NXP_SR150T_UCI_Specification

SR150T

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Document Information

Information	Content
Keywords	SR150T,UCI
Abstract	SR150T Proprietary UCI Specification.

Change Log

Table 1. Change History (Unified UCI Specification)

Revision	Date	Description	Author
2.0.17	2024.10.24	• Editorial Changes • Addition of PS38 in TX_PULSE_SHAPE_CONFIG • Updated SESSION_STATUS_NTF for UL_TDoA • Addition of new Reason Code for Incorrext Responder Slot Index configured • Updated Device Information Parameters to include ALIRO_SPEC_VERSION • Added a new command to set Localization Zone • Included a new parameter CSA_FINAL_DATA2_ CONFIG in vendor app • Included block index in CCC_RANGE_DATA_NTF notification • Updated the description of Wrapped RDS • Updated the description of SWAP_ANTENNA_ PAIR_3D_AOA. • Updated the fileds in CCC_RANGE_DATA_NTF for Aliro. • Included SESSION_INIT_CMD to have SESSION_TYPE_ALIRO. • Addition of parameters in UWB_SESSION_KDF_ NTF for CCC Session • Editorial changes in Wrapped RDS	
2.0.16	2024.07.08	• Editorial Changes	
2.0.15	2024.07.02	• Editorial Changes • Removed the WIFI_COEX_FEATURE legacy parameter. • New tag id assigned for WIFI_COEX_FEATURE_ ALL_CH. • Updated the GID/OID and name of WiFi_CoEx notifications. • **[UP-3338]** Rename WIFI_COEX_FEATURE_ALL_ CH as WIFI_COEX_FEATURE	
2.0.14	2024.07.10	• Editorial Changes • Added missing info about RX_TIMESTAMP •	
2.0.13	2024.05.25	• Editorial Changes • Update default value of XTAL_32K_CAP_CTRL	
2.0.12	2024.05.25	• Editorial Changes • Addition of WIFI_COEX_FEATURE_CH5 and WIFI_COEX_FEATURE_ALL_CH • Addition of Device status code STATUS_FATAL_ ERROR	

Table 1. **Change History (Unified UCI Specification)**...*continued*

Revision	Date	Description	Author
		• Correction in Vendor Specific data length in UL-TDoA • Addition of note for calibration parameters	
2.0.11	2024.04.01	• Editorial Changes • Set and Get GPIO pin state is applicable only to customer lifecycle • Addition of note regarding invalid SFD IDs • Addition of Max Supported Channels for AoA Calibration at a time column.	
2.0.10	2024.02.6	• Addition of proprietary test configuration carrier frequency offset • Update the minimum value supported by DPD_ENTRY_TIMEOUT from 10ms to 20ms • Allow access for SESSION_INFO_NTF_FILTER_NUM during active ranging • Change the default value of TX_PULSE_SHAPE_CONFIG to 47 • Updated the description of Device configuration parameters. • Updated the description of KDF NTF in UCI specification with CMAC of keys. • Editorial changes	
2.0.9	2024.02.06	• Editorial Changes • Rejecting Dual STS config with an error code.	
2.0.8	2024.2.01	• Editorial Changes	
2.0.7	2023.12.08	• Unify both RSSI_CALIB param for high power and low power into one parameter as RSSI_CALIB_CONSTANT_PER_ANTENNA • Modified DPD_ENTRY_TIMEOUT value range • Cummalative IoT 13.1 changes • Editorial Changes • Update in CCC_RANGE_DATA_NTF • Added new parameter SESSION_INFO_NTF_FILTER_NUM • Addition of rframe length in rframe debug notification • Included CARRIER_FREQUENCY_OFFSET in Proprietary Test Configurations • Additional note added for few calibration parameters	
2.0.6	2023.10.09	• Editorial Changes • Allowing default antenna settings as part of CORE_SET_CONFIG_CMD • Updated description of AoA / PDoA measurements per RX entry	

Table 1. Change History (Unified UCI Specification)...*continued*

Revision	Date	Description	Author
		• Added payload description for SE_GET_HOST_ CHALLENGE_APDU_CMD • Added new section CCC_RANGE_DATA_NTF • Added missing description of WRITE_CALIB_ DATA and READ_CALIB_DATA • Updated SESSION_INFO_NTF section • Renaming OTP_XTAL_CAP_GM_CTRL to OTP_ RF_CLK_ACCURACY_CALIB • Renaming OTP_TX_POWER to OTP_TX_ POWER_PER_ANTENNA. • Removed AoA FoV Flag from OWR Notification • change of Max Calibraiton entries for AoA per Antennas Pair per Channel from 8 to 4	
2.0.5	2023.09.25	• Added missing parameters to One Way (TDOA) Ranging Measurement table • Config mode4 reenabled for SR150 • Description of rx mode for rx-antenna-info is corrected • New Updates for CSA • 2D AOA FOV Changes added • Editorial Changes	
2.0.4	2023.09.05	Editorial Changes	
2.0.3	2023.08.07	IOT 13 • Added changes for Allegion front/back detection • Updates for CSA	

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Table 2. Change Log

Revision	Date	Description	Author
1.31	2023.04.10	**IOT 12 SR160_4** • Added radar antenna isolation test mode • Updated the default values for 38.4MHz_XTAL_CAP_GM_ CTRL • Added OTP_PDOA_MFG_0_OFFSET_CALIB & OTP_AOA_ ANT_MULTIPOINT_CALIB • Added SFD_ID for Proprietary extension for Generic Application Configurations • Added field Session Handle of Primary Session for RANGE_ DATA_NTF • GET_APP_CONFIG_RSP is updated based on NXP_ EXTENDED_NTF is enabled or disabled • Test param for FCC 10 second rule	
1.30	2023.02.15	**IOT 11.3**	

Table 2. Change Log...*continued*

Revision	Date	Description	Author
		• Updated reason(s) for ERR_INVALID_RANGING_INTERVAL	
1.29	2023.01.06	**IOT 11.2** • Added app configuration parameter to choose MAC frame format for UL-TDOA on UT-Tag • Added UL-TDOA device specific limitation in UCI platform spec • Added DL-TDOA Maximum active ranging rounds in UCI platform spe • PDOA_OFFSET_CALIB : Q9.7 value format added	
1.28	2022.11.18	**IOT 11 SR160_2** • Added calibration parameters default values • Support for OneWire CoEx • Clock drift parameter added for BLOB parser • Updated range values for XTAL CAP1 & CAP2 • Removed unsupported Unified Antenna parameters	
0.1	2022.07.08	SR160_1	
1.23	2022.06.02	IOT 10 RC2 Final RFP 3	
1.22	2022.04.08	IOT 9.0 RC3 Final RFP 2	
1.21	2022.02.24	IOT 8.0 RC3 Final RFP 1	

1 Introduction

This document specifies all extensions supported by SR150. Those extensions are NXP proprietary commands supported on top of standard UCI specification protocol.

1.1 Objectives

UCI is defined to meet the following requirements

- Be independent of a specific transport layer (independent of the physical connection and any associated link protocol).
- Provides most configurable way to program the UWB device for the needs of application and platform.
- Be extensive, to allow future extensions.

1.2 Scope

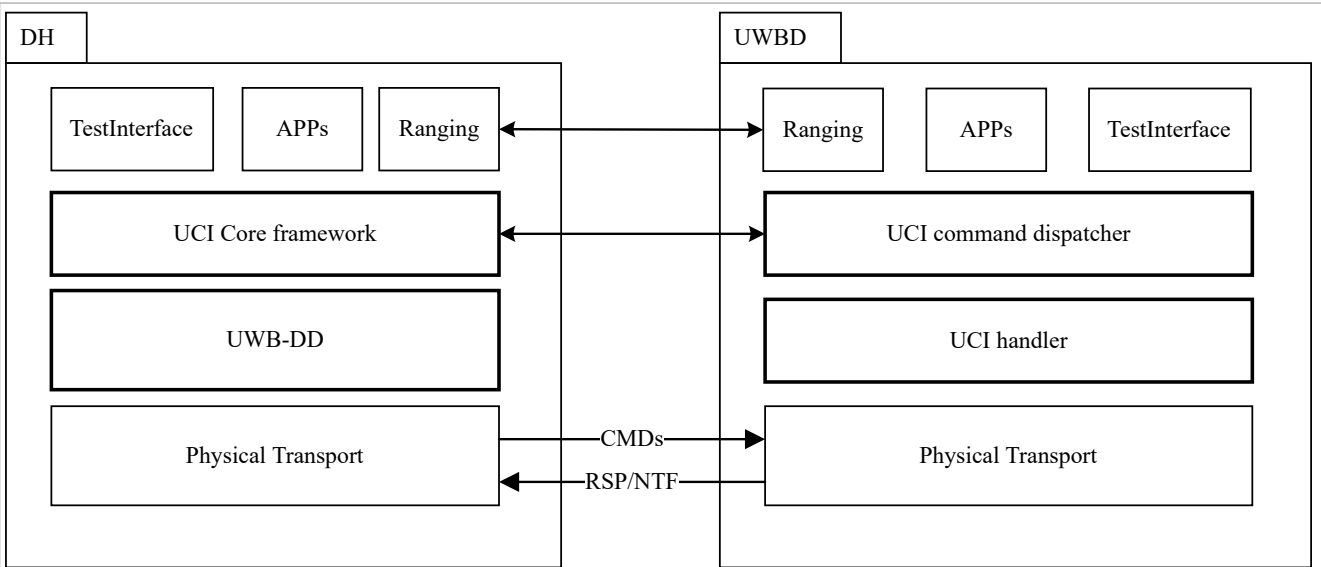The following figure outlines a typical architecture of UCI interface.

Figure 1. UCI architecture

1.3 Audience

This document is intended for internal use to allow user understanding extensions supported on top of generic UCI specification.

1.4 Abbreviations

Table 3. Abbreviations

Abbreviations	Description
DH	Device Host
GID	Group Identifier
LSB	Least Significant Byte

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Table 3. Abbreviations...*continued*

Abbreviations	Description
lsb	least significant bit
MSB	Most Significant Byte
msb	most significant bit
MT	Message Type
OID	Opcode Identifier
PDU	Protocol Data Unit
PTY	Proprietary
UWBS	Ultra-Wide Band Subsystem
WTX	Waiting Time Extension
URSK	UWB Ranging Session Key

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2 SR150 Architecture Overview

SR150 is an UWB transceiver device. SR150 system is depicted in below figure:

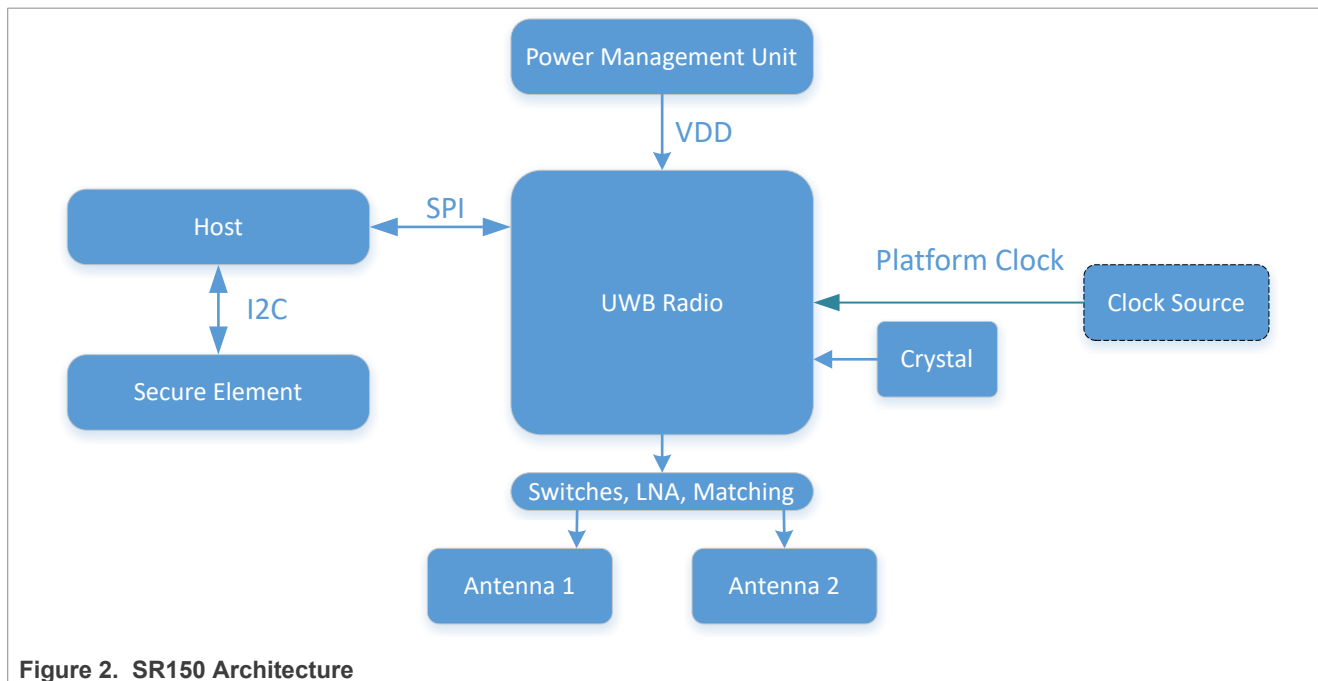**Figure 2. SR150 Architecture**

SR150 is connected to the DH through a physical interface. SR150 firmware supports [UCI-FORUM] specifications and are proprietary to NXP.

The firmware also provides support for additional extensions that are not covered in the [UCI-FORUM] specification.

Note: UWB system to Host Interface shall be any of the following

- SPI

3 UCI Overview

The aim of this section is to give an overview of the key points of the [UCI-FORUM] specification.

3.1 Overview

The following figure outlines a reference architecture of UWB enabled device. This document is meant for UCI as logical transport layer.
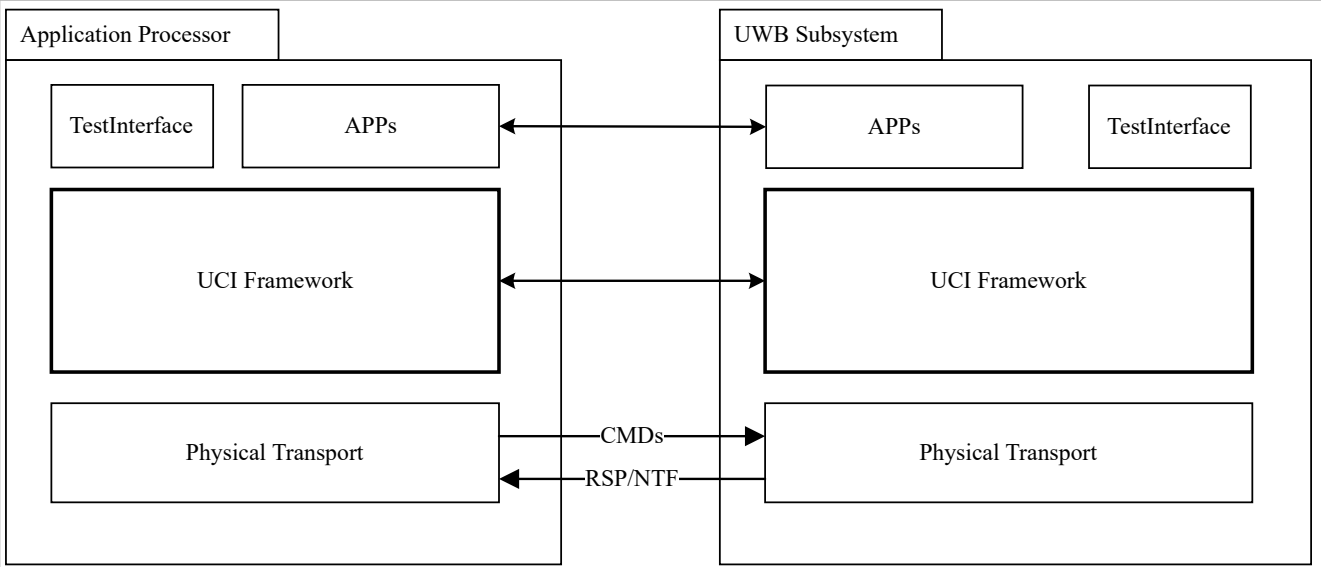

Figure 3. UCI Architecture

3.2 UCI Concepts

3.2.1 Control Messages

Refer [UCI-FORUM] for more details.

3.3 UCI Packet Format

3.3.1 Common packet Header

Refer [UCI-FORUM] for more details.

3.3.2 Format of Control Packets

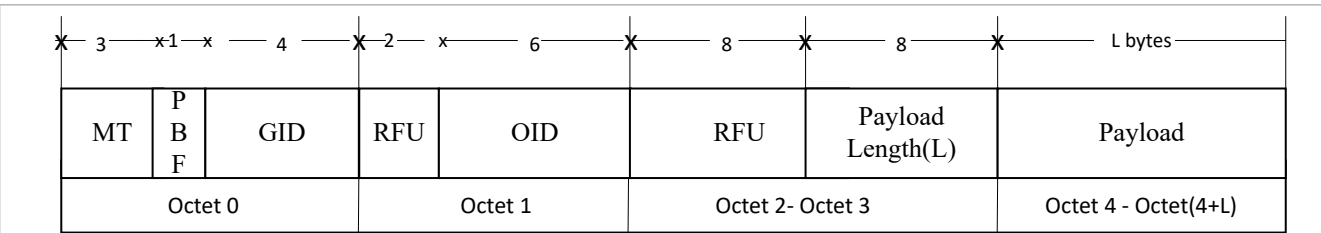| MT	P B F	GID	RFU	OID	RFU	Payload Length(L)	Payload
Octet 0			Octet 1		Octet 2- Octet 3		Octet 4 - Octet(4+L)

Figure 4. UCI Control packet format

Each Control Packet shall have a 4-bytes Packet Header and may have additional payload for carrying a Control Message payload or a segment of a Control Message payload or a segment of a Control Message payload.

NOTE: In the case of an 'empty' Control Message, only the Packet Header is sent.

Message Type (MT)

> Refer to [UCI-FORUM] Specification for details of the MT field

Packet Boundary Flag (PBF)

> Refer to [UCI-FORUM] Specification for details of the PBF field.

Group Identifier (GID)

> The UCI supports Commands, Responses are categorized according their individual groups. The Group Identifier (GID) indicates the categorization of the message and shall be a 4-bit field containing one of the values listed in [UCI] specification

Opcode Identifier (OID)

> The Opcode Identifier (OID) indicates the identification of the Control Message and shall be a 6-bit field that is a unique identification of a set of Command, Response Messages within the group. OID values are defined along with the definition of the respective Control Messages described in [UCI-FORUM] specification.

Payload Length (L)

> The Payload Length shall indicate the number of octets present in the payload. The Payload Length field shall be an 8-bit field containing a value from 0 to 255 or as specified by max control packet payload size.

