,–429:–409,–407:–387,–385:–365,–363:–343,–341:–321,–319:–299,–297:–277,–275:–255,–253:–233,–231:–216,–214:–206,–204:–189,–187:–167,–165:–145,–143:–123,–121:–101,–99:–79,–77:–57,–55:–35,–33:–13,–11:–2,2:9,11:31,33:53,55:75,77:97,99:119,121:141,143:163,165:185,187:202,204:212,214:229,231:251,253:273,275:295,297:317,319:339,341:361,363:383,385:405,407:427,429:449,451:471,473:493,495:515,517:537,539:559,561:581,583:596] |
| | 21 | [–596:–586,–584:–564,–562:–542,–540:–520,–518:–498,–496:–476,–474:–454,–452:–432,–430:–410,–408:–388,–386:–366,–364:–344,–342:–322,–320:–300,–298:–278,–276:–256,–254:–234,–232:–217,–215:–207,–205:–190,–188:–168,–166:–146,–144:–124,–122:–102,–100:–80,–78:–58,–56:–36,–34:–14,–12:–2,2:8,10:30,32:52,54:74,76:96,98:118,120:140,142:162,164:184,186:201,203:211,213:228,230:250,252:272,274:294,296:316,318:338,340:360,362:382,384:404,406:426,428:448,450:470,472:492,494:514,516:536,538:558,560:580,582:596] |
| | 22 | [–596:–587,–585:–565,–563:–543,–541:–521,–519:–499,–497:–477,–475:–455,–453:–433,–431:–411,–409:–389,–387:–367,–365:–345,–343:–323,–321:–301,–299:–279,–277:–257,–255:–235,–233:–218,–216:–208,–206:–191,–189:–169,–167:–147,–145:–125,–123:–103,–101:–81,–79:–59,–57:–37,–35:–15,–13:–2,2:7,9:29,31:51,53:73,75:95,97:117,119:139,141:161,163:183,185:200,202:210,212:227,229:249,251:271,273:293,295:315,317:337,339:359,361:381,383:403,405:425,427:447,449:469,471:491,493:513,515:535,537:557,559:579,581:596] |

### Table 28-65—Data tones definition *(continued)*

| Number of contiguous 2.16 GHz channels ($N_{CB}$) | Channel number | Data tones – $M_d(k)$ |
|---|---|---|
| 4 | 25 | [–805:–792,–790:–770,–768:–748,–746:–726,–724:–704,–702:–682,–680:–660,–658:–638,–636:–616,–614:–594,–592:–572,–570:–550,–548:–528,–526:–506,–504:–484,–482:–462,–460:–440,–438:–423,–421:–413,–411:–396,–394:–374,–372:–352,–350:–330,–328:–308,–306:–286,–284:–264,–262:–242,–240:–220,–218:–198,–196:–176,–174:–154,–152:–132,–130:–110,–108:–88,–86:–66,–64:–44,–42:–22,–20:–5,–3:–2,2:5,7:22,24:44,46:66,68:88,90:110,112:132,134:154,156:176,178:198,200:220,222:242,244:264,266:286,288:308,310:330,332:352,354:374,376:396,398:413,415:423,425:440,442:462,464:484,486:506,508:528,530:550,552:572,574:594,596:616,618:638,640:660,662:682,684:704,706:726,728:748,750:770,772:792,794:805] |
| | 26 | [–805:–793,–791:–771,–769:–749,–747:–727,–725:–705,–703:–683,–681:–661,–659:–639,–637:–617,–615:–595,–593:–573,–571:–551,–549:–529,–527:–507,–505:–485,–483:–463,–461:–441,–439:–424,–422:–414,–412:–397,–395:–375,–373:–353,–351:–331,–329:–309,–307:–287,–285:–265,–263:–243,–241:–221,–219:–199,–197:–177,–175:–155,–153:–133,–131:–111,–109:–89,–87:–67,–65:–45,–43:–23,–21:–6,–4:–2,2:4,6:21,23:43,45:65,67:87,89:109,111:131,133:153,155:175,177:197,199:219,221:241,243:263,265:285,287:307,309:329,331:351,353:373,375:395,397:412,414:422,424:439,441:461,463:483,485:505,507:527,529:549,551:571,573:593,595:615,617:637,639:659,661:681,683:703,705:725,727:747,749:769,771:791,793:805] |
| | 27 | [–805:–793,–791:–771,–769:–749,–747:–727,–725:–705,–703:–683,–681:–661,–659:–639,–637:–617,–615:–595,–593:–573,–571:–551,–549:–529,–527:–507,–505:–485,–483:–463,–461:–441,–439:–424,–422:–414,–412:–397,–395:–375,–373:–353,–351:–331,–329:–309,–307:–287,–285:–265,–263:–243,–241:–221,–219:–199,–197:–177,–175:–155,–153:–133,–131:–111,–109:–89,–87:–67,–65:–45,–43:–23,–21:–6,–4:–2,2:4,6:21,23:43,45:65,67:87,89:109,111:131,133:153,155:175,177:197,199:219,221:241,243:263,265:285,287:307,309:329,331:351,353:373,375:395,397:412,414:422,424:439,441:461,463:483,485:505,507:527,529:549,551:571,573:593,595:615,617:637,639:659,661:681,683:703,705:725,727:747,749:769,771:791,793:805] |
| | 28 | [–805:–794,–792:–772,–770:–750,–748:–728,–726:–706,–704:–684,–682:–662,–660:–640,–638:–618,–616:–596,–594:–574,–572:–552,–550:–530,–528:–508,–506:–486,–484:–464,–462:–442,–440:–425,–423:–415,–413:–398,–396:–376,–374:–354,–352:–332,–330:–310,–308:–288,–286:–266,–264:–244,–242:–222,–220:–200,–198:–178,–176:–156,–154:–134,–132:–112,–110:–90,–88:–68,–66:–46,–44:–24,–22:–7,–5:–2,2:3,5:20,22:42,44:64,66:86,88:108,110:130,132:152,154:174,176:196,198:218,220:240,242:262,264:284,286:306,308:328,330:350,352:372,374:394,396:411,413:421,423:438,440:460,462:482,484:504,506:526,528:548,550:570,572:592,594:614,616:636,638:658,660:680,682:702,704:724,726:746,748:768,770:790,792:805] |
| | 29 | [–805:–795,–793:–773,–771:–751,–749:–729,–727:–707,–705:–685,–683:–663,–661:–641,–639:–619,–617:–597,–595:–575,–573:–553,–551:–531,–529:–509,–507:–487,–485:–465,–463:–443,–441:–426,–424:–416,–414:–399,–397:–377,–375:–355,–353:–333,–331:–311,–309:–289,–287:–267,–265:–245,–243:–223,–221:–201,–199:–179,–177:–157,–155:–135,–133:–113,–111:–91,–89:–69,–67:–47,–45:–25,–23:–8,–6:–2,2,4:19,21:41,43:63,65:85,87:107,109:129,131:151,153:173,175:195,197:217,219:239,241:261,263:283,285:305,307:327,329:349,351:371,373:393,395:410,412:420,422:437,439:459,461:481,483:503,505:525,527:547,549:569,571:591,593:613,615:635,637:657,659:679,681:701,703:723,725:745,747:767,769:789,791:805] |

### 28.6.2.6 Pilot sequences

The pilot sequence $P(i_{STS}, n, k)$ is created by inserting a sequence of 0s corresponding to tones $–N_{SR}$ to $N_{SR}$. The pilots are then inserted at the tone indexes $M_p(k)$ defined in 28.6.2.4, which are frequency channel and bandwidth dependent, but independent of the space-time stream or OFDM symbol number as follows:

$$P\left(i_{STS}, n, M_p\left(k\right)\right) = P_{N_{SP}}\left(i_{STS}, n, k\right), k = 0, 1, ..., N_{SP} - 1$$

The pilot value $P_{N_{SP}}\left(i_{STS}, n, k\right)$ depends on the $i_{STS}{}^{th}$ space-time stream number, $n^{th}$ OFDM symbol, and $k^{th}$ subcarrier index and defined as follows:

$$P_{N_{SP}}\left(i_{STS}, n, k\right) = W\left(i_{STS}, n \bmod N_{STS}\right) \times \left(2 \times p\left(n\right) - 1\right) \times P_{N_{SP}}\left(i_{STS}, k\right)$$

where

| | |
|---|---|
| $P_{N_{SP}}\left(i_{STS}, k\right)$ | defines the pilot for $i_{STS}{}^{th}$ space-time stream and $k^{th}$ subcarrier |
| $W(i_{STS}, n) \times (2 \times p(n) - 1)$ | defines a common phase shift (over subcarriers) for the $i_{STS}{}^{th}$ space-time stream and $n^{th}$ OFDM symbol, $p(n)$ defines a bit coming from the scrambler defined in 28.6.9.1 with shift register x1, x2,…, x7 initialized to all 1s at the zeroth (i.e., $n = 0$) OFDM symbol |
| $N_{STS}$ | defines the total number of space-time streams |

The common phase shift is composed as a product of deterministic shift $W(i_{STS}, n)$ repeated with period $N_{STS}$ over the time and random shift defined by $(2 \times p(n) - 1)$, which is scrambler output dependent. The random component depends on the $n^{th}$ OFDM symbol number only and does not depend on the particular $i_{STS}{}^{th}$ space-time stream number.

The pilot sequence $P_{N_{SP}}\left(i_{STS}, :\right)$ for a given number of contiguous channel bandwidth, $N_{CB}$, is defined in Table 28-66.

**Table 28-66—Pilot sequence ($P_{N_{SP}}$) definition**

| $N_{CB}$ | $P_{N_{SP}}\left(i_{STS}, :\right)$ |
|---|---|
| 1 | $P_{16}(i_{STS},:)$ |
| 2 | $P_{36}(i_{STS},:) = [P_{12}(i_{STS},:), P_{12}(i_{STS},:), P_{12}(i_{STS},:)]$ |
| 3 | $P_{56}(i_{STS},:) = [P_{16}(i_{STS},:), P_{12}(i_{STS},:), P_{12}(i_{STS},:), P_{16}(i_{STS},:)]$ |
| 4 | $P_{76}(i_{STS},:) = [P_{16}(i_{STS},:), P_{16}(i_{STS},:), P_{12}(i_{STS},:), P_{16}(i_{STS},:), P_{16}(i_{STS},:)]$ |

The pilot sequences $P_{16}(i_{STS},:)$ and $P_{12}(i_{STS},:)$ are defined in Table 28-67.

The deterministic component of common phase shift, $W(i_{STS}, n)$, is defined as follows:

$$W\left(i_{STS}, n\right) = \exp\left(-j\frac{2\pi}{N_{STS}} \cdot \left(i_{STS} - 1\right) \cdot n\right), i_{STS} = 1, 2, ..., N_{STS}; n = 0, 1, ..., N_{SYM} - 1$$

where

$N_{SYM}$ is the total number of OFDM symbols

**Table 28-67—Pilot sequence ($P_{16}$ and $P_{12}$) definition**

| $i_{STS}$ | $P_{16}(i_{STS},:)$ | $P_{12}(i_{STS},:)$ |
|---|---|---|
| 1 | [+1 +1 +1 –1 +1 +1 –1 +1 +1 +1 +1 –1 –1 –1 +1 –1] | [–1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 +1] |
| 2 | [–1 –1 –1 +1 –1 –1 +1 –1 +1 +1 +1 –1 –1 –1 +1 –1] | [+1 –1 +1 +1 –1 –1 –1 –1 –1 +1 +1 –1] |
| 3 | [–1 –1 –1 +1 +1 +1 –1 +1 –1 –1 –1 +1 –1 –1 +1 –1] | [–1 +1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1] |
| 4 | [+1 +1 +1 –1 –1 –1 +1 –1 –1 –1 –1 +1 –1 –1 +1 –1] | [+1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 –1] |
| 5 | [–1 –1 +1 –1 –1 –1 –1 +1 –1 –1 +1 –1 +1 +1 +1 –1] | [+1 –1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1] |
| 6 | [+1 +1 –1 +1 +1 +1 +1 –1 –1 –1 +1 –1 +1 +1 +1 –1] | [–1 –1 +1 –1 –1 –1 +1 +1 –1 –1 +1 +1] |
| 7 | [+1 +1 –1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 +1 +1 –1] | [–1 –1 –1 +1 –1 +1 –1 +1 +1 +1 +1 +1] |
| 8 | [–1 –1 +1 –1 +1 +1 +1 –1 +1 +1 –1 +1 +1 +1 +1 –1] | [–1 –1 –1 –1 +1 –1 +1 –1 +1 +1 +1 –1] |

### 28.6.3 Transmitter block diagram

#### 28.6.3.1 General

An EDMG OFDM PPDU transmission may be generated using a transmitter consisting of the following blocks:

a) Scrambler scrambles the data to reduce the probability of long sequences of 0s and 1s; see 28.6.9.1.
b) LDPC encoder encodes the data to enable error correction. Data is padded with 0s to get an integer number of codewords and OFDM symbols; see 28.6.9.2.
c) Stream parser divides the output of the LDPC encoder into the groups of bits that are sent to different mapping devices. The sequence of the bits sent to different mapping devices is called a spatial stream; see 28.6.9.2.
d) Constellation mapper maps the sequence of bits in each spatial stream to constellation points (complex numbers); see 28.6.9.3.
e) Interleaver performs interleaving inside an OFDM symbol; see 28.6.9.3.9.
f) STBC encoder spreads constellation points from $N_{SS}$ spatial streams into $N_{STS}$ space-time streams using a space-time block code. OFDM mode defines STBC schemes with $N_{STS} = 2 \times N_{SS}$; see 28.6.9.3.10.
g) Preamble builder builds symbols of EDMG-STF and EDMG-CEF fields in frequency domain; see 28.6.4 and 28.6.5.
h) TRN builder builds symbols of TRN field; see 28.9.2.2.5.
i) Spatial mapper maps space-time streams to transmit chains. The spatial mapping is applied per subcarrier basis and may include one of the following (see 28.6.10.2):
   1) Direct mapping: constellation points from each space-time stream are mapped directly to the transmit chains.
   2) Indirect mapping: constellation points from each space-time stream are mapped to each transmit chain.
   3) Digital beamforming: each vector of constellation points from all of the space-time streams is multiplied by a matrix of steering vectors to produce the input to the transmit chains.
j) Cyclic shift (CSD) insertion prevents the transmission from unintentional beamforming. A cyclic shift is specified per transmitter chain for pre-EDMG portion of PPDU transmission; see 28.5.3.3.1.
k) IDFT applies Inverse Discrete Fourier Transform to the input block of subcarriers.
l) GI insertion and windowing prepends the OFDM symbol with a guard interval defined as a cyclic extension of the OFDM symbol in time domain and applies a window function; see 28.6.9.3.

### 28.6.3.2 EDMG PPDU transmission

#### 28.6.3.2.1 Pre-EDMG modulated fields of PPDU transmission

See 28.5.3.3.1.

#### 28.6.3.2.2 EDMG modulated fields of SU PPDU transmission

Figure 28-33 shows the transmitter blocks used to generate the EDMG modulated fields of an SU PPDU. The EDMG-STF and EDMG-CEF fields are generated using the preamble builder, IDFT, and GI insertion blocks. The TRN field is generated using the TRN builder, IDFT, and GI insertion blocks. The Data field is generated using the scrambler, the LDPC encoder, the constellation mapper, the interleaver, IDFT, and GI insertion blocks. If the STBC encoder is applied, then $N_{SS}$ spatial streams are mapped to $2 \times N_{SS}$ space-time streams as defined in 28.6.9.3.10. The $N_{STS}$ space-time streams are further mapped to $N_{TX}$ transmit chains, where $N_{STS} \leq N_{TX}$.

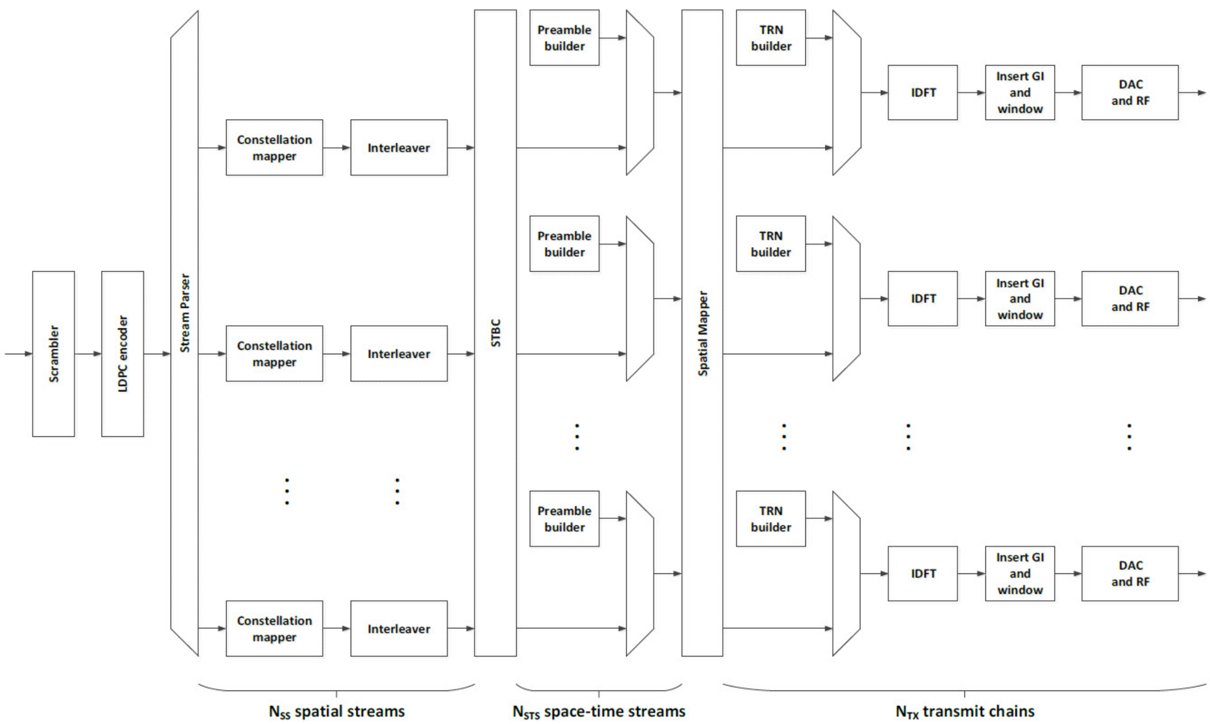


**Figure 28-33—Transmitter block diagram for the EDMG modulated fields of an SU PPDU transmission**

NOTE—The interleaver is applied to 16-QAM and 64-QAM modulations only.

### 28.6.3.2.3 EDMG modulated fields of MU PPDU transmission

Figure 28-34 shows the transmitter blocks used to generate the EDMG modulated fields of an MU PPDU. The EDMG-STF and EDMG-CEF fields are generated using the preamble builder, IDFT, and GI insertion blocks. The TRN field is generated using the TRN builder, IDFT, and GI insertion blocks. The EDMG-Header-B and Data fields are generated using the scrambler, the LDPC encoder, the constellation mapper, the interleaver, IDFT, and GI insertion blocks. The PPDU encoding uses the seed value defined in the EDMG-Header-B and has an independent flow per user. However, the transmitter keeps a common space-time stream enumeration over all users. If the STBC encoder is applied, then a single spatial stream is mapped to two space-time streams as defined in 28.6.9.3.10. The $N_{STS}$ space-time streams are further mapped to $N_{TX}$ transmit chains, where $N_{STS} \leq N_{TX}$.

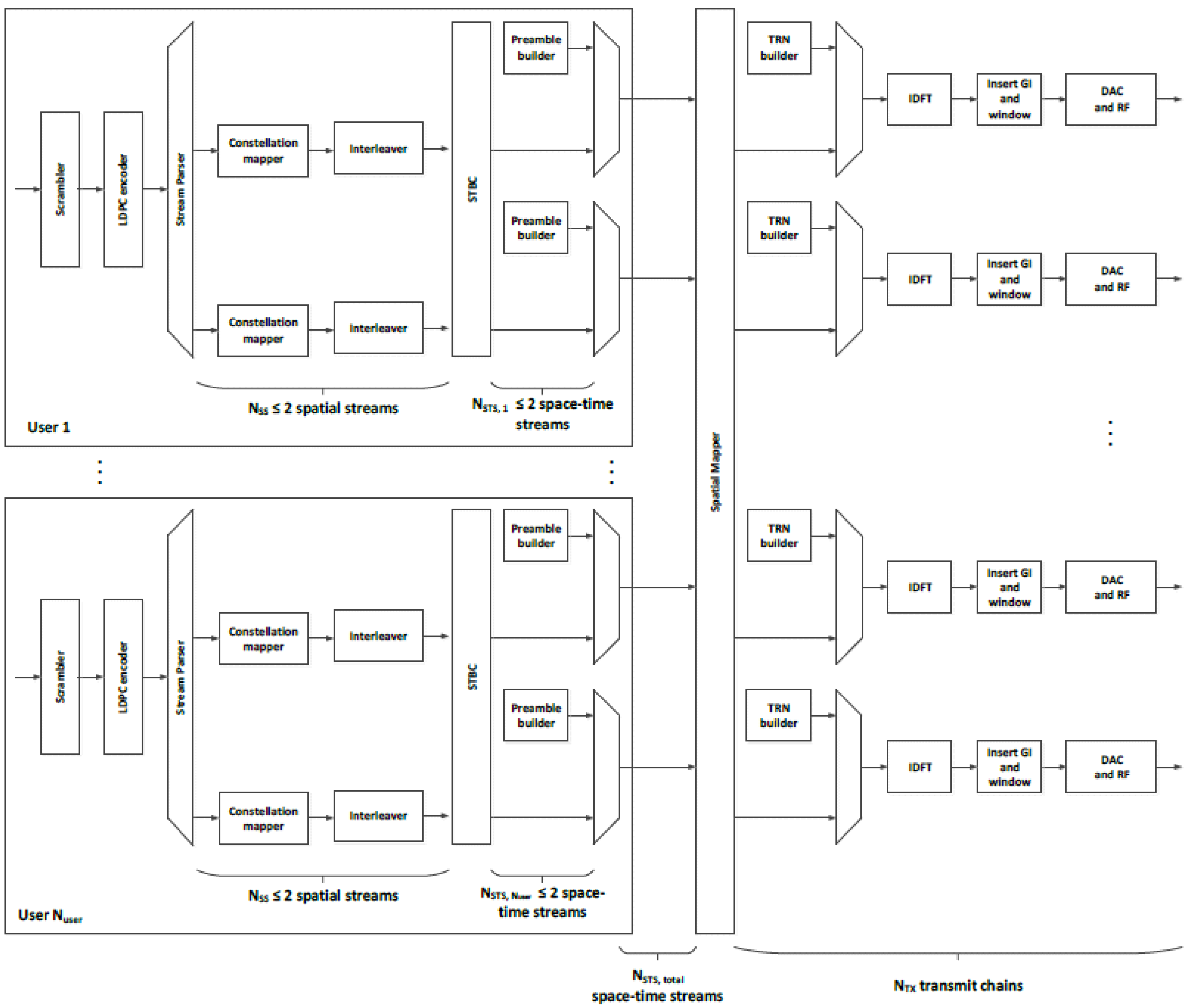


**Figure 28-34—Transmitter block diagram for the EDMG modulated fields of an MU PPDU transmission**

NOTE—The interleaver is applied to 16-QAM and 64-QAM modulations only.

### 28.6.4 EDMG-STF definition

#### 28.6.4.1 General

The EDMG-STF field has a fixed time duration independent on the number of space-time streams. The structure of the EDMG-STF field depends on the number of contiguous 2.16 GHz channels over which an EDMG PPDU is transmitted and the space-time stream number $i_{STS}$, where $1 \le i_{STS} \le 8$.

$EDMGS_{left,N}^{i_{STS}}$ and $EDMGS_{right,N}^{i_{STS}}$, the sequences of length $N$ used in the definition of the EDMG-STF field for different space-time streams, are defined in 28.11.1.

#### 28.6.4.2 Definition

For EDMG OFDM transmissions using a single 2.16 GHz channel, the frequency sequence used to construct the EDMG-STF field for the $i_{STS}$th space-time stream is given as follows:

$$EDMG\text{-}STF_{-177,177}^{i_{STS}} = \{EDMGS_{left,176}^{i_{STS}}, 0, 0, 0, EDMGS_{right,176}^{i_{STS}}\}$$

For EDMG OFDM transmissions using a single 4.32 GHz channel, the frequency sequence used to construct the EDMG-STF field for the $i_{STS}$th space-time stream is given as follows:

$$EDMG\text{-}STF_{-386,386}^{i_{STS}} = \{EDMGS_{left,385}^{i_{STS}}, 0, 0, 0, EDMGS_{right,385}^{i_{STS}}\}$$

For EDMG OFDM transmissions using a single 6.48 GHz channel, the frequency sequence used to construct the EDMG-STF field for the $i_{STS}$th space-time stream is given as follows:

$$EDMG\text{-}STF_{-596,596}^{i_{STS}} = \{EDMGS_{left,595}^{i_{STS}}, 0, 0, 0, EDMGS_{right,595}^{i_{STS}}\}$$

For EDMG OFDM transmissions using a single 8.64 GHz channel, the frequency sequence used to construct the EDMG-STF field for the $i_{STS}$th space-time stream is given as follows:

$$EDMG\text{-}STF_{-805,805}^{i_{STS}} = \{EDMGS_{left,804}^{i_{STS}}, 0, 0, 0, EDMGS_{right,804}^{i_{STS}}\}$$

The EDMG-STF field transmit waveform in time domain shall be defined at the OFDM sampling rate $F_s$ and sample time duration $T_s$ as follows:

$$r_{EDMG\text{-}STF}^{i_{TX}}(qT_s) = \frac{1}{\sqrt{N_{STS} \cdot N_{EDMG\text{-}STF}^{Tone}}} w(qT_s)$$
$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_{EDMG\ k}]_{i_{TX}, i_{STS}} EDMG\text{-}STF_k^{i_{STS}} \exp(j2\pi k \Delta_F (qT_s))$$

where

| | |
|---|---|
| $N_{EDMG\text{-}STF}^{Tone}$ | is 88 192 296 and 400 for $N_{CB}$ = 1, 2, 3, and 4, respectively |
| $N_{STS}$ | is the total number of space-time streams |
| $Q_{EDMG\ k}$ | is the spatial mapping matrix per $k$th subcarrier |
| $[\ ]_{m,n}$ | is a matrix element from $m$th row and $n$th column |
| $w(qT_s)$ | is a window function applied to smooth the transitions between consecutive OFDM symbols and its definition is implementation dependent |
| $q$ | is the time sample index, $q = 0, 1, ..., 30 \times (N_{DFT} / 4) - 1$ |

The fact that only spectral lines of $EDMG\text{-}STF_k^{i_{STS}}$ with indices that are a multiple of four have nonzero amplitude results in a periodicity of $T_{DFT}/4$ = 48.48 ns. The interval TEDMG-STF is equal to thirty 48.48 ns periods (i.e., 1.455 µs).

### 28.6.5 EDMG-CEF definition

#### 28.6.5.1 General

The structure of the EDMG-CEF field depends on the number of contiguous 2.16 GHz channels over which an EDMG PPDU is transmitted and the space-time stream number, $i_{STS}$.

$Seq_{left,N}^{i_{STS}}$ and $Seq_{right,N}^{i_{STS}}$, the sequences of length $N$ used in the definition of the EDMG-CEF field for different space-time streams, are defined in 28.11.2.

#### 28.6.5.2 Definition

For an EDMG PPDU transmission using the EDMG OFDM mode over a 2.16 GHz channel, the EDMG-CEF sequence is defined in frequency domain for the $i^{\text{th}}$ space-time stream as follows:

$$EDMG\text{-}CEF_{-177,177}^{i_{STS}} = \{Seq_{left,176}^{i_{STS}}, 0, 0, 0, Seq_{right,176}^{i_{STS}}\}$$

For an EDMG PPDU transmission using the EDMG OFDM mode over a 4.32 GHz channel, the EDMG-CEF sequence is defined in frequency domain for the $i^{\text{th}}$ space-time stream as follows:

$$EDMG\text{-}CEF_{-386,386}^{i_{STS}} = \{Seq_{left,385}^{i_{STS}}, 0, 0, 0, Seq_{right,385}^{i_{STS}}\}$$

For an EDMG PPDU transmission using the EDMG OFDM mode over a 6.48 GHz channel, the EDMG-CEF sequence is defined in frequency domain for the $i^{\text{th}}$ space-time stream as follows:

$$EDMG\text{-}CEF_{-596,596}^{i_{STS}} = \{Seq_{left,595}^{i_{STS}}, 0, 0, 0, Seq_{right,595}^{i_{STS}}\}$$

For an EDMG PPDU transmission using the EDMG OFDM mode over an 8.64 GHz channel, the EDMG-CEF sequence is defined in frequency domain for the $i^{\text{th}}$ space-time stream as follows:

$$EDMG\text{-}CEF_{-805,805}^{i_{STS}} = \{Seq_{left,804}^{i_{STS}}, 0, 0, 0, Seq_{right,804}^{i_{STS}}\}$$

The EDMG-CEF field transmit waveform in time domain shall be defined at the OFDM sampling rate $F_s$ and sample time duration $T_s$ as follows:

$$r_{EDMG\text{-}CEF}^{i_{TX}}\left(qT_s\right) = \frac{1}{\sqrt{N_{STS} \cdot N_{EDMG\text{-}CEF}^{Tone}}} \sum_{n=0}^{N_{EDMG-CEF}^{N_{STS}}-1} w\left(qT_s - nT_{SYM}\right)$$
$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_{EDMG\,k}\right]_{i_{TX},i_{STS}} \left[P_{EDMG\text{-}CEF}\right]_{i_{STS},n} EDMG\text{-}CEF_k^{i_{STS}} \exp\left(j2\pi k\Delta_F\left(qT_s - nT_{SYM} - T_{GI\,long}\right)\right)$$

where

| | |
|---|---|
| $N_{EDMG\text{-}CEF}^{Tone} = N_{ST} - N_{DC}$ | is the total number of active tones |
| $N_{STS}$ | is the total number of space-time streams |
| $T_{SYM} = T_{DFT} + T_{GI\,long}$ | is the OFDM symbol duration in time domain |
| $T_{GI\,long}$ | is the long guard interval time duration |

| | |
|---|---|
| $Q_{EDMG\,k}$ | is the spatial mapping matrix per $k^{\text{th}}$ subcarrier |
| $P_{EDMG\text{-}CEF}$ | is the EDMG-CEF mapping matrix defined below |
| $N_{EDMG\text{-}CEF}^{N_{STS}}$ | is the number of OFDM symbols in the EDMG-CEF for a given total number of space-time streams $N_{STS}$ defined below |
| $[\ ]_{m,n}$ | is a matrix element from $m^{\text{th}}$ row and $n^{\text{th}}$ column |
| $w(qT_s)$ | is the window function applied to smooth the transitions between consecutive OFDM symbols and its definition is implementation dependent |
| $q$ | is the time sample index, $q = 0,1,...,\left(N_{DFT} + N_{GI\,long}\right) \times N_{EDMG\text{-}CEF}^{N_{STS}} - 1$ |

The EDMG-CEF mapping matrix for $N_{STS} = 1$ is defined as follows:

$$P_{EDMG\text{-}CEF} = \begin{bmatrix} +1 & -1 \end{bmatrix},\ N_{EDMG\text{-}CEF}^{N_{STS}} = 2$$

The EDMG-CEF mapping matrix for $N_{STS} = 2$ is defined as follows:

$$P_{EDMG\text{-}CEF} = \begin{bmatrix} +1 & -1 \\ +1 & +1 \end{bmatrix},\ N_{EDMG\text{-}CEF}^{N_{STS}} = 2$$

The EDMG-CEF mapping matrix for $N_{STS} = 3$ is defined as follows:

$$P_{EDMG\text{-}CEF} = \begin{bmatrix} +1 & -1 & +1 \\ +1 & -w_3^1 & w_3^2 \\ +1 & -w_3^2 & w_3^4 \end{bmatrix},\ w_3 = \exp\left(-j2\pi/3\right),\ N_{EDMG\text{-}CEF}^{N_{STS}} = 3$$

The EDMG-CEF mapping matrix for $N_{STS} = 4$ is defined as follows:

$$P_{EDMG\text{-}CEF} = P_{4x4} = \begin{bmatrix} +1 & -1 & +1 & +1 \\ +1 & +1 & -1 & +1 \\ +1 & +1 & +1 & -1 \\ -1 & +1 & +1 & +1 \end{bmatrix},\ N_{EDMG\text{-}CEF}^{N_{STS}} = 4$$

The EDMG-CEF mapping matrix for $N_{STS} = 5$ or 6 is defined as follows:

$$P_{EDMG\text{-}CEF} = \begin{bmatrix} +1 & -1 & +1 & +1 & +1 & -1 \\ +1 & -w_6^1 & w_6^2 & w_6^3 & w_6^4 & -w_6^5 \\ +1 & -w_6^2 & w_6^4 & w_6^6 & w_6^8 & -w_6^{10} \\ +1 & -w_6^3 & w_6^6 & w_6^9 & w_6^{12} & -w_6^{15} \\ +1 & -w_6^4 & w_6^8 & w_6^{12} & w_6^{16} & -w_6^{20} \\ +1 & -w_6^5 & w_6^{10} & w_6^{15} & w_6^{20} & -w_6^{25} \end{bmatrix},\ w_6 = \exp\left(-j2\pi/6\right),\ N_{EDMG\text{-}CEF}^{N_{STS}} = 6$$

The EDMG-CEF mapping matrix for $N_{STS} = 7$ or 8 is defined as follows:

$$P_{EDMG\text{-}CEF} = \begin{bmatrix} P_{4x4} & P_{4x4} \\ P_{4x4} & -P_{4x4} \end{bmatrix},\ N_{EDMG\text{-}CEF}^{N_{STS}} = 8$$

### 28.6.6 Encoding of EDMG-Header-B

The EDMG-Header-B for the $i_{user}$th shall be encoded as follows:

— The input 64 bits of the EDMG-Header-B, $\mathbf{b} = (b_1, b_2, ..., b_{64})$, are scrambled with the PN sequence described in 20.3.9, starting from the eighth bit to create the $\mathbf{bq} = (bq_1, bq_2, ..., bq_{64})$ sequence. The scrambler seed value is initialized by the first seven bits of the EDMG-Header-B.

— The LDPC codeword of length 672 bits is created by concatenating the 440 0s to the scrambled header bits $\mathbf{bq} = (bq_1, bq_2, ..., bq_{64})$ and then computing 168 parity bits $\mathbf{p} = (p_1, p_2, ..., p_{168})$ using the LDPC matrix with $R = 3/4$ and $L_{CW} = 672$ defined in 20.3.8.4. The LDPC codeword is defined as $(bq_1, bq_2, ..., bq_{64}, 0_1, 0_2, ..., 0_{440}, p_1, p_2, ..., p_{168})$.

— The zero padded bits are discarded and the output codeword is defined as $\mathbf{c} = (\mathbf{c}_1, \mathbf{c}_2, \mathbf{c}_3)$, where
  — $\mathbf{c}_1 = (bq_1, bq_2, ..., bq_{64}, p_9, p_{10}, ..., p_{168})$
  — $\mathbf{c}_2 = (bq_1, bq_2, ..., bq_{64}, p_1, p_2, ..., p_{84}, p_{93}, p_{94}, ..., p_{168})$
  — $\mathbf{c}_3 = (bq_1, bq_2, ..., bq_{64}, p_1, p_2, ..., p_{160})$

— For a PPDU transmitted over a $N_{CB} \times 2.16$ GHz channel, where $1 \le N_{CB} \le 4$, the data block is defined as a repetition of codeword **c** bits as follows:
  — $\mathbf{cb} = \mathbf{c}$ for $N_{CB} = 1$
  — $\mathbf{cb} = (\mathbf{c}, \mathbf{c}, \mathbf{c}_{1:124})$ for $N_{CB} = 2$
  — $\mathbf{cb} = (\mathbf{c}, \mathbf{c}, \mathbf{c}, \mathbf{c}_{1:252})$ for $N_{CB} = 3$
  — $\mathbf{cb} = (\mathbf{c}, \mathbf{c}, \mathbf{c}, \mathbf{c}, \mathbf{c}_{1:376})$ for $N_{CB} = 4$

— For a PPDU transmitted using $N_{STS}$ ($N_{STS} = 1, 2$) space-time streams, the data block **cb** is repeated $N_{STS}$ times. Then the $N_{STS}$ data blocks are scrambled continuously with PN sequence defined in 28.5.9.3.2 without seed reset. The initial seed value is equal to all 1s $(1_1, 1_2, ..., 1_7)$. The scrambling starts at the 225th bit and ends at the $(N_{STS} \times 2 \times N_{SD})$th bit. The first scrambled **cb** block is mapped to the first space-time stream and the second scrambled **cb** block to the second space-time stream.

In the description above, the $\mathbf{c}_{1:m}$ notation defines an array of vector **c** elements, starting from the first bit (inclusive) and ending at the $m$th bit (inclusive).

The data blocks shall be modulated using DCM QPSK modulation. The EDMG-Header-B shall use the OFDM modulation as defined for the Data field of the PPDU (see 28.6.9.3).

### 28.6.7 Encoding of EDMG-Header-A for EDMG A-PPDU transmission

The EDMG-Header-A field in the first EDMG PPDU in an EDMG OFDM mode A-PPDU (i.e., $i_{PPDU} = 1$, where $i_{PPDU}$ represents the index of the PPDU into the EDMG A-PPDU) is encoded and modulated as specified in 28.3.3.3.2.4.

For the $i_{PPDU}$th EDMG PPDU in the EDMG SC mode A-PPDU, $i_{PPDU} > 1$, the EDMG-Header-A field shall be encoded and modulated using two OFDM symbols. The encoding and modulation shall be as follows:

— The input 112 header bits are appended with 16 HCS bits calculated as defined in 20.3.7.

— The resulting 128 bits including CRC, $\mathbf{b} = (b_1, b_2, \ldots, b_{128})$, are scrambled with the PN sequence as described in 20.3.9, starting from the first bit using a continuation of the scrambler bit sequence from the Data field of preceding EDMG PPDU in the EDMG OFDM mode A-PPDU to create the $\mathbf{bq} = (bq_1, bq_2, \ldots, bq_{128})$ sequence.

— The scrambled header bits, **bq**, are divided into two parts **bq1** = ($bq_1$, $bq_2$,…, $bq_{64}$) and **bq2** = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$) of 64 bits each.

— Two LDPC codewords of length 672 bits each are created by concatenating the 440 0s to each part, **bq1** and **bq2**, and then computing 168 parity bits **p1** = ($p1_1$, $p1_2$,…, $p1_{168}$) and **p2** = ($p2_1$, $p2_2$,…, $p2_{168}$) for **bq1** and **bq2**, respectively, using the LDPC matrix with $R$ = 3/4 and $L_{CW}$ = 672 defined in 20.3.8.4. The LDPC codewords are defined as follows:
  - **cw1** = ($bq_1$, $bq_2$,…, $bq_{64}$, $0_1$, $0_2$,…, $0_{440}$, $p1_1$, $p1_2$,…, $p1_{168}$)
  - **cw2** = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $0_1$, $0_2$,…, $0_{440}$, $p2_1$, $p2_2$,…, $p2_{168}$)

— The padded 0s are discarded and two output codewords are defined as **c1** = ($c1_1$, $c1_2$, $c1_3$) and **c2** = ($c2_1$, $c2_2$, $c2_3$), where
  - $\mathbf{c1_1}$ = ($bq_1$, $bq_2$,…, $bq_{64}$, $p1_9$, $p1_{10}$,…, $p1_{168}$)
  - $\mathbf{c1_2}$ = ($bq_1$, $bq_2$,…, $bq_{64}$, $p1_1$, $p1_2$,…, $p1_{84}$, $p1_{93}$, $p1_{94}$,…, $p1_{168}$)
  - $\mathbf{c1_3}$ = ($bq_1$, $bq_2$,…, $bq_{64}$, $p1_1$, $p1_2$,…, $p1_{160}$)
  - $\mathbf{c2_1}$ = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $p2_9$, $p2_{10}$,…, $p2_{168}$)
  - $\mathbf{c2_2}$ = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $p2_1$, $p2_2$,…, $p2_{84}$, $p2_{93}$, $p2_{94}$,…, $p2_{168}$)
  - $\mathbf{c2_3}$ = ($bq_{65}$, $bq_{66}$,…, $bq_{128}$, $p2_1$, $p2_2$,…, $p2_{160}$)

— For a PPDU transmitted over an $N_{CB}$ × 2.16 GHz channel, where $1 \le N_{CB} \le 4$, the data blocks are defined as a repetition of codeword **c1** and **c2** as follows:
  - **cb1** = $c1$, **cb2** = $c2$ for $N_{CB}$ = 1
  - **cb1** = ($c1$, $c1$, $c1_{1:124}$), **cb2** = ($c2$, $c2$, $c2_{1:124}$) for $N_{CB}$ = 2
  - **cb1** = ($c1$, $c1$, $c1$, $c1_{1:252}$), **cb2** = ($c2$, $c2$, $c2$, $c2_{1:252}$) for $N_{CB}$ = 3
  - **cb1** = ($c1$, $c1$, $c1$, $c1$, $c1_{1:376}$), **cb2** = ($c2$, $c2$, $c2$, $c2$, $c2_{1:376}$) for $N_{CB}$ = 4

— For a PPDU transmitted using $N_{STS}$ ($N_{STS}$ = 1, 2, …, 8) space-time streams, the data blocks **cb1** and **cb2** are concatenated as **cb** = (**cb1**, **cb2**) and the data block **cb** is repeated $N_{STS}$ times. Then, the $N_{STS}$ data blocks **cb** are scrambled continuously with the PN sequence defined in 28.5.9.3.2 without seed reset. The initial seed value is equal to all 1s ($1_1$, $1_2$,…, $1_7$). The scrambling starts at the 225$^{th}$ bit and ends at the ($N_{STS}$ × 4 × $N_{SD}$)$^{th}$ bit. The first scrambled **cb** block is mapped to the first space-time stream and the second scrambled **cb** block to the second space-time stream, and so on.

In the above description, the $\mathbf{c1_{1:\mathit{m}}}$ and $\mathbf{c2_{1:\mathit{m}}}$ notations define an array of vector **c1** and **c2** elements starting from the first bit (inclusive) and ending at the $m^{th}$ bit (inclusive).

The data blocks shall be modulated using DCM QPSK modulation. The EDMG-Header-A field shall use an OFDM modulation as defined for the Data field of the PPDU in 28.6.9.3.

### 28.6.8 Modulation and coding scheme (MCS)

The MCS is a value that determines modulation and coding. For an EDMG PPDU, the MCS value is carried in the EDMG-Header-A field and in the EDMG-Header-B field. The data rate provided by an MCS depends on the guard interval length, the number of spatial streams, $N_{SS}$ ($1 \le N_{SS} \le 8$), and the number of $N_{SD}$ data subcarriers defined per OFDM symbol.

Table 28-68 defines the set of MCSs for an EDMG OFDM mode PPDU. MCS indexes exceeding the largest MCS index defined in Table 28-68 are reserved.

**Table 28-68—EDMG-MCSs for the EDMG OFDM mode**

| EDMG-MCS index | Modulation | NBPSC | Code rate |
|---|---|---|---|
| 1 | DCM BPSK | 1 | 1/2 |
| 2 | DCM BPSK | 1 | 5/8 |
| 3 | DCM BPSK | 1 | 3/4 |
| 4 | DCM BPSK | 1 | 13/16 |
| 5 | DCM BPSK | 1 | 7/8 |
| 6 | DCM QPSK | 2 | 1/2 |
| 7 | DCM QPSK | 2 | 5/8 |
| 8 | DCM QPSK | 2 | 3/4 |
| 9 | DCM QPSK | 2 | 13/16 |
| 10 | DCM QPSK | 2 | 7/8 |
| 11 | 16-QAM | 4 | 1/2 |
| 12 | 16-QAM | 4 | 5/8 |
| 13 | 16-QAM | 4 | 3/4 |
| 14 | 16-QAM | 4 | 13/16 |
| 15 | 16-QAM | 4 | 7/8 |
| 16 | 64-QAM | 6 | 1/2 |
| 17 | 64-QAM | 6 | 5/8 |
| 18 | 64-QAM | 6 | 3/4 |
| 19 | 64-QAM | 6 | 13/16 |
| 20 | 64-QAM | 6 | 7/8 |

For a given type of guard interval used in the transmission of an EDMG OFDM mode PPDU, the total transmission data rate, ρ, provided by the PPDU is defined as follows:

$$\rho = \sum_{i_{SS}=1}^{N_{SS}} Data\_rate_{i_{SS}}$$

where

$N_{SS}$ is as defined in this subclause

$Data\_rate_{i_{SS}}$ is the data rate provided by the MCS of spatial stream $i_{SS}$ as defined in Table 28-69 and Table 28-70

Table 28-69 and Table 28-70 define the data rate for a given number of data subcarriers, $N_{SD}$, and guard interval type.

**Table 28-69—Data rate for the EDMG OFDM mode with $N_{SD}$ = 336, 734**

| MCS | Data rate per spatial stream (Mb/s) | | | | | |
|---|---|---|---|---|---|---|
| | $N_{SD}$ = 336 | | | $N_{SD}$ = 734 | | |
| | Normal GI | Short GI | Long GI | Normal GI | Short GI | Long GI |
| 1 | 729.47 | 792.00 | 630.00 | 1593.55 | 1730.14 | 1376.25 |
| 2 | 911.84 | 990.00 | 787.50 | 1991.94 | 2162.68 | 1720.31 |
| 3 | 1094.21 | 1188.00 | 945.00 | 2390.33 | 2595.21 | 2064.38 |
| 4 | 1185.39 | 1287.00 | 1023.75 | 2589.52 | 2811.48 | 2236.41 |
| 5 | 1276.58 | 1386.00 | 1102.50 | 2788.72 | 3027.75 | 2408.44 |
| 6 | 1458.95 | 1584.00 | 1260.00 | 3187.11 | 3460.29 | 2752.50 |
| 7 | 1823.68 | 1980.00 | 1575.00 | 3983.88 | 4325.36 | 3440.63 |
| 8 | 2188.42 | 2376.00 | 1890.00 | 4780.66 | 5190.43 | 4128.75 |
| 9 | 2370.79 | 2574.00 | 2047.50 | 5179.05 | 5622.96 | 4472.81 |
| 10 | 2553.16 | 2772.00 | 2205.00 | 5577.43 | 6055.50 | 4816.88 |
| 11 | 2917.89 | 3168.00 | 2520.00 | 6374.21 | 6920.57 | 5505.00 |
| 12 | 3647.37 | 3960.00 | 3150.00 | 7967.76 | 8650.71 | 6881.25 |
| 13 | 4376.84 | 4752.00 | 3780.00 | 9561.32 | 10 380.86 | 8257.50 |
| 14 | 4741.58 | 5148.00 | 4095.00 | 10 358.09 | 11 245.93 | 8945.63 |
| 15 | 5106.32 | 5544.00 | 4410.00 | 11 154.87 | 12 111.00 | 9633.75 |
| 16 | 4376.84 | 4752.00 | 3780.00 | 9561.32 | 10 380.86 | 8257.50 |
| 17 | 5471.05 | 5940.00 | 4725.00 | 11 951.64 | 12 976.07 | 10 321.88 |
| 18 | 6565.26 | 7128.00 | 5670.00 | 14 341.97 | 15 571.29 | 12 386.25 |
| 19 | 7112.37 | 7722.00 | 6142.50 | 15 537.14 | 16 868.89 | 13 418.44 |
| 20 | 7659.47 | 8316.00 | 6615.00 | 16 732.30 | 18 166.50 | 14 450.63 |

### Table 28-70—Data rate for the EDMG OFDM mode with $N_{SD}$ = 1134, 1532

| MCS | Data rate per spatial stream (Mb/s) | | | | | |
|---|---|---|---|---|---|---|
| | $N_{SD}$ = 1134 | | | $N_{SD}$ = 1532 | | |
| | Normal GI | Short GI | Long GI | Normal GI | Short GI | Long GI |
| 1 | 2461.97 | 2673.00 | 2126.25 | 3326.05 | 3611.14 | 2872.50 |
| 2 | 3077.47 | 3341.25 | 2657.81 | 4157.57 | 4513.93 | 3590.63 |
| 3 | 3692.96 | 4009.50 | 3189.38 | 4989.08 | 5416.71 | 4308.75 |
| 4 | 4000.71 | 4343.63 | 3455.16 | 5404.84 | 5868.11 | 4667.81 |
| 5 | 4308.45 | 4677.75 | 3720.94 | 5820.59 | 6319.50 | 5026.88 |
| 6 | 4923.95 | 5346.00 | 4252.50 | 6652.11 | 7222.29 | 5745.00 |
| 7 | 6154.93 | 6682.50 | 5315.63 | 8315.13 | 9027.86 | 7181.25 |
| 8 | 7385.92 | 8019.00 | 6378.75 | 9978.16 | 10 833.43 | 8617.50 |
| 9 | 8001.41 | 8687.25 | 6910.31 | 10 809.67 | 11 736.21 | 9335.63 |
| 10 | 8616.91 | 9355.50 | 7441.88 | 11 641.18 | 12 639.00 | 10 053.75 |
| 11 | 9847.89 | 10 692.00 | 8505.00 | 13 304.21 | 14 444.57 | 11 490.00 |
| 12 | 12 309.87 | 13 365.00 | 10 631.25 | 16 630.26 | 18 055.71 | 14 362.50 |
| 13 | 14 771.84 | 16 038.00 | 12 757.50 | 19 956.32 | 21 666.86 | 17 235.00 |
| 14 | 16 002.83 | 17 374.50 | 13 820.63 | 21 619.34 | 23 472.43 | 18 671.25 |
| 15 | 17 233.82 | 18 711.00 | 14 883.75 | 23 282.37 | 25 278.00 | 20 107.50 |
| 16 | 14 771.84 | 16 038.00 | 12 757.50 | 19 956.32 | 21 666.86 | 17 235.00 |
| 17 | 18 464.80 | 20 047.50 | 15 946.88 | 24 945.39 | 27 083.57 | 21 543.75 |
| 18 | 22 157.76 | 24 057.00 | 19 136.25 | 29 934.47 | 32 500.29 | 25 852.50 |
| 19 | 24 004.24 | 26 061.75 | 20 730.94 | 32 429.01 | 35 208.64 | 28 006.88 |
| 20 | 25 850.72 | 28 066.50 | 22 325.63 | 34 923.55 | 37 917.00 | 30 161.25 |

### 28.6.9 Data field

#### 28.6.9.1 Scrambler

The operation of the scrambler applied for the data bits is defined in 20.3.9. The scrambling of an SU PSDU continues the scrambling of L-Header and EDMG-Header-A. The initial seed value is defined in the L-Header.

The scrambling of an MU PSDU is performed on a per user basis and continues the scrambling of EDMG-Header-B with reset of the seed value. The initial seed value is defined in the EDMG-Header-B on a per user basis.

#### 28.6.9.2 Encoding

##### 28.6.9.2.1 General

An EDMG OFDM PSDU is encoded by a systematic LDPC block code. Each data word of $L_{CWD}$ information bits is concatenated with $L_{CWP}$ parity bits to create a codeword of length $L_{CW} = L_{CWD} + L_{CWP}$ bits. The EDMG LDPC encoding can employ the codeword lengths $L_{CW}$ = 624, 672, 1248, and 1344 and code rates $R$ = 1/2, 5/8, 3/4, 13/16, and 7/8.

Table 28-71 provides a summary of LDPC code rates.

**Table 28-71—LDPC code rates**

| Code rate | Codeword length ($L_{CW}$) | | Number of data bits ($L_{CWD}$) | |
|---|---|---|---|---|
| | Short | Long | Short | Long |
| 1/2 | 672 | 1344 | 336 | 672 |
| 5/8 | 672 | 1344 | 420 | 840 |
| 3/4 | 672 | 1344 | 504 | 1008 |
| 13/16 | 672 | 1344 | 546 | 1092 |
| 7/8 | 624 or 672 | 1248 or 1344 | 546 or 588 | 1092 or 1176 |

The LDPC encoding with codeword length $L_{CW}$ = 672 and 1344 is performed by solving the linear system of equations $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$ defined by the parity matrix H of size $L_{CWP}$ by $L_{CW}$, where $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right)$ defines the $m^{\text{th}}$ LDPC codeword, $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{L_{CWD}}^{(m)}\right)$ defines the data bits of the $m^{\text{th}}$ LDPC codeword (or data word), and $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{L_{CWP}}^{(m)}\right)$ defines parity bits for $m^{\text{th}}$ LDPC codeword.

The LDPC encoding with codeword length $L_{CW}$ = 624 and 1248 employs the matrices H with $L_{CW}$ = 672 and 1344 for code rate $R$ = 13/16 and then applies puncturing procedure to get a desired code rate $R$ = 7/8. For $L_{CW}$ = 624, the first 48 parity bits are discarded; and for $L_{CW}$ = 1248, the first 96 parity bits are discarded.

Table 28-72 defines the number of coded bits per OFDM symbol, $N_{CBPS}$, for different modulation types and number of data subcarriers, $N_{SD}$.

**Table 28-72—Values of $N_{CBPS}$ for different modulation types and number of data subcarriers**

| Symbol mapping | $N_{SD}$ = 336 | $N_{SD}$ = 734 | $N_{SD}$ = 1134 | $N_{SD}$ = 1532 |
|---|---|---|---|---|
| DCM BPSK | 336 | 734 | 1134 | 1532 |
| DCM QPSK | 672 | 1468 | 2268 | 3064 |
| 16-QAM | 1344 | 2936 | 4536 | 6128 |
| 64-QAM | 2016 | 4404 | 6804 | 9192 |

### 28.6.9.2.2 Parity check matrices

See 28.3.6.

### 28.6.9.2.3 LDPC encoding

This subclause defines the EDMG SU PSDU and EDMG MU PSDU per user basis LDPC encoding. The LDPC encoding can employ the codeword lengths $L_{CW}$ = 624, 672, 1248, and 1344 and code rates $R$ = 1/2, 5/8, 3/4, 13/16, and 7/8.

The LDPC encoding process for the $i_{user}$th user includes the following steps:

a) Compute the number of data pad bits, $N_{DATA\_PAD\,i_{user}}$, using the number of LDPC codewords, $N_{CW\,i_{user}}$, as follows:

$$N_{CW\ i_{user}} = \left\lceil \frac{Length_{i_{user}} \cdot 8}{L_{CW\ i_{user}} \cdot R_{i_{user}}} \right\rceil$$

$$N_{DATA\_PAD\ i_{user}} = N_{CW\ i_{user}} \cdot L_{CW\ i_{user}} \cdot R_{i_{user}} - Length_{i_{user}} \cdot 8$$

The scrambled PSDU is concatenated with $N_{DATA\_PAD\,i_{user}}$ zero bits. They are scrambled using the continuation of the scrambler sequence that scrambled the PSDU input bits.

b) Convert the scrambled PSDU bits to LDPC codewords as follows:

1) If $L_{CW}$ = 672 or 1344, $R$ = 1/2, 5/8, 3/4, 13/16, or 7/8:

i) The output stream of scrambler is broken into the blocks of length $L_{CWD} = L_{CW} \times R$ bits such that the $m$th data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{L_{CWD}}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{L_{CWP}}^{(m)}\right)$, $L_{CWP} = L_{CW} - L_{CWD}$, are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \le N_{CW\,i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$.

2) If $L_{CW}$ = 624, $R$ = 7/8:

i) The output stream of scrambler is broken into the blocks of length 546 bits such that the $m$th data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{546}^{(m)}\right), m \le N_{CW\,i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{126}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \leq N_{CW\, i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$; parity bits are computed applying the $L_{CW}$ = 672, $R$ = 13/16 LDPC matrix.

iii) Finally, the first 48 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{546}^{(m)}, p_{49}^{(m)}, p_{50}^{(m)}, \ldots, p_{126}^{(m)}\right), m \leq N_{CW\, i_{user}}$.

3) If $L_{CW}$ = 1248, $R$ = 7/8:

i) The output stream of scrambler is broken into the blocks of length 1092 bits such that the $m^{\text{th}}$ data word is $\mathbf{b}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{1092}^{(m)}\right), m \leq N_{CW\, i_{user}}$.

ii) To each data word, parity bits $\mathbf{p}^{(m)} = \left(p_1^{(m)}, p_2^{(m)}, \ldots, p_{252}^{(m)}\right)$ are added to create the codeword $\mathbf{c}^{(m)} = \left(\mathbf{b}^{(m)}, \mathbf{p}^{(m)}\right), m \leq N_{CW\, i_{user}}$ such that $\mathbf{H} \cdot \left(\mathbf{c}^{(m)}\right)^T = \mathbf{0}$; parity bits are computed applying the $L_{CW}$ = 1344, $R$ = 13/16 LDPC matrix.

iii) Finally, the first 96 parity bits are discarded (punctured) to create the output codeword $\mathbf{c}^{(m)} = \left(b_1^{(m)}, b_2^{(m)}, \ldots, b_{1092}^{(m)}, p_{97}^{(m)}, p_{98}^{(m)}, \ldots, p_{252}^{(m)}\right), m \leq N_{CW\, i_{user}}$.

c) For each spatial stream concatenate LDPC codewords one after the other to create the coded bit stream $\left(\mathbf{c}^{(1)}, \mathbf{c}^{(2)}, \ldots, \mathbf{c}^{\left(N_{CW\, i_{user}}\right)}\right)$.

d) Compute the number of coded pad bits, $N_{SYM\_PAD\, i_{user}}$, using the number of OFDM symbols, $N_{SYMS\, i_{user}}$, as follows:

$$N_{SYMS\, i_{user}} = \left\lceil \frac{N_{CW\, i_{user}} \cdot L_{CW\, i_{user}}}{N_{SD} \cdot \sum_{i_{SS}=1}^{N_{SS\, i_{user}}} N_{BPSC\, i_{user}\, i_{SS}}} \right\rceil$$

If (BRP PPDU) and $N_{SYMS\, i_{user}} < N_{SYMS\,\min}$, then $N_{SYMS\, i_{user}} = N_{SYMS\,\min}$.

