IEEE Standard for High Data Rate Wireless Multi-Media Networks

Amendment 2: 100 Gb/s Wireless Switched Point-to-Point Physical Layer

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 802.15.3d™-2017
(Amendment to
IEEE Std 802.15.3™-2016
as amended by
IEEE Std 802.15.3e™-2017)

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Approved 28 September 2017

IEEE-SA Standards Board

Abstract: An alternative physical layer (PHY) at the lower THz frequency range between 252 GHz and 325 GHz for switched point-to-point links is defined in this amendment. Two PHY modes are defined that enable data rates of up to 100 Gb/s using eight different bandwidths between 2.16 GHz and 69.12 GHz.

Keywords: 300 GHz, fixed point-to-point, IEEE 802.15.3™, IEEE 802.15.3d™, submillimeter waves, THz, wireless

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Introduction

This introduction is not part of IEEE Std 802.15.3d-2017, IEEE Standard for High Data Rate Wireless Multi-Media Networks—Amendment 2: 100 Gb/s Wireless Switched Point-to-Point Physical Layer.

IEEE Std 802.15.3d-2017 is an amendment to IEEE Std 802.15.3-2016 that defines an alternative physical layer (PHY) at the lower THz frequency range, between 252 GHz and 325 GHz, for switched point-to-point links, along with the necessary MAC changes to support this PHY. This amendment builds on the concept of pairnet, introduced in IEEE Std 802.15.3e-2017, and inherits the corresponding MAC changes defined there. Some of the key features and additions are as follows:

— Operation in the THz frequency band.
— Usage of eight different bandwidths between 2.16 GHz and 69.12 GHz.
— Designed for data rates of up to 100 Gb/s.
— Use of a pairnet structure supporting wireless links for intra-device communication (e.g., board-to-board communication), close proximity communication, wireless data centers, and backhaul/fronthaul links.
— Selectable PHY modes (single carrier and on-off keying) to achieve either ultra high-speed operation or system simplicity.

Interest in developing a wireless communication system at THz frequencies started in 2008 with the establishment of the THz Interest Group. In May 2014, Task Group 3d was formed, covering switched point-to-point connections operating in the frequencies from 60 GHz up to the lower THz bands. The Task Group started to work on four supporting documents: the Application Requirements Document, the Technical Requirements Document, the Channel Modeling Document, and the Evaluation Criteria Document. In September 2014, discussions split the Task Group into two, leading to the development of an amendment for close proximity links at 60 GHz as the separate Task Group 3e. The first meeting of Task Group 3e was in May 2015. In November 2015, the required PAR change for Task Group 3d to limit the activities to the lower THz frequency ranges was approved. During the March 2016 meeting, the supporting documents were approved and the call for proposals was issued. Proposals were reviewed during the July and September 2016 meetings. The group entered working group letter ballot in January 2017. After one working group recirculation ballot, the sponsor ballot started in March 2017. A total of two sponsor recirculation ballots were held, leading to approval of IEEE Std 802.15.3d-2017 by the IEEE-SA Standards Board on 28 September 2017.

Contents

IEEE Standard for High Data Rate Wireless Multi-Media Networks

Amendment 2: 100 Gb/s Wireless Switched Point-to-Point Physical Layer

(This amendment is based on IEEE Std 802.15.3-2016™ as amended by IEEE Std 802.15.3e™-2017)

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 <u>underscore</u> (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and 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. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.[1]

3. Definitions, acronyms, and abbreviations

3.2 Acronyms and abbreviations

Insert the following acronym in alphabetical order:

PW	pilot word

[1]Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

4. General description

4.1a Pairnet

Change 4.1a as indicated:

A pairnet consists of at most two DEVs, as shown in Figure 4-0a. Typical communication distance is 10 cm or less for a pairnet DEV (PRDEV) with a high rate close proximity (HRCP) PHY. For a PRDEV with a THz PHY, typical communication distance is from a few centimeters up to several hundred meters. A PRDEV always connects as a pairnet.

4.2 Components of an IEEE 802.15.3 piconet

Change the fourth paragraph of 4.2 as indicated:

For HRCP PHYs and THz PHYs, the IEEE 802.15.3 piconet is not used.

4.5a Characteristics of HRCP PHY

4.5a.2 Pairnet using HRCP PHY

Insert new subclauses as 4.5b, 4.5b.1, and 4.5b.2, after 4.5a.2, as follows:

4.5b Characteristics of THz PHY

4.5b.1 THz PHY characteristics

The THz PHY, as described in Clause 13, is designed as an extension for wireless switched point-to-point applications, operating at a nominal PHY data rate of 100 Gb/s with fallbacks to lower data rates as needed. The frequency band is from 252 GHz to 325 GHz. The THz PHY supports a range of channel bandwidths from 2 GHz to 70 GHz.

The following two PHY modes are defined for the THz PHY:

— THz single carrier mode PHY (THz-SC PHY), as described in 13.2
— THz on-off keying mode PHY (THz-OOK PHY), as described in 13.3

For DEVs that implement the THz PHY, at least one of the PHY modes is required.

The THz-SC PHY is designed for extremely high PHY-SAP payload data rates up to 100 Gb/s, depending on the combination of modulation, bandwidth, and coding used. The THz-SC PHY supports a wide range of modulations: $\pi/2$ BPSK, $\pi/2$ QPSK, $\pi/2$ 8-PSK, $\pi/2$ 8-APSK, 16-QAM, and 64-QAM. The FEC consists of two low-density parity-check (LDPC) codes with rates of 14/15 and 11/15.

The THz-OOK PHY is designed for cost effective DEVs that require low complexity and simple design. The THz-OOK PHY supports a single modulation scheme, OOK, and three FEC schemes. The Reed Solomon (RS) code is mandatory and allows simple decoding without soft decision information. The LDPC codes with rates of 14/15 and 11/15 are optional and allow the use of soft-decision information.

4.5b.2 Pairnet using THz PHY

When a PRC-capable DEV starts a pairnet, the type of pairnet it starts depends on the supported PHY modes. For example, if the PRC-capable DEV supports only the THz-SC mode, it will start a THz-SC pairnet in which the Beacon frame is sent with the THz-SC mode. DEVs that support only the THz-SC mode are able to find and connect to the pairnet in THz-SC mode. The same process is used for a PRC-capable DEV that supports only THz-OOK mode.

If a PRC-capable DEV supports more than one THz PHY mode, then it is able to select the type of pairnet it starts. It allows connection from each type of DEV by transmitting both the THz-SC mode Beacon frame and the THz-OOK mode Beacon frame. Figure 4-3a is an example of transmitting dual mode Beacon frames. The number and duration of the access slots and the superframe duration for each PHY mode are indicated by the Beacon frame with the corresponding PHY mode.

The switched point-to-point nature of the connection means that the pairnet connection can be terminated and a new pairnet connection can be set up with a different destination device. The process of switching and the determination of the direction to the new access point is out of the scope of this standard.

5. Layer management

5.3 MLME SAP interface

5.3.2 Scanning for piconets and pairnets

Change Table 5-6a (the entire table is not shown) as indicated:

Table 5-6a—Elements of PairnetDescription

Name	Type	Valid range	Description
PrcCapability	PRC Capability, as defined in 6.4.11a for HRCP PHY and 6.4.11d for THz PHY	As defined in 6.4.11a for HRCP PHY and 6.4.11d for THz PHY	Capability of the PRC in the Beacon frame.
PhyMode	Enumeration	HRCP_SC_PHY, HRCP_OOK_PHY, HRCP_BOTH_PHY, THZ_SC_PHY, THZ_OOK_PHY, THZ_BOTH_PHY	The PHY mode that is being used in the pairnet that was found.

5.3.3 Starting a piconet or pairnet

Change Table 5-8 (the entire table is not shown) as indicated:

Table 5-8—MLME-START primitive parameters

Name	Type	Valid range	Description
PhyMode	Enumeration	2.4_GHZ, SC_MMWAVE, HSI_MMWAVE, AV_MMWAVE, HRCP_SC_PHY, HRCP_OOK_PHY, HRCP_BOTH_PHY, THZ_SC_PHY, THZ_OOK_PHY, THZ_BOTH_PHY	The PHY mode that will be used for the Beacon frames and CP(s) in the piconet or pairnet that will be started.
PrcCapabilityIe	PRC Capability, as defined in 6.4.11a for HRCP PHY and 6.4.11d for THz PHY	As defined in 6.4.11a for HRCP PHY and 6.4.11d for THz PHY	Capability of the PRC in the Beacon frame.

5.3.5 Associating with a piconet or pairnet

Change Table 5-10 (the entire table is not shown) as indicated:

Table 5-10—MLME-ASSOCIATE primitive parameters

Name	Type	Valid range	Description
PrdevCapabilityIe	PRDEV Capability, as defined in 6.4.11b for HRCP PHY and 6.4.11e for THz PHY	As defined in 6.4.11b for HRCP PHY and 6.4.11e for THz PHY	Capability of the PRDEV in the Association Request command.
PairnetOperationParametersIe	As defined in 6.4.11c for HRCP PHY and 6.4.11f for THz PHY	As defined in 6.4.11c for HRCP PHY and 6.4.11f for THz PHY	Capability of the PRDEV in the Association Response command.

5.5 MAC SAP

Change the second paragraph of 5.5 as indicated:

The IEEE 802.15.3 MAC SAP primitives are summarized in Table 5-30. The same primitives used for the HRCP PHY are also used for the THz PHY.

Change Table 5-31 (the entire table is not shown) as indicated:

Table 5-31—MAC-ISOCH-DATA, MAC-ASYNC-DATA, MAC-HRCP-DATA, and MAC-HRCP-MUL-DATA primitive parameters

Name	Type	Valid range	Description
MCSIdentifier	Enumeration	Any valid MCS identifier, as defined in Table 11a-6 for HRCP-SC PHY, Table 13-8 for THz-SC PHY, or Table 13-12 for THz-OOK PHY	MCS used in the transmitted PHY frame. Only applicable ~~for~~to HRCP-SC PHY, THz-SC PHY, and THz-OOK PHY.
ChIdentifier	Enumeration	Any valid combination~~s~~ of channels, as defined in Figure 11a-1 for HRCP-SC PHY, or any channel defined in Table 13-1 for THz-SC PHY and THz-OOK PHY	The frequency channel used in the transmitted PHY frame. Only applicable ~~for~~to HRCP-SC PHY, THz-SC PHY, and THz-OOK PHY.