3.3.3 Format of Data Packets

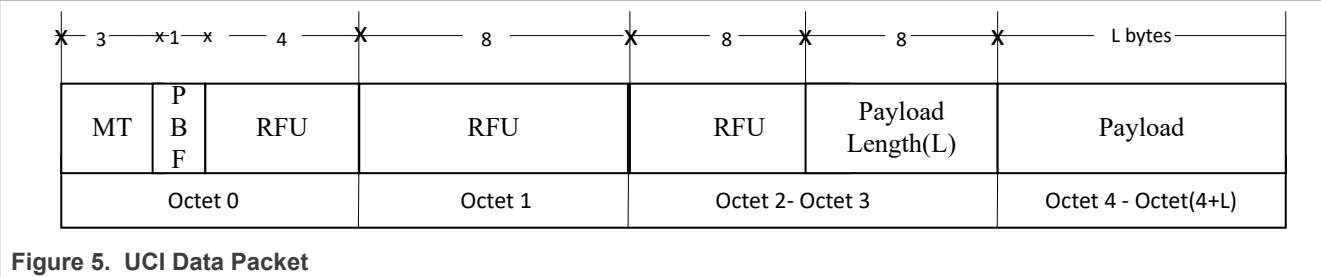| 3	1	4	8	8	8	L bytes
MT	PBF	RFU	RFU	RFU	Payload Length(L)	Payload
Octet 0			Octet 1	Octet 2- Octet 3		Octet 4 - Octet(4+L)

Figure 5. UCI Data Packet

Each Data Packet shall have a 4-octet Packet Header and shall have additional payload for carrying a Data Message payload or a segment of a Data Message payload.

Table 4. Message Type (MT)

MT	Description
0b000	Data Packet
0b001	Control Packet - Command message as payload
0b010	Control Packet - Response message as payload
0b011	Control Packet - Notification message as payload
0b100 - 0b111	RFU

Packet Boundary Flag (PBF)

Refer to [UCI-FORUM] Specification for details of the PBF field

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Payload Length (L)

The Payload Length shall indicate the number of octets present in the payload. The Payload Length field shall be a 8-bit field containing a value from 0 to MAX_DATA_PAYLOAD_SIZE [2]
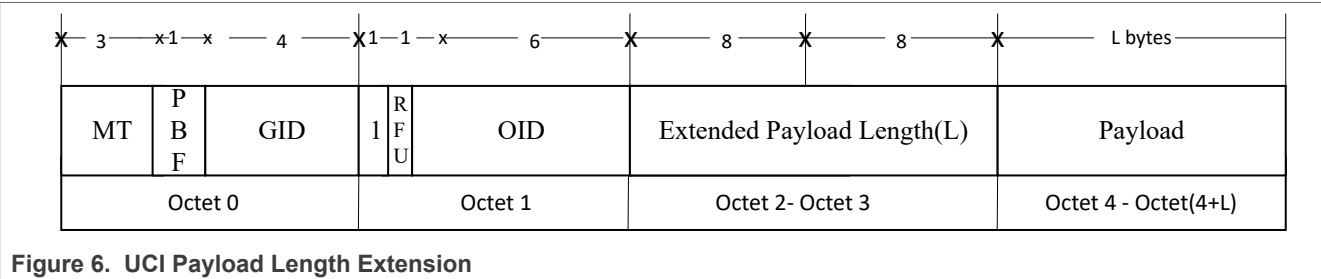
3.3.3.1 Data Packet Segmentation

The PBF flag within the Data Packet Header indicates if the sent message is a segment and more segments will follow (PBF=1) or the message is the last segment (PBF=0). PBF is 0 in case of a non-segmented message. The UWBS should maintain an implementation defined constant called MAX_DATA_PACKET_SIZE which refers to the maximum allowed UCI Data Packet size the UWBS can receive from the AP. The value of this constant is sent to the AP as part of the CORE_GET_CAPS_INFO_RSP. In case the UCI Data Packet sent exceeds MAX_DATA_PACKET_SIZE then AP has to segment the UCI message using PBF field.

3.3.4 UCI Payload Extension

UWBS and DH shall exchange the large UCI packets by using extended payload length (Octet[2] & Octet[3]) as shown in below UCI Header.

Extended payload length is indicated by using RFU bit[7] in Octet[1],If this bit is set to 1, DH and UWBS shall interpret Octet[2] & Octet[3] as extended payload length.

UWBS shall indicate the large packet payload. The maximum control packet from DH is limited by max UCI packet size supported by UWBS. UWBS shall indicate the maximum supported UCI packet size in capability information.

3	1	4	1	1	6	8	8	L bytes
MT	PBF	GID	1	RFU	OID	Extended Payload Length(L)		Payload
Octet 0			Octet 1			Octet 2- Octet 3		Octet 4 - Octet(4+L)

Figure 6. UCI Payload Length Extension

4　Compliance with [UCI-FORUM] and SR150 extension

The SR150 is a secure ranging chip, which offers additional features including UWB proprietary configuration, debug test capabilities and other compliance modes.

To configure those feature, platform specific commands shall be used with UCI proprietary extensions [SR150-UCI] and extensions to [UCI-FORUM] Control messages

Proprietary GID and GID Definition contains all the additional commands/notifications in [SR150-UCI].

4.1　[SR150-UCI] extensions to [UCI-FORUM] parameters space

[UCI-FORUM] defines a parameter space with a size of 255 parameters in each GID and OID group

[UCI-FORUM] defines that 29 IDs are allocated for proprietary use

Table 5.　Parameter Space

Parameters space sub-sections	IDs Space
Assigned & reserved for [UCI-FORUM]	0x00 : 0xE2
Reserved for Proprietary Use	0xE3 : 0xFF

To extend this space, the solution chosen is to define a space of IDs coded on 16 bits, instead of 8 bits. These extended Tags will always start by the value 0xE3, which is the first value available in the Proprietary range. This allows adding 255 new parameters.

Table 6.　Extended TLV for proprietary parameters

Payload	Field	Length	Description
m+3 Octets	Tag = 0xE3XX	2 Octets	Extended tag identifier.
	Len	1 Octet	The length of Val (m).
	Val	m Octets	Value of the configuration parameter.

5　Data Download Commands

Host will send the data in form of **extended control packets** to UCI.

In addition to support data download, FW will support additional two commands:

1. Query command : To report details of all data (or specific data) stored in FW.
2. Delete command : Host MW will delete the data from FW when it is no longer required for any use-case.

5.1　DATA_DOWNLOAD_START

Table 7.　DATA_DOWNLOAD_START_CMD

Payload Field	Length (Octet)	Value/Description
DATA_ID	1	This is unique number give to each data to be downloaded from Host. Range: 4-255 Value 1-3 are used for default models stored in flash memory. Default Value: 1
DATA_TYPE	1	Type of data: Model, binary.

Table 7. DATA_DOWNLOAD_START_CMD...*continued*

Payload Field	Length (Octet)	Value/Description
		0x1: Model Data 0x2: Library Data 0x3: Generic Data Default Value: 0x1
DATA_SIZE	4	Size of data to be downloaded Min Value: 256 bytes. Max Value: 32KB.
DATA_CHUNK_SIZE	2	Size of each data chunk. It could be 256bytes - 2k range.

Table 8. DATA_DOWNLOAD_START_RSP

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x31 : DATA_PAYLOAD_SIZE_NOT_SUPPORTED 0x32 : DATA_ID_NOT_SUPPORTED 0x33 : DATA_TYPE_NOT_SUPPORTED 0x34 : DATA_CHUNK_NOT_SUPPORTED 0x35 : DATA_DOWNLOAD_SUCCESS 0x37 : DATA_DOWNLOAD_MEM_ALLOC_FAIL

5.2 DATA_DOWNLOAD

Table 9. DATA_DOWNLOAD_CMD

Payload Field	Length (Octet)	Value/Description
Data	Variable	Actual Data

Table 10. DATA_DOWNLOAD_RSP

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x35: DATA DOWNLOAD SUCCESS 0X36: DATA DOWNLOAD FAILURE

Table 11. DATA_DOWNLOAD_NTF

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x35: DATA DOWNLOAD SUCCESS 0X36: DATA DOWNLOAD FAILURE

5.3 DATA_DOWNLOAD_STOP

Table 12. DATA_DOWNLOAD_STOP_CMD

Payload Field	Length (Octet)	Value/Description
DATA_ID	1	This is an unique number given to each data to be downloaded from Host.

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Table 13. DATA_DOWNLOAD_STOP_RSP

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x32 : DATA_ID_NOT_SUPPORTED 0x35 : DATA_DOWNLOAD_SUCCESS 0x36 : DATA_DOWNLOAD_FAILURE 0x39 :DATA_DOWNLOAD_NOT_ PRESENT

5.4 DATA_DOWNLOAD_COMPLETE

Table 14. DATA_DOWNLOAD_COMPLETE_NTF

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x35: DATA_DOWNLOAD_SUCCESS 0x36: DATA_DOWNLOAD_FAILURE

5.5 DATA_DOWNLOAD_DELETE

Table 15. DATA_DOWNLOAD_DELETE_CMD

Payload Field	Length (Octet)	Value/Description
DATA_ID	1	This is an unique number given to each data to be downloaded from Host.

Table 16. DATA_DOWNLOAD_DELETE_RSP

Payload Field	Length (Octet)	Value/Description
STATUS	1	0x32: DATA_ID_NOT_SUPPORTED 0x35: DATA_DOWNLOAD_SUCCESS 0x38: DATA_DOWNLOAD_IS_IN_USE 0x39: DATA_DOWNLOAD_NOT_ PRESENT

5.6 DATA_DOWNLOAD_QUERY

Table 17. DATA_DOWNLOAD_QUERY_CMD

Payload Field	Length (Octet)	Value/Description
DATA_ID	1	0: Send complete list of all data ids. 4-255: Send info of specific data id. Default Value: 0

Table 18. DATA_DOWNLOAD_QUERY_RSP

Payload Field	Length (Octet)	Value/Description		
STATUS	1	0x32 : DATA_ID_NOT_SUPPORTED 0x35 : DATA_DOWNLOAD_SUCCESS 0x39 :DATA_DOWNLOAD_NOT_PRESENT ***Note:*** *Only on status as SUCCESS, FW will report the structure list for the Data id/ids*		
Number of data Id list	1 Octet	Number of models present at FW (N).		
Structure of each data id.	N * 8 octets	Data Id	1 Octet	This is a unique number given to each

Table 18. DATA_DOWNLOAD_QUERY_RSP...*continued*

Payload Field	Length (Octet)	Value/Description		
				data to be downloaded from Host.
		Data Type	1 Octet	Type of data
		Data Size	4 Octet	Size of data (in bytes)
		Data Use Count	1 Octet	Indicated data being used by multiple sessions.
		Data Download Status	1 Octet	Status of current data to be downloaded. 0x0: Not present 0x1: Ongoing 0x2: Completed

5.7 Data Download Error Codes

Table 19. Error Codes

ERROR CODES	Values	Description
DATA_PAYLOAD_SIZE_NOTE_ SUPPORTED	0x31	Data Payload not supported
DATA_ID_NOT_SUPPORTED	0x32	Data Id not supported
DATA_TYPE_NOT_SUPPORTED	0x33	Data type not supported
DATA_CHUNK_NOT_SUPPORTED	0x34	Data chunk not supported
DATA_DOWNLOAD_SUCCESS	0x35	Data download syccess response
DATA_DOWNLOAD_FAILURE	0x36	Data download failure response
DATA_DOWNLOAD_MEM_ALLOC_ FAIL	0x37	Host is trying to download data at FW, but free memory not available
DATA_DOWNLOAD_IS_IN_USE	0x38	Host is trying to delete data that is being used by FW
DATA_DOWNLOAD_NOT_PRESENT	0x39	Host starts a session with a data which is not present in FW

6 Initialization and Configuration

6.1 UWB Session Initiation

The Host shall establish a session by sending the SESSION_INIT_CMD command to create the new UWB session with parameter session ID and type of the session. The UWBS shall respond SESSION_INIT_RSP with Status set to STATUS_OK and the Session Handle field if the command is successfully accepted by the UWBS, otherwise the UWBS shall send the SESSION_INIT_RSP with proper status code which indicates a failure. The UWBS shall send the SESSION_INIT_RSP with STATUS_OK and a Session Handle after the session is created followed by sending SESSION_STATUS_NTF with SESSION_STATE_INIT Session State. The UWBS and Host shall use the Session Handle as a reference for a UWB session and use the Session Handle in any session specific UCI Messages during communication. The Host shall receive the SESSION_STATUS_NTF notification on every UWB session state change. The Host shall wait for SESSION_STATUS_NTF notification with Session State of SESSION_STATE_INIT before applying application configurations for a UWB session.

The UWBS shall respond with STATUS_ERROR_SESSION_NOT_EXIST error status when the Host tries to Configure/Start/Stop the UWB session without initializing the UWB session.

Table 20. SESSION_INIT_CMD

Payload Field(s)	Length	Value/Description
Session ID	4 Octets	Session ID is 4 Octets unique random number generated by application. ***Note:*** Session ID = 0x00000000: Reserved for Device Test Mode session
Session Type	1 Octet	Type of session 0x00 = Ranging session (no in-band data) 0x01 = Ranging and in-band data session 0x02 = Assigned 0x03 = Assigned 0x04 = Assigned 0x05 = Assigned 0x06-0x9F = RFU 0xA0 = CCC Ranging session 0xA2 = Aliro Ranging Session 0xA1, 0xA3-0xCF = Reserved for Vendor Specific use case 0xD0 = Device Test Mode 0xD1-0xDF = RFU 0xE0-0xFF = Vendor Specific use

Note: *For all other generic commands and notifications refer FiRa_UCI_Technical_Specification.*

6.2 Platform variant selection

CORE_DEVICE_INIT_CMD is used to initialize the UWBS for specific platform variant.

The Major and Minor Version parameters are shown :.

• Board Variant Parameters

Table 21. CORE_DEVICE_INIT_CMD

Payload Field(s)	Length	Value/Description
Major Version	1 Octet	Platform identifier
Minor Version	1 Octet	Variant identifier

Table 22. CORE_DEVICE_INIT_RSP

Payload Field(s)	Length	Value/ Description
Status	1 Octet	Status values. Refer Status Codes

This command shall be sent by DH after DH receives the DEVICE_STATUS_NTF with proprietary status of STATUS_INIT notification from UWBS. Added proprietary status to UCI UWBS device status table as mentioned in Table 24. After the platform selection status response, firmware performs a soft reset followed by DEVICE_STATUS_NTF with STATUS_READY.

Table 23. Board Variant Parameters

Major Version	Minor Version	Selected Platform
0x00	0x00	Default value, uninitialized state
0x01	0x01	BOARD_VARIANT_NXPREF_V1
	0x02	BOARD_VARIANT_NXPREF_V2
0x73	0x01	BOARD_VARIANT_RHODES_V1
	0x02	BOARD_VARIANT_RHODES_V2
	0x03	NA
	0x04	BOARD_VARIANT_RHODES_V4

Table 24. Proprietary device state on top of [UCI-FORUM] devices state

Status	Value/ Description
DEVICE_STATUS_NTF	
0x00	STATUS_INIT UWBS is in initialized state and waiting for proprietary init command.
0x01	STATUS_READY UWBD is ready for performing UWB session
0x02	STATUS_ACTIVE UWBS is busy running uwb session
0x03 : 0xFC	RFU
0xFD	STATUS_FATAL_ERROR Firmware write is corrupted and needs re-flashing
0xFE	STATUS_HW_RESET UWBD is not in working condition and needs a hardware reset

Table 24. Proprietary device state on top of [UCI-FORUM] devices state...*continued*

Status	Value/ Description
0xFF	STATUS_ERROR Error occurred within UWBS. Refer [UCI-FORUM] Specification for more details

6.2.1 Handling unified Antennas Configuration

WARNING: When using Unified antennas configuration feature, UWBS may return STATUS_READY, but the UWBS is not yet ready to do ranging, because none of the antannes are defined yet.

As of release of this document, the order of commands have to be:

1. Host -> UWBS : CORE_DEVICE_INIT_CMD
2. Host <- UWBS : CORE_DEVICE_INIT_RSP
3. Host <- UWBS : CORE_DEVICE_STATUS_NTF. (Although status is STATUS_READY, device is not yet ready to do Ranging)
4. Host -> UWBS : ANTENNA_RX_IDX_DEFINE
5. Host -> UWBS : ANTENNA_TX_IDX_DEFINE

Table 25. Channel IDs

Channel IDs
5
6
8
9

6.3 Device specific information

SR150 sends device specific information as **"Manufacturer Specific Information"** in CORE_GET_DEVICE_INFO_RSP. Refer Table 119 for device information parameters description.

6.4 Device configuration parameters

Device Configuration Parameters are the device specific configuration parameters related to the UWBS and these parameters shall be set by the Host before creating first session in the UWBS device.

The CORE_SET_CONFIG_CMD/CORE_GET_CONFIG_CMD commands are used to set and get the device configuration parameters.

CORE_SET_CONFIG_CMD will be rejected if any of the session is already initialized.

Refer for Table 121 device configuration parameters description.

6.4.1 Clock Settings

CLK_CONFIG_CTRL parameter shall be used as part of CORE_SET_CONFIG_CMD to define the clock options provided by the platform to the UWBS.

There are following two clocks:

38.4MHz - Used during RF operations

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32.768KHz - Base clock, used for time tracking during DPD phases.

Each of the above clock can be either derived from external platform clock or from onboard crystal.

6.4.1.1 RF clock (38.4 MHz clock)

6.4.1.1.1

External Clock option:

This clock is needed for RF operations and GPIO 1 is used to let the Host know that the UWBS needs the external 38.4MHz clock. UWBS will make the GPIO 1 as level **"high"** when external 38.4MHz clock input is needed and level **"low"** when not needed.

On board crystal option:

UWBS shall use the on board crystal option to derive the 38.4MHz clock. No GPIO 1 signaling is needed here.

6.4.1.2 Slow clock (32.768 KHz clock)

6.4.1.2.1

External Clock option:

Host SW is expected to use UWBS **"Chip Enable"** signal value to decide whether to provide external 32.768 KHz clock input or not to UWBS.

Just before making UWBS Chip enable = 1, the 32.768 KHz clock input should be provided to UWBS by Host SW.

On board crystal option:

UWBS shall use the on board crystal option to derive the 32.768 KHz clock.

6.4.2 CLOCK_PRESENT_WAITING_TIME Configuration

This config shall be used to wait a dedicated time for *38.4/26MHz or* XTAL to become stable. This time is platform dependent depending on the XTAL type used.

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This requires fine-tuning. To cope with that dependency a dedicated configuration parameter is proposed to allow customer adjusting this value.