If last PPDU in A-PPDU, then $N_{SYMS\, i_{user}} = N_{SYMSspoof}$.

If STBC applied and $N_{SYMS\, i_{user}}$ is odd, then $N_{SYMS\, i_{user}} = N_{SYMS\, i_{user}} + 1$.

$$N_{SYM\_PAD\, i_{user}} = N_{SYMS\, i_{user}} \cdot N_{SD} \cdot \sum_{i_{SS}=1}^{N_{SS\, i_{user}}} N_{BPSC\, i_{user}\, i_{SS}} - N_{CW\, i_{user}} \cdot L_{CW\, i_{user}}$$

e) For an MU PPDU transmission, update the number of OFDM symbols $N_{SYMS\, i_{user}}$ as described in 28.6.9.2.4, then update the number of pad bits $N_{SYM\_PAD\, i_{user}}$ as described in step d) using updated number of OFDM symbols $N_{SYMS\, i_{user}}$.

f) Concatenate coded bits with $N_{SYM\_PAD\, i_{user}}$ zero bits. They are scrambled using the continuation of the scrambler sequence that scrambled the PSDU input bits and data pad bits in step a).

g) Distribute the encoded and padded bits over the $N_{SS\,i_{user}}$ spatial streams on a group basis with the number of $N_{CBPS\,i_{user}\;i_{ss}}$ bits in a group. The first group of bits goes to the first spatial stream, the second group of bits goes to the second spatial stream, and so on. The procedure is repeated when the maximum number of spatial streams, $N_{SS\,i_{user}}$, is reached. The procedure ends when all PSDU encoded bits, including $N_{SYM\_PAD\,i_{user}}$ pad bits, are distributed over the $N_{SS\,i_{user}}$ spatial streams.

For each user, if STBC coding is applied, then $N_{SS\,i_{user}}$ space-time streams are mapped to $N_{STS\,i_{user}} = 2N_{SS\,i_{user}}$ space-time streams as defined in 28.6.9.3.10. Otherwise, a one-to-one mapping of $N_{SS\,i_{user}}$ spatial streams to $N_{STS\,i_{user}}$ space-time streams shall be applied.

NOTE—For a PPDU carrying a BRP frame, the value of $N_{SYMS\,\min}$ is specified in 28.9.2.2.4.

#### 28.6.9.2.4 MU PPDU padding and space-time streams mapping

For an MU PPDU transmission, all user PPDUs shall be aligned in time. If necessary, user PSDUs shall be padded according to the following steps:

— Compute the maximum number of OFDM symbols over all users $N_{SYMS\max} = \max\limits_{i_{user}}\left(N_{SYMS\;i_{user}}\right)$ for $i_{user} = 1, 2, \ldots, N_{user}$.
— Update the number of OFDM symbols at step e) in 28.6.9.2.3 as $N_{SYMS\;i_{user}} = N_{SYMS\max}$ for $i_{user} = 1, 2, \ldots, N_{user}$. Update the number of pad bits for the $i_{user}{}^{th}$ user, $N_{SYM\_PAD\,i_{user}}$, accordingly.
— The number of pad OFDM symbols for the MU PPDU transmission for the $i_{user}{}^{th}$ user is defined as $N_{PAD\_SYMS\;i_{user}} = N_{SYMS\;\max} - N_{SYMS\;i_{user}}$.

The number of pad symbols $N_{PAD\_SYMS\;i_{user}}$ takes into account MU PPDU padding only and does not include the regular padding described in 28.6.9.2.3.

A receiver can compute the number of pad OFDM symbols, $N_{PAD\_SYMS\;i_{user}}$, using the overall PPDU time duration computed using the MCS and PSDU Length fields defined in the L-Header, MCS, and PSDU Length fields defined in EDMG-Header-B, and TRN field duration defined in the EDMG-Header-A.

— For a nonzero spoofing error and if the spoofing error duration is shorter than one OFDM symbol duration ($T_{SYM} = T_{DFT} + T_{GI}$), the fractional part of OFDM symbol is discarded.
— For a nonzero spoofing error and if the spoofing error duration is longer than or equal to an OFDM symbol duration, then one OFDM symbol and possible fractional part of OFDM symbol are discarded; this is signaled by the Spoofing Error Length Indicator field in the EDMG-Header-B.

This procedure also allows a receiver to determine the beginning of a TRN field if one is present in a received MU PPDU.

The space-time stream index per user, $i_{STS\,i_{user}}$, is mapped to the space-time stream index over all users, $i_{STS}$, as follows:

$$i_{STS}\left(i_{user}, i_{STS\;i_{user}}\right) = \sum_{m=0}^{i_{user}-1} Num_m + i_{STS\;i_{user}},\ 1 \le i_{STS\;i_{user}} \le N_{STS\;i_{user}}, 1 \le i_{user} \le N_{user}$$

$$Num_m = N_{STS\;m} \text{ for } m > 0 \text{ and } Num_m = 0 \text{ otherwise}$$

NOTE—$i_{STS}$ is a function of $i_{user}$ and $i_{STS\,i_{user}}$ indices. However, to simplify notations, this dependence is not indicated explicitly in other equations.

#### 28.6.9.2.5 SU A-PPDU padding

For the last PPDU in an EDMG A-PPDU, $N_{SYMSspoof}$ shall be set, at step d) in 28.6.9.2.3, so that the spoofing error is non-negative and smaller than one SC symbol block (i.e., $T_{DFT}$, defined in Table 28-47). If the last PPDU in an EDMG A-PPDU contains a BRP frame, $N_{SYMSspoof}$ shall be equal to or greater than $N_{SYMS\min}$ and set so that the spoofing error is smaller than one OFDM symbol duration (i.e., $T_{SYM} = T_{DFT} + T_{GI}$, where $T_{DFT}$ and $T_{GI}$ are defined in Table 28-62) to enable the receiver to determine the start of the TRN field. $N_{SYMSspoof}$ is calculated as follows:

$$T_{Data\max}^{(N_{PPDU})} = TXTIME_{spoof} - \Big(T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + T_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}STF} + T_{EDMG\text{-}CEF} + (N_{PPDU} - 1)T_{EDMG\text{-}Header\text{-}A}^{(OFDM)} + \sum_{i_{PPDU}=1}^{N_{PPDU}-1} T_{Data}^{(i_{PPDU})} + T_{TRN}\Big)$$

$$N_{SYMSspoof} = \left\lfloor \frac{T_{Data\max}^{(N_{PPDU})}}{T_{SYM}} \right\rfloor$$

where

| | |
|---|---|
| $TXTIME_{spoof}$ | is the spoofed PPDU duration calculated based on L-Header |
| $T_{L\text{-}STF}$, $T_{L\text{-}CEF}$, $T_{L\text{-}Header}$, $T_{EDMG\text{-}STF}$, $T_{EDMG\text{-}CEF}$, $T_{EDMG\text{-}Header\text{-}A}$, and $T_{TRN}$ | are the durations of the L-STF, L-CEF, L-Header, EDMG-STF, EDMG-CEF, EDMG-Header-A, and TRN fields as defined in 28.12.3.4 |
| $T_{SYM} = T_{DFT} + T_{GI}$ | where $T_{DFT}$ and $T_{GI}$ are defined in Table 28-62; $T_{GI}$ can be equal to $T_{GI\ short}$, $T_{GI\ normal}$, or $T_{GI\ long}$ |
| $T_{EDMG\text{-}Header\text{-}A}^{(OFDM)}$ | is the duration of the EDMG-Header-A of the second to the last PPDU using OFDM modulation (see 28.6.7) |
| $T_{Data}^{(i_{PPDU})}$, for $i_{PPDU} = 1, \ldots, N_{PPDU} - 1$, | is the duration of the data field of $i_{PPDU}$th PPDU, except for the last PPDU, as defined in 28.12.3.4 |
| $T_{Data\max}^{(N_{PPDU})}$ | is the maximum duration of the last PPDU that fulfills the spoofing error requirement |

For an EDMG A-PPDU transmission, the spoofed values of the L-Header fields and the duration of the PPDUs except the last PPDU shall be determined so that $N_{SYMSspoof}$ is equal to or greater than $N_{SYMS\min}$.

NOTE—The EDMG Header-A field in the first PPDU is modulated with SC mode while the EDMG Header-A fields in the following PPDUs are modulated with OFDM mode as described in 28.6.7. The duration of the fields might be different from that of the field in the first PPDU.

### 28.6.9.3 Modulation mapping

#### 28.6.9.3.1 General

This subclause defines the OFDM transmission for the data part of a PPDU over 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels with $i_{STS} = 1, 2, 3, 4, 5, 6, 7$, or 8.

The coded and padded bit stream is converted into a stream of complex constellation points, following the rules defined in this subclause for BPSK, Dual Stream DCM BPSK, DCM QPSK, 16-QAM, 64-QAM, and phase hopping modulations.

The DCM BPSK, Dual Stream DCM BPSK, and DCM QPSK modulations use the tone pairing mechanism to extract channel frequency diversity as defined in 28.6.9.3.3, 28.6.9.3.4, and 28.6.9.3.5, respectively. The 16-QAM and 64-QAM modulations use the interleaver defined in 28.6.9.3.9.

### 28.6.9.3.2 Transmission in EDMG format

The EDMG data transmit waveform for $i_{TX}$<sup></sup>th transmit chain in time domain shall be defined at the OFDM sampling rate $F_s$ as follows:

$$r_{Data}^{i_{TX}}\left(qT_s\right) = \frac{1}{\sqrt{N_{STS} \cdot N_{EDMG\text{-}DATA}^{Tone}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}\left(qT_s - nT_{SYM}\right)$$

$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_{EDMG\,k}\right]_{i_{TX},i_{STS}} \left(D\left(i_{STS},n,k\right) + P\left(i_{STS},n,k\right)\right) \exp\left(j2\pi k \Delta_F \left(qT_s - nT_{SYM} - T_{GI}\right)\right)$$

where

| | |
|---|---|
| $N_{EDMG\text{-}DATA}^{Tone} = N_{SD} + N_{SP}$ | is the total number of active tones |
| $N_{STS}$ | is the total number of space-time streams |
| $T_{SYM} = T_{DFT} + T_{GI}$ | is the OFDM symbol duration in time domain |
| $T_{GI}$ | is the guard interval duration |
| $Q_{EDMG\,k}$ | is the spatial mapping matrix per $k^{th}$ subcarrier |
| $[\ ]_{m,n}$ | is a matrix element from $m^{th}$ row and $n^{th}$ column |
| $w_{T_{SYM}}\left(qT_s\right)$ | is a window function applied to smooth the transitions between consecutive OFDM symbols and its definition is implementation specific |
| $D\left(i_{STS},n,k\right)$ | is the data sequence, it is defined by inserting 0s from $–N_{SR}$ to $N_{SR}$, and then inserting data at the $M_d(k)$ tones defined in 28.6.2.5, $D(i_{STS}, n, M_d(k)) = d(i_{STS}, n, k)$, for $k = 0, 1, \ldots, N_{SD} – 1$ |
| $P\left(i_{STS},n,k\right)$ | is the pilot sequence defined in 28.6.2.6 |
| $q$ | is a time sample index |

NOTE—For EDMG-Header-B transmission, the zeroth OFDM symbol corresponds to the EDMG-Header-B, $n = 0$, and the numbering of OFDM symbols for the data part starts from $n = 1$.

### 28.6.9.3.3 DCM BPSK modulation

The input encoded bits belonging to the $i_{SS}^{th}$ spatial stream are broken into the groups of $N_{CBPS}$ bits, $\left(c_0^{(q)}, c_1^{(q)}, \ldots, c_{N_{CBPS}-1}^{(q)}\right)$, where $q$ denotes the group number. Each pair of bits $\left(c_{2k}^{(q)}, c_{2k+1}^{(q)}\right)$, $k = 0, 1, \ldots, N_{SD}/2 – 1$, is converted into the pair of complex points $\left(d\left(i_{SS},q,k\right), d\left(i_{SS},q,P\left(k\right)\right)\right)$. The modulation is performed in two steps:

— First, two BPSK points are modulated as $x_{2k}^{(q)} = \left(2 \times c_{2k}^{(q)} - 1\right)$, $x_{2k+1}^{(q)} = \left(2 \times c_{2k+1}^{(q)} - 1\right)$.

— Second, two BPSK points $\left(x_{2k}^{(q)}, x_{2k+1}^{(q)}\right)$ are converted to two QPSK points $\left(d\left(i_{SS}, q, k\right), d\left(i_{SS}, q, P\left(k\right)\right)\right)$ by multiplication on mapping matrix $W$ as follows:

$$\begin{bmatrix} d\left(i_{SS}, q, k\right) \\ d\left(i_{SS}, q, P\left(k\right)\right) \end{bmatrix} = W \cdot \begin{bmatrix} x_{2k}^{(q)} \\ x_{2k+1}^{(q)} \end{bmatrix}, W = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & j \\ 1 & -j \end{bmatrix}$$

where the tone pairing index $P(k)$ is defined as $P(k) = k + N_{SD}/2$ in the range $N_{SD}/2$ to $N_{SD} - 1$. The $q^{\text{th}}$ modulated data block of the $i_{SS}{}^{\text{th}}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{\text{th}}$ OFDM symbol of the $i_{SS}{}^{\text{th}}$ spatial stream.

### 28.6.9.3.4 Dual Stream DCM BPSK modulation

Dual Stream DCM BPSK modulation is applied if the number of spatial streams, $N_{SS}$, is equal to 2 and the DCM BPSK Applied field in EDMG-Header-A is set to 1.

The input encoded bits of $i_{SS}{}^{\text{th}}$ spatial stream are broken into the groups of $N_{CBPS}$ bits, $\left(c_0^{(i_{SS},q)}, c_1^{(i_{SS},q)}, \ldots, c_{N_{CBPS}-1}^{(i_{SS},q)}\right)$, where $q$ denotes the group number. Each pair of bits $\left(c_{2k}^{(i_{SS},q)}, c_{2k+1}^{(i_{SS},q)}\right)$, $k = 0, 1, \ldots, N_{SD}/2 - 1$, is converted into the complex point $d\left(i_{SS}, q, k\right)$.

For 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channel configurations, the modulation is performed as follows:

$$d\left(i_{SS}=1, q, k\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=1,q)} - 1\right) + j\left(2 \times c_{2k+1}^{(i_{SS}=1,q)} - 1\right)\right)$$
$$d\left(i_{SS}=1, q, P\left(k\right)\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=2,q)} - 1\right) - j\left(2 \times c_{2k+1}^{(i_{SS}=2,q)} - 1\right)\right)$$
$$d\left(i_{SS}=2, q, k\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=2,q)} - 1\right) + j\left(2 \times c_{2k+1}^{(i_{SS}=2,q)} - 1\right)\right)$$
$$d\left(i_{SS}=2, q, P\left(k\right)\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=1,q)} - 1\right) - j\left(2 \times c_{2k+1}^{(i_{SS}=1,q)} - 1\right)\right)$$

where the tone pairing index $P(k)$ is defined as $P(k) = k + N_{SD}/2$ in the range $N_{SD}/2$ to $N_{SD} - 1$. The $q^{\text{th}}$ modulated data block of the $i_{SS}{}^{\text{th}}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{\text{th}}$ OFDM symbol of the $i_{SS}{}^{\text{th}}$ spatial stream.

For 2.16+2.16 GHz and 4.32+4.32 GHz channel configurations, the modulation is performed as follows:

$$d\left(i_{SS}=1, q, k\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=1,q)} - 1\right) + j\left(2 \times c_{2k+1}^{(i_{SS}=1,q)} - 1\right)\right)$$
$$d\left(i_{SS}=1, q, P\left(k\right)\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=2,q)} - 1\right) + j\left(2 \times c_{2k+1}^{(i_{SS}=2,q)} - 1\right)\right)$$
$$d\left(i_{SS}=2, q, k\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=1,q)} - 1\right) - j\left(2 \times c_{2k+1}^{(i_{SS}=1,q)} - 1\right)\right)$$
$$d\left(i_{SS}=2, q, P\left(k\right)\right) = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS}=2,q)} - 1\right) - j\left(2 \times c_{2k+1}^{(i_{SS}=2,q)} - 1\right)\right)$$

where the tone pairing index $P(k)$ is defined as $P(k) = k + N_{SD}/2$ in the range $N_{SD}/2$ to $N_{SD} - 1$. The $q^{th}$ modulated data block of the $i_{SS}{}^{th}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{th}$ OFDM symbol of the $i_{SS}{}^{th}$ spatial stream.

### 28.6.9.3.5 DCM QPSK modulation

The input encoded bits of the $i_{SS}{}^{th}$ spatial stream are broken into the groups of $N_{CBPS}$ bits, $\left(c_0^{(q)}, c_1^{(q)}, \ldots, c_{N_{CBPS}-1}^{(q)}\right)$, where $q$ denotes the group number. Each four bits $\left(c_{4k}^{(q)}, c_{4k+1}^{(q)}, c_{4k+2}^{(q)}, c_{4k+3}^{(q)}\right)$, $k = 0, 1, \ldots, N_{SD}/2 - 1$, are converted into the pair of complex points $\left(d\left(i_{SS}, q, k\right), d\left(i_{SS}, q, P(k)\right)\right)$. The modulation is performed in two steps:

— First, two QPSK points are modulated as $x_{2k}^{(q)} = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{4k}^{(q)} - 1\right) + j\left(2 \times c_{4k+2}^{(q)} - 1\right)\right)$, $x_{2k+1}^{(q)} = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{4k+1}^{(q)} - 1\right) + j\left(2 \times c_{4k+3}^{(q)} - 1\right)\right)$.

— Second, two QPSK points $\left(x_{2k}^{(q)}, x_{2k+1}^{(q)}\right)$ are converted to two 16-QAM points $\left(d\left(i_{SS}, q, k\right), d\left(i_{SS}, q, P(k)\right)\right)$ by multiplication on mapping matrix $W$ as follows:

$$\begin{bmatrix} d\left(i_{SS}, q, k\right) \\ d\left(i_{SS}, q, P(k)\right) \end{bmatrix} = W \cdot \begin{bmatrix} x_{2k}^{(q)} \\ x_{2k+1}^{(q)} \end{bmatrix}, \quad W = \frac{1}{\sqrt{5}} \begin{bmatrix} 1 & 2 \\ -2 & 1 \end{bmatrix}$$

where the tone pairing index $P(k)$ is defined as $P(k) = k + N_{SD}/2$ in the range $N_{SD}/2$ to $N_{SD} - 1$. The $q^{th}$ modulated data block of the $i_{SS}{}^{th}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{th}$ OFDM symbol of the $i_{SS}{}^{th}$ spatial stream.

### 28.6.9.3.6 16-QAM modulation

The input encoded bits of the $i_{SS}{}^{th}$ spatial stream are broken into the groups of $N_{CBPS}$ bits, $\left(c_0^{(q)}, c_1^{(q)}, \ldots, c_{N_{CBPS}-1}^{(q)}\right)$, where $q$ denotes the group number. Each four bits $\left(c_{4k}^{(q)}, c_{4k+1}^{(q)}, c_{4k+2}^{(q)}, c_{4k+3}^{(q)}\right)$, $k = 0, 1, \ldots, N_{SD} - 1$, are converted into the single constellation point $d\left(i_{SS}, q, k\right)$. The modulation is performed as follows:

$$d\left(i_{SS}, q, k\right) = \frac{1}{\sqrt{10}}\left(\left(2 \times \left(2c_{4k}^{(q)} - 1\right) - \left(2c_{4k}^{(q)} - 1\right) \times \left(2c_{4k+1}^{(q)} - 1\right)\right)\right.$$
$$\left. + j\left(2 \times \left(2c_{4k+2}^{(q)} - 1\right) - \left(2c_{4k+2}^{(q)} - 1\right) \times \left(2c_{4k+3}^{(q)} - 1\right)\right)\right)$$

The $q^{th}$ modulated data block of the $i_{SS}{}^{th}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{th}$ OFDM symbol of the $i_{SS}{}^{th}$ spatial stream.

### 28.6.9.3.7 64-QAM modulation

The input encoded bits of the $i_{SS}{}^{th}$ spatial stream are broken into the groups of $N_{CBPS}$ bits, $\left(c_0^{(q)}, c_1^{(q)}, \ldots, c_{N_{CBPS}-1}^{(q)}\right)$, where $q$ denotes the group number. Each six bits $\left(c_{6k}^{(q)}, c_{6k+1}^{(q)}, c_{6k+2}^{(q)}, c_{6k+3}^{(q)}, c_{6k+4}^{(q)}, c_{6k+5}^{(q)}\right)$, $k = 0, 1, \ldots, N_{SD} - 1$, are converted into the single constellation point $d\left(i_{SS}, q, k\right)$. The modulation is performed as follows:

$$d\left(i_{SS},q,k\right)=\frac{1}{\sqrt{42}}\left(\left(4\times\left(2c_{6k}^{(q)}-1\right)-2\times\left(2c_{6k}^{(q)}-1\right)\times\left(2c_{6k+1}^{(q)}-1\right)+\left(2c_{6k}^{(q)}-1\right)\times\left(2c_{6k+1}^{(q)}-1\right)\times\left(2c_{6k+2}^{(q)}-1\right)\right)\right.$$
$$\left.+j\left(4\times\left(2c_{6k+3}^{(q)}-1\right)-2\times\left(2c_{6k+3}^{(q)}-1\right)\times\left(2c_{6k+4}^{(q)}-1\right)+\left(2c_{6k+3}^{(q)}-1\right)\times\left(2c_{6k+4}^{(q)}-1\right)\times\left(2c_{6k+5}^{(q)}-1\right)\right)\right)$$

The $q^{\text{th}}$ modulated data block of the $i_{SS}{}^{\text{th}}$ spatial stream is mapped to $N_{SD}$ data subcarriers of the $q^{\text{th}}$ OFDM symbol of the $i_{SS}{}^{\text{th}}$ spatial stream.

### 28.6.9.3.8 Phase hopping modulation

The phase hopping modulation is applied if the number of spatial streams is equal to two (i.e., $N_{SS} = 2$) and the Phase Hopping field in the EDMG-Header-A is equal to 1.

The phase hopping modulation shall use the (BPSK, BPSK), (QPSK, QPSK), (QPSK, 16-QAM), (16-QAM, QPSK), (16-QAM, 16-QAM), or (64-QAM, 64-QAM) modulations for the first and the second spatial streams accordingly.

For each modulation type, the encoded bits of $i_{SS}{}^{\text{th}}$ spatial stream are broken into groups of $N_{CBPSi_{SS}}$ bits, $\left(c_0^{(i_{SS},q)},c_1^{(i_{SS},q)},\ldots,c_{N_{CBPSi_{SS}}-1}^{(i_{SS},q)}\right)$, where $q$ denotes the group number.

For (BPSK, BPSK) configuration, the modulation is performed in two steps:

— First, BPSK points are modulated as $x_k^{(i_{SS},q)}=\left(2\times c_k^{(i_{SS},q)}-1\right)$, $i_{SS}=1,2$, $k = 0, 1, \ldots, N_{SD} - 1$.

— Second, two BPSK points $\left(x_k^{(i_{SS}=1,q)},x_k^{(i_{SS}=2,q)}\right)$ are converted to two modulation points $\left(d\left(i_{SS}=1,q,k\right),d\left(i_{SS}=2,q,k\right)\right)$ by multiplication with mapping matrix $Q$ and phase hopping matrix $W(k)$ as follows:

$$\begin{bmatrix} d\left(i_{SS}=1,q,k\right) \\ d\left(i_{SS}=2,q,k\right) \end{bmatrix}=W\left(k\right)\cdot Q\cdot\begin{bmatrix} x_k^{(i_{SS}=1,q)} \\ x_k^{(i_{SS}=2,q)} \end{bmatrix}$$

If the Open Loop Precoding field in the EDMG-Header-A is equal to 1, then matrix $Q$ is defined as $Q=\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & j \\ 1 & -j \end{bmatrix}$. Otherwise, it is defined as an identity matrix.

For (QPSK, QPSK) configuration, the modulation is performed in two steps:

— First, QPSK points are modulated as $x_k^{(i_{SS},q)}=\frac{1}{\sqrt{2}}\left(\left(2\times c_{2k}^{(i_{SS},q)}-1\right)+j\left(2\times c_{2k+1}^{(i_{SS},q)}-1\right)\right)$, $i_{SS}=1,2$, $k = 0, 1, \ldots, N_{SD} - 1$.

— Second, two QPSK points $\left(x_k^{(i_{SS}=1,q)},x_k^{(i_{SS}=2,q)}\right)$ are converted to two modulation points $\left(d\left(i_{SS}=1,q,k\right),d\left(i_{SS}=2,q,k\right)\right)$ by multiplication with mapping matrix $Q$ and phase hopping matrix $W(k)$ as follows:

$$\begin{bmatrix} d\left(i_{SS}=1,q,k\right) \\ d\left(i_{SS}=2,q,k\right) \end{bmatrix}=W\left(k\right)\cdot Q\cdot\begin{bmatrix} x_k^{(i_{SS}=1,q)} \\ x_k^{(i_{SS}=2,q)} \end{bmatrix}$$

If the Open Loop Precoding field in the EDMG-Header-A is equal to 1, then matrix $Q$ is defined as $Q = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$. Otherwise, it is defined as an identity matrix.

For (QPSK, 16-QAM) and (16-QAM, QPSK) configuration, the modulation is performed in two steps:

- First QPSK and 16-QAM points are modulated as follows:
  - QPSK points are modulated as $x_k^{(i_{SS},q)} = \frac{1}{\sqrt{2}}\left(\left(2 \times c_{2k}^{(i_{SS},q)} - 1\right) + j\left(2 \times c_{2k+1}^{(i_{SS},q)} - 1\right)\right)$.
  - 16-QAM points are modulated as defined in 28.6.9.3.6.
- Second, two (QPSK, 16-QAM) or (16-QAM, QPSK) points $\left(x_k^{(i_{SS}=1,q)}, x_k^{(i_{SS}=2,q)}\right)$ are converted to two modulation points $\left(d\left(i_{SS}=1,q,k\right), d\left(i_{SS}=2,q,k\right)\right)$ by multiplication with mapping matrix $Q$ and phase hopping matrix $W(k)$ as follows:

$$\begin{bmatrix} d\left(i_{SS}=1,q,k\right) \\ d\left(i_{SS}=2,q,k\right) \end{bmatrix} = W\left(k\right) \cdot Q \cdot \begin{bmatrix} x_k^{(i_{SS}=1,q)} \\ x_k^{(i_{SS}=2,q)} \end{bmatrix}$$

If the Open Loop Precoding field in the EDMG-Header-A is equal to 1 and the modulation configuration is (QPSK, 16-QAM), then matrix $Q$ is defined as $Q = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \cdot \begin{bmatrix} \sqrt{2/3} & 0 \\ 0 & \sqrt{4/3} \end{bmatrix}$. Otherwise, it is defined as an identity matrix.

If the Open Loop Precoding field in the EDMG-Header-A is equal to 1 and the modulation configuration is (16-QAM, QPSK), then matrix $Q$ is defined as $Q = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \cdot \begin{bmatrix} \sqrt{4/3} & 0 \\ 0 & \sqrt{2/3} \end{bmatrix}$. Otherwise, it is defined as an identity matrix.

For (16-QAM, 16-QAM) and (64-QAM, 64-QAM) configurations, the modulation is performed in two steps:

- First, 16-QAM or 64-QAM points are modulated as defined in 28.6.9.3.6 or 28.6.9.3.7, respectively.
- Second, two 16-QAM or 64-QAM points $\left(x_k^{(i_{SS}=1,q)}, x_k^{(i_{SS}=2,q)}\right)$ are converted to two modulation points $\left(d\left(i_{SS}=1,q,k\right), d\left(i_{SS}=2,q,k\right)\right)$ by multiplication with mapping matrix $Q$ and phase hopping matrix $W(k)$ as follows:

$$\begin{bmatrix} d\left(i_{SS}=1,q,k\right) \\ d\left(i_{SS}=2,q,k\right) \end{bmatrix} = W\left(k\right) \cdot Q \cdot \begin{bmatrix} x_k^{(i_{SS}=1,q)} \\ x_k^{(i_{SS}=2,q)} \end{bmatrix}$$

If the Open Loop Precoding field in the EDMG-Header-A is equal to 1, then matrix $Q$ is defined as $Q = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$. Otherwise, it is defined as an identity matrix.

The phase hopping matrix $W(k)$ depends on $k$ and is defined as follows:

$$W(k) = \begin{bmatrix} 1 & 0 \\ 0 & e^{j\phi(y(k))} \end{bmatrix}, \phi(y(k)) = \frac{3\pi \cdot y(k)}{4}$$

where

$y(k)$ is initialized to the value 0 at ($x_k^{(i_{SS}=1,q)}, x_k^{(i_{SS}=2,q)}$) including a first bit of the LDPC codeword; otherwise, $y(k)$ is incremented by 1 for every ($x_k^{(i_{SS}=1,q)}, x_k^{(i_{SS}=2,q)}$) inside the LDPC codeword

### 28.6.9.3.9 Interleaver

This subclause defines a symbol interleaver for 16-QAM and 64-QAM modulations. The interleaver performs modulated complex symbols interleaving inside an OFDM symbol and its parameters depend on the $N_{SD}$, $N_{CB}$, $N_{SS\ i_{user}}$, $L_{CW\ i_{user}}$, and $N_{BPSC\ i_{user}\ i_{SS}}$ parameters.

The input to the interleaver for the $i_{SS}$th spatial stream is an OFDM data block $d_{in}^{(i_{SS},q)}$ of length $N_{SD}$ composed of 16-QAM or 64-QAM symbols $d_{in}^{(i_{SS},q)} = \left(d_0^{(i_{SS},q)}, d_1^{(i_{SS},q)}, \ldots, d_{N_{SD}-1}^{(i_{SS},q)}, 0_0, 0_1, \ldots, 0_{N_p-1}\right)$, where $q$ denotes the OFDM symbol number and $q = 0, 1, \ldots, N_{SYM} - 1$.

The interleaving is performed inside the block of length $N_{SD} + N_p$, where $N_p$ is equal to 0, 34, 18, and 4 for $N_{CB}$ equal to 1, 2, 3, and 4, respectively.

The output of the interleaver scheme for the $i_{SS}$th spatial stream is a permutated OFDM data block of length $N_{SD}$ and defined as $d_{out}^{(i_{SS},q)} = \left(d_{idx(0)}^{(i_{SS},q)}, d_{idx(1)}^{(i_{SS},q)}, \ldots, d_{idx((N_{SD}+N_p)-1)}^{(i_{SS},q)}\right)$, where $idx()$ defines the array of permutation indexes.

The array of permutation indexes, $idx()$, is constructed as follows:

Let $x = \left( (N_{SD} + N_p) \times \sum_{i_{SS}=1}^{N_{SS\ i_{user}}} N_{BPSC\ i_{user}\ i_{SS}} \right) / L_{CW\ i_{user}}$.

Moreover, for each $x$, let $N_x = \begin{cases} 2 \times N_{CB} & \text{if} \quad x < 2.5 \times N_{CB} \\ 3 \times N_{CB} & \text{if} \quad 2.5 \times N_{CB} \le x < 3.5 \times N_{CB} \\ 4 \times N_{CB} & \text{if} \quad 3.5 \times N_{CB} \le x < 5 \times N_{CB} \\ 6 \times N_{CB} & \text{if} \quad 5 \times N_{CB} \le x < 7 \times N_{CB} \\ 8 \times N_{CB} & \text{if} \quad 7 \times N_{CB} \le x < 10 \times N_{CB} \\ 12 \times N_{CB} & \text{if} \quad 10 \times N_{CB} \le x < 14 \times N_{CB} \\ 16 \times N_{CB} & \text{if} \quad 14 \times N_{CB} \le x < 20 \times N_{CB} \\ 24 \times N_{CB} & \text{if} \quad x \ge 20 \times N_{CB} \end{cases}$ and $N_y = (N_{SD} + N_p)/N_x$.

Then, $idx(j \times N_x + i) = N_y \times i + j$, where $i = 0, 1, \ldots, N_x - 1$ and $j = 0, 1, \ldots, N_y - 1$.

After permutation, the padded 0s at the first step are discarded (punctured) to form the output array of length $N_{SD}$.

#### 28.6.9.3.10 Space-time block coding

An EDMG STA shall only apply STBC to an EDMG PPDU transmitted to a peer EDMG STA if the STBC Type field in the peer STA's EDMG Capabilities element is nonzero.

The space-time block coding (STBC) for the EDMG OFDM mode maps $N_{SS}$ spatial streams to $2 \times N_{SS}$ space-time streams. STBC is applied to an EDMG PPDU if, in the EDMG-Header-A of the PPDU, the STBC field is equal to 1. The number of STBC modulated spatial streams $N_{SS}$ is given by Number of SS field in the EDMG-Header-A. $N_{SS}$ shall not exceed four for an SU PPDU and one per user for an MU PPDU.

The mapping of each spatial stream, $i_{SS} = 1, \ldots, N_{SS}$, includes the following steps for the data subcarriers mapping:

a) The input bits of spatial stream $i_{SS}$ are broken into the groups of $N_{CBPS}(i_{SS})$ bits, $\left(c_0^{(q)}, c_1^{(q)}, \ldots, c_{N_{CBPS}(i_{SS})-1}^{(q)}\right)$, where $q$ denotes the group number. The STBC applies the encoding procedure defined in 28.6.8. The padding procedure requires that the total number of groups of $N_{CBPS}(i_{SS})$ bits shall be an even number.

b) Each group of bits $\left(c_{N_{BPSC}(i_{SS})\cdot k}^{(q)}, c_{N_{BPSC}(i_{SS})\cdot k+1}^{(q)}, \ldots, c_{N_{BPSC}(i_{SS})\cdot k+N_{BPSC}(i_{SS})-1}^{(q)}\right)$, $k = 0, 1, \ldots, N_{SD} - 1$ is converted to the constellation point $d\left(i_{SS}, q, k\right)$, $q = 0, 1, \ldots, N_{SYM} - 1$, following the rules defined in 28.6.9.3.3, 28.6.9.3.5, 28.6.9.3.6, and 28.6.9.3.7.

c) The modulated data sequence $D(i_{STS} = 2 \times i_{SS} - 1, n, k)$ for the odd space-time stream is defined by inserting 0s from $-N_{SR}$ to $N_{SR}$ and then inserting data at tones $M_d(k)$ defined in 28.6.2.5 as follows:

$$D\left(i_{STS} = 2i_{SS} - 1, 2n, M_d(k)\right) = d\left(i_{SS}, 2n, k\right),$$
$$D\left(i_{STS} = 2i_{SS} - 1, 2n+1, M_d(k)\right) = d\left(i_{SS}, 2n+1, k\right),\ k = 0, 1, \ldots, N_{SD} - 1$$

d) The modulated data sequence $D(i_{STS} = 2 \times i_{SS}, n, k)$ for the even space-time stream is defined by inserting 0s from $-N_{SR}$ to $N_{SR}$ and then inserting data at tones $M_d(k)$ defined in 28.6.2.5 as follows:

$$D\left(i_{STS} = 2i_{SS}, 2n, M_d(k)\right) = -conj\left(d\left(i_{SS}, 2n+1, k\right)\right),$$
$$D\left(i_{STS} = 2i_{SS}, 2n+1, M_d(k)\right) = conj\left(d\left(i_{SS}, 2n, k\right)\right),\ k = 0, 1, \ldots, N_{SD} - 1$$

e) The modulated pilot sequence $P(i_{STS} = 2 \times i_{SS} - 1, n, k)$ for the odd space-time stream is defined by inserting 0s from $-N_{SR}$ to $N_{SR}$ and then inserting pilots at tones $M_p(k)$ defined in 28.6.2.4 as follows:

$$P\left(i_{STS} = 2i_{SS} - 1, 2n, M_p(k)\right) = P_{N_{SP}}\left(i_{STS} = 2i_{SS} - 1, k\right) \cdot \left(2p(2n) - 1\right),$$
$$P\left(i_{STS} = 2i_{SS} - 1, 2n+1, M_p(k)\right) = P_{N_{SP}}\left(i_{STS} = 2i_{SS}, k\right) \cdot \left(2p(2n+1) - 1\right),\ k = 0, 1, \ldots, N_{SP} - 1$$

f) The modulated pilot sequence $P(i_{STS} = 2 \times i_{SS}, n, k)$ for the even space-time stream is defined by inserting 0s from $-N_{SR}$ to $N_{SR}$ and then inserting pilots at tones $M_p(k)$ defined in 28.6.2.4 as follows:

$$P\left(i_{STS} = 2i_{SS}, 2n, M_p(k)\right) = -P_{N_{SP}}\left(i_{STS} = 2i_{SS}, k\right) \cdot \left(2p(2n) - 1\right),$$
$$P\left(i_{STS} = 2i_{SS}, 2n+1, M_p(k)\right) = P_{N_{SP}}\left(i_{STS} = 2i_{SS} - 1, k\right) \cdot \left(2p(2n+1) - 1\right),\ k = 0, 1, \ldots, N_{SP} - 1$$

In the above procedure, index $n = 0, 1, \ldots, N_{SYM} / 2 - 1$, pilot sequences $P_{N_{SP}}\left(i_{STS} = 2 \times i_{SS} - 1, k\right)$ and $P_{N_{SP}}\left(i_{STS} = 2 \times i_{SS}, k\right)$ are defined in 28.6.2.6 and $p(n)$ defines a bit coming from the scrambler defined in 28.6.9.1 with shift register $x_1, x_2, \ldots, x_7$ initialized to all 1s for the $n = 0$ OFDM symbol.

### 28.6.10 PPDU transmission

#### 28.6.10.1 General

This subclause defines the waveform for an EDMG OFDM mode PPDU transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel using $N_{TX}$ transmit chains.

The spatial mapping methods are defined in 28.6.10.2. The EDMG SU PPDU transmission shall be as defined in 28.6.10.3. The EDMG MU PPDU transmission shall be as defined in 28.6.10.4.

#### 28.6.10.2 Spatial mapping

Spatial mapping defines the method of $N_{STS}$ space-time streams to $N_{TX}$ transmit chains mapping, where $N_{STS} \leq N_{TX}$. This may be implemented by means of spatial mapping matrix $Q_k$ of size $N_{TX}$ by $N_{STS}$ defined per subcarrier basis and cyclic shift diversity (CSD), if applied.

The standard defines four basic mappings, including direct mapping, indirect mapping, digital beamforming, and spatial expansion. Examples of spatial mapping methods and $Q_k$ matrices that might be used in different cases are as follows:

- Direct mapping, $N_{STS} = N_{TX}$: spatial mapping matrix $Q_k$ is a square diagonal complex value matrix of size $N_{TX}$ that might be defined as follows:
  - $\left[Q_k\right]_{i,i} = 1, i = 1, 2, ..., N_{TX}$, the identity matrix
  - $\left[Q_k\right]_{i,i} = \exp\left(j2\pi\phi_i\right), i = 1, 2, ..., N_{TX}$, the exponential matrix
- Indirect mapping, $N_{STS} = N_{TX}$: spatial mapping matrix $Q_k$ is a square matrix of size $N_{TX}$ composed of complex values that might be defined as follows:
  - Normalized discrete Fourier matrix
  - Normalized Hadamard matrix
  - Normalized direct mapping diagonal matrix with permuted rows and/or columns
- Digital beamforming, $N_{STS} \leq N_{TX}$: spatial mapping matrix $Q_k$ is a rectangular matrix of size $N_{TX}$ by $N_{STS}$ composed of complex values that might be defined based on the knowledge of the channel.
- Spatial expansion, $N_{STS} = 1 < N_{TX}$: spatial expansion that might be applied to the pre-EDMG fields is performed by multiplication by matrix $Q$, which is defined as a column vector of size $N_{TX}$ by 1 and composed of all 1s and application of CSD over different transmit chains. The cyclic shift is applied to the number of consecutive fields in the PPDU. This allows duplication of the PPDU fields transmission over the $N_{TX}$ transmit chains and avoids unintentional beamforming existing with a coherent signal transmission.
- Channel aggregation, in this case $N_{TX}$ is an even number: the transmit chains 1 through $N_{TX}/2$ are assigned to the primary or primary and secondary channels and transmit chains $N_{TX}/2 + 1$ are assigned to the secondary or secondary1 and secondary2 channels. The mapping of space-time streams to the transmit chains is defined by the spatial mapping matrix $Q_k$, which is implementation specific.

#### 28.6.10.3 EDMG SU PPDU transmission

##### 28.6.10.3.1 General

An EDMG OFDM mode SU PPDU transmitted over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel with single and multiple space-time streams ($1 \leq i_{STS} \leq N_{STS}$) is composed of pre-EDMG, EDMG preamble, Data field and TRN field.

The pre-EDMG modulated fields of the EDMG PPDU includes the L-STF, L-CEF, L-Header, and EDMG-Header-A and shall be transmitted using SC modulation as defined in 28.5.10.4.4.2. The EDMG-STF, EDMG-CEF, Data field, and TRN field shall be transmitted using OFDM modulation as defined in 28.6.4, 28.6.5, 28.6.9, and 28.9.2.2.5, respectively.

The total number of transmit chains, $N_{TX}$, shall be constant over the different fields of a transmitted EDMG SU PPDU.

### 28.6.10.3.2 Pre-EDMG modulated fields transmission

See 28.5.10.4.4.2. The upsampling factor shall be equal to $N_{up} = (3/2) \times N_{CB}$.

### 28.6.10.3.3 EDMG preamble, Data field, and TRN field transmission

For a single PPDU transmission, the EDMG modulated field of the EDMG preamble, Data field, and TRN field of an SU PPDU is defined for the $i_{TX}$th transmit chain at the $F_s$ sampling rate and sample time duration $T_s$ and includes the following modulated fields:

$$
\begin{aligned}
& r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}}(nT_s) = r_{EDMG\text{-}STF}^{i_{TX}}(nT_s) + r_{EDMG\text{-}CEF}^{i_{TX}}(nT_s - t_{EDMG\text{-}CEF}) \\
& + r_{Data}^{i_{TX}}(nT_s - t_{Data}) + r_{TRN}^{i_{TX}}(nT_s - t_{TRN}),\ 1 \le i_{TX} \le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $t_{EDMG\text{-}CEF} = T_{EDMG\text{-}STF}$ | is the duration of the EDMG-STF field of the PPDU |
| $t_{Data} = t_{EDMG\text{-}CEF} + T_{EDMG\text{-}CEF}$ | is the total duration of the EDMG-STF and the EDMG-CEF fields of the PPDU |
| $t_{TRN} = t_{Data} + T_{Data}$ | is the total duration of the EDMG-STF, the EDMG-CEF, and Data fields of the PPDU |

For an EDMG A-PPDU transmission of $N_{PPDU}$ PPDUs, the EDMG modulated field of the EDMG preamble, Data field, and TRN field of an SU PPDU is defined for $i_{TX}$th transmit chain at the $F_s$ sampling rate, sample time duration $T_s$ and includes the following modulated fields:

$$
\begin{aligned}
& r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}}(nT_s) = r_{EDMG\text{-}STF}^{i_{TX}}(nT_s) + r_{EDMG\text{-}CEF}^{i_{TX}}(nT_s - t_{EDMG\text{-}CEF}) \\
& + r_{Data_1}^{i_{TX}}(nT_s - t_{Data_1}) \\
& + r_{EDMG\text{-}Header\text{-}A_2}^{i_{TX}}(nT_s - t_{EDMG\text{-}Header\text{-}A_2}) + r_{Data_2}^{i_{TX}}(nT_s - t_{Data_2}) \\
& + \ldots \\
& + r_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}^{i_{TX}}\left(nT_s - t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}\right) + r_{Data_{N_{PPDU}}}^{i_{TX}}\left(nT_s - t_{Data_{vN_{PPDU}}}\right) \\
& + r_{TRN}^{i_{TX}}(nT_s - t_{TRN}),\ 1 \le i_{TX} \le N_{TX}
\end{aligned}
$$

where

| | |
|---|---|
| $t_{EDMG\text{-}CEF} = T_{EDMG\text{-}STF}$ | is the duration of the EDMG-STF field of the PPDU |
| $t_{DATA_1} = t_{EDMG\text{-}CEF} + T_{EDMG\text{-}CEF}$ | is the total duration of the EDMG-STF and EDMG-CEF fields of the PPDU |

$t_{EDMG\text{-}Header\text{-}A_2} = t_{Data_1} + T_{Data_1}$ is the total duration of the EDMG-STF, EDMG-CEF, and $Data_1$ fields of the PPDU

$t_{Data_2} = t_{EDMG\text{-}Header\text{-}A_2} + T_{EDMG\text{-}Header\text{-}A_2}$
is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, and EDMG-Header-$A_2$ fields of the PPDU

…

$t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} = t_{Data_{N_{PPDU}-1}} + T_{Data_{N_{PPDU}-1}}$
is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, and $Data_{NPPDU-1}$ fields of the PPDU

$t_{Data_{N_{PPDU}}} = t_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}} + T_{EDMG\text{-}Header\text{-}A_{N_{PPDU}}}$
is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU-1}$, and EDMG-Header-$A_{NPPDU}$ fields of the PPDU

$t_{TRN} = t_{Data_{N_{PPDU}}} + T_{Data_{N_{PPDU}}}$ is the total duration of the EDMG-STF, EDMG-CEF, $Data_1$, EDMG-Header-$A_2$, $Data_2$, …, $Data_{NPPDU-1}$, EDMG-Header-$A_{NPPDU}$, and $Data_{NPPDU}$ fields of the PPDU

The EDMG OFDM mode SU PPDU waveform for the $i_{TX}{}^{th}$ transmit chain concatenates the pre-EDMG, EDMG preamble, Data field and TRN field, with DC relative shift applied to the EDMG modulated fields as described in 28.6.2.3, and shall be defined as follows:

$$r_{PPDU}^{i_{TX}}\left(nT_s\right) = r_{pre\text{-}EDMG}^{i_{TX}}\left(nT_s\right) + r_{EDMG\text{-}Pream,\,Data,\,TRN}^{i_{TX}}\left(nT_s - t_{EDMG}\right)\cdot e^{j2\pi(f_{DC}-f_c)\cdot nT_s}, 1 \le i_{TX} \le N_{TX}$$

where

$t_{EDMG} = T_{pre\text{-}EDMG}$ is the total duration of the L-STF, the L-CEF, the L-Header, and the EDMG-Header-A fields of the PPDU

$f_c$ is the center frequency of the carrier

$f_{DC}$ is the DC subcarrier frequency defined in 28.6.2.3

The definition of the pulse shaping filter impulse response, $h_{SC\,CB}$, used for the transmission of the pre-EDMG modulated fields is implementation specific and beyond the scope of this standard.

### 28.6.10.4 EDMG MU PPDU transmission

#### 28.6.10.4.1 General

An EDMG OFDM mode MU PPDU transmission over a 2.16 GHz, 4.32 GHz, 6.48 GHz, 8.64 GHz, or 2.16+2.16 GHz channel with single and multiple space-time streams ($1 \le i_{STS} \le N_{STS}$) is composed of pre-EDMG, EDMG preamble, Data field and TRN field.

The pre-EDMG modulated fields of the PPDU includes the L-STF, L-CEF, L-Header, and EDMG-Header-A and shall be transmitted using SC modulation as defined in 28.5.10.4.4.2. The EDMG-STF, EDMG-CEF, EDMG-Header-B, Data field, and TRN field shall be transmitted using OFDM modulation as defined in 28.6.4, 28.6.5, 28.6.6, 28.6.9, and 28.9.2.2.5, respectively.

The total number of transmit chains, $N_{TX}$, shall be constant over the different fields of a transmitted EDMG MU PPDU.

#### 28.6.10.4.2 Pre-EDMG modulated fields transmission

See 28.5.10.4.4.2. The upsampling factor shall be equal to $N_{up} = (3/2) \times N_{CB}$.

#### 28.6.10.4.3 EDMG preamble, Data field, and TRN field transmission

The EDMG preamble, Data field, and TRN field of an MU PPDU is defined for the $i_{TX}$th transmit chain at the $F_s$ sampling rate and sample time duration $T_s$ and includes the following modulated fields:

$$r^{i_{TX}}_{EDMG\text{-}Pream,\,Data,\,TRN}\left(nT_s\right) = r^{i_{TX}}_{EDMG\text{-}STF}\left(nT_s\right) + r^{i_{TX}}_{EDMG\text{-}CEF}\left(nT_s - t_{EDMG\text{-}CEF}\right)$$
$$+ r^{i_{TX}}_{EDMG\text{-}Header\text{-}B}\left(nT_s - t_{EDMG\text{-}Header\text{-}B}\right) + r^{i_{TX}}_{Data}\left(nT_s - t_{Data}\right) + r^{i_{TX}}_{TRN}\left(nT_s - t_{TRN}\right),\ 1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $t_{EDMG\text{-}CEF} = T_{EDMG\text{-}STF}$ | is the duration of the EDMG-STF field of the PPDU |
| $t_{EDMG\text{-}Header\text{-}B} = t_{EDMG\text{-}CEF} + T_{EDMG\text{-}CEF}$ | is the total duration of the EDMG-STF and EDMG-CEF fields of the PPDU |
| $t_{Data} = t_{EDMG\text{-}Header\text{-}B} + T_{EDMG\text{-}Header\text{-}B}$ | is the total duration of the EDMG-STF, EDMG-CEF, and EDMG-Header-B fields of the PPDU |
| $t_{TRN} = t_{Data} + T_{Data}$ | is the total duration of the EDMG-STF, EDMG-CEF, EDMG-Header-B, and Data fields of the PPDU |

The Data field of an MU PPDU shall be modulated using $N_{SYM\ i_{user}}$ OFDM symbols for the $i_{user}$th user as defined in 28.6.9.

The EDMG OFDM mode MU PPDU waveform for the $i_{TX}$th transmit chain concatenates the pre-EDMG, EDMG preamble, Data field and TRN field, with DC relative shift applied to the EDMG modulated fields as described in 28.6.2.3, and shall be defined as follows:

$$r^{i_{TX}}_{PPDU}\left(nT_s\right) = r^{i_{TX}}_{pre\text{-}EDMG}\left(nT_s\right) + r^{i_{TX}}_{EDMG\text{-}Pream,\,Data,\,TRN}\left(nT_s - t_{EDMG}\right) \cdot e^{j2\pi\left(f_{DC} - f_c\right) \cdot nT_s},1 \le i_{TX} \le N_{TX}$$

where

| | |
|---|---|
| $t_{EDMG} = T_{pre\text{-}EDMG}$ | is the total duration of the L-STF, the L-CEF, the L-Header, and the EDMG-Header-A fields of the PPDU |
| $f_c$ | is the center frequency of the carrier |
| $f_{DC}$ | is the DC subcarrier frequency defined in 28.6.2.3 |

The definition of the pulse shaping filter impulse response, $h_{SC\ CB}$, used for the transmission of the pre-EDMG modulated fields is implementation specific and beyond the scope of this standard.

### 28.6.11 Performance requirements

#### 28.6.11.1 Transmit requirements

#### 28.6.11.1.1 Transmit modulation accuracy (EVM) test and requirements

This subclause specifies the EVM test and corresponding requirements for PPDUs transmitted with the TXVECTOR parameter EDMG_MODULATION equal to EDMG_OFDM_MODE and TXVECTOR parameters CH_BANDWIDTH and CHANNEL_AGGREGATION equal to any valid combination indicated in Table 28-21, Table 28-22, or Table 28-23.

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted signals into a stream of complex samples at sampling rate greater than or equal to the OFDM sampling rate $F_s$. The TXVECTOR parameters NUM_STS and NUM_TX_CHAINS shall be equal, and the value of both parameters shall be equal to the number of utilized testing instrumentation input ports or antennas. Each port or antenna of the transmitting STA, which is connected to a transmit chain, shall be assigned to a port or antenna of the testing instrumentation in a way that makes signal coupling between the different transmit signal paths negligible. In the test, $N_{SS} = N_{STS}$ (i.e., no STBC) shall be used. If the TXVECTOR parameter NUM_STS is set to a value greater than 1, the two or more space-time streams shall have the same modulation type.

The instrumentation used shall have sufficient accuracy in terms of I/Q arm amplitude and phase balance, DC offsets, phase noise, and analog-to-digital quantization noise, so as not to mask or degrade the true EVM measurement. A possible embodiment of such a setup is converting the signals to a low IF frequency with a microwave synthesizer, sampling the signal with a digital oscilloscope and decomposing it digitally into quadrature components. The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps, or equivalent procedure:

- Detect the start of the PPDU.
- Establish fine timing.
- Estimate coarse and fine frequency offsets.
- De-rotate the symbols in the PPDU according to the estimated frequency offset.
- Estimate the complex channel for each of the subcarriers and each of the spatial streams using the EDMG-CEF field.
- For each of the OFDM symbols: transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers, de-rotate the subcarrier values according to the estimated phase, group the results from all RF chains in each subcarrier to a vector, and multiply the vector by an equalization matrix generated from the estimated channel.
- For each data-carrying subcarrier and each spatial stream, find the closest constellation point and compute the Euclidean distance from it.
- Compute the average relative constellation RMS error (EVM) across PPDUs according to the formula:

$$EVM = 20\log_{10}\left(\frac{1}{N_f}\sum_{f=1}^{N_f}\sqrt{\frac{\sum_{n=0}^{N_{SYMS}-1}\sum_{j=1}^{N_{SS}}\sum_{k\epsilon M_d(k)}\left(I(f,n,j,k)-I^*(f,n,j,k)\right)^2+\left(Q(f,n,j,k)-Q^*(f,n,j,k)\right)^2}{N_{SYMS}\times N_{SS}\times N_{SD}\times P_0}}\right)$$

where

$N_f$ is the number of frames for the measurement
$N_{SYMS}$ is the number of OFDM symbols
$N_{SS}$ is the number of spatial streams
$M_d(k)$ is set of data subcarriers defined in 28.6.2.5
$N_{SD}$ is the number of data subcarriers
$P_0$ is the average power of the constellation
$I(f,n,j,k)$ and $Q(f,n,j,k)$
denote the observed symbol point in the complex plane for the $k^{th}$ subcarrier of the $n^{th}$ OFDM symbol and $j^{th}$ spatial stream within the $f^{th}$ frame
$I^*(f,n,j,k)$ and $Q^*(f,n,j,k)$
denote the ideal symbol point in the complex plane for the $k^{th}$ subcarrier of the $n^{th}$ OFDM symbol and $j^{th}$ spatial stream within the $f^{th}$ frame

The total number of symbol points used in the test, which is equal to $N_f \times N_{SYMS} \times N_{SS} \times N_{SD}$, shall be at least 1000, with the constraint that $N_{SYMS}$ shall be at least 16 and that $N_f$ shall be at least 20. Random data shall be used for the symbols and frames.

The EVM shall not exceed an MCS dependent value provided in Table 28-73. If the TXVECTOR parameter CHANNEL_AGGREGATION is set to AGGREGATE, the transmission in the two 2.16 GHz channels or 4.32 GHz channels may be tested independently. In this case, the transmit modulation accuracy of each 2.16 GHz channel or of each 4.32 GHz channel shall meet the required value in Table 28-73.

**Table 28-73—EVM requirement for the EDMG OFDM mode**

| MCS | EVM value (dB) |
|---|---|
| 1 | –7 |
| 2 | –9 |
| 3 | –10 |
| 4 | –12 |
| 5 | –13 |
| 6 | –10 |
| 7 | –11 |
| 8 | –12 |
| 9 | –14 |
| 10 | –15 |
| 11 | –15 |
| 12 | –16 |
| 13 | –17 |
| 14 | –18 |
| 15 | –19 |
| 16 | –21 |
| 17 | –22 |
| 18 | –23 |
| 19 | –25 |
| 20 | –27 |

### 28.6.11.1.2 Time of Departure accuracy

The Time of Departure accuracy test evaluates TIME_OF_DEPARTURE against aTxPHYTxStartRMS and aTxPHYTxStartRMS against TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH as defined in Annex P with the following test parameters:

— MULTICHANNEL_SAMPLING_RATE is set to aDMGChipRate.
— FIRST_TRANSITION_FIELD is L-STF of the waveform transmitted in the primary channel.

— SECOND_TRANSITION_FIELD is L-CEF of the waveform transmitted in the primary channel.
— TRAINING_FIELD is L-CEF of the waveform transmitted in the primary channel.
— TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH is set to aDMGTimeOfDepartureAccuracyThresh.

#### 28.6.11.2 Receive requirements

CCA sensitivity requirements are defined in 28.3.8.

### 28.7 EDMG transmit procedure

This subclause defines the PHY transmit procedure for EDMG and non-EDMG duplicate format. The format selection is performed based on the FORMAT parameter of the PHY-TXSTART.request(TXVECTOR) primitive.