Change 5.5.7 to 5.5.12 as indicated:

5.5.7 MAC-HRCP-DATA.request

This primitive is used to initiate the transfer of an MSDU from one MAC entity to another MAC entity or entities using the HRCP PHY or the THz PHY. The semantics of this primitive are as follows:

```
MAC-HRCP-DATA.request        (
                             RequestID,
                             LogicalChannel,
                             ACKRequested,
                             ConfirmRequested,
```

```
                                ~~Length,~~
                                Data
                                )
```

The primitive parameters are defined in Table 5-31.

5.5.8 MAC-HRCP-DATA.confirm

This primitive is used to report the result of a request to transfer an MSDU from one MAC entity to another MAC entity or entities using the HRCP PHY or the THz PHY. This primitive is only generated if the ConfirmRequested parameter in the MAC-HRCP-DATA.request primitive with the same RequestID value is either: ~~ALWAYS or is ON_ERROR and the ResultCode is FAILURE.~~

— ALWAYS, or
— ON_ERROR and the ResultCode of the MAC-THZ-DATA.confirm primitive is FAILURE.

The MCSIdentifier and ChIdentifier parameters are used to indicate the current MCS identifier and frequency channel used in the transmitted frame to the upper layer. These two parameters are only applicable for the HRCP-SC PHY or the THz PHY. The semantics of this primitive are as follows:

```
MAC-HRCP-DATA.confirm           (
                                RequestID,
                                TransmitDelay,
                                MCSIdentifier,
                                ChIdentifier,
                                ResultCode,
                                ReasonCode
                                )
```

The primitive parameters are defined in Table 5-31.

5.5.9 MAC-HRCP-DATA.indication

This primitive is used to indicate the reception of an MSDU. The semantics of this primitive are as follows:

```
MAC-HRCP-DATA.indication        (
                                ~~Length,~~
                                Data
                                )
```

The primitive parameter~~s are~~ is defined in Table 5-31.

5.5.10 MAC-HRCP-MUL-DATA.request

This primitive is used to initiate the transfer of a Multi-protocol MSDU from one MAC entity to another MAC entity or entities using the HRCP PHY or the THz PHY. The semantics of this primitive are as follows:

```
MAC-HRCP-MUL-DATA.request       (
                                RequestID,
                                StreamIndex,
                                LogicalChannel,
                                ACKRequested,
```

```
                              ConfirmRequested,
                              ~~Length,~~
                              DataID,
                              DestinationAddress,
                              SourceAddress,
                              Ethertype,
                              OUI_CID,
                              Data
                              )
```

The primitive parameters are defined in Table 5-31.

5.5.11 MAC-HRCP-MUL-DATA.confirm

This primitive is used to report the result of a request to transfer a Multi-protocol MSDU from one MAC entity to another MAC entity or entities using either the HRCP PHY or the THz PHY. This primitive is only generated if the ConfirmRequested parameter in the MAC-HRCP-MUL-DATA.request primitive with the same RequestID value is either:~~ALWAYS or is ON_ERROR and the ResultCode is FAILURE.~~

— ALWAYS, or
— ON_ERROR and the ResultCode of the MAC-THZ-MUL-DATA.confirm primitive is FAILURE.

The semantics of this primitive are as follows:

```
MAC-HRCP-MUL-DATA.confirm   (
                              RequestID,
                              TransmitDelay,
                              ResultCode,
                              ReasonCode,
                              MCSIdentifier,
                              ChIdentifier
                              )
```

The primitive parameters are defined in Table 5-31.

5.5.12 MAC-HRCP-MUL-DATA.indication

This primitive is used to indicate the reception of a Multi-Protocol MSDU while using the HRCP PHY or the THz PHY. The semantics of this primitive are as follows:

```
MAC-HRCP-MUL-DATA.indication(
                              ~~Length,~~
                              DataID,
                              DestinationAddress,
                              SourceAddress,
                              Ethertype,
                              OUI_CID,
                              LogicalChannel,
                              Data
                              )
```

The primitive parameters are defined in Table 5-31.

6. MAC frame formats

6.2 General frame format

Add the following entry to the end of the dashed list in 6.2:

— 13.1.5.2 for the THz PHY

6.2.6 MAC header validation

Change the dashed list after the first paragraph of 6.2.6 as follows:

— 10.2.9 for the 2.4 GHz PHY
— 11.2.3.2.2 for the SC PHY mode
— 11.3.3.4 for the HSI PHY mode
— 11.4.1.4 for the AV PHY mode
— 11a.2.3.2.2 for the HRCP-SC PHY mode, the THz-SC PHY mode, and the THz-OOK PHY mode
— 11a.3.3.2.2 for HRCP-OOK PHY mode

6.4 Information elements (IEs)

Change the third paragraph of 6.4 as indicated, and replace Table 6-13b with the following table:

The requirements for supporting an IE are listed in Table 6-13b for HRCP PHY DEVs and THz PHY DEVs. IEs not shown in the table are not used by either of the aforementioned PHYs.

Table 6-13b—Requirements for supporting an IE

Element	HRCP PHY	THz PHY
BSID IE	Mandatory	Mandatory
PRC Capability IE	Mandatory	Mandatory
MIMO Information IE	Optional	Not used
PRDEV Capability IE	Mandatory	Mandatory
Pairnet Operation Parameters IE	Mandatory	Mandatory
Higher Layer Protocol Information IE	Optional	Optional
Vendor Specific IE	Optional	Optional

6.4.11c Pairnet Operation Parameters IE

Insert the following new subclauses, 6.4.11d, 6.4.11e, and 6.4.11f, after 6.4.11c, as shown:

6.4.11d THz PRC Capability IE

The THz PRC Capability IE shall be included in each Beacon frame. The THz PRC Capability IE Content field shall be formatted as illustrated in Figure 6-87n.

Octets: 9
PRC Capability

Figure 6-87n—THz PRC Capability IE Content field format

The PRC Capability field shall be formatted as illustrated in Figure 6-87o.

The SC Capable field shall be set to one if the DEV supports the THz-SC PHY, as defined in 13.2, and shall be set to zero otherwise.

The OOK Capable field shall be set to one if the DEV supports the THz-OOK PHY, as defined in 13.3, and shall be set to zero otherwise.

The Supported SIFS field shall be set to the value of the shortest SIFS supported by the DEV in units of 0.1 µs encoded as an unsigned integer. For example, a value of 0b01001 indicates that the shortest SIFS supported by the DEV is 0.9 µs. Values greater than 0b11001 (2.5 µs) are reserved.

The Multi-protocol Support field shall be set to one if the THz-SC PHY DEV supports the Pairnet Multi-protocol Data Frame, as defined in 6.3.5a.1 and 6.3.5a.2, and shall be set to zero otherwise.

The Low Latency Power Save (LLPS) Control field contains LLPS related parameters, as defined in 6.4.11a.

The LLPS Allow field shall be set to one if the PRC allows the PRDEVs to use power save mode after association is completed; otherwise, it shall be set to zero.

The LLPS Interval field indicates the value of the ACK sending interval when the DEV is in DEV Sleep mode. The field is defined in Table 6-17a.

The LLPS Start field tells the PRDEV when to enter LLPS mode. The field value is equal to a period of time during which consecutive ACKs are sent but no payload is sent. The valid values of the LLPS Start field are given in Table 6-17b.

The LLPS Extend field tells the PRDEV when to extend LLPS mode. The field value is equal to a period of time during which consecutive ACKs are sent but no payload is sent. The valid values of the LLPS Extend field are given in Table 6-17c.

The Preferred Payload Size field indicates the maximum preferred data size of a single subframe payload to be received by the DEV. This field shall be set to a non-reserved value defined in Table 6-17d.

Bits: b0	b1	b2	b3	b4	b5	b6	b7
SC Capable	OOK Capable	Supported SIFS					Multi-protocol Support

Bits: b8	b9	b10	b11	b12	b13	b14	b15
LLPS Control							

Bits: b16	b17	b18	b19	b20	b21	b22	b23
Preferred Payload Size		Preferred Total Aggregation Size			Supported Unit of Subframe Padding		Pilot Symbol Capable

Bits: b24	b25	b26	b27	b28	b29	b30	b31
SC Supported Modulations				Reserved	Reserved	OOK Supported FEC	

Bits: b32	b33	b34	b35	b36	b37	b38	b39
Supported Bandwidths							

Bits: b40	b41	b42	b43	b44	b45	b46	b47
Spectrum Part Supported							

Bits: b48	b49	b50	b51	b52	b53	b54	b55
Spectrum Part Supported							
Bits: b56	**b57**	**b58**	**b59**	**b60**	**b61**	**b62**	**b63**
Spectrum Part Supported							

Bits: b64	b65	b66	b67	b68	b69	b70	b71
Spectrum Part Supported							

Figure 6-87o—PRC Capability field format

The Preferred Total Aggregation Size field indicates the maximum preferred total data size in a single frame to be received by the DEV when fragmentation is used. This field shall be set to a value defined in Table 6-17e.

The Supported Unit of Subframe Padding field indicates the unit of the subframe padding that can be received by the DEV, as defined in Figure 6-87d. Each field shall be set to one for supported capability and shall be set to zero otherwise.

The Pilot Symbol Capable field shall be set to one if the DEV is capable of decoding the frame with pilot symbols and shall be set to zero otherwise.

The SC Supported Modulations field includes only those modulation schemes that are optional, as described in 13.2.2.1. The field is encoded as a bitmap and is given in Table 6-17h. A bit shall be set to one if the modulation is supported and shall be set to zero otherwise.