The same parameter can also be used in case external/platform clock is used where GPIO1 is used as clock-request signal. The waiting time is then used to indicate the maximum time waiting time after clock request assertion until clock is available

The description of the CLOCK_PRESENT_WAITING_TIME is defined at Device Configuration Parameters

6.4.3 Controlee RX window offset Configuration

When UWBS acting as responder/controlee, this config shall be used to set the offset for RX antenna to turn on to receive the first message of a ranging round, i.e. RCM or RIM.

Background: If counterpart device (controller/initiator) has too huge clock drift between two ranging cycles, controlee might miss the RCM/RIM leading to a failed ranging round. This can be avoided by enabling Rx much

earlier before expected RCM/RIM. However, the earlier Rx is enabled (=bigger Rx on window), the higher is the power consumption so a trade-off must be defined between power consumption and interoperability.

The INITIAL_RX_ON_OFFSET_ABS and INITIAL_RX_ON_OFFSET_REL parameters allows customer to fine-tune offset value. The description for the parameters is defined at [Device Configuration Parameters](#).

6.5 DPD wake up source configuration and DPD Handling

DH shall configure the wake-up source with DPD_WAKEUP_SRC config by using CORE_SET_CONFIG_CMD. This UCI command is defined in [UCI-FORUM] specification.

The wake-up sources are defined as below

Table 26. DPD wakeup sources

Bit mask								Descriptions
7	6	5	4	3	2	1	0	
								RFU
						X		GPIO1
					X			GPIO3
X	X	X	X	X				RFU

6.5.1 DPD Handling

This section describes the low power mode handling of UWBS.

UWBS can enter into low power mode if device configuration parameter LOW_POWER_MODE config is enabled.

UWBS shall enter into DPD immediately after DEVICE_STATUS_NTF with STAUS_READY is sent from UWBS and DH has received. UWBS shall also enter into low power mode during STAUS_READY (ranging round).

If the host receives CORE_GENERIC_ERROR_NTF with Status Retry then it shall retry to send the command as the UWBS was in DPD when the previous attempt of sending the UCI command occured.

The DPD_ENTRY_TIMEOUT is started if the wake-up reason is host interface and it shall restart the timer if it receives subsequent UCI commands and once the timer is expired UWBS shall enter into DPD

6.6 Application configuration parameters

6.6.1 Antenna pair selection for RX

RX_ANTENNA_PAIR_SELECTION options supported for different board variants are as follows:

Table 27. Antenna Pair Selection

Board Variant	Rx Antenna Pairs
BOARD_VARIANT_NXPREF_V1 BOARD_VARIANT_NXPREF_V2 BOARD_VARIANT_RHODES_V1 BOARD_VARIANT_RHODES_V2	0x01 - UWB_ANT0 & UWB_ANT1 (default = 1)
BOARD_VARIANT_RHODES_V4	0x01 = ANT2_ANT0, Rx1v-ANT2, Rx2 ANT0 0x02 = ANT3_ANT0, Rx1h-ANT3, Rx2 ANT0 0x04 = ANT2_ANT1, Rx1v-ANT2, Rx2 TRXCo/ANT1

Table 27. Antenna Pair Selection...*continued*

Board Variant	Rx Antenna Pairs
	0x08 = ANT3_ANT1, Rx1h-ANT3, Rx2 TRXCo/ANT1 (default = 1)
BOARD_VARIANT_SSG_GS9_V1	0x01 - SIDE_ANT & METAL_ANT (Rev. 1, 2 & 3) 0x02 - SIDE_ANT & TOP_ANT (Rev. 3) (default = 1)
BOARD_VARIANT_SSG_GN10_V1	0x01 - UWB_ANT2 & UWB_6G_ANT0 0x02 - UWB_ANT3 & UWB_6G_ANT0 0x04 - UWB_6G_ANT1 & UWB_6G_ANT0 0x08 - UWB_ANT4 & UWB_6G_ANT0 0x10 - UWB_ANT2 & UWB_ANT1 0x20 - UWB_ANT3 & UWB_ANT1 0x40 - UWB_6G_ANT1 & UWB_ANT1 0x80 - UWB_ANT4 & UWB_ANT1 (default = 1)
BOARD_VARIANT_SSG_GN20_V1 BOARD_VARIANT_CUSTOMER_V1	0x01 - UWB_ANT3 & UWB_ANT2 0x02 - UWB_ANT4 & UWB_ANT2 0x04 - UWB_ANT3 & UWB_ANT1 0x08 - UWB_ANT4 & UWB_ANT1 (default = 1)
BOARD_VARIANT_SSG_GS21_V2	0x01 - UWB_ANT2 & UWB_ANT0 0x02 - UWB_ANT2 & UWB_ANT1 0x04 - UWB_ANT3 & UWB_ANT0 0x08 - UWB_ANT3 & UWB_ANT1 0x10 - UWB_ANT4 & UWB_ANT0 0x20 - UWB_ANT4 & UWB_ANT1 (default = 1)
BOARD_VARIANT_SSG_GS21_V3	0x01 Patch ANT2 & Metal ANT0 0x02 Patch ANT3 & Metal ANT0 0x04 Patch ANT2 & Patch ANT1 0x08 Patch ANT3 & Patch ANT1 0x10 Metal ANT1 & Metal ANT0 0x20 Metal ANT1 & Patch ANT1 0x40 Metal ANT1_1 & Metal ANT0 0x80 Metal ANT1_1 & Patch ANT1 (default = 1) Note for GPIO setting corresponding to this antenna pair, refer Table 28

Note that combination of pairs (say, 0x03 for pairs 0x01 and 0x02) is not supported.

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Table 28. RX GPIO configuration for BOARD_VARIANT_SSG_GS21_V3

Antenna pair selection		Antenna combination		Control pin		
Column1	Antenna Pair	Rx1	Rx2	EF1(VCTL)	EF2(VC2)	GPIO11(VC1)
				UWB_SW_CTL_1	UWB_SW_CTL_2	UWB_SW_CTL_3
	0x01	Patch ANT2	Metal ANT0	1	0	0
	0x02	Patch ANT3	Metal ANT0	1	1	0
AoA	0x04	Patch ANT2	Patch ANT1	0	0	0
AoA	0x08	Patch ANT3	Patch ANT1	0	1	0
	0x10	Metal ANT1	Metal ANT0	1	0	1
	0x20	Metal ANT1	Patch ANT1	0	0	1
	0x40	Metal ANT1_1	Metal ANT0	1	1	1
	0x80	Metal ANT1_1	Patch ANT1	0	1	1

6.6.2 Antenna selection for TX

TX_ANTENNA SELECTION options supported for different board variants are as follows:

Table 29. Antenna Pair Selection

Board Variant	Tx Antenna
BOARD_VARIANT_NXPREF_V1 BOARD_VARIANT_NXPREF_V2 BOARD_VARIANT_RHODES_V1 BOARD_VARIANT_RHODES_V2	0x01 - Default antenna
BOARD_VARIANT_RHODES_V4	0x01 - UWB_ANT1 0x02 - UWB_ANT2 0x04 - UWB_ANT_RADAR (default = 1)
BOARD_VARIANT_SSG_GS9_V1	0x01 - Default antenna
BOARD_VARIANT_SSG_GN10_V1	0x01 - UWB_6G_ANT0 0x02 - UWB_ANT1 (default = 1)
BOARD_VARIANT_SSG_GN20_V1 BOARD_VARIANT_CUSTOMER_V1	0x01 - UWB_ANT1 0x02 - UWB_ANT2 (default = 1)
BOARD_VARIANT_SSG_GS21_V2	0x01 - UWB_ANT0 0x02 - UWB_ANT1 0x04 - UWB_ANT4 (default = 1)
BOARD_VARIANT_SSG_GS21_V3	0x01 Metal_ANT0 0x02 PATCH ANT!

Table 29. Antenna Pair Selection*...continued*

Board Variant	Tx Antenna
	(default =1) For GPIO configuraiton refer Table 30

Table 30. TX GPIO configuration for BOARD_VARIANT_SSG_GS21_V3

Antenna ID	TX_OUT	EF1 UWB_SW_CTL_1
0x01	METAL_ANT0	0
0x02	PATCH_ANT1	1

6.7 Vendor Application configuration parameters

UWBS offers Vendor application configurations used to configure the UWB session. The Table 123 contains the proprietary application configuration which are specific to SR150 device

DH shall configure Vendor APP parameters by using SET_VENDOR_APP_CONFIG_CMD.

6.8 Capability information

AP shall use CORE_GET_CAPS_INFO_CMD command to get the capability of the UWBS. The capability information is vendor specific and AP shall use capability information to communicate with UWBS. Refer Table 120 for capability parameters.

6.9 Query on temperature

AP shall use QUERY_TEMPERATURE_CMD to query the instantaneous temperature of the UWBS. Temperature value is reported via QUERY_TEMPERATURE_RSP by UWBS.

Table 31. QUERY_TEMPERATURE_CMD

Payload Field(s)	Length	Value/ Description
Command	0 Octet	Query thermal sensor reading

Table 32. QUERY_TEMPERATURE_RSP

Payload Field(s)	Length	Value/ Description
Status	1 Octet	Status values. Refer Status Codes. Below field is valid if status is STATUS_OK
Temperature value	1 Octet	Signed temperature value in degree Celsius

6.10 Notification of high temperature to host

UWBS shall send GENERIC_ERROR_NTF with status STATUS_DEVICE_TEMP_REACHED_THERMAL_ RUNAWAY when UWBs detects over temperature. FW will send DEVICE_STATUS_NTF with state DEVICE_STATE_READY once internal temperature is back to its operating range. It is recommended to do a POR and re-configure the session.

6.11 DPD/CLK Switching Test CMD

UWBS shall use TEST_CLK_DPD_SWITCHING_CMD command to perform the Clock/DPD switching test, FW will switch the clock from RFPLL to ADPLL and enter DPD for the time specified, once out of DPD the CLK switching followed by DPD entry will continue until the specified count . This command will be accepted only in UWBS state IDLE

This command is only avialable in Factory FW build

Table 33. TEST_CLK_DPD_SWITCHING_CMD

Payload Field(s)	Length	Value/Description
Count	1 Octet	No of times the clock/DPD switching has to be performed Minimum =1, Max =255
Time in ms	1 Octet	Amount of Time UWBS goes to DPD Mode Minimum =1, Max =255 Note1:Host should not send any UCI command until the reception of "TEST_CLK_DPD_SWITCHING_NTF" Note2:Clk/DPD switching will only start after 50ms, this 50ms timer is used to send TEST_CLK_DPD_SWITCHING_RSP to host before UWBS enters DPD

Table 34. TEST_CLK_DPD_SWITCHING_RSP

Payload Field(s)	Length	Value/Description
Status	1 Octet	Status values. Refer Table 36 in "FiRa Consortium - UCI Generic Specification_v1.1.0.4"

Table 35. TEST_CLK_DPD_SWITCHING_NTF

Payload Field(s)	Length	Value/Description
Status	1 Octet	Status values. Value =0x00 = STATUS_OK

Notes

Host Application should wait for TEST_CLK_DPD_SWITCHING_NTF with a minimum timeout = Host Clock test NTF timeout = count * time + 50ms(RSP to host timer) + DPD boot time ~5ms * count + buffer (~50ms)

if TEST_CLK_DPD_SWITCHING_NTF is not received within "Host Clock test NTF timeout", than host application should start the recovery sequence

if DEVICE_STATUS_NTF(Error) is received within "Host Clock test NTF timeout", than MW shall trigger a recovery sequence

if TEST_CLK_DPD_SWITCHING_NTF is not received within "Host Clock test NTF timeout" and host receives DEVICE_STATUS_NTF(Error), than MW shall trigger the recovery sequence

6.12 True Random GEN

The following UCI command(s) are used to generate the Random Number for TRNG_DATA

Table 36. TRNG_DATA_CMD

Payload Field(s)	Length	Value / Description
Length	1 Octet	Number of bytes of True Random Number to be generated.

Table 37. TRNG_DATA_RSP

Payload Field(s)	Length	Value / Description
Status	1 Octet	Status code as per FIRA UCI Specification
Length	m Octet	True Random number generated.

6.13 Module Maker Info

Following UCI commands are used to access the OTP memory for writing and reading the module maker information.

6.13.1 Write Module Maker Info

Table 38. WRITE_MODULE_MAKER_INFO_CMD

Payload Field(s)	Length	Value / Description
Module Maker Info	2 Octet	Module maker information to be written *into the OTP*.

Table 39. WRITE_MODULE_MAKER_INFO_RSP

Payload Field(s)	Length	Value / Description
Status	1 Octet	UCI Status

6.13.2 Read Module Maker Info

Table 40. READ_MODULE_MAKER_INFO_CMD

Payload Field(s)	Length	Value / Description
NA	0 Octet	NA

Table 41. READ_MODULE_MAKER_INFO_RSP

Payload Field(s)	Length	Value / Description
Status	1 Octet	UCI Status
Module Maker Info	2 Octet	Module maker information read *from the OTP.*

6.14 Profile Parser

6.14.1 Profile Parser Requirement Details

1. Phone receives the accessory configuration data, phone configures and sends the shareable configuration data to configure the accessory.
2. This accessory information termed as 'Profile' or 'Blob' is a session configuration data which is received over BLE.

6.14.2 Profile Parser UCI Details

Following are the profile parser UCI commands.

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Table 42. PROP_SET_PROFILE_CMD

Payload Field(s)	Length (Bytes)	Value / Description
Profile ID	1	MW Data (0x0B)
Device Type	1	MW Data DEVICE_TYPE (FiRa)
Source Mac Address	2	MW Data DEVICE_MAC_ADDRESS (FiRa)
Device Role	1	MW Data DEVICE_ROLE (FiRa)
Version (Major, Minor)	4	MW Data Profile Data versioning format Byte[1:0] : Major version • Major number in version is set to 0x0001 Byte[3:2] : Minor version • Minor number in version is set to 0x0000 / 0x0001 (based on IOS version)
Profile Data Length	1	MW Data • 0x17 if Minor version is set to 0x0000 • 0x19 if Minor version is set to 0x0001
Profile Data	23 or 25	Profile or Blob Data

Table 43. PROP_SET_PROFILE_RSP

Payload Field(s)	Length (Bytes)	Value / Description
Status	1	UCI Status Session Handle field shall be present if UCI Status is STATUS_OK
Session Handle	4	Session Handle is a 32bit unique number generated by the UWBS and it shall be used to uniquely identify the UWB Session. The Host and the UWBS shall use a Session Handle as a reference for a UWB session in any session specific command/response/notification.

6.14.3 Profile Parser Debug Enable

To debug the profile parser, the following SET_VENDOR_APP_CONFIG/CORE_SET_CONFIG parameters can be enabled.

Table 44. SET_NXP_APP_CONFIG Parameters

Parameter Name
CIR_LOG_NTF
PSDU_LOG_NTF
CIR_CAPTURE_WINDOW
ANTENNAS_CONFIGURATION_RX

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Table 44.   SET_NXP_APP_CONFIG Parameters..._continued_

Parameter Name
TX_ADAPTIVE_PAYLOAD_POWER

Table 45. CORE_SET_CONFIG Parameters

Parameter Name
NXP_EXTENDED_NTF_CONFIG

Steps to enable the debug for profile praser :

1. Send PROP_SET_PROFILE_CMD
2. Send SESSION_SET_VENDOR_APP_CONFIG/CORE_SET_CONFIG (with the required parameters)

6.14.4 Profile Parser Implementation

1. INITIAL_RX_ON_OFFSET_ABS : This will be set to 0 when Blob parser command is received.
2. INITIAL_RX_ON_OFFSET_REL : CLOCK_DRIFT will be mapped to this UCI parameter

It is offset in PPM relative to ranging interval, So if INITIAL_RX_ON_OFFSET_REL is set to 100ppm and ranging interval is 100ms, then relative offset will be 10us. (INITIAL_RX_ON_OFFSET_REL * Ranging Interval / 100000)

Example :

- RI (Ranging Interval) = 100ms and CLOCK DRIFT = 100 ppm will lead to RX ON window = 10 us
- RI = 5 seconds and CLOCK DRIFT = 1 ppm will lead to RX ON window = 5us
- RI = 5 seconds and CLOCK DRIFT = 300 ppm will lead to RX ON window = 1500 us or 1.5 m

7 UWB session

7.1 Get the list of UWB sessions

Below proprietary command shall be used to get all the sessions in UWBS. UWBS shall send GET_ALL_UWB_SESSIONS_RSP with all the sessions (Init/Active/Idle) in UWBS.

Table 46. GET_ALL_UWB_SESSIONS_CMD

Payload Field(s)	Length	Value/ Description
Command	0 Octets	Get the list of UWB sessions

Table 47. GET_ALL_UWB_SESSIONS_RSP

Payload Field(s)	Length	Value/ Description		
Status	1 Octet	Status values. Refer Status Codes		
Session Count	1 Octet		Number of sessions(n)	
Session(1..n)	n * 6 Octets	Session Handle	Byte[3:0]	Session handle
		Session Type	Byte[4]	Session type
		Session State	Byte[5]	Session state, Refer generic spec for different session states

7.2 Scheduler status notification

UWBS shall SCHEDULER_STATUS_NTF notification when SCHED_STATUS_NTF is enabled. UWBS shall send SCHED_STATUS_NTF notification when scheduler meets either SESSION_SCHEDULER_ATTEMPTS or SESSION_SYNC_ATTEMPTS configuration criteria.