There are two paths for the transmit PHY procedure:

— The first path is selected if the FORMAT parameter is EDMG. In this case, the modulation is defined by EDMG_MODULATION parameter. If EDMG_MODULATION parameter is set to EDMG_C_MODE, EDMG_SC_MODE, or EDMG_OFDM_MODE, then it indicates EDMG control mode, EDMG SC mode, or EDMG OFDM mode defined in 28.4, 28.5, and 28.6, respectively. An example of the EDMG PHY transmit procedure provided in this subclause does not include optional features like EDMG A-PPDU, SU with multiple space-time streams, STBC, Dual Stream DCM BPSK, DCM π/2-BPSK and MU transmission.
— The second path is selected if the FORMAT parameter is non-EDMG. In this case, the modulation is defined by NON_EDMG_MODULATION parameter. If NON_EDMG_MODULATION is set to DMG_C_MODE or DMG_SC_MODE, then it indicates control mode or SC mode defined in Clause 20, respectively. If NON_EDMG_MODULATION is set to NON_EDMG_DUP_C_MODE or NON_EDMG_DUP_SC_MODE, then it indicates non-EDMG duplicate control mode or non-EDMG duplicate SC mode defined in 28.4 and 28.5, respectively.

In both paths, in order to transmit data, the MAC generates a PHY-TXSTART.request primitive, which causes the PHY entity to enter the transmit state. Further, the PHY is set to operate at the appropriate frequency through station management via the PLME as specified in EDMG PLME. Other transmit parameters, such as EDMG-MCS, PSDU Length, and others are set via the PHY SAP using the PHY-TXSTART.request(TXVECTOR) primitive, as described in 28.2.

The PHY indicates the state of the 2.16 GHz primary channel and any secondary channels, including 2.16 GHz Secondary, 2.16 GHz secondary1, and 2.16 GHz secondary2 via a PHY-CCA.indication primitive as defined in 8.3.5.12. Transmission of the PPDU shall be initiated by the PHY after receiving the PHY-TXSTART.request(TXVECTOR) primitive. The TXVECTOR parameters for the PHY-TXSTART.request primitive are specified in 28.2.2 (Table 28-1).

Figure 28-35 shows PHY transmit procedure for EDMG_C_MODE mode with schematic diagram of primitives exchange between the MAC and PHY layers through PHY SAP interface. Figure 28-36 shows PHY transmit procedure for SU PPDU format for EDMG_SC_MODE or EDMG_OFDM_MODE. The fields of the PPDU highlighted by dotted line might not be present for some particular parameters configuration.

The EDMG-STF and EDMG-CEF fields are not transmitted if EDMG_MODULATION parameter is set to EDMG_C_MODE.

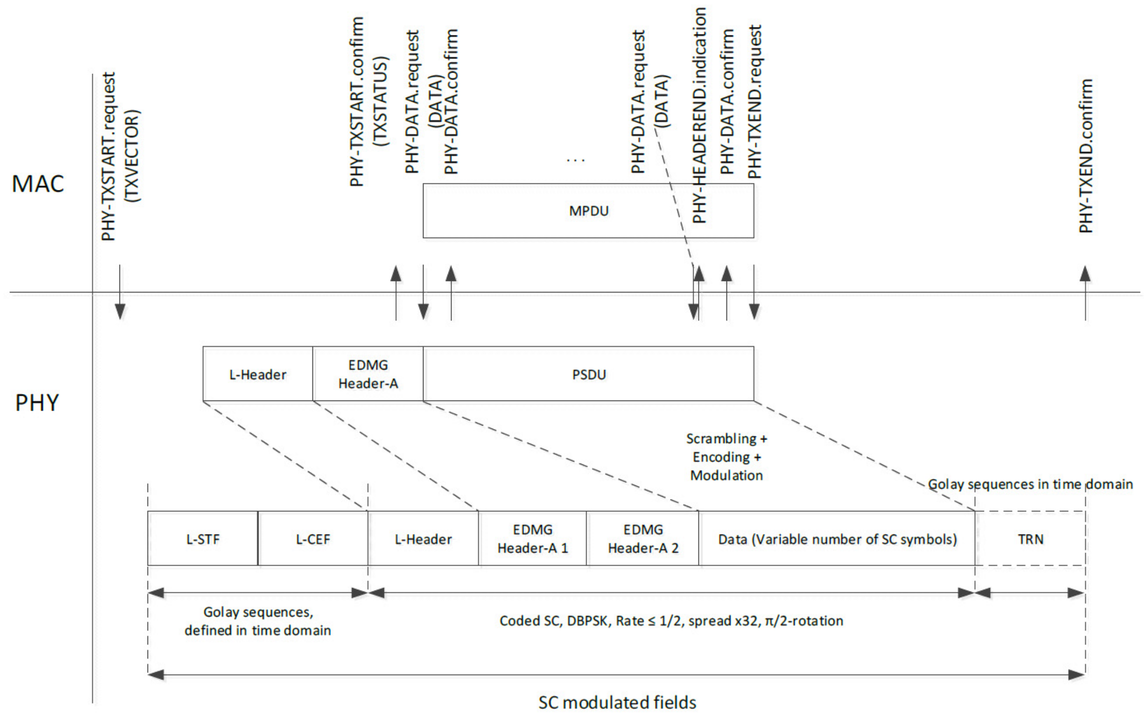


**Figure 28-35—PHY transmit procedure for the control mode**

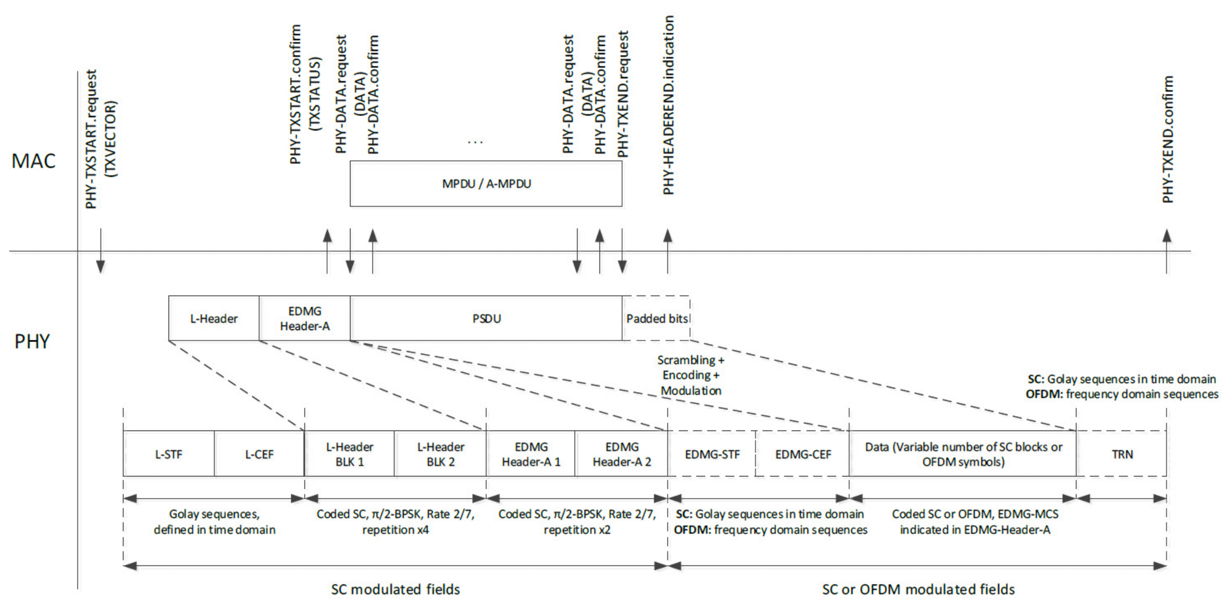


**Figure 28-36—PHY transmit procedure for the SU SC and OFDM modes**

The EDMG-STF and EDMG-CEF fields are not transmitted if the number of bits set to 1 in the CH_BANDWIDTH parameter is equal to 1, EDMG_MODULATION parameter is set to EDMG_SC_MODE, the number of space-time streams NUM_STS is set to 1, and STBC is set to 0 [see 28.2.2 (Table 28-1)].

The TRN field is not transmitted if EDMG_TRN_LEN is 0 [see 28.2.2 (Table 28-1)] or, as defined in 10.12.7, if EDMG_TRN_LEN is set to a value greater than 0, BEAM_TRACKING_REQUEST is set to 0, EDMG_BEAM_TRACKING_REQUEST is set to 1, and EDMG_PPDU_TYPE is set to EDMG-TRN-R. It may also not be transmitted if EDMG_TRN_LEN > 0 and beam tracking request was initiated (see 28.9).

NOTE 1—This procedure does not describe the operation of optional features, such as A-PPDU, SU multiple space-time streams, STBC, DCM BPSK, DCM π/2-BPSK, and MU transmission.

The PHY entity performs TXVECTOR parsing to extract the transmission parameters and build up the L-Header and EDMG-Header-A bit content. It computes CRC per each header separately.

If the EDMG_MODULATION parameter is set to EDMG_C_MODE, all fields are transmitted using SC modulation. The L-STF and L-CEF fields are transmitted using π/2-BPSK modulated Golay complementary sequences defined in time domain as specified in 20.4.3.1.2 and 20.4.3.1.3, respectively. The L-Header, EDMG-Header-A composed of two parts EDMG-Header-$A_1$ and EDMG-Header-$A_2$, and data (PSDU) are transmitted by applying scrambling, LDPC code with effective rate less or equal to 1/2, DBPSK modulation, 32× spreading applying Golay sequences, and π/2-rotation as defined in 28.4.5.2. The TRN field is transmitted using π/2-BPSK modulated Golay complementary sequences in time domain as defined in 28.9.2.2.5.

If the EDMG_MODULATION parameter is set to EDMG_SC_MODE or EDMG_OFDM_MODE, the L-STF, L-CEF, L-Header, and EDMG-Header-A are transmitted using SC modulation. The rest of the frame, including EDMG-STF, EDMG-CEF, Data (PSDU), and TRN field can be transmitted using SC or OFDM modulation.

The L-STF and L-CEF fields are transmitted using π/2-BPSK modulated Golay complementary sequences defined in time domain as specified in 28.3.3.2.2 and 28.3.3.2.3, respectively. The L-Header is transmitted by applying LDPC code with effective rate 2/7, π/2-BPSK modulation, and codeword repetition 4× times. The transmission of L-Header occupies two SC symbol blocks. The EDMG-Header-A is transmitted by applying the LDPC code with effective rate 2/7, π/2-BPSK modulation, and codeword repetition 2× times. It is composed of two parts: EDMG-Header-$A_1$ and EDMG-Header-$A_2$. The transmission of EDMG-Header-A occupies two SC symbol blocks.

The SC symbol blocks used for the L-Header and EDMG-Header-A transmission are prepended with Guard Intervals (GIs). The extra GI is inserted at the end of EDMG-Header-$A_2$ block. This creates the blocking structure when each SC symbol block is surrounded by two GIs. The GI is defined using π/2-BPSK modulated Golay sequence in time domain as specified in 28.5.9.1.

If the EDMG_MODULATION parameter is set to EDMG_SC_MODE, the EDMG-STF and EDMG-CEF are defined using π/2-BPSK modulated Golay complementary sequences in time domain as specified in 28.6.4 and 28.6.5, respectively. The data (PSDU) is padded and scrambled to get an integer number of LDPC codewords and SC symbol blocks and then encoded as defined in 28.5.9.4. The encoded bits are modulated as defined in 28.5.9.5. The modulated symbols are grouped into the SC symbol blocks and prepended with GIs as defined in 28.5.9.2. The extra GI is inserted at the end of last SC symbol block. This creates the blocking structure when each SC symbol block is surrounded by two GIs. The GI is defined using π/2-BPSK modulated Golay sequence in time domain as specified in 28.5.9.1. The TRN field is defined using π/2-BPSK modulated Golay complementary sequences in time domain as specified in 28.9.2.2.5.

If the EDMG_MODULATION parameter is set to EDMG_OFDM_MODE, the EDMG-STF and EDMG-CEF are defined using 4-PSK modulated sequences in frequency domain as specified in EDMG-STF definition and EDMG-CEF definition, respectively. The data (PSDU) is padded and scrambled to get an integer number of LDPC codewords and OFDM symbols and then encoded as defined in 28.6.9.2. The encoded bits are modulated as defined in 28.6.9.3. The modulated symbols are grouped into the OFDM data blocks, supplemented with pilots and converted to time domain applying IDFT. The OFDM symbol in time domain is prepended with GI, which is in fact a cyclic extension of OFDM symbol.

Transmission of the PHY preamble may start if TIME_OF_DEPARTURE_REQUESTED is false, and shall start immediately if TIME_OF_DEPARTURE_REQUESTED is true, based on the parameters passed in the PHY-TXSTART.request primitive.

The PHY layer shall issue a PHY-TXSTART.confirm primitive to the MAC in response to the PHY-TXSTART.request(TXVECTOR) primitive when it is ready to receive an MPDU/A-MPDU from the MAC layer. The receipt of this primitive by the MAC entity causes the MAC to start the transfer of data octets.

The PHY-TXSTART.confirm(TXSTATUS) primitive shall contain the TXSTATUS vector defined in Table 20-2, if the conditions below are met:

— If dot11TODImplemented and dot11TODActivated are both true or dot11TimingMsmtActivated is true; and the parameter TIME_OF_DEPARTURE_REQUESTED in the TXVECTOR specified in the PHY-TXSTART.request is true, then the PHY shall include the TIME_OF_DEPARTURE corresponding to the time when the first frame energy is sent by the transmitting port and TIME_OF_DEPARTURE_ClockRate parameters in the TXSTATUS vector (see Table 20-2).
— If dot11TimingMsmtActivated is true, then the PHY shall include TX_START_OF_FRAME_OFFSET in the TXSTATUS vector (see Table 20-2).

Once a PHY-TXSTART.confirm primitive is issued, the MAC initiates data (MPDU octets) exchange with the PHY entity. The data shall be exchanged between the MAC and the PHY through a series of PHY-DATA.request(DATA) primitives issued by the MAC, and PHY-DATA.confirm primitives issued by the PHY.

If TIME_OF_DEPARTURE_REQUESTED is true, the PHY entity shall generate the PHY-TXHEADEREND.indication primitive at the end of transmission of the last symbol containing the PHY EDMG-Header-A for an SU PPDU and the last symbol containing the PHY EDMG-Header-B for an MU PPDU. The receipt of this primitive by the MAC entity causes the MAC to record the time when this primitive is received.

Transmission can be prematurely terminated by the MAC through the PHY-TXEND.request primitive. The PSDU transmission is terminated by receiving a PHY-TXEND.request primitive. Each PHY-TXEND.request primitive is acknowledged with a PHY-TXEND.confirm primitive from the PHY. In an SU transmission, normal termination occurs after the transmission and confirmation of the last PSDU octet.

Once the PPDU transmission is completed the PHY entity issues PHY-TXEND.confirm primitive and enters the receive state.

A typical transmit state machine for an SU transmission with NUM_STS = 1 and no TRN field is shown in Figure 28-37.

NOTE 2—PSDU encoding and modulation can be started in parallel with preamble transmission and depends on the particular hardware pipeline implementation.

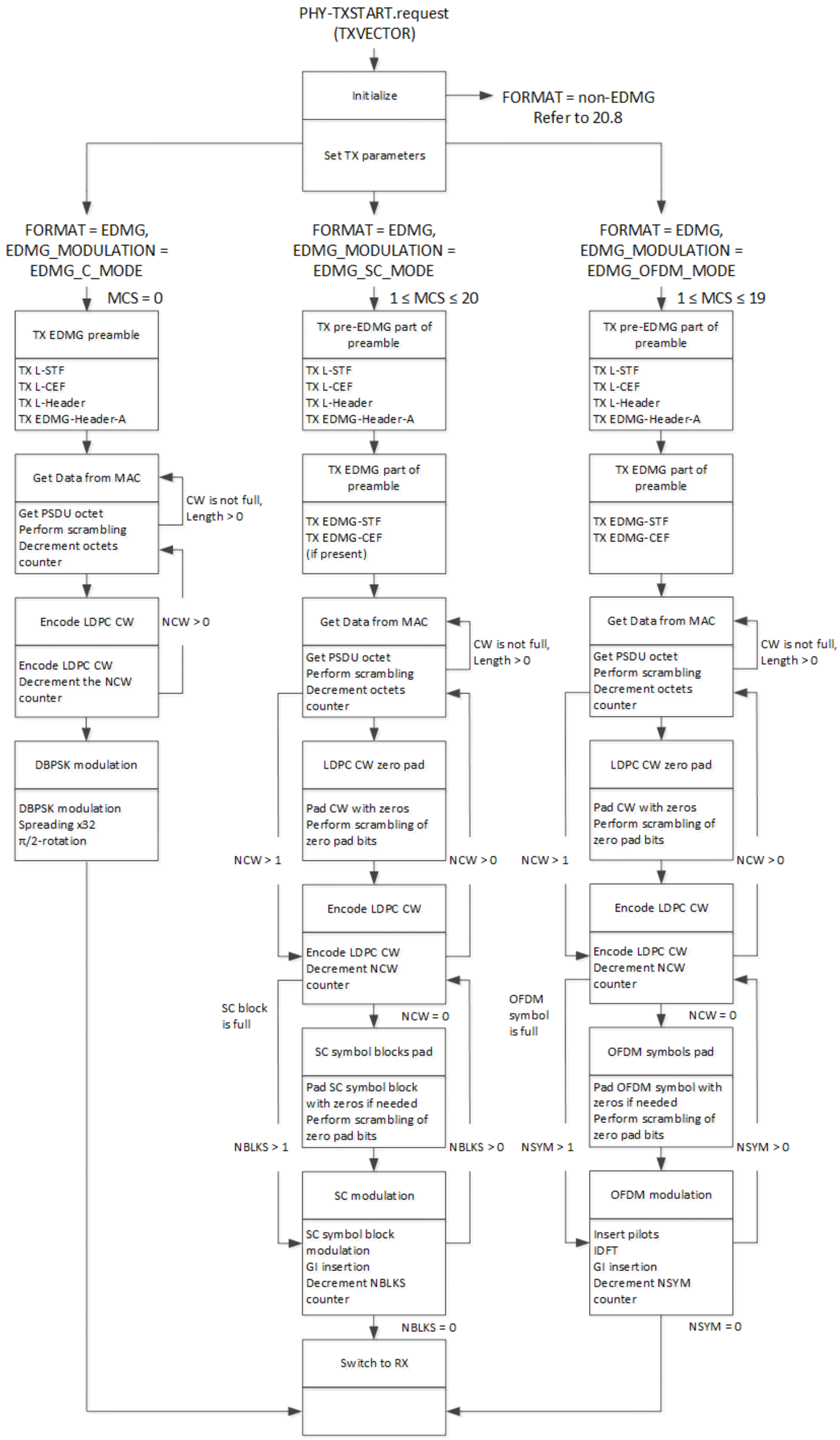


**Figure 28-37—PHY transmit state machine for SU transmission (NUM_STS = 1 and no TRN field)**

## 28.8 EDMG receive procedure

This subclause defines the PHY receive procedure for the EDMG format. The receive procedure for the non-EDMG duplicate format is defined in 20.9.

Figure 28-38 shows the PHY receive procedure for the EDMG_C_MODE mode with a schematic diagram of primitives exchange between the MAC and PHY layers through PHY SAP interface. Figure 28-39 shows the PHY receive procedure for an SU PPDU format for the EDMG_SC_MODE or the EDMG_OFDM_MODE. The fields of the PPDU highlighted by dotted line might not be present for some particular parameters configuration.

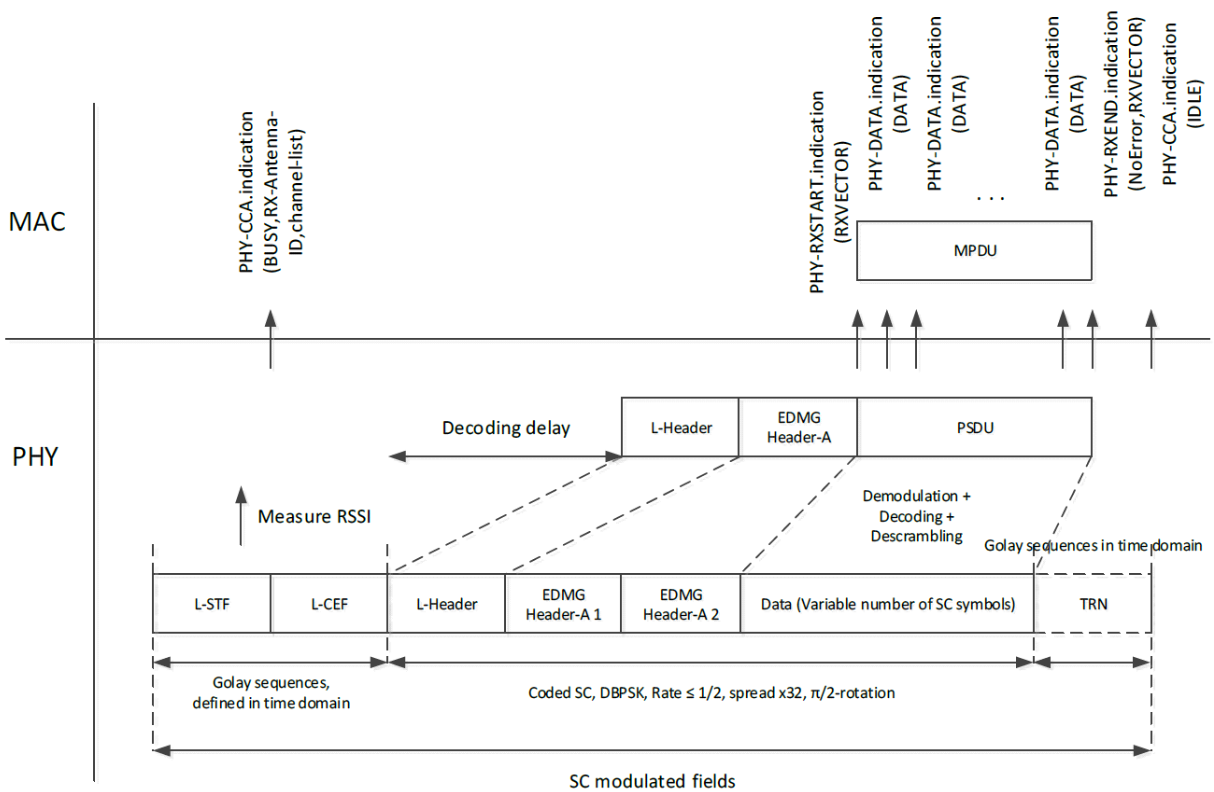


**Figure 28-38—PHY receive procedure for the EDMG control mode**

NOTE—This procedure does not describe the operation of optional features, such as A-PPDU, SU multiple space-time streams, STBC, DCM BPSK, DCM π/2-BPSK, and MU reception.

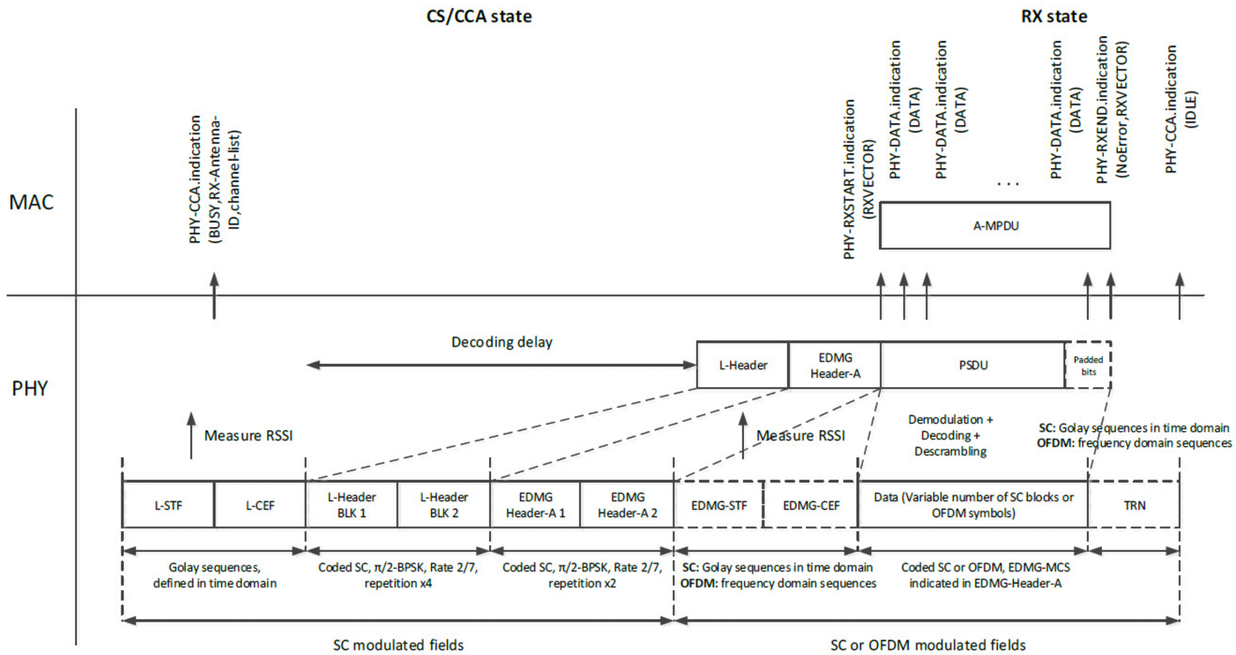


**Figure 28-39—PHY receive procedure for the SU EDMG SC and SU EDMG OFDM modes**

Upon receiving the transmitted PHY preamble over the primary 2.16 GHz channel, the PHY measures a receive signal strength. The PHY indicates this activity to the MAC by issuing a PHY-CCA.indication primitive. A PHY-CCA.indication(BUSY, RX-Antenna-ID, channel-list) primitive is also issued as an initial indication of reception of a signal as defined in 8.3.5.12. The channel-list parameter of the CCA-PHY.indication primitive is absent when the operating channel width is 2.16 GHz. The channel-list parameter is present and includes the element primary when operating channel width is 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz. The RX-Antenna-ID parameter is present if the PHY entity has more than one active RX chain and the CCA sensitivity condition defined in 28.3.8 applies to any DMG antenna connected to an active receive chain.

The PHY includes the most recently measured RSSI value in the PHY-RXSTART.indication(RXVECTOR) primitive issued to the MAC.

After the PHY-CCA.indication(BUSY, channel-list) primitive is issued, the PHY entity shall continue receiving the pre-EDMG part of the PPDU, including L-STF, L-CEF, L-Header, and EDMG-Header-A fields.

For an EDMG control mode PPDU, the L-Header contains the channel bandwidth indication field, the EDMG-Header-A indication field that indicates that the PPDU is an EDMG control mode PPDU, and the control trailer indication field as defined in 28.3.3.2.4 (Table 28-5 and Table 28-6).

For an EDMG SC or EDMG OFDM mode PPDU, the L-Header contains the IsSC field indicating the EDMG SC or EDMG OFDM modulation type, the IsSISO field indicating the single or multiple spatial streams transmission, the GI length field indicating the type of GI used for the data (PSDU) transmission, and the compressed bandwidth indication as defined in 28.3.3.2.4 (Table 28-7, Table 28-8, and Table 28-9).

If the check of the L-Header CRC bits is not valid, a PHY-RXSTART.indication primitive is not issued, and instead the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation) primitive. If a check of the L-Header CRC bits is valid, the EDMG PHY shall maintain the PHY-CCA.indication(BUSY, channel-list) primitive for the predicted duration of the transmitted PPDU, as defined by RXTIME parameter, for all supported modes, unsupported modes, and invalid EDMG-Header-A CRC.

If the check of the EDMG-Header-A CRC bits is not valid, a PHY-RXSTART.indication primitive is not issued, and instead the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation) primitive. For an EDMG STA, if the EDMG-Header-A indicates an unsupported mode, the PHY shall issue a PHY-RXEND.indication(UnsupportedRate) primitive.

After receiving a valid L-Header and EDMG-Header-A indicating a supported mode, the PHY entity shall begin reception of the EDMG portion of the PPDU. For an EDMG STA and EDMG control mode PPDU, the EDMG portion of the PPDU includes the data (PSDU) and possible TRN field as defined in 28.4.

For an EDMG STA and EDMG SC mode PPDU, if the SU/MU Format field in the EDMG-Header-A indicates an SU PPDU, the Number of SS field indicates a single spatial stream, the STBC Applied field is 0, and the BW field indicates a single 2.16 GHz channel, then the EDMG part of the frame includes data (PSDU) and possibly a TRN field.

For an EDMG STA and EDMG SC mode PPDU, if the SU/MU Format field in the EDMG-Header-A indicates an SU PPDU and the Number of SS field indicates multiple spatial streams, or STBC Applied field is 1, or the BW field indicates 4.32 GHz, 6.48 GHz, 8.64 GHz, 2.16+2.16 GHz, or 4.32+4.32 GHz channel, then the EDMG part of the frame includes EDMG-STF, EDMG-CEF, data (PSDU), and possibly a TRN field as defined in 28.5.

For an EDMG STA and EDMG OFDM mode PPDU, if the SU/MU Format field in the EDMG-Header-A indicates an SU PPDU, then the EDMG part of the frame includes EDMG-STF, EDMG-CEF, data (PSDU), and possibly a TRN field as defined in 28.6.

For an EDMG STA and EDMG SC or OFDM mode PPDU, if the SU/MU Format field in the EDMG-Header-A indicates an MU PPDU, then the EDMG part of the frame includes EDMG-STF, EDMG-CEF, EDMG-Header-B, data (PSDU), and possibly a TRN field as defined in 28.5 and 28.6.

If an MU PPDU is indicated in the EDMG-Header-A, the EDMG STA verifies the AIDs included into the SS descriptors. If there is no match between the STA's AID and one included in any of the SS descriptors, then PHY shall issue a PHY-RXEND.indication(Filtered) primitive. If AID verification is successful, then the STA continues with EDMG-Header-B decoding.

If the check of the EDMG-Header-B CRC bits is not valid, a PHY-RXSTART.indication primitive is not issued, and instead the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation) primitive. For an EDMG STA, if the EDMG-Header-B indicates an unsupported mode, the PHY shall issue a PHY-RXEND.indication(UnsupportedRate) primitive.

For successful decoding of the L-Header, the EDMG-Header-A, and the EDMG-Header-B (for MU only), the PHY shall issue a PHY-RXSTART.indication(RXVECTOR) primitive to the MAC containing the RXVECTOR parameters as defined in 28.2.2 (Table 28-1).

After successful decoding of the header fields, the PHY performs decoding of the PSDU and initiates the series of PHY-DATA.indication(DATA) primitive exchanges. The decoded PSDU bits are assembled into octets and any pad bits added at the stage of encoding are discarded. If the PSDU decoding is successful, then the PHY shall issue the PHY-RXEND.indication(NoError, RXVECTOR) primitive.

If signal loss occurs during reception prior to completion of the PPDU reception, the error condition shall be reported to the MAC using a PHY-RXEND.indication(CarrierLost) primitive. After waiting for the intended end of the PPDU as determined by the RXTIME parameter, including possibly a TRN field, the PHY shall generate a PHY-CCA.indication(IDLE) primitive and return to the IDLE state. If the decoding of the L-Header is unsuccessful, then the RXTIME parameter cannot be determined. In this case, the PHY-CCA(BUSY) shall be maintained as long as the detected energy is 20 dB above the minimum sensitivity for a 2.16 GHz PPDU using the SC MCS 1. The PHY entity shall switch to the IDLE state immediately after the energy drops below the specified threshold.

A typical receive state machine for an SU PPDU reception with NUM_STS = 1 and no TRN field is shown in Figure 28-40.

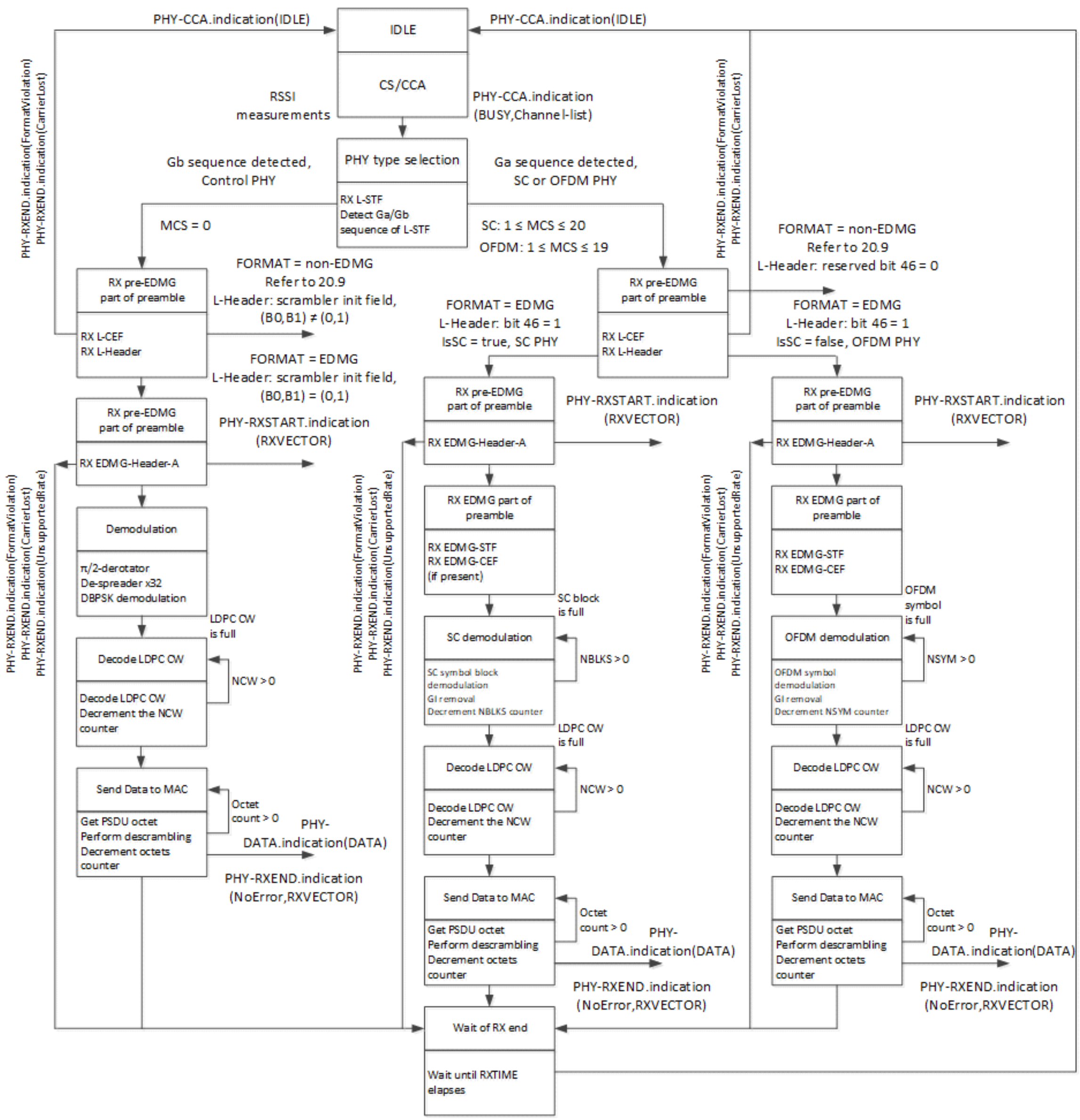


**Figure 28-40—PHY receive state machine for an SU PPDU reception (NUM_STS = 1, no TRN field)**

For an EDMG STA and EDMG and non-EDMG control mode PPDUs, the RXTIME parameter shall be computed using the Length and Training Length fields defined in the L-Header (see Table 20-11). The minimum value for the Length field is equal to 14 octets, with the exception for the Short SSW PPDU where the minimum value for the Length field is equal to 6 octets, and the Training Length (*TRN_LEN*) can be equal to 0. In the latter case, the TRN field is not appended to the PPDU.

The RXTIME parameter shall be defined in microseconds as follows:

$$RXTIME\ (\mu s) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header+Data} + T_{TRN}$$

where

$T_{L\text{-}STF}$ = 6400 × aDMGChipTimeDuration ~ 3.63 µs

$T_{L\text{-}CEF}$ = 1152 × aDMGChipTimeDuration ~ 0.65 µs

$T_{L\text{-}Header+Data} = ((Length + L_{L\text{-}Header}) \times 8 + 168 \times N_{CW}) \times 32 \times$ aDMGChipTimeDuration µs

$$N_{CW} = 1 + \left\lceil \frac{(Length - 6) \times 8}{168} \right\rceil$$

$L_{L\text{-}Header} = 5$

$T_{TRN} = (4992 \times TRN\_LEN) \times$ aDMGChipTimeDuration µs

For an EDMG and non-EDMG PPDU transmission, the RXTIME computation using the above equation shall cause a spoofing error less than or equal to 0.15 µs, except for PPDU durations between 347.56 µs and 347.93 µs and between 349.10 µs and 350.76 µs where the maximum spoofing error can be 0.37 µs and 1.66 µs, respectively, as defined in 28.3.3.2.4.1. Spoofing error is defined as the difference between the PPDU duration calculated based on the L-Header and the actual PPDU duration.

For an EDMG STA and EDMG and non-EDMG SC mode PPDUs, the RXTIME parameter shall be computed using the Base MCS, Length, Extended SC MCS Indication, and Training Length fields of the L-Header (see Table 20-13).

The RXTIME parameter shall be defined in microseconds as follows:

$$RXTIME\ (\mu s) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + T_{Data} + T_{TRN}$$

where

$T_{L\text{-}STF}$ = 2176 × aDMGChipTimeDuration ~ 1.24 µs

$T_{L\text{-}CEF}$ = 1152 × aDMGChipTimeDuration ~ 0.65 µs

$T_{L\text{-}Header}$ = 1024 × aDMGChipTimeDuration µs ~ 0.58 µs

$T_{Data} = (N_{BLKS} \times 512 + 64) \times$ aDMGChipTimeDuration µs

$T_{TRN} = (4992 \times TRN\_LEN) \times$ aDMGChipTimeDuration µs

The number of SC symbol blocks, $N_{BLKS}$, shall be as defined in 20.5.3.2.3.3.

For a DMG A-PPDU reception (i.e., Additional PPDU field is equal to 1), the RXTIME parameter shall be updated every time when receiving the next L-Header field. For an EDMG A-PPDU, the RXTIME parameter predicts the reception time for the entire EDMG A-PPDU. In both cases, the TRN field can be appended only once at the very end of the A-PPDU.

For an EDMG and non-EDMG PPDU transmission, the RXTIME computation using the above equation shall cause a spoofing error less than one SC symbol block, i.e., 512×aDMGChipTimeDuration as defined in 28.3.3.2.4.1. Spoofing error is defined as the difference between the PPDU duration calculated based on the L-Header and the actual PPDU duration.

Optionally, an EDMG STA can estimate more accurately the actual RXTIME parameter for an EDMG PPDU by using the fields within the EDMG-Header-A.

## 28.9 EDMG beamforming

### 28.9.1 Short SSW PPDU

#### 28.9.1.1 General

A Short SSW PPDU is a DMG control mode PPDU (see 20.4) that has the Length field in the PHY header equal to 6 and the PPDU Type subfield within the Short SSW Payload field equal to 0.

The contents of the Short SSW Payload field, which consists of 6 octets and shall be transmitted following the PHY header, depend on whether the Short SSW PPDU is transmitted as part of an I-TXSS or R-TXSS, and whether it is used for MU-MIMO beamforming training.

The Short SSW Payload field of a Short SSW PPDU that is transmitted as part of an I-TXSS for SISO beamforming training is shown in Figure 28-41. The Short SSW Payload field of a Short SSW PPDU that is transmitted as part of an I-TXSS for MU-MIMO beamforming training is shown in Figure 28-42. The Short SSW Payload field of a Short SSW PPDU that is transmitted as part of an R-TXSS is shown in Figure 28-43. The subfields of the Short SSW Payload field are defined in Table 28-74.

| | PPDU Type | Direction | Addressing Mode | Source AID | Destination AID |
|---|---|---|---|---|---|
| Bits | 1 | 1 | 1 | 8 | 8 |

| | CDOWN | RF Chain ID | Short Scrambled BSSID | Unassociated | FCS |
|---|---|---|---|---|---|
| Bits | 11 | 3 | 10 | 1 | 4 |

**Figure 28-41—Short SSW Payload field when the Direction field is 0 (I-TXSS) and Addressing Mode field is 0**

| | PPDU Type | Direction | Addressing Mode | Source AID | Destination AID |
|---|---|---|---|---|---|
| Bits | 1 | 1 | 1 | 8 | 8 |

| | CDOWN | RF Chain ID | SISO Feedback Duration | Reserved | FCS |
|---|---|---|---|---|---|
| Bits | 11 | 3 | 10 | 1 | 4 |

**Figure 28-42—Short SSW Payload field when the Direction field is 0 (I-TXSS) and Addressing Mode field is 1**

| | PPDU Type | Direction | Reserved | Source AID | Destination AID |
|---|---|---|---|---|---|
| Bits | 1 | 1 | 1 | 8 | 8 |

| CDOWN | RF Chain ID | Short SSW Feedback | FCS |
|---|---|---|---|
| 11 | 3 | 11 | 4 |

**Figure 28-43—Short SSW Payload field when the Direction field is 1 (R-TXSS)**

**Table 28-74—Short SSW Payload field definition**

| Subfield | Definition |
|---|---|
| PPDU Type | Indicates the type of the PPDU. Possible values:<br>0: Short SSW<br>1: Reserved |
| Direction | Corresponds to TXVECTOR parameter SSSW_DIR. Indicates the direction of the transmission. The Direction field is set to 0 to indicate that the frame is transmitted by the beamforming initiator and set to 1 to indicate that the frame is transmitted by the beamforming responder. |
| Addressing Mode | Corresponds to TXVECTOR parameter SSSW_ADD_MODE. If set to 0, this indicates that the Destination AID field contains an individual address. Otherwise, the Destination AID field contains a group address.<br><br>For an individual address, the SISO beamforming training is used. Otherwise, the MU-MIMO beamforming training is used. |
| Source AID | Corresponds to TXVECTOR parameter SSSW_SOURCE_AID. In an ISS, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID (see 9.4.2.266) or the transmitting STA is not associated to intended recipient in which case this field contains a random value in the range of 0 to 255.<br><br>In an RSS, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID (see 9.4.2.266) or the transmitting STA is not associated to the intended recipient in which case this field contains the value contained in the Source AID field in the received Short SSW PPDU during the preceding ISS. |
| Destination AID | Corresponds to TXVECTOR parameter SSSW_DESTINATION_AID. In an ISS, contains the AID of the STA addressed by the Short SSW PPDU, except if the addressed STA is a PCP or an AP in which case this field contains the BSS AID (see 9.4.2.266) or the transmitting STA is not associated to the intended recipient in which case this field contains a random value in the range of 0 to 255.<br><br>In an RSS, contains the AID of the STA that transmits the Short SSW PPDU, except if the transmitting STA is a PCP or an AP in which case this field contains the BSS AID (see 9.4.2.266) or the transmitting STA is not associated to the intended recipient in which case this field contains the value contained in the Destination AID field in the received Short SSW PPDU during the preceding ISS. |
| CDOWN | Corresponds to TXVECTOR parameter SSSW_CDOWN. A down counter indicating the number of remaining Short SSW PPDU transmissions and LBIFSs to the end of the TXSS/RXSS across all antennas. This field is set to 0 in the last Short SSW PPDU transmission. |

**Table 28-74—Short SSW Payload field definition *(continued)***

| Subfield | Definition |
|---|---|
| RF Chain ID | Corresponds to TXVECTOR parameter SSSW_RF_CHAIN_ID. The content of this field is set to the value of the RF_CHAIN_ID parameter minus one. Identifies the transmit chain currently being used for the transmission. |
| Short Scrambled BSSID | Derived from the TXVECTOR parameter SSSW_BSSID. The content of this field is defined in 28.9.1.2. |
| Unassociated | Corresponds to TXVECTOR parameter SSSW_UNASSOCIATED. Indicates whether the transmitting STA is associated to the intended recipient. This field is set to 1 if the transmitting STA is not associated to the intended recipient. Otherwise, it is set to 0. |
| SISO Feedback Duration | Corresponds to TXVECTOR parameter SSSW_SISO_FEEDBACK_DURATION. Specifies the duration, in microseconds, of the SISO Feedback subphase that starts following the Short SSW PPDU transmission with CDOWN field equal to 0. |
| Short SSW Feedback | Corresponds to TXVECTOR parameter SSSW_FEEDBACK. In an RSS, contains the value of the CDOWN field of the Short SSW PPDU that was received with the best quality in the immediately preceding sector sweep. The determination of which PPDU was received with the best quality is implementation dependent. |
| FCS | The four MSBs of the FCS. The FCS is calculated as defined in 9.2.4.8. |

### 28.9.1.2 Short Scrambled BSSID subfield definition

The process for generating the Short Scrambled BSSID subfield is depicted in Figure 28-44.

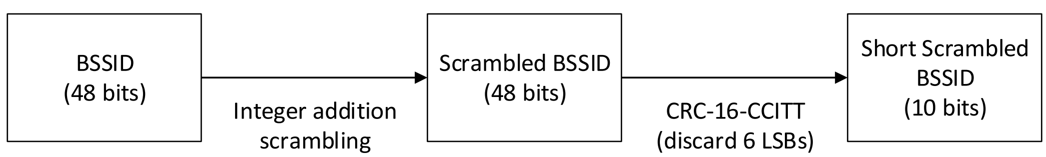


**Figure 28-44—Generation of Short Scrambled BSSID subfield**

The process starts by using the BSSID to generate the scrambled BSSID. The BSSID is divided into three words, $word_i$ ($0 \le i \le 2$), of 16 bits each, where $word_0$ is the 16 MSB of the BSSID and $word_2$ is the 16 LSB of the BSSID. For each $word_i$, a $scrambled\_word_i$ is created as shown in Equation (28-1).

$$scrambled\_word_i = (word_i + scramble\_pattern) \bmod 2^{16} \tag{28-1}$$

where

| | |
|---|---|
| $word_i$ | is the corresponding 16 bit word from the BSSID |
| $scramble\_pattern$ | is $((0x5795 \times seed\_value) \bmod 2^{15})$, where $seed\_value$ is the value of the Scrambler Initialization field in the L-Header of the PPDU carrying the Short SSW PPDU |

The scrambled BSSID is generated by the consecutive concatenation of $scrambled\_word_0$, $scrambled\_word_1$, and $scrambled\_word_2$.

Finally, the Short Scrambled BSSID subfield is generated by taking the 10 MSBs of CRC-16-CCITT computed over the scrambled BSSID. The CRC-16 is computed as defined in 20.3.7.

#### 28.9.1.3 Short SSW Payload field example

This subclause describes an example configuration of a Short SSW Payload field using the following configuration as input:

- BSSID = 0B-25-4D-00-B8-6A
- L-Header:
  - Scrambler Initialization = 1
- Short SSW Payload field:
  - PPDU Type = 0
  - Direction = 0
  - Addressing Mode = 0
  - Source AID = 0x15
  - Destination AID = 1
  - CDOWN = 0x3F
  - RF Chain ID = 3
  - Short Scrambled BSSID = 0x02D
  - Unassociated = 0
  - FCS = 0xE

Using the above configuration, the Short SSW Payload field encoding using the convention in 9.2.2 is as follows: 00010101 00010000 00011111 10000011 01011010 00000111.

### 28.9.2 Beam refinement

#### 28.9.2.1 General

An EDMG STA shall support the beam refinement procedure and PPDUs defined in 20.9.2 in addition to the mechanisms described in this subclause.

An EDMG PPDU shall not include a TRN field

- If the EDMG TRN Length field is equal to 0; or
- If the EDMG TRN Length field is greater than 0, the Beam Tracking Request field is equal to 0, the EDMG Beam Tracking Request field is equal to 1, the PPDU Type field is equal to 0, and the RX TRN-Units per Each TX TRN-Unit field is equal to 0. As defined in 10.42.7, this configuration corresponds to a request for receive beam tracking.

#### 28.9.2.2 EDMG BRP PPDU

##### 28.9.2.2.1 General

An EDMG BRP PPDU is an EDMG PPDUs that contains a TRN field and enable antenna configuration training for transmission and/or reception. There are three types of EDMG BRP PPDUs: EDMG BRP-RX PPDUs, EDMG BRP-TX PPDUs, and EDMG BRP-RX/TX PPDUs:

- EDMG BRP-RX PPDU are used for receive AWV training. All TRN subfields of an EDMG BRP-RX PPDU are transmitted with the same AWV.
- EDMG BRP-TX PPDU are used for transmit AWV training. The transmitter may change the AWV at the beginning of each set of $N$ TRN subfields present in the last $M$ TRN subfields of each TRN-Unit present in the TRN field. The transmitter may transmit all TRN subfields of a TRN field with the same AWV. The receiver performs measurements during the reception of the EDMG BRP-TX PPDU and sends feedback to the STA that transmitted the PPDU.

— EDMG BRP-RX/TX PPDUs are used for simultaneous training of the transmitter's transmit AWV and the receiver's receive AWV. To enable simultaneous receive and transmit training using the same EDMG BRP-RX/TX PPDU, different from an EDMG BRP-TX PPDU, the transmitter sends a number of consecutive TRN-Units in which the last *M* TRN subfields of each TRN-Unit are transmitted with the same AWV configuration.

NOTE—An EDMG BRP PPDU does not necessarily have to include a BRP frame in the PSDU.

#### 28.9.2.2.2 EDMG BRP PPDU structure

The EDMG_TRN_LEN parameter in the TVXVECTOR of an EDMG BRP PPDU shall be greater than 0.

As defined in 28.9.2.2.6 for EDMG SC PPDUs and EDMG control mode PPDUs, and in 28.9.2.2.7 for EDMG OFDM PPDUs, if beam refinement is performed on a 4.32 GHz, 6.48 GHz, or 8.64 GHz channel, the TRN field in EDMG BRP PPDUs sent as part of beam refinement shall occupy 2, 3, or 4 contiguous 2.16 GHz channels, respectively. Also, if beam refinement is performed on a 2.16+2.16 GHz or 4.32+4.32 GHz channel, the TRN field in EDMG BRP PPDUs sent as part of beam refinement shall occupy one or two contiguous 2.16 GHz channels, respectively, for each of the two aggregated channels.

#### 28.9.2.2.3 EDMG BRP PPDU header fields

The PPDU Type field within the L-Header together with the indication that the PPDU is an EDMG PPDU as defined in 28.3.3.2.4 are used to indicate that a PPDU is an EDMG BRP PPDU. In the EDMG-Header-A of an EDMG PPDU, as defined in Table 28-12, the fields EDMG TRN Length, RX TRN-Units per Each TX TRN-Unit, the EDMG TRN-Unit P, EDMG TRN-Unit M and EDMG TRN-Unit N are used to indicate the length of the training field, the EDMG BRP-RX/TX PPDU configuration, the number of TRN subfields in a TRN-Unit that are used for channel estimation, the number of TRN subfields in a TRN-Unit that are used for beamforming training, and the number of consecutive TRN subfields within EDMG TRN-Unit M that are transmitted using the same AWV, respectively.

An EDMG STA that has the DMG TRN RX Only Capable subfield in its EDMG Capabilities element equal to 0 shall support the following transmit and receive configurations of the EDMG TRN-Unit P, EDMG TRN-Unit M and EDMG TRN-Unit N fields in a PPDU:

— EDMG TRN-Unit P = 2, EDMG TRN-Unit M = 5 and EDMG TRN-Unit N = 2
— EDMG TRN-Unit P = 2, EDMG TRN-Unit M = 7 and EDMG TRN-Unit N = 0
— EDMG TRN-Unit P = 0, EDMG TRN-Unit M = 2, 5, 8, 11, and 14, and EDMG TRN-Unit N = 2
— EDMG TRN-Unit P = 0, EDMG TRN-Unit M = 0 through 15, and EDMG TRN-Unit N = 0

All other configurations are optionally supported by an EDMG STA. In all cases, the value of the EDMG TRN-Unit M field plus one shall be an integer multiple of the value indicated in the EDMG TRN-Unit N field.

A value of 0 in the PPDU Type field, a value of 0 in the Beam Tracking Request field, a value of 0 in the EDMG Beam Tracking Request field, a value of 0 in the RX TRN-Units per Each TX TRN-Unit field, and a value greater than 0 in the EDMG TRN Length field indicate an EDMG BRP-RX PPDU.

A value of 1 in the PPDU Type field, a value of 0 in the Beam Tracking Request field, a value of 0 in the RX TRN-Units per Each TX TRN-Unit field, and a value greater than 0 in the EDMG TRN Length field indicate an EDMG BRP-TX PPDU.

A value of 1 in the PPDU Type field, a value of 0 in the Beam Tracking Request field, a value greater than 0 in the RX TRN-Units per Each TX TRN-Unit field, and a value greater than 0 in the EDMG TRN Length field indicate an EDMG BRP-RX/TX PPDU.

A value in the EDMG TRN Length field of an EDMG BRP-RX PPDU shall be equal to the value of the L-RX field requested by the intended receiver of the EDMG BRP-RX PPDU in the last received EDMG BRP Request element (see 9.4.2.270). A value in the RX TRN-Units per Each TX TRN-Unit field of an EDMG BRP-RX/TX PPDU shall be equal to the value of the L-TX-RX field requested by the intended receiver of the EDMG BRP-RX/TX PPDU in the last received EDMG BRP Request element (see 9.4.2.270).

When the DMG TRN field is equal to 1 in an EDMG PPDU that has the EDMG TRN Length field greater than 0, the TRN field appended to the PPDU has the structure of a DMG training field containing an AGC training field and a TRN field as defined in 20.9.2.2.2. In this case, the value of the EDMG TRN Length field is smaller than 32 and only one bit is set to 1 in the BW field.

#### 28.9.2.2.4 EDMG BRP PPDU duration

The minimum duration of the Data field of an EDMG BRP PPDU sent in EDMG SC mode or in EDMG OFDM mode is specified by the TXVECTOR parameter EDMG_BRP_MIN_SC_BLOCKS.

If the BRP PPDU is sent in EDMG SC mode, the number of the minimum SC symbol blocks, $N_{BLKS\,\min}$ (see 28.5.9.4.3), shall be equal to the value of the TXVECTOR parameter EDMG_BRP_MIN_SC_BLOCKS. If necessary, the Data field of the EDMG BRP PPDU shall be extended by extra zero padding to generate the required number of EDMG SC blocks.

If the BRP PPDU is sent in EDMG OFDM mode, the number of the minimum OFDM symbol blocks, $N_{SYMS\,\min}$ (see 28.6.9.2.3), is defined as follows:

$$N_{SYMS\ \min} = \left\lceil N_{SCBLKS\ \min} \cdot \frac{T_{DFT}^{(SC)}}{T_{DFT}^{(OFDM)} + T_{GI}^{(OFDM)}} \right\rceil$$

where

| | |
|---|---|
| $N_{SCBLKS\,\min}$ | is the value of the TXVECTOR parameter EDMG_BRP_MIN_SC_BLOCKS |
| $T_{DFT}^{(SC)}$ | is the SC IDFT/DFT period defined in 28.5.2.2 |
| $T_{DFT}^{(OFDM)}$ | is the OFDM IDFT/DFT period defined in 28.6.2.2 |
| $T_{GI}^{(OFDM)}$ | is the guard interval duration of the EDMG PPDU |

If necessary, the Data field of the EDMG BRP PPDU shall be extended by extra zero padding to generate the required number of EDMG OFDM symbols.

The value of the PSDU Length field within the EDMG-Header-A of an EDMG BRP PPDU sent in EDMG control mode shall be greater than or equal to 19.

NOTE—The above requirement can be met by, for example, including a BRP frame in the PSDU.

#### 28.9.2.2.5 TRN field definition

The TRN field enables transmit and receive AWV training by EDMG STAs. The TRN field has the same form for all EDMG PHY modes (EDMG control, EDMG SC, and EDMG OFDM). The TRN field structure of EDMG BRP-TX PPDUs, of EDMG BRP-RX/TX PPDUs, and of EDMG BRP-RX PPDUs are shown in Figure 28-45, Figure 28-46, and Figure 28-47, respectively.

The total number of TRN-Units present in the TRN field of an EDMG PPDU is equal to the value of the EDMG TRN Length field contained in the EDMG-Header-A field of the PPDU.