Table 6-17h—SC Supported Modulations field format

Bit	Description
0	π/2 8-PSK
1	π/2 8-APSK
2	16-QAM
3	64-QAM

The OOK Supported FEC field is encoded as a bitmap, as given in Table 6-17i. A bit shall be set to one if the LDPC code is supported and shall be set to zero otherwise.

Table 6-17i—OOK Supported FEC field format

Bit	Description
0	LDPC (1440,1344)
1	LDPC (1440,1056)

A maximum of eight different bandwidths are supported for the THz PHY. The Supported Bandwidths field is encoded as a bitmap, as given in Table 6-17j. A bit shall be set to one if the bandwidth is supported and shall be set to zero otherwise.

Table 6-17j—Supported Bandwidths field format

Bit	Description
0	Bandwidth 2.16 GHz
1	Bandwidth 4.32 GHz
2	Bandwidth 8.64 GHz
3	Bandwidth 12.96 GHz
4	Bandwidth 17.28 GHz
5	Bandwidth 25.92 GHz
6	Bandwidth 51.84 GHz
7	Bandwidth 69.12 GHz

Spectrum parts are given in the smallest granularity of 2.16 GHz. The spectrum parts correspond to the frequency ranges of CHNL_ID 1 to 32, as defined in Table 13-1. The Spectrum Parts Supported field is encoded as a bitmap. The bit i–1 shall be set to one if the spectrum part corresponding to $(250.56 + 2.16 \times i)$ GHz $< f <$ $(252.72 + 2.16 \times i)$ GHz is supported and shall be set to zero otherwise. Since CHNL_ID 41 is the default channel, the bits corresponding to the spectrum parts of CHNL_ID 17 and CHNL_ID 18 shall be set to one; bit b_1, as defined in Table 6-17j, shall also be set to one.

6.4.11e THz PRDEV Capability IE

The THz PRDEV Capability IE shall be included in each Beacon frame. The THz PRDEV Capability IE Content field shall be formatted as illustrated in Figure 6-87p.

Octets: 9
PRDEV Capability

Figure 6-87p—THz PRDEV Capability IE Content field format

The PRDEV Capability field shall be formatted as illustrated in Figure 6-87o, with the exception that the LLPS Control field is replaced by a reserved field.

6.4.11f THz Pairnet Operation Parameter IE

The THz Pairnet Operation Parameters IE shall be included in each Association Response command frame.

The THz Pairnet Operation Parameters IE Content field shall be formatted as illustrated in Figure 6-87q. The Operation Parameters field indicates the communication parameters to be used in the current session, as decided by the PRC to satisfy both PRC and PRDEV capabilities.

The Operation Parameters field shall be formatted as illustrated in Figure 6-87r.

Octets: 9
Operation Parameters

Figure 6-87q—THz Pairnet Operation Parameters IE Content field format

Bits: b0	b1	b2	b3	b4	b5	b6	b7
PHY Mode		Supported SIFS					Multi-protocol Support

Bits: b8	b9	b10	b11	b12	b13	b14	b15
Reserved							

Bits: b16	b17	b18	b19	b20	b21	b22	b23
Preferred Payload Size		Preferred Total Aggregation Size			Reserved		Reserved

Bits: b24	b25	b26	b27	b28	b29	b30	b31
SC Supported Modulations				Reserved	Reserved	OOK Supported FEC	

Bits: b32	b33	b34	b35	b36	b37	b38	b39
Supported Bandwidths							

Bits: b40	b41	b42	b43	b44	b45	b46	b47
Spectrum Part Supported							

Bits: b48	b49	b50	b51	b52	b53	b54	b55
Spectrum Part Supported							

Bits: b56	b57	b58	b59	b60	b61	b62	b63
Spectrum Part Supported							

Bits: b64	b65	b66	b67	b68	b69	b70	b71
Spectrum Part Supported							

Figure 6-87r—Operation Parameters field format

The PHY Mode field indicates which PHY mode is used in the session and shall be set to a non-reserved value defined in Table 6-17k.

Table 6-17k—PHY Mode field values

Bits: b0	b1	PHY Mode
1	0	SC
0	1	OOK
0	0	Reserved
1	1	Reserved

The Supported SIFS field is defined in 6.4.11d. The SIFS values in the PRC Capability field and in the PRDEV Capability field are compared, and the larger of the two values shall be encoded in this field.

The Multi-protocol Support field is defined in 6.4.11d. It shall be set to one if both the Multi-protocol Support field in the PRC Capability IE and the Multi-protocol Support field in the PRDEV Capability IE are set to one and shall be set to zero otherwise.

The Preferred Payload Size field is defined in 6.4.11d. The value of the Preferred Payload Size field in the PRC Capability field is compared with the Preferred Payload Size field in the PRDEV Capability IE, and the smaller of these two values shall be encoded in this field.

The Preferred Total Aggregation Size field is defined in 6.4.11d. The Preferred Total Aggregation Size fields in the PRC Capability field and the PRDEV Capability field are compared, and the smaller of the two values shall be encoded in this field.

The SC Supported Modulations field is defined in 6.4.11d. Each bit in this field shall be set to one if both of the bits in the SC Supported MCS fields in the PRC Capability IE and the PRDEV Capability IE are set to one and shall be set to zero otherwise.

The OOK Supported FEC field is defined in 6.4.11d. Each bit in this field shall be set to one if both of the bits in the OOK Supported FEC fields in the PRC Capability IE and the PRDEV Capability IE are set to one and shall be set to zero otherwise.

The Supported Bandwidths field is defined in 6.4.11d. Each bit in this field shall be set to one if both of the bits in the Supported Bandwidths fields in the PRC Capability IE and the PRDEV Capability IE are set to one and shall be set to zero otherwise.

The Supported Spectrum Part field is defined in 6.4.11d. Each bit in this field shall be set to one if both of the bits in the Supported Spectrum Part fields in the PRC Capability IE and the PRDEV Capability IE are set to one and shall be set to zero otherwise.

6.5 MAC commands

Change the fourth paragraph of 6.5, and replace Table 6-22b with the table shown:

The requirements for MAC commands based on the PHY type are listed in Table 6-22b. <u>MAC commands not shown in the table are not used by those PHYs listed.</u>

Table 6-22b—MAC command usage requirements

Command name	HRCP PHY	THz PHY
Association Request command	Mandatory	Mandatory
Association Response command	Mandatory	Mandatory
Disassociation Request command	Mandatory	Mandatory
Request Key command	Optional	Optional
Request Key Response command	Optional	Optional
Distribute Key Request command	Optional	Optional
Distribute Key Response command	Optional	Optional
Security Information Request command	Optional	Optional
Security Information command	Optional	Optional
Probe Request command	Optional	Optional
Probe Response command	Optional	Optional
Transmit Power Change command	Optional	Optional
Array Training command	Optional	Not used
Array Training Feedback command	Optional	Not used
Security Message command	Optional	Optional
Vendor Defined	Optional	Optional

7. MAC functional description

7.4 Channel access

7.4.1 Interframe space (IFS)

Add the following entries to the end of the dashed list in 7.4.1:

— In 13.2.6.1 for the THz-SC PHY
— In 13.3.6.1 for the THz-OOK PHY

7.8 Aggregation

7.8.3 Pairnet aggregation

Insert the following line before the first paragraph in 7.8.3:

Pairnets using the THz PHY shall not use aggregation.

7.13 Multi-rate support

Add the following entries to the end of the dashed list in 7.13:

— In 13.2 for the THz-SC PHY mode
— In 13.3 for the THz-OOK PHY mode

7.16 MAC sublayer parameters

Change the title of Table 7-10a as indicated:

Table 7-10a—MAC sublayer parameters—~~for~~ HRCP-SC PHY,~~and~~ HRCP-OOK PHY, THz-SC PHY, and THz-OOK PHY dependent

Change the title of Table 7-10b as indicated:

Table 7-10b—MAC sublayer parameters—HRCP-SC PHY, THz-SC PHY, and THz-OOK PHY dependent

Insert the following new Clause 13, after Clause 12, as follows:

13. PHY specification for THz

13.1 General requirements

A compliant THz PHY shall implement at least one of the following PHY modes:

— THz single carrier mode PHY (THz-SC PHY), as defined in 13.2
— THz on-off keying mode PHY (THz-OOK PHY), as defined in 13.3

Unless otherwise stated, in all figures in this clause, the ordering of the octets and bits as they are presented for the THz PHY is the same as defined in 6.1.

13.1.1 RF power measurements

Unless otherwise stated, all RF power measurements for the purpose of this standard are corrected to compensate for the antenna gain in the implementation. The gain of the antenna is the maximum estimated gain given in the data sheet of the antenna, as provided by the manufacturer.

13.1.2 RF channelization

The THz PHY uses the channels defined in Table 13-1.