Table 48. Control message for schedule notification

Payload Field(s)	Length	Value/ Description		
SCHEDULER_STATUS_NTF				
Num of sessions	1 Octet		Num of sessions (m)	
Session Data	M+18 Octets	Session Handle	4 Octets	Session Handle
		Scheduler status	1 Octet	Scheduler status. Refer Table 49 for status codes
		Num of successful scheduling	4 Octets	Number of successfully scheduled session
		Num of unsuccessful scheduling	4 Octets	Number of failed scheduled session
		Priority	1 Octets	Current priority of the session

Table 49. Scheduler status codes

Codes	Name	Description
0x00	SCHD_STATUS_SESSION_SUCCESS	Session scheduled successfully
0x01	SCHD_STATUS_SESSION_CANNOT_SCHEDULE	There is not enough time slots available to schedule the session
0x02	SCHD_STATUS_SESSION_SYNC_FAILURE	Controlee session couldn't receive any message from Controller for a long time

7.3 Extension to reason code in SESSION_STATUS_NTF

Table 50. Extension to reason code in SESSION_STATUS_NTF

Value	Description
	SESSION_STATUS_NTF Reason codes. Refer section Error Code description for description on error code)
0x80	ERROR_INVALID_ANTENNA_CFG
0x81	ERROR_INVALID_RX_MODE
0x82	ERROR_FAIL_DYNAMIC_STS_NOT_ALLOWED
0x83	ERROR_FEATURE_NOT_SUPPORTED_FOR_MODEL
0x84	ERROR_RX_MODE_TOA_MODE_MISMATCH
0x85	ERROR_INSUFFICIENT_MEMORY_FOR_INBAND_DATA
0x86	ERROR_INVALID_DATA_TRANSFER_MODE
0x87	ERROR_INVALID_MAC_CFG
0x88	ERROR_ANTENNA_DEFINES_NOT_CONFIGURED
0x89	ERROR_INVALID_MAX_TDOA_SESSION_COUNT_REACHED
0x8A	ERROR_LOOPBACK_MODE_TX_POWER_TOO_HIGH
0x8B	ERROR_WRONG_SESSION_TYPE_FOR_INBAND_DATA
0x8C	ERROR_AOA_NOT_SUPPORTED_IN_SINGLE_RX
0x8D	ERROR_DUPLICATE_DST_MAC_ADDRESS_DETECTED
0x8E	ERROR_INVALID_ADAPTIVE_HOPPING_THRESHOLD
0x8F	ERROR_UNSUPPORTED_RANGING_LIMIT
0x90	ERROR_INVALID_HOPPING_MODE
0x91	ERROR_RNG_INVALID_DEVICE_ROLE
0x92	ERROR_KEY_ROTATION_NOT_SUPPORTED
0x93	ERROR_TEST_KDF_NOT_SUPPORTED
0x94	ERROR_INVALID_ANTENNA_PAIR_SWAP_CONFIGURATION
0xA0	ERROR_URSK_TTL_MAX_VALUE_REACHED
0xA1	ERROR_CCC_TERMINATION_ON_MAX_STS_INDEX

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Table 50. Extension to reason code in SESSION_STATUS_NTF...*continued*

Value	Description
0xA2	ERROR_SESSION_STOPPED_DUE_TO_FCC_LIMIT_REACHED
0xA3	ERROR_CSA_INVALID_CFG
0xB0	ERROR_RADAR_CIR_MAX_TAP_IDX_EXCEEDED
0xB1	ERROR_RADAR_ANTENNA_CONFIG_RX_NOT_OK
0xB2	ERROR_RADAR_PRESENCE_DETECTION_RANGE_EXCEEDED
0xB3	ERROR_RADAR_RX_GAIN_INDEX_NOT_OK
0xB4	ERROR_RADAR_DRIFTCOMP_ANTENNA_CONFIG_NOT_OK

NOTE:

- [0xA0 - 0xAF]: CCC specific use
- [0xB0 - 0xBF]: Radar specific use

7.3.1 Error Code description

UWBS shall report below error codes when required application configurations are not met.

7.3.1.1 List of Error Code(s)

SESSION_STOPPED_DUE_TO_INBAND_SIGNAL

- Sent when in-band stop request is received from remove device

ERROR_SLOT_LENGTH_NOT_SUPPORTED

- For NUMBER_OF_STS_SEGMENTS > 1,SLOT_DURATION of 1ms is not supported
- With STS_LENGTH = 128 symbols, the SLOT_DURATION should be >= 2ms
- With STS_LENGTH = 64 symbols and NUMBER_OF_STS_SEGMENTS > 1, the SLOT_DURATION should be >= 2ms

ERROR_INSUFFICIENT_SLOTS_PER_RR

- When SCHEDULED_MODE = 1, slots per ranging round should large enough to complete the Ranging round operations.
  Round interval should be big enough to meet the below criteria:
  Ranging Round interval >= Slot length (in ms) + UWBS session start offset (4ms)

ERROR_MAC_ADDRESS_MODE_NOT_SUPPORTED

- In SCHEDULED_MODE = 1, For SS_TWR, DS_TWR RANGING_METHOD, MAC_ADDRESS_MODE should be short
- In SCHEDULED_MODE = 0, MAC_ADDRESS_MODE = 1 is not supported
- For STS_CONFIG = 2 (PHY ACCESS), MAC_ADDRESS_MODE must be = 0

ERROR_INVALID_RANGING_DURATION

- When SCHEDULED_MODE = 1, RoundIndex should not be greater than 16bit value
- When WiFi-CoEx is enabled and *OneWire* GPIO based CoEx protocol is selected, the ranging interval value in ms should be greater or equal to following expression
  – (ADVANCED GRANT DURATION **+** ROUND DURATION)
- When RANGING_INTERVAL is not integer multiple of round duration (SLOTS_PER_RR * SLOT_DURATION)

ERROR_INVALID_STS_CONFIG

- STS_CONFIG should be STATIC when contention based ranging is enabled
- Returned by FW when Dynamic STS is selected but WRDS is not set

ERROR_INVALID_RFRAME_CONFIG

- With PSDU_DATA_RATE 27.2 Mbps, RFRAME_CONFIG = 3 is invalid
- For RFRAME_CONFIG = 0, NUMBER_OF_STS_SEGMENTS = 0 is valid
- For RFRAME_CONFIG = 1,3, NUMBER_OF_STS_SEGMENTS > 0 is valid
- With DUAL_AOA_PREAMBLE_STS = 1 RFRAME_CONFIG = 0 (no STS) is invalid
- RFRAME_CONFIG should not be 3 when contention based ranging is enabled

ERROR_STATUS_SESSION_KEY_NOT_FOUND

- STS_CONFIG = 0x04 (Provisioned STS for Responder specific Sub-session Key)
- DEVICE_TYPE = Controlee
- SESSION_KEY = FALSE
- SUB_SESSION_KEY = TRUE

ERROR_STATUS_SUB_SESSION_KEY_NOT_FOUND

- STS_CONFIG = 0x04 (Provisioned STS for Responder specific Sub-session Key)
- DEVICE_TYPE = Controlee
- SESSION_KEY = TRUE
- SUB_SESSION_KEY = FALSE

ERROR_INVALID_PREAMBLE_CODE_INDEX

- When PRF_MODE = BPRF, PREAMBLE_CODE_INDEX should be in range of 9 <= PREAMBLE_CODE_INDEX <= 12
- When PRF_MODE = HPRF, PREAMBLE_CODE_INDEX should be in range of 25 =< PREAMBLE_CODE_INDEX =< 32

ERROR_INVALID_SFD_ID

- When PRF_MODE = BPRF and PSDU_DATA_RATE != 850Kbps -> Supported SFD ID's are 0 and 2.
- When PRF_MODE = BPRF and PSDU_DATA_RATE == 850Kbps -> Supported SFD ID is 5.
- When PRF_MODE = HPRF, Supported SFD ID's are 1, 2, 3, 4.

ERROR_INVALID_PSDU_DATA_RATE

- When PRF_MODE = BPRF, the PSDU_DATA_RATE should not be other than 6.81 Mbps, 850 Kbps
- When PRF_MODE = HPRF (124.8MHz), The PSDU_DATA_RATE supported are 6.81 Mbps, 7.8 Mbps
- When PRF_MODE = HPRF (249.6MHz), The PSDU_DATA_RATE supported are 27.2 Mbps , 31.2 Mbps

ERROR_INVALID_PHR_DATA_RATE

- When PRF mode = BPRF, This error code will be reported when the BPRF PHR Data Rate is not equal to or lesser than PSDU Data Rate

ERROR_INVALID_PREAMBLE_DURATION

- When PRF_MODE = BPRF, The PREAMBLE_DURATION should not be 32 symbols
- With PSDU_DATA_RATE 27.2 Mbps, PREAMBLE_DURATION should be 32 symbols

ERROR_INVALID_STS_LENGTH

- With PSDU_DATA_RATE 27.2 Mbps, STS_LENGTH 128 symbols is invalid
- When PRF_MODE = BPRF, if RFRAME_CONFIG != NO_STS then other than STS_LENGTH = 64 is not supported

ERROR_INVALID_NUM_OF_CONTROLEES

- For SCHEDULED_MODE = 1, RANGING_METHOD = SS_TWR or DS_TWR and STS_CONFIG != 2, NUM_OF_CONTROLEES = 0 is invalid.
  I.e., in Physical Access use case, number of controlees can be 0

ERROR_MAX_RANGING_REPLY_TIME_EXCEEDED

- When SCHEDULED_MODE = 1
  For RANGING_METHOD = DS_TWR or SS_TWR and MULTINODE_MODE != UNICAST,
  SLOT_DURATION * NUMBER_OF_CONTROLEES < PH_UCI_MAX_RNG_REPLY_TIME (67ms)
  AP action is to ensure that the slot duration or the number of anchors should be adjusted to meet the maximum reply time requirement (which is 67ms)
- When SCHEDULED_MODE = 0
  SLOT_DURATION * CAP_SIZE < PH_UCI_MAX_RNG_REPLY_TIME is expected, Else error is thrown
  Note: CAP_SIZE is configured as per "FiRa Consortium - UCI Generic Specification"

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ERROR_INVALID_DST_ADDRESS_LIST

- DEVICE_ROLE = INITIATOR:
  When SCHEDULED_MODE = 1,
  For RANGING_METHOD = SS_TWR or DS_TWR and MULTINODE_MODE !=
  UNICAST and STS_CONFIG != PHYSICAL_ACCESS,
  It is an error to have more/less number of valid destination addresses than what is
  configured via NUM_OF_CONTROLEES
- For DEVICE_ROLE = RESPONDER:
  For SCHEDULED_MODE = 1, RANGING_METHOD = DS_TWR or SS_TWR,
  The destination address value cannot be invalid value (0xFFFF).

ERROR_INVALID_OR_NOT_FOUND_SUB_SESSION_ID

- When SCHEDULED_MODE = 1, DEVICE_ROLE = RESPONDER, RANGING_
  METHOD = DS_TWR or SS_TWR, STS_CONFIG = 2 or 4, and sub Session Handle not
  configured
  Note: The sub Session Handle 0 is invalid during physical access use case and it will be
  rejected during SET APP config.

ERROR_INVALID_RESULT_REPORT_CONFIG

- When SCHEDULED_MODE = 1, For RANGING_METHOD = DS_TWR or SS_TWR,
  If Result report in RANGING_ROUND_CONTROL app config is enabled then RESULT_
  REPORT_CONFIG should not be disabled

ERROR_INVALID_RANGING_ROUND_CONTROL_CONFIG

- When SCHEDULED_MODE = 1, For RANGING_METHOD = DS_TWR or SS_TWR,
  If Measurement Report in RANGING_ROUND_CONTROL is enabled then RANGING_
  ROUND_CONTROL Result Report should be disabled
- Enabling result reporting via RANGING_ROUND_CONTROL is disallowed in contention
  based ranging
- Enabling RCM phase via (Control Phase = 1 from RANGING_ROUND_CONTROL) is
  disallowed in contention based ranging (as there is no RCM)

ERROR_INVALID_RANGING_ROUND_USAGE

- When SCHEDULED_MODE = 0, Only RANGING_METHOD = SS_TWR is supported

ERROR_INVALID_MULTI_NODE_MODE

- For STS_CONFIG = 2 (PHY ACCESS), MULTI_NODE_MODE should not be UNICAST

ERROR_RDS_FETCH_FAILURE

- For Dynamic STS, if Session Key fetch failed due to any I2C or ESE errors

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ERROR_INVALID_ANTENNA_CFG

- When the session type and the antenna configuration is incorrect.
- RX_ANTENNA_CONFIG mode 5 and 6 only applicable when CSA_MAC_MODE [b7-b6] is set to 1 (2 active RR).

ERROR_INVALID_RX_MODE

- With DUAL_AOA_PREAMBLE_STS = 1, RX_MODE != 0 (Dual Rx) is invalid

ERROR_FAIL_DYNAMIC_STS_NOT_ALLOWED

- For Dynamic STS, if UWBS and ESE is not bound and locked

- If Dynamic STS config is set in factory FW

ERROR_FEATURE_NOT_SUPPORTED_FOR_MODEL

- If requested feature is not supported in given model ID

ERROR_RX_MODE_TOA_MODE_MISMATCH

- RX_MODE = 1 (Rx0) should have the TOA_MODE as 0
- RX_MODE = 2 (Rx1) should have the TOA_MODE as 1
- RX_MODE = 0 (Dual Rx) should have the TOA_MODE as 2

ERROR_INSUFFICIENT_MEMORY_FOR_INBAND_DATA

- This reason code shall be sent when requested buffer blocks via below config are not available in UWBS
  - SESSION_INBAND_DATA_TX_BLOCKS
  - SESSION_INBAND_DATA_RX_BLOCKS

ERROR_INVALID_MAC_CFG

- MAC_CFG !=3 for RANGING_METHOD = SS_TWR or DS_TWR is not supported

ERROR_INVALID_MAX_TDOA_SESSION_COUNT_REACHED

- When SCHEDULED_MODE = 1, For RANGING_METHOD = ONE_WAY_RANGING, only one TDOA session allowed at a time

ERROR_WRONG_SESSION_TYPE_FOR_INBAND_DATA

- This reason code shall be sent when requested buffer blocks via below config and session type is not 'Ranging and in-band data session' or 'Data transfer session'
  - SESSION_INBAND_DATA_TX_BLOCKS
  - SESSION_INBAND_DATA_RX_BLOCKS

ERROR_AOA_NOT_SUPPORTED_IN_SINGLE_RX

- AoA should be enabled only in Dual Rx cases

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ERROR_DUPLICATE_DST_MAC_ADDRESS_DETECTED

- Reported when DST_MAC_ADDRESS List should not contain duplicate entries

ERROR_INVALID_ADAPTIVE_HOPPING_THRESHOLD

- When SCHEDULED_MODE = 1,
  With DEVICE_TYPE = CONTROLLER and HOPPING_MODE = FIRA_ADAPTIVE_
  HOPPING / CCC_ADAPTIVE_MODULO_HOPPING / CCC_ADAPTIVE_AES_
  HOPPING,
  then ADAPTIVE_HOPPING_THRESHOLD should be < NUMBER_OF_CONTROLEES

ERROR_UNSUPPORTED_RANGING_LIMIT

- In ONE_WAY_RANGING, TDOA mode has only SP1 packet and Distance Limit is not applicable
  (i.e SESSION_INFO_NTF_CONFIG should not be 2)

ERROR_INVALID_HOPPING_MODE

- ROUND_HOPPING should be disabled during contention based ranging
- Restricting HOPPING_MODES with respect to session-type:
  - For Ranging Sessions:
    - 0x00 = Hopping Disable
    - 0x01 = FiRa Hopping Enable
    - 0xA0 = NXP Adaptive Hopping Enable
  - For CCC Sessions:
    - 0 = no hopping
    - 2 = adaptive hopping using MODULO
    - 3 = continuous hopping using MODULO
    - 4 = adaptive hopping using AES
    - 5 = continuous hopping using AES

ERROR_RNG_INVALID_DEVICE_ROLE

- UWBS shall report below error codes when required application configurations are not met.
  - DEVICE_ROLE with 0x02 (Master Anchor - TDoA Synchronizer)
    when RANGING_ROUND_USAGE is not equal to 0x00 (One Way Ranging)
  - DEVICE_ROLE with 0x05 (Advertiser) / 0x06 (Observer)
    when RANGING_ROUND_USAGE is not equal to 0x06 (OWR for AoA Measurement)
  - DEVICE_ROLE is not 0x05 (Advertiser) or 0x06 (Observer) and
    RANGING_ROUND_USAGE is equal to 0x06 (OWR for AoA Measurement)

ERROR_KEY_ROTATION_NOT_SUPPORTED

- The key rotation feature is enabled only during Dynamic STS ranging (STS_CONFIG = 0x01).

ERROR_TEST_KDF_NOT_SUPPORTED

- For STS_CONFIG = 2 (PHY ACCESS), bTest KDF feature Enable should not be enabled

ERROR_INVALID_ANTENNA_PAIR_SWAP_CONFIGURATION

- SWAP_ANTENNA_PAIR_3D_AOA is applicable only for Responders in CCC Session for 3D AoA scenario only.
- Setting of SWAP_ANTENNA_PAIR_3D_AOA = 1 with DEVICE_ROLE != RESPONDER or ANTENNA_CFG_MODE != 3D_AOA, SESSION_TYPE != CCC_SESSION or RANGING_METHOD != DSTWR_DEFERRED is invalid. In such case, UWBS will report the error message.

SESSION_STOPPED_DUE_TO_FCC_LIMIT_REACHED

- Session will stop with this error code if there is no reception for 10 seconds

ERROR_CSA_INVALID_CFG

- CSA active number of ranging rounds can be set for CCC session only.
- CSA offset to be in the range of 1 to Nround-1.

ERROR_INVALID_NUM_OF_STS_SEGMENTS

- NUM_STS_SEGMENTS>=2 will be rejected with error code SSN_RSNCODE_ERROR_ INVALID_NUM_OF_STS_SEGMENTS = 0x32

7.3.2 UWB session stop by in-band signaling

UWBS shall notify SESSION_STATUS_NTF with below reason code for in-band stop of the UWB session. The AP Shall de-initialize the session after received session status notification with idle state due to in-band stop signal over UWB.

Reason Code:

- 0x05

7.4 Dynamic Application Configuration Parameters

Below is the list of Application configuration parameters, which can be dynamically modified, meaning while the session is active.