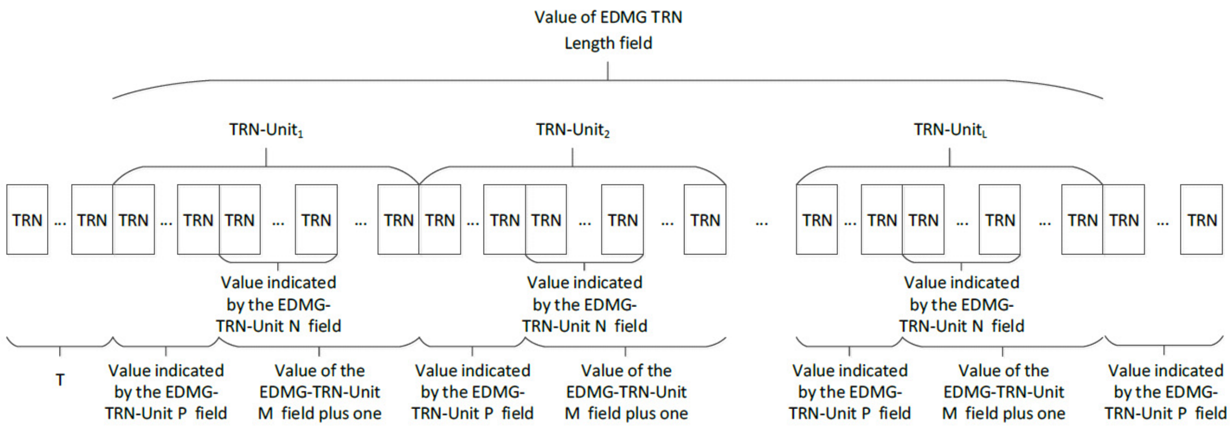


**Figure 28-45—TRN field structure of EDMG BRP-TX PPDUs**

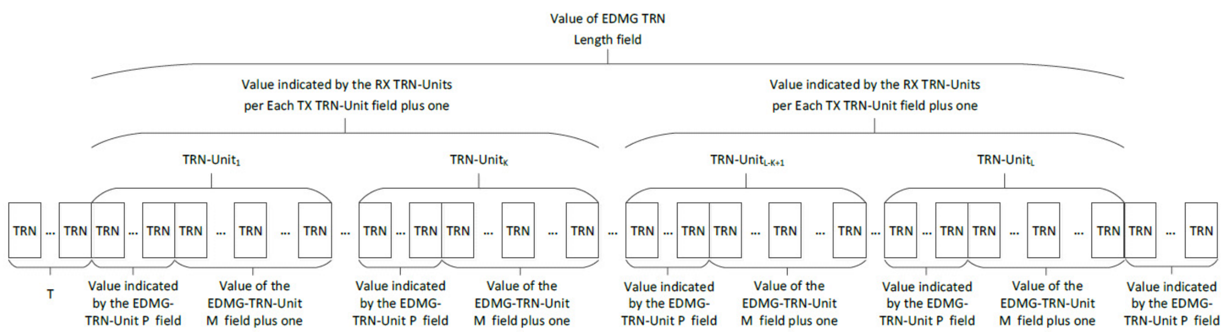


**Figure 28-46—TRN field structure of EDMG BRP-RX/TX PPDUs**

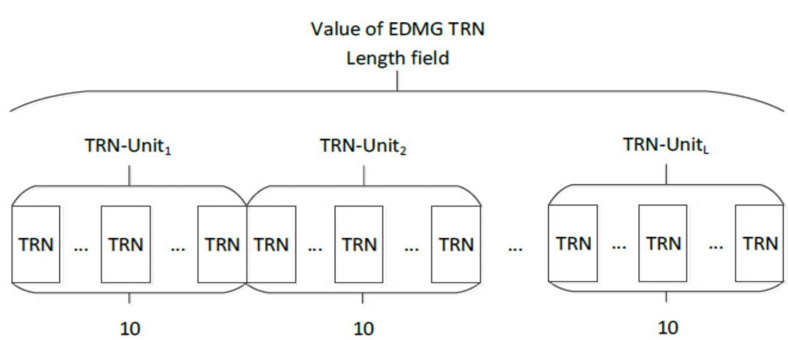


**Figure 28-47—TRN field structure of EDMG BRP-RX PPDUs**

For EDMG BRP-TX and EDMG BRP-RX/TX PPDUs, each TRN-Unit comprises $P$ plus $M$ repetitions of the TRN subfield defined in 28.9.2.2.6, where $P$ is the value indicated by the EDMG TRN-Unit P field and $M$ is the value of the EDMG TRN-Unit M field in the EDMG-Header-A plus one. The first $P$ TRN subfields of each TRN-Unit shall be transmitted using the same AWV as the preamble and Data fields of the PPDU, except for the case when the DMG antenna used in the transmission of an EDMG BRP-TX PPDU changes at the beginning of the TRN field, as described in 10.42.10.5.2 for the BRP TXSS procedure. In this particular case, the AWV used in the transmission of the first $P$ TRN subfields of each TRN-Unit is selected in an implementation dependent manner and should be the same for all TRN-Units.

For EDMG BRP-TX PPDUs, the transmitter may change the AWV at the beginning of each set of $N$ TRN subfields present in the last $M$ TRN subfields of each TRN-Unit in the TRN field, where $N$ is the value indicated by the EDMG TRN-Unit N field within the EDMG-Header-A. The $N$ consecutive TRN subfields that comprise each set of $N$ TRN subfields shall be transmitted with the same AWV. For EDMG BRP-RX/TX PPDUs, the transmitter may change AWV once at the beginning of the last $M$ TRN subfields of each TRN-Unit with the constraint that the same AWV configuration shall be used in the transmission of $R$ TRN-Units, where $R$ is the value of the RX TRN-Units per Each TX TRN-Unit field in the EDMG-Header-A plus one. Any transmit signal transients that occur due to TX AWV configuration changes at the beginning of a TRN subfield shall settle within $64 \times T_c$ from the beginning of the TRN subfield.

In an EDMG BRP-RX PPDU, all TRN subfields of all TRN-Units shall be transmitted using the same AWV as the preamble and data fields of the PPDU. Moreover, each TRN-Unit shall have 10 TRN subfields.

The transmission of the TRN field starts with $T$ repetitions of the TRN subfield, which should be transmitted with the same AWV that is used for the transmission of the first $P$ TRN subfields of each TRN-Unit. The $T$ repetitions of the TRN subfield at the beginning of the TRN field are defined to provide a transition interval between the processing of the data and TRN fields. As such, the $T$ repetitions of the TRN subfield shall not be used for AWV training and shall not be used to compute channel measurement feedback. For EDMG BRP-TX PPDUs and EDMG BRP-RX/TX PPDUs, $T$ is determined by the value of the TRN Subfield Sequence Length field in EDMG-Header-A of the PPDU. If the TRN Subfield Sequence Length field is 0, $T$ shall be equal to 2. If the TRN Subfield Sequence Length field is 1, $T$ shall be equal to 1. If the TRN Subfield Sequence Length field is 2, $T$ shall be equal to 4. For EDMG BRP-RX PPDUs or if the value of the EDMG TRN Length field contained in the EDMG-Header-A is 0, $T$ shall be equal to 0.

NOTE 1—The duration of $T$ repetitions of the TRN subfield is the same for all values of the TRN Subfield Sequence Length field in the EDMG-Header-A.

In EDMG BRP-TX and EDMG BRP-RX/TX PPDUs, following the transmission of all TRN-Units as indicated by the value of the EDMG TRN Length field, there are $P$ repetitions of the TRN subfield, which shall be transmitted with the same AWV that is used for the transmission of the preamble and Data fields of the PPDU containing the TRN field, except for the case when the DMG antenna used in the transmission of an EDMG BRP-TX PPDU changes at the beginning of the TRN field, as described in 10.42.10.5.2 for the BRP TXSS procedure. In this particular case, the AWV used in the transmission of the $P$ repetitions of the TRN subfield is selected in an implementation dependent manner.

In an EDMG BRP-TX PPDU that has the value of the EDMG TRN-Unit N field in the EDMG-Header-A equal to 0, the EDMG TRN Length field in the EDMG-Header-A shall be less than or equal to $2040/M$, where $M$ is the value of the EDMG TRN-Unit M field in the EDMG-Header-A of the PPDU plus one.

The concept of AWV feedback ID is defined to indicate TRN subfields transmitted with the same AWV in the feedback of measurements made with EDMG BRP-TX and EDMG BRP-RX/TX PPDUs. For EDMG BRP-TX and EDMG BRP-RX/TX PPDUs, a TRN subfield with index $i$ is defined as the $(i + 1)^{\text{th}}$ TRN subfield transmitted in the TRN field of the PPDU, where $i = 0, 1, \ldots, (M \times L) - 1$, $M$ is the value of the EDMG TRN-Unit M field in the EDMG-Header-A plus one, and $L$ is the value of the EDMG TRN Length field in the EDMG-Header-A. The $P$ TRN subfields at the start of each TRN-Unit transmitted with the same

AWV are not indexed, where $P$ is the value indicated by the EDMG TRN-Unit P field in the EDMG-Header-A of the PPDU.

An AWV feedback ID of value a indicates the TRN subfields transmitted with the $(a + 1)^{th}$ AWV used in the transmission of the TRN field. For EDMG BRP-TX PPDUs in which the value of the EDMG TRN-Unit N field in the EDMG-Header-A is greater than 0, a TRN subfield with index $i$ shall have AWV feedback ID equal to the following:

$$a = \lfloor i / N \rfloor$$

where
- $N$ is the number of consecutive TRN subfields within a TRN-Unit that are transmitted with the same AWV configuration, which can be equal to 1, 2, 3, 4, or 8, as indicated by the EDMG TRN-Unit M and EDMG TRN-Unit N fields in the EDMG-Header-A

For EDMG BRP-TX PPDUs in which the value of the EDMG TRN-Unit N field in the EDMG-Header-A is greater than 0, $a = 0, 1, \ldots, (M \times L)/N - 1$.

For EDMG BRP-TX PPDUs in which the value of the EDMG TRN-Unit N field in the EDMG-Header-A is equal to 0, $a = i$ and $a = 0, 1, \ldots, (M \times L) - 1$. For EDMG BRP-RX/TX PPDUs, a TRN subfield with index $i$ shall have AWV feedback ID a equal to the following:

$$a = \lfloor i / (C \times M) \rfloor$$

where
- $M$ is as defined above
- $N$ is as defined above
- $C$ is the value of the RX TRN-Units per Each TX TRN-Unit field in the EDMG-Header-A
- $L$ is as defined above

For EDMG BRP-RX/TX PPDUs, $a = 0, 1, \ldots, L/C - 1$.

NOTE 2—When processing the TRN field of an EDMG BRP PPDU, the repeated transmission of TRN subfields with the same AWV, which could be obtained by setting the EDMG TRN-Unit P field and/or EDMG TRN-Unit N field in the EDMG-Header-A to values greater than 0, can be used for AGC.

If the Dual Polarization TRN Training field is 1 and the value $N$ indicated by the EDMG TRN-Unit N field in the EDMG-Header-A of an EDMG BRP-RX, EDMG BRP-TX or EDMG BRP-RX/TX PPDU is even, the transmitter changes the antenna polarization at the end of each group of $N/2$ TRN subfields, in the last $M$ subfields in each TRN unit, where $M$ is the value of EDMG TRN-Unit M plus one. The antenna polarization change shall be done while keeping the same AWV. The antenna polarization change should take no more time than the settling time for the change of an AWV.

The receiver shall also switch polarization at the end of each $k$ TRN subfields within the last $M$ subfields in each TRN unit, where $k$ is $N/2$, $M$ is the value of EDMG TRN-Unit M plus one, and $N$ is the value indicated by the EDMG TRN-Unit N field in the EDMG-Header-A of the received PPDU.

### 28.9.2.2.6 TRN subfield definition for EDMG SC PPDUs and EDMG control mode PPDUs

The TRN subfield shall consist of $N_{TX}$ orthogonal waveforms, where $N_{TX}$ is the total number of transmit chains used in the transmission of the EDMG PPDU. The total number of transmit chains is indicated by the value of the TXVECTOR or RXVECTOR parameter NUM_TX_CHAINS.

The basic SC TRN subfield waveform for the $i_{TX}$th transmit chain in time domain shall be defined at the EDMG SC chip rate $F_{c\ EDMG}$ and chip time duration $T_c/N_{CB}$ as follows:

$$r_{TRN\_BASIC}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)=\left(Ga_{TRN\_BL\times N_{CB}}^{i_{TX}}(q)-Gb_{TRN\_BL\times N_{CB}}^{i_{TX}}\left(q-TRN\_BL\times N_{CB}\right)\right.$$
$$+Ga_{TRN\_BL\times N_{CB}}^{i_{TX}}\left(q-2\times TRN\_BL\times N_{CB}\right)+Gb_{TRN\_BL\times N_{CB}}^{i_{TX}}\left(q-3\times TRN\_BL\times N_{CB}\right)$$
$$\left.+Ga_{TRN\_BL\times N_{CB}}^{i_{TX}}\left(q-4\times TRN\_BL\times N_{CB}\right)-Gb_{TRN\_BL\times N_{CB}}^{i_{TX}}\left(q-5\times TRN\_BL\times N_{CB}\right)\right)$$

Sequences $Ga_{TRN\_BL\times N_{CB}}^{i_{TX}}(n)$ and $Gb_{TRN\_BL\times N_{CB}}^{i_{TX}}(n)$, $i_{TX}$ = 1, 2, …, 8, are defined for $0 \le n \le TRN\_BL \times N_{CB}$ – 1. For other values of $n$, $Ga_{TRN\_BL\times N_{CB}}^{i_{TX}}(n)$ and $Gb_{TRN\_BL\times N_{CB}}^{i_{TX}}(n)$ are set to 0.

If the $TRN\_BL \times N_{CB}$ length is equal to 64 ($TRN\_BL$ = 64 and $N_{CB}$ = 1), then the basic TRN subfield waveform for the $i_{TX}$th transmit chain in time domain shall be defined at the DMG SC chip rate $F_c$ and chip time duration $T_c$ as follows:

$$r_{TRN\_BASIC}^{i_{TX}}\left(qT_c\right)=\left(Gc_{64}^{i_{TX}}(q)-Gd_{64}^{i_{TX}}(q-64)\right.$$
$$+Gc_{64}^{i_{TX}}(q-2\times 64)+Gd_{64}^{i_{TX}}(q-3\times 64)$$
$$\left.+Gc_{64}^{i_{TX}}(q-4\times 64)-Gd_{64}^{i_{TX}}(q-5\times 64)\right)$$

Sequences $Gc_{64}^{i_{TX}}(n)$ and $Gd_{64}^{i_{TX}}(n)$, $i_{TX}$ = 1, 2, …, 8, are defined for $0 \le n \le 63$. For other values of $n$, $Gc_{64}^{i_{TX}}(n)$ and $Gd_{64}^{i_{TX}}(n)$ are set to 0.

*TRN_BL* represents the length of the Golay sequence used in the TRN subfield and depends on the value of the TRN Subfield Sequence Length field in the EDMG-Header-A of the PPDU. If the TRN Subfield Sequence Length field is 0, *TRN_BL* is equal to 128. If the TRN Subfield Sequence Length field is 1, *TRN_BL* is equal to 256. If the TRN Subfield Sequence Length field is 2, *TRN_BL* is equal to 64.

Moreover, $N_{CB}$ = 1 for a 2.16 GHz or a 2.16+2.16 GHz channel, $N_{CB}$ = 2 for a 4.32 GHz or a 4.32+4.32 GHz channel, $N_{CB}$ = 3 for a 6.48 GHz channel, and $N_{CB}$ = 4 for an 8.64 GHz channel.

An EDMG STA shall support Golay sequences of length 128 and 256 (i.e., *TRN_BL* equal to 128 and $N_{CB}$ equal to 1 or 2). Other lengths are optional and support is indicated in the STA's EDMG Capabilities element.

The pairs of Golay complementary sequences ($Gc^i_{64}$, $Gd^i_{64}$), ($Ga^i_{128}$, $Gb^i_{128}$), ($Ga^i_{192}$, $Gb^i_{192}$), ($Ga^i_{256}$, $Gb^i_{256}$), ($Ga^i_{384}$, $Gb^i_{384}$), ($Ga^i_{512}$, $Gb^i_{512}$), ($Ga^i_{768}$, $Gb^i_{768}$), and ($Ga^i_{1024}$, $Gb^i_{1024}$) are defined in 28.10. These sequences shall be transmitted using π/2-BPSK modulation.

The TRN subfield waveform for the $i_{TX}$th transmit chain is defined as follows:

$$r_{TRN\_SUBFIELD}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)=\sum_{n=1}^{N_{TRN}^{TX}}\left[P_{TRN}\right]_{i_{TX},n} r_{TRN\_BASIC}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}-(n-1)\times T_{BASIC}\right)$$

where

$P_{TRN}$ is the TRN mapping matrix

$N_{TRN}^{N_{TX}}$ is the number of SC TRN basic subfields in a TRN subfield for the given total number of transmit chains $N_{TX}$

$[\ ]_{m,n}$ is a matrix element from $m^{\text{th}}$ row and $n^{\text{th}}$ column

$T_{BASIC}$ is the duration of the basic TRN subfield

$q$ is a chip time index, $q = 0,1,\ldots,TRN\_BL \times N_{CB} \times 6 \times N_{TRN}^{TX} - 1$

The TRN mapping matrix used in the TRN subfield definition for a 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz PPDU transmission is defined as follows:

— The TRN mapping matrix for $N_{TX}$ = 1, 2 is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 \\ +1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 1$$

— The TRN mapping matrix for $N_{TX}$ = 3, 4 is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & +1 \\ +1 & +1 \\ +1 & -1 \\ +1 & -1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 2$$

— The TRN mapping matrix for $N_{TX}$ = 5, 6, 7, and 8 is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \\ +1 & -1 & -1 & +1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 4$$

The TRN mapping matrix used in the TRN subfield definition for a 2.16+2.16 GHz and a 4.32+4.32 GHz PPDU transmission is defined as follows:

— The TRN mapping matrix for $N_{TX}$ = 2, 4 is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 \\ +1 \\ +1 \\ +1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 1$$

— The TRN mapping matrix for $N_{TX} = 6, 8$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & +1 \\ +1 & +1 \\ +1 & -1 \\ +1 & -1 \\ +1 & +1 \\ +1 & +1 \\ +1 & -1 \\ +1 & -1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 2$$

The TRN field waveform for the $i_{TX}$th transmit chain in an EDMG control PPDU or EDMG SC PPDU is defined as follows:

$$r_{TRN}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right) = \sum_{n=1}^{N_{SUBFIELD}} r_{TRN\_SUBFIELD}^{i_{TX}}\left(q\frac{T_c}{N_{CB}} - (n-1)\times T_{SUBFIELD}\right)$$

where

| | |
|---|---|
| $r_{TRN\_SUBFIELD}^{i_{TX}}\left(q\frac{T_c}{N_{CB}}\right)$ | is the TRN subfield waveform defined in this subclause |
| $T_{SUBFIELD}$ | is the time duration of the TRN subfield |
| $N_{SUBFIELD}$ | is the total number of TRN subfields transmitted in the TRN field |
| $q$ | is a chip time index, $q = 0,1,\ldots, N_{SUBFIELD}\times TRN\_BL\times N_{CB}\times 6\times N_{TRN}^{TX} - 1$ |

### 28.9.2.2.7 TRN subfield definition for EDMG OFDM PPDUs

For EDMG PPDU transmissions using the EDMG OFDM mode over a 2.16 GHz or 2.16+2.16 GHz channel, the OFDM *TRN_BASIC* sequence is defined in frequency domain for the $i_{TX}$th transmit chain as follows:

— $TRN\_BASIC^{iTX}_{-177,177} = [Seq^{iTX}_{left,176}, 0, 0, 0, Seq^{iTX}_{right,176}]$, for $i_{TX}$=1, 2, 3, 4, 5, 6, 7, 8

For EDMG PPDU transmissions using the EDMG OFDM mode over a 4.32 GHz or 4.32+4.32 GHz channel, the OFDM *TRN_BASIC* sequence is defined in frequency domain for the $i_{TX}$th transmit chain as follows:

— $TRN\_BASIC^{iTX}_{-386,386} = [Seq^{iTX}_{left,385}, 0, 0, 0, Seq^{iTX}_{right,385}]$, for $i_{TX}$=1, 2, 3, 4, 5, 6, 7, 8

For EDMG PPDU transmissions using the EDMG OFDM mode over a 6.48 GHz channel, the OFDM *TRN_BASIC* sequence is defined in frequency domain for the $i_{TX}$th transmit chain as follows:

— $TRN\_BASIC^{iTX}_{-596,596} = [Seq^{iTX}_{left,595}, 0, 0, 0, Seq^{iTX}_{right,595}]$, for $i_{TX}$=1, 2, 3, 4, 5, 6, 7, 8

For EDMG PPDU transmissions using the EDMG OFDM mode over an 8.64 GHz channel, the OFDM *TRN_BASIC* sequence is defined in frequency domain for the $i_{TX}$th transmit chain as follows:

— $TRN\_BASIC^{iTX}_{-805,805} = [Seq^{iTX}_{left,804}, 0, 0, 0, Seq^{iTX}_{right,804}]$, for $i_{TX}$=1, 2, 3, 4, 5, 6, 7, 8

The basic OFDM TRN subfield waveform for the $i_{TX}^{\text{th}}$ transmit chain in time domain shall be defined at the OFDM sampling rate $F_s$ and sample time duration $T_s$ as follows:

$$r_{TRN\_BASIC}^{i_{TX}}\left(qT_s\right)=\sum_{n=1}^{N_{TRN}^{N_{TX}}} r_{TRN}^{n,i_{TX}}\left(qT_s-(n-1)\cdot\left(T_{DFT}+T_{GI\ long}\right)\right)$$

where

$$r_{TRN}^{n,i_{TX}}\left(qT_s\right)=\frac{1}{\sqrt{N_{TRN}^{Tone}}}w\left(qT_s\right)$$

$$\cdot\sum_{k=-N_{SR}}^{N_{SR}}\left[P_{TRN}\right]_{i_{TX},n} TRN\_BASIC_k^{i_{TX}}\exp\left(j2\pi k\Delta_F\left(qT_s-T_{GI\ long}\right)\right), 1\le n\le N_{TRN}^{N_{TX}}$$

| | |
|---|---|
| $N_{TRN}^{Tone}=N_{ST}-N_{DC}$ | is the total number of active tones |
| $P_{TRN}$ | is the TRN mapping matrix (see below) |
| $N_{TRN}^{N_{TX}}$ | is the number of OFDM symbols in a TRN subfield for the given total number of transmit chains $N_{TX}$ (see below) |
| $[\ ]_{m,n}$ | is a matrix element from $m^{\text{th}}$ row and $n^{\text{th}}$ column |
| $w(qT_s)$ | is window function applied to smooth the transitions between consecutive OFDM symbols and its definition is implementation specific |
| $q$ | is a time sample index |

The TRN subfield waveform for the $i_{TX}^{\text{th}}$ transmit chain is defined as follows:

$$r_{TRN\_SUBFIELD}^{i_{TX}}\left(qT_S\right)=\sum_{n=1}^{N_{SEQ\_LEN}} r_{TRN\_BASIC}^{i_{TX}}\left(qT_s-(n-1)\cdot T_{BASIC}\right)$$

where

| | |
|---|---|
| $r_{TRN\_BASIC}^{i_{TX}}\left(qT_S\right)$ | is the basic TRN subfield waveform for the $i_{TX}^{\text{th}}$ transmit chain |
| $T_{BASIC}$ | is the duration of the basic TRN subfield |
| $N_{SEQ\_LEN}$ | shall be set to 2 if the value of the TXVECTOR parameter TRN_SEQ_LENGTH of the PPDU is equal to Normal; or to 1 if TRN_SEQ_LENGTH is equal to Short; or to 4 if TRN_SEQ_LENGTH is equal to Long |
| $q$ | is a time sample index |

The TRN field transmit waveform for $i_{TX}^{\text{th}}$ transmit chain in an EDMG OFDM PPDU is defined as follows:

$$r_{TRN}^{i_{TX}}\left(qT_s\right)=\sum_{n=1}^{N_{SUBFIELD}} r_{TRN\_SUBFIELD}^{i_{TX}}\left(qT_s-(n-1)\times T_{SUBFIELD}\right)$$

where

| | |
|---|---|
| $r_{TRN\_SUBFIELD}^{i_{TX}}\left(qT_s\right)$ | is the TRN subfield waveform defined in this subclause |
| $T_{SUBFIELD}$ | is the time duration of the TRN subfield |
| $N_{SUBFIELD}$ | is the total number of TRN subfields transmitted in the TRN field |
| $q$ | is a sample time index, $q=0,1,\ldots,N_{SUBFIELD}\times\left(N_{DFT}+N_{GI\ long}\right)\times N_{TRN}^{N_{TX}}\times N_{SEQ\_LEN}-1$ |

If the Maximum OFDM MCS subfield in a STA's EDMG Capabilities element is greater than 0, the STA shall support 2 repetitions of the basic TRN subfield. Other repetitions are optional and support is indicated in the STA's EDMG Capabilities element.

The OFDM TRN mapping matrix for $N_{TX} = 1$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 2$$

The OFDM TRN mapping matrix for $N_{TX} = 2$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 \\ +1 & +1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 2$$

The OFDM TRN mapping matrix for $N_{TX} = 3$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 & +1 \\ +1 & -w_3^1 & w_3^2 \\ +1 & -w_3^2 & w_3^4 \end{bmatrix},\ w_3 = \exp(-j2\pi/3),\ N_{TRN}^{N_{TX}} = 3$$

The OFDM TRN mapping matrix for $N_{TX} = 4$ is defined as follows:

$$P_{TRN} = P_{4x4} = \begin{bmatrix} +1 & -1 & +1 & +1 \\ +1 & +1 & -1 & +1 \\ +1 & +1 & +1 & -1 \\ -1 & +1 & +1 & +1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 4$$

The OFDM TRN mapping matrix for $N_{TX} = 5, 6$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 & +1 & +1 & +1 & -1 \\ +1 & -w_6^1 & w_6^2 & w_6^3 & w_6^4 & -w_6^5 \\ +1 & -w_6^2 & w_6^4 & w_6^6 & w_6^8 & -w_6^{10} \\ +1 & -w_6^3 & w_6^6 & w_6^9 & w_6^{12} & -w_6^{15} \\ +1 & -w_6^4 & w_6^8 & w_6^{12} & w_6^{16} & -w_6^{20} \\ +1 & -w_6^5 & w_6^{10} & w_6^{15} & w_6^{20} & -w_6^{25} \end{bmatrix},\ w_6 = \exp(-j2\pi/6),\ N_{TRN}^{N_{TX}} = 6$$

The OFDM TRN mapping matrix for $N_{TX} = 7, 8$ is defined as follows:

$$P_{TRN} = \begin{bmatrix} P_{4x4} & P_{4x4} \\ P_{4x4} & -P_{4x4} \end{bmatrix},\ N_{TRN}^{N_{TX}} = 8$$

For 2.16+2.16 GHz and 4.32+4.32 GHz PPDU transmission, the OFDM TRN mapping matrix for each channel is determined by the number of transmit chains per channel, which is half of the total number of transmit chains.

If the number of transmit chains per channel is 1 ($N_{TX} = 2$), the OFDM TRN mapping matrix for each channel is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 \end{bmatrix},\ N_{TRN}^{N_{TX}} = 2$$

If the number of transmit chains per channel is 2 ($N_{TX}$ = 4), the OFDM TRN mapping matrix for each channel is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 \\ +1 & +1 \end{bmatrix}, \ N_{TRN}^{N_{TX}} = 2$$

If the number of transmit chains per channel is 3 ($N_{TX}$ = 6), the OFDM TRN mapping matrix for each channel is defined as follows:

$$P_{TRN} = \begin{bmatrix} +1 & -1 & +1 \\ +1 & -w_3^1 & w_3^2 \\ +1 & -w_3^2 & w_3^4 \end{bmatrix}, \ w_3 = \exp\left(-j2\pi/3\right), \ N_{TRN}^{N_{TX}} = 3$$

If the number of transmit chains per channel is 4 ($N_{TX}$ = 8), the OFDM TRN mapping matrix for each channel is defined as follows:

$$P_{TRN} = P_{4x4} = \begin{bmatrix} +1 & -1 & +1 & +1 \\ +1 & +1 & -1 & +1 \\ +1 & +1 & +1 & -1 \\ -1 & +1 & +1 & +1 \end{bmatrix}, \ N_{TRN}^{N_{TX}} = 4$$

$TRN\_BASIC^{i_{TX}}$ for the first $N_{TX}/2$ transmit chains shall be correspond to the transmit chain number $i_{TX} = 1, \ldots, N_{TX}/2$ and $TRN\_BASIC^{i_{TX}}$ for the second $N_{TX}/2$ transmit chains shall be correspond to the transmit chain number $i_{TX} = N_{TX}/2 + 1, \ldots, N_{TX}$.

### 28.9.2.2.8 Channel measurement

The autocorrelation properties of the Golay sequence used in the TRN field allow for the estimation of the impulse response of the channel between transmitter and receiver. When the channel measurement is performed using an EDMG BRP-TX PPDU, the receiver should determine the channel tap with largest magnitude using the first *P* TRN subfields of the first TRN-Unit of the PPDU, where *P* is the number of TRN subfields indicated in the EDMG TRN-Unit P field within the EDMG-Header-A of the PPDU. The receiver then selects the set of taps that is measured around the tap with the largest magnitude, according to dot11ChanMeasFBCKNtaps. It can select a contiguous set of taps or select a noncontiguous set of taps, and include the delays of the selected taps in the Tap Delay field of the Channel Measurement Feedback element. The receiver then measures the amplitude of the corresponding channel taps in each of the last *M* TRN subfields of all TRN-Units in the PPDU if *N* is equal to 0, where *M* and *N* are the number of TRN subfields indicated in the EDMG TRN-Unit M field and in the EDMG TRN-Unit N field within the EDMG-Header-A of the PPDU, respectively. If *N* is greater than 0, one set of amplitudes are obtained for each group of *N* consecutive TRN subfields that have the same AWV feedback ID, as defined in 28.9.2.2.5. The in-phase and quadrature components of the selected taps measured using the $k^{th}$ TRN subfield (if *N* is equal to 0) or $k^{th}$ group of *N* consecutive TRN subfields that have the same AWV feedback ID (if *N* is greater than 0) included in the Channel Measurement *k* subfield of the Channel Measurement field within the Channel Measurement Feedback element. As defined in 9.4.2.136, the in-phase and quadrature values in the Channel Measurement field are normalized with respect to the tap with largest magnitude over all measurements made using the TRN field of the EDMG BRP-TX PPDU.

## 28.10 Golay sequences

### 28.10.1 General

The EDMG PHY uses the pairs of complementary sequences defined in 20.11 and defines new sequences. The use of each sequence depends on the transmitted channel bandwidth, number of transmitted space-time streams or transmit chains and the field of the PPDU.

### 28.10.2 Sequences of length 32, 64, 128, 256, 512, and 1024

Golay sequences of length 32, 64, 128, 256, 512, and 1024 are generated using the procedure and notation specified in 20.11. The $i^{th}$ index defines the space-time stream or the transmit chain number.

The value of the $D_K$ vector for each of the EDMG sequences are as follows:

- For $Gc^i_{32}$ and $Gd^i_{32}$: $D_K$ = [2 1 4 8 16]
- For $Ga^i_{64}$ and $Gb^i_{64}$: $D_K$ = [2 1 4 8 16 32]
- For $Gc^i_{64}$ and $Gd^i_{64}$: $D_K$ = [1 8 2 4 16 32]
- For $Ga^i_{128}$ and $Gb^i_{128}$: $D_K$ = [1 8 2 4 16 32 64]
- For $Gc^i_{128}$ and $Gd^i_{128}$: $D_K$ = [2 1 4 8 16 32 64]
- For $Ga^i_{256}$ and $Gb^i_{256}$: $D_K$ = [1 8 2 4 16 32 64 128]
- For $Ga^i_{512}$ and $Gb^i_{512}$: $D_K$ = [1 8 2 4 16 32 64 128 256]
- For $Ga^i_{1024}$ and $Gb^i_{1024}$: $D_K$ = [1 8 2 4 16 32 64 128 256 512]

NOTE 1—The sequences $Gc^i_{32}$, $Gd^i_{32}$, $Gc^i_{64}$, $Gd^i_{64}$, $Gc^i_{128}$, $Gd^i_{128}$ are different from the corresponding $Ga^i_{32}$, $Gb^i_{32}$, $Ga^i_{64}$, $Gb^i_{64}$, $Ga^i_{128}$, $Gb^i_{128}$ sequences defined in 20.11 for the DMG PHY.

NOTE 2—For $i$ = 1, the sequences $Ga^i_{64}$ and $Gb^i_{64}$ are equal to the corresponding $Ga_{64}$ and $Gb_{64}$ sequences defined in 20.11 for the DMG PHY. Similarly, for $i$ = 1, the sequences $Ga^i_{128}$ and $Gb^i_{128}$ are equal to the corresponding $Ga_{128}$ and $Gb_{128}$ sequences defined in 20.11 for the DMG PHY.

As opposed to the $D_K$ vector, the value of the $W_K$ vector depends on the space-time stream number or transmit chain number used to define the Golay pair ($Ga^i_N$, $Gb^i_N$). Table 28-75 shows the value of the $W_K$ vector defined for each space-time stream or transmit chain and sequence lengths of 32, 64, and 128. Table 28-76 shows the value of the $W_K$ vector defined for each space-time stream or transmit chain and sequence lengths of 256, 512, and 1024.

**Table 28-75—$W_K$ vector value to generate Golay sequences of length 32, 64, and 128**

| Space-time stream/ transmit chain number | $W_K$ for $Gc^i_{32}$ and $Gd^i_{32}$ | $W_K$ for $Ga^i_{64}$ and $Gb^i_{64}$ | $W_K$ for $Gc^i_{64}$ and $Gd^i_{64}$ | $W_K$ for $Ga^i_{128}$ and $Gb^i_{128}$ | $W_K$ for $Gc^i_{128}$ and $Gd^i_{128}$ |
|---|---|---|---|---|---|
| 1 | [+1,+1,–1,–1, +1] | [+1,+1,–1,–1, +1,–1] | [–1,–1,–1,–1, +1,–1] | [–1,–1,–1,–1, +1,–1,–1] | [+1,+1,–1,–1, +1,+1,+1] |
| 2 | [–1,+1,–1,–1, +1] | [–1,+1,–1,–1, +1,–1] | [+1,–1,–1,–1, +1,–1] | [+1,–1,–1,–1, +1,–1,–1] | [–1,+1,–1,–1, +1,+1,+1] |
| 3 | [–1,–1,–1,–1, –1] | [–1,–1,–1,–1, –1,–1] | [–1,–1,–1,+1, –1,–1] | [–1,–1,–1,+1, –1,–1,+1] | [–1,–1,–1,–1, –1,+1,+1] |
| 4 | [+1,–1,–1,–1, –1] | [+1,–1,–1,–1, –1,–1] | [+1,–1,–1,+1, –1,–1] | [+1,–1,–1,+1, –1,–1,+1] | [+1,–1,–1,–1, –1,+1,+1] |

### Table 28-75—$W_K$ vector value to generate Golay sequences of length 32, 64, and 128 *(continued)*

| Space-time stream/ transmit chain number | $W_K$ for $Gc^i_{32}$ and $Gd^i_{32}$ | $W_K$ for $Ga^i_{64}$ and $Gb^i_{64}$ | $W_K$ for $Gc^i_{64}$ and $Gd^i_{64}$ | $W_K$ for $Ga^i_{128}$ and $Gb^i_{128}$ | $W_K$ for $Gc^i_{128}$ and $Gd^i_{128}$ |
|---|---|---|---|---|---|
| 5 | [–1,–1,–1,–1,+1] | [–1,–1,–1,–1,+1,–1] | [–1,–1,–1,+1,–1,+1] | [–1,–1,–1,+1,–1,+1,+1] | [–1,–1,–1,–1,+1,+1,+1] |
| 6 | [+1,–1,–1,–1,+1] | [+1,–1,–1,–1,+1,–1] | [+1,–1,–1,+1,–1,+1] | [+1,–1,–1,+1,–1,+1,+1] | [+1,–1,–1,–1,+1,+1,+1] |
| 7 | [–1,–1,–1,+1,–1] | [–1,–1,–1,+1,–1,–1] | [–1,–1,–1,+1,+1,+1] | [–1,–1,–1,+1,+1,+1,–1] | [–1,–1,–1,+1,–1,+1,+1] |
| 8 | [+1,–1,–1,+1,–1] | [+1,–1,–1,+1,–1,–1] | [+1,–1,–1,+1,+1,+1] | [+1,–1,–1,+1,+1,+1,–1] | [+1,–1,–1,+1,–1,+1,+1] |

### Table 28-76—$W_K$ vector value to generate Golay sequences of length 256, 512, and 1024

| Space-time stream/ transmit chain number | $W_K$ for $Ga^i_{256}$ and $Gb^i_{256}$ | $W_K$ for $Ga^i_{512}$ and $Gb^i_{512}$ | $W_K$ for $Ga^i_{1024}$ and $Gb^i_{1024}$ |
|---|---|---|---|
| 1 | [–1,–1,–1,–1,+1,–1,–1,+1] | [–1,–1,–1,–1,+1,–1,–1,+1,+1] | [–1,–1,–1,–1,+1,–1,–1,+1,+1,+1] |
| 2 | [+1,–1,–1,–1,+1,–1,–1,+1] | [+1,–1,–1,–1,+1,–1,–1,+1,+1] | [+1,–1,–1,–1,+1,–1,–1,+1,+1,+1] |
| 3 | [–1,–1,–1,+1,–1,–1,+1,–1] | [–1,–1,–1,+1,–1,–1,+1,–1,+1] | [–1,–1,–1,+1,–1,–1,+1,–1,+1,+1] |
| 4 | [+1,–1,–1,+1,–1,–1,+1,–1] | [+1,–1,–1,+1,–1,–1,+1,–1,+1] | [+1,–1,–1,+1,–1,–1,+1,–1,+1,+1] |
| 5 | [–1,–1,–1,+1,–1,+1,+1,–1] | [–1,–1,–1,+1,–1,+1,+1,–1,+1] | [–1,–1,–1,+1,–1,+1,+1,–1,+1,+1] |
| 6 | [+1,–1,–1,+1,–1,+1,+1,–1] | [+1,–1,–1,+1,–1,+1,+1,–1,+1] | [+1,–1,–1,+1,–1,+1,+1,–1,+1,+1] |
| 7 | [–1,–1,–1,+1,+1,+1,–1,–1] | [–1,–1,–1,+1,+1,+1,–1,–1,+1] | [–1,–1,–1,+1,+1,+1,–1,–1,+1,+1] |
| 8 | [+1,–1,–1,+1,+1,+1,–1,–1] | [+1,–1,–1,+1,+1,+1,–1,–1,+1] | [+1,–1,–1,+1,+1,+1,–1,–1,+1,+1] |

The sequences are defined from Table 28-77 through Table 28-92. The sequences in the tables are normative; the description above is informative.

### Table 28-77—The sequence $Gc^{i}_{32}(n)$

| |
|---|
| The sequence $Gc^{1}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 |
| The sequence $Gc^{2}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 |
| The sequence $Gc^{3}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gc^{4}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Gc^{5}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gc^{6}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |
| The sequence $Gc^{7}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gc^{8}_{32}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 |

### Table 28-78—The sequence $Gd^{i}_{32}(n)$

| |
|---|
| The sequence $Gd^{1}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 |
| The sequence $Gd^{2}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 |
| The sequence $Gd^{3}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gd^{4}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Gd^{5}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gd^{6}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |
| The sequence $Gd^{7}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gd^{8}_{32}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 |

### Table 28-79—The sequence $Ga^{i}_{64}(n)$

| |
|---|
| The sequence $Ga^{1}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1<br>–1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 |
| The sequence $Ga^{2}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 |
| The sequence $Ga^{3}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Ga^{4}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |
| The sequence $Ga^{5}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Ga^{6}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Ga^{7}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Ga^{8}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 |

### Table 28-80—The sequence $Gb^{i}_{64}(n)$

| |
|---|
| The sequence $Gb^{1}_{64}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1<br>+1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 |
| The sequence $Gb^{2}_{64}(n)$, to be transmitted from left to right, up to down |
| +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 |
| The sequence $Gb^{3}_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gb^{4}_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |

**Table 28-80—The sequence $Gb^i_{64}(n)$ *(continued)***

| |
|---|
| The sequence $Gb^5_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gb^6_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1<br>+1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Gb^7_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gb^8_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 |

**Table 28-81—The sequence $Gc^i_{128}(n)$**

| |
|---|
| The sequence $Gc^1_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1<br>–1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 |
| The sequence $Gc^2_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1<br>–1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1<br>–1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 |
| The sequence $Gc^3_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1<br>–1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1<br>–1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1<br>–1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gc^4_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1<br>–1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1<br>–1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Gc^5_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1<br>–1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 +1<br>–1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1<br>–1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |

### Table 28-81—The sequence $Gc^{i}_{128}(n)$ *(continued)*

| |
|---|
| The sequence $Gc^{6}_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |
| The sequence $Gc^{7}_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1<br>–1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gc^{8}_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1<br>–1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 |

### Table 28-82—The sequence $Gd^{i}_{128}(n)$

| |
|---|
| The sequence $Gd^{1}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1<br>–1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 |
| The sequence $Gd^{2}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1<br>–1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 |
| The sequence $Gd^{3}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1<br>+1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1<br>–1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 |
| The sequence $Gd^{4}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1<br>+1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 |
| The sequence $Gd^{5}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1<br>–1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1<br>–1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 |

### Table 28-82—The sequence $Gd^{i}_{128}(n)$ *(continued)*

| |
|---|
| The sequence $Gd^{6}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 |
| The sequence $Gd^{7}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 +1<br>+1 –1 +1 –1 +1 +1 –1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 |
| The sequence $Gd^{8}_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 +1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 –1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 +1<br>–1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 –1 –1 –1 –1 +1 –1 +1 –1 –1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 +1 –1 |

### Table 28-83—The sequence $Gc^{i}_{64}(n)$

| |
|---|
| The sequence $Gc^{1}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 |
| The sequence $Gc^{2}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 |
| The sequence $Gc^{3}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| The sequence $Gc^{4}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |
| The sequence $Gc^{5}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Gc^{6}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |
| The sequence $Gc^{7}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| The sequence $Gc^{8}_{64}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |

### Table 28-84—The sequence $Gd^i_{64}(n)$

| |
|---|
| The sequence $Gd^1_{64}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 |
| The sequence $Gd^2_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 |
| The sequence $Gd^3 64(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| The sequence $Gd^4_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |
| The sequence $Gd^5_{64}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Gd^6_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |
| The sequence $Gd^7_{64}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| The sequence $Gd^8_{64}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |

### Table 28-85—The sequence $Ga^i_{128}(n)$

| |
|---|
| The sequence $Ga^1_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| The sequence $Ga^2_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 |
| The sequence $Ga^3_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |

**Table 28-85—The sequence $Ga^i_{128}(n)$ *(continued)***

| The sequence $Ga^4_{128}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |
| The sequence $Ga^5_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Ga^6_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |
| The sequence $Ga^7_{128}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Ga^8_{128}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |

**Table 28-86—The sequence $Gb^i_{128}(n)$**

| The sequence $Gb^1_{128}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| The sequence $Gb^2_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 |
| The sequence $Gb^3_{128}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |

### Table 28-86—The sequence $Gb^i_{128}(n)$ *(continued)*

| |
|---|
| The sequence $Gb^4_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |
| The sequence $Gb^5_{128}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Gb^6_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |
| The sequence $Gb^7_{128}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 |
| The sequence $Gb^8_{128}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |

### Table 28-87—The sequence $Ga^i_{256}(n)$

| |
|---|
| The sequence $Ga^1_{256}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 |
| The sequence $Ga^2_{256}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 |

**Table 28-87—The sequence $Ga^i_{256}(n)$ *(continued)***

| |
|---|
| The sequence $Ga^3_{256}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 |
| The sequence $Ga^4_{256}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 |
| The sequence $Ga^5_{256}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| The sequence $Ga^6_{256}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1<br>–1 –1 +1 +1 |
| The sequence $Ga^7_{256}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 |
| The sequence $Ga^8_{256}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>+1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 +1 –1 –1<br>+1 +1 |

**Table 28-88—The sequence $Gb^{i}_{256}(n)$**

| |
|---|
| The sequence $Gb^{1}_{256}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1<br>–1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 |
| The sequence $Gb^{2}_{256}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 |
| The sequence $Gb^{3}_{256}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 |
| The sequence $Gb^{4}_{256}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 |
| The sequence $Gb^{5}_{256}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1<br>+1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 |

### Table 28-88—The sequence $Gb^i_{256}(n)$ *(continued)*

| The sequence $Gb^6_{256}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1<br>–1 –1 +1 +1 |
| The sequence $Gb^7_{256}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1<br>+1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 |
| The sequence $Gb^8_{256}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1<br>+1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 |

### Table 28-89—The sequence $Ga^i_{512}(n)$

| The sequence $Ga^1_{512}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1<br>–1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>–1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 |

**Table 28-89—The sequence $Ga^i_{512}(n)$ *(continued)***

| The sequence $Ga^2_{512}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 |
| The sequence $Ga^3_{512}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 |
| The sequence $Ga^4_{512}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1<br>–1 +1 +1 –1 –1 |

**Table 28-89—The sequence $Ga^{i}_{512}(n)$ *(continued)***

| The sequence $Ga^{5}_{512}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1<br>+1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1<br>+1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1<br>+1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 |
| The sequence $Ga^{6}_{512}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1<br>–1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>+1 +1 –1 –1 +1 +1 |
| The sequence $Ga^{7}_{512}(n)$, to be transmitted from left to right, up to down |
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1<br>+1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 |

**Table 28-89—The sequence $Ga^{i}_{512}(n)$ *(continued)***

| The sequence $Ga^{8}_{512}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1<br>+1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1<br>+1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>+1 +1 –1 –1 +1 +1 |

**Table 28-90—The sequence $Gb^{i}_{512}(n)$**

| The sequence $Gb^{1}_{512}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1<br>–1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>–1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 |
| The sequence $Gb^{2}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1<br>+1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1<br>+1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 |

### Table 28-90—The sequence $Gb^{i}_{512}(n)$ *(continued)*

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|---|
| The sequence $Gb^3{}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>–1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 |
| The sequence $Gb^4{}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1<br>–1 +1 +1 –1 –1 |
| The sequence $Gb^5{}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |

**Table 28-90—The sequence $Gb^{i}_{512}(n)$ *(continued)***

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|---|
| The sequence $Gb^{6}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1<br>+1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 |
| The sequence $Gb^{7}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1<br>+1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 |
| The sequence $Gb^{8}_{512}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1<br>+1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1<br>+1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1<br>–1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$**

| The sequence $Ga^{1}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1<br>–1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>–1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>–1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1<br>+1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1<br>–1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$ *(continued)***

| The sequence $Ga^{2}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1<br>+1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1<br>+1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$ *(continued)***

| The sequence $Ga^{3}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 |
| +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 |
| –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 |
| –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 |
| –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 |
| +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 |
| –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 |
| +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 |
| –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 |
| –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 |
| –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 |
| –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 |
| +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 |
| +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 |
| +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 |
| –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 |
| –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 |
| +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 |
| +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 |
| +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 |
| –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 |
| –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 |
| –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 |
| –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 |
| +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 |
| +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 |
| –1 –1 +1 –1 +1 +1 –1 –1 +1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$ *(continued)***

| The sequence $Ga^{4}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1<br>–1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 |

**Table 28-91—The sequence $Ga^i_{1024}(n)$ *(continued)***

| The sequence $Ga^5_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1<br>+1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1<br>+1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$ *(continued)***

| The sequence $Ga^{6}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1<br>+1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |

**Table 28-91—The sequence $Ga^{i}_{1024}(n)$ *(continued)***

| The sequence $Ga^{7}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1<br>+1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1<br>+1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1<br>+1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1<br>+1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>+1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 |

**Table 28-91—The sequence $Ga^i_{1024}(n)$ *(continued)***

| The sequence $Ga^8_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>+1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1<br>+1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1<br>+1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1<br>+1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1<br>–1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1<br>–1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1<br>+1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$**

| The sequence $Gb^{1}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1<br>–1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1<br>+1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1<br>–1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |

**Table 28-92—The sequence $Gb^i_{1024}(n)$ *(continued)***

| The sequence $Gb^2_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1<br>+1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1<br>–1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)***

| The sequence $Gb^{3}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1<br>+1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1<br>–1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1<br>–1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1<br>+1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1<br>+1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 –1 +1 +1 –1 –1 +1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)***

| The sequence $Gb^{4}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1<br>–1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1<br>–1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1<br>–1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1<br>–1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1<br>–1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1<br>–1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1<br>–1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 –1 –1 +1 +1 –1 –1 |

### Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)*

| The sequence $Gb^{5}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 |
| +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 |
| –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 |
| +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 |
| +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 |
| –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 |
| +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 |
| –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 |
| +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 |
| +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 |
| +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 |
| –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 |
| –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 |
| –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 |
| +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 |
| –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 |
| –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 |
| –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 |
| +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 |
| +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 |
| –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 |
| –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 |
| +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 |
| –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 |
| –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 |
| +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 |
| +1 –1 +1 –1 –1 +1 +1 –1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)***

| The sequence $Gb^{6}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1<br>–1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>+1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1<br>–1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1<br>–1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1<br>–1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1<br>–1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1<br>–1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1<br>+1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1<br>–1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1<br>+1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1<br>+1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)***

| The sequence $Gb^{7}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1<br>+1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1<br>+1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1<br>–1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1<br>–1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1<br>+1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1<br>–1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1<br>+1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1<br>+1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>–1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1<br>+1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1<br>+1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1<br>–1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1<br>+1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 +1 +1<br>+1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1<br>–1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1<br>+1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1<br>–1 +1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 +1 +1 +1 –1 –1 –1 –1 –1 –1 –1 +1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 –1 –1 –1 +1 –1 +1 –1 +1 –1 –1 +1 –1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 +1 +1 +1 –1 +1 –1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 +1 –1 –1 +1 +1 –1 |

**Table 28-92—The sequence $Gb^{i}_{1024}(n)$ *(continued)***

| The sequence $Gb^{8}_{1024}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1<br>–1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1<br>+1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1<br>–1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1<br>+1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1<br>+1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1<br>+1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1<br>–1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1<br>+1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1<br>–1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1<br>+1 –1 –1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1<br>–1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1<br>–1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1<br>+1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1<br>+1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1<br>+1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 +1 –1<br>–1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1<br>–1 +1 +1 +1 +1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1<br>+1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1<br>–1 –1 +1 –1 –1 +1 –1 +1 –1 +1 –1 –1 –1 –1 +1 +1 –1 –1 –1 +1 +1 –1 –1 +1 –1 +1 +1 +1 +1 +1 +1 +1 –1 –1 –1 +1 +1<br>–1 +1 –1 +1 –1 +1 +1 +1 +1 –1 –1 +1 +1 +1 –1 –1 +1 +1 –1 +1 –1 –1 –1 –1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 –1 +1<br>–1 +1 +1 +1 +1 –1 –1 +1 +1 |

## 28.10.3 Sequences of length 96, 192, 384, and 768

The Golay sequences of length 96, 192, 384, and 768 use a quadri-phase complex Golay complementary pair and are generated using the following recursive procedure, where *i* is the index of the space-time stream or transmit chain number:

— $Ga_3 = [+1, +1, -1]$

— $Gb_3 = [+1, +j, +1]$

— If ($i$ = 1, 3, 5, or 7), then $(A^{i}_{0}(n), \mathrm{B}^{i}_{0}(n)) = (+\mathrm{Ga}_3(2-n), +\mathrm{Gb}_3(2-n))$. Otherwise, if ($i$ = 2, 4, 6, or 8), then $(A^{i}_{0}(n), B^{i}_{0}(n)) = (+\mathrm{conj}(Gb_3(n)), -\mathrm{conj}(Ga_3(n)))$

— $A^{i}_{k}(n) = W^{i}_{k}A^{i}_{k-1}(n) + B^{i}_{k-1}(n-D_k)$

— $B^{i}_{k}(n) = \quad W^{i}_{k}A^{i}_{k-1}(n) - B^{i}_{k-1}(n-D_k)$

In the paragraph above, $A^{i}_{k}(n)$ and $B^{i}_{k}(n)$ are zero for $n < 0$ and for $n > 3 \times 2k$.

Starting with $k = 1$ and making 5, 6, 7, and 8 iterations, corresponding sequences of length 96, 192, 384, and 768 are obtained.

The Golay sequences are defined as follows, where *i* is the space-time stream or transmit chain number and $1 \le i \le 8$:

— $Ga^{i}_{96}(n) = \mathrm{conj}(A^{i}_{5}(95-n))$ and $Gb^{i}_{96} = \mathrm{conj}(B^{i}_{5}(95-n))$

— $Ga^{i}_{192}(n) = \mathrm{conj}(A^{i}_{6}(191-n))$ and $Gb^{i}_{192} = \mathrm{conj}(B^{i}_{6}(191-n))$

— $Ga^i{}_{384}(n) = \text{conj}(A^i{}_7(383 - n))$ and $Gb^i{}_{384} = \text{conj}(B^i{}_7(383 - n))$
— $Ga^i{}_{768}(n) = \text{conj}(A^i{}_8(767 - n))$ and $Gb^i{}_{768} = \text{conj}(B^i{}_8(767 - n))$

The value of the $D_K$ vector for each of the sequences are defined as follows, where $i$ is the space-time stream or transmit chain number and $1 \leq i \leq 8$:

— For $Ga^i{}_{96}$ and $Gb^i{}_{96}$: $D_K$ = [3 24 6 12 48].
— For $Ga^i{}_{192}$ and $Gb^i{}_{192}$: $D_K$ = [3 24 6 12 48 96].
— For $Ga^i{}_{384}$ and $Gb^i{}_{384}$: $D_K$ = [3 24 6 12 48 96 192].
— For $Ga^i{}_{768}$ and $Ga^i{}_{768}$: $D_K$ = [3 24 6 12 48 96 192 384].

As opposed to the $D_K$ vector, the value of the $W^i{}_k$ vector depends on the space-time stream or transmit chain number used to define the Golay pair ($Ga^i{}_{96}$, $Gb^i{}_{96}$), ($Ga^i{}_{192}$, $Gb^i{}_{192}$), ($Ga^i{}_{384}$, $Gb^i{}_{384}$), and ($Ga^i{}_{768}$, $Ga^i{}_{768}$). Table 28-93 shows the value of the $W^i{}_k$ vector defined for each space-time stream or transmit chain.

**Table 28-93—$W^i{}_K$ vector value to generate Golay sequences of length 96, 192, 384, and 768**

| Space-time stream/ transmit chain number ($i$) | $W^i{}_K$ for $Ga^i{}_{96}$ and $Gb^i{}_{96}$ | $W^i{}_K$ for $Ga^i{}_{192}$ and $Gb^i{}_{192}$ | $W^i{}_K$ for $Ga^i{}_{384}$ and $Gb^i{}_{384}$ | $W^i{}_K$ for $Ga^i{}_{768}$ and $Ga^i{}_{768}$ |
|---|---|---|---|---|
| 1 | [–1,–1,–1,–1,+1] | [–1,–1,–1,–1,+1,+1] | [–1,–1,–1,–1,+1,–1, –1] | [–1,–1,–1,–1,+1,–1, –1,+1] |
| 2 | | | | |
| 3 | [–1,–1,–1,+1,–1] | [–1,–1,–1,+1,–1,+1] | [–1,–1,–1,+1,–1,–1, +1] | [–1,–1,–1,+1,–1,–1, +1, +1] |
| 4 | | | | |
| 5 | [–1,–1,+1,–1,–1] | [–1,–1,+1,–1,–1,+1] | [–1,–1,–1,+1,–1,+1, +1] | [–1,–1,–1,+1,–1,+1, +1, +1] |
| 6 | | | | |
| 7 | [–1,–1,+1,+1,–1] | [–1,–1,+1,+1,–1,+1] | [–1,–1,–1,+1,+1,+1, –1] | [–1,–1,–1,+1,+1,+1, –1, +1] |
| 8 | | | | |

The sequence $Ga_{96}(n) = \text{conj}(A_5(95 - n))$ and the sequence $Gb_{96}(n) = \text{conj}(B_5(95 - n))$, $n = 0, 1, \ldots, 95$.

The sequence $Ga_{192}(n) = \text{conj}(A_6(191 - n))$ and the sequence $Gb_{192}(n) = \text{conj}(B_6(191 - n))$, $n = 0, 1, \ldots, 191$.

The sequence $Ga_{384}(n) = \text{conj}(A_7(383 - n))$ and the sequence $Gb_{384}(n) = \text{conj}(B_7(383 - n))$, $n = 0, 1, \ldots, 383$.

The sequence $Ga_{768}(n) = \text{conj}(A_8(767 - n))$ and the sequence $Gb_{768}(n) = \text{conj}(B_8(767 - n))$, $n = 0, 1, \ldots, 767$.

The sequences are defined from Table 28-94 through Table 28-101. The sequences in the tables are normative; the description above is informative.