Table 13-1—THz PHY channelization

CHNL_ID	Bandwidth (GHz)	Start frequency[a] (GHz)	Center frequency (GHz)	Stop frequency[a] (GHz)
1	2.16	252.72	253.8	254.88
2	2.16	254.88	255.96	257.04
3	2.16	257.04	258.12	259.2
4	2.16	259.2	260.28	261.36
5	2.16	261.36	262.44	263.52
6	2.16	263.52	264.6	265.68
7	2.16	265.68	266.76	267.84
8	2.16	267.84	268.92	270.0
9	2.16	270.0	271.08	272.16
10	2.16	272.16	273.24	274.32
11	2.16	274.32	275.4	276.48
12	2.16	276.48	277.56	278.64
13	2.16	278.64	279.72	280.8
14	2.16	280.8	281.88	282.96
15	2.16	282.96	284.04	285.12

Table 13-1—THz PHY channelization *(continued)*

CHNL_ID	Bandwidth (GHz)	Start frequency[a] (GHz)	Center frequency (GHz)	Stop frequency[a] (GHz)
16	2.16	285.12	286.2	287.28
17	2.16	287.28	288.36	289.44
18	2.16	289.44	290.52	291.6
19	2.16	291.6	292.68	293.76
20	2.16	293.76	294.84	295.92
21	2.16	295.92	297.0	298.08
22	2.16	298.08	299.16	300.24
23	2.16	300.24	301.32	302.4
24	2.16	302.4	303.48	304.56
25	2.16	304.56	305.64	306.72
26	2.16	306.72	307.8	308.88
27	2.16	308.88	309.96	311.04
28	2.16	311.04	312.12	313.2
29	2.16	313.2	314.28	315.36
30	2.16	315.36	316.44	317.52
31	2.16	317.52	318.6	319.68
32	2.16	319.68	320.76	321.84
33	4.32	252.72	254.88	257.04
34	4.32	257.04	259.2	261.36
35	4.32	261.36	263.52	265.68
36	4.32	265.68	267.84	270.0
37	4.32	270.0	272.16	274.32
38	4.32	274.32	276.48	278.64
39	4.32	278.64	280.8	282.96
40	4.32	282.96	285.12	287.28
41	4.32	287.28	289.44	291.6
42	4.32	291.6	293.76	295.92
43	4.32	295.92	298.08	300.24
44	4.32	300.24	302.4	304.56
45	4.32	304.56	306.72	308.88
46	4.32	308.88	311.04	313.2
47	4.32	313.2	315.36	317.52
48	4.32	317.52	319.68	321.84

Table 13-1—THz PHY channelization *(continued)*

CHNL_ID	Bandwidth (GHz)	Start frequency[a] (GHz)	Center frequency (GHz)	Stop frequency[a] (GHz)
49	8.64	252.72	257.04	261.36
50	8.64	261.36	265.68	270.0
51	8.64	270.0	274.32	278.64
52	8.64	278.64	282.96	287.28
53	8.64	287.28	291.6	295.92
54	8.64	295.92	300.24	304.56
55	8.64	304.56	308.88	313.2
56	8.64	313.2	317.52	321.84
57	12.96	252.72	259.2	265.68
58	12.96	265.68	272.16	278.64
59	12.96	278.64	285.12	291.6
60	12.96	291.6	298.08	304.56
61	12.96	304.56	311.04	317.52
62	17.28	252.72	261.36	270.0
63	17.28	270.0	278.64	287.28
64	17.28	287.28	295.92	304.56
65	17.28	304.56	313.2	321.84
66	25.92	252.72	265.68	278.64
67	25.92	278.64	291.6	304.56
68	51.84	252.72	278.64	304.56
69	69.12	252.72	287.28	321.84

[a]The start and stop frequencies are nominal values. The frequency spectrum of the transmitted signal shall conform to the transmit power spectral density (PSD) mask for the PHY mode.

The bandwidths of all channels are integer multiples of 2.16 GHz. The center frequencies for channels having a CHNL_ID in the range of 33 to 69 are integer multiples of 2.16 GHz. The channel having CHNL_ID equal to 41 shall be defined as the default channel.

13.1.3 Transmit PSD mask

The transmitted spectrum for the THz-SC PHY shall adhere to the transmit PSD mask shown in Figure 13-1. The transmitted spectrum for the THz-OOK PHY shall adhere to the transmit PSD mask shown in Figure 13-2. The additional single line spectrum of 40 dB above the 0 dB line in Figure 13-2 is within the frequency band of (–6MHz, +6MHz) from the carrier frequency. For all transmit mask measurements, the resolution bandwidth is set to 3 MHz and the video bandwidth is set to 300 kHz.

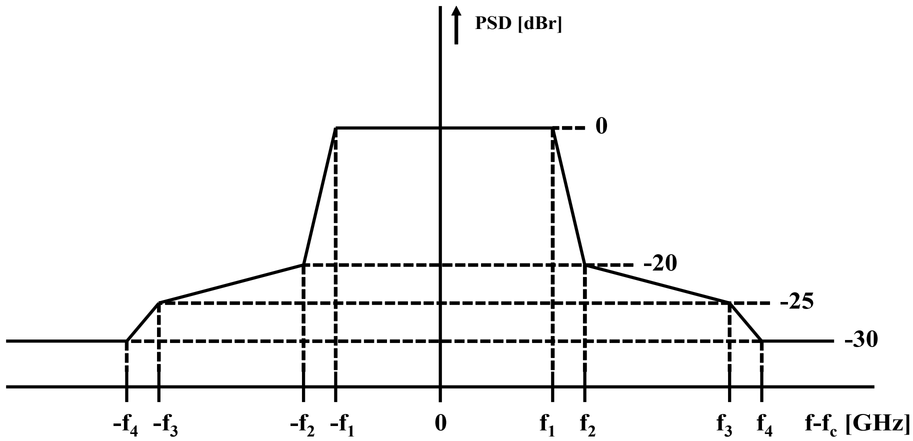

Figure 13-1—Transmit spectral mask for THz-SC PHY

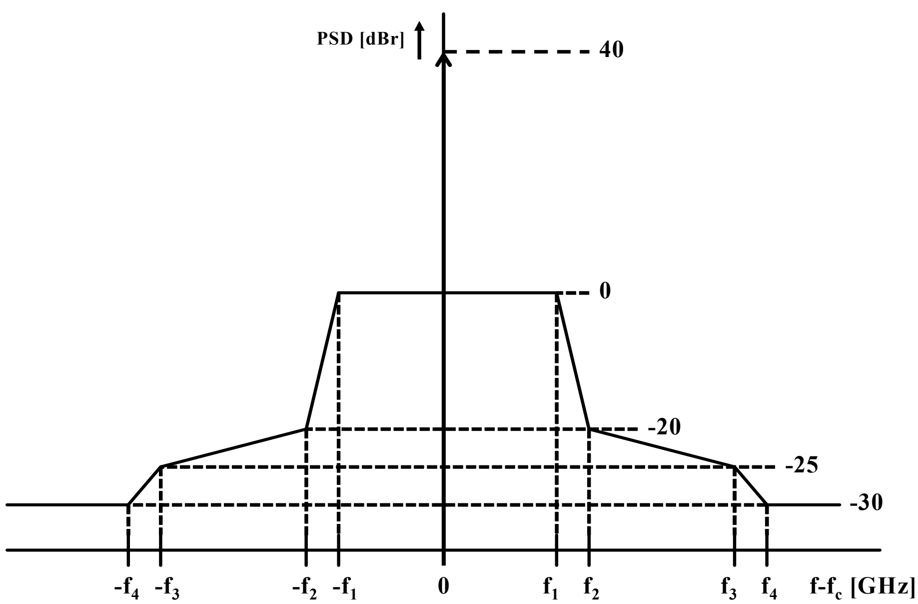

Figure 13-2—Transmit spectral mask for THz-OOK PHY

The parameters of the PSDs indicated in Figure 13-1 and Figure 13-2 are defined in Table 13-2.

Table 13-2—Transmit spectrum mask parameters

Channel bandwidth (GHz)	f_1 (GHz)	f_2 (GHz)	f_3 (GHz)	f_4 (GHz)
2.160	0.94	1.10	1.60	2.20
4.320	2.02	2.18	2.68	3.28
8.640	4.18	4.34	4.84	5.44
12.960	6.34	6.50	7.00	7.60
17.280	8.50	8.66	9.16	9.76
25.920	12.82	12.98	13.48	14.08
51.840	25.78	25.94	26.44	27.04
69.120	34.42	34.58	35.08	35.68

13.1.4 Error vector magnitude calculation

The error vector magnitude (EVM) for the THz PHY shall be measured and calculated using the method defined in 11.1.7.1.

13.1.5 THz PHY management

The PHY PIB comprises the managed objects, attributes, actions, and notifications required to manage the THz PHY layer of a PRDEV.

13.1.5.1 THz PHY PIB

The PHY dependent PIB values for the THz PHY are given in Table 13-3.

Table 13-3—PHY PIB characteristics group parameters

Managed Object	Octets	Definition	Access
phyType	1	0x03 = THz PHY	Read/Write
phyMode	1	bit 1 = THz-SC PHY bit 2 = THz-OOK PHY bit 3–8 = Reserved A bit is set to one if the associated PHY is supported and is set to zero otherwise.	Read/Write
phyRegDomainsSupported	Variable	One octet for each regulatory domain supported, as defined for *phyCurrentRegDomain*.	Read/Write

Table 13-3—PHY PIB characteristics group parameters *(continued)*

Managed Object	Octets	Definition	Access
phyCurrentRegDomain	1	0x00 = European Telecommunications Standards Institute (ETSI) 0x01 = Federal Communications Commission (FCC) 0x02 = Industry Canada (IC) 0x03 = Association of Radio Industries and Businesses (ARIB)	Read/Write
phyDataRateVector	Variable	One octet for each supported MCS. The MSB indicates the THz PHY mode: MSB 0 = 0 for THz-SC PHY and MSB 0 = 1 for THz OOK PHY. MSB 1–3 indicate the bandwidth identifier described in Table 13-9. For the THz-SC PHY mode, the four LSBs indicate the MCS supported for that mode using the encoding described in Table 13-8. For the THz-OOK PHY mode, the two LSBs indicate the MCS supported for that mode using the encoding described in Table 13-16.	Read/Write
phyChannelBandwidthSupported	1	Bits b32–b39 in the PRC Capability field, as defined 6.4.11d.	Read/Write
phySpectrumPartSupported	4	Bits b40–b71 in the PRC Capability field, as defined 6.4.11d.	Read/Write
phyCurrentChannel	1	Indicates the channel that is currently being used, as defined in 13.1.2.	Read/Write
phyFrameLengthMax	2	The value of *pMaxFrameBodySize*.	Read/Write

13.1.5.2 Maximum frame size

The maximum frame length allowed, *pMaxFrameBodySize*, shall be 2 099 200 octets. This total includes the MAC frame body, but not the PHY preamble or base header (PHY header, MAC header, and HCS). The maximum frame length also does not include the stuff bits. See Table 11a-9 for details regarding the relationship between the payload size and the size of the MAC frame body.