Table 51. Dynamic APP configuration parameter List

Parameter Name
RX_ANTENNA_PAIR_SELECTION
ANTENNAS_CONFIGURATION_TX
TX_ANTENNA_SELECTION
THREAD_SECURE
THREAD_SECURE_ISR

Table 51. Dynamic APP configuration parameter List...*continued*

Parameter Name
THREAD_NON_SECURE_ISR
THREAD_SHELL
THREAD_PHY
THREAD_RANGING
THREAD_SECURE_ELEMENT
CIR_LOG_NTF
PSDU_LOG_NTF
SESSION_INFO_NTF_FILTER_NUM

7.5 Extension to SESSION_INFO_NTF

The vendor extension for SESSION_INFO_NTF can be added at the end of the generic SESSION_INFO_NTF as shown below. UWBS shall append the vendor extension only if NXP_EXTENDED_NTF_CONFIG core device configuration parameter is set to 0x01. Refer Table 121 for details on NXP_EXTENDED_NTF_CONFIG core configuration parameter.
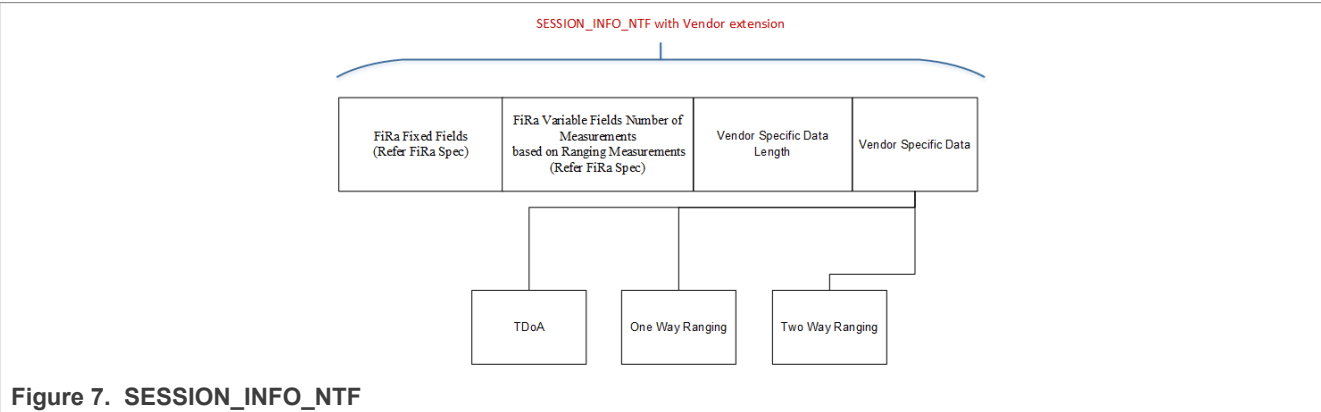
Figure 7. SESSION_INFO_NTF

Table 52. SESSION_INFO_NTF

Fields Description	UL-TDoA	Two Way Ranging / One Way Ranging
FiRa Fixed Fields	Refer FiRa Spec	Refer FiRa Spec
FiRa Variable Fields - Number of Measurements based on Ranging Measurements	Refer to Table OWR UL-TDoA Measurement Result from FiRa spec, if Ranging Measurement Type = 0x00	• Refer to Table Two Way Ranging Measurement Result from FiRa spec, if Ranging Measurement Type = 0x01 • Refer to Table DL-TDoA Ranging Measurement Result from FiRa spec, if Ranging Measurement Type = 0x02 ***Note:*** *No vendor extension for DL-TDoA* • Refer to Table OWR for AOA Measurement Result from FiRa spec, if Ranging Measurement Type = 0x03
Vendor Specific Data Length	2 Octets	2 Octets

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Table 52. SESSION_INFO_NTF...*continued*

Fields Description	UL-TDoA	Two Way Ranging / One Way Ranging
	• Vendor Data Length for vendor specific ranging data, Vendor Specific Data field is not present if Vendor Data Length = 0. • This Vendor Data Length field is present if NXP_EXTENDED_NTF_CONFIG is set to 0x01(Vendor extended notifications)	• Vendor Data Length for vendor specific ranging data, Vendor Specific Data field is not present if Vendor Data Length = 0. • This Vendor Data Length field is present if NXP_EXTENDED_NTF_CONFIG is set to 0x01(Vendor extended notifications)
Vendor Specific Data	N Octets Vendor Specific extension for SESSION_INFO_NTF (UL-TDoA Specific). Refer Table 53 for details	N Octets Vendor Specific extension for SESSION_INFO_NTF for TWR Measurements and OWR Advertisement. Refer Vendor Specific extensions in SESSION_INFO_NTF for details

Table 53. Vendor Specific extensions in SESSION_INFO_NTF for UL-TDoA

Parameter Name	Length	Value/ Description
Ranging Measurements vendor extension	M*ranging meas. Size	Refer Vendor specific extension for UL-TDoA Measurement at Table 54 if Ranging Measurement Type = 0x00.

Table 54. Vendor specific extension for One Way Ranging (UL-TDoA) Measurement

Parameter Name	Length	Value/ Description
Vendor Extension Length	1 Octet	Vendor extension length for TDOA Measurements below.
RSSI RX1	2 Octets	Received Signal Strength Indicator for RX1 in dB. It is expressed in Q8.8 format, Non zero values are always interpreted as negative value.
RSSI RX2	2 Octets	Received Signal Strength Indicator for RX2 in dB. It is expressed in Q8.8 format, Non zero values are always interpreted as negative value.
Number of PDoA Measurements	1 Octet	Number of PDoA measurements to follow (N).
PDoA Measurements	N x 4 Octets	Where N is the number of PDoA measurements to follow and Each measurement includes the PDoA estimate (2 octets) and the corresponding PDoA index (2 Octets) at which the estimate has been taken, Refer Vendor Specific PDoA Measurements for more details

Table 55. Vendor Specific PDoA Measurements (UL-TDoA)

Parameter Name	Length	Value/ Description
PDoA [1…N]	2 Octets	Estimation of phase difference in degrees from antenna pair [1…N]. It is a signed degree in Q9.7 format.

Table 55. Vendor Specific PDoA Measurements (UL-TDoA)...*continued*

Parameter Name	Length	Value/ Description
		This field is zero if AOA_RESULT_REQ = 0. Value ranges from -180 to 180 degrees.
PDoA Index [1…N]	2 Octets	CIR index estimate at which PDoA [1…N] has been detected. This is vendor specific. This field is zero if AOA_RESULT_REQ = 0.

Table 56. Vendor Specific extensions in SESSION_INFO_NTF Continued for UL-TDoA

Parameter Name	Length	Value/ Description

Antenna Pair Info	4 Octets	Antenna Rx Configuration information used in current ranging round.
		• Octet[0] : Configuration Mode as per ANTENNAS_CONFIGURATION_RX supported configuration mode are 0, 1
		  - 0: Configuration Mode 0: ToF only mode.
		  - 1: Configuration Mode 1: 3D/2D AoA, implicit ToA mode usecase.
		• Octet[1] :
		  – Config mode(s) 0:
		    Antenna ID 1 as per ANTENNA_RX_IDX_DEFINE
		  – Config mode(s) 1:
		    Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE
		• Octet[2] :
		  – Config mode(s) 0:
		    Antenna ID 2 as per ANTENNA_RX_IDX_DEFINE
		  – Config mode(s) 1:
		    Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE
		• Octet[3] :
		  – Config mode(s) 0:
		    Antenna ID 3 as per ANTENNA_RX_IDX_DEFINE
		  – Config mode(s) 1:
		    Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE

WiFi-CoEx Status Code	1 Octet	Status code for WLAN during ranging RR 0x00 : WLAN_UWB_IND_LOW 0x01 : WLAN_UWB_IND_HIGH 0x02 : WLAN_UWB_IND_ERR 0xFF - 0x03 : RFU
Authenticity Info Presence	1 Octet	Indicator for presence of Authentication Tag. 0x00 : Authenticity info is not present 0x01 : Authenticity info is present This field is 0x00 if AUTHENTICITY_TAG = 0x00 (disable). Authenticity Tag is applicable when STS_CONFIG is set to 0x01 or 0x02 otherwise this field is always 0x00

Table 56. Vendor Specific extensions in SESSION_INFO_NTF Continued for UL-TDoA...continued

Parameter Name	Length	Value/ Description
Authentication Tag	16 Octets	Generated Authentication Tag for RANGE_DATA_NTF and this filed is present when Authenticity Info Presence is set to 0x01

Table 57. Vendor Specific extensions in SESSION_INFO_NTF fot TWR Measurements and OWR Advertisement

Parameter Name	Length	Value/ Description
Ranging Measurements vendor extension	M*ranging meas. Size	Refer Vendor specific extension for Two-way measurement at Vendor specific extension for Two Way Ranging Measurement Table if Ranging Measurement Type = 0x01. Refer Vendor specific extension for One-way Ranging Advertisement at Vendor specific extension for One Way Ranging (AoA) Advertisement Table if Ranging Measurement Type = 0x03.

Table 58. Vendor specific extension for Two Way Ranging Measurement

Parameter Name	Length	Value/ Description	
NXP Specific Data type	1 Octet	This parameter indicates the type of vendor specific data 0x00 : Specific Data V1 for TWR .. 0xA0 : FoV Specific Data 0xA2 to 0xFF : reserved for UWB chipset vendor specific usage	
NXP Specific Data (FIXED PART)	1 Octet	WiFi CoEx Status	WiFi co-existence status Wlan State as defined in WLAN_UWB_IND_STATUS_NTF 0x00 = WLAN_UWB_IND_LOW 0x01 = WLAN_UWB_IND_HIGH_AT_RR_START 0x02 = WLAN_UWB_IND_HIGH_DURING_RR Others = RFU Note: If pin state from Wlan to UWB is low will send WLAN_UWB_IND_LOW(0x00).
...	2 + M Octets	Rx Antenna Info for AoA Measurements	Antenna used for RX Octet[0] : RX mode - ToA mode = 0 (following ids are RX antenna IDs) - AoA mode = 1 (following ids are RX pair IDs)

Table 58. Vendor specific extension for Two Way Ranging Measurement...*continued*

Parameter Name	Length	Value/ Description	
			-TOA RFM Mode = 3 - AoA RFM mode = 4 (following ids are RX pair IDs) - Octet[1] : Number of following RX antennas (M >=1) - Octet[2] : RX antenna ID (or RX pair ID) - Octet[3] : RX antenna ID (or RX pair ID) ... Following values (AoA, PDoA, PDoA Index Etc..) shall be matched according to the order of RX antenna Info (values are filed with 0 if RX mode is set to ToA mode).
...	2 + N Octets	Rx Antenna Info For Debug Notifications	Antenna used for RX operations: Octet[0] : RX mode - ToA mode = 0 (following ids are RX antenna IDs) - Octet[1] : Number of following RX antennas (N >=1) - Octet[2] : RX antenna ID - Octet[3] : RX antenna ID ... Following values (Snr First, SnrMain, Etc..) shall be matched according to the order of RX antenna Ids
Repitition part (This fields are repeated for each responder)	M * 7 Octets(If Vendor Speciifc Data Type is 0xA0)	*AoA / PDoA/FoV measurements per RX entry*	Octet[1-0] : Angle of arrival (2 Octets signed value in Q9.7 format) Octet[3-2] : Phase difference of arrival (2 Octets signed value in Q9.7 format) Octet[5-4] : Phase difference of arrival index in the whole CIR (2 Octets unsigned integer value)

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Table 58. Vendor specific extension for Two Way Ranging Measurement*...continued*

Parameter Name	Length	Value/ Description	
			Octet[6] : Field of View Flag (Value 0 indicates that Peer Device is not present in FoV and Value 1 indicates that Peer Device is present in FoV). Note: If DUAL RX is configured, AoA FoV Elevation Flag shall be ignored by host. (This is present only if Vendor Specific Data Type is 0xA0) *Note: This field will be reported when ANTENNA_CONFIG_ RX is AoA mode or RFM mode for AoA, in all other cases of ANTENNA_CONFIG_ RX this field will not be reported*
...	N * 6 Octets	SNRFirst / SNRMain / FirstIndex / Main Index measurements per RX entry	Octet[0] : Signal-to-Noise (SNR) of the First Path in dB (1 Octet unsigned integer value) compared to noise floor in the same RX entry Octet[1] : Signal-to-Noise (SNR) of the Main Path in dB (1 Octet unsigned integer value) compared to noise floor inthe same RX entry Octet[3-2] : First path index in the whole CIR Octet[5-4] : Main path index in the whole CIR
...	2 Octets	Distance_2	Distance between the device and target measured with the antenna enabled on RFM (2 Octets unsigned integer value) Note1: This field is reported only in AOA_RFM and TOA_RFM modes Note2: In Initator device role, UWBS reports the value 0x0000 as this measurement is not applicable to this role

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Table 59. Vendor specific extension for One Way Ranging (AoA) Advertisement

Parameter Name	Length	Value/ Description	
NXP SPECIFIC DATA TYPE	1 Octet	This parameter indicates the type of vendor specific data 0x00 : Specific Data V1 for OWR .. 0xA0 to 0xFF : reserved for UWB chipset vendor specific usage	
VENDOR_ SPECIFIC_DATA	2 + N Octets	Rx Antenna Info for AoA Measurements	Antenna used for RX Octet[0] : RX mode • ToA mode = 0 (following ids are RX antenna IDs) • AoA mode = 1 (following ids are RX pair IDs) • • TOA RFM Mode = 3 • AoA RFM mode = 4 (following ids are RX pair IDs) Octet[1] : Number of following RX antennas (N >=1) Octet[2] : RX antenna ID (or RX pair ID) Octet[3] : RX antenna ID (or RX pair ID) Following values (AoA, PDoA, PDoA Index Etc..) shall be matched according to the order of RX antenna Info (values are filed with 0 if RX mode is set to ToA mode).
...	N * 6 Octets	AoA / PDoA measurements per RX entry	Octet[1-0] : Angle of arrival (2 Octets signed value in Q9.7 format) Octet[3-2] : Phase difference of arrival (2 Octets signed value in Q9.7 format) Octet[5-4] : Phase difference of arrival index in the whole CIR (2 Octets unsigned integer value) ***Note:*** *This field will be reported when ANTENNA_CONFIG_RX is AoA mode or RFM mode for AoA, in all other cases of ANTENNA_CONFIG_RX this field will not be reported*
...	2 Octets	RSSI	RSSI in dB (signed value expressed in Q8.8 format)

Table 60. One Way Ranging (UL-TDOA) Measurement(For Legacy Devices)

Payload Field(s)	Length	Value/ Description
One Way (UL-TDOA) Ranging Measurement		
MAC Address	2/8 Octets	MAC address of the initiator TAG device. 2 bytes short address (if MAC addressing mode indicator = 0x00) 8 bytes extended address (if MAC addressing mode indicator = 0x01)
Status	1 Octet	For various status values refer to Status Codes

Table 60. One Way Ranging (UL-TDOA) Measurement(For Legacy Devices)...*continued*

Payload Field(s)	Length	Value/ Description
		If status field is other than STATUS_OK, then all other values shall be ignored.
Message Control	1 Octet	b0-1: Presence and length of UL-TDoA Device ID. 0b00 = UL-TDoA Device ID is not present 0b01 = 16-bit UL-TDoA Device ID 0b10 = 32-bit UL-TDoA Device ID 0b11 = 64-bit UL-TDoA Device ID b2-3: Presence and length of TX timestamp of the received Blink or Synchronization UTM. 0b00 = TX timestamp is not present 0b01 = 40-bit TX timestamp 0b10 = 64-bit TX timestamp 0b11 = RFU b4-5: Length of the measured RX timestamp by the UWBS that receives the UTM. 0b00 = 40-bit RX timestamp 0b01 = 64-bit RX timestamp 0b10-0b11 = RFU b6-7: RFU
Frame Type	1 Octet	0x00 : BLINK message to indicate that data notification received from Tag 0x01 : SYNC message to indicate that data notification received from Master Anchor
NLoS	1 Octet	Indicates if the ranging measurement was in Line of sight or non-line of sight. 0x00 : LoS 0x01 : NLoS 0x02 - 0xEF : RFU 0xFF : Unable to determine
AoA Azimuth	2 Octets	AoA Azimuth in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.
AoA Azimuth FOM	1 Octet	The AoA Azimuth FOM field conveys the reliability of the estimated AOA in the Azimuth. FOM goes from 0 to 100. Higher values indicate better quality AoA estimates. Lower values suggest decreased reliability in the estimates.
AoA Elevation	2 Octets	AoA Elevation in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.
AoA Elevation FOM	1 Octet	The AoA Elevation FOM field conveys the reliability of the estimated AOA Elevation. FOM goes from 0 to 100. Higher values indicate better quality AoA estimates. Lower values suggest decreased reliability in the estimates.
Timestamp	8 Octets	Timestamp of UWB RFRAME in 15.65ps ticks

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Table 60. One Way Ranging (UL-TDOA) Measurement(For Legacy Devices)...*continued*

Payload Field(s)	Length	Value/ Description
Blink Frame Number	4 Octets	Number received in UWB blink frame from Tag or SYNC frame from Master Anchor
RFU	12/6 Octets	Reserved for future use 12 bytes RFU if MAC Address is 2 Octets 6 bytes RFU if MAC Address is 8 Octets
Device Specific Information Size	1 Octet	Size of Device Specific Information(N) to follow
Device Specific Information	N Octets	Device specific data. This field is present if Device Specific Information Size >= 1
Blink Payload Data Size	1 Octet	Size of Blink Payload Data(M) to follow.
Blink Payload Data	M Octets	Blink payload data as part of Blink Frame over UWB. This field is present if Blink Payload Data Size >= 1

7.6 Selection of Antennas for a given Session

The process to use arbitrary antenna for a given session is as follows.

Step 1: Define Individual Antenna (Core Set Config). See ANTENNA_TX_IDX_DEFINE and ANTENNA_RX_IDX_DEFINE

Step 2: Define RX Antennas Group (Core Set Config). See ANTENNAS_RX_PAIR_DEFINE

Step 3: Store Calibration information for RX Groups

This is required per antennas pair (H and V), for One channel (5 OR 9)

Step 4: For a given session, select the Antennas to be used.

This is optional. TX Antenna ID 1 is default for Tx, RX Pair ID 1 is for RX-H, RX Pair ID 2 is for RX-V.

See ANTENNAS_CONFIGURATION_TX to define TX Antenna(s).

See ANTENNAS_CONFIGURATION_RX. Select RX Antenna, RX-H Pair and RX-V Pair to be used. The RX-H and RX-V pair IDs are as defined by ANTENNAS_RX_PAIR_DEFINE.

If ANTENNAS_CONFIGURATION_TX, ANTENNAS_CONFIGURATION_RX is used with values=0, Scan Phase for the session is enabled by default.

Table 61. GPIO Bit Masks

Pin	Mask
EF1	1
EF2	2
GPIO6	4
GPIO7	8
GPIO9	16
GPIO10	32
GPIO11	64

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Table 61. GPIO Bit Masks...*continued*

Pin	Mask
GPIO12	128
GPIO14	256
GPIO2	512
GPIO4	1024

Table 62. ANTENNA_SELECTION_GPIO_BITMASK

GPIO Bit Masks for Antennas Selection

Pin	Mask	b[8]	b[7]	b[6]	b[5]	b[4]	b[3]	b[2]	b[1]	b[0]
EF1	1 (Dedicated for Tx/Rx Switching)									X
EF2	2 (Dedicated for RxH/ RxV Switching)								X	
GPIO6	4							X		
GPIO7	8						X			
GPIO9	16					X				
GPIO10	32				X					
GPIO11	64			X						
GPIO12	128		X							
GPIO14	256 (Dedicated for RxH/ RxV Switching)	X								

Note: *Bit(s) from b[15] to b[8] are reserved for future use.*

Table 63. Max number of entries per Product Variant

Variant	# TX Antennas	# RX Antennas (GPIO)	# Antenna Pairs / Single (Functional)	# Max Calibraiton entries for AoA per Antennas Pair per Channel	# Max Supported Channels for AoA Calibration at a time
IOT	4	12	8	4	1

- All the IDs that are used and defined must to be sequential.
  - Partial update/set configurations are not permitted. UWBS Does not implement parsing/traversal logic and hence
- The FW internally can use this Indexes to "optimize" access to the look up table without traversing to any arrary. Or find any empty or filled slots.

If the HOST calls one the APIs with the Same ID, the FW may choose to over-write the values and the behavior may be non deterministic for advanced use cases. Hence the Host has to ensure all the slots are required filled before exercising any use case.