### Table 28-94—The sequence $Ga^{i}_{96}(n)$

| |
|---|
| The sequence $Ga^{1}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{2}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{3}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{4}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>+1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{5}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{6}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1<br>–1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{7}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 |
| The sequence $Ga^{8}_{96}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 |

### Table 28-95—The sequence $Gb^{i}_{96}(n)$

| |
|---|
| The sequence $Gb^{1}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Gb^{2}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |

### Table 28-95—The sequence $Gb^{i}_{96}(n)$ *(continued)*

| |
|---|
| The sequence $Gb^{3}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Gb^{4}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Gb^{5}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 |
| The sequence $Gb^{6}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 |
| The sequence $Gb^{7}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 |
| The sequence $Gb^{8}_{96}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 |

### Table 28-96—The sequence $Ga^{i}_{192}(n)$

| |
|---|
| The sequence $Ga^{1}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{2}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |

### Table 28-96—The sequence $Ga^{i}_{192}(n)$ *(continued)*

| |
|---|
| The sequence $Ga^{3}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>–1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 |
| The sequence $Ga^{4}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 |
| The sequence $Ga^{5}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1<br>–1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1<br>+j –1 +1 +1 –1 |
| The sequence $Ga^{6}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1<br>–j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 |
| The sequence $Ga^{7}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 |
| The sequence $Ga^{8}_{192}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1<br>–1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>–1 –j –1 |

### Table 28-97—The sequence $Gb^{i}_{192}(n)$

| |
|---|
| The sequence $Gb^{1}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 |
| The sequence $Gb^{2}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>–1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 |
| The sequence $Gb^{3}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 |
| The sequence $Gb^{4}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 |
| The sequence $Gb^{5}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>+1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 |
| The sequence $Gb^{6}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1<br>–1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>–1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 +1<br>–1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 +1 +j +1 |
| The sequence $Gb^{7}_{192}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1<br>–j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1<br>–1 –1 +1 |

### Table 28-97—The sequence $Gb^{i}_{192}(n)$ *(continued)*

| The sequence $Gb^{8}_{192}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1<br>+1 –1 –1 –1 –j –1 |

### Table 28-98—The sequence $Ga^{i}_{384}(n)$

| The sequence $Ga^{1}_{384}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1<br>+j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{2}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1<br>–j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{3}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 |

### Table 28-98—The sequence $Ga^{i}_{384}(n)$ *(continued)*

| |
|---|
| The sequence $Ga^{4}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1<br>–j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 |
| The sequence $Ga^{5}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1<br>+1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 |
| The sequence $Ga^{6}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1<br>–1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{7}_{384}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 |

### Table 28-98—The sequence $Ga^i_{384}(n)$ *(continued)*

| The sequence $Ga^8_{384}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>+1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1<br>+1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j<br>+1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |

### Table 28-99—The sequence $Gb^i_{384}(n)$

| The sequence $Gb^1_{384}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1<br>–1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 |
| The sequence $Gb^2_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1<br>–1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Gb^3_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>–1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1<br>–1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1<br>–1 +1 –j +1 –1 –1 +1 |

**Table 28-99—The sequence $Gb^{i}_{384}(n)$ *(continued)***

| |
|---|
| The sequence $Gb^{4}_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1<br>–1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j<br>+1 +1 –1 –1 –1 –j –1 |
| The sequence $Gb^{5}_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 |
| The sequence $Gb^{6}_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1<br>+j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1<br>–1 +1 +1 +1 +j +1 |
| The sequence $Gb^{7}_{384}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1<br>+j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 |

### Table 28-99—The sequence $Gb^{i}_{384}(n)$ *(continued)*

| The sequence $Gb^{8}_{384}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j<br>–1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 |

### Table 28-100—The sequence $Ga^{i}_{768}(n)$

| The sequence $Ga^{1}_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1<br>–1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1<br>–1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1<br>–1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j<br>+1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

**Table 28-100—The sequence $Ga^{i}_{768}(n)$ *(continued)***

| |
|---|
| The sequence $Ga^{2}_{768}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1<br>–1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1<br>–1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j<br>+1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1<br>–1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{3}_{768}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>–1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1<br>–1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1<br>–1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1<br>–1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 |

**Table 28-100—The sequence $Ga^i_{768}(n)$ *(continued)***

| The sequence $Ga^4_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1<br>–1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j<br>+1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1<br>–1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>–1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 |
| The sequence $Ga^5_{768}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1<br>–1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

**Table 28-100—The sequence $Ga^{i}_{768}(n)$ *(continued)***

| |
|---|
| The sequence $Ga^{6}_{768}(n)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1<br>+j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1<br>–1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1<br>–j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1<br>–j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Ga^{7}_{768}(n)$, to be transmitted from left to right, up to down |
| –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1<br>+j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1<br>–1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

### Table 28-100—The sequence $Ga^i_{768}(n)$ *(continued)*

| The sequence $Ga^8_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j<br>–1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>–1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j<br>–1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |

### Table 28-101—The sequence $Gb^i_{768}(n)$

| The sequence $Gb^1_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1<br>+1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

**Table 28-101—The sequence $Gb^{i}_{768}(n)$ *(continued)***

| The sequence $Gb^{2}_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1<br>–j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j<br>+1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1<br>+1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1<br>–1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>–1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1<br>–1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>–1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j<br>–1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Gb^{3}_{768}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1<br>+1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1<br>–1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1<br>+1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1<br>+1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1<br>–1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1<br>+1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j<br>–1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 |

**Table 28-101—The sequence $Gb^{i}_{768}(n)$ *(continued)***

| The sequence $Gb^{4}_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1<br>–j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1<br>+1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1<br>–1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1<br>–j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1<br>–1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j<br>–1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 |
| The sequence $Gb^{5}_{768}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1<br>+1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1<br>+j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>–1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1<br>–1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j<br>+1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1<br>+1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1<br>+1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1<br>+1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1<br>–1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1<br>+j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

**Table 28-101—The sequence $Gb^{i}_{768}(n)$ *(continued)***

| |
|---|
| The sequence $Gb^{6}_{768}(n)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1<br>+1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j<br>+1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j<br>+1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1<br>+1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1<br>+1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1<br>+j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |
| The sequence $Gb^{7}_{768}(n)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1<br>–1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1<br>–j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1<br>–1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j<br>+1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1<br>–1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1<br>+j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1<br>–1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1<br>–1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 +1 –j +1 +1 +1 –1 +1 –j +1 +1 +1 –1<br>–1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j<br>–1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j –1 –1<br>–1 +1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1 +1 –j +1 –1 –1 +1<br>–1 +j –1 +1 +1 –1 +1 –j +1 +1 +1 –1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –1 +j<br>–1 +1 +1 –1 +1 –j +1 –1 –1 +1 –1 +j –1 +1 +1 –1 |

### Table 28-101—The sequence $Gb^{i}_{768}(n)$ *(continued)*

| The sequence $Gb^{8}_{768}(n)$, to be transmitted from left to right, up to down |
|---|
| +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1<br>+1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1<br>+1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j<br>–1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1<br>+1 –1 –1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1<br>–1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1<br>+j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1<br>+1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1<br>+1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 –1 +1 +1<br>+1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1<br>+j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1<br>–1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1<br>+1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1<br>–1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 +1 –1 –1 +1 +j +1 +1 –1 –1 +1 +j +1<br>–1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1<br>+1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 –1 +1<br>+1 –1 –j –1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1 –j –1 +1 –1 –1 –1<br>–j –1 –1 +1 +1 +1 +j +1 +1 –1 –1 +1 +j +1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 –1 –j –1 –1 +1 +1 +1 +j +1<br>–1 +1 +1 +1 +j +1 +1 –1 –1 –1 –j –1 –1 +1 +1 +1 +j +1 |

## 28.11 OFDM sequences

### 28.11.1 EDMG-STF sequence

#### 28.11.1.1 General

For transmissions over a 2.16 GHz (or 2.16+2.16 GHz), 4.32 GHz (or 4.32+4.32 GHz), 6.48 GHz, and 8.64 GHz channel, the EDMG OFDM mode uses the pairs of $EDMGS^{i_{STS}}_{left,N}$ and $EDMGS^{i_{STS}}_{right,N}$ sequences ($i_{STS}$ = 1, 2, …, 8) with length $N$ = 176, 385, 595, and 804, respectively, to define the EDMG-STF field in frequency domain.

#### 28.11.1.2 Sequence definition

The sequence pairs $EDMGS^{i_{STS}}_{left,N}$ and $EDMGS^{i_{STS}}_{right,N}$ of length $N$ = 176, 385, 595, and 804 use {±1, ±$j$} symbols alphabet and are defined in Table 28-102 through Table 28-109.

**Table 28-102—The sequence $EDMGS^{i_{STS}}_{left,176}(n)$**

| |
|---|
| The sequence $EDMGS^{1}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{2}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{3}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{4}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{5}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{6}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{7}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |
| The sequence $EDMGS^{8}_{left,176}(n)$, to be transmitted from left to right, up to down |
| 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 |

**Table 28-103—The sequence $EDMGS^{i_{STS}}_{right,176}(n)$**

| |
|---|
| The sequence $EDMGS^{1}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0<br>–1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0<br>0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0<br>–j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 |
| The sequence $EDMGS^{2}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0<br>+1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0<br>0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j<br>0 0 0 –j 0 0 0 +1 0 0 0 +1 0 |
| The sequence $EDMGS^{3}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0<br>–j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0<br>0 0 –j 0 0 0 +1 0 0 0 +1 0 |
| The sequence $EDMGS^{4}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +j<br>0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0<br>–j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0<br>0 0 –j 0 0 0 +1 0 0 0 +1 0 |
| The sequence $EDMGS^{5}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0<br>+1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0<br>0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 |
| The sequence $EDMGS^{6}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0<br>–1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0<br>0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 |
| The sequence $EDMGS^{7}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +j<br>0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0<br>0 0 +j 0 0 0 –1 0 0 0 –1 0 |
| The sequence $EDMGS^{8}_{right,176}(n)$, to be transmitted from left to right, up to down |
| 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 +j 0<br>0 0 +j 0 0 0 –1 0 0 0 –1 0 |

## Table 28-104—The sequence $EDMGS_{left,385}^{i_{STS}}(n)$

| |
|---|
| The sequence $EDMGS_{left,385}^{1}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS_{left,385}^{2}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS_{left,385}^{3}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS_{left,385}^{4}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0<br>0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1<br>0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS_{left,385}^{5}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |

**Table 28-104—The sequence $EDMGS^{i_{STS}}_{left,385}(n)$ *(continued)***

| The sequence $EDMGS^{6}_{left,385}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0<br>0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS^{7}_{left,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 |
| The sequence $EDMGS^{8}_{left,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0<br>0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1<br>0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0<br>0 +1 0 0 0 +j 0 0 0 +1 0 0 |

**Table 28-105—The sequence $EDMGS^{i_{STS}}_{right,385}(n)$**

| The sequence $EDMGS^{1}_{right,385}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{2}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 |

**Table 28-105—The sequence $EDMGS^{i_{STS}}_{right,385}(n)$ *(continued)***

| |
|---|
| The sequence $EDMGS^{3}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0<br>0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{4}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0<br>0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 –j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{5}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{6}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{7}_{right,385}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 |

### Table 28-105—The sequence $EDMGS^{i_{STS}}_{right,385}(n)$ *(continued)*

| The sequence $EDMGS^{8}_{right,385}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0<br>0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0<br>–1 0 0 0 –j 0 0 0 –1 0 0 |

### Table 28-106—The sequence $EDMGS^{i_{STS}}_{left,595}(n)$

| The sequence $EDMGS^{1}_{left,595}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0<br>0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>+j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1<br>0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0<br>0 +1 0 0 |
| The sequence $EDMGS^{2}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0<br>+1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>+j 0 0 0 +1 0 0 |
| The sequence $EDMGS^{3}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 +1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0<br>0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>+j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0<br>0 +1 0 0 |

**Table 28-106—The sequence $EDMGS^{i_{STS}}_{left,595}(n)$ *(continued)***

| |
|---|
| The sequence $EDMGS^{4}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0<br>0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0<br>0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j<br>0 0 0 +1 0 0 |
| The sequence $EDMGS^{5}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0<br>–j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0<br>0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0<br>+1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j<br>0 0 0 +1 0 0 |
| The sequence $EDMGS^{6}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0<br>–j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0<br>0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0<br>0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0<br>+1 0 0 |
| The sequence $EDMGS^{7}_{left,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1<br>0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0<br>0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j<br>0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0<br>0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0<br>0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j<br>0 0 0 +1 0 0 |

**Table 28-106—The sequence $EDMGS^{i_{STS}}_{left,595}(n)$ *(continued)***

| The sequence $EDMGS^{8}_{left,595}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0<br>0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j<br>0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0<br>0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0<br>–1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j<br>0 0 0 +1 0 0 |

**Table 28-107—The sequence $EDMGS^{i_{STS}}_{right,595}(n)$**

| The sequence $EDMGS^{1}_{right,595}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j<br>0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 0 |
| The sequence $EDMGS^{2}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j<br>0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j<br>0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 –1 0 0 0 0 |
| The sequence $EDMGS^{3}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0<br>0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0<br>0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0<br>0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0<br>0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 0 |

**Table 28-107—The sequence $EDMGS^{i_{STS}}_{right,595}(n)$ *(continued)***

| |
|---|
| The sequence $EDMGS^{4}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0<br>+j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0<br>+j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0<br>+j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0<br>+j 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0<br>–1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 0 |
| The sequence $EDMGS^{5}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0<br>+1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j<br>0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j<br>0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 0 |
| The sequence $EDMGS^{6}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1<br>0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0<br>0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j<br>0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 0 |
| The sequence $EDMGS^{7}_{right,595}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0<br>+j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0<br>+j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0<br>–j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0<br>+j 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0<br>0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 0 |

### Table 28-107—The sequence $EDMGS^{i_{STS}}_{right,595}(n)$ *(continued)*

| The sequence $EDMGS^{8}_{right,595}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 –j<br>0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –j 0 0 0 +j 0 0 0 –j<br>0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –1 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 +1 0 0 0 0 |

### Table 28-108—The sequence $EDMGS^{i_{STS}}_{left,804}(n)$

| The sequence $EDMGS^{1}_{left,804}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0<br>0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>–1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0<br>0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0<br>0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 +j<br>0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j<br>0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0<br>0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0<br>0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0<br>0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 |
| The sequence $EDMGS^{2}_{left,804}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0<br>0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j<br>0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0<br>0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0<br>0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –j<br>0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0<br>+j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0<br>0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0<br>0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1<br>0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0<br>+1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0<br>0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0<br>–j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 |

**Table 28-108—The sequence $EDMGS_{left,804}^{i_{STS}}(n)$ *(continued)***

| The sequence $EDMGS_{left,804}^{3}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0<br>0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0<br>0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –j<br>0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0<br>0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0<br>0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0<br>–1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0<br>0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0<br>–1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0<br>0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 |
| The sequence $EDMGS_{left,804}^{4}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0<br>0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>–1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0<br>0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0<br>0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +j 0 0 0 +j<br>0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j<br>0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0<br>–1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0<br>0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0<br>–1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0<br>0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0<br>+1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0<br>0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 |
| The sequence $EDMGS_{left,804}^{5}(n)$, to be transmitted from left to right, up to down |
| 0 0 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0<br>0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j<br>0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0<br>0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0<br>0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –j<br>0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0<br>+1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0<br>0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0<br>0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1<br>0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0<br>+j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 |

**Table 28-108—The sequence $EDMGS_{left,804}^{i_{STS}}(n)$ *(continued)***

| The sequence $EDMGS_{left,804}^{6}(n)$, to be transmitted from left to right, up to down |
|---|
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| The sequence $EDMGS_{left,804}^{7}(n)$, to be transmitted from left to right, up to down |
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| The sequence $EDMGS_{left,804}^{8}(n)$, to be transmitted from left to right, up to down |
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**Table 28-109—The sequence $EDMGS^{i_{STS}}_{right,804}(n)$**

| The sequence $EDMGS^{1}_{right,804}(n)$, to be transmitted from left to right, up to down |
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| 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j<br>0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0<br>–j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0<br>0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0<br>–j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0<br>0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +j<br>0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0<br>–j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0<br>0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0<br>0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0<br>+1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0<br>0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |
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**Table 28-109—The sequence $EDMGS^{i_{STS}}_{right,804}(n)$ *(continued)***

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| The sequence $EDMGS^{4}_{right,804}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j<br>0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j<br>0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0<br>0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j<br>0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0<br>0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0<br>0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j<br>0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0<br>+1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0<br>0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |
| The sequence $EDMGS^{5}_{right,804}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j<br>0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0<br>–j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0<br>–j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0<br>0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j<br>0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0 –j 0<br>0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0<br>+1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0<br>0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |
| The sequence $EDMGS^{6}_{right,804}(n)$, to be transmitted from left to right, up to down |
| 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j<br>0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0<br>–j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0<br>0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0<br>0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0<br>+j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0<br>0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0<br>+j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0<br>0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0<br>0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1<br>0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0<br>–1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0<br>0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |

**Table 28-109—The sequence $EDMGS^{i_{STS}}_{right,804}(n)$ *(continued)***

| The sequence $EDMGS^{7}_{right,804}(n)$, to be transmitted from left to right, up to down |
|---|
| 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j<br>0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0<br>0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1<br>0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0<br>+j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0<br>0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j<br>0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0<br>–1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –1 0 0 0 –1 0 0 0 +j 0<br>0 0 –j 0 0 0 +j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j<br>0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0<br>+1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0<br>0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1<br>0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0<br>+j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |
| The sequence $EDMGS^{8}_{right,804}(n)$, to be transmitted from left to right, up to down |
| 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j<br>0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0<br>+j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 –j 0 0<br>0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1<br>0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0<br>0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0<br>0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0<br>+j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0<br>0 0 –1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 +1 0 0 0<br>–j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 +j 0 0 0 –j 0 0 0 +j 0 0 0 –1 0 0<br>0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 –1 0 0 0 +j 0 0 0 +j 0 0 0 –1 0 0 0 –j 0<br>0 0 +1 0 0 0 +1 0 0 0 –j 0 0 0 +j 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1<br>0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 –j 0 0 0 –j 0 0 0 –1 0 0 0 +1 0 0 0 –1 0 0 0 –j 0 0 0 –1 0 0 0<br>–1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0 0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 –j 0 0 0 –1 0 0 0 –1 0 0 0 –j 0 0 0 +1 0 0 0 +j 0<br>0 0 +j 0 0 0 +1 0 0 0 –1 0 0 0 +1 0 0 0 +j 0 0 0 +1 0 0 0 +1 0 0 0 +j 0 0 0 –1 0 0 0 0 0 |

## 28.11.2 EDMG-CEF sequence

### 28.11.2.1 General

For transmissions over a 2.16 GHz (or 2.16+2.16 GHz), 4.32 GHz (or 4.32+4.32 GHz), 6.48 GHz, and 8.64 GHz channel, the EDMG OFDM mode uses the pairs of $Seq^{i}_{left,N}$ and $Seq^{i}_{right,N}$ sequences of length $N$ = 176, 385, 595, and 804, respectively, to define the EDMG-CEF field in frequency domain. The $i^{\text{th}}$ index defines the space-time stream or the transmit chain number.

### 28.11.2.2 Sequences definition

The sequence pairs $Seq^{i}_{left,N}$ and $Seq^{i}_{right,N}$ of length $N$ = 176, 385, 595, and 804 use {±1, ±$j$} symbols alphabet and are defined in Table 28-110 through Table 28-117.

### Table 28-110—The sequence $Seq^{i}_{left,176}(k)$

| |
|---|
| The sequence $Seq^{1}_{left,176}(k)$, to be transmitted from left to right, up to down |
| –1 –j –j +1 +j –j +1 –1 +1 –j –1 +1 –1 +1 –j –1 –1 +j +j +j –1 –1 +1 +j +j –1 –j +j –1 +1 –1 +j +1 +1 –1 +1 –j –1 –1<br>+j +j +j –1 –1 +j –1 –1 –j +1 –1 –j +j –j –1 +j –j +j –j –1 +j +j +1 +1 +1 +j +j +j –1 –1 –j +1 –1 –j +j –j –1 +j +j –j +j<br>+1 –j –j –1 –1 –1 –j –j +j –1 –1 –j +1 –1 –j +j –j –1 +j –j +j –j –1 +j +j +1 +1 +1 +j +j –j +1 +1 +j –1 +1 +j –j +j +1<br>–j –j +j –j –1 +j +j +1 +1 +1 +j +j –1 –j –j +1 +j –j +1 –1 +1 –j –1 +1 –1 +1 –j –1 –1 +j +j +j –1 –1 –1 –j –j +1 +j –j<br>+1 –1 +1 –j –1 –1 +1 –1 +j +1 +1 –j –j –j +1 +1 |
| The sequence $Seq^{2}_{left,176}(k)$, to be transmitted from left to right, up to down |
| +1 –j –j –1 +j –j –1 +1 –1 –j +1 +1 –j –j –1 +j –j –1 +1 –1 –j +1 +j +1 +1 –j –1 +1 –j +j –j +1 +j –j –1 –1 +j +1 –1 +j<br>–j +j –1 –j +1 –1 +1 +j –1 –1 –j –j –j –1 –1 +1 –1 +1 +j –1 –1 –j –j –j –1 –1 +j –j +j –1 –j –j +1 +1 +1 –j –j –j +j –j<br>+1 +j +j –1 –1 –1 +j +j +j +1 +1 –j –1 +1 –j +j –j +1 +j –j –1 –1 +j +1 –1 +j –j +j –1 –j –1 +j +j +1 –j +j +1 –1 +1 +j<br>–1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 –j +j –j +1 +j +j –1 –1 –1 +j +j +j –j +j –1 –j –j +1 +1 +1 –j –j +1 –1 +1 +j –1 –1<br>–j –j –j –1 –1 +1 –1 +1 +j –1 –1 –j –j –j –1 –1 |
| The sequence $Seq^{3}_{left,176}(k)$, to be transmitted from left to right, up to down |
| +1 +1 +j +j +j +1 +1 –j –1 +1 –1 +1 +1 +j +j +j +1 +1 –j –1 +1 –1 +j +j –1 –1 –1 +j +j +1 –j +j –j –j –j +1 +1 +1 –j<br>–j –1 +j –j +j +j +j –1 –1 –1 +j +j +1 –j +j –j +j +j –1 –1 –1 +j +j +1 –j +j –j +1 +1 +j +j +j +1 +1 –j –1 +1 –1 –1 –1<br>–j –j –j –1 –1 +j +1 –1 +1 –j –1 +j –j +j –1 +1 +j –1 –1 –j +j +1 –j +j –j +1 –1 –j +1 +1 +j +1 –j –1 +1 –1 –j +j –1 –j<br>–j +1 +1 –j –1 +1 –1 –j +j –1 –j –j +1 +1 –j –1 +1 –1 –j +j –1 –j –j +1 –1 +j +1 –1 +1 +j –j +1 +j +j –1 –j –1 +j –j +j<br>–1 +1 +j –1 –1 –j –j –1 +j –j +j –1 +1 +j –1 –1 –j |
| The sequence $Seq^{4}_{left,176}(k)$, to be transmitted from left to right, up to down |
| –1 +j +j +1 –j +j +1 –1 +1 +j –1 –j –1 –1 +j +1 –1 +j –j +j –1 –j +j –j +j –1 –j –j +1 +1 +1 –j –j –1 +1 –1 –j +1 +1 +j<br>+j +j +1 +1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 –j –1 –1 +j +1 –1 +j –j +j –1 –j –j +j –j +1 +j +j –1 –1 –1 +j +j +1 –1 +1<br>+j –1 –1 –j –j –j –1 –1 +1 –j –j –1 +j –j –1 +1 –1 –j +1 –j –1 –1 +j +1 –1 +j –j +j –1 –j –j +j –j +1 +j +j –1 –1 –1 +j<br>+j –1 +1 –1 –j +1 +1 +j +j +j +1 +1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 +j +1 +1 –j –1 +1 –j +j –j +1 +j –j +j –j +1 +j +j<br>–1 –1 –1 +j +j –1 +1 –1 –j +1 +1 +j +j +j +1 +1 |
| The sequence $Seq^{5}_{left,176}(k)$, to be transmitted from left to right, up to down |
| +1 –1 +1 –j –1 –1 +j +j +j –1 –1 +1 +j +j –1 –j +j –1 +1 –1 +j +1 +1 –1 +1 –j –1 –1 +j +j +j –1 –1 +1 +j +j –1 –j +j<br>–1 +1 –1 +j +1 +j –j +j +1 –j –j –1 –1 –1 –j –j +j –1 –1 –j +1 –1 –j +j –j –1 +j –j +j –j –1 +j +j +1 +1 +1 +j +j –j +1<br>+1 +j –1 +1 +j –j +j +1 –j –j +j –j –1 +j +j +1 +1 +1 +j +j +j –1 –1 –j +1 –1 –j +j –j –1 +j +j –j +j +1 –j –j –1 –1 –1 –j<br>–j –j +1 +1 +j –1 +1 +j –j +j +1 –j +1 –1 +1 –j –1 –1 +j +j +j –1 –1 –1 –j –j +1 +j –j +1 –1 +1 –j –1 +1 –1 +1 –j –1 –1<br>+j +j +j –1 –1 –1 –j –j +1 +j –j +1 –1 +1 –j –1 |
| The sequence $Seq^{6}_{left,176}(k)$, to be transmitted from left to right, up to down |
| +1 +j –1 +1 –1 +j –j –1 +j +j +1 –1 –j +1 –1 +1 –j +j +1 –j –j –1 +j –1 –j +j –j –1 +1 –j –1 –1 +j –j +1 +j –j +j +1 –1<br>+j +1 +1 –j +j +j +1 +1 +1 +j +j –1 –j +j –j +j +j +1 +1 +1 +j +j –1 –j +j –j –1 –1 +j +j +j –1 –1 –j +1 –1 +1 –1 –1 +j<br>+j +j –1 –1 –j +1 –1 +1 +j –1 –j +j –j –1 +1 –j –1 –1 +j +j –1 –j +j –j –1 +1 –j –1 –1 +j +1 +j –1 +1 –1 +j –j –1 +j +j<br>+1 +1 +j –1 +1 –1 +j –j –1 +j +j +1 –1 –1 +j +j +j –1 –1 –j +1 –1 +1 +1 +1 –j –j –j +1 +1 +j –1 +1 –1 +j +j +1 +1 +1<br>+j +j –1 –j +j –j –j –j –1 –1 –1 –j –j +1 +j –j +j |
| The sequence $Seq^{7}_{left,176}(k)$, to be transmitted from left to right, up to down |
| –j –1 +j –j +j –1 +1 +j –1 –1 –j +j +j –1 –1 –1 +j +j +1 –j +j –j +1 –j –1 +1 –1 –j +j –1 –j –j +1 –1 –1 –j –j –j –1 –1<br>+j +1 –1 +1 +1 –j –1 +1 –1 –j +j –1 –j –j +1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 –j –1 +j –j +j –1 +1 +j –1 –1 –j +j +j –1<br>–1 –1 +j +j +1 –j +j –j +1 –j –1 +1 –1 –j +j –1 –j –j +1 +1 +1 +j +j +j +1 +1 –j –1 +1 –1 –j –1 +j –j +j –1 +1 +j –1 –1<br>–j –j –j +1 +1 +1 –j –j –1 +j –j +j +j +1 –j +j –j +1 –1 –j +1 +1 +j +j +j –1 –1 –1 +j +j +1 –j +j –j –1 +j +1 –1 +1 +j<br>–j +1 +j +j –1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 |
| The sequence $Seq^{8}_{left,176}(k)$, to be transmitted from left to right, up to down |
| +1 –1 +1 +j –1 –1 –j –j –j –1 –1 +j –j +j –1 –j –j +1 +1 +1 –j –j –j +j –j +1 +j +j –1 –1 –1 +j +j +1 –1 +1 +j –1 –1 –j<br>–j –j –1 –1 +1 –1 +1 +j –1 –1 –j –j –j –1 –1 –j +j –j +1 +j +j –1 –1 –1 +j +j +j –j +j –1 –j –j +1 +1 +1 –j –j +1 –1 +1<br>+j –1 –1 –j –j –j –1 –1 +j +1 +1 –j –1 +1 –j +j –j +1 +j –1 +j +j +1 –j +j +1 –1 +1 +j –1 –1 +j +j +1 –j +j +1 –1 +1 +j<br>–1 –j –1 –1 +j +1 –1 +j –j +j –1 –j +j +1 +1 –j –1 +1 –j +j –j +1 +j +1 –j –j –1 +j –j –1 +1 –1 –j +1 +1 –j –j –1 +j –j<br>–1 +1 –1 –j +1 –j –1 –1 +j +1 –1 +j –j +j –1 –j |

### Table 28-111—The sequence $Seq^{i}_{right,176}(k)$

| |
|---|
| The sequence $Seq^{1}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 –j –j +1 +j –j +1 –1 +1 –j –1 +1 –1 +1 –j –1 –1 +j +j +j –1 –1 +1 +j +j –1 –j +j –1 +1 –1 +j +1 +1 –1 +1 –j –1 –1<br>+j +j +j –1 –1 +j –1 –1 –j +1 –1 –j +j –j –1 +j –j +j –j –1 +j +j +1 +1 +1 +j +j +j –1 –1 –j +1 –1 –j +j –j –1 +j +j –j +j<br>+1 –j –j –1 –1 –1 –j –j –j +1 +1 +j –1 +1 +j –j +j +1 –j +j –j +j +1 –j –j –1 –1 –1 –j –j +j –1 –1 –j +1 –1 –j +j –j –1 +j<br>+j –j +j +1 –j –j –1 –1 –1 –j –j +1 +j +j –1 –j +j –1 +1 –1 +j +1 –1 +1 –1 +j +1 +1 –j –j –j +1 +1 +1 +j +j –1 –j +j –1<br>+1 –1 +j +1 +1 –1 +1 –j –1 –1 +j +j +j –1 –1 |
| The sequence $Seq^{2}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 +j +j +1 –j +j +1 –1 +1 +j –1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 +j +1 +1 –j –1 +1 –j +j –j +1 +j –j –1 –1 +j +1 –1<br>+j –j +j –1 –j –1 +1 –1 –j +1 +1 +j +j +j +1 +1 –1 +1 –1 –j +1 +1 +j +j +j +1 +1 +j –j +j –1 –j –j +1 +1 +1 –j –j –j +j<br>–j +1 +j +j –1 –1 –1 +j +j –j –1 –1 +j +1 –1 +j –j +j –1 –j +j +1 +1 –j –1 +1 –j +j –j +1 +j –1 +j +j +1 –j +j +1 –1 +1<br>+j –1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 +j –j +j –1 –j –j +1 +1 +1 –j –j –j +j –j +1 +j +j –1 –1 –1 +j +j +1 –1 +1 +j –1<br>–1 –j –j –j –1 –1 +1 –1 +1 +j –1 –1 –j –j –j –1 –1 |
| The sequence $Seq^{3}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 –1 –j –j –j –1 –1 +j +1 –1 +1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 –j –j +1 +1 +1 –j –j –1 +j –j +j +j +j –1 –1 –1 +j +j<br>+1 –j +j –j +j +j –1 –1 –1 +j +j +1 –j +j –j +j +j –1 –1 –1 +j +j +1 –j +j –j +1 +1 +j +j +j +1 +1 –j –1 +1 –1 –1 –1 –j<br>–j –j –1 –1 +j +1 –1 +1 +j +1 –j +j –j +1 –1 –j +1 +1 +j –j –1 +j –j +j –1 +1 +j –1 –1 –j –1 +j +1 –1 +1 +j –j +1 +j +j<br>–1 –1 +j +1 –1 +1 +j –j +1 +j +j –1 +1 –j –1 +1 –1 –j +j –1 –j –j +1 –1 +j +1 –1 +1 +j –j +1 +j +j –1 –j –1 +j –j +j –1<br>+1 +j –1 –1 –j –j –1 +j –j +j –1 +1 +j –1 –1 –j |
| The sequence $Seq^{4}_{right,176}(k)$, to be transmitted from left to right, up to down |
| +1 –j –j –1 +j –j –1 +1 –1 –j +1 –j –1 –1 +j +1 –1 +j –j +j –1 –j –j +j –j +1 +j +j –1 –1 –1 +j +j –1 +1 –1 –j +1 +1 +j<br>+j +j +1 +1 +1 –j –j –1 +j –j –1 +1 –1 –j +1 –j –1 –1 +j +1 –1 +j –j +j –1 –j +j –j +j –1 –j –j +1 +1 +1 –j –j +1 –1 +1<br>+j –1 –1 –j –j –j –1 –1 –1 +j +j +1 –j +j +1 –1 +1 +j –1 –j –1 –1 +j +1 –1 +j –j +j –1 –j +j –j +j –1 –j –j +1 +1 +1 –j<br>–j –1 +1 –1 –j +1 +1 +j +j +j +1 +1 +1 –j –j –1 +j –j –1 +1 –1 –j +1 +j +1 +1 –j –1 +1 –j +j –j +1 +j +j –j +j –1 –j –j<br>+1 +1 +1 –j –j –1 +1 –1 –j +1 +1 +j +j +j +1 +1 |
| The sequence $Seq^{5}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 +1 –1 +j +1 +1 –j –j –j +1 +1 –1 –j –j +1 +j –j +1 –1 +1 –j –1 –1 +1 –1 +j +1 +1 –j –j –j +1 +1 –1 –j –j +1 +j –j<br>+1 –1 +1 –j –1 +j –j +j +1 –j –j –1 –1 –1 –j –j +j –1 –1 –j +1 –1 –j +j –j –1 +j –j +j –j –1 +j +j +1 +1 +1 +j +j –j +1<br>+1 +j –1 +1 +j –j +j +1 –j +j –j +j +1 –j –j –1 –1 –1 –j –j –j +1 +1 +j –1 +1 +j –j +j +1 –j –j +j –j –1 +j +j +1 +1 +1<br>+j +j +j –1 –1 –j +1 –1 –j +j –j –1 +j +1 –1 +1 –j –1 –1 +j +j +j –1 –1 –1 –j –j +1 +j –j +1 –1 +1 –j –1 +1 –1 +1 –j –1<br>–1 +j +j +j –1 –1 –1 –j –j +1 +j –j +1 –1 +1 –j –1 |
| The sequence $Seq^{6}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 –j +1 –1 +1 –j +j +1 –j –j –1 +1 +j –1 +1 –1 +j –j –1 +j +j +1 +j –1 –j +j –j –1 +1 –j –1 –1 +j –j +1 +j –j +j +1 –1<br>+j +1 +1 –j –j –j –1 –1 –1 –j –j +1 +j –j +j –j –j –1 –1 –1 –j –j +1 +j –j +j –1 –1 +j +j +j –1 –1 –j +1 –1 +1 –1 –1 +j<br>+j +j –1 –1 –j +1 –1 +1 –j +1 +j –j +j +1 –1 +j +1 +1 –j –j +1 +j –j +j +1 –1 +j +1 +1 –j +1 +j –1 +1 –1 +j –j –1 +j +j<br>+1 +1 +j –1 +1 –1 +j –j –1 +j +j +1 +1 +1 –j –j –j +1 +1 +j –1 +1 –1 –1 –1 +j +j +j –1 –1 –j +1 –1 +1 +j +j +1 +1 +1<br>+j +j –1 –j +j –j –j –j –1 –1 –1 –j –j +1 +j –j +j |
| The sequence $Seq^{7}_{right,176}(k)$, to be transmitted from left to right, up to down |
| +j +1 –j +j –j +1 –1 –j +1 +1 +j –j –j +1 +1 +1 –j –j –1 +j –j +j –1 +j +1 –1 +1 +j –j +1 +j +j –1 +1 +1 +j +j +j +1 +1<br>–j –1 +1 –1 +1 –j –1 +1 –1 –j +j –1 –j –j +1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 –j –1 +j –j +j –1 +1 +j –1 –1 –j +j +j –1<br>–1 –1 +j +j +1 –j +j –j –1 +j +1 –1 +1 +j –j +1 +j +j –1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 +j +1 –j +j –j +1 –1 –j +1 +1<br>+j +j +j –1 –1 –1 +j +j +1 –j +j –j +j +1 –j +j –j +1 –1 –j +1 +1 +j +j +j –1 –1 –1 +j +j +1 –j +j –j –1 +j +1 –1 +1 +j<br>–j +1 +j +j –1 –1 –1 –j –j –j –1 –1 +j +1 –1 +1 |
| The sequence $Seq^{8}_{right,176}(k)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –j +1 +1 +j +j +j +1 +1 +j –j +j –1 –j –j +1 +1 +1 –j –j +j –j +j –1 –j –j +1 +1 +1 –j –j +1 –1 +1 +j –1 –1 –j<br>–j –j –1 –1 –1 +1 –1 –j +1 +1 +j +j +j +1 +1 –j +j –j +1 +j +j –1 –1 –1 +j +j –j +j –j +1 +j +j –1 –1 –1 +j +j +1 –1 +1<br>+j –1 –1 –j –j –j –1 –1 –j –1 –1 +j +1 –1 +j –j +j –1 –j –1 +j +j +1 –j +j +1 –1 +1 +j –1 +1 –j –j –1 +j –j –1 +1 –1 –j<br>+1 –j –1 –1 +j +1 –1 +j –j +j –1 –j –j –1 –1 +j +1 –1 +j –j +j –1 –j +1 –j –j –1 +j –j –1 +1 –1 –j +1 –1 +j +j +1 –j +j<br>+1 –1 +1 +j –1 –j –1 –1 +j +1 –1 +j –j +j –1 –j |

**Table 28-112—The sequence $Seq^{i}_{left,385}(k)$**

| |
|---|
| The sequence $Seq^{1}_{left,385}(k)$, to be transmitted from left to right, up to down |
| –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j +j +1 +j<br>–j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j<br>+1 +j +j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j +1 +1 +1<br>–1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j<br>+j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –j –1 –j +j +j –j –1<br>+j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j<br>+j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1<br>–j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j<br>–j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j |
| The sequence $Seq^{2}_{left,385}(k)$, to be transmitted from left to right, up to down |
| –j +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j<br>–j –1 –j +1 –1 –1 +1 –j +1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 +1 –1 –1 –1 +j –1<br>–j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1<br>+j –1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j<br>–j +j +1 +j –1 +1 +1 –1 +j –1 –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j –j –1 –j +1 –1 –1 +1 –j +1 +j –j –j –j –1 –j<br>–1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j –j +j +j +j +1 +j +1 –1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j<br>–j –1 –j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1<br>+1 +1 –1 +j –1 +j –j –j +j +1 +j –j +j +j +j +1 +j +1 –1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j –j –1 –j –j +j +j +j +1<br>+j +1 –1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j –j –1 –j –j +j +j +j +1 +j +1 –1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j<br>–j –1 –j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j |
| The sequence $Seq^{3}_{left,385}(k)$, to be transmitted from left to right, up to down |
| +1 –1 +j –1 +1 –j +1 +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j –1 +j –1<br>+1 –j +1 +j +1 +j –j –1 –j +1 +1 –1 –1 –1 +1 –j –j +j +j +j –j +1 +1 –1 –1 –1 +1 +j +j –j –j –j +j –1 –1 +1 +1 +1 –1<br>–j –j +j +j +j –j –1 –1 +1 +1 +1 –1 +j +j –j –j –j +j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +1 –j +1 –1 +j<br>–1 +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –1 +j –1 +1 –j +1 –j –j +j +j +j –j –1 –1 +1 +1 +1 –1 –j –j +j<br>+j +j –j +1 +1 –1 –1 –1 +1 –j –j +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j +j +j –j –1 –1 +1 +1 +1 –1 +j +1 +j +j +1 +j +1<br>–j +1 +1 –j +1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 –j<br>+1 –j –j +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j –j –j +j +1 +1 –1 +1 +1 –1 +j +j –j +j +j –j –1 –1 +1 –1 –1 +1 +j +j –j<br>+j +j –j +1 +1 –1 +1 +1 –1 –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j –1 +j –1 –1 +j –1<br>–j –1 –j –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j +1 +1 –1 +1 +1 –1 –j –j +j –j –j +j +1 +1 –1 +1 +1 –1 +j +j –j +j<br>+j –j +1 +1 –1 +1 +1 –1 +j +j –j +j +j –j +1 +1 –1 +1 +1 –1 –j –j +j –j –j +j |
| The sequence $Seq^{4}_{left,385}(k)$, to be transmitted from left to right, up to down |
| –1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 +1 –j +1 –j –1 –j –1 –1 +1 +j +j –j +j +1 +j<br>–1 +j –1 –j –j +j +1 +1 –1 –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 +1 –j +1 +j +1 +j +1 +1 –1 +j +j –j +j +1 +j +1 –j +1 +j<br>+j –j +1 +1 –1 –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j –j –1 –j +1 –j +1 +j +j –j –1 –1<br>+1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 +j +1 +j +1 –j +1 +j +j –j +1 +1 –1 –1 +j –1<br>–j –1 –j –1 –1 +1 –j –j +j +j +1 +j +1 –j +1 +j +j –j +1 +1 –1 –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j +j +1 +j –1 +j –1 –j<br>–j +j +1 +1 –1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j +j +1 +j –1 +j –1 –j –j +j +1 +1 –1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j<br>+j –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j –j –1 –j –1<br>+j –1 –j –j +j –1 –1 +1 +j +1 +j –1 +j –1 –j –j +j +1 +1 –1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j –j –1 –j +1 –j +1 +j +j<br>–j –1 –1 +1 +1 –j +1 –j –1 –j –1 –1 +1 +j +j –j +1 –j +1 +j +1 +j +1 +1 –1 +j +j –j +j +1 +j +1 –j +1 +j +j –j +1 +1 –1<br>–1 +j –1 –j –1 –j –1 –1 +1 –j –j +j –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 |

### Table 28-112—The sequence $Seq^{i}_{left,385}(k)$ *(continued)*

| The sequence $Seq^{5}_{left,385}(k)$, to be transmitted from left to right, up to down |
|---|
| –j –1 +1 +1 –1 +1 +1 +j –j –j +j –j –j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j –j +j +j<br>–j +j +j –1 +1 +1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 +1 +1<br>+j –j –j –j +j +j +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 +j –j –j –j<br>+j +j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –1 +1<br>+1 +1 –1 –1 +j –j –j –j +j +j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j +1 –j +1 +1 –j +1<br>–j –1 –j –j –1 –j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +j +1 +j +j +1 +j +1 –j +1 +1<br>–j +1 +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +j +1<br>+j +j +1 +j –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –j –1 –j +j +1 +j<br>+1 –j +1 –1 +j –1 +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +j +1 +j<br>–j –1 –j –j –1 –j +j +1 +j –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j |
| The sequence $Seq^{6}_{left,385}(k)$, to be transmitted from left to right, up to down |
| +j –1 +j –1 +j +1 +j –1 +j –1 +j +1 +j –j –1 –j –1 +j –1 –j –1 –j –1 +j –1 –1 +j –1 –j –1 –j –1 +j –1 –j –1 –j +j +1 +j<br>–1 +j –1 +j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j +1 –j +1 +1 –j +1 –j –1 –j –1 +j –1 +j +1 +j –j –1 –j +1 –j +1 +j<br>+1 +j –1 +j –1 –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 +1 –1 –1 –j +j +j +1 –1 –1 –j +j<br>+j –j +j +j +1 –1 –1 –j +j +j +1 –1 –1 –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 –j +j +j –j +j +j<br>–1 +1 +1 +j –j –j +1 –1 –1 –1 +1 +1 –j +j +j +1 –1 –1 +j –j –j +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 +1 –j +1 +j +1 +j –1<br>+j –1 –j –1 –j +j +1 +j –1 +j –1 –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –1 +j –1 +j +1 +j –j –1 –j –1 +j –1 +j +1 +j +1 –j<br>+1 +j +1 +j –1 +j –1 +j +1 +j –1 +j –1 –1 +j –1 –j –1 –j –1 +j –1 –j –1 –j +j +1 +j +1 –j +1 +j +1 +j +1 –j +1 +1 –j +1<br>–j –1 –j +1 –j +1 –j –1 –j +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 –1 +1 +1 –j +j +j +1 –1 –1 +j –j –j +j –j –j +1 –1 –1 –j<br>+j +j –1 +1 +1 +1 –1 –1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 +j –j –j +1 –1 –1 +j –j –j +j –j –j –1 +1 +1 +j –j –j –1 +1<br>+1 +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 |
| The sequence $Seq^{7}_{left,385}(k)$, to be transmitted from left to right, up to down |
| –1 +1 –1 –1 +j –j –j +1 –1 –1 +j –j –j +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j +j +1 +j –1 +j –1 +j +1 +j –1 +j –1 +j +1 +j<br>+1 –j +1 +j +1 +j +1 –j +1 +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 +j –j –j +1 –1 –1 –j +j +j –1 +1 +1 +1 –j +1 +j +1 +j –1<br>+j –1 –j –1 –j +1 –j +1 –j –1 –j –1 +j –1 +j +1 +j –1 +1 +1 +j –j –j –1 +1 +1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 –j +j<br>+j –j –1 –j –1 +j –1 –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 –j –1 –j +1 –j +1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 –j +j +j +1<br>–1 –1 +j –j –j –1 +1 +1 –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j +j –j –j –1 +1 +1 –j +j<br>+j +1 –1 –1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j –1 +j –1 +j +1 +j<br>–1 +1 +1 –j +j +j –1 +1 +1 –j +j +j +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j +j +1 +j –1 +j –1 +j +1 +j –1 +j –1 –j –1 –j –1<br>+j –1 –j –1 –j –1 +j –1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 +1 –j +1 –j –1 –j –1 +j<br>–1 +j +1 +j –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j<br>–j –1 –j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j –1 +j –1 +j +1 +j –1 +j –1 |
| The sequence $Seq^{8}_{left,385}(k)$, to be transmitted from left to right, up to down |
| +1 +1 –j +1 –j –1 –j +1 –j +1 +j +1 +j –1 +1 +1 +j –j –j –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j +1 –1 –1<br>+j –j –j +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j –1 +j –1 –j –1 –j +1 –1 –1 –j +j +j +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j +1<br>–j +1 –j –1 –j –1 +1 +1 –j +j +j –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j +1 –j +1 +j +1 +j –1 +1 +1 +j –j –j +1 –1 –1 +j –j<br>–j +1 –j +1 +j +1 +j –1 +j –1 +j +1 +j +1 –1 –1 +j –j –j –1 +1 +1 +j –j –j +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j +1 –1 –1<br>–j +j +j –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j +1 –j +1 –j –1 –j –1 +1 +1 –j +j +j +1 –1 –1 –j +j +j –j –1 –j –1 +j –1 –j<br>–1 –j +1 –j +1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –j –1 –j –1 +j –1 +j –j –j –1 +1 +1 +j –j –j +1 –1<br>–1 –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –j –1 –j –1 +j –1 +j –j –j –1<br>+1 +1 +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 –j +j +j +1 –1 –1 +j +1 +j –1 +j –1 –j –1<br>–j –1 +j –1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 +j +1 +j +1 –j +1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 –j +j +j +1 –1 –1<br>+j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 |

**Table 28-113—The sequence $Seq^{i}_{right,385}(k)$**

| |
|---|
| The sequence $Seq^{1}_{right,385}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j<br>+j –j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j<br>–1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1<br>+1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j<br>–j –j +j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –j –1 –j +j +j –j –1<br>+j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j<br>+j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1<br>–j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j<br>–j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +j |
| The sequence $Seq^{2}_{right,385}(k)$, to be transmitted from left to right, up to down |
| –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j –j –1 –j +1 –1 –1 +1 –j +1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j<br>+1 +j –1 +1 +1 –1 +j –1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 +1 –1 –1 –1 +j –1 –j<br>+j +j +j +1 +j +j –j –j +j +1 +j –1 +1 +1 –1 +j –1 –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j –j –1 –j +1 –1 –1 +1 –j<br>+1 –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j –j –1 –j +1 –1 –1 +1 –j +1 +1 –1 –1 –1 +j –1 –j +j +j +j +1 +j +j –j –j<br>+j +1 +j –1 +1 +1 –1 +j –1 –1 +1 +1 +1 –j +1 +j –j –j –j –1 –j –j +j +j –j –1 –j +1 –1 –1 +1 –j +1 –j +j +j +j +1 +j +1<br>–1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j –j –1 –j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1<br>+j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1<br>–1 +j –1 +j –j –j +j +1 +j +j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j +j –j –j –j –1 –j –1 +1<br>+1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j –j +j +j +j +1 +j +1 –1 –1 –1 +j –1 +1 –1 –1 +1 –j +1 –j +j +j –j –1 –j<br>+j –j –j –j –1 –j –1 +1 +1 +1 –j +1 –1 +1 +1 –1 +j –1 +j –j –j +j +1 +j –j |
| The sequence $Seq^{3}_{right,385}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +1<br>–j +1 –j –1 –j –j –1 –j –1 –1 +1 –1 –1 +1 +j +j –j +j +j –j –1 –1 +1 –1 –1 +1 –j –j +j –j –j +j +1 +1 –1 +1 +1 –1 +j +j<br>–j +j +j –j +1 +1 –1 +1 +1 –1 –j –j +j –j –j +j –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j –1 +j –1 –1 +j –1<br>–j –1 –j –j –1 –j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 +j +j –j +j +j –j +1 +1 –1 +1 +1 –1 +j +j –j +j<br>+j –j –1 –1 +1 –1 –1 +1 +j +j –j +j +j –j –1 –1 +1 –1 –1 +1 +j +j –j +j +j –j +1 +1 –1 +1 +1 –1 –j –1 –j +j +1 +j –1 +j<br>–1 +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –1 +j –1 +1 –j +1<br>+j +j –j –j –j +j +1 +1 –1 –1 –1 +1 +j +j –j –j –j +j –1 –1 +1 +1 +1 –1 –j –j +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j +j<br>+j –j –1 –1 +1 +1 +1 –1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j +1 –j +1 –1 +j –1 +j<br>+1 +j –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j –j –1 –j –1 –1 +1 +1 +1 –1 +j +j –j –j –j +j –1 –1 +1 +1 +1 –1 –j –j +j +j +j<br>–j –1 –1 +1 +1 +1 –1 –j –j +j +j +j –j –1 –1 +1 +1 +1 –1 +j +j –j –j –j +j +j |
| The sequence $Seq^{4}_{right,385}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 –j –1 –j –1 –1 +1 +j +j –j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j +j +1 +j –1<br>+j –1 –j –j +j +1 +1 –1 +j +1 +j +1 –j +1 +j +j –j +1 +1 –1 +1 –j +1 +j +1 +j +1 +1 –1 +j +j –j –j –1 –j –1 +j –1 –j –j<br>+j –1 –1 +1 –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j +1 –j +1 –j –1 –j –1 –1 +1 +j +j –j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1<br>+1 –j +1 –j –1 –j –1 –1 +1 +j +j –j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 –1 +j –1 –j<br>–1 –j –1 –1 +1 –j –j +j –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j –j –1 –j +1 –j +1 +j +j –j<br>–1 –1 +1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j +1<br>–j +1 +j +1 +j +1 +1 –1 +j +j –j –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 +1 –j +1 +j +1 +j +1 +1 –1 +j +j –j –j –1 –j –1 +j<br>–1 –j –j +j –1 –1 +1 –j –1 –j +1 –j +1 +j +j –j –1 –1 +1 –1 +j –1 +j +1 +j +1 +1 –1 –j –j +j +j +1 +j –1 +j –1 –j –j +j<br>+1 +1 –1 +1 –j +1 –j –1 –j –1 –1 +1 +j +j –j –1 +j –1 –j –1 –j –1 –1 +1 –j –j +j +j +1 +j +1 –j +1 +j +j –j +1 +1 –1 +1<br>–j +1 +j +1 +j +1 +1 –1 +j +j –j –j –1 –j –1 +j –1 –j –j +j –1 –1 +1 –j |

### Table 28-113—The sequence $Seq^{i}_{right,385}(k)$ *(continued)*

| |
|---|
| The sequence $Seq^{5}_{right,385}(k)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 +1 +1 –j +j +j +j –j –j –j +j +j –j<br>+j +j –1 +1 +1 –1 +1 +1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 –1 +1 +1 +1 –1 –1 –j<br>+j +j +j –j –j +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 +1 –1 –1 –1 +1 +1 +j –j –j –j +j<br>+j –j +j +j +j –j –j +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 –1 +1 +1<br>+1 –1 –1 +j –j –j –j +j +j +j –j –j –j +j +j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j –1 +j –1 –1 +j –1 +j<br>+1 +j +j +1 +j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –1 +j –1 +1 –j +1 +j +1 +j –j –1 –j +j +1 +j +j +1 +j +1 –j +1 +1 –j<br>+1 –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j +j +1 +j<br>+j +1 +j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j +j +1 +j –j –1 –j –1<br>+j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +j +1 +j –j –1<br>–j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j –j |
| The sequence $Seq^{6}_{right,385}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 –j –1 –j +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +1 –j +1 +j +1 +j +j +1 +j –1<br>+j –1 +j +1 +j –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j –1 +j –1 +j +1 +j +j +1 +j –1 +j –1 –j –1<br>–j +1 –j +1 –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j +j –j –j +1 –1 –1 +j –j –j +1 –1 –1 +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j<br>+j –j –j –1 +1 +1 +j –j –j –1 +1 +1 –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j +1 –1 –1 –j +j +j –1 +1 +1 +j –j –j –j +j +j –1<br>+1 +1 +j –j –j +1 –1 –1 +1 –1 –1 +j –j –j –1 +1 +1 –j +j +j +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 –1 +j –1 –j –1 –j +1 –j<br>+1 +j +1 +j +j +1 +j –1 +j –1 –j –1 –j +1 –j +1 –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 +j +1 +j +1 –j +1<br>–j –1 –j +1 –j +1 –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j –1 +j –1 –j –1 –j –j –1 –j –1 +j –1 –j –1 –j –1 +j –1 +1 –j +1 –j<br>–1 –j +1 –j +1 –j –1 –j –j +j +j +1 –1 –1 +j –j –j –1 +1 +1 –1 +1 +1 –j +j +j +1 –1 –1 +j –j –j –j +j +j –1 +1 +1 +j –j<br>–j +1 –1 –1 +1 –1 –1 –j +j +j –1 +1 +1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j +j –j –j –1 +1 +1 +j –j –j –1 +1 +1<br>–1 +1 +1 +j –j –j –1 +1 +1 +j –j –j –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 –j |
| The sequence $Seq^{7}_{right,385}(k)$, to be transmitted from left to right, up to down |
| –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 +j –j –j –1 +1 +1 +j –j –j –j –1 –j +1 –j +1 –j –1 –j +1 –j +1 –j –1 –j –1<br>+j –1 –j –1 –j –1 +j –1 –j +j +j +1 –1 –1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 –1 +j –1 –j –1 –j +1 –j<br>+1 +j +1 +j –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j –1 +1 +1 +j –j –j –1 +1 +1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j<br>–j –1 –j –1 +j –1 –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 –j –1 –j +1 –j +1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 –j +j +j +1<br>–1 –1 +j –j –j –1 +1 +1 –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j –j +j +j +1 –1 –1 +j –j<br>–j –1 +1 +1 +j –j –j +1 –1 –1 –j +j +j –1 +1 +1 +1 –j +1 +j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j +1 –j +1 –j –1 –j<br>+1 –1 –1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 +j –j –j –1 +1 +1 +j –j –j –j –1 –j +1 –j +1 –j –1 –j +1 –j +1 +j +1 +j +1<br>–j +1 +j +1 +j +1 –j +1 –j +j +j –1 +1 +1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 –j +j +j +1 –1 –1 +1 –j +1 –j –1 –j –1 +j<br>–1 +j +1 +j –1 +j –1 –j –1 –j +1 –j +1 +j +1 +j +1 –1 –1 –j +j +j +1 –1 –1 –j +j +j –1 +1 +1 –j +j +j –1 +1 +1 –j +j +j<br>–j –1 –j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j –1 +j –1 +j +1 +j –1 +j –1 +1 |
| The sequence $Seq^{8}_{right,385}(k)$, to be transmitted from left to right, up to down |
| –1 +j –1 +j +1 +j –1 +j –1 –j –1 –j +1 –1 –1 –j +j +j +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j –1 +1 +1 –j<br>+j +j –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j –1 +j –1 –j –1 –j +1 –1 –1 –j +j +j +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j +1 –j<br>+1 –j –1 –j –1 +1 +1 –j +j +j –1 +1 +1 +j –j –j +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j +1 –1 –1 –j +j +j –1 +1 +1 –j +j +j<br>–1 +j –1 –j –1 –j +1 –j +1 –j –1 –j –1 +1 +1 –j +j +j +1 –1 –1 –j +j +j +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j +1 –1 –1 –j<br>+j +j –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j +1 –j +1 –j –1 –j –1 +1 +1 –j +j +j +1 –1 –1 –j +j +j +j +1 +j +1 –j +1 +j +1<br>+j –1 +j –1 –j +j +j –1 +1 +1 –j +j +j +1 –1 –1 +j +1 +j –1 +j –1 +j +1 +j +1 –j +1 –j +j +j +1 –1 –1 –j +j +j –1 +1 +1<br>–j –1 –j –1 +j –1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –j –1 –j –1 +j –1 +j –j –j –1<br>+1 +1 +j –j –j +1 –1 –1 –j –1 –j –1 +j –1 +j +1 +j –1 +j –1 –j +j +j –1 +1 +1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 +j +1<br>+j +1 –j +1 –j +j +j +1 –1 –1 +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 –j +j +j +1 –1 –1<br>+j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +j –j –j –1 +1 +1 –j +j +j –1 +1 +1 +1 |