13.1.5.3 Maximum transfer unit size

The maximum size data frame passed from the upper layers, *pMaxTransferUnitSize*, shall be 2 097 152 octets. If security is enabled for the data connection, the upper layers should limit data frames to 2 097 152 octets minus the security overhead, as defined in 6.3.1.2a, 6.3.3a.2, 6.3.4a.2, and 6.3.5a.2.

13.1.5.4 Minimum fragment size

The minimum fragment size, *pMinFragmentSize*, allowed shall be 2048 octets.

13.2 THz-SC PHY

The THz-SC PHY is designed for extremely high PHY-SAP payload bit rates of 100 Gb/s using multiple bandwidths. Higher data rates are achievable, depending on the combination of modulation, bandwidth, and coding.

13.2.1 Channelization of THz-SC PHY

The RF channels are defined in Table 13-1. A compliant implementation shall support at least the channel with the default CHNL_ID, as defined in 13.1.2.

The *phyCurrentChannel* is the CHNL_ID of the current channel. For the purpose of the Remote Scan Request and Remote Scan Response commands, as described in 6.5.7.3 and 6.5.7.4, respectively, the Channel Index field is the CHNL_ID in Table 13-1 in 13.1.2.

The *phyCurrentChannel* is the CHNL_ID of the current channel.

13.2.2 Modulation and coding

13.2.2.1 Modulation

After channel encoding and spreading, the bits shall be inserted into the constellation mapper.

The constellations of π/2 BPSK, π/2 QPSK, and π/2 8-PSK used for the THz-SC PHY are the same as illustrated in Figure 11-10 (a), (b), and (c), respectively, in 11.2.2.5. The constellations of 16-QAM and 64-QAM used for the THz-SC PHY are the same as illustrated in Figure 11-29 in 11.3.2.6.

The constellation diagram of π/2 8-APSK is shown in Figure 13-3. The π/2 8-APSK shall encode 3 bits per symbol, with input bit d_1 being the earliest in the stream. The π/2-rotation is performed in the same manner as in 11.2.2.5.1.

The normalization factors for π/2 QPSK, π/2 8-PSK, π/2 8-APSK, 16-QAM, and 64-QAM are 1, 1, $\sqrt{2}/\sqrt{11}$, $1/(\sqrt{10})$, and $1/\sqrt{42}$, respectively. The purpose of the normalization factor is to achieve the same average power for all mappings. In practical implementations, an approximate value of the normalization can be used as long as the DEV conforms to the modulation accuracy requirements described in 13.2.4.1.

All modulation schemes are used for payload, and π/2 BPSK is also used for preamble and header sequences. The modulations of π/2 BPSK and π/2 QPSK are mandatory for THz-SC PHY; other modulations are optional.

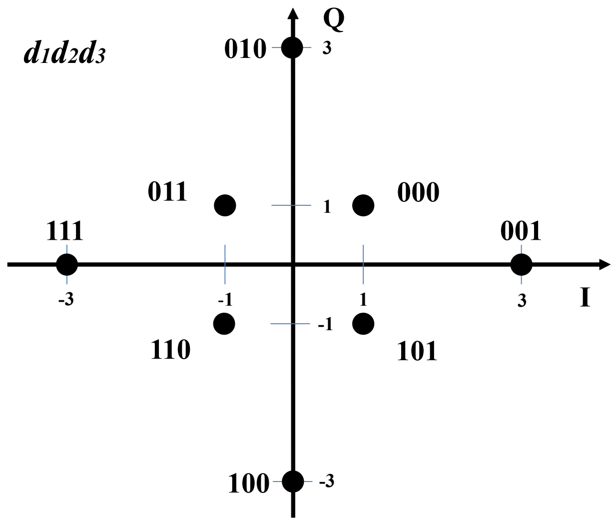

Figure 13-3—π/2 8-APSK

13.2.2.2 Forward error correction

The forward error correction (FEC) schemes are specified in this subclause. Supporting the following two LDPC codes is mandatory for the THz-SC PHY: a rate-14/15 LDPC(1440,1344) code, defined in 11.2.2.6.3, and a rate-11/15 LDPC(1440,1056) code, defined in 11a.2.2.6.

13.2.2.3 MCS dependent parameters

The MCS dependent parameters shall be set according to Table 13-4. The chip rate for all THz-SC PHY MCSs is given in Table 13-6. The data rates in the table are approximate values.

A block length for THz-SC PHY shall be 64 chips. A block is formed according to 11a.2.3.4.1. The pilot word (PW) length, where a PW is defined in 11a.2.3.4.1, for the THz-SC PHY shall be 0 chips or 8 chips. The PW length of 8 chips is mandatory and that of 0 chips is optional.

Table 13-4—MCS dependent parameters for the THz-SC PHY

MCS identifier	Modulation	FEC rate	Bandwidth 2.16 GHz		Bandwidth 4.32 GHz		Bandwidth 8.64 GHz		Bandwidth 12.96 GHz		Bandwidth 17.28 GHz		Bandwidth 25.92 GHz		Bandwidth 51.84 GHz		Bandwidth 69.12 GHz	
			Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)		Data rate (Gb/s)	
			without PW	with PW	without PW	with PW	without PW	with PW	without PW	with PW	without PW	with PW	without PW	with PW	without PW	with PW	without PW	with PW
0	BPSK	11/15	1.29	1.13	2.58	2.26	5.16	4.52	7.74	6.78	10.33	9.04	15.49	13.55	30.98	27.11	41.30	36.14
1	BPSK	14/15	1.64	1.44	3.29	2.87	6.57	5.75	9.86	8.62	13.14	11.50	19.71	17.25	39.42	34.50	52.56	45.99
2	QPSK	11/15	2.58	2.26	5.16	4.52	10.33	9.03	15.49	13.55	20.65	18.07	30.98	27.10	61.95	54.21	82.60	72.28
3	QPSK	14/15	3.29	2.87	6.57	5.75	13.14	11.50	19.71	17.25	26.28	23.00	39.42	34.50	78.85	68.99	105.13	91.99
4	8-PSK	11/15	3.87	3.39	7.74	6.78	15.49	13.55	23.23	20.33	30.98	27.11	46.47	40.66	92.93	81.32	123.91	108.42
5	8-PSK	14/15	4.93	4.31	9.86	8.62	19.71	17.25	29.57	25.87	39.42	34.50	59.13	51.74	118.27	103.49	157.69	137.98
6	8-APSK	11/15	3.87	3.39	7.74	6.78	15.49	13.55	23.23	20.33	30.98	27.11	46.47	40.66	92.93	81.32	123.91	108.42
7	8-APSK	14/15	4.93	4.31	9.86	8.62	19.71	17.25	29.57	25.87	39.42	34.50	59.13	51.74	118.27	103.49	157.69	137.98
8	16-QAM	11/15	5.16	4.52	10.33	9.03	20.65	18.07	30.98	27.10	41.30	36.14	61.95	54.21	123.90	108.42	165.21	144.55
9	16-QAM	14/15	6.57	5.75	13.14	11.50	26.28	23.00	39.42	34.50	52.57	45.99	78.85	68.99	157.70	137.98	210.26	183.98
10	64-QAM	11/15	7.74	6.78	15.49	13.55	30.98	27.10	46.46	40.66	61.95	54.21	92.93	81.31	185.86	162.62	247.81	216.83
11	64-QAM	14/15	9.86	8.62	19.71	17.25	39.42	34.50	59.14	51.74	78.85	68.99	118.27	103.49	236.54	206.98	315.39	275.97

13.2.2.4 Header dependent parameters

The header dependent parameters shall be set according to Table 13-5. The header rate is proportional to the bandwidth used. The headers use an extended Hamming (EH) code, as defined in 11a.2.3.2.3.

Table 13-5—Header rate dependent parameters for the THz-SC PHY

Bandwidth (GHz)	Header rate (Mb/s)	Modulation scheme	Spreading factor, L_{SF}	FEC	PW length (chips), L_{PW}	Code bits per block, L_{CBPS}	Number of occupied blocks, N_{block_hdr}	Number of stuff bits, L_{STUFF}
2.160	162	π/2 BPSK	4	EH	8	14	19	40
4.320	324	π/2 BPSK	4	EH	8	14	19	40
8.640	648	π/2 BPSK	4	EH	8	14	19	40
12.960	972	π/2 BPSK	4	EH	8	14	19	40
17.280	1296	π/2 BPSK	4	EH	8	14	19	40
25.920	1944	π/2 BPSK	4	EH	8	14	19	40
51.840	3888	π/2 BPSK	4	EH	8	14	19	40
69.120	5184	π/2 BPSK	4	EH	8	14	19	40

13.2.2.5 Timing-related parameters

Table 13-6 lists the general timing parameters associated with the THz-SC PHY.

Table 13-6—Timing-related parameters

Parameter	Description	Value		Unit	Formula
R_C	Chip rate	1760–42 240		Mchip/s	B×1760/(2.16 GHz)
T_C	Chip duration	0.024–0.568		ns	$1/R_C$
L_{block}	Block length	64		chips	—
L_{PW}	PW length	0	8	chips	—
T_{PW}	PW duration	0	0.192–4.544	ns	$L_{PW}\times T_C$
L_{DC}	Data chips per block	64	56	chips	—
T_{block}	Block duration	1.536–36.352		ns	$L_{block}\times T_C$
R_{block}	Block rate	27.509–651.042		MHz	$1/T_{block}$

13.2.2.6 Frame-related parameters

The frame parameters associated with the THz-SC PHY are the same as for the HRCP-SC PHY, given in Table 11a-9, with the exception of the N_{CBPC} parameter. The values of the N_{CBPC} parameter for the various modulation schemes are 1, 2, 3, 3, 4, and 6 for BPSK, QPSK, 8-PSK, 8-APSK, 16-QAM and 64-QAM, respectively.