The FW fills up slots based on the indexes given as the ID parameters of these set configs.

In some cases IDs 1 and 2 have special purpose. See the description in ANTENNAS_RX_PAIR_DEFINE.

Maximum supported Channel for calibration at a time is variant specific (See Table 63).

7.7 Antenna Switching During Active Ranging

UWBS shall use SESSION_SET_VENDOR_APP_CONFIG("ANTENNAS_CONFIGURATION_RX") command to perform the dynamic switch based on session specific antenna pair to be used based on ANTENNAS_CONFIGURATION_RX application configuration. ANTENNAS_CONFIGURATION_RX application configuration is configured based on ANTENNAS_RX_PAIR_DEFINE and ANTENNA_RX_IDX_DEFINE core set configuration parameters.

Application shall use this command to switch between configuration modes such as Dual Rx Pair, Dual Rx and Single Rx.

AoA Result Req during Active Ranging

If the antenna configuration specified via ANTENNAS_CONFIGURATION_RX , ANTENNAS_RX_PAIR_DEFINE and ANTENNA_RX_IDX_DEFINE is SINGLE RX and application sets AOA Res Req to enabled, than FW will ignore this setting and implicitly treat AoA Res Req to be disabled

7.8 UWB Session Vendor App Configurations

The Host may retrieve current proprietary application configurations for a given UWB session at any session states.

The Host may establish new UWB sessions and configure UWB sessions during the DEVICE_STATE_READY/DEVICE_STATE_ACTIVE Device State of the UWBS.

7.8.1 Setting Vendor App Configurations

The Host shall use the SET_VENDOR_APP_CONFIG_CMD command to set APP Configuration Parameters for the requested UWB session. The UWBS shall respond with the SET_VENDOR_APP_CONFIG_RSP with Status indicating that APP Configuration Parameters are applied or not.

Table 64. SET_VENDOR_APP_CONFIG_CMD

Payload Field(s)	Length	Value/Description		
Session Handle	4 Octets	Unique session identifier of a session for which the Vendor APP Configuration Parameters are to be set		
Number of Vendor App Configurations	1 Octet	The number (n) of APP Configuration Parameters (TLV) to follow. Each APP Configuration Parameter follows TLV structure as below.		
Vendor APP Configuration Parameter [1...n]	(2+m)*n Octets	Tag	1 Octet	Vendor APP configuration Parameter ID
		Length	1 Octet	Length of Value(m)
		Value	m Octets	Value of the Vendor APP Configuration parameter

Table 65. SET_VENDOR_APP_CONFIG_RSP

Payload Field(s)	Length	Value/Description		
Status	1 Octet	Status code		
Number of Vendor APP Configurations	1 Octet	If the Status is STATUS_OK, the value shall be 0x00 and no Vendor APP Configuration Parameters are listed. If the Status is something other than STATUS_OK, the value shall indicate the number (n) of failed Vendor APP Configuration Parameters to follow.		
Failed Vendor APP Configuration Parameter [1...n]	2*n Octets	Vendor APP Config ID	1 Octet	The identifier of the failed Application Configuration Parameter.
		Status	1 Octet	STATUS_INVALID_PARAM / STATUS_INVALID_RANGE/ STATUS_ERROR_SESSION_ACTIVE

7.8.2 Retrieve Vendor App Configurations

The Host shall use the GET_VENDOR_APP_CONFIG_CMD command to read APP Configuration Parameters for the requested UWB session. The UWBS shall respond with the GET_NXP_APP_CONFIG_RSP with Status indicating that APP Configuration Parameters are applied or not.

Table 66. GET_VENDOR_APP_CONFIG_CMD

Payload Field(s)	Length	Value/Description	
Session Handle	4 Octets	Unique session identifier of a session for which the Vendor APP Configuration Parameters are to be set	
Number of Vendor App Configurations	1 Octet	The number (n) of APP Configuration Parameters (TLV) to follow. Each vendor APP Configuration Parameter follows TLV structure as below.	
Vendor App Configuration Parameter [1...n]	n Octets	Vendor APP config IDs	This field is required if Number of APP Configurations field is > 0.

Table 67. GET_VENDOR_APP_CONFIG_RSP

Payload Field(s)	Length	Value/Description		
Status	1 Octet	Status code		
Number of Vendor App Configurations	1 Octet	If the Status is STATUS_OK, the value shall be 0x00 and no Vendor APP Configuration Parameters are listed. If the Status is something other than STATUS_OK, the value shall indicate the number (n) of failed vendor APP Configuration Parameters to follow.		
Vendor App Configuration Parameter [0...n]	(2+m)*n Octets	Type	1 Octet	Vendor APP Configuration Parameter Tag ID.
		Length	1 Octet	The length (m) of Value.
		Value	m Octets	The value of the Vendor APP Configuration Parameter.

7.9 Scan Phase of Antennas

The FW shall iterate for each Tx, Rx1 and Rx2 combination as defined in ANTENNAS_SCAN_PAIRS_DEFINE.

Once FW identifies, which is the best RX Antennas pair, FW has to reverse look up that Antennas from available RX Pairs.

7.10 DL-TDOA Maximum Active Ranging Rounds

- The maximum number of active ranging rounds of a DT-Tag within a ranging block is UWBS dependent and is denoted in FIRA document as DT_TAG_MAX_ACTIVE_RR.
  – Value of DT_TAG_MAX_ACTIVE_RR is 20.

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7.11 CCC Range Data NTF

While the UWB session is ongoing, the UWBS shall send ranging result with the CCC_RANGE_DATA_NTF notification to the Host when the ranging round is complete.

Table 68. CCC_RANGE_DATA_NTF

Payload	Length	Value/Description
Session Handle	4 Octet	Session ID of the currently active session
Ranging status	1 Octet	For the CCC session, the lower nibble represents the ranging status of the controller and the higher nibble represents the ranging status of the Controllee. For other sessions, this contains only the status of the Controllee. 0x0: Success 0x1: Transaction overflow 0x2: Transaction expired 0x3: Incorrect frame 0xD: Responder is in listen only mode (Not available for the controller) 0xF: Ranging Control Message lost (Not available for the controller)
STS index	4 Octets	STS index received in final data message
RR Index	2 Octets	The ranging round in which the next ranging cycle will be executed
Block Index	2 Octets	Index of the Ranging block for which the following measurement result applies
Distance	2 Octets	Distance between Initiator and Anchor in cm
Uncertainty Anchor (FoM)	1 Octet	Ranging timestamp uncertainty of Controllee
Uncertainty Initiator (FoM)	1 Octet	Ranging timestamp uncertainty of Controller
CCM TAG	8 Octets	CCM* TAG calculated over all payload fields. CCM* TAG can be set to all 0xFF if not used.

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Table 68. CCC_RANGE_DATA_NTF...*continued*

Payload	Length	Value/Description
AOA Azimuth	2 Octets	AoA Azimuth in degrees measured at the device that is sending this SESSION_INFO_NTF notification. It is a signed value in Q9.7 format. Allowed values range from -180° to +180°.
AOA Azimuth FOM	1 Octet	The AoA Elevation FOM field conveys the reliability of the estimated AOA Elevation. FOM goes from 0 to 100. Higher values indicate better quality AoA estimates. Lower values suggest decreased reliability in the estimates. This field shall be set to zero and ignored if AOA_RESULT_REQ = 0
AOA Elevation	2 Octets	AoA Elevation in degrees measured at the device that is sending this SESSION_INFO_NTF notification. It is a signed value in Q9.7 format. Allowed values range from -90 to +90.
AOA Elevation FOM	1 Octet	The AoA Elevation FOM field conveys the reliability of the estimated AOA Elevation. FOM goes from 0 to 100. Higher values indicate better quality AoA estimates. Lower values suggest decreased reliability in the estimates. This field shall be set to zero and ignored if AOA_RESULT_REQ = 0

Antenna Pair Info	4 Octets	Antenna Rx Configuration information used in current ranging round.
		• Octet[0] : Configuration Mode as per ANTENNAS_ CONFIGURATION_RX supported configuration modes are 0 ,1, 5 and 6
		  – 0 : Configuration Mode 0: ToF Only Mode
		  – 1 : Configuration Mode 1: Configuration Mode for 3D/2D AoA, test/loopback session and implicit ToA mode usecase
		  – 5 : Configuration Mode 5: Configuration Mode for CSA ToA mode use case
		  – 6 : Configuration Mode 6: Configuration Mode for CSA AoA mode use case
		• Octet[1] :
		  – Config mode(s) 0: Antenna ID 1 as per ANTENNA_ RX_IDX_DEFINE
		  – Config mode(s) 1: Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE

Table 68. CCC_RANGE_DATA_NTF...*continued*

Payload	Length	Value/Description
		– Config mode(s) 5: Antenna ID as per ANTENNA_RX_ IDX_DEFINE mapped to current active RR
		– Config mode(s) 6: Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE mapped to current active RR
		• Octet[2] :
		– Config mode(s) 0 : Antenna ID 2 as per ANTENNA_ RX_IDX_DEFINE
		– Config mode(s) 1: Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE
		– Config mode(s) 5: Antenna ID as per ANTENNA_RX_ IDX_DEFINE mapped to current active RR
		– Config mode(s) 6: Antenna Pair ID as per ANTENNAS_RX_PAIR_DEFINE mapped to current active RR
		• Octet[3] :
		– RFU
Number of PDoAMeasurements	1 Octet	Number of PDoA measurements to follow (M).
PDoA Measurements	M x 4 Octets	Where M is the number of PDoA measurements to follow and Each measurement includes the PDoA estimate (2 octets) and the corresponding PDoA index (2 Octets) at which the estimate has been taken • PDoA – 2 Octets – Estimation of phase difference in degrees from antenna pair. – It is a signed degree in Q9.7 format. – This field is zero if AOA_RESULT_REQ = 0. – Value ranges from -180 to 180 degrees. • PDoA Index – 2 Octets – CIR index estimate at which PDoA has been detected. – This is vendor specific. – This field is zero if AOA_RESULT_REQ = 0.

Table 68. CCC_RANGE_DATA_NTF...*continued*

Payload	Length	Value/Description
		This field shall not be present when Number of PDoA Measurements field is 0
Number of RSSI measurements	1 Octect	'Number of RSSI measurements' to follow = N. (Each measurement = RSSI_RX1, RSSI_RX2). Where N = 2 (Measured at Poll and Final).
RSSI measurements	N x 4 Octets	Where N is the number of RSSI measurements. Each measurement is reported in the sequence according to antenna pair in Antenna Pair Info field. Each measurement includes the RSSI from RX1 and RSSI from RX2. RSSI_RX1 [1…N] -2 Octets Received Signal Strength Indicator for RX1 in dB. It is signed value expressed in Q8.8 format RSSI_RX2 [1…N] -2 Octets Received Signal Strength Indicator for RX2 in dB. It is signed value expressed in Q8.8 format For example: With SWAP_ANTENNA_PAIR_3D_AOA enabled RSSI-RX1| RSSI-RX2 for Pair 1 for POLL RSSI-RX1| RSSI-RX2 for Pair 2 for FINAL With SWAP_ANTENNA_PAIR_3D_AOA disabled For RX Pair- RSSI-RX1| RSSI-RX2 for Pair 1 for POLL RSSI-RX1| RSSI-RX2 for Pair 1 for FINAL For single RX- RSSI-RX1 for RX1, RSSI-RX2 will be 0, for POLL and FINAL. RSSI-RX2 for RX2, RSSI-RX1 will be 0, for POLL and FINAL
Number of SNR measurements	1 Octect	Number of SNR measurements to follow = N x K K indicates the number of RX port pins. K = 2 (RX1 and RX2)

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Table 68. CCC_RANGE_DATA_NTF...*continued*

Payload	Length	Value/Description

SNR measurements	N x K x 5 Octets	This field contains the SNR measurements. Each SNR measurement element contains 5 octets as below:
		[
		• **Octet [0]:Slot index and Antenna mapping details**
		  – bits[5:0] - RFRAME slot index
		  – bits[7:6]
		    – bit[6] - RFU
		    – bit[7] - 0: RX1, 1: RX2
		• **Octet [1]: SNR_MAIN_PATH**
		Signal-to-Noise Ratio (SNR) of the main path and it is reported as unsigned value in dB.
		• **Octet [2]: SNR_FIRST_PATH**
		Signal-to-Noise Ratio (SNR) of the first path and it is reported as unsigned value in dB.
		• **Octets [4-3]: SNR_TOTAL**
		Signal-to-Noise Ratio (SNR) of configured RX in Q8.8 dB.
		] Repeat up to N x K
		For example:
		With SWAP_ANTENNA_PAIR_3D_AOA enabled:
		SNR-RX1| SNR-RX2 for Pair 1 for POLL
		SNR-RX1| SNR-RX2 for Pair 2 for FINAL
		With SWAP_ANTENNA_PAIR_3D_AOA disabled:
		For RX Pair-
		SNR-RX1| SNR-RX2 for Pair 1 for POLL
		SNR-RX1| SNR-RX2 for Pair 1 for FINAL
		For single RX-
		SNR-RX1 for RX1, SNR-RX2 will be 0, for POLL and FINAL.
		SNR-RX2 for RX2, SNR-RX1 will be 0, for POLL and FINAL.
		Note:*Thisfields shall contain the SNR values measured for both" Poll and Final FRAMES"*

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8 UCI Test Specification Extensions

The UWBS shall not send any proprietary information in any response/notification if NXP_EXTENDED_NTF_CONFIG is set to 0x00.

8.1 TEST_PER_RX_NTF

Additional fields which are highlighted below are added TEST_PER_RX_NTF.

Table 69. TEST_PER_RX_NTF Extensions

Payload Field(s)	Length (Octets)	Value/ Description
Status	1	Notify host after receiving NUM_PACKETS. Refer Generic Status Codes
ATTEMPTS	4	No. of RX attempts
ACQ_DETECT	4	No. of times signal was detected
ACQ_REJECT	4	No. of times signal was rejected
RX_FAIL	4	No. of times RX did not go beyond ACQ stage
SYNC_CIR_READY	4	No. of times sync CIR ready event was received
SFD_FAIL	4	No. of time RX was stuck at either ACQ detect or sync CIR ready
SFD_FOUND	4	No. of times SFD was found
PHR_DEC_ERROR	4	No. of times PHR decode failed
PHR_BIT_ERROR	4	No. of times PHR bits in error
PSDU_DEC_ERROR	4	No. of times payload decode failed
PSDU_BIT_ERROR	4	No. of times payload bits in error
STS_FOUND	4	No. of times STS detection was successful
EOF	4	No. of times end of frame event was triggered
Vendor Specific Data Length	2	Vendor Data Length, Vendor Data field is not present if Vendor Data Length = 0. Otherwise = (N+1) This Vendor Data Length field is present if NXP_ EXTENDED_NTF_CONFIG is set to 0x01(Vendor extended notifications) and Vendor presence is based on Vendor Data Length
NXP Specific Data type	1	This parameter indicates the type of vendor specific data: 0x00 : Specific Data V1 for TEST_PER_RX_NTF
NXP Specific Data	N	Specific Data Refer : • TEST_PER_RX_NTF Vendor Specific Data for more details

Table 70. TEST_PER_RX_NTF Vendor Specific Data

Parameter Name	Length	Value/ Description
RX antenna information	1 +1 + N	RX mode and number of antenna used Octet[0] - 0x00 (TOA RX mode) Octet[1] - Number of RX antenna to follow - Octet[2] RX1 antenna ID - Octet[3] RX2 antenna ID ... - Octet[N] RXN antenna ID
RSSI_RX1	2 Octets	Average value of the computed RSSI value on RX1 path. It is signed value expressed in Q8.8 format
RSSI_RX2	2 Octets	Average value of the computed RSSI value on RX2 path. It is signed value expressed in Q8.8 format
RSSI_RX[N]	2 Octets	Average value of the computed RSSI value on RXN path. It is signed value expressed in Q8.8 format
SNR_RX1	2 Octets	Averaged value of the SNR computed on RX1 path. It is a signed value in Q 8.8 format
SNR_RX2	2 Octets	Averaged value of the SNR computed on RX2 path. It is a signed value in Q 8.8 format.
SNR_RX[N]	2 Octets	Averaged value of the SNR computed on RXN path. It is a signed value in Q 8.8 format.
RX_CFO_EST	2 Octets	Average value of the computed carrier frequency offset estimate from the reception in PPM. It is a signed value in Q 5.11 format

8.2 TEST_RX_NTF

Table 71. TEST_RX_NTF Extensions

Payload Field(s)	Length	Value/ Description
TEST_RX_NTF		
Status	1 Octet	Refer Generic Status Codes
RX_DONE_TS_INT	4 Octet	Integer part of timestamp 1/124.8Mhz ticks.
RX_DONE_TS_FRAC	2 Octet	Fractional part of timestamp in 1/128 * 499.2Mhz ticks.
AoA Azimuth	2 Octet	AoA Azimuth in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.
AoA Elevation	2 Octet	AoA Elevation in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.

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Table 71. TEST_RX_NTF Extensions...*continued*

Payload Field(s)	Length	Value/ Description
ToA Gap	1 Octet	ToA of main path minus ToA of first path in nanoseconds.
PHR	2 Octet	Received PHR (bits 0-12 as per IEEE spec)
PSDU Data Length	2 Octet	Length of PSDU Data(N) to follow
PSDU_Data	N Octet	Received PSDU Data[0:N] bytes 0 <= N <= 127 for BPRF 0 <= N <= 4095 for HPRF
Vendor Specific Data Length	2 Octets	Vendor Data Length, Vendor Data field is not present if Vendor Data Length = 0. Otherwise = (N+1) This Vendor Data Length field is present if NXP_EXTENDED_NTF_CONFIG is set to 0x01(Vendor extended notifications) and Vendor presence is based on Vendor Data Length
NXP Specific Data type	1 Octet	This parameter indicates the type of vendor specific data: 0x00 : Specific Data V1 for TEST_RX_NTF
NXP Specific Data	N Octet	Specific Data Refer : • TEST_RX_NTF Vendor Specific Data for more details

Table 72. TEST_RX_NTF Vendor Specific Data

Parameter Name	Length	Value/ Description
RX antenna information	1 +1 + N	RX mode and number of antenna used Octet[0] - 0x00 (TOA RX mode) Octet[1] - Number of RX antenna to follow - Octet[2] RX1 antenna ID - Octet[3] RX2 antenna ID ... - Octet[N] RXN amtenna ID (or RX antenna pair N)
RSSI_RX1	2 Octets	Average value of the computed RSSI value on RX1 path. It is signed value expressed in Q8.8 format
RSSI_RX2	2 Octets	Average value of the computed RSSI value on RX2 path. It is signed value expressed in Q8.8 format
RSSI_RX[N]	2 Octets	Average value of the computed RSSI value on RXN path. It is signed value expressed in Q8.8 format
SNR_RX1	2 Octets	Averaged value of the SNR computed on RX1 path. It is a signed value in Q 8.8 format
SNR_RX2	2 Octets	Averaged value of the SNR computed on RX2 path. It is a signed value in Q 8.8 format.
SNR_RX[N]	2 Octets	Averaged value of the SNR computed on RXN path. It is a signed value in Q 8.8 format.