### Table 28-114—The sequence $Seq^{i}_{left,595}(k)$

| |
|---|
| The sequence $Seq^{1}_{left,595}(k)$, to be transmitted from left to right, up to down |
| +j +1 –1 +j +1 +j –j –1 –1 +j +j –1 –1 +1 +1 +1 –j –j –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1<br>–1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j<br>–1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –j –1 –j +j +j<br>–j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1<br>–j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1<br>+1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1<br>–1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j<br>+1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –j –1 –j +j +j –j –1 +j –1 –1 –1 +1<br>+1 –j +1 –1 –1 +1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j<br>+j –j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +j<br>+1 +j +j +j –j –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j<br>–j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +j –1<br>+1 +1 –1 +j +1 +j +j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1<br>–j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1<br>+1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j |
| The sequence $Seq^{2}_{left,595}(k)$, to be transmitted from left to right, up to down |
| –1 +1 –j +1 –j –1 +j +j +j –1 –1 +1 –1 –1 +j +1 +j –j –1 +1 –j +1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 –1 +j<br>–1 –1 +j –1 –j –1 –j +j +1 +j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 +j –1 +1 –j +1 –1 +j –1 –1 +j –1 –1<br>+j –1 +1 –j +1 +1 –j +1 +1 –j +1 –j –1 –j +j +1 +j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1 –j –j –1 –j +j +j –j –j –j +j<br>+j +j –j +j +j –j +j +j –j –j –j +j –j –j +j –j –j +j +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 +1<br>+1 –1 +j +j –j –j –j +j +j +j –j +j +j –j +j +j –j –j –j +j –j –j +j –j –j +j –1 –1 +1 +1 +1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1<br>–1 –1 +1 –1 –1 +1 –1 –1 +1 +1 –j +1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 –j –1 –j +j +1 +j<br>–j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 +j –1 +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +1 –j +1 +1<br>–j +1 –j –1 –j +j +1 +j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1 –j –j –1 –j +j +j –j –j –j +j +j +j –j +j +j –j +j +j –j –j –j<br>+j –j –j +j –j –j +j +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 +1 +1 –1 +j +j –j –j –j +j +j +j<br>–j +j +j –j +j +j –j –j –j +j –j –j +j –j –j +j –1 –1 +1 +1 +1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 +1 –1 –1 +1 –1 –1<br>+1 –1 +j –1 +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j +1 +j –j –1 –j +j +1 +j +j +1 +j –j –1<br>–j +j +1 +j +j +1 +j +j +1 +j +1 –j +1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 +j +1 +j –j –1<br>–j +j +1 +j +j +1 +j –j –1 –j +j +1 +j +j +1 +j +j +1 +j –j –j +j +j +j –j –j –j +j –j –j +j –j –j +j +j +j –j +j +j –j +j +j –j<br>–1 –1 +1 +1 +1 –1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 +1 –1 –1 +1 –1 –1 +1 –j –j +j +j +j –j –j –j +j –j –j +j –j –j +j<br>+j +j –j +j +j –j +j +j –j +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 +1 +1 –1 |
| The sequence $Seq^{3}_{left,595}(k)$, to be transmitted from left to right, up to down |
| –j –j –j –j –j +j –j +1 –j –j –j +j +j +j +1 –1 +j –1 +1 +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 –j –1 –j +1<br>–j +1 –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 –1 –1 +1 –j –j +j –1 –1 +1 +j +j –j +j +j<br>–j +1 +1 –1 +j +j –j –1 –1 +1 –1 –1 +1 –j –j +j –1 –1 +1 +j +j –j –j –j +j –1 –1 +1 –j –j +j +1 +1 –1 +j +1 +j –1 +j –1<br>–j –1 –j –1 +j –1 +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +j +1 +j +1 –j +1 +1 –j +1 –j –1 –j –1 +j –1 –j<br>–1 –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 –1 –1 +1 +j +j –j +1 +1 –1 +j +j –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 +1 +1<br>–1 –j –j +j –1 –1 +1 –j –j +j +j +1 +j –1 +j –1 +j +1 +j +1 –j +1 +1 –j +1 –j –1 –j +1 –j +1 +j +1 +j –j –1 –j +1 –j +1<br>–j –1 –j –1 +j –1 +1 –j +1 –j –1 –j +1 –j +1 +j +1 +j –j –j +j +1 +1 –1 –j –j +j –1 –1 +1 –1 –1 +1 +j +j –j –1 –1 +1 –j<br>–j +j –j –j +j +1 +1 –1 –j –j +j –1 –1 +1 +1 +1 –1 –j –j +j +1 +1 –1 +j +j –j –1 +j –1 –j –1 –j +1 –j +1 –j –1 –j +j +1<br>+j +1 –j +1 –j –1 –j +1 –j +1 +1 –j +1 +j +1 +j –1 +j –1 +j +1 +j +j +1 +j +1 –j +1 –j –1 –j +1 –j +1 +1 +1 –1 +j +j –j<br>–1 –1 +1 +j +j –j –j –j +j –1 –1 +1 +j +j –j –1 –1 +1 +1 +1 –1 +j +j –j –1 –1 +1 +j +j –j +j +j –j +1 +1 –1 –j –j +j +1<br>+1 –1 +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j –j –1<br>–j –1 +j –1 –j –1 –j +1 –j +1 –1 –1 +1 –j –j +j –1 –1 +1 +j +j –j +j +j –j +1 +1 –1 +j +j –j –1 –1 +1 –1 –1 +1 –j –j +j<br>–1 –1 +1 +j +j –j –j –j +j –1 –1 +1 –j –j +j +1 +1 –1 +j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j –1 +j –1 –j<br>–1 –j –j –1 –j +1 –j +1 +j +1 +j +1 –j +1 +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 –1 –1<br>+1 +j +j –j +1 +1 –1 +j +j –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 +1 +1 –1 –j –j +j –1 –1 +1 –j –j +j |

**Table 28-114—The sequence $Seq^{i}_{left,595}(k)$ *(continued)***

| |
|---|
| The sequence $Seq^{4}_{left,595}(k)$, to be transmitted from left to right, up to down |
| +1 +1 +1 –1 –j –1 +1 –1 –j –1 –j –j –1 –j +j +1 +j –1 +1 +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 +1 –1 +j +j –j +j +j<br>–j +1 +1 –1 +j +1 +j +1 –j +1 –1 +j –1 –j –1 –j –j –j +j –1 –1 +1 +1 +1 –1 +j +j –j –1 +j –1 –j –1 –j –j –1 –j –1 +j –1<br>–1 –1 +1 –j –j +j –j –j +j –1 –1 +1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j +1 –j +1 +j<br>+1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j +j –1 –1 +1 +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j –j –j +j –1 –1 +1 –1 –1<br>+1 –j –j +j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j +j –1 –1 +1 +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j<br>–j –j +j –1 –1 +1 –1 –1 +1 –j –j +j +j +1 +j –1 +j –1 –1 +j –1 +j +1 +j +j +j –j –1 –1 +1 –1 –1 +1 +j +j –j –1 +j –1 +j<br>+1 +j –j –1 –j +1 –j +1 +1 +1 –1 –j –j +j +j +j –j –1 –1 +1 –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –j –j +j +1 +1 –1 +1 +1<br>–1 –j –j +j +1 –j +1 –j –1 –j +j +1 +j –1 +j –1 –1 –1 +1 +j +j –j –j –j +j +1 +1 –1 +j +1 +j –1 +j –1 +1 –j +1 –j –1 –j<br>+j +j –j –1 –1 +1 +1 +1 –1 –j –j +j –1 +j –1 +j +1 +j +j +1 +j –1 +j –1 +1 +1 –1 –j –j +j –j –j +j +1 +1 –1 +j +1 +j –1<br>+j –1 +1 –j +1 –j –1 –j +j +j –j –1 –1 +1 +1 +1 –1 –j –j +j –1 +j –1 +j +1 +j +j +1 +j –1 +j –1 +1 +1 –1 –j –j +j –j –j<br>+j +1 +1 –1 +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 +1 –1 +j +j –j +j +j –j +1 +1 –1 +j +1 +j +1 –j +1 –1 +j –1 –j –1<br>–j –j –j +j –1 –1 +1 +1 +1 –1 +j +j –j –1 +j –1 –j –1 –j –j –1 –j –1 +j –1 –1 –1 +1 –j –j +j –j –j +j –1 –1 +1 –j –1 –j –1<br>+j –1 +1 –j +1 +j +1 +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j<br>+j –1 –1 +1 +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1<br>+1 +1 –1 +j +j –j –j –j +j –1 –1 +1 +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j |
| The sequence $Seq^{5}_{left,595}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 –1 +1 –j –j –1 –j +j –1 +j +1 +1 +j +1 –j +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 +j –j –j +j –j –j +j –j<br>–j –j +j +j –j –1 –j –j –1 –j +j +1 +j –j –1 –j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 –j +j +j –j +j +j –j +j +j +j –j –j –1<br>+1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 +j +1 +j +j +1 +j –j –1 –j +j +1 +j –1 +1 +1<br>+1 –1 –1 –1 +1 +1 –1 +1 +1 –j +j +j +j –j –j –j +j +j –j +j +j +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 +j –1 +1 –j +1 +1<br>–j +1 +1 –j +1 –j +j +j +j –j –j –j +j +j –j +j +j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +j –1 +1 –j +1 +1 –j +1 +1<br>–j +1 +j +1 +j –j –1 –j –j –1 –j –j –1 –j +j –j –j +j –j –j +j –j –j –j +j +j –1 +1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 +1 –j<br>+1 +1 –j +1 –1 +j –1 +1 –j +1 +j +1 +j +j +1 +j –j –1 –j +j +1 +j +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 –j +j +j –j +j<br>+j –j +j +j +j –j –j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 –j +j +j +j –j –j –j +j +j –j +j<br>+j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –j –1 –j +j +1 +j +j +1 +j +j +1 +j +1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j +j –j –j –j +j +j –j +j +j –j –1 –j +j +1 +j +j +1 +j +j +1 +j –1 +j –1 +1 –j +1<br>+1 –j +1 +1 –j +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 +j –j –j +j –j –j +j –j –j –j +j +j –j –1 –j –j –1 –j +j +1 +j –j<br>–1 –j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 –j +j +j –j +j +j –j +j +j +j –j –j –1 +1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 –1<br>+j –1 –1 +j –1 +1 –j +1 –1 +j –1 +j +1 +j +j +1 +j –j –1 –j +j +1 +j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –j +j +j +j<br>–j –j –j +j +j –j +j +j +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –j +j +j +j –j –j –j +j +j –j<br>+j +j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j +1 +j –j –1 –j –j –1 –j –j –1 –j |
| The sequence $Seq^{6}_{left,595}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 +1 –j +j +1 –1 –j +j –j –1 +j +j +1 –1 +1 +1 –1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j –j +j +j –1 +1 +1 +j +1<br>+j +1 –j +1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j +j –j –j +1 –1 –1 –j –1 –j –1 +j –1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1<br>–1 +1 +1 –j +j +j +1 –j +1 +j +1 +j +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 +1 –1 –1 +j –j –j –1 +j –1 –j –1 –j –1 +1 +1 –j<br>+j +j –1 +j –1 –j –1 –j +j –j –j –1 +1 +1 +j +1 +j –1 +j –1 –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j –j +j +j +1 –1 –1 –j –1<br>–j +1 –j +1 –j +j +j –1 +1 +1 –j –1 –j –1 +j –1 +1 –1 –1 –j +j +j +1 –j +1 –j –1 –j –j +j +j –1 +1 +1 –j –1 –j –1 +j –1<br>–1 +1 +1 +j –j –j –1 +j –1 +j +1 +j +j –j –j +1 –1 –1 –j –1 –j –1 +j –1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j +j –j –j +1<br>–1 –1 –j –1 –j –1 +j –1 –1 +1 +1 +j –j –j +1 –j +1 –j –1 –j –1 +1 +1 –j +j +j +1 –j +1 +j +1 +j –j +j +j +1 –1 –1 +j +1<br>+j –1 +j –1 –1 +1 +1 –j +j +j +1 –j +1 +j +1 +j +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –j +j +j +1 –1 –1 –j –1 –j +1 –j +1<br>–1 +1 +1 –j +j +j –1 +j –1 –j –1 –j –j +j +j +1 –1 –1 –j –1 –j +1 –j +1 +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j +1 –1 –1 –j<br>+j +j +1 –j +1 –j –1 –j +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 +1 –1 –1 –j +j +j +1 –j +1 –j –1 –j –j +j +j –1 +1 +1 –j –1<br>–j –1 +j –1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j –j +j +j –1 +1 +1 +j +1 +j +1 –j +1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j<br>+j –j –j +1 –1 –1 –j –1 –j –1 +j –1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –1 +1 +1 –j +j +j +1 –j +1 +j +1 +j +j –j –j –1<br>+1 +1 –j –1 –j +1 –j +1 +1 –1 –1 +j –j –j –1 +j –1 –j –1 –j –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j +j –j –j –1 +1 +1 +j +1<br>+j –1 +j –1 –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j –j +j +j +1 –1 –1 –j –1 –j +1 –j +1 –j +j +j –1 +1 +1 –j –1 –j –1 +j –1<br>+1 –1 –1 –j +j +j +1 –j +1 –j –1 –j –j +j +j –1 +1 +1 –j –1 –j –1 +j –1 –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j |

**Table 28-114—The sequence $Seq^{i}_{left,595}(k)$ *(continued)***

| The sequence $Seq^{7}_{left,595}(k)$, to be transmitted from left to right, up to down |
|---|
| +j –j +j –1 –1 +1 +j +1 –1 –j +j –j –j –j –j –1 +1 +1 +1 +1 –1 –1 –1 +1 +1 –j +j +j +j –j –j +j –j –j +j –j –j +1 –1 –1<br>+1 –1 –1 –j +j +j +j –j –j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 +1<br>–1 –1 +1 –1 –1 +j –j –j +j –j –j +1 –1 –1 –1 +1 +1 –j +j +j +j –j –j –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +1 –j +1 +1 –j<br>+1 –j –1 –j –j –1 –j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 +j +1 +j<br>–j –1 –j +j +1 +j +j +1 +j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j –j<br>–1 –j +j +1 +j –1 +j –1 +1 –j +1 +1 –1 –1 –1 +1 +1 –j +j +j +j –j –j +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –j +j +j +j –j<br>–j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 +j –j<br>–j +j –j –j +1 –1 –1 –1 +1 +1 –j +j +j +j –j –j –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j<br>+j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +j +1 +j +j<br>+1 +j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j –j –1 –j +j +1 +j –1 +j<br>–1 +1 –j +1 –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +j –j –j –j +j +j –1 +1 +1 +1 –1 –1<br>–1 +1 +1 –1 +1 +1 –j +j +j –j +j +j –j +j +j +j –j –j +1 –1 –1 –1 +1 +1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j –1 +1 +1<br>+1 –1 –1 +j –j –j –j +j +j +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j –j –1 –j +j +1 +j –1<br>+j –1 +1 –j +1 +j +1 +j +j +1 +j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –j –1 –j –j –1 –j +1 –j +1 +1 –j<br>+1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 |
| The sequence $Seq^{8}_{left,595}(k)$, to be transmitted from left to right, up to down |
| –1 +j +j +1 +1 –1 –j +j –j –1 –j +j –1 +j –j +j –1 +j +1 +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j –1 +j –1 –1 +j –1 –j –1 –j<br>–j –1 –j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +j<br>+1 +j –j –1 –j +1 –j +1 –1 +j –1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +1 –1 –1 –1<br>+1 +1 +j –j –j –j +j +j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j +j –j –j –j +j +j +1 –1 –1 –1 +1 +1 –j –1 –j –j –1 –j –1 +j –1<br>–1 +j –1 –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j –1<br>+j –1 +1 –j +1 –j –1 –j +j +1 +j +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j –j +j +j +j –j –j<br>–1 +1 +1 +1 –1 –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 –j +j +j –j +j +j –1 +1 +1 –1 +1 +1 +j +1 +j –j –1 –j +1 –j +1<br>–1 +j –1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j –1<br>+j –1 –1 +j –1 –j –1 –j –j –1 –j +j –j –j –j +j +j +1 –1 –1 –1 +1 +1 –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 –j +j +j –j +j +j<br>–1 +1 +1 –1 +1 +1 +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j –1 +j –1 +1 –j +1 –j –1 –j<br>+j +1 +j –1 +1 +1 +1 –1 –1 –j +j +j +j –j –j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +j –j –j –j +j +j +1 –1 –1 –1 +1 +1 –j<br>–1 –j –j –1 –j –1 +j –1 –1 +j –1 +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –j –1 –j +j +1 +j –1 +j –1 +1 –j +1 +1 –1 –1 +1 –1<br>–1 +j –j –j +j –j –j –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j –1 +1 +1 +1 –1 –1 –j +j +j +j –j –j +1 –j +1 +1 –j +1 +j +1 +j<br>+j +1 +j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –j<br>–1 –j +j +1 +j –1 +j –1 +1 –j +1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j |

### Table 28-115—The sequence $Seq^{i}_{right,595}(k)$

| |
|---|
| The sequence $Seq^{1}_{right,595}(k)$, to be transmitted from left to right, up to down |
| –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1<br>+1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1<br>–1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1<br>–j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j<br>–1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j +1 +j +j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j<br>–j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 –1<br>+j –1 +1 +1 –1 +j +1 +j +j +j –j –j –1 –j +j +j –j +1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j<br>–j +1 –j +1 +1 +1 –1 +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1<br>+1 +1 –1 +1 –j +1 –1 –1 +1 +j +1 +j +j +j –j +j +1 +j –j –j +j +1 –j +1 +1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j<br>–1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1<br>+1 +j +1 +j +j +j –j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +j +1 +j –j –j +j +1 –j +1<br>+1 +1 –1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j –j –1 –j +j +j –j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 –j –1 –j –j –j +j +1<br>–j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j –j –1 –j +j +j –j<br>+1 –j +1 +1 +1 –1 +1 –j +1 –1 –1 +1 –j –1 –j –j –j +j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +j –1 +1 +1 –1 +j +1 +j<br>+j +j –j +j +1 +j –j –j +j –1 +j –1 –1 –1 +1 –1 +1 +j +j –1 +1 +1 +j –j +j –1 +j +1 +1 +j +1 +j –1 –j |
| The sequence $Seq^{2}_{right,595}(k)$, to be transmitted from left to right, up to down |
| –j –1 –j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j<br>+1 –1 +j –1 +1 –j +1 +j +1 +j +j +1 +j +j +1 +j –j –1 –j +j +1 +j +j +1 +j –j –1 –j +j +1 +j –1 +j –1 –1 +j –1 –1 +j –1<br>+1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1<br>+1 –1 –j –j +j –j –j +j –j –j +j +j +j –j +j +j –j +j +j –j –j –j +j +j +j –j +1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1<br>+1 +1 –1 –1 –1 +1 +1 +1 –1 +j +j –j +j +j –j +j +j –j –j –j +j –j –j +j –j –j +j +j +j –j –j –j +j +1 –j +1 +1 –j +1 +1 –j<br>+1 –1 +j –1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 –j –1 –j –j –1 –j –j –1 –j +j +1 +j +j +1 +j +j +1 +j –j –1 –j +j +1 +j<br>–1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 –j –1 –j –j –1 –j –j –1 –j +j +1 +j +j +1 +j +j<br>+1 +j –j –1 –j +j +1 +j +j +j –j +j +j –j +j +j –j –j –j +j +j +j –j +j +j –j –j –j +j +j +j –j +1 +1 –1 +1 +1 –1 +1 +1 –1<br>–1 –1 +1 –1 –1 +1 –1 –1 +1 +1 +1 –1 –1 –1 +1 +j +j –j +j +j –j +j +j –j –j –j +j +j +j –j +j +j –j –j –j +j +j +j –j –1 –1<br>+1 –1 –1 +1 –1 –1 +1 +1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 –j –1 –j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –j –1<br>–j +j +1 +j –j –1 –j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +j +1 +j +j +1 +j +j +1<br>+j –j –1 –j +j +1 +j +j +1 +j –j –1 –j +j +1 +j –1 +j –1 –1 +j –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1<br>+1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 –j –j +j –j –j +j –j –j +j +j +j –j +j +j –j<br>+j +j –j –j –j +j +j +j –j +1 +1 –1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +1 +1 –1 –1 –1 +1 +1 +1 –1 +j +j –j +j +j –j<br>+j +j –j –j –j +j –j –j +j –j –j +j +j +j –j –j –j +j –1 –j +j –1 +1 –1 –1 +j –1 +j –j –1 +1 +1 –1 +1 –j –j +1 |
| The sequence $Seq^{3}_{right,595}(k)$, to be transmitted from left to right, up to down |
| +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j –j –1 –j –1 +j –1 –j –1 –j +1 –j +1 –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j –j –1 –j –1<br>+j –1 –j –1 –j +1 –j +1 –1 –1 +1 –j –j +j –1 –1 +1 +j +j –j +j +j –j +1 +1 –1 +j +j –j –1 –1 +1 –1 –1 +1 –j –j +j –1 –1<br>+1 +j +j –j –j –j +j –1 –1 +1 –j –j +j +1 +1 –1 –j –1 –j +1 –j +1 +j +1 +j +1 –j +1 –1 +j –1 +j +1 +j +1 –j +1 +j +1 +j<br>+j +1 +j –1 +j –1 –j –1 –j –1 +j –1 –1 +j –1 +j +1 +j +1 –j +1 +j +1 +j +j +j –j –1 –1 +1 –j –j +j –1 –1 +1 +1 +1 –1 –j<br>–j +j –1 –1 +1 –j –j +j +j +j –j –1 –1 +1 –j –j +j –1 –1 +1 –1 –1 +1 +j +j –j +1 +1 –1 +j +j –j –1 +j –1 –j –1 –j –1 +j<br>–1 +j +1 +j +j +1 +j +1 –j +1 +j +1 +j –1 +j –1 +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j +j +1 +j +1 –j +1 +j +1 +j –1 +j –1<br>+1 +1 –1 +j +j –j +1 +1 –1 –j –j +j –j –j +j –1 –1 +1 –j –j +j +1 +1 –1 +1 +1 –1 +j +j –j +1 +1 –1 –j –j +j +j +j –j +1<br>+1 –1 +j +j –j –1 –1 +1 +j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +j +1<br>+j +1 –j +1 +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 –1 –1 +1 +j +j –j +1 +1 –1 +j +j –j<br>–j –j +j +1 +1 –1 +j +j –j +1 +1 –1 +1 +1 –1 –j –j +j –1 –1 +1 –j –j +j –1 +j –1 –j –1 –j –1 +j –1 +j +1 +j +j +1 +j +1<br>–j +1 +j +1 +j –1 +j –1 +1 –j +1 +j +1 +j +1 –j +1 –j –1 –j +j +1 +j +1 –j +1 +j +1 +j –1 +j –1 +1 +1 –1 +j +j –j +1<br>+1 –1 –j –j +j –j –j +j –1 –1 +1 –j –j +j +1 +1 –1 +1 +1 –1 +j +j –j +1 +1 –1 –j –j +j +j +j –j +1 +1 –1 +j +j –j –1 –1<br>+1 +j +1 +j –1 +j –1 –j –1 –j –1 +j –1 +1 –j +1 –j –1 –j –1 +j –1 –j –1 –j –j –1 –j +1 –j +1 +j +1 +j +1 –j +1 +1 –j +1<br>–j –1 –j –1 +j –1 –j –1 –j –j –j +j +1 +1 –1 +j +j –j +1 +1 –1 –1 –1 +1 +j +j –j +1 +1 –1 +j +j –j –j –j +j +1 +1 –1 +j<br>+j –j +1 +1 –1 +1 +1 –1 –j –j +j –1 –1 +1 –j –j +j –j –j +j +1 –1 –1 –j +j –j +j –1 +j +1 +1 +1 –1 +1 –1 –j |

**Table 28-115—The sequence $Seq^{i}_{right,595}(k)$ *(continued)***

| The sequence $Seq^{4}_{right,595}(k)$, to be transmitted from left to right, up to down |
|---|
| +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 +1 –1 +j +j –j +j +j –j +1 +1 –1 +j +1 +j +1 –j +1 –1 +j –1 –j –1 –j –j –j +j –1<br>–1 +1 +1 +1 –1 +j +j –j +1 –j +1 +j +1 +j +j +1 +j +1 –j +1 +1 +1 –1 +j +j –j +j +j –j +1 +1 –1 +j +1 +j +1 –j +1 –1<br>+j –1 –j –1 –j –j –j +j –1 –1 +1 +1 +1 –1 +j +j –j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j +j –1 –1<br>+1 +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j –1 +j –1 –j –1 –j +j +1 +j +1 –j +1 –1 –1 +1<br>–j –j +j +j +j –j +1 +1 –1 –j –1 –j –1 +j –1 –1 +j –1 –j –1 –j +j +j –j +1 +1 –1 +1 +1 –1 +j +j –j –1 +j –1 –j –1 –j –j<br>–1 –j –1 +j –1 –1 –1 +1 –j –j +j –j –j +j –1 –1 +1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j<br>+j –1 +j –1 –j –1 –j –j –1 –j –1 +j –1 –1 –1 +1 –j –j +j –j –j +j –1 –1 +1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +j +j –j +1<br>+1 –1 –1 –1 +1 –j –j +j –1 +j –1 –j –1 –j +j +1 +j +1 –j +1 –1 –1 +1 –j –j +j +j +j –j +1 +1 –1 –j –1 –j –1 +j –1 –1 +j<br>–1 –j –1 –j +j +j –j +1 +1 –1 +1 +1 –1 +j +j –j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j +j –1 –1 +1<br>+j +1 +j +1 –j +1 +1 –j +1 +j +1 +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j –1 +j –1 –j –1 –j –j –1 –j –1 +j –1 –1 –1 +1 –j<br>–j +j –j –j +j –1 –1 +1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j –1 +j –1 –j –1 –j –j –1<br>–j –1 +j –1 –1 –1 +1 –j –j +j –j –j +j –1 –1 +1 –j –1 –j –1 +j –1 +1 –j +1 +j +1 +j +j +j –j +1 +1 –1 –1 –1 +1 –j –j +j<br>–1 +j –1 –j –1 –j +j +1 +j +1 –j +1 –1 –1 +1 –j –j +j +j +j –j +1 +1 –1 –j –1 –j –1 +j –1 –1 +j –1 –j –1 –j +j +j –j +1<br>+1 –1 +1 +1 –1 +j +j –j +1 –j +1 +j +1 +j –j –1 –j –1 +j –1 +1 +1 –1 +j +j –j –j –j +j –1 –1 +1 +j +1 +j +1 –j +1 +1 –j<br>+1 +j +1 +j –j –j +j –1 –1 +1 –1 –1 +1 –j –j +j –j –1 +j +1 +j –1 +1 +1 +j +1 –j –j +1 +1 +1 +j +1 –1 –1 |
| The sequence $Seq^{5}_{right,595}(k)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 –j +j +j –j +j +j –j +j +j +j –j –j –j –1 –j –j –1 –j +j +1 +j –j –1 –j –1 +j –1 –1<br>+j –1 +1 –j +1 –1 +j –1 –j +j +j –j +j +j –j +j +j +j –j –j +1 –1 –1 +1 –1 –1 +1 –1 –1 –1 +1 +1 –1 +j –1 –1 +j –1 +1 –j<br>+1 –1 +j –1 –j –1 –j –j –1 –j +j +1 +j –j –1 –j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +j –j –j –j +j +j +j –j –j +j –j –j<br>+j +1 +j –j –1 –j –j –1 –j –j –1 –j +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 –j +j +j +j –j –j –j +j +j –j +j +j +1 –1 –1 –1 +1<br>+1 +1 –1 –1 +1 –1 –1 –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 –j –1 –j +j +1 +j +j +1 +j +j +1 +j –1 +1 +1 –1 +1 +1 –1<br>+1 +1 +1 –1 –1 +j –j –j +j –j –j +j –j –j –j +j +j +j +1 +j +j +1 +j –j –1 –j +j +1 +j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j<br>+1 +j –j –j +j –j –j +j –j –j –j +j +j –1 +1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +j +1<br>+j +j +1 +j –j –1 –j +j +1 +j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j +j –j –j –j +j +j –j +j +j –j –1 –j +j +1 +j<br>+j +1 +j +j +1 +j –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j –j –j –j +j +j +j –j –j +j –j –j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1<br>+1 +1 +1 –j +1 –1 +j –1 –1 +j –1 –1 +j –1 +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 +1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 +j<br>–j –j +j –j –j +j –j –j –j +j +j +j +1 +j +j +1 +j –j –1 –j +j +1 +j +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +j –j –j +j –j –j<br>+j –j –j –j +j +j –1 +1 +1 –1 +1 +1 –1 +1 +1 +1 –1 –1 +1 –j +1 +1 –j +1 –1 +j –1 +1 –j +1 +j +1 +j +j +1 +j –j –1 –j<br>+j +1 +j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j +j –j –j –j +j +j –j +j +j –j –1 –j +j +1 +j +j +1 +j +j +1 +j –1<br>+j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j –j –j –j +j +j +j –j –j +j –j –j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 +1 –j +1 –1<br>+j –1 –1 +j –1 –1 +j –1 +j +1 +j –j –1 –j –j –1 –j –j –1 –j –1 –j +1 –j –1 +1 +j –j +1 +j –1 –j +1 +1 +1 –j +j +j +j |
| The sequence $Seq^{6}_{right,595}(k)$, to be transmitted from left to right, up to down |
| +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j –j +j +j –1 +1 +1 +j +1 +j +1 –j +1 –1 +1 +1 +j –j –j +1 –j +1 –j –1 –j –j +j +j –1<br>+1 +1 +j +1 +j +1 –j +1 +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 –1 +1 +1 –j +j +j +1 –j +1 +j +1 +j –j +j +j +1 –1 –1 +j<br>+1 +j –1 +j –1 –1 +1 +1 –j +j +j +1 –j +1 +j +1 +j –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j +j –j –j –1 +1 +1 +j +1 +j –1 +j<br>–1 +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j +j –j –j –1 +1 +1 +j +1 +j –1 +j –1 –j +j +j –1 +1 +1 –j –1 –j –1 +j –1 +1 –1 –1<br>–j +j +j +1 –j +1 –j –1 –j +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 +1 –1 –1 –j +j +j +1 –j +1 –j –1 –j –1 +1 +1 +j –j –j +1<br>–j +1 –j –1 –j +j –j –j +1 –1 –1 –j –1 –j –1 +j –1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j +j –j –j +1 –1 –1 –j –1 –j –1 +j<br>–1 –j +j +j +1 –1 –1 +j +1 +j –1 +j –1 +1 –1 –1 +j –j –j –1 +j –1 –j –1 –j +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 +1 –1 –1<br>+j –j –j –1 +j –1 –j –1 –j +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j –j +j +j +1 –1 –1 –j –1 –j +1 –j +1 –1 +1 +1 –j +j +j –1<br>+j –1 –j –1 –j –j +j +j +1 –1 –1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 –1 +1 +1 +j –j –j –1 +j –1 +j +1<br>+j –j +j +j –1 +1 +1 –j –1 –j –1 +j –1 –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j –1 +1 +1 +j –j –j +1 –j +1 –j –1 –j +j –j –j<br>+1 –1 –1 –j –1 –j –1 +j –1 +1 –1 –1 –j +j +j –1 +j –1 +j +1 +j +j –j –j +1 –1 –1 –j –1 –j –1 +j –1 –j +j +j +1 –1 –1 +j<br>+1 +j –1 +j –1 +1 –1 –1 +j –j –j –1 +j –1 –j –1 –j +j –j –j –1 +1 +1 –j –1 –j +1 –j +1 +1 –1 –1 +j –j –j –1 +j –1 –j –1<br>–j +1 –1 –1 +j –j –j +1 –j +1 +j +1 +j –j +j +j +1 –1 –1 –j –1 –j +1 –j +1 –1 +1 +1 –j +j +j –1 +j –1 –j –1 –j –j +j +j<br>+1 –1 –1 –j –1 –j +1 –j +1 +j –j –j +1 –1 –1 +j +1 +j +1 –j +1 –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j –j +j +j –1 +1 +1 –j<br>–1 –j –1 +j –1 –1 +1 +1 +j –j –j –1 +j –1 +j +1 +j +1 +1 +1 +j +j –1 +j +1 –j +1 +j –1 +1 +1 +1 +j –j +j +j |

**Table 28-115—The sequence $Seq^{i}_{right,595}(k)$ *(continued)***

| The sequence $Seq^{7}_{right,595}(k)$, to be transmitted from left to right, up to down |
|---|
| –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j +j –j –j +j<br>–j –j –1 +1 +1 –1 +1 +1 +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j –j +j +j –j +j +j +1 –1 –1 +1 –1 –1 +j –j –j –j +j +j +1 –1<br>–1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j<br>+1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +j +1 +j –j –1 –j –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j –j –1 –j +j<br>+1 +j +1 –j +1 –1 +j –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +1 –1 –1 –1 +1 +1 –j<br>+j +j +j –j –j +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j<br>+j +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 +1 –1 –1 +1 –1 –1 +j –j –j +j –j –j –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j +j –j –j<br>+j –j –j +1 –1 –1 +1 –1 –1 +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 +j +1 +j +j +1 +j –1<br>+j –1 –1 +j –1 –1 +j –1 +1 –j +1 –j –1 –j +j +1 +j +j +1 +j +j +1 +j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 +j +1 +j –j –1<br>–j –1 +j –1 –1 +j –1 +j +1 +j +j +1 +j +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +1 –1 –1<br>+1 –1 –1 –j +j +j –j +j +j +1 –1 –1 –1 +1 +1 +j –j –j –j +j +j +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 +1 –1 –1 –1 +1 +1 +j<br>–j –j –j +j +j –j +j +j –j +j +j +1 –1 –1 +1 –1 –1 +j –j –j –j +j +j +1 –1 –1 –1 +1 +1 +1 –1 –1 +1 –1 –1 –j +j +j –j +j<br>+j –j –1 –j –j –1 –j –1 +j –1 –1 +j –1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j +j +1 +j<br>–j –1 –j –1 +j –1 +1 –j +1 +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j –j –1 –j +j +1 +j +1 –j +1 –1 +j –1 +j +1 +j +j +1 +j +1<br>–j +1 +1 –j +1 +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j –1 +1 –1 +1 +j +j –1 –1 –j +1 –1 +j +1 +1 –1 –j +j +j +1 |
| The sequence $Seq^{8}_{right,595}(k)$, to be transmitted from left to right, up to down |
| –j +j +j +j –j –j +1 –1 –1 –1 +1 +1 +j +1 +j +j +1 +j –1 +j –1 –1 +j –1 –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j +1 –j +1 +1<br>–j +1 –j –1 –j –j –1 –j –1 +1 +1 –1 +1 +1 +j –j –j +j –j –j +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +j –j –j +j –j –j –1 +1 +1<br>–1 +1 +1 –j –1 –j +j +1 +j +1 –j +1 –1 +j –1 +j –j –j –j +j +j –1 +1 +1 +1 –1 –1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 –1<br>+1 +1 +1 –1 –1 +j –j –j –j +j +j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j –1 +j –1 +1 –j<br>+1 +j +1 +j –j –1 –j +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 –j –1 –j +j +1 +j +1 –j +1 –1 +j –1 +1 –1 –1 –1 +1 +1 +j –j –j<br>–j +j +j –1 +j –1 –1 +j –1 –j –1 –j –j –1 –j –j +j +j +j –j –j –1 +1 +1 +1 –1 –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 –j<br>+j +j –j +j +j –1 +1 +1 –1 +1 +1 +j +1 +j –j –1 –j +1 –j +1 –1 +j –1 –1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –j +1 –1<br>+j –1 +j +1 +j –j –1 –j –1 +1 +1 +1 –1 –1 –j +j +j +j –j –j +1 –j +1 +1 –j +1 +j +1 +j +j +1 +j –j +j +j +j –j –j –1 +1<br>+1 +1 –1 –1 +j +1 +j +j +1 +j +1 –j +1 +1 –j +1 +j –j –j +j –j –j +1 –1 –1 +1 –1 –1 –j –1 –j +j +1 +j –1 +j –1 +1 –j +1<br>–1 +1 +1 –1 +1 +1 –j +j +j –j +j +j +1 –j +1 –1 +j –1 +j +1 +j –j –1 –j –j +j +j +j –j –j +1 –1 –1 –1 +1 +1 +j +1 +j +j<br>+1 +j –1 +j –1 –1 +j –1 –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j +1 –j +1 +1 –j +1 –j –1 –j –j –1 –j –1 +1 +1 –1 +1 +1 +j<br>–j –j +j –j –j +1 –j +1 –1 +j –1 –j –1 –j +j +1 +j +j –j –j +j –j –j –1 +1 +1 –1 +1 +1 –j –1 –j +j +1 +j +1 –j +1 –1 +j –1<br>+j –j –j –j +j +j –1 +1 +1 +1 –1 –1 –j –1 –j –j –1 –j +1 –j +1 +1 –j +1 –1 +1 +1 +1 –1 –1 +j –j –j –j +j +j +1 –j +1 +1<br>–j +1 –j –1 –j –j –1 –j +1 –1 –1 +1 –1 –1 –j +j +j –j +j +j –1 +j –1 +1 –j +1 +j +1 +j –j –1 –j +j –j –j +j –j –j –1 +1 +1<br>–1 +1 +1 –j –1 –j +j +1 +j +1 –j +1 –1 +j –1 +j +1 –1 +1 +1 –1 +1 –1 +j +j –1 –1 +1 +1 –1 –j –j –j +1 |

**Table 28-116—The sequence $Seq^{i}_{left,804}(k)$**

| |
|---|
| The sequence $Seq^{1}_{left,804}(k)$, to be transmitted from left to right, up to down |
| –j +j +1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j<br>–j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j<br>–j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j<br>+j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1<br>–1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1<br>–1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1<br>–1 +1 –j –j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1<br>–1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1<br>–1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1<br>+1 –1 +j +j |
| The sequence $Seq^{2}_{left,804}(k)$, to be transmitted from left to right, up to down |
| +1 –1 –1 +1 +j –1 –j –j –1 +j –1 –j –j –1 +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1<br>+j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j –j +1 +j +j +1 +j –1 –j –j –1 –1 –j +1 +1 –j +1<br>+j –1 –1 +j +1 –1 +1 –j –j +1 –1 +1 –j –j –j +j –j –1 –1 –j +j –j –1 –1 +1 –1 +1 –j –j +1 –1 +1 –j –j +j –j +j +1 +1 +j<br>–j +j +1 +1 +1 –1 +1 –j –j –1 +1 –1 +j +j +j –j +j +1 +1 –j +j –j –1 –1 +1 –1 +1 –j –j –1 +1 –1 +j +j –j +j –j –1 –1 +j<br>–j +j +1 +1 +j –1 –j –j –1 +j –1 –j –j –1 +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1<br>+j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j –j +1 +j +j +1 +j –1 –j –j –1 –1 –j +1 +1 –j +1<br>+j –1 –1 +j +1 –1 +1 –j –j +1 –1 +1 –j –j –j +j –j –1 –1 –j +j –j –1 –1 +1 –1 +1 –j –j +1 –1 +1 –j –j +j –j +j +1 +1 +j<br>–j +j +1 +1 +1 –1 +1 –j –j –1 +1 –1 +j +j +j –j +j +1 +1 –j +j –j –1 –1 +1 –1 +1 –j –j –1 +1 –1 +j +j –j +j –j –1 –1 +j<br>–j +j +1 +1 +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –j +1 +j +j +1 –j<br>+1 +j +j +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j<br>+1 +j +j +1 –j +j –j –1 –1 –j +j –j –1 –1 –1 +1 –1 +j +j –1 +1 –1 +j +j –j +j –j –1 –1 –j +j –j –1 –1 +1 –1 +1 –j –j +1<br>–1 +1 –j –j –j +j –j –1 –1 +j –j +j +1 +1 +1 –1 +1 –j –j –1 +1 –1 +j +j –j +j –j –1 –1 +j –j +j +1 +1 –1 +1 –1 +j +j +1<br>–1 +1 –j –j –1 –j +1 +1 –j –1 –j +1 +1 –j +j –1 –j –j –1 +j –1 –j –j –1 +1 +j –1 –1 +j +1 +j –1 –1 +j +j –1 –j –j –1 +j<br>–1 –j –j –1 –1 –j +1 +1 –j +1 +j –1 –1 +j –j +1 +j +j +1 +j –1 –j –j –1 +1 +j –1 –1 +j –1 –j +1 +1 –j –j +1 +j +j +1 +j<br>–1 –j –j –1 +j –j +j +1 +1 +j –j +j +1 +1 +1 –1 +1 –j –j +1 –1 +1 –j –j +j –j +j +1 +1 +j –j +j +1 +1 –1 +1 –1 +j +j –1<br>+1 –1 +j +j +j –j +j +1 +1 –j +j –j –1 –1 –1 +1 –1 +j +j +1 –1 +1 –j –j +j –j +j +1 +1 –j +j –j –1 –1 +1 –1 +1 –j –j –1<br>+1 –1 +j +j +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –j +1 +j +j +1 –j<br>+1 +j +j +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j<br>+1 +j +j +1 –j +j –j –1 –1 –j +j –j –1 –1 –1 +1 –1 +j +j –1 +1 –1 +j +j –j +j –j –1 –1 –j +j –j –1 –1 +1 –1 +1 –j –j +1<br>–1 +1 –j –j –j +j –j –1 –1 +j –j +j +1 +1 +1 –1 +1 –j –j –1 +1 –1 +j +j –j +j –j –1 –1 +j –j +j +1 +1 –1 +1 –1 +j +j +1<br>–1 +1 –j –j |

**Table 28-116—The sequence $Seq^{i}_{left,804}(k)$ *(continued)***

| The sequence $Seq^{3}_{left,804}(k)$, to be transmitted from left to right, up to down |
|---|
| –j –1 –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 |
| +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j –j +1 +j +j +1 +j |
| –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 |
| –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j |
| +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 |
| –1 +1 –j –j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j +j –1 –j –j –1 –j |
| +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 |
| +1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j –j +1 +j +j +1 +j |
| –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 |
| +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j –j +1 +j +j +1 +j |
| –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 |
| –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j |
| +j –j –1 –1 –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j |
| +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 |
| +1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j –j +1 +j +j +1 +j |
| –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 |
| –1 +1 –j –j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j |
| +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 |
| +1 –1 +j +j –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j –j +1 +j +j +1 +j |
| –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 |
| –1 +1 –j –j |
| The sequence $Seq^{4}_{left,804}(k)$, to be transmitted from left to right, up to down |
| +1 +j +j –j +j –1 –j –j –1 +j –1 –j –j –1 –j +j –j –1 –1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 |
| –1 +1 –j –j –1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +1 +j +j +1 –j +j –j –1 –1 +j |
| –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 +1 –1 +j +j +j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j |
| –j +j +1 +1 –j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 |
| +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 +j –1 –1 +j –1 +1 –1 +j +j –1 |
| +1 –1 +j +j +1 +j –1 –1 +j –1 –j +1 +1 –j –1 +1 –1 +j +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j |
| +j –j –1 –1 +1 +j –1 –1 +j +1 +j –1 –1 +j +1 –1 +1 –j –j +1 –1 +1 –j –j –j +1 +j +j +1 –j +1 +j +j +1 –j +j –j –1 –1 –j |
| +j –j –1 –1 +j –1 –j –j –1 –j +1 +j +j +1 +j –j +j +1 +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 +j –1 –1 +j –1 +1 –1 +j +j +1 |
| –1 +1 –j –j +j –1 –j –j –1 +j –1 –j –j –1 –j +j –j –1 –1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 |
| –1 +1 –j –j –1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +1 +j +j +1 –j +j –j –1 –1 +j |
| –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 +1 –1 +j +j +j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j |
| –j +j +1 +1 –j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 |
| +1 –1 +j +j –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 –1 +1 –j –j –j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j |
| –j +j +1 +1 –j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 |
| +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 –j +j –j –1 –1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 |
| +1 –1 +j +j +1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +1 +j +j +1 +j –j +j +1 +1 –j |
| +j –j –1 –1 –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 –1 +1 –j –j –j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j |
| –j +j +1 +1 –j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 |
| +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 –j +j –j –1 –1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 |
| +1 –1 +j +j +1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +1 +j +j +1 +j –j +j +1 +1 –j |
| +j –j –1 –1 |

**Table 28-116—The sequence $Seq^{i}_{left,804}(k)$ *(continued)***

| The sequence $Seq^{5}_{left,804}(k)$, to be transmitted from left to right, up to down |
|---|
| –j –j +1 –j –1 –1 –j +j –j –1 –1 –j +j –j +1 +1 +j –j +j –1 –1 –j +j –j –j +1 +1 –j –1 –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 +j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –j –j –1 +j –1 –j –j –1 +j –1 –j –j –1 +j +1 +j<br>+j +1 –j +j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j +1 +j<br>+j +1 –j –1 –1 –j +j –j –1 –1 –j +j –j +1 +1 +j –j +j –1 –1 –j +j –j –j +1 +1 –j –1 –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 +j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –j –j –1 +j –1 –j –j –1 +j –1 –j –j –1 +j +1 +j<br>+j +1 –j +j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j +1 +j<br>+j +1 –j +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –j –j –1 +j –1 –j –j –1 +j +1 +j +j +1 –j –1 –j<br>–j –1 +j +j +j –1 +1 –1 –j –j +1 –1 +1 –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +j +j +1 –j –1 –j –j –1 +j –1 –j –j –1 +j –1 –j<br>–j –1 +j +1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 –j –j +1 –1 +1 –j –j +1 –1 +1 +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +j +j +1 –j +1 +j +j +1 –j –1 –j –j –1 +j +1 +j<br>+j +1 –j –j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –j –j –1 +j +1 +j +j +1 –j +1 +j +j +1 –j +1 +j<br>+j +1 –j –1 –1 –j +j –j –1 –1 –j +j –j –1 –1 –j +j –j +1 +1 +j –j +j –j +1 +1 –j –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +j –1<br>–1 +j +1 –1 –1 –j +j –j +1 +1 +j –j +j –1 –1 –j +j –j –1 –1 –j +j –j +j –1 –1 +j +1 –j +1 +1 –j –1 +j –1 –1 +j +1 +j –1<br>–1 +j +1 +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –j –j –1 +j –1 –j –j –1 +j +1 +j +j +1 –j –1 –j<br>–j –1 +j +j +j –1 +1 –1 –j –j +1 –1 +1 –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +j +j +1 –j –1 –j –j –1 +j –1 –j –j –1 +j –1 –j<br>–j –1 +j +1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 |
| The sequence $Seq^{6}_{left,804}(k)$, to be transmitted from left to right, up to down |
| +j +j +1 –1 +1 +j +j +1 –j –j +1 +1 –j –1 –1 –j –j –1 +j –j +1 +1 –j –1 –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1<br>–j –j –1 +j +1 +1 +j –j +j –j –j +1 –1 +1 +1 +1 +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1<br>+1 +j –j +j +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j<br>+1 +1 –j –1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1 +1 +j –j +j –1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j<br>+j –1 +1 –1 +1 +j +j +1 –j –j +1 +1 –j –1 –1 –j –j –1 +j –j +1 +1 –j –1 –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1<br>–j –j –1 +j +1 +1 +j –j +j –j –j +1 –1 +1 +1 +1 +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1<br>+1 +j –j +j +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j<br>+1 +1 –j –1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1 +1 +j –j +j –1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j<br>+j –1 +1 –1 –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1 –j –j –1 +j –1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j<br>–1 –1 +j +1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1 +1 +j –j +j –1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j<br>–j +1 –1 +1 +1 +j +j +1 –j +j –1 –1 +j +1 –1 –j –j –1 +j +j –1 –1 +j +1 +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1<br>–j –j –1 +j +1 +1 +j –j +j +j +j –1 +1 –1 +1 +1 +j –j +j –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1<br>+1 +j –j +j +j –1 –1 +j +1 +1 +j +j +1 –j –j +1 +1 –j –1 +1 +j +j +1 –j +1 +j +j +1 –j –j +1 +1 –j –1 –1 –j –j –1 +j –j<br>+1 +1 –j –1 +j +j –1 +1 –1 +1 +1 +j –j +j +j +j –1 +1 –1 –1 –1 –j +j –j +1 +1 +j –j +j –j –j +1 –1 +1 +1 +1 +j –j +j +j<br>+j –1 +1 –1 –1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +j +j +1 –j +j –1 –1 +j +1 +1<br>+j +j +1 –j –1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +1 +j –j +j –j –j +1 –1 +1 –1<br>–1 –j +j –j –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1 –j –j –1 +j –1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j<br>–1 –1 +j +1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1 +1 +j –j +j –1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j<br>–j +1 –1 +1 +1 +j +j +1 –j +j –1 –1 +j +1 –1 –j –j –1 +j +j –1 –1 +j +1 +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1<br>–j –j –1 +j +1 +1 +j –j +j +j +j –1 +1 –1 +1 +1 +j –j +j –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1<br>+1 +j –j +j |

**Table 28-116—The sequence $Seq^{i}_{left,804}(k)$ *(continued)***

| The sequence $Seq^{7}_{left,804}(k)$, to be transmitted from left to right, up to down |
|---|
| +j –j –1 –1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j<br>–1 –1 +j +1 +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1<br>–j –j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1<br>–j –j –1 +j –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j<br>+j +1 –j +j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j<br>+j +1 –j +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j +j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1<br>–1 +j +1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1<br>–1 +j +1 +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j<br>–j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j<br>–j –1 +j –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j<br>–j –1 +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j<br>+j +1 –j –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j<br>–j –1 +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1<br>+1 –j –1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1<br>+1 –j –1 –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j<br>+j +1 –j |
| The sequence $Seq^{8}_{left,804}(k)$, to be transmitted from left to right, up to down |
| –1 +j +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j –1 –1 –j +j –j +j +j –1 +1 –1 –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j +j<br>–1 –1 +j +1 +1 +1 +j –j +j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j +1 +j +j +1 –j +j –1 –1 +j +1 +j –1 –1 +j +1<br>–1 –j –j –1 +j +j +j –1 +1 –1 –1 –1 –j +j –j +1 +1 +j –j +j +j +j –1 +1 –1 –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j<br>–j +1 +1 –j –1 –1 –1 –j +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j +1 +j +j +1 –j –j +1 +1 –j –1 +j –1 –1 +j +1<br>+1 +j +j +1 –j +j +j –1 +1 –1 +1 +1 +j –j +j +1 +1 +j –j +j –j –j +1 –1 +1 +j –1 –1 +j +1 +1 +j +j +1 –j +1 +j +j +1 –j<br>–j +1 +1 –j –1 –1 –1 –j +j –j –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +1 +j –j +j –1 –j –j –1 +j –j +1 +1 –j –1 –j +1 +1 –j –1<br>+1 +j +j +1 –j –j –j +1 –1 +1 +1 +1 +j –j +j –1 –1 –j +j –j –j –j +1 –1 +1 +j –1 –1 +j +1 –1 –j –j –1 +j +1 +j +j +1 –j<br>+j –1 –1 +j +1 +1 +1 +j –j +j –j –j +1 –1 +1 +j +j –1 +1 –1 +1 +1 +j –j +j –1 –j –j –1 +j +j –1 –1 +j +1 –j +1 +1 –j –1<br>–1 –j –j –1 +j –j –j +1 –1 +1 –1 –1 –j +j –j –1 –1 –j +j –j +j +j –1 +1 –1 –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j +j<br>–1 –1 +j +1 +1 +1 +j –j +j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j +1 +j +j +1 –j +j –1 –1 +j +1 +j –1 –1 +j +1<br>–1 –j –j –1 +j +j +j –1 +1 –1 –1 –1 –j +j –j +1 +1 +j –j +j +j +j –1 +1 –1 –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j<br>–j +1 +1 –j –1 –1 –1 –j +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j +1 +j +j +1 –j –j +1 +1 –j –1 +j –1 –1 +j +1<br>+1 +j +j +1 –j +1 +1 +j –j +j –j –j +1 –1 +1 –j –j +1 –1 +1 –1 –1 –j +j –j +1 +j +j +1 –j –j +1 +1 –j –1 –j +1 +1 –j –1<br>–1 –j –j –1 +j +j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 +j –1 –1 +j +1 –1 –j –j –1 +j –1 –j –j –1 +j –j<br>+1 +1 –j –1 –1 –1 –j +j –j –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –1 –j +j –j +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 +1<br>+j +j +1 –j –j –j +1 –1 +1 –1 –1 –j +j –j +1 +1 +j –j +j –j –j +1 –1 +1 +j –1 –1 +j +1 +1 +j +j +1 –j –1 –j –j –1 +j +j<br>–1 –1 +j +1 +1 +1 +j –j +j –j –j +1 –1 +1 –j –j +1 –1 +1 –1 –1 –j +j –j +1 +j +j +1 –j –j +1 +1 –j –1 –j +1 +1 –j –1 –1<br>–j –j –1 +j +j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 +j –1 –1 +j +1 –1 –j –j –1 +j –1 –j –j –1 +j –j +1<br>+1 –j –1 –1 –1 –j +j –j –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –1 –j +j –j +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +j<br>+j +1 –j –j –j +1 –1 +1 –1 –1 –j +j –j +1 +1 +j –j +j –j –j +1 –1 +1 +j –1 –1 +j +1 +1 +j +j +1 –j –1 –j –j –1 +j +j –1<br>–1 +j +1 |

### Table 28-117—The sequence $Seq^{i}_{right,804}(k)$

| The sequence $Seq^{1}_{right,804}(k)$, to be transmitted from left to right, up to down |
|---|
| –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>+1 +1 +j –1 |
| The sequence $Seq^{2}_{right,804}(k)$, to be transmitted from left to right, up to down |
| –j +1 +j +j +1 +j –1 –j –j –1 –1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j<br>–j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1 +j –1 –1 +j +j –1 –j –j –1 +j –1 –j –j –1 +1 +j –1 –1 +j +1 +j –1 –1 +j<br>–1 +1 –1 +j +j +1 –1 +1 –j –j +j –j +j +1 +1 –j +j –j –1 –1 –1 +1 –1 +j +j +1 –1 +1 –j –j –j +j –j –1 –1 +j –j +j +1 +1<br>–1 +1 –1 +j +j –1 +1 –1 +j +j –j +j –j –1 –1 –j +j –j –1 –1 –1 +1 –1 +j +j –1 +1 –1 +j +j +j –j +j +1 +1 +j –j +j +1 +1<br>–1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +j –1 –j –j –1 –j +1 +j +j +1<br>–1 –j +1 +1 –j –1 –j +1 +1 –j –j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1<br>+j –j +j +1 +1 –j +j –j –1 –1 +1 –1 +1 –j –j –1 +1 –1 +j +j +j –j +j +1 +1 –j +j –j –1 –1 –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+j –j +j +1 +1 +j –j +j +1 +1 –1 +1 –1 +j +j –1 +1 –1 +j +j +j –j +j +1 +1 +j –j +j +1 +1 +1 –1 +1 –j –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 +1 +j –1 –1 +j –1 –j +1 +1 –j +j –1 –j –j –1 –j +1 +j +j +1<br>–1 –j +1 +1 –j –1 –j +1 +1 –j –j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1 +j –1 –1 +j –j +1 +j +j +1 –j +1 +j +j +1<br>+j –j +j +1 +1 –j +j –j –1 –1 +1 –1 +1 –j –j –1 +1 –1 +j +j +j –j +j +1 +1 –j +j –j –1 –1 –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+j –j +j +1 +1 +j –j +j +1 +1 –1 +1 –1 +j +j –1 +1 –1 +j +j +j –j +j +1 +1 +j –j +j +1 +1 +1 –1 +1 –j –j +1 –1 +1 –j –j<br>–j +1 +j +j +1 +j –1 –j –j –1 –1 –j +1 +1 –j +1 +j –1 –1 +j +j –1 –j –j –1 –j +1 +j +j +1 –1 –j +1 +1 –j +1 +j –1 –1 +j<br>–j +1 +j +j +1 –j +1 +j +j +1 +1 +j –1 –1 +j +1 +j –1 –1 +j +j –1 –j –j –1 +j –1 –j –j –1 +1 +j –1 –1 +j +1 +j –1 –1 +j<br>–1 +1 –1 +j +j +1 –1 +1 –j –j +j –j +j +1 +1 –j +j –j –1 –1 –1 +1 –1 +j +j +1 –1 +1 –j –j –j +j –j –1 –1 +j –j +j +1 +1<br>–1 +1 –1 +j +j –1 +1 –1 +j +j –j +j –j –1 –1 –j +j –j –1 –1 –1 +1 –1 +j +j –1 +1 –1 +j +j +j –j +j +1 +1 +j –j +j +1 +1<br>+1 +j –1 –1 +j –1 –j +1 +1 –j –j +1 +j +j +1 +j –1 –j –j –1 –1 –j +1 +1 –j +1 +j –1 –1 +j –j +1 +j +j +1 +j –1 –j –j –1<br>+1 +j –1 –1 +j +1 +j –1 –1 +j +j –1 –j –j –1 +j –1 –j –j –1 –1 –j +1 +1 –j –1 –j +1 +1 –j +j –1 –j –j –1 +j –1 –j –j –1<br>–j +j –j –1 –1 +j –j +j +1 +1 –1 +1 –1 +j +j +1 –1 +1 –j –j –j +j –j –1 –1 +j –j +j +1 +1 +1 –1 +1 –j –j –1 +1 –1 +j +j<br>–j +j –j –1 –1 –j +j –j –1 –1 +1 –1 +1 –j –j +1 –1 +1 –j –j –j +j –j –1 –1 –j +j –j –1 –1 –1 +1 –1 +j +j –1 +1 –1 +j +j<br>+j +j +j –j |

**Table 28-117—The sequence $Seq^{i}_{right,804}(k)$ *(continued)***

| |
|---|
| The sequence $Seq^{3}_{right,804}(k)$, to be transmitted from left to right, up to down |
| +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1<br>–j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j –j +1 +j +j +1 +j –j +j +1 +1<br>+j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1<br>–1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j –j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j<br>–j +1 +j +j +1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>–1 –j +1 +1 –j –1 +1 –1 +j +j +j –1 –j –j –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j +j –1 –j –j –1 –j +j –j –1 –1<br>+j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j +1 –1 +1 –j –j –j +1 +j +j +1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 –1 +1 –j –j +j –1 –j –j –1 +j –j +j +1 +1 +1 +j –1 –1 +j –1 +1 –1 +j +j +j –1 –j –j –1 –j +j –j –1 –1<br>–1 +1 –1 –j |
| The sequence $Seq^{4}_{right,804}(k)$, to be transmitted from left to right, up to down |
| +1 +j –1 –1 +j –1 –j +1 +1 –j –1 +1 –1 +j +j +1 –1 +1 –j –j +j –1 –j –j –1 –j +1 +j +j +1 –j +j –j –1 –1 +j –j +j +1 +1<br>+j –1 –j –j –1 +j –1 –j –j –1 –j +j –j –1 –1 –j +j –j –1 –1 +1 +j –1 –1 +j +1 +j –1 –1 +j –1 +1 –1 +j +j –1 +1 –1 +j +j<br>+j –1 –j –j –1 –j +1 +j +j +1 +j –j +j +1 +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 –j +j –j –1 –1 –j +j –j –1 –1<br>–j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 –j +1 +1 –j –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 +j –1 –1 +j –1 +1 –1 +j +j –1 +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j –j +j +1 +1<br>+1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1<br>+j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 +1 –1 +j +j<br>–1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 –1 +1 –j –j<br>–j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 +j –1 –1 +j –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 +j –1 –1 +j +1 –1 +1 –j –j +1 –1 +1 –j –j +j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j –j +j +1 +1<br>–1 –j +1 +1 –j +1 +j –1 –1 +j +1 –1 +1 –j –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1<br>–j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j +1 –1 +1 –j –j +1 –1 +1 –j –j<br>–j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1 –1 –j +1 +1 –j +1 +j –1 –1 +j –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 +j –1 –1 +j +1 –1 +1 –j –j +1 –1 +1 –j –j +j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j –j +j +1 +1<br>–j +1 +j +j +1 +j –1 –j –j –1 +j –j +j +1 +1 –j +j –j –1 –1 +1 +j –1 –1 +j –1 –j +1 +1 –j –1 +1 –1 +j +j +1 –1 +1 –j –j<br>+1 +j –1 –1 +j +1 +j –1 –1 +j –1 +1 –1 +j +j –1 +1 –1 +j +j –j +1 +j +j +1 –j +1 +j +j +1 +j –j +j +1 +1 +j –j +j +1 +1<br>+1 +j –1 –1 +j –1 –j +1 +1 –j +1 –1 +1 –j –j –1 +1 –1 +j +j –j +1 +j +j +1 +j –1 –j –j –1 –j +j –j –1 –1 +j –j +j +1 +1<br>+j –1 –j –j –1 +j –1 –j –j –1 +j –j +j +1 +1 +j –j +j +1 +1 –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 –1 +j +j –1 +1 –1 +j +j<br>+1 +1 –1 –j |