13.2.2.7 Stuff bits

Stuff bits shall be added to the end of the encoded MAC frame body if the number of the encoded data bits is not an integer multiple of the length of the data portion in the block. The calculation of stuff bits follows the definition in 11a.2.2.7, where N_{CBPB} is defined in Table 13-7 for each MCS of the THz-SC PHY.

Table 13-7—MCS dependent coded bits per block for the THz-SC PHY

MCS identifier	N_{CBPB} (PW length = 0)	N_{CBPB} (PW length = 8)
0,1	64	56
2,3	128	112
4,5,6,7	192	168
8,9	256	224
10,11	384	336

13.2.2.8 Code spreading

Code spreading of the frame headers shall be done as described in 11a.2.2.8.

13.2.2.9 Scrambling

The frames shall be scrambled by modulo-2 addition of the data with the output of a pseudo random bit sequence (PRBS) generator, as defined in 11a.2.2.9.

13.2.3 THz-SC PHY frame format

The THz-SC PHY frame shall be formatted as illustrated in Figure 11-18.

The Frame Header field for the THz-SC PHY frame shall be formatted as illustrated in Figure 11a-4. It shall be constructed according to 11a.2.3.2.

The PHY preamble is described in 13.2.3.1. The MAC header is defined in 6.2. The PHY header is defined in 13.2.3.2.1, and the header check sequence (HCS) is defined in 11a.2.3.2.2. The header FEC is defined in 11a.2.3.2.3. The PHY Payload field consisting of the MAC frame body, the pilot preamble (PPRE), and stuff bits is described in 13.2.3.3. The PPRE is described in 13.2.3.4.2. The stuff bits are described in 11a.2.2.7.

13.2.3.1 PHY preamble

A PHY preamble shall be added prior to the frame header to aid receiver algorithms related to auto-gain control (AGC) setting, frame detection, timing acquisition, frequency offset estimation, frame synchronization, and channel estimation.

The PHY preamble, i.e., PHY long preamble and PHY short preamble, shall be transmitted at the chip rate described in Table 13-6.

A PHY long preamble shall be used during PSP and a PHY short preamble shall be used during PAP.

The structure of the PHY long and PHY short preambles are shown in Figure 11a-5.

For the PHY preamble, T_{SFD} is 0.07 s and T_{CES} is 0.80 s. For PHY long preamble, T_{SYNC} is 2.01 s and T_{PRE} is 2.91 s. For the PHY short preamble, T_{SYNC} is 1.02 s and T_{PRE} is 1.89 s. The fields for frame synchronization (SYNC), SFD, and channel estimation sequence (CES) shall be set as described in 11a.2.3.1.1, 11.2.3.1.2, and 11a.2.3.1.3.

13.2.3.2 Frame header

A frame header shall be added after the PHY preamble, as described in 11a.2.3.2.

13.2.3.2.1 THz-SC PHY frame header

The THz-SC PHY header shall be formatted as illustrated in Figure 13-4.

Bits: b0–b3	**b4–b6**	**b7**	**b8–b11**	**b12–b13**	**b14**	**b15–b36**
MCS	Bandwidth	PW	Scrambler Seed ID	PPRE	Reserved	Frame Length

Figure 13-4—PHY header format for THz-SC PHY

The MCS field shall be set according to the values in Table 13-8.

Table 13-8—MCS field definition for the THz-SC PHY

MCS field value	**MCS identifier**
0b0000	0
0b0001	1
0b0010	2
0b0011	3
0b0100	4
0b0101	5
0b0110	6
0b0111	7
0b1000	8
0b1001	9
0b1010	10
0b1011	11
0b1100–0b1111	Reserved

The Bandwidth field shall be set according to the values in Table 13-9.

Table 13-9—Bandwidth field definition

Bandwidth field value	Bandwidth (GHz)
0b000	2.16
0b001	4.32
0b010	8.64
0b011	12.96
0b100	14.28
0b101	25.92
0b110	51.84
0b111	69.12

The PW field shall be set to one if the PW is used in the current frame and shall be set to zero otherwise.

The Scrambler Seed ID field contains the scrambler seed identifier value, as defined in 11.2.2.10.

The PPRE field shall be set according to the values in Table 11a-15.

The Frame Length field shall be an unsigned integer equal to the number of octets in the MAC frame body of a regular frame, excluding the FCS.

13.2.3.2.2 Header HCS

The combination of the PHY header and MAC header shall be protected with the CRC-16 HCS, as described in 11a.2.3.2.2.

13.2.3.2.3 Header FEC

The combination of the PHY header, scrambled MAC header, and HCS shall be encoded, as described in 11a.2.3.2.3.

13.2.3.3 THz-SC PHY Payload field

The THz-SC PHY Payload field is the last component of the frame and is constructed as shown in Figure 11-23.

The PHY Payload field shall be constructed as follows:

a) Scramble the MAC frame body according to 11.2.2.10.
b) Encode the scrambled MAC frame body, as specified in 13.2.2.2.
c) Add stuff bits to the encoded and scrambled MAC frame body according to 13.2.2.7.
d) Map the resulting MAC frame body onto the appropriate constellation, as described in 13.2.2.1.

e) Build blocks from the resulting MAC frame body according to 11a.2.3.4.1.

f) Insert PPRE periodically, as described in 13.2.3.4.2.

13.2.3.3.1 THz-SC PHY payload scrambling

The THz-SC PHY payload shall use the scrambling process defined in 11.2.2.10.

13.2.3.3.2 Modulation

Modulation for the MAC frame body is defined in 13.2.2.1.

13.2.3.3.3 FEC

FEC for the MAC frame body is defined in 13.2.2.2.

13.2.3.4 PW and PPRE

13.2.3.4.1 Block and PW

The block and PW is defined as in 11a.2.3.4.1.

13.2.3.4.2 PPRE

The PPRE is defined as in 11a.2.3.4.2.

13.2.4 Transmitter specifications

13.2.4.1 EVM requirement

The EVM of a compliant transmitter shall be measured and calculated, as defined in 11.1.7, and shall not exceed the values given in Table 13-10 for the indicated mode.

Table 13-10—Max EVM

MCS identifier	Modulation	FEC rate	Max. EVM (dB)
0	BPSK	11/15	–3
1	BPSK	14/15	–6
2	QPSK	11/15	–6
3	QPSK	14/15	–9
4	8-PSK	11/15	–11
5	8-PSK	14/15	–14
6	8-APSK	11/15	–11
7	8-APSK	14/15	–14
8	16-QAM	11/15	–13

Table 13-10—Max EVM *(continued)*

MCS identifier	Modulation	FEC rate	Max. EVM (dB)
9	16-QAM	14/15	–16
10	64-QAM	11/15	–18
11	64-QAM	14/15	–22

13.2.4.2 Transmit center frequency tolerance

The transmitted center frequency tolerance shall be $\pm 30 \times 10^{-6}$ at maximum.

13.2.4.3 Symbol rate

The THz-SC PHY shall be capable of transmitting at the chip rate, as defined in Table 13-6, to within $\pm 30 \times 10^{-6}$.

The MAC parameter, *pPHYClockAccuracy*, shall be $\pm 30 \times 10^{-6}$.

13.2.5 Receiver specifications

13.2.5.1 Error rate criterion

The error rate criterion shall be a frame error rate (FER) of less than 1.3×10^{-7} with a frame payload length of 2^{14} octets, which corresponds to a bit error rate (BER) of 10^{-12}. The error rate shall be determined at the PHY SAP interface after any error correction methods (excluding retransmission) have been applied. The measurement shall be performed in AWGN channel.

13.2.5.2 Receiver sensitivity

The receiver sensitivity is the minimum power level of the incoming signal, in dBm, present at the input of the receiver for which the error rate criterion in 13.2.5.1 is met. The error ratio shall be determined after any error correction has been applied. A compliant DEV that implements the THz-SC PHY shall achieve at least the reference sensitivity listed in Table 13-11.

Table 13-11—Reference sensitivity levels for MCS for the THz-SC PHY

MCS identifier	Modulation	FEC rate	Receiver Sensitivity (dBm) depending on the bandwidth							
			2.16 GHz	4.32 GHz	8.64 GHz	12.96 GHz	17.28 GHz	25.92 GHz	51.84 GHz	69.12 GHz
0	BPSK	11/15	–67	–64	–61	–59	–58	–56	–53	–52
1	BPSK	14/15	–63	–60	–57	–55	–54	–52	–49	–48
2	QPSK	11/15	–64	–61	–58	–56	–55	–53	–50	–49
3	QPSK	14/15	–60	–57	–54	–52	–51	–49	–46	–45
4	8-PSK	11/15	–59	–56	–53	–51	–50	–48	–45	–44
5	8-PSK	14/15	–57	–54	–51	–49	–48	–46	–43	–42

Table 13-11—Reference sensitivity levels for MCS for the THz-SC PHY *(continued)*

MCS identifier	Modulation	FEC rate	Receiver Sensitivity (dBm) depending on the bandwidth							
			2.16 GHz	4.32 GHz	8.64 GHz	12.96 GHz	17.28 GHz	25.92 GHz	51.84 GHz	69.12 GHz
6	8-APSK	11/15	–59	–56	–53	–51	–50	–48	–45	–44
7	8-APSK	14/15	–57	–54	–51	–49	–48	–46	–43	–42
8	16-QAM	11/15	–57	–54	–51	–49	–48	–46	–43	–42
9	16-QAM	14/15	–53	–50	–47	–45	–44	–42	–39	–38
10	64-QAM	11/15	–52	–49	–46	–44	–43	–41	–38	–36
11	64-QAM	14/15	–47	–44	–41	–40	–38	–36	–33	–32

13.2.5.3 Receiver maximum input level

The receiver maximum input level is the maximum power level of the incoming signal, in dBm, present at the input of the receiver for which the error rate criterion in 13.2.5.1 is met. A compliant receiver shall have a receiver maximum input level of at least –10 dBm for each of the modulation formats that the DEV supports.

13.2.6 PHY layer timing

The PHY layer timing parameters are defined in 11.a.2.6.