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8.3 TEST_LOOPBACK_NTF

Table 73. TEST_LOOPBACK_NTF Extensions

Payload Field(s)	Length	Value/ Description
TEST_LOOPBACK_NTF		
Status	1 Octet	Refer Generic Status Codes
TX_TS_INT	4 Octet	Integer part of timestamp in 1/124.8 μs resolution
TX_TS_FRAC	2 Octet	Fractional part of timestamp in 1/124.8/512 μs resolution
RX_TS_INT	4 Octet	Integer part of timestamp in 1/124.8 μs resolution
RX_TS_FRAC	2 Octet	Fractional part of timestamp in 1/124.8/512 μs resolution
AoA Azimuth	2 Octet	AoA Azimuth in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.
AoA Elevation	2 Octet	AoA Elevation in degrees and it is a signed value in Q9.7 format. This field is zero if AOA_RESULT_REQ = 0.
PHR	2 Octet	Received PHR
PSDU Data Length	2 Octet	Length of PSDU DATA (N) to follow
PSDU_DATA	N Octet	Received PSDU Data bytes
Vendor Specific Data Length	2 Octets	Vendor Data Length, Vendor Data field is not present if Vendor Data Length = 0. Otherwise = (N+1) This Vendor Data Length field is present if NXP_EXTENDED_NTF_CONFIG is set to 0x01(Vendor extended notifications) and Vendor presence is based on Vendor Data Length
NXP Specific Data type	1 Octet	This parameter indicates the type of vendor specific data: 0x00 : Specific Data V1 for TEST_LOOPBACK_NTF
NXP Specific Data	N Octet	Vendor Data Refer TEST_LOOPBACK_NTF Vendor Specific Data for more details

Table 74. TEST_LOOPBACK_NTF Vendor Specific Data

Parameter Name	Length	Value/ Description
RX antenna information	1 +1 + N	RX mode and number of antenna used Octet[0] - 0x00 (TOA RX mode) Octet[1] - Number of RX antenna to follow - Octet[2] RX1 antenna ID - Octet[3] RX2 antenna ID ...

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Table 74. TEST_LOOPBACK_NTF Vendor Specific Data...*continued*

Parameter Name	Length	Value/ Description
		- Octet[N] RXN antenna ID
RSSI_RX1	2 Octets	Average value of the computed RSSI value on RX1 path. It is signed value expressed in Q8.8 format
RSSI_RX2	2 Octets	Average value of the computed RSSI value on RX2 path. It is signed value expressed in Q8.8 format
RSSI_RX[N]	2 Octets	Average value of the computed RSSI value on RXN path. It is signed value expressed in Q8.8 format
SNR_RX1	2 Octets	Averaged value of the SNR computed on RX1 path. It is a signed value in Q 8.8 format
SNR_RX2	2 Octets	Averaged value of the SNR computed on RX2 path. It is a signed value in Q 8.8 format.
SNR_RX[N]	2 Octets	Averaged value of the SNR computed on RXN path. It is a signed value in Q 8.8 format.
RX_CFO_EST	2 Octets	Average value of the computed carrier frequency offset estimate from the reception in PPM. It is a signed value in Q 5.11 format

8.4 TEST_CLK_SWITCHING_CMD

UWBS shall use TEST_CLK_SWITCHING_CMD command to perform the Clock switching test, FW will switch the clock from RFPLL to ADPLL and vice versa until the specified count. This command will be accepted only in UWBS state IDLE

Table 75. TEST_CLK_SWITCHING_CMD

Payload Field(s)	Length	Value/Description
Count	1 Octet	No of times the clock switching has to be performed Minimum =1, Max =255
Time in ms	1 Octet	Waiting time in milli seconds per switching Minimum =0, Max =255 Example - If count =10 and Time = 10 switching will happen 10 times and 1 switching takes 10ms.Total time taken before TEST_CLK_SWITCHING_NTF is sent will be 100ms

Table 76. TEST_CLK_SWITCHING_RSP

Payload Field(s)	Length	Value/Description
Status	1 Octet	Status values. Refer Table 36 in "FiRa Consortium - UCI Generic Specification_v1.1.0.4"

Table 77. TEST_CLK_SWITCHING_NTF

Payload Field(s)	Length	Value/Description
Status	1 Octet	Status values. 0x00: STATUS_OK

Notes:

- Host Application should wait for TEST_CLK_SWITCHING_NTF with a minimum timeout = Host Clock test NTF timeout = count * time + buffer (~50ms)

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- If TEST_CLK_SWITCHING_NTF is not received within "Host Clock test NTF timeout", than host application should start the recovery sequence
- If DEVICE_STATUS_NTF(Error) is received within "Host Clock test NTF timeout", than MW shall trigger a recovery sequence
- If TEST_CLK_SWITCHING_NTF is not received within "Host Clock test NTF timeout" and host receives DEVICE_STATUS_NTF(Error), than MW shall trigger the recovery sequence

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9 Debug Configurations

9.1 CIR log configuration

Below proprietary config parameter is used to enable the CIR log dump feature. DH shall use SET_VENDOR_APP_CONFIG_CMD command to enable the CIR log dump feature with CIR_LOG_NTF config.

Once CIR_LOG_NTF is set to non-zero, the UWBS starts sending below CIR log notifications to DH.

Table 78. CIR log Notification Packets (CIR_LOG_NTF)

Payload Field(s)	Length	Value/ Description
Session Handle	4 Octets	Session Handle for which data CIR NTF belongs
Slot Index	1 Octet	Slot index for which received RFrame
RX Antenna ID	1 Octet	RX Antenna ID for which received RFrame
Number of CIR sample	2 Octets	Number of CIR sample to follow
CIR0 log sample	(n * 4) Octets	CIR samples payload

9.2 PSDU log configuration

PSDU_LOG_NTF **config** parameter is used to enable/disable PSDU payload logging feature. DH shall use SET_VENDOR_APP_CONFIG_CMD command to enable this feature via PSDU_LOG_NTF configuration paramter.

Once PSDU_LOG_NTF is set to 0x01, the UWBS starts sending PSDU_LOG_NTF notification to DH. UWBS shall not send DBG_PSDU_LOG_NTF notification when DBG_PPDU_LOG_NTF application config is set to 0x00.

Table 79. PSDU_LOG_NTF

Payload Field(s)	Length	Value/ Description		
Session Handle	4 Octets	Session Handle for which PSDU payload belongs		
PSDU log Info	N * (3 + M) Octets	Slot Index	1 Octet	Slot Index of the PSDU in the Ranging Round
		PSDU Size	2 Octet	PSDU size in bytes
		PSDU Bytes	M Octets	PSDU payload (MFR+Payload) *Note: MFR is optional*

9.3 RFRAME log configuration

RFRAME_LOG_NTF config parameter is used to enable/disable RFRAME details feature. DH shall use SET_VENDOR_APP_CONFIG_CMD command to configure this feature via RFRAME_LOG_NTF parameter.

Once RFRAME_LOG_NTF is set to 0x01, the UWBS starts sending RFRAME details as DBG_RFRAME_LOG_NTF notification to DH.

Table 80. RFRAME Data Notification

Payload Field(s)	Length	Value/ Description
DBG_RFRAME_LOG_NTF		
Session Handle	4 Octets	Session Handle for which RFRAME details belongs
Number of RFRAME measurements	1	N: Number of RFRAME measurements to follow
Size of RFRAME measurement	1	Length of each RFRAME measurement
RFRAME log Info	N * RFRAME measurement	RFRAME measurement details

Table 81. RFRAME Notification Details

Payload Field(s)	Length	Value/ Description
RFRAME measurement details		
Mapping	1 Octet	bits[5:0] - RFRAME slot index bits[7:6] for H1 bit[6] - RFU bit[7] - 0: RX1, 1: RX2 for H1
Dec Status	1 Octet	Decode status of the RFRAME. Refer Table 82 for different decode status codes
NLoS	1 Octet	Indicates if the ranging measurement was in Line of sight or Non-Line of Sight. 0x00: LoS 0x01: NLoS 0xFF: Invalid
First Path Index	2 Octets	Estimated first path index in nanoseconds expressed in unsigned Q10.6 format
Main Path Index	2 Octets	Estimated main path index in nanoseconds expressed in unsigned Q10.6 format
SNR Main Path	1 Octet	Signal-to-Noise Ratio (SNR) of the main path in dB
SNR First Path	1 Octet	Signal-to-Noise Ratio (SNR) of the first path in dB
SNR Total	2 Octets	Signal-to-Noise Ratio (SNR) of configured RX in Q8.8 dB, it is used for internal purpose only.
RSSI	2 Octets	Received Signal Strength Indicator in dB. It is signed value expressed in Q8.8 signed format
CIR Main Power	4 Octets	CIR main power : It represents cir_real^2 + cir_imag^2 of the main path. This is unsigned 32bit value.
CIR first path power	4 Octets	CIR first path power : It represents cir_real^2 + cir_imag^2 of the first path. This is unsigned 32bit value.

Table 81. RFRAME Notification Details...*continued*

Payload Field(s)	Length	Value/ Description
Noise variance	2 Octets	Noise variance in the CIR
CFO	2 Octets	CFO estimate in PPM. It is signed value coded in Q5.11 format.
AoA Phase	2 Octets	Phase in degrees expressed in Q9.7 format, used for calculating phase difference
CIR samples	16*2*2 Octets	CIR samples from (first path index-8) to (first path index+7) Octet[4*i+1:4*i+0] = Real value Octet[4*i+3:4*i+2] = Imaginary value
RX_TIMESTAMP	6 Octets	Octet [0:3] - Integer part of timestamp when RMARKER has been received Octet [4:5] - Fractional part of timestamp when RMARKER has been received. Fractional part is coded in Q7.9 format

Table 82. Rx decode status codes in RFRAME

Codes	Description
0x00	STATUS_RX_ACQ_FAILURE: Signal acquisition failed
0x01	STATUS_RX_SECDEC_FAILURE: Single error correction decoding failed
0x02	STATUS_RX_RSDEC_FAILURE : Reed solomon decoding failed
0x03	STATUS_RX_DEC_FAILURE : Generic error for packet decode failure
0x04	STATUS_RX_DEC_SUCCESS : Packet decode success
0x05	STATUS_RX_DEC_NO_DATA : No data frame received (SYNC+STS only frame)
0x06	STATUS_PHY_RX_ERR : Generic receive error
0x07	STATUS_RX_STS_FAILURE: Generic error for STS mismatch failure
0x08	STATUS_RX_TOA_DETECT_FAILURE TOA detect failure
0x09	STATUS_RX_PHR_DEC_FAILURE PHR decoding failure
0x0A	STATUS_RX_SYNC_SFD_FAILURE Sync or start frame delimiter is not received
0x0B	STATUS_PHR_DATA_RATE_ERROR In PHR data rate error

Table 82. Rx decode status codes in RFRAME_...continued_

Codes	Description
0x0C	STATUS_RX_PHR_RANGING_ERROR In PHR ranging setting error

9.4 KDF debug notification

UWBS shall communicate output of KDF functionality to HOST through the UWB_SESSION_KDF_NTF notification.

The generation of UWB_SESSION_KDF_NTF notification shall be enable via TEST_KDF_FEATURE configuration.

KDF debug feature shall enable/disabled by using TEST_KDF_FEATURE proprietary configuration. As KDF feature is specific to session and shall be enabled using SESSION_SET_VENDOR_APP_CONFIG_CMD command with TEST_KDF_FEATURE config.

UWBS shall keep generating UWB_SESSION_KDF_NTF notification and send it those notifications DH when TEST_KDF_FEATURE is set to 0x01 and when KEY_ROTATION_RATE condition satisfies

Table 83. UWB_SESSION_KDF_NTF

Payload Field(s)	Length			Value/ Description
Number of Parameters	1 Octet			The number of Parameter fields to follow (n)
Parameter [1..n]	m+2 Octets	ID	1 Octet	The identifier of the configuration parameter. Refer Table 84
		Length	1 Octet	The length of Val (m).
		Value	m Octets	The value of the parameter Refer Table 84

Table 84. Parameters in UWB_SESSION_KDF_NTF for Fira Session

Parameter Name	Length (Octets)	Tag (IDs)	Description
KDF_BLOCK_INDEX	2	0x00	Block Index on which key rotation was applied
KDF_STS_INDEX	4	0x01	STS index value used for KDF
KDF_FIRA_CONFIG_DIGEST	17	0x02	Config digest value _(Applicable in FiRa Ranging session)_
KDF_FIRA_DERIVED_AUTH_IV	16	0x03	Derived Authentication IV _(Applicable in FiRa Ranging session)_
KDF_FIRA_DERIVED_AUTH_KEY	16	0x04	CMAC of Derived Authentication Key in FiRa UWB session _(Applicable in FiRa Ranging session)_
KDF_FIRA_DERIVED_PAYLOAD_KEY	16	0x05	CMAC of KDF Context Data using Derived Payload Key _(Applicable in FiRa Ranging session)_

Table 84. Parameters in UWB_SESSION_KDF_NTF for Fira Session...*continued*

Parameter Name	Length (Octets)	Tag (IDs)	Description
KDF_FIRA_DATA_PROTECTION_KEY	16	0x06	CMAC of FiRa data protection key *(Applicable in FiRa Ranging session)*
KDF_FIRA_PRIVACY_KEY	16	0x08	FIRA data privacy key *(Applicable in FiRa Ranging session)*
KDF_FIRA_NOTIFICATION_KEY	16	0x09	FIRA data notification key *(Applicable in FiRa Ranging session)*
KDF_CCC_RANGING_ CONFIGURATION	17	0xA0	Negotiated Ranging Configuration data (Applicable in CCC Ranging session)
KDF_CCC_MUPSK1	16	0xA1	CMAC of mUPSK1 key. mUPSK1 is used in order to encrypt the Type 2 Pre-POLL. (Applicable in CCC Ranging session)
KDF_CCC_DURSK	16	0xA2	CMAC of dURSK key. Derived UWB Ranging Secret Key (Applicable in CCC Ranging session)
KDF_CCC_DUDSK	16	0xA3	CMAC of dUDSK key. Derived UWB Data Secret Key (Applicable in CCC Ranging session)
KDF_CCC_SALTED_HASH	16	0xA4	CMAC of Salted Hash. Salted Hash of configuration (Applicable in CCC Ranging session)
KDF_CCC_MURSK	16	0xA5	CMAC of mURSK key. Master UWB Ranging Secret Key (Applicable in CCC Ranging session)
KDF_CCC_MUPSK2	16	0xA6	CMAC of mUPSK2 key. mUPSK2 is used to derive the UWB addresses. (Applicable in CCC Ranging session)

9.5 Error log information

SR150 notifies device panic state as STATUS_ERROR in DEVICE_STATUS_NTF. DH shall use

DBG_GET_ERROR_LOG_CMD command to fetch the error log from SR150 in STATUS_ERROR state. SR150 responds by DBG_GET_ERROR_LOG_RSP with error log data.

Table 85. Control messages to fetch error log (DBG_GET_ERROR_LOG_CMD)

Payload Field(s)	Length	Value/ Description
Command	0 Octet	Get error log information

The crash log buffer will have the following information:

Table 86. DBG_GET_ERROR_LOG_RSP

Payload Field(s)	Length	Value/ Description
Exception Type	4 Octets	As defined in the Exception types
R0	4 Octets	Cortex-M33 CPU core R0 register
R1	4 Octets	Cortex-M33 CPU core R1 register
R2	4 Octets	Cortex-M33 CPU core R2 register
R3	4 Octets	Cortex-M33 CPU core R3 register
R12	4 Octets	Cortex-M33 CPU core R12 register
LR	4 Octets	Cortex-M33 CPU core Link Register
PC	4 Octets	Cortex-M33 CPU core Program Counter register
PSR	4 Octets	Cortex-M33 CPU Program Status Register
STACK_WORDS	128 Octets	Crash stack words
S_CFSR	4 Octets	Cortex-M33 Secure Configure Fault Status Register
NS_CFSR	4 Octets	Cortex-M33 Non-secure Configure Fault Status Register
HFSR	4 Octets	Cortex-M33 Hard Fault Status Register
DFSR	4 Octets	Cortex-M33 Debug Fault Status Register
AFSR	4 Octets	Cortex-M33 Auxiliary Fault Status Register
BFAR	4 Octets	Cortex-M33 Bus Fault Address R Register
MMFAR	4 Octets	Cortex-M33 Memory Management Fault Address Register
FW_STAT	4 Octets	Firewall Status Register
FW_BUS_ERR_INFO	28 Octets	Firewall bus error information Registers
FW_SEC_ERR_INFO	8 Octets	Firewall security error information Registers

Table 87. Exception types

Type	Description
0x00	No Fault
0x01	Hard Fault
0x02	Bus Fault
0x04	Secure Fault
0x08	Usage Fault
0x10	Watchdog
0x20	CoolFlux Fault
0x40	Assert Fault log. Refer Assert fault log information

Note: When No Fault occurs DBG_GET_ERROR_LOG_RSP will be only 4 octets long

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Table 88. Assert fault log information

Payload Field(s)	Length	Value/ Description
Exception Type	4 Octets	0x00000040
Assertion Code	2 Octets	Assertion Error code, refer Table 89
Line Number	4 Octets	Line number from the file below

Table 89. Assertion Error Code

Assertion Code	Value	Description
VCO_LOCK_FAIL	34	PLL not locked.
RF_CLK_ABSENT	36	RF Clock is not available after waiting time.

Table 90. Device Specific Assertion Error Codes

Assertion Code	Value	Description
WATCH_DOG_TIMEOUT	77	Watch dog reset
LPUART_INVALID_INSTANCE	78	Incorrect reference for LPUART
SYS_TIMER_FAILURE	79	Problem in sysTimer tick reading
NSC_API_FAIL	80	Checks failed in NSC API

9.6 WiFi Co-Existence Feature

9.6.1 Debug notification for WIFI CoEx status

UWB_WLAN_IND_STATUS_NTF notification is used to notify the UWB_WLAN_IND GPIO toggle status . This notification shall be sent when *GPIO* based CoEx feature with debug verbose is enabled via WIFI_COEX_FEATURE config

9.6.1.1 GPIO based CoEx feature debug notification

Below is the UWB_WLAN_IND_STATUS_NTF notification format is received when GPIO *or OneWire* based CoEx feature with debug verbose is enabled via WIFI_COEX_FEATURE config

Table 91. UWB_WLAN_IND_STATUS_NTF

Payload Field(s)	Length	Value/ Description
Status	1 Octet	UWB_WLAN_IND GPIO Status 0x00 : High to Low 0x01 : Low to High
Time index	4 Octets	Time index where the GPIO change occurred
Session Handle	4 Octets	Session Handle with which UWB_WLAN_IND_STATUS_NTF notification belongs.