**Table 28-117—The sequence $Seq^{i}_{right,804}(k)$ *(continued)***

| The sequence $Seq^{5}_{right,804}(k)$, to be transmitted from left to right, up to down |
|---|
| +1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1 +1 –j –1 +j –1 –1 +j +1<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –1 –j +j –j –1 –1 –j +j –j –j +1 +1 –j –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1<br>+j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –j –j –1 +j –1 –j –j –1 +j –1 –j –j –1 +j +1 +j +j +1 –j<br>+j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j +1 +j +j +1 –j<br>–j –j +1 –1 +1 –j –j +1 –1 +1 +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +j +j +1 –j +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j<br>–j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –j –j –1 +j +1 +j +j +1 –j +1 +j +j +1 –j +1 +j +j +1 –j<br>+1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>+1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1 +1 –j –1<br>–j –j +1 –1 +1 –j –j +1 –1 +1 +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +j +j +1 –j +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j<br>–j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –j –j –1 +j +1 +j +j +1 –j +1 +j +j +1 –j +1 +j +j +1 –j<br>+1 +1 +j –j +j +1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>+1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +1 +1 +j –j +j –j +1 +1 –j –1 +j –1 –1 +j +1 –j +1 +1 –j –1 –j +1 +1 –j –1<br>+1 +1 +j –j +j +1 +1 +j –j +j –1 –1 –j +j –j +1 +1 +j –j +j +j –1 –1 +j +1 +j –1 –1 +j +1 –j +1 +1 –j –1 +j –1 –1 +j +1<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –1 –j +j –j –1 –1 –j +j –j –j +1 +1 –j –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +j –1 –1 +j +1<br>+j +j –1 +1 –1 +j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –j –j –1 +j –1 –j –j –1 +j –1 –j –j –1 +j +1 +j +j +1 –j<br>+j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +j +j +1 –j –1 –j –j –1 +j +1 +j +j +1 –j +1 +j +j +1 –j<br>+j +j –1 +1 –1 +j +j –1 +1 –1 –j –j +1 –1 +1 +j +j –1 +1 –1 –1 –j –j –1 +j –1 –j –j –1 +j +1 +j +j +1 –j –1 –j –j –1 +j<br>+j +j –1 +1 –1 –j –j +1 –1 +1 –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +j +j +1 –j –1 –j –j –1 +j –1 –j –j –1 +j –1 –j –j –1 +j<br>–1 –1 –j +j –j –1 –1 –j +j –j –1 –1 –j +j –j +1 +1 +j –j +j –j +1 +1 –j –1 –j +1 +1 –j –1 –j +1 +1 –j –1 +j –1 –1 +j +1<br>–1 –1 –j +j –j +1 +1 +j –j +j –1 –1 –j +j –j –1 –1 –j +j –j +j –1 –1 +j +1 –j +1 +1 –j –1 +j –1 –1 +j +1 +j –1 –1 +j +1<br>+j –1 +1 +1 |
| The sequence $Seq^{6}_{right,804}(k)$, to be transmitted from left to right, up to down |
| –1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1 –j –j –1 +j<br>–1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j –j +1 –1 +1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1 +1 +j –j +j<br>–j +1 +1 –j –1 +1 +j +j +1 –j +j –1 –1 +j +1 +1 +j +j +1 –j –1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j +1 +1 –j –1<br>–j –j +1 –1 +1 +1 +1 +j –j +j –j –j +1 –1 +1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j +j –1 +1 –1<br>+j –1 –1 +j +1 +1 +j +j +1 –j –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j –1 –1 +j +1<br>+j +j –1 +1 –1 +1 +1 +j –j +j +j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j –j +1 –1 +1<br>–1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j +1 +1 –j –1 +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1 –j –j –1 +j<br>–1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1 +1 +j –j +j<br>+j –1 –1 +j +1 +1 +j +j +1 –j –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j –1 –1 +j +1<br>+j +j –1 +1 –1 +1 +1 +j –j +j +j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j –j +1 –1 +1<br>–1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j +1 +1 –j –1 +j –1 –1 +j +1 –1 –j –j –1 +j –j +1 +1 –j –1 –1 –j –j –1 +j<br>–1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j +j +j –1 +1 –1 +1 +1 +j –j +j<br>–1 –j –j –1 +j +j –1 –1 +j +1 +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1 –j –j –1 +j<br>–1 –1 –j +j –j +j +j –1 +1 –1 –1 –1 –j +j –j –j –j +1 –1 +1 –j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1 +1 +j –j +j<br>–j +1 +1 –j –1 +1 +j +j +1 –j +j –1 –1 +j +1 +1 +j +j +1 –j –1 –j –j –1 +j –j +1 +1 –j –1 +1 +j +j +1 –j –j +1 +1 –j –1<br>–j –j +1 –1 +1 +1 +1 +j –j +j –j –j +1 –1 +1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 –1 –1 –j +j –j +j +j –1 +1 –1<br>–j +1 +1 –j –1 –1 –j –j –1 +j +j –1 –1 +j +1 –1 –j –j –1 +j +1 +j +j +1 –j –j +1 +1 –j –1 –1 –j –j –1 +j –j +1 +1 –j –1<br>–j –j +1 –1 +1 –1 –1 –j +j –j –j –j +1 –1 +1 +1 +1 +j –j +j +1 +1 +j –j +j –j –j +1 –1 +1 +1 +1 +j –j +j +j +j –1 +1 –1<br>+1 +j +j +1 –j +j –1 –1 +j +1 –1 –j –j –1 +j +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +j +j +1 –j +j –1 –1 +j +1 +1 +j +j +1 –j<br>+1 +1 +j –j +j +j +j –1 +1 –1 +1 +1 +j –j +j –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +1 +j –j +j –j –j +1 –1 +1 –1 –1 –j +j –j<br>–1 –j +1 +1 |

**Table 28-117—The sequence $Seq^{i}_{right,804}(k)$ *(continued)***

| |
|---|
| The sequence $Seq^{7}_{right,804}(k)$, to be transmitted from left to right, up to down |
| +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1 –1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j<br>–1 –1 –j +j –j +1 +1 +j –j +j +1 +j +j +1 –j +1 +j +j +1 –j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1<br>–1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j +j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1<br>–j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1<br>+j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j<br>+j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j<br>–1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>–j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1<br>+1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>+j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1 –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j<br>–j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j –j –j +1 –1 +1 +j +j –1 +1 –1 +j –1 –1 +j +1 +j –1 –1 +j +1<br>+1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>+j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1 –1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j<br>+1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j +j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1<br>+j +j –1 +1 –1 –j –j +1 –1 +1 –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +1 +j –j +j –1 –1 –j +j –j –1 –j –j –1 +j –1 –j –j –1 +j<br>+j +j –1 +1 –1 +j +j –1 +1 –1 –j +1 +1 –j –1 +j –1 –1 +j +1 +1 +1 +j –j +j +1 +1 +j –j +j –1 –j –j –1 +j +1 +j +j +1 –j<br>–1 –1 –j +j –j –1 –1 –j +j –j +1 +j +j +1 –j –1 –j –j –1 +j –j –j +1 –1 +1 –j –j +1 –1 +1 +j –1 –1 +j +1 –j +1 +1 –j –1<br>+j –j –1 –j |
| The sequence $Seq^{8}_{right,804}(k)$, to be transmitted from left to right, up to down |
| +1 +1 +j –j +j –j –j +1 –1 +1 +j +j –1 +1 –1 +1 +1 +j –j +j +1 +j +j +1 –j –j +1 +1 –j –1 +j –1 –1 +j +1 +1 +j +j +1 –j<br>+j +j –1 +1 –1 –1 –1 –j +j –j +1 +1 +j –j +j +j +j –1 +1 –1 +j –1 –1 +j +1 –1 –j –j –1 +j +1 +j +j +1 –j +j –1 –1 +j +1<br>–1 –1 –j +j –j –j –j +1 –1 +1 –j –j +1 –1 +1 +1 +1 +j –j +j +1 +j +j +1 –j +j –1 –1 +j +1 +j –1 –1 +j +1 –1 –j –j –1 +j<br>–j –j +1 –1 +1 –1 –1 –j +j –j –1 –1 –j +j –j +j +j –1 +1 –1 +j –1 –1 +j +1 +1 +j +j +1 –j +1 +j +j +1 –j –j +1 +1 –j –1<br>–j –j +1 –1 +1 –1 –1 –j +j –j +1 +1 +j –j +j –j –j +1 –1 +1 –j +1 +1 –j –1 –1 –j –j –1 +j +1 +j +j +1 –j –j +1 +1 –j –1<br>+1 +1 +j –j +j +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +1 +j –j +j +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +j +j +1 –j<br>+j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 –j +1 +1 –j –1 +1 +j +j +1 –j +1 +j +j +1 –j +j –1 –1 +j +1<br>–1 –1 –j +j –j +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +1 +j –j +j +1 +j +j +1 –j –j +1 +1 –j –1 –j +1 +1 –j –1 –1 –j –j –1 +j<br>–1 –1 –j +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j –1 –j –j –1 +j +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –j –j –1 +j<br>–j –j +1 –1 +1 +1 +1 +j –j +j –1 –1 –j +j –j –j –j +1 –1 +1 –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j –j +1 +1 –j –1<br>+1 +1 +j –j +j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j –1 –j –j –1 +j –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +j +j +1 –j<br>+j +j –1 +1 –1 +1 +1 +j –j +j +1 +1 +j –j +j –j –j +1 –1 +1 –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j +j –1 –1 +j +1<br>–1 –1 –j +j –j +j +j –1 +1 –1 –j –j +1 –1 +1 –1 –1 –j +j –j –1 –j –j –1 +j +j –1 –1 +j +1 –j +1 +1 –j –1 –1 –j –j –1 +j<br>–j –j +1 –1 +1 +1 +1 +j –j +j –1 –1 –j +j –j –j –j +1 –1 +1 –j +1 +1 –j –1 +1 +j +j +1 –j –1 –j –j –1 +j –j +1 +1 –j –1<br>+1 +1 +j –j +j +j +j –1 +1 –1 +j +j –1 +1 –1 –1 –1 –j +j –j –1 –j –j –1 +j –j +1 +1 –j –1 –j +1 +1 –j –1 +1 +j +j +1 –j<br>+j +j –1 +1 –1 +1 +1 +j –j +j +1 +1 +j –j +j –j –j +1 –1 +1 –j +1 +1 –j –1 –1 –j –j –1 +j –1 –j –j –1 +j +j –1 –1 +j +1<br>–j –j +1 –1 +1 –1 –1 –j +j –j +1 +1 +j –j +j –j –j +1 –1 +1 –j +1 +1 –j –1 –1 –j –j –1 +j +1 +j +j +1 –j –j +1 +1 –j –1<br>+1 +1 +j –j +j +j +j –1 +1 –1 –j –j +1 –1 +1 +1 +1 +j –j +j +1 +j +j +1 –j +j –1 –1 +j +1 –j +1 +1 –j –1 +1 +j +j +1 –j<br>+j +j –1 +1 –1 –1 –1 –j +j –j –1 –1 –j +j –j –j –j +1 –1 +1 –j +1 +1 –j –1 +1 +j +j +1 –j +1 +j +j +1 –j +j –1 –1 +j +1<br>–1 –1 –j +j –j +j +j –1 +1 –1 +j +j –1 +1 –1 +1 +1 +j –j +j +1 +j +j +1 –j –j +1 +1 –j –1 –j +1 +1 –j –1 –1 –j –j –1 +j<br>–1 –1 +j –1 |

## 28.12 EDMG PLME

### 28.12.1 PLME_SAP sublayer management primitives

Table 28-118 lists the MIB attributes that may be accessed by the PHY entities and the intra-layer of higher level LMEs. These attributes are accessed via the PLME-GET, PLME-SET, PLME-RESET, and PLME-CHARACTERISTICS primitives defined in 6.5.

**Table 28-118—EDMG PHY MIB attribute default values**

| Managed object | Default range/value | Operational semantics |
|---|---|---|
| dot11PHYOperationTable | | |
| dot11PHYType | EDMG | Static |
| dot11PHYEDMGTable | | |
| | | |

### 28.12.2 PHY MIB

All EDMG PHY MIB attributes are defined in Annex C, with specific values defined in Table 28-118. The “Operational semantics” column in Table 28-118 contains two types: static and dynamic. Static MIB attributes are fixed and cannot be modified for a given PHY implementation. Dynamic MIB attributes can be modified by some management entity.

### 28.12.3 TXTIME calculation

#### 28.12.3.1 General

This subclause defines the TXTIME parameter calculation for control, SC, and OFDM mode of an EDMG STA PHY entity. The TXTIME parameter is returned from the PHY to the MAC entity using the PLME-TXTIME.confirm primitive issued in response to a PLME-TXTIME.request(TXVECTOR) primitive. The TXTIME represents the time, in microseconds, required to transmit PPDU configured using the indicated TXVECTOR parameters.

#### 28.12.3.2 TXTIME calculation for EDMG control mode

If the FORMAT parameter of TXVECTOR is EDMG, then the modulation is defined by the EDMG_MODULATION parameter. If the EDMG_MODULATION parameter is set to EDMG_C_MODE, the TXTIME parameter shall be defined in microseconds as follows:

$$TXTIME\left(\mu\mathrm{s}\right) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header+EDMG\text{-}Header\text{-}A+Data} + T_{TRN}$$

where

$T_{L\text{-}STF} = 6400 \times \mathrm{aDMGChipTimeDuration} \approx 3.63\ \mu\mathrm{s}$

$T_{L\text{-}CEF} = 1152 \times \mathrm{aDMGChipTimeDuration} \approx 0.65\ \mu\mathrm{s}$

$$T_{L\text{-}Header+EDMG\text{-}Header\text{-}A+Data} = \left(\left(Length + L_{L\text{-}Header} + L_{EDMG\text{-}Header\text{-}A}\right) \times 8 + 168 \times N_{CW}\right) \times 32 \times \mathrm{aDMGChipTimeDuration}\ \mu\mathrm{s}$$

$$N_{CW} = 1 + \left\lceil \frac{\left(Length + L_{EDMG-Header-A2}\right) \times 8}{168} \right\rceil$$

$$L_{L-Header} = 5 \text{ octets}$$

$$L_{EDMG-Header-A} = 9 \text{ octets}$$

$$L_{EDMG-Header-A2} = 3 \text{ octets}$$

The parameter Length (EDMG_LENGTH in TXVECTOR) indicates the number of data octets in the PSDU and ranges from 14 to 1023.

If the CH_BANDWIDTH parameter has a single bit set to 1, the number of space-time streams NUM_STS is equal to 1, and DMG-TRN parameter is equal to 1, then the TRN field duration is defined as follows:

$$T_{TRN} = \left(4992 \times EDMG\_TRN\_LEN\right) \times \text{aDMGChipTimeDuration}\ \mu\text{s}$$

The EDMG_TRN_LEN parameter indicates the length of the training field in the range 0 to 31.

For other values of the CH_BANDWIDTH parameter, the TRN field duration is defined as follows:

$$T_{TRN} = \Big(L_T$$
$$+ \left(L_{TRN\text{-}Unit\text{-}P} + L_{TRN\text{-}Unit\text{-}M}\right) \times TRN\_BASIC\_LENGTH \times EDMG\_TRN\_LEN$$
$$+ L_{TRN\text{-}Unit\text{-}P} \times TRN\_BASIC\_LENGTH\Big) \times \text{aDMGChipTimeDuration}\ \mu\text{s}$$

where

$TRN\_BASIC\_LENGTH = 6 \times TRN\_BL \times N_{TRN}^{N_{TX}}$

If EDMG_TRN_LEN > 0, EDMG-TRN-T or EDMG-TRN-R/T, then $L_T = 6 \times 256 \times N_{TRN}^{N_{TX}}$, $L_{TRN\text{-}Unit\text{-}P}$ = 0, 1, 2, or 4, and $L_{TRN\text{-}Unit\text{-}M}$ = 1, 2, ..., or 16

If EDMG_TRN_LEN > 0, EDMG-TRN-R, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 10$

If EDMG_TRN_LEN = 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$

If the TRN_SEQ_LENGTH parameter is equal to NORMAL, then *TRN_BL* is set to 128. If the TRN_SEQ_LENGTH parameter is equal to LONG, then *TRN_BL* is set to 256. If the TRN_SEQ_LENGTH parameter is equal to SHORT, then *TRN_BL* is set to 64.

If the CHANNEL_AGGREGATION parameter is equal to AGGREGATE and the NUM_TX_CHAINS parameter is equal to 2 or 4, then $N_{TRN}^{N_{TX}}$ is set to 1. If the CHANNEL_AGGREGATION parameter is equal to AGGREGATE and the NUM_TX_CHAINS parameter is equal to 6 or 8, then $N_{TRN}^{N_{TX}}$ is set to 2.

If the CHANNEL_AGGREGATION parameter is equal to NOT_AGGREGATE and the NUM_TX_CHAINS parameter is equal to 1 or 2, then $N_{TRN}^{N_{TX}}$ is set to 1. If the CHANNEL_AGGREGATION parameter is equal to NOT_AGGREGATE and the NUM_TX_CHAINS parameter is equal to 3 or 4, then $N_{TRN}^{N_{TX}}$ is set to 2. If the CHANNEL_AGGREGATION parameter is equal to NOT_AGGREGATE and the NUM_TX_CHAINS parameter is equal to 5, 6, 7, or 8, then $N_{TRN}^{N_{TX}}$ is set to 4.

If the EDMG_TRN_LEN parameter is greater than 0 and the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-T or EDMG-TRN-R/T, then $L_T = 6 \times 256 \times N_{TRN}^{N_{TX}}$, $L_{TRN\text{-}Unit\text{-}P}$ = 0, 1, 2, or 4, and $L_{TRN\text{-}Unit\text{-}M}$ = 1, 2, ..., or 16.

If the EDMG_TRN_LEN parameter is greater than 0 and the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-R, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 10$.

If the EDMG_TRN_LEN parameter is equal to 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$.

The EDMG_TRN_LEN parameter indicates the length of the training field in the range 0 to 255.

### 28.12.3.3 TXTIME calculation for EDMG SC mode

If the EDMG_MODULATION parameter is set to EDMG_SC_MODE, the TXTIME parameter shall be defined in microseconds as follows:

$$TXTIME\left(\mu\text{s}\right) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + T_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}STF} + T_{EDMG\text{-}CEF}$$
$$+ T_{EDMG\text{-}Header\text{-}B} + T_{Data} + T_{TRN}$$

where

$T_{L\text{-}STF} = 2176 \times \text{aDMGChipTimeDuration} \approx 1.24\ \mu\text{s}$

$T_{L\text{-}CEF} = 1152 \times \text{aDMGChipTimeDuration} \approx 0.65\ \mu\text{s}$

$T_{L\text{-}Header} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu\text{s}$

If EDMG_ADD_PPDU = NO-ADD-PPDU, NUM_USERS = 1, CH_BANDWIDTH has a single bit set to 1, and NUM_STS = 1, then $T_{EDMG\text{-}Header\text{-}A} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu\text{s}$

If EDMG_ADD_PPDU = NO-ADD-PPDU, NUM_USERS ≥ 1, CH_BANDWIDTH has more than 1 bit set to 1 and/or NUM_STS ≠ 1, then $T_{EDMG\text{-}Header\text{-}A} = 1088 \times \text{aDMGChipTimeDuration} \approx 0.62\ \mu\text{s}$

If EDMG_ADD_PPDU = ADD-PPDU, $i_{PPDU}$ = 1, CH_BANDWIDTH has a single bit set to 1, and NUM_STS = 1, then $T_{EDMG\text{-}Header\text{-}A} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu\text{s}$

If EDMG_ADD_PPDU = ADD-PPDU, $i_{PPDU}$ = 1, CH_BANDWIDTH has more than 1 bit set to 1 and/or NUM_STS ≠ 1, then $T_{EDMG\text{-}Header\text{-}A} = 1088 \times \text{aDMGChipTimeDuration} \approx 0.62\ \mu\text{s}$

If EDMG_ADD_PPDU = ADD-PPDU, $i_{PPDU}$ > 1, then $T_{EDMG\text{-}Header\text{-}A} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu\text{s}$

If NUM_USERS = 1, CH_BANDWIDTH has a single bit set to 1, and NUM_STS = 1, then $T_{EDMG\text{-}STF}$ = 0 and $T_{EDMG\text{-}CEF}$ = 0

If NUM_USERS ≥ 1, CH_BANDWIDTH has more than 1 bit set to 1 and/or NUM_STS ≠ 1, then $T_{EDMG\text{-}STF} = 2432 \times \text{aDMGChipTimeDuration} \approx 1.38\ \mu\text{s}$ and $T_{EDMG-CEF} = \left(1152 + 1280 \times \left(N_{EDMG-CEF}^{N_{STS}} - 1\right)\right) / \left(1.76 \times 10^3\right)$

If NUM_USERS = 1, then $T_{EDMG\text{-}Header\text{-}B}$ = 0

If NUM_USERS > 1, then $T_{EDMG\text{-}Header\text{-}B} = 512 \times \text{aDMGChipTimeDuration} \approx 0.29\ \mu\text{s}$

$T_{Data} = \left(N_{BLKS} \times 512 + N_{GI}\right) \times \text{aDMGChipTimeDuration}\ \mu\text{s}$

If the NUM_USERS parameter is equal to 1, the CH_BANDWIDTH parameter has a single bit set to 1, and the NUM_STS parameter is equal to 1, then the EDMG-STF and EDMG-CEF fields are not transmitted and $T_{EDMG\text{-}STF}$ = 0 and $T_{EDMG\text{-}CEF}$ = 0.

If the NUM_USERS parameter is greater than or equal to 1 and the CH_BANDWIDTH parameter has more than 1 bit set to 1 and/or the NUM_STS parameter is not equal to 1, then the EDMG-STF and EDMG-CEF fields are transmitted with a time duration specified above.

If the NUM_USERS parameter is equal to 1, then the EDMG-Header-B is not transmitted and TEDMG-Header-B = 0. If the NUM_USERS is equal to a value greater than 1, then the EDMG-Header-B is transmitted with a time duration specified above.

If the NUM_STS parameter is equal to 1 or 2, then the $N_{EDMG-CEF}^{N_{STS}}$ parameter is set to 1. If the NUM_STS parameter is equal to 3 or 4, then the $N_{EDMG-CEF}^{N_{STS}}$ parameter is set to 2. If the NUM_STS parameter is equal to 5, 6, 7, or 8, then the $N_{EDMG-CEF}^{N_{STS}}$ parameter is set to 4.

The number of SC symbol blocks, $N_{BLKS}$, depends on the EDMG_LENGTH, MCS and other parameters in the TXVECTOR and shall be as defined in 28.5.9.4.

If the EDMG_ADD_PPDU parameter is equal to NO-ADD-PPDU, the NUM_USERS parameter is equal to 1, the CH_BANDWIDTH parameter has a single bit set to 1, and the NUM_STS is equal to 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 64.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

If the EDMG_ADD_PPDU parameter is equal to NO-ADD-PPDU, the NUM_USERS parameter is equal to 1, the CH_BANDWIDTH parameter has more than 1 bit set to 1 and/or the NUM_STS parameter is not equal to 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 32.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

If the EDMG_ADD_PPDU parameter is equal to NO-ADD-PPDU and the NUM_USERS parameter is greater than 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 64.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

If the EDMG_ADD_PPDU parameter is equal to ADD-PPDU, $i_{PPDU}$ is equal to 1, the CH_BANDWIDTH parameter has a single bit set to 1, and the NUM_STS is equal to 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 64.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

If the EDMG_ADD_PPDU parameter is equal to ADD-PPDU, $i_{PPDU}$ is equal to 1, the CH_BANDWIDTH parameter has more than 1 bit set to 1 and/or the NUM_STS parameter is not equal to 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 32.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

If the EDMG_ADD_PPDU parameter is equal to ADD-PPDU and $i_{PPDU}$ is greater than 1, then

- If the GI_TYPE parameter is equal to SHORT, $N_{GI}$ = 64.
- If the GI_TYPE is equal to NORMAL, $N_{GI}$ = 64.
- If the GI_TYPE is equal to LONG, $N_{GI}$ = 128.

The TRN field duration shall be as defined in 28.12.3.2.

If the L_BEAM_TRACKING_REQUEST parameter is equal to BEAM-TRACKING-NOT-REQUESTED, the L_PPDU_TYPE parameter is equal to TRN-R, the EDMG_BEAM_TRACKING_REQUEST parameter is equal to Beam_Tracking_Requested, the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-R, and the EDMG_TRN_LEN parameter is greater than 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$.

If the EDMG_ADD_PPDU parameter is equal to ADD-PPDU, then the TXTIME parameter shall be updated every time a PLME-TXTIME.request(TXVECTOR) primitive is received for each consecutive PPDU. The TXTIME shall be increased by the duration of ($T_{EDMG\text{-}Header\text{-}A} + T_{Data}$) every time the PHY entity receives a new PPDU transmitted as a part of the A-PPDU.

If present in an A-PPDU, the TRN field shall be appended only once at the last PPDU of the A-PPDU.

### 28.12.3.4 TXTIME calculation for EDMG OFDM mode

If the EDMG_MODULATION parameter is equal to EDMG_OFDM_MODE, the TXTIME parameter shall be defined in microseconds as follows:

$$TXTIME\left(\mu\text{s}\right) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + T_{EDMG\text{-}Header\text{-}A} + T_{EDMG\text{-}STF} + T_{EDMG\text{-}CEF}$$
$$+ T_{EDMG\text{-}Header\text{-}B} + T_{Data} + T_{TRN}$$

where

$T_{L\text{-}STF} = 2176 \times \text{aDMGChipTimeDuration} \approx 1.24\ \mu\text{s}$

$T_{L\text{-}CEF} = 1152 \times \text{aDMGChipTimeDuration} \approx 0.65\ \mu\text{s}$

$T_{L\text{-}Header} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu\text{s}$

If EDMG_ADD_PPDU is equal to NO-ADD-PPDU, then $T_{EDMG\text{-}Header\text{-}A} = 1088 \times \text{aDMGChipTimeDuration} \approx 0.62\ \mu\text{s}$

If EDMG_ADD_PPDU is equal to ADD-PPDU and $i_{PPDU} = 1$, then $T_{EDMG\text{-}Header\text{-}A} = 1088 \times \text{aDMGChipTimeDuration} \approx 0.62\ \mu\text{s}$

$T_{EDMG\text{-}CEF} = \left(704 \times N_{EDMG\text{-}CEF}^{N_{STS}}\right) \times \text{aDMGSampleTimeDuration}\ \mu\text{s}$

If NUM_USERS = 1, then $T_{EDMG\text{-}Header\text{-}B} = 0$

If NUM_USERS > 1, then $T_{EDMG\text{-}Header\text{-}B} = \left(512 + N_{GI}\right) \times \text{aDMGSampleTimeDuration}\ \mu\text{s}$

$T_{Data} = \left(N_{SYMS} \times (512 + N_{GI})\right) \times \text{aDMGSampleTimeDuration}\ \mu\text{s}$

$$T_{TRN} = \Big(L_T$$
$$+ \left(L_{TRN\text{-}Unit\text{-}P} + L_{TRN\text{-}Unit\text{-}M}\right) \times TRN\_BASIC\_LENGTH \times EDMG\_TRN\_LEN$$
$$+ L_{TRN\text{-}Unit\text{-}P} \times TRN\_BASIC\_LENGTH\Big) \times \text{aDMGSampleTimeDuration}\ \mu\text{s}$$

$TRN\_BASIC\_LENGTH = TRN\_BL \times N_{TRN}^{N_{TX}}$

If EDMG_TRN_LEN > 0, EDMG-TRN-T or EDMG-TRN-R/T, then $L_T = 4 \times 704 \times N_{TRN}^{N_{TX}}$, $L_{TRN\text{-}Unit\text{-}P}$ = 0, 1, 2, or 4, and $L_{TRN\text{-}Unit\text{-}M}$ = 1, 2, ..., or 16

If EDMG_TRN_LEN > 0 and EDMG-TRN-R, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 10$

If EDMG_TRN_LEN = 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$

If the NUM_STS parameter is equal to 1 or 2, then the $N_{EDMG\text{-}CEF}^{N_{STS}}$ parameter is set to 2. If the NUM_STS parameter is equal to 3, then the $N_{EDMG\text{-}CEF}^{N_{STS}}$ parameter is set to 3. If the NUM_STS parameter is equal to 4, then the $N_{EDMG\text{-}CEF}^{N_{STS}}$ parameter is set to 4. If the NUM_STS parameter is equal to 5 or 6, then the $N_{EDMG\text{-}CEF}^{N_{STS}}$ parameter is set to 6. If the NUM_STS parameter is equal to 7 or 8, then the $N_{EDMG\text{-}CEF}^{N_{STS}}$ parameter is set to 8.

If the NUM_USERS parameter is equal to 1, then the EDMG-Header-B is not transmitted and $T_{EDMG\text{-}Header\text{-}B} = 0$. If the NUM_USERS parameter is equal to a value greater than 1, then the EDMG-Header-B is transmitted with time a duration specified above.

If the GI_TYPE parameter is equal to SHORT, $N_{GI} = 48$. If the GI_TYPE parameter is equal to NORMAL, $N_{GI} = 96$. If the GI_TYPE parameter is equal to LONG, $N_{GI} = 192$.

The number of OFDM symbols, $N_{SYMS}$, depends on the EDMG_LENGTH, MCS and other parameters in the TXVECTOR and shall be as defined in 28.6.9.2.

If the TRN_SEQ_LENGTH parameter is equal to NORMAL, then $TRN\_BL$ is set to $2 \times 704$. If the TRN_SEQ_LENGTH parameter is equal to LONG, then $TRN\_BL$ is set to $4 \times 704$. If the TRN_SEQ_LENGTH parameter is equal to SHORT, then $TRN\_BL$ is set to 704.

If the NUM_TX_CHAINS parameter is equal to 1 or 2, then $N_{TRN}^{N_{TX}}$ is set to 2. If the NUM_TX_CHAINS parameter is equal to 3, then $N_{TRN}^{N_{TX}}$ is set to 3. If the NUM_TX_CHAINS parameter is equal to 4, then $N_{TRN}^{N_{TX}}$ is set to 4. If the NUM_TX_CHAINS parameter is equal to 5 or 6, then $N_{TRN}^{N_{TX}}$ is set to 6. If the NUM_TX_CHAINS parameter is equal to 7 or 8, then $N_{TRN}^{N_{TX}}$ is set to 8.

If the EDMG_TRN_LEN parameter is greater than 0 and the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-T or EDMG-TRN-R/T, then $L_T = 4 \times 704 \times N_{TRN}^{N_{TX}}$, $L_{TRN\text{-}Unit\text{-}P} = 0$, 1, 2, or 4, and $L_{TRN\text{-}Unit\text{-}M} =$ 1, 2, ..., or 16.

If the EDMG_TRN_LEN parameter is greater than 0 and the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-R, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 10$.

If the EDMG_TRN_LEN parameter is equal to 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$.

If the L_BEAM_TRACKING_REQUEST parameter is equal to BEAM-TRACKING-NOT-REQUESTED, the L_PPDU_TYPE parameter is equal to TRN-R, the EDMG_BEAM_TRACKING_REQUEST parameter is equal to Beam_Tracking_Requested, the EDMG_PPDU_TYPE parameter is equal to EDMG-TRN-R, and the EDMG_TRN_LEN parameter is greater than 0, then $L_T = 0$, $L_{TRN\text{-}Unit\text{-}P} = 0$, and $L_{TRN\text{-}Unit\text{-}M} = 0$.

If the EDMG_ADD_PPDU parameter is equal to ADD-PPDU, then the TXTIME parameter shall be updated every time a PLME-TXTIME.request(TXVECTOR) is received for each consecutive PPDU. The TXTIME shall be increased by the duration of ($T_{EDMG\text{-}Header\text{-}A} + T_{Data}$) every time the PHY entity receives a new PPDU to be transmitted as a part of the A-PPDU.

The duration of the EDMG-Header-A starting from the second PPDU aggregated in an A-PPDU is defined in microseconds as follows:

$$T_{EDMG\text{-}Header\text{-}A} = \left(1024 + 2 \times N_{GI}\right) \times \text{aDMGSampleTimeDuration } \mu\text{s}$$

where
$N_{GI}$ depends on the GI_TYPE parameter as defined above

If present in an A-PPDU, the TRN field shall be appended only once at the last PPDU of the A-PPDU.

#### 28.12.3.5 TXTIME calculation for non-EDMG control mode

If the FORMAT parameter of the TXVECTOR is NON_EDMG, then the modulation is defined by the NON_EDMG_MODULATION parameter. If the NON_EDMG_MODULATION parameter is equal to DMG_C_MODE or NON_EDMG_DUP_C_MODE, then the TXTIME parameter shall be defined in microseconds as follows:

$$TXTIME(\mu s) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header+Data} + T_{TRN}$$

where

$$T_{L\text{-}STF} = 6400 \times \text{aDMGChipTimeDuration} \approx 3.63\ \mu s$$

$$T_{L\text{-}CEF} = 1152 \times \text{aDMGChipTimeDuration} \approx 0.65\ \mu s$$

$$T_{L\text{-}Header+Data} = \left(\left(Length + L_{L\text{-}Header}\right) \times 8 + 168 \times N_{CW}\right) \times 32 \times \text{aDMGChipTimeDuration}\ \mu s$$

$$N_{CW} = 1 + \left\lceil \frac{(Length - 6) \times 8}{168} \right\rceil$$

$$L_{L\text{-}Header} = 5 \text{ octets}$$

$$T_{TRN} = (4992 \times TRN\_LEN) \times \text{aDMGChipTimeDuration}\ \mu s$$

The parameter Length (LENGTH parameter in the TXVECTOR) indicates the number of data octets in the PSDU in the range 14 to 1023. The TRN_LEN parameter indicates the length of the training field in the range 0 to 16.

#### 28.12.3.6 TXTIME calculation for non-EDMG SC mode

If the NON_EDMG_MODULATION parameter is equal to DMG_SC_MODE or NON_EDMG_DUP_SC_MODE, the TXTIME parameter shall be defined in microseconds as follows:

$$TXTIME(\mu s) = T_{L\text{-}STF} + T_{L\text{-}CEF} + T_{L\text{-}Header} + T_{Data} + T_{GI} + T_{TRN}$$

where

$$T_{L\text{-}STF} = 2176 \times \text{aDMGChipTimeDuration} \approx 1.24\ \mu s$$

$$T_{L\text{-}CEF} = 1152 \times \text{aDMGChipTimeDuration} \approx 0.65\ \mu s$$

$$T_{L\text{-}Header} = 1024 \times \text{aDMGChipTimeDuration} \approx 0.58\ \mu s$$

$$T_{Data} = \left(N_{BLKS} \times 512\right) \times \text{aDMGChipTimeDuration}\ \mu s$$

$$T_{GI} = 64 \times \text{aDMGChipTimeDuration} \approx 0.036\ \mu s$$

$$T_{TRN} = (4992 \times TRN\_LEN) \times \text{aDMGChipTimeDuration}\ \mu s$$

The number of SC symbol blocks, $N_{BLKS}$, depends on the LENGTH and MCS parameters in the TXVECTOR and shall be as defined in 20.5.3.2.3.3.

The LENGTH parameter indicates the number of data octets in the PSDU in the range 1 to 262143.

The MCS parameter indicates the modulation type and coding scheme used in the transmission of the PPDU. For a SC mode transmission, the MCS parameter is in the range 1 to 12, with possible extension to 9.1, 12.1, 12.2, 12.3, 12.4, 12.5, and 12.6 MCS subset.

The TRN_LEN parameter indicates the length of the training field in the range 0 to 16.

If the L_BEAM_TRACKING_REQUEST is equal to BEAM-TRACKING-REQUESTED, the L_PPDU_TYPE parameter is equal to TRN-R, and the L_TRN_LEN parameter is greater than 0, then $T_{TRN} = 0$.

If the ADD_PPDU parameter is equal to ADD-PPDU, then the TXTIME parameter shall be updated every time a PLME-TXTIME.request(TXVECTOR) primitive is received for each consecutive PPDU. The TXTIME shall be increased by a duration of (TL-Header + TData) every time the PHY entity receives a new PPDU to be transmitted as a part of the A-PPDU.

If present in an A-PPDU, the TRN field shall be appended only once at the last PPDU of the A-PPDU.

### 28.12.4 EDMG PHY characteristics

The static EDMG PHY characteristics, provided through the PLME-CHARACTERISTICS service primitive, shall be as shown in Table 20-30 unless otherwise listed in Table 28-119. The definitions for these characteristics are given in 6.5.

**Table 28-119—EDMG PHY characteristics**

| PHY parameter | Value |
|---|---|
| aTxPHYDelay | Implementation dependent |
| aRxPHYDelay | Implementation dependent |
| aCCATime | Implementation dependent |
| aDMGChipRate | 1760 MHz |
| aDMGTimeOfDepartureAccuracyThresh | 0.5 ns |
| aDMGChipTimeDuration | 1/1760 µs |
| aDMGSampleTimeDuration | 1/2640 µs |
| aDMGCCAEDDetectTime | 4 µs |

# Annex B

(normative)

# Protocol Implementation Conformance Statement (PICS) proforma

## B.4 PICS proforma—IEEE Std 802.11-2020

***Change the table in B.4.3 as follows (not all rows are shown):***

### B.4.3 IUT configuration

| Item | IUT configuration | References | Status | Support |
|---|---|---|---|---|
| | What is the configuration of the IUT? | | | |
| … | | | | |
| *CFPBSS | Operation in a PBSS | 4.3.3 | CFIndepSTA AND CFDMG:M<br>CFDMG:O.7<br><br><u>CFEDMG:M</u> | |
| … | | | | |
| *CFInfraSTA | Infrastructure mode | 4.3.4 | CFAP OR CFSTAofAP: M<br>CFDMG:O.7<br><br><u>CFEDMG:M</u> | Yes ☐ No ☐ |
| … | | | | |
| *CFDMG | Directional multi-gigabit (DMG) PHY | 9.4.2.127 | O.2<br>CFDMG:M<br><br><u>CFEDMG:M</u><br><u>CFTDD:M</u> | Yes ☐ No ☐ |
| … | | | | |
| <u>*CFEDMG</u> | <u>Enhanced directional multi-gigabit (EDMG) PHY</u> | <u>9.4.2.265</u> | <u>CFEDMG: M</u> | <u>Yes ☐ No ☐</u> |
| <u>*CFTDD</u> | <u>Time division duplex (TDD) features</u> | <u>9.4.2.127</u> | <u>CFDMG:O</u><br><u>CFEDMG:O</u> | <u>Yes ☐ No ☐</u> |

### B.4.4 MAC protocol

***Insert the following row into the table in B.4.4.1 after PC40.3.2:***

#### B.4.4.1 MAC protocol capabilities

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| PC40.4 | Multi-band Discovery Assistance | 9.4.2.288, 11.31.7 | (CFDMG AND PC40.1): O | Yes ☐ No ☐ N/A ☐ |

***Insert the following rows at the end of the indicated sections of the table in B.4.4.2:***

#### B.4.4.2 MAC frames

| Item | MAC frame | References | Status | Support |
|---|---|---|---|---|
| | Is transmission of the following MAC frames supported? | ... | | |
| FT54 | Sector Ack | Clause 9 | EDMG-M16.4:M | Yes ☐ No ☐ |
| FT55 | Block Ack Schedule | Clause 9 | EDMG-M9.2:M | Yes ☐ No ☐ |
| FT56 | TDD Beamforming | Clause 9 | CFTDD:M | Yes ☐ No ☐ |
| | Is reception of the following MAC frames supported? | ... | | |
| FR55 | Sector Ack | Clause 9 | EDMG-M16.4:M | Yes ☐ No ☐ |
| FR56 | Block Ack Schedule | Clause 9 | EDMG-M9.2:M | Yes ☐ No ☐ |
| FR57 | TDD Beamforming | Clause 9 | CFTDD:M | Yes ☐ No ☐ |

***Change the table in B.4.12 as follows (not all rows are shown):***

### B.4.12 QoS base functionality

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| … | | | | |
| QB4.3 | Unsolicited block ack ~~Compressed Block Ack~~ | 9.4.2.279, 10.25.10 | CFQoS:O | Yes ☐ No ☐ N/A ☐ |
| … | | | | |
| QB4.3.3 | EDMG Compressed BlockAck | 9.3.1.8.8 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| QB4.4 | Multi-TID Block Ack | ~~9.3.1.8.3~~ | ~~CFQoS:O CFHT OR CFTVHT:M~~ | ~~Yes ☐ No ☐ N/A ☐~~ |
| QB4.4.1 | Multi-TID Block Ack | 9.3.1.8.3 | CFQoS:O CFHT OR CFTVHT:M | Yes ☐ No ☐ N/A ☐ |

### B.4.12 QoS base functionality *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| QB4.4.2 | EDMG Multi-TID BlockAck | 9.3.1.8.9 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| … | | | | |

### B.4.24 DMG features

***Change the table in B.4.24.1 as follows (not all rows are shown):***

#### B.4.24.1 DMG MAC features

| Item | IUT configuration | References | Status | Support |
|---|---|---|---|---|
| … | | | | |
| *DMG-M7 | DMG channel access | | | |
| … | | | | |
| DMG-M22 | ... | | | |
| DMG-M23 | Segmentation and Reassembly (SAR) | 10.69 | CFDMG:O | Yes ☐ No ☐ N/A ☐ |

***Insert the following subclauses (B.4.34, B.4.34.1, B.4.34.2, and B.4.35) after B.4.33.2:***

### B.4.34 Enhanced directional multi-gigabit (EDMG) features

#### B.4.34.1 EDMG MAC features

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| | Are the following MAC protocol features supported? | | | |
| EDMG-M1 | EDMG capabilities signaling | | | |
| EDMG-M1.1 | EDMG Capabilities element | 9.4.2.265 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M1.2 | Signaling of STA capabilities in Probe Request, (Re)Association Request frames | 9.3.3.5, 9.3.3.7, 9.3.3.9, 9.4.2.265 | (CFEDMG AND (CFSTAofAP OR CFIBSS OR CFPBSSnotPCP)):M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M1.3 | Signaling of STA capabilities in Probe Response, (Re)Association Response frames | 9.3.3.6, 9.3.3.8, 9.3.3.10, 9.4.2.265 | (CFEDMG AND (CFAP OR CFPCP)):M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M.2 | Signaling of EDMG Capabilities, EDMG Operation | 9.4.2.265, 9.4.2.265.1 | (CFEDMG AND (CFAP OR CFPCP)):M | Yes ☐ No ☐ N/A ☐ |

### B.4.34.1 EDMG MAC features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-M3 | MPDU aggregation | | | |
| EDMG-M3.1 | Maximum A-MPDU Length Exponent | 9.4.2.265.1 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M3.2 | Negotiation of window sizes: 64; 128; 256; 512; 1024 | 9.4.2.265.1 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M3.3 | A-MPDU with multiple TIDs | 9.3.1.7.4, 9.3.1.8.9, 10.25.5, 10.70 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M4 | EDMG flow control | | | |
| EDMG-M4.1 | Flow control operation | 10.25 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M4.2 | EDMG Flow Control Extension Configuration element | | | |
| EDMG-M4.2.1 | RBUFCAP values: 0, FF | 9.4.2.277 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M4.2.2 | RBUFCAP values: 1 – FE | 9.4.2.277 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M4.2.3 | Recipient Memory Configuration subelement | 9.4.2.277 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M4.2.4 | Advanced Recipient Memory Length Exponent | 9.4.2.277 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M5 | EDMG spatial stream feedback | 10.43.4 | EDMG-M9.1:O EDMG-M9.2:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M6 | Directional allocation | 10.39.12.3 | CFEDMG: O EDMG-M16.4:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M7 | EDMG AP or EDMG PCP distributed scheduling | 10.68 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M8 | Use of multiple channels | | | |
| EDMG-M8.1 | CCA on the primary, secondary channels | 8.3.5.12 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M8.2 | CCA on secondary1 channels | 8.3.5.12, 9.4.2.265.5 | EDMG-P2.3 OR EDMG-P2.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M8.3 | CCA on secondary2 channels | 8.3.5.12, 9.4.2.265.5 | EDMG-P2.4 OR EDMG-P2.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M8.3 | RTS, DMG CTS, DMG DTS, Ack, Block Ack duplicate transmission | 10.3.2 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M8.4 | RTS, DMG CTS, DMG DTS bandwidth signaling | 10.3.2, 10.39.12.2 | CFEDMG: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M9 | MIMO | | | |
| *EDMG-M9.1 | SU-MIMO capable | 9.4.2.265.2, 10.39.12.4.2 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| *EDMG-M9.2 | MU-MIMO capable | 9.4.2.265.2 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M9.3 | SU-MIMO channel access | 10.39.12.4.2, 10.39.12.4.43 | EDMG-M9.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M9.4 | MU-MIMO channel access | 10.39.12.4.2, 10.39.12.4.4 | EDMG-M9.2:M | Yes ☐ No ☐ N/A ☐ |

### B.4.34.1 EDMG MAC features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-M10 | EDMG A-PPDU format | 10.13, 28.3.2.2 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M11 | EDMG phase hopping | 10.67 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M12 | Unsolicited RSS | 10.42.6.2 | CFEDMG: O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M13 | EDMG Extended Schedule element | 9.4.2.267 | (CFEDMG AND (CFSTAofAP OR CFIBSS OR CFPBSSnotPCP)):M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M14 | EDMG power save enhancements | | | |
| EDMG-M14.1 | QoS Triggered unscheduled (QoS-TU) power save | 9.4.2.278, 11.2.7.2 | (CFEDMG AND (CFAP OR CFPCP)):M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M14.2 | Spatial multiplexing power save | 11.2.7.2 | EDMG-M9.1: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M14.3 | MU-MIMO power save | 11.2.7.5 | EDMG-M9.2: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M15 | Reverse direction protocol | | | |
| EDMG-M15.1 | Reverse direction for SU-SISO | 10.29 | (CFEDMG AND DMG-M7): M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M15.2 | Reverse direction for SU-MIMO | 10.29 | (EDMG-M9.1 AND DMG-M7): M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M15.3 | Reverse direction for MU-MIMO | 10.29.5 | (EDMG-M9.2 AND DMG-M7): M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M15.4 | Scheduled reverse direction | | EDMG-M15.3: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16 | EDMG beamforming | | | |
| EDMG-M16.1 | SU-MIMO beamforming | 10.42.10.2.2 | EDMG-M9.1: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.2 | MU-MIMO beamforming | 10.42.10.2.3 | EDMG-M9.2: M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.3 | Hybrid beamforming | 10.42.10.2.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| *EDMG-M16.4 | Beamforming for asymmetric links | 10.42.10.3 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.5 | Group beamforming | 10.42.10.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.6 | BRP transmit sector sweep | 10.42.10.5 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.7 | First path beamforming | 10.42.10.6 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.8 | Partial sector level sweep | 10.42.6.4, 11.27.1 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |

### B.4.34.1 EDMG MAC features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| *EDMG-M16.9 | DMG TRN RX only capable | 9.4.2.265 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-M16.10 | Dual polarization TRN beamforming training | 10.42.10.7 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |

### B.4.34.2 EDMG PHY features

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| | Are the following PHY protocol features supported? | | | |
| EDMG-P1 | PHY operating modes | | | |
| EDMG-P1.1 | Operation according to Clause 30 | Clause 28 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P2 | Channel bandwidth | | | |
| EDMG-P2.1 | 2.16 GHz | 28.3.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P2.2 | 4.32 GHz | 28.3.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| *EDMG-P2.3 | 6.48 GHz | 28.3.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| *EDMG-P2.4 | 8.64 GHz | 28.3.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P2.5 | 2.16+2.16 GHz | 28.3.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| *EDMG-P2.6 | 4.32+4.32 GHz | 28.3.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P3 | Channelization | | | |
| EDMG-P3.1 | Channels 2 and 10 | 28.3.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P3.2 | Other channels | 28.3.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P4 | PHY capabilities | | | |
| EDMG-P4.1 | SU-SISO | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P4.2 | SU-MIMO | | EDMG-M9.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P4.3 | MU-MIMO | | EDMG-M9.2:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P4.4 | Support of one spatial streams (transmit and receive) in all supported channel bandwidth configurations | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P4.5 | Support of 2 through 8 spatial streams (transmit and receive) in all supported channel bandwidth configurations | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5 | PHY frame format | | | |
| EDMG-P5.1 | EDMG preamble | 28.3.3 | | |
| EDMG-P5.1.1 | Non-EDMG portion of EDMG preamble | 28.3.3.2 | | |

### B.4.34.2 EDMG PHY features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-P5.1.1.1 | L-STF | 28.3.3.2.2 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.1.2 | L-CEF | 28.3.3.2.3 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.1.3 | L-Header | 28.3.3.2.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.2 | EDMG portion of EDMG preamble | 28.3.3.3 | | |
| EDMG-P5.1.2.1 | EDMG-Header-A | 28.3.3.3.2 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.2.2 | EDMG-STF | 28.3.3.3.3 | EDMG-P2.2 OR EDMG-P2.3 OR EDMG-P2.4 OR EDMG-P2.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.2.3 | EDMG-CEF | 28.3.3.3.4 | EDMG-P2.2 OR EDMG-P2.3 OR EDMG-P2.4 OR EDMG-P2.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.1.2.4 | EDMG-Header-B | 28.3.3.3.5 | EDMG-P4.3:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.2 | EDMG control mode PPDU | | | |
| EDMG-P5.2.1 | MCS 0 | 28.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.2.2 | Non-EDMG duplicate MCS 0 | 28.4.7.2 | EDMG-P2.2 OR EDMG-P2.3 OR EDMG-P2.4 OR EDMG-P2.5 OR EDMG-P2.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.2.3 | Control mode | 28.3.3.2.4 | | |
| EDMG-P5.2.3.1 | Control trailer | 28.3.7, 10.39.12.5 | CFEDMG:O (EDMG-M9.1 OR EDMG-M9.2):M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.2.3.2 | EDMG-Header-A, MCS 0 | 28.3.3.3 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.2.3.3 | Channel bandwidth signaling in L-Header | 28.3.3.2.4 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3 | EDMG SC mode PPDU | 28.5 | | |
| EDMG-P5.3.1 | MCSs | 28.5.8 | | |
| EDMG-P5.3.1.1 | MCS 1–5, 7–10 | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |

### B.4.34.2 EDMG PHY features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-P5.3.1.2 | MCS 6, 11–21 | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.1.3 | ?/2-8-PSK MCS 12, 13 | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.1.4 | NUC ?/2-64-QAM MCS 17–21 | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.2 | Non-EDMG duplicate MCS | 28.5.10.3 | | |
| EDMG-P5.3.2.1 | MCS 1–4 | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.2.2 | Other MCSs | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.3 | Guard interval | 28.5.9.1 | | |
| EDMG-P5.3.3.1 | Short | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.3.2 | Normal | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.3.3 | Long | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.3.4 | STBC | 28.5.9.5.4 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4 | EDMG OFDM mode PPDU | 28.6 | EDMG-P1.1:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.1 | MCSs | | | |
| EDMG-P5.4.1.1 | MCS 1–20 | | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.2 | Guard Interval | 28.6.2.2 | | |
| EDMG-P5.4.2.1 | Short | | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.2.2 | Normal | | EDMG-P5.4:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.2.3 | Long | | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.3 | STBC | 28.6.9.3.10 | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.4 | Phase hopping | 28.6.9.3.8 | | |
| EDMG-P5.4.4.1 | Open Loop Spatial Multiplexing | | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.4.4.2 | Phase hopping | | EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P5.5 | EDMG A-PPDU | 28.3.2.2 | EDMG-P5.3:O EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6 | EDMG beamforming | 28.9 | | |
| EDMG-P6.1 | Short SSW | 28.9.1 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |

### B.4.34.2 EDMG PHY features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-P6.2 | Beam refinement | 28.9.2 | | |
| EDMG-P6.2.1 | EDMG BRP PPDU (TRN fields) | 28.9.2.2 | CFEDMG AND (NOT EDMG-M16.9):M | |
| EDMG-P6.2.1.1 | TRN P / TRN M / TRN N | 28.9.2.2.3 | | |
| EDMG-P6.2.1.1.1 | P=2, M=5, N=2 | | EDMG-P6.2.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.1.2 | P=2, M=7, N=0 | | EDMG-P6.2.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.1.3 | P=0, M=2/5/8/11, N=2 | | EDMG-P6.2.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.1.4 | P=0, M=0-15, N=0 | | EDMG-P6.2.1:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.1.5 | All other valid combinations of P, M, N | | EDMG-P6.2.1:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.2 | TRN Subfield Sequence | 28.9.2.2.6 | | |
| EDMG-P6.2.1.2.1 | 0 = 128×$N_{CB}$ | | | |
| EDMG-P6.2.1.2.1.1 | $N_{CB}$ = 1 or 2 | | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.2.1.2 | $N_{CB}$ = 3 or 4 | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.2.2 | 1 = 256×$N_{CB}$ | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.1.2.3 | 2 = 64×$N_{CB}$ | | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.2 | Channel measurement | 28.9.2.2.8 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.3 | DMG AGC and TRN support over 2.16 GHz channel | | | |
| EDMG-P6.2.3.1 | Transmission | 20.9.2.2.2 | CFEDMG:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P6.2.3.2 | Reception | 20.9.2.2.2 | CFEDMG:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P7 | LDPC | | | |
| EDMG-P7.1 | Codeword = 672, *R* = 1/2, 5/8, 3/4, 13/16 | 20.3.8 | EDMG-P5.3 OR EDMG-P5.4:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P7.2 | Codeword = 624, *R* = 7/8 punctured | 28.5.9.4.3, 28.6.9.2.3 | EDMG-P5.3 OR EDMG-P5.4:O EDMG-P7.3:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P7.3 | Codeword = 672, *R* = 7/8 superimposed | 28.3.6 | EDMG-P5.3 OR EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |

### B.4.34.2 EDMG PHY features *(continued)*

| Item | Protocol capability | References | Status | Support |
|---|---|---|---|---|
| EDMG-P7.4 | Codeword = 1344, *R* = 1/2, 5/8, 3/4, 13/16 | 28.3.6 | EDMG-P5.3 OR EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |
| EDMG-P7.5 | Codeword = 1248, *R* = 7/8 punctured | 28.5.9.4.3, 28.6.9.2.3 | EDMG-P5.3 OR EDMG-P5.4:O EDMG-P7.6:M | Yes ☐ No ☐ N/A ☐ |
| EDMG-P7.6 | Codeword = 1344, *R* = 7/8 superimposed | 28.3.6 | EDMG-P5.3 OR EDMG-P5.4:O | Yes ☐ No ☐ N/A ☐ |

## B.4.35 Time division duplex (TDD) features

| Item | IUT configuration | References | Status | Support |
|---|---|---|---|---|
| | Are the following TDD protocol features supported? | | | |
| TDD-M1 | TDD capabilities signaling | | | |
| TDD-M1.1 | DMG Capabilities element | 9.4.2.127 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M1.2 | Signaling of STA capabilities in Probe Request, (Re)Association Request frames | 9.3.3.5, 9.3.3.7, 9.3.3.9, 9.4.2.127 | (CFTDD AND (CFSTAofAP OR CFIBSS OR CFPBSSnotPCP)):M | Yes ☐ No ☐ N/A ☐ |
| TDD-M1.3 | Signaling of STA capabilities in Probe Response, (Re)Association Response frames | 9.3.3.6, 9.3.3.8, 9.3.3.10, 9.4.2.127 | (CFTDD AND (CFAP OR CFPCP)):M | Yes ☐ No ☐ N/A ☐ |
| TDD-M.2 | TDD channel access | | | |
| TDD-M.2.1 | SP with TDD channel access | 10.30.6.2.1, 10.30.6.2.2, 9.4.2.281, 9.4.2.282 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M.2.2 | BlockAck procedure within a TDD SP | 10.25.6.5 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M.2.3 | Acknowledgment procedure within a TDD SP | 10.3.2.11 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M.2.4 | Beacon generation under TDD channel access | 11.1.3.3.4 | CFTDD:O | Yes ☐ No ☐ N/A ☐ |
| TDD-M.2.5 | Directional Transmit Activity Report frames transmission | 11.30.5 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M3 | MIMO | | | |
| *TDD-M3.1 | SU-MIMO capable | 9.4.2.265.2 | CFTDD: O | Yes ☐ No ☐ N/A ☐ |
| TDD-M3.2 | SU-MIMO channel access | 10.39.12.4.2, 10.39.12.4.3 | TDD-M3.1:M | Yes ☐ No ☐ N/A ☐ |