13.2.6.1 Interframe space

A conformant implementation shall support the IFS parameters, as described in 11a.2.6.1.

13.2.6.2 Receive-to-transmit turnaround time

The receive to transmit turnaround time shall be set as described in 11a.2.6.2.

13.2.6.3 Transmit-to-receive turnaround-time

The transmit to receive turnaround time shall be less than *pPHYSIFSTime*, as described in Table 11a-20.

13.2.6.4 Time between successive transmissions

The minimum time between the end of the last transmitted frame and the beginning of the retransmitted frame shall be less than a RIFS time. The RIFS times for both a PRC and a DEV are given in Table 11a-20.

13.2.6.5 Channel switch

The channel switch time is defined as the time from when the last valid bit is received at the antenna on one channel until the DEV is ready to transmit or receive on a new channel. The channel switch time shall be less than *pPHYChannelSwitchTime*, as defined in Table 11a-19.

13.3 THz-OOK PHY

The THz-OOK PHY is designed for cost-effective devices that require low power, low complexity, and simple design. For applications using this PHY, transmission ranges of a few tens of centimeters are targeted. The THz-OOK PHY is designed for PHY-SAP payload-bit rates between 1.3 Gb/s, using a single channel with a bandwidth of 2.16 GHz, and the maximum 52.6 Gb/s, using a bandwidth of 69.12 GHz.

13.3.1 Channelization for THz-OOK PHY

The possible channels are the same as defined in 13.1.2. The transmit spectral masks for the THz-OOK PHY are the same as defined in 13.1.3.

13.3.2 Modulation and coding

The entire THz-OOK frame shall be modulated with OOK, as specified in 13.3.2.1. The MCS dependent parameters shall be set according to Table 13-12. The chip rate of the THz-OOK PHY is given in Table 13-6. The FEC for the THz-OOK PHY shall be as specified in 13.3.2.2.

13.3.2.1 Modulation

THz-OOK frames shall be modulated using OOK, as described in 11a.3.2.5.

13.3.2.2 Forward error correction

The FEC scheme is specified by a (240,224)-Reed Solomon code and two LDPC codes with code rates of 14/15 and 11/15. The Reed Solomon Code, defined in 11a.3.2.6.1, is mandatory for the THz OOK-PHY. The LDPC (1440,1344), defined in 11.2.2.6.3, and the LDPC (1440,1056), defined in 11a.2.2.6, are both optional for the THz-OOK PHY.

13.3.2.3 MCS dependent parameters

Table 13-12—MCS dependent parameters for the THz-OOK PHY

MCS identifier	Bandwidth (GHz)	FEC rate	Data rate (Gb/s) with PW	Data rate (Gb/s) without PW
0	2.16	224/240	1.64	1.44
0	4.32	224/240	3.29	2.87
0	8.64	224/240	6.57	5.75
0	12.96	224/240	9.86	8.62
0	17.28	224/240	13.14	11.50
0	25.92	224/240	19.71	17.25
0	51.84	224/240	39.42	34.50
0	69.12	224/240	59.14	51.74
1	2.16	11/15	1.29	1.29
1	4.32	11/15	2.58	2.26

Table 13-12—MCS dependent parameters for the THz-OOK PHY *(continued)*

MCS identifier	Bandwidth (GHz)	FEC rate	Data rate (Gb/s) with PW	Data rate (Gb/s) without PW
1	8.64	11/15	5.16	4.52
1	12.96	11/15	7.74	6.78
1	17.28	11/15	10.33	9.04
1	25.92	11/15	15.49	13.55
1	51.84	11/15	30.98	27.11
1	69.12	11/15	41.30	36.14
2	2.16	14/15	1.64	1.44
2	4.32	14/15	3.29	2.87
2	8.64	14/15	6.57	5.75
2	12.96	14/15	9.86	8.62
2	17.28	14/15	13.14	11.50
2	25.92	14/15	19.71	17.25
2	51.84	14/15	39.42	34.50
2	69.12	14/15	52.56	45.99

A block length for the THz-OOK PHY shall be 64 chips. The PW length, where a PW is defined in 11a.2.3.4.1, for the THz-OOK PHY shall be 0 chips or 8 chips. The PW length of 8 chips is mandatory and that of 0 chips is optional.

13.3.2.4 Header dependent parameters

The header dependent parameters shall be set according to the values defined in Table 13-13. The header rate is proportional to the bandwidth used. The headers use an EH code, as defined in 11a.2.3.2.3.

Table 13-13—Header rate dependent parameters for the THz-OOK PHY

Bandwidth (GHz)	Header rate (Mb/s)	Modulation scheme	Spreading factor, L_{SF}	FEC	PW length (chips), L_{PW}	Code bits per block, L_{CBPS}	Number of occupied blocks, N_{block_hdr}	Number of stuff bits, L_{STUFF}
2.160	162	OOK	4	EH	8	14	19	40
4.320	324	OOK	4	EH	8	14	19	40
8.640	648	OOK	4	EH	8	14	19	40
12.960	972	OOK	4	EH	8	14	19	40
17.280	1296	OOK	4	EH	8	14	19	40

Table 13-13—Header rate dependent parameters for the THz-OOK PHY *(continued)*

Bandwidth (GHz)	Header rate (Mb/s)	Modulation scheme	Spreading factor, L_{SF}	FEC	PW length (chips), L_{PW}	Code bits per block, L_{CBPS}	Number of occupied blocks, N_{block_hdr}	Number of stuff bits, L_{STUFF}
25.920	1944	OOK	4	EH	8	14	19	40
51.840	3888	OOK	4	EH	8	14	19	40
69.120	5184	OOK	4	EH	8	14	19	40

13.3.2.5 Timing-related parameters

The general timing parameters for the THz-OOK PHY shall be set as defined for the THz-SC PHY according to Table 13-6.

13.3.2.6 Frame-related parameters

The frame parameters associated with the THz-OOK PHY are the same as for the THz-SC PHY defined in 13.2.2.6, with the exception that the parameter N_{CBPC} takes the value one.

13.3.2.7 Stuff bits

Stuff bits shall be added to the end of the encoded MAC frame body if the number of the encoded data bits is not an integer multiple of the length of the data portion in the block. The calculation of stuff bits follows the definition in 11a.2.2.7, where N_{CBPB} is defined in Table 13-14 for each MCS of the THz-OOK PHY.

Table 13-14—MCS dependent coded bits per block for the THz-OOK PHY

MCS identifier	N_{CBPB} (PW length = 0)	N_{CBPB} (PW length = 8)
0,1,2	64	56

13.3.2.8 Code spreading

Code spreading shall be applied to THz-OOK frame headers according to 11a.2.2.8.

13.3.2.9 Scrambling

Scrambling of THz-OOK fields shall be performed as defined in 11a.2.2.9.

13.3.3 THz-OOK PHY frame format

The THz-OOK PHY frame shall be formatted as illustrated in Figure 11-18.

The Frame Header field for the THz-OOK PHY frame shall be formatted as illustrated in Figure 11a-4. It shall be constructed according to 11a.2.3.2.

The PHY preamble is described in 13.3.3.1. The MAC header is defined in 6.2. The THz-OOK PHY frame header is defined in 13.3.3.1, and the HCS is defined in 11a.3.3.2.2. The header FEC is defined in 11a.2.3.2.3. The PHY Payload field, consisting of the MAC frame body and stuff bits, is described in 11a.3.3.3. The stuff bits are described in 13.3.2.7.

13.3.3.1 THz-OOK PHY frame header

The THz-OOK PHY header shall be formatted as illustrated in Figure 13-5.

Bits: b0–b1	b2–b4	b5	b6–b9	b10–b11	b12	b13–b34
MCS	Bandwidth	PW	Scrambler Seed ID	PPRE	Reserved	Frame Length

Figure 13-5—PHY header format for THz-OOK PHY

The MCS field shall be set according to the values in Table 13-15.

The Bandwidth field shall be set according to Table 13-9.

Table 13-15—MCS field definition for the THz-OOK PHY

MCS field value	MCS identifier
0b00	0
0b01	1
0b10	2
0b11	Reserved

The PW field shall be set to one if the PW is used in the current frame and shall be set to zero otherwise.

The Scrambler Seed ID field contains the scrambler seed identifier value, as defined in 11.2.2.10.

The PPRE field shall be set according to the values in Table 11a-15.

The Frame Length field shall be an unsigned integer equal to the number of octets in the MAC frame body of a regular frame, excluding the FCS.

13.3.3.2 THz-OOK PHY Payload field

The THz-OOK PHY Payload field is the last component of the frame and is constructed as shown in Figure 11a-26.

The PHY Payload field shall be constructed as follows:

a) Scramble the MAC frame body according to 13.3.3.2.1.
b) Encode the scrambled MAC frame body, as specified in 13.3.3.2.3.
c) Add stuff bits to the encoded and scrambled MAC frame body according to 13.3.2.7.

d) Map the resulting MAC frame body onto the appropriate constellation, as described in 13.3.2.1.
e) Build blocks from the resulting MAC frame body according to 11a.2.3.4.1.

13.3.3.2.1 THz-OOK PHY Payload scrambling

The THz-OOK PHY payload shall use the scrambling process defined in 11.2.2.10.

13.3.3.2.2 Modulation

Modulation for the MAC frame body is defined in 13.3.2.1.

13.3.3.2.3 FEC

FEC for the MAC frame body is defined in 13.3.2.2.

13.3.3.3 Blocks and PW

The block and PW is defined in 11a.2.3.4.1, and the PW shall be modulated with OOK.

13.3.3.4 PPRE

PPRE insertion is defined in 11a.2.3.4.2, and the PPRE shall be modulated with OOK.

13.3.4 Transmitter specifications

13.3.4.1 EVM requirement

Eye opening for OOK is described in G.7.

13.3.4.2 Transmit center frequency tolerance

The transmitted center frequency tolerance shall be $\pm 30 \times 10^{-6}$ at maximum.