### B.4.35 Time division duplex (TDD) features *(continued)*

| Item | IUT configuration | References | Status | Support |
|---|---|---|---|---|
| TDD-M4 | TDD beamforming features | | | |
| TDD-M4.1 | TDD beamforming | 10.42.11 | CFTDD:M | Yes ☐ No ☐ N/A ☐ |
| TDD-M4.2 | SU-MIMO beamforming | 10.42.10.2.2.1 | TDD-M3.1:M | Yes ☐ No ☐ N/A ☐ |

# Annex C

(normative)

# ASN.1 encoding of the MAC and PHY MIB

## C.3 MIB detail

***Change the dot11smt OBJECT IDENTIFIER element list in the "Major sections" part of C.3 as follows (not all lines shown):***

```
   dot11smt OBJECT IDENTIFIER ::= { ieee802dot11 1 }
   -- ...
   -- dot11PPEThresholdsMappingsTable                      ::= { dot11smt 43 }
   -- dot11EDMGSTAConfigTable                              ::= { dot11smt 44 }
```

***Change the dot11mac OBJECT IDENTIFIER element list in the "Major sections" part of C.3 as follows (not all lines shown):***

```
   dot11mac OBJECT IDENTIFIER ::= { ieee802dot11 2 }

-- MAC GROUPS
   -- ...
   -- dot11CDMGOperationTable                              ::= { dot11mac 11 }
   -- dot11EDMGOperationTable                              ::= { dot11mac 14 }
   -- dot11MUEDCATable                                     ::= { dot11mac 15 }
```

***Change the dot11phy OBJECT IDENTIFIER element list in the "Major sections" part of C.3 as follows (not all lines shown):***

```
   dot11phy OBJECT IDENTIFIER ::= { ieee802dot11 4 }

-- PHY GROUPS
   -- ...
   -- dot11PHYCMMGTable                                    ::= { dot11mac 30 }
   -- dot11PHYEDMGTable                                    ::= { dot11phy 33 }
   -- dot11EDMGBeamformingConfigTable                      ::= { dot11phy 34 }
```

***Change the Dot11StationConfigEntry SEQUENCE list in the "dot11StationConfig TABLE" in C.3 as follows:***

```
Dot11StationConfigEntry ::= SEQUENCE
   {
          ...
          dot11ColocatedRNRImplemented                TruthValue,
          dot11UnsolicitedBAActivated                 TruthValue
   }
```

***Change the following object definition in the "dot11StationConfig TABLE" in C.3 as follows***

```
dot11BeaconPeriod OBJECT-TYPE
    SYNTAX Unsigned32 (1..65535)
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by an external management entity.
        Changes take effect for the next MLME-START.request primitive.

        For non-DMG STAs, this attribute specifies the number of TUs that a
        station uses for scheduling Beacon transmissions. For DMG STAs, this
        attribute specifies the number of TUs that a station uses for scheduling
        TDD slots for DMG Beacon transmission or for scheduling BTI and/or ATI in
        the beacon interval. This value is transmitted in Beacon and Probe
        Response frames."
    ::= { dot11StationConfigEntry 12 }
```

***Insert the following object definition into the "dot11StationConfig TABLE" in C.3 after the "dot11LocalMACAddressPolicyActivated" definition:***

```
dot11UnsolicitedBAActivated OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by the SME or external management entity.
        Changes take effect as soon as practical in the implementation.

        This attribute, when true, indicates that the station supports Unsolicited
        Block Ack Extension procedures."
    DEFVAL { false }
    ::= { dot11StationConfigEntry 189 }
```

***Change the following object definition in the "dot11BeaconReport TABLE" in C.3 as shown:***

```
dot11BeaconRprtPhyType OBJECT-TYPE
    SYNTAX INTEGER {
        dsss(2),
        ofdm(4),
        hrdsss(5),
        erp(6),
        ht(7),
        dmg(8),
        vht (9),
        tvht (10),
        s1g(11),
        cdmg(12),
        cmmg(13),
        edmg (14)}
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This is a status variable. It is written by the SME when a measurement
        report is completed.

        This attribute indicates the PHY Type for this row of Beacon Report."
    ::= { dot11BeaconReportEntry 9 }
```

***Change the following object definition in the "dot11FrameReport TABLE" in C.3 as shown:***

```
dot11FrameRprtPhyType OBJECT-TYPE
    SYNTAX INTEGER {
        dsss(2),
        ofdm(4),
        hrdsss(5),
        erp(6),
        ht(7),
        dmg(8),
        vht (9),
        tvht (10),
        s1g(11),
        cdmg(12),
        cmmg(13),
        edmg (14) }
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "This is a status variable. It is written by the SME when a measurement
        report is completed.

        This attribute indicates the PHY used for frame reception in this row of
        the frame report."
    ::= { dot11FrameReportEntry 10 }
```

***Change the following object definition in the "dot11RMNeighborReport TABLE" in C.3 as shown:***

```
dot11RMNeighborReportPhyType OBJECT-TYPE
    SYNTAX INTEGER {
        dsss(2),
        ofdm(4),
        hrdsss(5),
        erp(6),
        ht(7),
        dmg(8),
        vht (9),
        tvht (10),
        s1g(11),
        cdmg(12),
        cmmg(13),
        edmg (14) }
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "This is a status variable. It is written by the SME when a measurement
        report is completed.

        This attribute indicates the PHY Type of the neighbor AP identified by
        this BSSID."
    ::= { dot11RMNeighborReportEntry 15 }
```

***Change the Dot11DMGSTAConfigEntry SEQUENCE list in the "dot11DMGSTAConfigEntry TABLE" in C.3 as follows:***

```
Dot11DMGSTAConfigEntry ::=
        SEQUENCE {
                dot11DMGOptionImplemented                    TruthValue,
                dot11RelayActivated                          TruthValue,
                dot11REDSActivated                           TruthValue,
```

```
        dot11RDSActivated                              TruthValue,
        dot11MultipleMACActivated                      TruthValue,
        dot11ClusteringActivated                       TruthValue,
        dot11DiscoveryAssistanceActivated              TruthValue,
        dot11DMGTDDLocalClockModeActivated             TruthValue,
        dot11DMGTimeAdvertisementBeaconInterval        Unsigned32,
        dot11ExtendedTPCActivated                      INTEGER,
        dot11TDDOptionImplemented                      TruthValue,
        dot11SAROptionImplemented                      TruthValue,
        dot11ProtectedAnnounceImplemented              TruthValue,
        dot11DMGExtendedMPDULimitValid                 TruthValue,
        dot11DMGSTATxActivityReportImplemented         TruthValue,
        dot11DMGSTATxActivityReportActivated           TruthValue
    }
```

***Insert the following MIB variable definitions at the end of "dot11DMGSTAConfigEntry TABLE" in C.3:***

```
dot11DiscoveryAssistanceActivated OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute, when true, indicates that the discovery assistance feature
      is currently operational. This attribute, when false or not present,
      indicates that the discovery assistance feature is currently not
      operational."
   ::= { dot11DMGSTAConfigEntry 7 }

dot11DMGTDDLocalClockModeActivated OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute, when true, indicates that the STA uses a TSF timer that is
      synchronized to a local source of timing."
   DEFVAL { false }
   ::= { dot11DMGSTAConfigEntry 8 }

dot11DMGTimeAdvertisementBeaconInterval OBJECT-TYPE
   SYNTAX Unsigned32 (0..65535)
   UNITS "beacon interval"
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute indicates the number of beacon intervals between successive
      DMG Beacon frame transmissions that includes the Time Advertisement
      element."
   DEFVAL { 4 }
   ::= { dot11DMGSTAConfigEntry 9 }
```

```
dot11ExtendedTPCActivated OBJECT-TYPE
    SYNTAX INTEGER { none(0), tx(1), rx(2) }
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by the SME or external management entity.
        Changes take effect for the next MLME-LINKMEASURE.request primitive.

        A STA uses the defined TPC procedure according to this attribute if
        attribute is > 0; otherwise, it does not use any defined TPC procedure."
    DEFVAL { 0 }
    ::= { dot11DMGSTAConfigEntry 10 }

dot11TDDOptionImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        " This is a capability variable.
        Its value is determined by device capabilities.

        This attribute, when true, indicates that the station supports TDD
        procedures."
    ::= { dot11DMGSTAConfigEntry 11 }

dot11SAROptionImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by the SME or external management entity.
        Changes take effect as soon as practical in the implementation.

        This attribute, when true, indicates that the station supports SAR
        procedures."
    DEFVAL { false }
    ::= { dot11DMGSTAConfigEntry 12 }

dot11ProtectedAnnounceImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by an external management entity.
        Changes take effect as soon as practical in the implementation.

        This attribute, when true indicates the station supports the use of
        Protected Announce Action frame. The attribute is set to true only if the
        dot11RSNAProtectedManagementFramesActivated is true."
    DEFVAL { false }
    ::= { dot11DMGSTAConfigEntry 13 }

dot11DMGExtendedMPDULimitValid OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This is a control variable.
        It is written by the SME or external management entity.
        Changes take effect as soon as practical in the implementation.
```

```
      This attribute, when true, indicates that the station can receive MPDUs
      larger than 7989 octets.”
   DEFVAL { false }
   ::= { dot11DMGSTAConfigEntry 14 }

dot11DMGSTATxActivityReportImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute, when true, indicates that the STA supports transmitting
      DMG STA Directional Transmit Activity Report frames."
   DEFVAL { false }
   ::= { dot11DMGSTAConfigEntry 15 }

dot11DMGSTATxActivityReportActivated OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute, when true, indicates that the STA transmits DMG STA
      Directional Transmit Activity Report frames using each antenna pattern and
      2.16 GHz channel that is actively being used for data communication, as
      long as the STA supports this feature."
   DEFVAL { false }
   ::= { dot11DMGSTAConfigEntry 16 }
```

***Insert the "dot11EDMGSTAConfig TABLE" into C.3 after the "dot11PPEThresholdsMappings TABLE":***

```
-- *******************************************************************
-- * dot11EDMGSTAConfig TABLE
-- *******************************************************************

dot11EDMGSTAConfigTable OBJECT-TYPE
   SYNTAX SEQUENCE OF Dot11EDMGSTAConfigEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "This is a table management object.
   ::= { dot11smt 44 }

dot11EDMGSTAConfigEntry OBJECT-TYPE
   SYNTAX Dot11EDMGSTAConfigEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "This is an entry in the dot11EDMGSTAConfig Table.

      ifIndex - Each IEEE 802.11 interface is represented by an ifEntry.
      Interface tables in this MIB module are indexed by ifIndex."
   INDEX { ifIndex }
   ::= { dot11EDMGSTAConfigTable 1 }
```

```
Dot11EDMGSTAConfigEntry ::=
       SEQUENCE {
              dot11EDMGOptionImplemented                    TruthValue,
              dot11EDMGAMPDUwithMultipleTIDOptionImplemented TruthValue,
              dot11EDMGScheduledRDImplemented               TruthValue
       }

dot11EDMGOptionImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable. Its value is determined by device
      capabilities.

      This attribute, when true, indicates the STA is EDMG capable. This
      attribute, when false, indicates the STA is not EDMG capable. The default
      value of this attribute is false."
   DEFVAL { false }
   ::= { dot11EDMGSTAConfigEntry 1 }

dot11EDMGAMPDUwithMultipleTIDOptionImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable. Its value is determined by device
      capabilities.

      This attribute, when true, indicates that the station implementation is
      capable of generating an A-MPDU that contains QoS Data frames with two or
      more different TID values. The capability is disabled, otherwise."
   DEFVAL { false }
   ::= { dot11EDMGSTAConfigEntry 2 }

dot11EDMGScheduledRDImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable. Its value is determined by device
      capabilities.

      This attribute, when true, indicates the STA supports Scheduled Reverse
      Direction. This attribute, when false, indicates the STA does not support
      Scheduled Reverse Direction. "
   DEFVAL { false }
   ::= { dot11EDMGSTAConfigEntry 3 }

-- **********************************************************************
-- * End of dot11EDMGSTAConfig TABLE
-- **********************************************************************
```

***Change the dot11DMGOperationEntry SEQUENCE list in the "dot11DMGOperation TABLE" in C.3 as follows:***

```
Dot11DMGOperationEntry ::=
       SEQUENCE {
              dot11MaxLostBeacons                           Unsigned32,
              dot11MinBHIDuration                           Unsigned32,
              dot11PSRequestSuspensionInterval              Unsigned32,
              dot11BroadcastSTAInfoDuration                 Unsigned32,
```

```
            dot11NbrOfChangeBeacons                          Unsigned32,
            dot11ImplicitHandoverLostBeacons                 Unsigned32,
            dot11MinPPDuration                               Unsigned32,
            dot11SPIdleTimeout                               Unsigned32,
            dot11QABTimeout                                  Unsigned32,
            dot11ClusterEnableTime                           Unsigned32,
            dot11PNWarningThresholdLow                       Unsigned32,
            dot11PNWarningThresholdHigh                      INTEGER,
            dot11BeaconSPDuration                            Unsigned32,
            dot11PNExhaustionThresholdLow                    Unsigned32,
            dot11PNExhaustionThresholdHigh                   INTEGER,
            dot11MaxNumberOfClusteringMonitoringPeriods      Unsigned32,
            dot11DMGEcssPolicyDetailUpdateDurationMax        Unsigned32,
            dot11DMGEcssClusterReportDurationMin             Unsigned32,
            dot11DMGNavSync                                  Unsigned32,
            dot11DMGChannelAccessScheme                      INTEGER,
            dot11DMGSTATxActivityReportTimeUnit              Unsigned32,
            dot11DMGSTATxActivityReportMinActiveTimeUnits    Unsigned32,
            dot11DMGSTATxActivityReportActiveMonitoringTimeUnsigned32,
            dot11DMGSTATxActivityReportInterval              Unsigned32
      }
```

***Insert the following object definitions at the end of the "dot11DMGOperation TABLE" in C.3:***

```
dot11DMGChannelAccessScheme OBJECT-TYPE
   SYNTAX INTEGER ( dmgChannelAccessOnly (0), tddChannelAccessOnly (1),
      dmgAndTddMixedChannelAccess (2) }
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute indicates which channel access scheme the STA activates. "
   DEFVAL { 0 }
   ::= { dot11DMGOperationEntry 21 }

dot11DMGSTATxActivityReportTimeUnit OBJECT-TYPE
   SYNTAX Unsigned32 (1..60000000)
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      This attribute specifies the duration of the time unit, in microseconds,
      which is used to monitor the transmit activity of the STA for different
      antenna patterns and 2.16 GHz channels."
   DEFVAL { 1000000 }
   ::= { dot11DMGOperationEntry 22 }

dot11DMGSTATxActivityReportMinActiveTimeUnits OBJECT-TYPE
   SYNTAX Unsigned32 (0..60000)
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.
```

```
      For a given receiver (or group of receivers always reached through a
      common transmit antenna pattern and transmit power) and a given 2.16 GHz
      channel, this attribute specifies the minimum number of active contiguous
      or non-contiguous time units (specified by another MIB variable) inside a
      sliding window of a given duration (specified by another MIB variable)
      that would require the STA to transmit DMG STA Directional Transmit
      Activity Report frames using that antenna pattern and 2.16 GHz channel."
   DEFVAL { 10 }
   ::= { dot11DMGOperationEntry 23 }

dot11DMGSTATxActivityReportActiveMonitoringTime OBJECT-TYPE
   SYNTAX Unsigned32 (1..60000)
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      For a given receiver (or group of receivers always reached through a
      common transmit antenna pattern and transmit power) and a given 2.16 GHz
      channel, this attribute specifies the duration of a sliding time window,
      as a multiple of a given time unit (specified by another MIB variable),
      during which the transmit activity of the STA is monitored to determine a
      minimum level of transmit activity (specified by another MIB variable)
      that would require the STA to transmit DMG STA Directional Transmit
      Activity Report frames using that antenna pattern and 2.16 GHz channel."
   DEFVAL { 60 }
   ::= { dot11DMGOperationEntry 24 }

dot11DMGSTATxActivityReportInterval OBJECT-TYPE
   SYNTAX Unsigned32 (1.. 2000000)
   MAX-ACCESS read-write
   STATUS current
   DESCRIPTION
      "This is a control variable.
      It is written by the SME or an external management entity.
      Changes take effect as soon as practical in the implementation.

      For a given receiver (or group of receivers always reached through a
      common transmit antenna pattern and transmit power) and a given 2.16 GHz
      channel, this attribute specifies the duration of a time interval, in
      microseconds, during which the STA must transmit at least one DMG STA
      Directional Transmit Activity Report frame using that antenna pattern and
      2.16 GHz channel, provided that the STA has been actively transmitting
      data using that antenna pattern and 2.16 GHz channel, where the threshold
      for active transmission is specified by other MIB variables."
   DEFVAL { 1000000 }
   ::= { dot11DMGOperationEntry 25 }
```

***Insert the "dot11EDMGOperation TABLE" into C.3 after the "dot11CMDGOperation TABLE":***

```
-- **********************************************************************
-- * dot11EDMGOperation TABLE
-- **********************************************************************

dot11EDMGOperationTable OBJECT-TYPE
   SYNTAX SEQUENCE OF Dot11EDMGOperationEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "This is a table management object."
```

```
    ::= { dot11mac 14 }

dot11EDMGOperationEntry OBJECT-TYPE
    SYNTAX Dot11EDMGOperationEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "This is an entry in the dot11EDMGOperatingTable Table.

        ifIndex - Each IEEE 802.11 interface is represented by an ifEntry.
        Interface tables in this MIB module are indexed by ifIndex."
    INDEX { ifIndex }
    ::= { dot11EDMGOperationTable 1 }

Dot11EDMGOperationEntry ::=
        SEQUENCE {
                dot11EDMGDistributedSchedulingProtocolActivated TruthValue
        }

dot11EDMGDistributedSchedulingProtocolActivated OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
    "This is a control variable.

        It is written by the SME or an external management entity. Changes take
        effect as soon as practical in the implementation. If true, distributed
        scheduling is activated. Otherwise, distributed scheduling is not
        activated."
    DEFVAL { false }
    ::= { dot11EDMGOperationEntry 1 }

-- **********************************************************************
-- * End of dot11EDMGOperation TABLE
-- **********************************************************************
```

***Change the dot11PHYType element definition in the "dot11PhyOperation TABLE" in C.3 as follows:***

```
dot11PHYType OBJECT-TYPE
    SYNTAX INTEGER {
        dsss(2),
        ofdm(4),
        hrdsss(5),
        erp(6),
        ht(7)
        dmg(8),
        vht(9),
        tvht(10),
        s1g(11),
        cdmg(12),
        cmmg(13),
        he (14),
        edmg (15)}
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This is a status variable. It is written by the PHY.

        This is an 8-bit integer value that identifies the supported PHY type.
        Currently defined values and their corresponding PHY types are:
```

```
        DSSS 2.4 GHz = 02, OFDM = 04, HRDSSS = 05, ERP = 06, HT = 07, DMG = 08,
        VHT = 09, TVHT = 10, S1G = 11, CDMG = 12, CMMG = 13, HE = 14, EDMG = 15"
    ::= { dot11PhyOperationEntry 1 }
```

***Insert the "dot11 PHY EDMG TABLE" and "dot11EDMGBeamformingConfig TABLE" into C.3 after the "dot11 HE Transmit Beamforming Config TABLE":***

```
-- **********************************************************************
-- * dot11 PHY EDMG TABLE
-- **********************************************************************

dot11PHYEDMGTable OBJECT-TYPE
    SYNTAX SEQUENCE OF Dot11PHYEDMGEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "Entry of attributes for dot11PhyEDMGTable. Implemented as a table indexed
        on ifIndex to allow for multiple instances on an Agent."
    ::= { dot11phy 33 }

dot11PHYEDMGEntry OBJECT-TYPE
    SYNTAX Dot11PHYEDMGEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "An entry in the dot11PHYEDMGEntry Table.

        ifIndex - Each IEEE 802.11 interface is represented by an ifEntry.
        Interface tables in this MIB module are indexed by ifIndex."
    INDEX {ifIndex}
    ::= { dot11PHYEDMGTable 1 }

Dot11PHYEDMGEntry ::=
        SEQUENCE {
                dot11EDMGCurrentChannelWidth                    INTEGER,
                dot11EDMGCurrentChannelCenterFrequencyIndex0    Unsigned32,
                dot11EDMGCurrentChannelCenterFrequencyIndex1    Unsigned32,
                dot11EDMGCurrentPrimaryChannel                  Unsigned32,
                dot11EDMGPolarizationCapability                 OCTET-STRING,
                dot11EDMGSCMaxSUSpatialStreams                  Unsigned32,
                dot11EDMGOFDMMaxSUSpatialStreams                Unsigned32,
                dot11EDMGNumConcurrentRFChains                  Unsigned32,
                dot11EDMGPhaseHoppingImplemented                TruthValue,
                dot11EDMGOpenLoopPrecodingImplemented           TruthValue,
                dot11EDMGDCMBPSKImplemented                     TruthValue,
                dot11EDMGShortCWPuncturedImplemented            TruthValue,
                dot11EDMGShortCWSuperimposedImplemented         TruthValue,
                dot11EDMGLongCWPuncturedImplemented             TruthValue,
                dot11EDMGLongCWSuperimposedImplemented          TruthValue,
                dot11EDMGNUCTXImplemented                       TruthValue,
                dot11EDMGNUCRXImplemented                       TruthValue,
                dot11EDMG8PSKImplemented                        TruthValue,
                dot11EDMGSTBCType                               INTEGER,
                dot11EDMGAPPDUImplemented                       TruthValue,
                dot11EDMGLongCWImplemented                      TruthValue
        }

dot11EDMGCurrentChannelWidth OBJECT-TYPE
    SYNTAX INTEGER { cbw216(0), cbw432(1), cbw648(2), cbw864(3), cbw216p216(4),
        cbw432p432(5) }
```

```
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a status variable.

       Indicates the operating channel width.
              0 = 2.16 GHz
              1 = 4.32 GHz
              2 = 6.48 GHz
              3 = 8.64 GHz
              4 = 2.16+2.16 GHz
              5 = 4.32+4.32 GHz"
    DEFVAL { cbw216 }
    ::= { dot11PHYEDMGEntry 3 }

dot11EDMGCurrentChannelCenterFrequencyIndex0 OBJECT-TYPE
    SYNTAX Unsigned32 (0..3000)
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a status variable.

       For a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel, denotes the
       channel center frequency.
       For a 2.16+2.16 GHz or 4.32+4.32 GHz channel, denotes the channel center
       frequency of frequency segment 0."
    DEFVAL { 0 }
    ::= { dot11PHYEDMGEntry 4 }

dot11EDMGCurrentChannelCenterFrequencyIndex1 OBJECT-TYPE
    SYNTAX Unsigned32 (0..3000)
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a status variable.

       Set to 0 for a 2.16 GHz, 4.32 GHz, 6.48 GHz, or 8.64 GHz channel.
       For a 2.16+2.16 GHz or 4.32+4.32 GHz channel, denotes the channel center
       frequency of frequency segment 1."
    DEFVAL { 0 }
    ::= { dot11PHYEDMGEntry 5 }

dot11EDMGCurrentPrimaryChannel OBJECT-TYPE
    SYNTAX Unsigned32
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a status variable. It is written by the PHY.

       This attribute indicates the primary channel number."
    ::= { dot11PHYEDMGEntry 6 }

dot11EDMGPolarizationCapability OBJECT-TYPE
    SYNTAX OCTET STRING (SIZE(0..9))
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates EDMG antenna polarization capabilities defined in
       the Antenna Polarization Capability field in the EDMG Capabilities
       element."
    ::= { dot11PHYEDMGEntry 7 }
```

```
dot11EDMGSCMaxSUSpatialStreams OBJECT-TYPE
   SYNTAX Unsigned32 (1..8)
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates number of supported spatial streams for EDMG SC
      PHY."
   DEFVAL { 1 }
   ::= { dot11PHYEDMGEntry 8 }

dot11EDMGOFDMMaxSUSpatialStreams OBJECT-TYPE
   SYNTAX Unsigned32 (1..8)
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates number of supported spatial streams for EDMG OFDM
      PHY."
   DEFVAL { 1 }
   ::= { dot11PHYEDMGEntry 9 }

dot11EDMGNumConcurrentRFChains OBJECT-TYPE
   SYNTAX Unsigned32 (1..8)
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates number of concurrent RF chains the EDMG PHY
      supports."
   DEFVAL { 1 }
   ::= { dot11PHYEDMGEntry 10 }

dot11EDMGPhaseHoppingImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for phase hopping."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 11 }

dot11EDMGOpenLoopPrecodingImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for open loop precoding."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 12 }
```

```
dot11EDMGDCMBPSKImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for DCM Pi/2 BPSK."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 13 }

dot11EDMGShortCWPuncturedImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for punctured short CW."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 14 }

dot11EDMGShortCWSuperimposedImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for superimposed short CW."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 15 }

dot11EDMGLongCWPuncturedImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for punctured Long CW."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 16 }

dot11EDMGLongCWSuperimposedImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates support for superimposed Long CW."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 17 }

dot11EDMGNUCTXImplemented OBJECT-TYPE
   SYNTAX TruthValue
   MAX-ACCESS read-only
   STATUS current
```

```
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates support for NUC TX."
    DEFVAL { false }
    ::= { dot11PHYEDMGEntry 18 }

dot11EDMGNUCRXImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates support for NUC RX."
    DEFVAL { false }
    ::= { dot11PHYEDMGEntry 19 }

dot11EDMG8PSKImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates support for Pi/2 8PSK."
    DEFVAL { false }
    ::= { dot11PHYEDMGEntry 20 }

dot11EDMGSTBCType OBJECT-TYPE
    SYNTAX INTEGER {notSupported (0), singleStreamRx (1), oneOrMoreStreamRx (2)}
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates support for STBC."
    DEFVAL { 0 }
    ::= { dot11PHYEDMGEntry 21 }

dot11EDMGAPPDUImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates support for A-PPDU."
    DEFVAL { false }
    ::= { dot11PHYEDMGEntry 22 }

dot11EDMGLongCWImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.
```

```
      This attribute indicates support for the long (1344) LDPC codeword
      length."
   DEFVAL { false }
   ::= { dot11PHYEDMGEntry 23 }

-- **********************************************************************
-- * End of dot11 Phy EDMG TABLE
-- **********************************************************************

-- **********************************************************************
-- * dot11EDMGBeamformingConfig TABLE
-- **********************************************************************

dot11EDMGBeamformingConfigTable OBJECT-TYPE
   SYNTAX SEQUENCE OF Dot11EDMGBeamformingConfigEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "This is a table management object."
   ::= { dot11phy 34 }

dot11EDMGBeamformingConfigEntry OBJECT-TYPE
   SYNTAX Dot11EDMGBeamformingConfigEntry
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "This is an entry in the dot11EDMGBeamformingConfigTable Table.
      ifIndex - Each IEEE 802.11 interface is represented by an ifEntry.
      Interface tables in this MIB module are indexed by ifIndex."
   INDEX { ifIndex }
   ::= { dot11EDMGBeamformingConfigTable 1 }

Dot11EDMGBeamformingConfigEntry ::=
      SEQUENCE {
            dot11RequestedBRPMinDataLength                Unsigned32,
            dot11EDMGMIMOSupport                          INTEGER,
            dot11EDMGBFGrantRequired                      TruthValue,
            dot11EDMGBFDMGTRNRXOnlyImplemented            TruthValue,
            dot11FirstPathTrainingImplemented             TruthValue,
            dot11EDMGHybridMUMIMOImplemented              TruthValue,
            dot11EDMGHybridSUMIMOImplemented              TruthValue,
            dot11EDMGBFGrantLargestNgSupported            Integer32,
            dot11EDMGBFDynamicGroupingImplemented         TruthValue
      }

dot11RequestedBRPMinDataLength OBJECT-TYPE
   SYNTAX Unsigned32 (0..65535)
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "This is a capability variable.
      Its value is determined by device capabilities.

      This attribute indicates the minimum number of data SC blocks or OFDM
      symbols that the STA requests be included in a PPDU carrying a TRN field
      and transmitted to the STA."
   DEFVAL { 1 }
   ::= { dot11EDMGBeamformingConfigEntry 1 }

dot11EDMGMIMOSupport OBJECT-TYPE
   SYNTAX INTEGER {notSupported (0), suMimoOnly (1), muAndSuMimo (2),
      reciprocalMuMimoAndSuMimo (3)}
   MAX-ACCESS read-only
   STATUS current
```

```
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates EDMG MIMO Capabilities."
    DEFVAL { 0 }
    ::= { dot11EDMGBeamformingConfigEntry 2 }

dot11EDMGBFGrantRequired OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This a primary/secondary variable.  Its value is determined by device
       capabilities of the STA when responding to a MIMO setup, to indicate that
       the MIMO initiator has to transmit a Grant frame before initiating MIMO
       channel access."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 3 }

dot11EDMGBFDMGTRNRXOnlyImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates EDMG Beamforming TRN RX Only Capabilities."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 4 }

dot11FirstPathTrainingImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates EDMG Beamforming First Path Training Supported."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 5 }

dot11EDMGHybridMUMIMOImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.

       This attribute indicates EDMG Hybrid BF MU-MIMO Capability."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 6 }

dot11EDMGHybridSUMIMOImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
       "This is a capability variable.
       Its value is determined by device capabilities.
```

```
        This attribute indicates EDMG Hybrid BF SU-MIMO Capability."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 7 }

dot11EDMGBFGrantLargestNgSupported OBJECT-TYPE
    SYNTAX Integer32 (0..2)
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This is a capability variable.
        Its value is determined by device capabilities.

        This attribute indicates largest value of Ng that the EDMG STA supports
        for the beamforming feedback matrix."
    DEFVAL { 1 }
    ::= { dot11EDMGBeamformingConfigEntry 8 }

dot11EDMGBFDynamicGroupingImplemented OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This is a capability variable.
        Its value is determined by device capabilities.

        This attribute indicates support for dynamic grouping."
    DEFVAL { false }
    ::= { dot11EDMGBeamformingConfigEntry 9 }

-- **********************************************************************
-- * End of dot11EDMGBeamformingConfig TABLE
-- **********************************************************************
```

***Change the following object definitions in the "dot11Groups - units of compliance" section in C.3:***

```
dot11DMGComplianceGroup OBJECT-GROUP
    OBJECTS {
        dot11MultibandImplemented, dot11DMGOptionImplemented,
        dot11RelayActivated, dot11REDSActivated, dot11RDSActivated,
        dot11RSNAProtectedManagementFramesActivated, dot11MultipleMACActivated,
        dot11ClusteringActivated, dot11LowPowerSCPHYImplemented,
        dot11LowPowerSCPHYActivated, dot11DiscoveryAssistanceActivated,
        dot11DMGTDDLocalClockModeActivated,
        dot11DMGTimeAdvertisementBeaconInterval,
        dot11ExtendedTPCActivated,
        dot11TDDOptionImplemented,
        dot11SAROptionImplemented,
        dot11UnsolicitedBAActivated,
        dot11DMGExtendedMPDULimitValid,
        dot11DMGSTATxActivityReportImplemented,
        dot11DMGSTATxActivityReportActivated
        }
    STATUS current
    DESCRIPTION
        "Attributes that configure the DMG Group for IEEE Std 802.11."
    ::= { dot11Groups 64 }

dot11DMGOperationsComplianceGroup OBJECT-GROUP
    OBJECTS {
        dot11MaxLostBeacons, dot11MinBHIDuration,
        dot11PSRequestSuspensionInterval,
        dot11BroadcastSTAInfoDuration, dot11NbrOfChangeBeacons,
        dot11ImplicitHandoverLostBeacons, dot11MinPPDuration,
```

```
        dot11SPIdleTimeout, dot11QABTimeout, dot11ClusterEnableTime,
        dot11PNWarningThresholdLow, dot11PNWarningThresholdHigh,
        dot11BeaconSPDuration,
        dot11PNExhaustionThresholdLow, dot11PNExhaustionThresholdHigh,
        dot11MaxNumberOfClusteringMonitoringPeriods,
        dot11DMGEcssPolicyDetailUpdateDurationMax,
        dot11DMGEcssClusterReportDurationMin,
        dot11DMGNavSync,
        dot11DMGChannelAccessScheme,
        dot11DMGSTATxActivityReportTimeUnit,
        dot11DMGSTATxActivityReportMinActiveTimeUnits,
        dot11DMGSTATxActivityReportActiveMonitoringTime,
        dot11DMGSTATxActivityReportInterval
        }
    STATUS current
    DESCRIPTION
        "Attributes that configure the DMG Operation for IEEE Std 802.11."
    ::= { dot11Groups 65 }
```

***Insert the following groups into the "dot11Groups - units of compliance" section in C.3 after dot11SMTRMReport2:***

```
dot11EDMGComplianceGroup OBJECT-GROUP
    OBJECTS {
        dot11EDMGOptionImplemented,
        dot11EDMGAMPDUwithMultipleTIDOptionImplemented,
        dot11EDMGScheduledRDImplemented
        }
    STATUS current
    DESCRIPTION
        "Attributes that configure the EDMG Group for IEEE 802.11."
    ::= { dot11Groups 111 }

dot11EDMGOperationsComplianceGroup OBJECT-GROUP
    OBJECTS {
        dot11EDMGCurrentChannelWidth,
        dot11EDMGCurrentChannelCenterFrequencyIndex0,
        dot11EDMGCurrentChannelCenterFrequencyIndex1,
        dot11EDMGCurrentPrimaryChannel
        }
    STATUS current
    DESCRIPTION
        "Attributes that configure the EDMG Operation for IEEE 802.11."
    ::= { dot11Groups 112 }

        dot11EDMGPHYComplianceGroup OBJECT-GROUP
OBJECTS {
dot11EDMGPolarizationCapability,
        dot11EDMGSCMaxSUSpatialStreams,
        dot11EDMGOFDMMaxSUSpatialStreams,
        dot11EDMGNumConcurrentRFChains,
        dot11EDMGPhaseHoppingImplemented,
        dot11EDMGOpenLoopPrecodingImplemented,
        dot11EDMGDCMBPSKImplemented,
        dot11EDMGShortCWPuncturedImplemented,
        dot11EDMGShortCWSuperimposedImplemented,
        dot11EDMGLongCWPuncturedImplemented,
        dot11EDMGLongCWSuperimposedImplemented,
        dot11EDMGNUCTXImplemented,
        dot11EDMGNUCRXImplemented,
        dot11EDMG8PSKImplemented,
        dot11EDMGSTBCType,
```

```
      dot11EDMGAPPDUImplemented
      }
   STATUS current
   DESCRIPTION
      "Attributes that configure the EDMG PHY for IEEE 802.11."
   ::= { dot11Groups 113 }

dot11EDMGBeamformingComplianceGroup OBJECT-GROUP
   OBJECTS {
      dot11RequestedBRPMinDataLength,
      dot11EDMGMIMOSupport,
      dot11EDMGBFGrantRequired,
      dot11EDMGBFDMGTRNRXOnlyImplemented,
      dot11FirstPathTrainingImplemented,
      dot11EDMGHybridMUMIMOImplemented,
      dot11EDMGHybridSUMIMOImplemented,
      dot11EDMGBFGrantLargestNgSupported,
      dot11EDMGBFDynamicGroupingImplemented
      }
   STATUS current
   DESCRIPTION
      "Attributes that configure the EDMG beamforming for IEEE 802.11."
   ::= { dot11Groups 114 }
```

***Change the beginning of "dot11Compliance MODULE-COMPLIANCE" in the "Compliance Statements" part of C.3 as follows:***

```
dot11Compliance MODULE-COMPLIANCE
   STATUS current
   DESCRIPTION
      "The compliance statement for SNMPv2 entities that implement the IEEE
      802.11 MIB."
   MODULE -- this module
   MANDATORY-GROUPS {
      dot11SMTbase16,
      dot11MACbase5,
      dot11CountersGroup5,
      dot11SmtAuthenticationAlgorithms,
      dot11ResourceTypeID,
      dot11PhyOperationComplianceGroup2,
      dot11EDMGComplianceGroup }

   GROUP dot11PhyDSSSComplianceGroup
   DESCRIPTION
      "Implementation of this group is required when object dot11PHYType is
      dsss.
      This group is mutually exclusive to the following groups:
      dot11PhyOFDMComplianceGroup3
      dot11PhyHRDSSSComplianceGroup
      dot11PhyERPComplianceGroup
      dot11PhyHTComplianceGroup
      dot11DMGComplianceGroup
      dot11PhyVHTComplianceGroup
      dot11PhyTVHTComplianceGroup
      dot11PhyS1GComplianceGroup
      dot11CDMGComplianceGroup1
      dot11CMMGComplianceGroup
      dot11PhyHEComplianceGroup
      dot11EDMGComplianceGroup"

   GROUP dot11PhyOFDMComplianceGroup3
   DESCRIPTION
```

```
    "Implementation of this group is required when object dot11PHYType is
    ofdm.
    This group is mutually exclusive to the following groups:
    dot11PhyDSSSComplianceGroup
    dot11PhyHRDSSSComplianceGroup
    dot11PhyERPComplianceGroup
    dot11PhyHTComplianceGroup
    dot11DMGComplianceGroup
    dot11PhyVHTComplianceGroup
    dot11PhyTVHTComplianceGroup
    dot11PhyS1GComplianceGroup
    dot11CDMGComplianceGroup1
    dot11CMMGComplianceGroup
    dot11PhyHEComplianceGroup
    dot11EDMGComplianceGroup"

GROUP dot11PhyHRDSSSComplianceGroup
DESCRIPTION
    "Implementation of this group is required when object dot11PHYType is
    hrdsss.
    This group is mutually exclusive to the following groups:
    dot11PhyDSSSComplianceGroup
    dot11PhyOFDMComplianceGroup3
    dot11PhyERPComplianceGroup
    dot11PhyHTComplianceGroup
    dot11DMGComplianceGroup
    dot11PhyVHTComplianceGroup
    dot11PhyTVHTComplianceGroup
    dot11PhyS1GComplianceGroup
    dot11CDMGComplianceGroup1
    dot11CMMGComplianceGroup
    dot11PhyHEComplianceGroup
    dot11EDMGComplianceGroup"

GROUP dot11PhyERPComplianceGroup
DESCRIPTION
    "Implementation of this group is required when object dot11PHYType is ERP.
    This group is mutually exclusive to the following groups:
    dot11PhyDSSSComplianceGroup
    dot11PhyOFDMComplianceGroup3
    dot11PhyHRDSSSComplianceGroup
    dot11PhyHTComplianceGroup
    dot11DMGComplianceGroup
    dot11PhyVHTComplianceGroup
    dot11PhyTVHTComplianceGroup
    dot11PhyS1GComplianceGroup
    dot11CDMGComplianceGroup1
    dot11CMMGComplianceGroup
    dot11PhyHEComplianceGroup
    dot11EDMGComplianceGroup"

GROUP dot11PhyHTComplianceGroup
DESCRIPTION
    "Implementation of this group is required when object dot11PHYType has the
    value of ht.
    This group is mutually exclusive to the following groups:
    dot11PhyDSSSComplianceGroup
    dot11PhyOFDMComplianceGroup3
    dot11PhyHRDSSSComplianceGroup
    dot11PhyERPComplianceGroup
    dot11DMGComplianceGroup
    dot11PhyVHTComplianceGroup
    dot11PhyTVHTComplianceGroup
    dot11PhyS1GComplianceGroup
```

```
        dot11CDMGComplianceGroup1
        dot11CMMGComplianceGroup
        dot11PhyHEComplianceGroup
        dot11EDMGComplianceGroup"

    GROUP dot11PhyVHTComplianceGroup
    DESCRIPTION
        "Implementation of this group is required when object dot11PHYType has the
        value of vht.
        This group is mutually exclusive to the following groups:
        dot11PhyDSSSComplianceGroup
        dot11PhyOFDMComplianceGroup3
        dot11PhyHRDSSSComplianceGroup
        dot11PhyERPComplianceGroup
        dot11DMGComplianceGroup
        dot11PhyHTComplianceGroup
        dot11PhyTVHTComplianceGroup
        dot11PhyS1GComplianceGroup
        dot11CDMGComplianceGroup1
        dot11CMMGComplianceGroup
        dot11PhyHEComplianceGroup
        dot11EDMGComplianceGroup"

    GROUP dot11PhyTVHTComplianceGroup
    DESCRIPTION
        "Implementation of this group is required when object dot11PHYType has the
        value of tvht.
        This group is mutually exclusive to the following groups:
        dot11PhyDSSSComplianceGroup
        dot11PhyOFDMComplianceGroup3
        dot11PhyHRDSSSComplianceGroup
        dot11PhyERPComplianceGroup
        dot11PhyHTComplianceGroup
        dot11DMGComplianceGroup
        dot11PhyVHTComplianceGroup
        dot11PhyS1GComplianceGroup
        dot11CDMGComplianceGroup1
        dot11CMMGComplianceGroup
        dot11PhyHEComplianceGroup
        dot11EDMGComplianceGroup"
        dot11PhyTVHTComplianceGroup
        dot11PhyS1GComplianceGroup
        dot11CDMGComplianceGroup1
        dot11CMMGComplianceGroup
        dot11PhyHEComplianceGroup"
```

***Insert the following groups into dot11Compliance module of the "Compliance Statements" section of C.3 after "GROUP dot11TransmitBeamformingGroup":***

```
GROUP dot11EDMGComplianceGroup
    DESCRIPTION
        "Implementation of this group is required when the object dot11PHYType has
        the value of EDMG.
        This group is mutually exclusive to the following groups:
              dot11PhyDSSSComplianceGroup
              dot11PhyOFDMComplianceGroup3
              dot11PhyHRDSSSComplianceGroup
              dot11PhyERPComplianceGroup
              dot11PhyHTComplianceGroup
              dot11PhyVHTComplianceGroup
              dot11PhyTVHTComplianceGroup"
```

```
GROUP dot11EDMGOperationsComplianceGroup
    DESCRIPTION
        "EDMG operations compliance group"

GROUP dot11EDMGPHYComplianceGroup
    DESCRIPTION
        "EDMG PHY compliance group."

GROUP dot11EDMGBeamformingComplianceGroup
    DESCRIPTION
        "EDMG beamforming compliance group"
```

***Insert the following part into C.3 after the "Compliance Statements - HE" part:***

```
-- ******************************************************************
-- * Compliance Statements - EDMG
-- ******************************************************************

dot11EDMGCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "The compliance statement for SNMPv2 entities that implement the IEEE
        802.11 MIB for EDMG operation."
    MODULE -- this module
    MANDATORY-GROUPS {
        dot11EDMGComplianceGroup,
        dot11EDMGOperationsComplianceGroup,
        dot11EDMGPHYComplianceGroup,
        dot11EDMGBeamformingComplianceGroup
        }

    -- OPTIONAL-GROUPS { }
    ::= { dot11Compliances 23 }
```

# Annex E

(normative)

# Country elements and operating classes

## E.1 Country information and operating classes

*Change Table E-1, Table E-2, Table E-3, and Table E-4 as follows (not all rows are shown):*

**Table E-1—Operating classes in the United States**

| Operating class | Nonglobal operating class(es) | Channel starting frequency (GHz) | Channel spacing (MHz) | Channel set | Channel center frequency index | Behavior limits set |
|---|---|---|---|---|---|---|
| ... | | | | | | |
| 34 | 180 | 56.16 | 2160 | 1, 2, 3, 4, 5, 6, 7, 8 | — | — |
| ... | | | | | | |
| 35 | 181 | 56.16 | 4320 | 9, 10, 11, 12, 13, 14, 15 | — | — |
| 36 | 182 | 56.16 | 6480 | 17, 18, 19, 20, 21, 22 | — | — |
| 37 | 183 | 56.16 | 8640 | 25, 26, 27, 28, 29 | — | — |
| ~~35~~ 38–127 | — | Reserved | Reserved | Reserved | Reserved | Reserved |
| ... | | | | | | |

**Table E-2—Operating classes in Europe**

| Operating class | Nonglobal operating class(es) | Channel starting frequency (GHz) | Channel spacing (MHz) | Channel set | Channel center frequency index | Behavior limits set |
|---|---|---|---|---|---|---|
| ... | | | | | | |
| 19 | 181 | 56.16 | 4320 | 9, 10, 11 | — | — |
| 20 | 182 | 56.16 | 6480 | 17, 18 | — | — |
| 21 | 183 | 56.16 | 8640 | 25 | — | — |
| ~~19~~ 22–127 | — | Reserved | Reserved | Reserved | Reserved | Reserved |
| ... | | | | | | |

### Table E-3—Operating classes in Japan

| Operating class | Nonglobal operating class(es) | Channel starting frequency (GHz) | Channel spacing (MHz) | Channel set | Channel center frequency index | Behavior limits set |
|---|---|---|---|---|---|---|
| ... | | | | | | |
| 60 | 181 | 56.16 | 4320 | 9, 10, 11 | — | — |
| 61 | 182 | 56.16 | 6480 | 17, 18 | — | — |
| 62 | 183 | 56.16 | 8640 | 25 | — | — |
| ~~60~~ 63–191 | — | Reserved | Reserved | Reserved | Reserved | Reserved |
| ... | | | | | | |

### Table E-4—Global operating classes

| Operating class | Nonglobal operating class(es) | Channel starting frequency (GHz) | Channel spacing (MHz) | Channel set | Channel center frequency index | Behavior limits set |
|---|---|---|---|---|---|---|
| ... | | | | | | |
| 187 | E-1-37, E-2-21, E-3-62 | 56.16 | 4320 | 9, 10, 11, 12, 13 | — | — |
| 188 | E-1-38, E-2-22, E-3-63 | 56.16 | 6480 | 17, 18, 19, 20 | — | — |
| 189 | E-1-39, E-2-23, E-3-64 | 56.16 | 8640 | 25, 26, 27 | — | — |
| ~~187~~ 190–191 | — | Reserved | Reserved | Reserved | Reserved | Reserved |
| ... | | | | | | |

# Annex G

(normative)

# Frame exchange sequences

## G.1 General

***Change Table G.1 as follows (not all rows are shown):***

### Table G-1—Attributes applicable to frame exchange sequence definition

| Attribute | Description |
|---|---|
| ... | |
| *QAP* | Frame is transmitted by a QoS AP or a PCP. |
| ... | |
| *RD* | For a non-DMG STA, f~~F~~rame includes an HT Control field in which the RDG/More PPDU subfield is equal to 1. For a DMG STA, frame has RDG/More PPDU subfield in the QoS Control field equal to 1. |
| ... | |
| *CT* | A frame that contains a control trailer. |
| *TRN* | A DMG PPDU that carries a TRN field. |
| *ssw* | TDD Beamforming frame with TDD Beamforming Frame Type subfield set to 0. |
| *ssw-ack* | TDD Beamforming frame with TDD Beamforming Frame Type subfield set to 2. |
| *ssw-feedback* | TDD Beamforming frame with TDD Beamforming Frame Type subfield set to 1. |
| ... | |

## G.2 Basic sequences

***Change the following text in G.2 as shown:***

(* This rule defines all of the allowable frame exchange sequences *)
frame-exchange-sequence =
( [**CTS**] (**Management** +*broadcast* | **Data** +*group*) ) |
( [**CTS** | **RTS CTS** | **PS-Poll**] {frag-frame **Ack**} last-frame **Ack** ) |
(**PS-Poll Ack**) |
hcf-sequence |
mcf-sequence |
s1g-sequence |
dmg-sequence;

## G.4 HT, VHT, ~~and~~ S1G, and DMG sequences

***Insert the following text at the end of G.4:***

(* A dmg-sequence represents additional sequences that may be generated by a DMG STA during a BTI, A-BFT, ATI, CBAP and SP.*)

dmg-sequence =
bti-sequence |
abft-bf-sequence |
ati-sequence |
(**[DMG CTS+self[+CT]]** 1{(**Data** +group +QoS | **Management** +broadcast)} |
(**[DMG CTS+self[+CT]** | **RTS[+CT] DMG CTS[+CT]** | **Grant** [**Grant Ack**] | **Poll SPR Grant**]
{frag-frame **Ack**} last-frame **Ack**) |
dmg-bf-sequence |
(**RTS[+CT] DMG DTS[+CT]**) |
(**[DMG CTS+self[+CT]** | **RTS[+CT] DMG CTS[+CT]** | **Grant** [**Grant Ack**] | **Poll SPR Grant**]
1{dmg-txop-sequence}) |
tdd-sequence;

bti-sequence =
(1{**DMG Beacon**});

ati-sequence =
(**Management** +individual **Management** +individual) |
(**Management** +individual **Ack**);

abft-sequence =
(1{**SSW**} **SSW-Feedback**) |
([1{**Short SSW**} **SSW-Feedback**]);

dmg-bf-sequence =
(1{**SSW**} 1{**SSW**} **SSW-Feedback SSW-Ack**) |
([1{**Short SSW**} 1{**Short SSW**} **SSW-Feedback SSW-Ack**]) |
([**BRP BRP**] 1{**BRP[+TRN] BRP[+TRN]**}) |
(**[BRP BRP 1{BRP[+TRN]} BRP BRP 1{BRP[+TRN]} BRP 1{BRP[+TRN]} BRP]**);

(* A TXOP may be filled with dmg-txop-sequences, which are initiated by a TXOP holder. *)
dmg-txop-sequence =
dmg-bf-sequence |
(((**RTS[+CT] DMG CTS[+CT]**) | **DMG CTS+self[+CT]**) **Data** +individual +QoS +(block-ack | no-ack)) |
**[RTS[+CT] DMG CTS[+CT]]** (txop-part-requiring-ack txop-part-providing-ack) |
**[RTS[+CT] DMG CTS[+CT]]** (**Management** | (**Data** +QAP)) +individual **Ack** |
**[RTS[+CT] DMG CTS[+CT]]** (**BlockAckReq BlockAck**) |
dmg-nav-protected-sequence |
1{initiator-sequence};

(* a dmg-nav-protected sequence consists of setting the NAV, performing one or more initiator-sequences and then resetting the NAV if time permits *)
dmg-nav-protected-sequence =
dmg-nav-set 1{initiator-sequence} [**CF-End**];

(* These are the series of frames that establish NAV protection for a DMG sequence *)
dmg-nav-set =
(**RTS[+CT] DMG CTS[+CT]**) |
**DMG CTS+self[+CT]** |
(**Grant [Grant Ack]**) |
(**Data** +individual [+null] [+QoS +normal-ack] **Ack**) |
**Data** +individual +QoS [+(no-ack|block-ack)] |
**Data** +group [+null] +QoS |
(1{ **Data** +individual +QoS +implicit-bar +a-mpdu} +a-mpdu-end **BlockAck**) |
(**BlockAckReq BlockAck**) |
1{**RTS[+CT] DMG CTS[+CT]**};

(* These are the frame exchanges that can take place within a TDD slot in a TDD SP. *)
tdd-sequence =
dmg-tdd-beamforming-sequence |
dmg-tdd-basic-slot-sequence |
dmg-tdd-data-slot-sequence

(* Series of frames transmitted during BF TDD slots. *)
dmg-tdd-beamforming-sequence =
({**TDD Beamforming** +*ssw*}{**TDD Beamforming** +*ssw-ack*}) |
{**TDD Beamforming** +*ssw-feedback*};

(* Series of frames transmitted during Basic TDD slots; dmg-tdd-ack and dmg-tdd-block-ack sequences can appear only once during the slot. *)
dmg-tdd-basic-slot-sequence =
{dmg-tdd-ack}{dmg-tdd-block-ack}{dmg-tdd-mgmt}{dmg-tdd-extension}{dmg-tdd-mgmt-data}{dmg-tdd-data}

(* Series of frames transmitted during Data TDD slots; dmg-tdd-ack and dmg-tdd-block-ack sequences represent acknowledgment of Management and Data frames received in a prior TDD slot, and can appear only once during the slot. *)
dmg-tdd-data-slot-sequence =
{dmg-tdd-data}{dmg-tdd-ack}{dmg-tdd-block-ack}{dmg-tdd-extension}{dmg-tdd-mgmt}

dmg-tdd-data = {[**DMG CTS** +*self*[**+CT**]] 1{**Data**} [**DMG CTS** +*self*[**+CT**]] [**BlockAckReq**]};

dmg-tdd-ack = **Ack** | (1{**Ack** +*a-mpdu*} 1{**Management** +*action-no-ack*+*a-mpdu*}+*a-mpdu-end*);

dmg-tdd-block-ack = [**BlockAck**] | (1{**BlockAck** +*a-mpdu*} 1{**Management** +*action-no-ack*+*a-mpdu*}+*a-mpdu-end*);

dmg-tdd-extension = 1{**Extension**};

dmg-tdd-mgmt = {([**DMG CTS** +*self[*[**+CT**]] 1{**Management**} [**DMG CTS** +*self*[**+CT**]])};

dmg-tdd-mgmt-data = {([**DMG CTS** +*self* [**+CT**]] 1{**Management** +*a-mpdu*}1{**Data** +*a-mpdu*} [**DMG CTS** +*self*[**+CT**]])};

# Annex I

(informative)

***Change the title of Annex I as follows:***

# Examples of encoding a frame for OFDM PHYs, ~~and~~ DMG PHYs, and EDMG PHYs

***Insert the following subclause (I.8) into Annex I after I.7.4.6:***

## I.8 EDMG example data vectors

Encoding examples are provided for the FORMAT parameter set to EDMG and the EDMG_MODULATION parameter set to EDMG_C_MODE or EDMG_SC_MODE. Encoding examples for the EDMG_OFDM_MODE are not provided.

Encoding examples are contained in the EDMGEncodingExamples.zip file embedded into the IEEE 802.11 Working Group document 11-18/1346r0, located at https://mentor.ieee.org/802.11/documents?is_dcn=1346&is_group=00ay. The specified document provides the detailed description of the input and output interfaces as well as the modes that were tested.

The EDMGEncodingExamples.zip contains three types of files:

- "PSDU.txt" – the TXT-file containing a time ordered sequence of 1 and 0 digits, separated by commas. It contains PSDU payload bit content used in all configuration modes.
- "*.xlsx" – the XLSX-file containing the configuration parameters for given mode of operation. The file represents an XL table with fields used to configure the PPDU transmission. Each field is represented in the decimal notation with bit precision defined in the EDMG PHY. The field names are aligned with the ones used in the TX/RXVECTOR and PHY headers.
- "*.mat" – the MATLAB MAT-file containing the output encoded and modulated PPDU. The file names for the MAT-files are identical to the XLSX-files to which they are coupled. The MAT-file contains a time ordered sequence of complex symbols, formatted as ±<real>±<imag>*j* with double floating point precision.

For EDMG_C_MODE and EDMG_SC_MODE, the spectrum shaping filter is not applied to the output PPDU and it is defined at the original chip rate. The shaping filter is not defined in the EDMG PHY and is implementation dependent.

For EDMG_C_MODE, the Preamble and Data fields are defined at the chip rate $F_c$ = 1.76 GHz and the TRN field (if present) is defined at the chip rate $F_{c\ EDMG} = 1.76 \times N_{CB}$ GHz, where $N_{CB}$ defines the number of contiguous 2.16 GHz channels. For EDMG_SC_MODE, the pre-EDMG modulated fields are defined at the chip rate $F_c$ = 1.76 GHz and the EDMG modulated fields are defined at the chip rate $F_{c\ EDMG} = 1.76 \times N_{CB}$ GHz.

The TXT, XLSX, and MAT-files can be read using the standard MATLAB dlmread(), xlsread(), and load() functions respectively. To convert the cell array into the ordinary array and to the char array, the standard MATLAB cell2mat() and char() functions can be used.

***Insert the following text (Annex AB) after Annex AA:***

# Annex AB

(informative)

# Radar implementation using the DMG PHY and EDMG PHY

A radar is used to estimate the relative position and velocity of a target object with respect to the radar by transmitting a signal from a transmitting antenna and measuring the time and direction in which one or more reflections of the signal arrive at a receiving antenna. Given their directional propagation characteristics, the DMG PHY and EDMG PHY can be used to implement radar functionality.

To implement radar functionality, a STA (non-EDMG STA or EDMG STA) can transmit a PPDU and measure the time it takes and direction from which reflections arrive at the STA. Any type of PPDU can be used by the STA as long as the following conditions are met:

- The PPDU is a valid EDMG or DMG PPDU constructed according to the EDMG or DMG PHY specification, respectively
- The STA follows all corresponding medium access rules to transmit the PPDU.
- The TA field and RA field of the frame in the PPDU are set to the MAC address of the transmitting STA.
- For a Short SSW PPDU, the source AID field and Destination AID field of the PPDU are set to the same value.

By using the approach described in this Annex to implement radar function, coexistence with DMG and EDMG transmissions on the same channel is achieved due to the use of IEEE 802.11 EDCA medium access rules and DMG or EDMG PPDUs, which allow other STAs to determine the duration of a transmission. The addressing rules described above enhance coexistence by reducing the probability that a STA gets confused by radar transmissions. When radars follow these rules, the throughput of a DMG or an EDMG STA operating in the vicinity of the radar transmissions can increase due to reduced collisions with such transmissions.

Examples of transmissions that can be used to realize radar functionality include the following:

- A STA may transmit an SSW frame with both the RA field and the TA field set to the MAC address of the transmitting STA to implement radar functionality. In this case, the TXVECTOR parameter TRN_LEN, if the frame is transmitted with the DMG PHY, or the EDMG_TRN_LEN, if the frame is transmitted with the EDMG PHY, may be set to a nonzero value.
- A non-PCP and non-AP EDMG STA may transmit a Short SSW PPDU with both the TXVECTOR parameter SSW_SOURCE_AID and SSW_DESTINATION_AID set to the AID of the transmitting STA to implement radar functionality.
- An EDMG PCP STA or an EDMG AP STA may transmit a Short SSW PPDU with both the TXVECTOR parameter SSW_SOURCE_AID and SSW_DESTINATION_AID set to the BSS AID of the transmitting STA to implement radar functionality.

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