13.3.4.3 Symbol rate

The THz-SC PHY shall be capable of transmitting at the chip rate, as defined in Table 13-6, to within $\pm 30 \times 10^{-6}$.

The MAC parameter, *pPHYClockAccuracy*, shall be $\pm 30 \times 10^{-6}$.

13.3.5 Receiver specifications

13.3.5.1 Error rate criterion

The error rate criterion shall be an FER of less than 1.3×10^{-7} with a frame payload length of 214 octets, which corresponds to a BER of 10^{-12}. The error rate shall be determined at the PHY SAP interface after any error correction methods (excluding retransmission) have been applied. The measurement shall be performed in an AWGN channel.

13.3.5.2 Receiver sensitivity

The receiver sensitivity is the minimum power level of the incoming signal, in dBm, present at the input of the receiver for which the error rate criterion in 13.3.5.1 is met. The error ratio shall be determined after any error correction has been applied. A compliant DEV that implements the THz-OOK PHY shall achieve at least the reference sensitivity listed in Table 13-16.

Table 13-16—Reference sensitivity levels for MCS for the THz-OOK PHY

MCS identifier	Modulation	FEC rate	Receiver sensitivity (dBm) depending on the bandwidth							
			2.16 GHz	4.32 GHz	8.64 GHz	12.96 GHz	17.28 GHz	25.92 GHz	51.84 GHz	69.12 GHz
0	OOK	224/240	–62	–59	–56	–54	–53	–51	–48	–47
1	OOK	11/15	–67	–64	–61	–59	–58	–56	–53	–52
2	OOK	14/15	–63	–60	–57	–55	–54	–52	–49	–48

13.3.5.3 Receiver maximum input level

The receiver maximum input level is the maximum power level of the incoming signal, in dBm, present at the input of the receiver for which the error rate criterion in 13.3.5.1 is met. A compliant receiver shall have a receiver maximum input level of at least –10 dBm for each of the modulation formats that the DEV supports.

13.3.6 PHY layer timing

The PHY layer timing parameters are defined in 11a.2.6.

13.3.6.1 Interframe space

A conformant implementation shall support the IFS parameters, as described in 11a.2.6.1.

13.3.6.2 Receive-to-transmit turnaround time

The receive to transmit turnaround time shall be set as described in 11a.2.6.2.

13.3.6.3 Transmit-to-receive turnaround-time

The transmit to receive turnaround time shall be less than *pPHYSIFSTime*, as described in Table 11a-20.

13.3.6.4 Time between successive transmissions

The minimum time between the end of the last transmitted frame and the beginning of the retransmitted frame shall be less than a RIFS time. The RIFS times for both a PRC and a DEV are given in Table 11a-20.

13.3.6.5 Channel switch

The channel switch time is defined as the time from when the last valid bit is received at the antenna on one channel until the DEV is ready to transmit or receive on a new channel. The channel switch time shall be less than *pPHYChannelSwitchTime*, as defined in Table 11a-19.

Annex E

Change Annex E from normative to informative as shown:

~~(normative)~~ (informative)

Protocol implementation conformance statement (PICS) proforma

Change the title and first paragraph of E.7 as indicated:

E.7 PICS proforma—IEEE Std 802.15.3-2016, IEEE Std 802.15.3d-2017, and IEEE Std 802.15.3e-2017

Table E-1 through Table E-5a are composed of the detailed questions to be answered, which make up the PICS proforma. Subclause E.7.1 contains the major roles for an IEEE 802.15.3, IEEE 802.15.3d, and IEEE 802.15.3e DEV. Subclause E.7.2 contains the major capabilities for the PHY and radio frequencies. Subclause E.7.3 contains the major capabilities for the MAC sublayer. Subclause E.7.4 indicates which level and type of security is supported in the implementation.

E.7.1 Major roles for IEEE 802.15.3 DEVs

Insert the following new rows at the end of Table E-1a:

Table E-1a—Functional PRDEV types

Item number	Item description	References	Status	Support		
				N/A	Yes	No
FHD5	Supports THz-SC PHY	13.2	O.1			
FHD6	Supports THz-OOK PHY	13.3	O.1			

E.7.2 PHY functions

Insert the following two new tables, Table E-2c and Table E-2d, after Table E-2b, as shown:

Table E-2c—THz-SC PHY functions

Item number	Item description	References	Status	Support		
				N/A	Yes	No
SC-TPLF1	Conforms to general requirements (e. g., timing, frequency)	13.1	FHD5: M			
SC-TPLF2.1	Supports a bandwidth of 2.16 GHz	13.1.2	FHD5: O			
SC-TPLF2.2	Supports a bandwidth of 4.32 GHz	13.1.2	FHD5: M			
SC-TPLF2.3	Supports a bandwidth of 8.64 GHz	13.1.2	FHD5: O			
SC-TPLF2.4	Supports a bandwidth of 12.96 GHz	13.1.2	FHD5: O			
SC-TPLF2.5	Supports a bandwidth of 17.28 GHz	13.1.2	FHD5: O			
SC-TPLF2.6	Supports a bandwidth of 25.92 GHz	13.1.2	FHD5: O			
SC-TPLF2.7	Supports a bandwidth of 51.84 GHz	13.1.2	FHD5: O			
SC-TPLF2.8	Supports a bandwidth of 69.12 GHz	13.1.2	FHD5: O			
SC-TPLF3.1	Supports $\pi/2$ BPSK and $\pi/2$ QPSK modulation	13.2 13.2.2	FHD5: M			
SC-TPLF3.2	Supports $\pi/2$ 8-PSK modulation	13.2 13.2.2	FHD5: O			
SC-TPLF3.3	Supports $\pi/2$ 8-APSK modulation	13.2 13.2.2	FHD5: O			
SC-TPLF3.4	Supports 16-QAM modulation	13.2 13.2.2	FHD5: O			
SC-TPLF3.5	Supports 64-QAM modulation	13.2 13.2.2	FHD5: O			
SC-TPLF4	Supports rate 14/15 and rate 11/15 LDPC codes	13.2 13.2.2.2	FHD5: M			
SC-TPLF5	Encodes and decodes PHY frame format	13.2.3.1 13.2.3.3	FHD5: M			
SC-TPLF5.1	Insertion and detection of pilot word (PW)	13.2.3.4	FHD5: O			
SC-TPLF5.2	Insertion and detection of pilot preamble (PPRE)	13.2.3.4	FHD5: O			
SC-TPLF6	Conforms to transmitter requirements	13.2.4	FHD5: M			
SC-TPLF7	Conforms to receiver requirements	13.2.5	FHD5: M			

Table E-2c—THz-SC PHY functions *(continued)*

Item number	Item description	References	Status	Support		
				N/A	Yes	No
SC-TPLF8	Conforms to timing requirements	13.2.6	FHD5: M			
SC-TPLF9	Sends an Association Request command by using access slot	4.3.6	FHD5: M			
SC-TPLF10	PHY PIB values supported	13.1.5	FHD5: M			

Table E-2d—THz-OOK PHY functions

Item number	Item description	References	Status	Support		
				N/A	Yes	No
OOK-TPLF1	Conforms to general requirements (e. g., timing, frequency)	13.1	FHD6: M			
OOK-TPLF2.1	Supports a bandwidth of 2.16 GHz	13.1.2	FHD6: O			
OOK-TPLF2.2	Supports a bandwidth of 4.32 GHz	13.1.2	FHD6: M			
OOK-TPLF2.3	Supports a bandwidth of 8.64 GHz	13.1.2	FHD6: O			
OOK-TPLF2.4	Supports a bandwidth of 12.96 GHz	13.1.2	FHD6: O			
OOK-TPLF2.5	Supports a bandwidth of 17.28 GHz	13.1.2	FHD6: O			
OOK-TPLF2.6	Supports a bandwidth of 25.92 GHz	13.1.2	FHD6: O			
OOK-TPLF2.7	Supports a bandwidth of 51.84 GHz	13.1.2	FHD6: O			
OOK-TPLF2.8	Supports a bandwidth of 69.12 GHz	13.1.2	FHD6: O			
OOK-TPLF3	Supports OOK modulation	13.3 13.3.2	FHD6: M			
OOK-TPLF4	Supports RS (240,224) and its shortened version	13.3.2.2	FHD6: M			
OOK-TPLF4.1	Supports rate 14/15 LDPC codes	13.3.2.2	FHD6: O			
OOK-TPLF4.2	Supports rate 11/15 LDPC codes	13.3.2.2	FHD6: O			
OOK-TPLF5	Encodes and decodes PHY frame format	13.3.3.1 13.3.3.2	FHD6: M			
OOK-TPLF5.1	Insertion and detection of PW	13.3.3.3	FHD6: O			
OOK-TPLF5.2	Insertion and detection of PPRE	13.3.3.4	FHD6: O			
OOK-TPLF6	Conforms to transmitter requirements	13.3.4	FHD6: M			
OOK-TPLF7	Conforms to receiver requirements	13.3.5	FHD6: M			

Table E-2d—THz-OOK PHY functions *(continued)*

Item number	Item description	References	Status	Support		
				N/A	Yes	No
OOK-TPLF8	Conforms to timing requirements	13.3.6	FHD6: M			
OOK-TPLF9	Send an Association Request command by using access slot	4.3.6	FHD6: M			
OOK-TPLF10	PHY PIB values supported	13.1.5	FHD6: M			

E.7.3 Major capabilities for the MAC sublayer

E.7.3.1a MAC frames for pairnet

Insert the following new rows after MF3.11c in Table E-3a:

Table E-3a—MAC frames for pairnet

Item number	Item description	References	Pairnet transmitter		Pairnet receiver	
			Status	Support N/A Yes No	Status	Support N/A Yes No
MF3.11d	THz PRC Capability IE	6.4.11d	O FHD2: M		O	
MF3.11e	THz PRDEV Capability IE	6.4.11e	M		M	
MF3.11f	THz Pairnet Operation Parameters IE	6.4.11f	O FHD2: M		O	

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