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9.6.2 Debug notification for WLAN_UWB_IND status during ranging round *(only for GPIO)*

WLAN_UWB_IND_STATUS_NTF notification is used to notify the WLAN_UWB_IND GPIO status during ranging round. This notification shall be sent when WIFI_COEX_FEATURE config is set to 0x02 (Enable with Debug Verbose)

Table 92. WLAN_UWB_IND_STATUS_NTF

Payload Field(s)	Length	Value/ Description
Status	1 Octet	**0x01: WLAN_UWB_IND_HIGH_AT_RR_START** WLAN_UWB_IND GPIO is high at the start of the ranging round and ranging round shall be attempted **0x02: WLAN_UWB_IND_HIGH_DURING_RR** WLAN_UWB_IND GPIO changed to high during Ranging round *Note : Don't need to report status 0x00 for this notification*
Time index	4 Octets	Time index where the GPIO change occurred

Note:

When Wifi Coex feature is enabled, Wlan State will be checked twice

One before ranging and one during ranging.

- *Pre Check (before Ranging) - If pin state from Wlan to UWB is high, Wlan state set to WLAN_UWB_IND_HIGH_AT_RR_START(0x01),*

- *Post Check (during Ranging) - If Wlan state is not set during Pre Check, Wlan State is set as WLAN_UWB_IND_HIGH_DURING_RR(0x02) in Post check Else, will retain the state set in Pre Check.*

9.6.3 Maximum Grant duration exceeded warning notification

The UWBS shall send warning UWB_WLAN_COEX_MAX_GRANT_DURATION_EXCEEDED_WRN_NTF notification when maximum active grand duration is exceeded.

This notification will be sent for OneWire CoEx when required ranging runtime > MAX_WIFI_BLOCKAGE_DURATION.

Table 93. UWB_WLAN_COEX_MAX_GRANT_DURATION_EXCEEDED_WRN_NTF

Payload Field(s)	Length	Value/ Description
Status	1 Octet	0x00: MAX Active Grant Duration Exceeded Warning Notification

10 UWBS Device Calibration

10.1 Performing Device Calibration

10.1.1 Calibration of CHIP

Below commands are used to perform the calibration for requested parameter. UWBS shall perform calibration process by itself and return the calibrated value via DO_CHIP_CALIBRATION_NTF notification after calibration process is completed.

The UWBS shall not accept another DO_CHIP_CALIBRATION_CMD if DO_CHIP_CALIBRATION_NTF is pending. UWBS shall reject command by DO_CHIP_CALIBRATION_RSP with STATUS_CALIBRATION_IN_PROGRESS indicating that calibration process is under progress.

Table 94. DO_CHIP_CALIBRATION_CMD

Payload Field(s)	Length	Value/Description
DO_CHIP_CALIBRATION_CMD		
Channel ID	1 Octet	**Channel IDs**

Table 95. DO_CHIP_CALIBRATION_RSP

Payload Field(s)	Length	Value/Description
DO_CHIP_CALIBRATION_RSP		
Status	1 Octet	Status values. Refer Status Codes. Below fields are valid if status is STATUS_OK

Table 96. DO_CHIP_CALIBRATION_NTF

Payload Field(s)	Length	Value/Description
DO_CHIP_CALIBRATION_NTF		
Status	1 Octet	Status values. Refer Status Codes. Below fields are valid if status is STATUS_OK
Value	2 Octets	bit[8:0] : Calibration code bit[14:9] : RFU bit[15] : Calibration status as below • 0b1: Calibration is valid • 0b0: Calibration is invalid

10.2 Setting Calibration Parameters

Below UCI commands are used to set the calibration values for requested parameter and channel Generally the calibrated values shall be set during UWBS power on sequence.

Table 97. SET_DEVICE_CALIBRATION_CMD

Payload Field(s)	Length	Value/Description
Channel ID	1 Octet	Channel ID for which calibration to be applied. **Channel IDs**

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Table 97. SET_DEVICE_CALIBRATION_CMD...*continued*

Payload Field(s)	Length	Value/Description
Tag	1 Octet	Calibration parameter for which calibration to be configured. Refer Calibration Parameters for Tag IDs and Values.
Length	Length depends on the parameter	Refer Calibration Parameters
Value	N Octets	Calibration value Refer Calibration Parameters

Table 98. SET_DEVICE_CALIBRATION_RSP

Payload Field(s)	Length	Value/Description
Status	1 Octet	Status values. Refer Status Codes

10.3 Retrieving Calibration Parameters

Below UCI commands are used to get the configured calibration values for requested parameter and channel. The UWBS shall respond via GET_DEVICE_CALIBRATION_RSP with configured calibration values.

Table 99. GET_DEVICE_CALIBRATION_CMD

Payload Field(s)	Length	Value/Description
Channel ID	1 Octet	**Channel IDs**
Tag	1 Octet	Calibration parameter for which calibration to retrieved. Refer Calibration Parameters for Tag IDs and Values.
RX Antenna Pair ID	1 Octet	Only applicable when calibration parameter ID is AOA_ANTENNAS_PDOA_CALIB. This Octet shall be set to Rx Antenna Pair ID as defined by ANTENNAS_RX_PAIR_DEFINE for which the PDoA Calibration table needs to be retrieved. For the other Calibration Parameter IDs this field is not required to be used.

Table 100. GET_DEVICE_CALIBRATION_RSP

Payload Field(s)	Length	Value/Description
GET_CALIBRATION_RSP		
Status	1 Octet	Status values. Refer Status Codes. Below fields are valid if status is STATUS_OK
Calibration state	1 Octet	Refer Calibration Parameter States for possible Calibration Parameter State
Tag	1 Octet	Tag of the calibration parameter
Length	Refer Calibration Parameters	Length of the value following

Table 100. GET_DEVICE_CALIBRATION_RSP...*continued*

Payload Field(s)	Length	Value/Description
Value	n Octets	Calibration value for requested channel and parameter. Note: FW will return the calibration data for maximum Rx antenna pairs (ANTENNAS_RX_PAIR_DEFINE) or Rx antennas (ANTENNA_RX_IDX_DEFINE) or Tx Antennas (ANTENNA_TX_ IDX_DEFINE) as per Table 63, Host has to ignore all the entries beyond the entries configured via CORE_SET_CONFIG

Table 101. Calibration Parameter States

Value	Calibration state	Description
0x00	DEFAULT	Calibration parameter carries default value by UWBS

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10.4 Calibration Parameters

Table 102. Calibration Parameters

Parameter name	Tag	Length	Value range/Description
Calibration Parameters			
CHIP_CALIBRATION	0x00	2 Octets	Description details are in the next immediate row
			Value determined during calibration process and this parameter is channel dependent. Channel number to be provide in calibration commands to set this parameter. bits[0-14] : Calibration code bit[15] : Calibration status as below 0: Calibration failure 1: Calibration success
RF_CLK_ACCURACY_CALIB	0x01	7 Octets	Channel independent and remains same for each channel and channel number in calibration command shall be ignored by UWBS. For Board Variant: **[0x2A, 0x03]** • Octet [0]: Number of registers (must be 0x03) • Octet [2-1]: 38.4 MHz XTAL CAP1 (Default: 0x13) • Octet [4-3]: 38.4 MHz XTAL CAP2 (Default: 0x13) • Octet [6-5]: 38.4 MHz XTAL GM CURRENT CONTROL (Default: 0x30) Rest all variants (Except [0x2A, 0x03]) • Octet [0]: Number of registers (must be 0x03) • Octet [2-1]: 38.4 MHz XTAL CAP1 (Default: 0x0F) • Octet [4-3]: 38.4 MHz XTAL CAP2 (Default: 0x0F) • Octet [6-5]: 38.4 MHz XTAL GM CURRENT CONTROL (Default: 0x21) Values : [0x00-0xFF] for 38.4 MHz XTAL CAP Values : [0x00-0x3F] for 38.4 MHz XTAL GM
RX_ANT_DELAY_CALIB	0x02	1 + (N*3) Octets	Delay Calibration for each RX Antenna This parameter is channel dependent **Channel IDs** • Octet[0]: Number of Entries (Must be greater than 0) • [– 1 Octet: RX Antennas IDs as defined by ANTENNA_RX_IDX_DEFINE

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Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
			– 2 Octets each: RX Delay (unsigned Q14.2).] (Repeat) (Default: 0x0000 for all RX antenna IDs) Example to Set RX Delay Calib for Antenna ID =0x01,0x02,0x03 for Channel 5 and 9 • Other lifecycle: SET_DEVICE_CALIBRATION_CMD **–** channel Id=5, Calibration Param=0x02 = Rx Ant Delay calib **–** Number Of entries = 3 **–** Ant ID : 0x01, Delay Value1 **–** Ant ID : 0x02, Delay Value2 **–** Ant ID : 0x03, Delay Value3 Repat the same command for Channel 9 RX_ANT_DELAY_CALIB unit is cm and step size is 0.25 cm i.e value 1 =0.25 cm
PDOA_OFFSET_CALIB (Channel_ID 5 setting is applied to channels 5 and 8) (Channel_ID 9 setting is applied to channels 6 and 9)	0x03	1 + N*(1+2) Octets	PDOA Offset Calibration This parameter is channel dependent **Channel IDs** • Octet[0]: Number of Entries (Must be greater than 0) (Depends on available RAM) • [**–** 1 Octet each: RX Antennas PAIR IDs as defind by ANTENNAS_RX_PAIR_DEFINE **–** 2 Octets each: PDoA Offsets. (signed value in Q9.7 format)] (Repeat) (Default: 0x0000 for all RX antenna pair ID) Example to Set PDoA Offset Calib for Antenna Pair ID=0x01, 0x02, 0x03 for Channel 5 and 9 SET_DEVICE_CALIBRATION_CMD(ch Id=5, Calib Param=0x10 = PDoA1, No Of Entries=3, Ant ID=0x01,PDOA Value1, 0x02,PDOA Value2, 0x03,PDOA Value3) Repeat the same command for Channel 9 GET_DEVICE_CALIBRATION_CMD is a cyclic fetch logic as explained below First Invocation GET_DEVICE_CALIBRATION_CMD (ch Id=5, Calib Param=0x10) will report the data for PAIR1

Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
			Second Invocation GET_DEVICE_CALIBRATION_CMD (ch Id=5, Calib Param=0x10) will report the data for PAIR2 Repeats until MAX_N of ANTENNAS_RX_PAIR_DEFINE See Table 63 for max value of MAX_N ***Note:*** *Refer **Recommendation while using Calibration Parameters***

TX_POWER_PER_ANTENNA	0x04	1 + (N*5) Octets	TX POWER
			This parameter is channel dependent
			channel_ID :
			Channel IDs
			• Octet[0]: Number of Entries (Must be greater than 0)
			• [
			  – 1 Octet : TX Antenna IDs as defind by ANTENNAS_TX_IDX_DEFINE
			  – 2 Octets : TX_POWER_DELTA_PEAK
			    - If TX_ADAPTIVE_PAYLOAD_POWER is enabled, this value represents the delta peak ie : PEAK_ID - RMS_ID. This value is a delta and comes from calibration process, It ranges from 0 (max power) to 127 (min power) with steps of 0.25.
			    - If TX_ADAPTIVE_PAYLOAD_POWER is not enabled, this value has no specific use.
			  – 2 Octets : TX_POWER_ID_RMS
			    - If TX_ADAPTIVE_PAYLOAD_POWER is enabled, this value come from RMS calibration as RMS_ID
			    - If TX_ADAPTIVE_PAYLOAD_POWER is not enabled, this value serves as a gain index for TX power control. It ranges from 0 (max power) to 127 (min power) with steps of 0.25.
			] (Repeat)
			Default value for all: 0x00
			Note: TEST_LOOPBACK_CMD is rejected if TX_POWER_ID_RMS is below than 80

MANUAL_TX_POW_CTRL	0x60	5 Octets	Refer Tx Power Control parameter for details Octet [0]: PA_GAIN (default: 0x00) Octet [1]: PA_DRIVE_GAIN (default: 0x00) Octet [2]: DIG_GAIN (default: 0x00) Octet [3]: TX_DAC_GAIN (default: 0x38) Octet [4]: RFU

Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
AOA_ANTENNAS_PDOA_CALIB (Added for 360 FoV)	0x62	1 + N*(1 + S*S*2) Octets	PDOA Calibration tables Octet[0] : No of entries, it shall be set to 1 for Set Calibration Cmd. (Refer to a) of <u>Note</u> for this limitation.) Octet[1] : RX Pair Antennas ID as defined *earlier* by <u>ANTENNAS_RX_PAIR_DEFINE</u> Octet[2 - M]: PDoA calibration table for specified RX Pair Antennas ID. For details on the format refer <u>AOA_CALIB_CTRL_RX_ANT_PAIR_1_CH5</u>. The older entries would get overwritten, if more than supported data is uploaded to the UWBS. See <u>Table 63</u> for max supported calibration tables per channel per antennas pair. S is number of steps is Octet[1] of <u>PDOA_CALIB_TABLE_DEFINE</u> Allowed Range: 3<= S <= 17 (to include 0^o(default : 11) N = 1 Always <u>Note</u>: a) In order to support Hosts that can not send more than 255 + 4 bytes, this UCI interface can only be used to set PDoA calibration table for one RX Pair Antennas ID at a time. b) The Get Calibration Cmd response for this ID returns the total number of "RX Pair Antennas IDs" for which PDOA calibration table is set in Octet[0]. ***Note:*** *Refer **Recommendation while using Calibration Parameters***

AOA_ANTENNAS_MULTIPOINT_CALIB (Added for 360 FoV. Supersedes AOA_MULTIPOINT_CALIB) (Only Set Calib is supported, Get Calibration is not supported for this parameter)	0x63	1 + M(1 + *N*4)) Octets	Multi point ('N') PDoA manufacturing offset calibration command for each of 'M' Rx Antenna Pairs IDs.Each of the N points PDoA manufacturing value corrects the PDoA calibration value for specified coordinate in the PDoA calibration table. Each point is of 4 octet value and the description for the format of each point is specified below. The max size of N is limited by max Rx Antenna Pairs that is configured and the max possible command length for this command.
			• Octet[0]: Number of Entries of Rx Antenna Pair IDs ('M')
			• [
			  – 1 Octet each: RX Antennas IDs as defined *earlier* by <u>ANTENNAS_RX_PAIR_DEFINE</u>
			  – N PDoA Manufacturing Calibration Points Repeated N * 4 octets per Rx Antenna Pair: [
			    – Octet[0] Azimuth co-ordinate
			      The azimuth coordinate of the additional calibration point -128° offset (for getting negative and positive calibration points), the unit is ° (LSB is one °). The point needs to have the position of one calibration point within the table.
			    – Octet[1] Eelevation Co-Oridnate.

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Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
			The elevation coordinate of the additional calibration point -128° offset (for getting negative and positive calibration points), the unit is ° (LSB is one °). The point needs to have the position of one calibration point within the table. – Octets[3,2] PDoA measurement The PDoA measurement at this point in Q9.7 Format. (In Little Endian Format) – *Repeat of same 4 octets for the remaining points.* ...]] (repeat) Since we have different Horizontal and Vertical Anteanne Paris, Here we only set PDoA meassurement. No need to have PDoA1, PDoA2 meassurement here.
PDOA_MANUFACT_ZERO_OFFSET_CALIB	0x65	1 + (N*1) + (N*2) Octets	Zero offset Manufacturing PDOA Calibration • Octet[0]: Number of Entries (Must be greater than 0) (Depends on available RAM) • [– Array of 1 Octet each: RX Antennas PAIR IDs as defind by ANTENNAS_RX_PAIR_DEFINE – Array of 2 Octets each: Manufacture PDOA1 Offset] (Repeat) Example to Set PDoA1 Calib for Antenna Pair ID=0x01, 0x02, 0x03 for Channel 5 and 9 SET_DEVICE_CALIBRATION_CMD (ch Id=5, Calib Param=0x10 = PDoA1, No Of Entries=3, Ant ID=0x01,Offset Calib Val1, 0x02,Offset Calib Val2, 0x03,Offset Calib Val3) Repat the same command for Channel 9 Supersedes Antenna Spacing enable in "AOA_CALIBRATION_CTRL" This value (PDOA_MANUFACT_ZERO_OFFSET_CALIB) will have higher precedence as compared to this PDOA_OFFSET_CALIB. ***Note:*** *Refer Recommendation while using Calibration Parameters*
AOA_THRESHOLD_PDOA	0x66	1 + (N*1) + (N*2) Octets	AoA Threshold PDOA

Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description

			• Octet[0]: Number of Entries (Must be greater than 0)
			• [
			  – Array of 1 Octet each: RX Antennas PAIR IDs as defind by <u>ANTENNAS_RX_PAIR_DEFINE</u>
			  – Array of 2 Octets each: Threshold Values
			  ] (Repeat)
			
			Example to Set Threshold for Antenna Pair ID=0x01, 0x02, 0x03 for Channel 5 and 9
			SET_DEVICE_CALIBRATION_CMD (ch Id=5, Calib Param=0x15 = Threshold PDoA, No Of Entries=3, Ant ID=0x01,Threshold PDoA Value1, 0x02,Threshold PDoA Value2, 0x03,Threshold PDoA Value3)
			Repat the same command for Channel 9.
			Supersedes Threshold PDoA in "AOA_CALIB_CTRL_THRESHOLD_PDOA"
			Note: Refer ***Recommendation while using Calibration Parameters***

TX_TEMPERATURE_COMP_PER_ANTENNA	0x67	1 + N*(1+8) Octets	TX temperature compensation per antenna
			Channel IDs
			• Octet[0]: Number of Entries (Must be greater than 0)
			• [
			  – 1 Octet : TX Antenna IDs as defind by ANTENNAS_TX_IDX_DEFINE
			  – 1 Octet : RANGE1_TX_POWER_UPPER_BOUND
			  – 1 Octet : RANGE1_TX_POWER_GAIN_OFFSET
			  – 1 Octet : RANGE2_TX_POWER_UPPER_BOUND
			  – 1 Octet : RANGE2_TX_POWER_GAIN_OFFSET
			  – 1 Octet : RANGE3_TX_POWER_UPPER_BOUND
			  – 1 Octet : RANGE3_TX_POWER_GAIN_OFFSET
			  – 1 Octet : RANGE4_TX_POWER_UPPER_BOUND
			  – 1 Octet : RANGE4_TX_POWER_GAIN_OFFSET
			  ] (Repeat)
			• TX_POWER_UPPER_BOUND:
			  Upper bound for the temperature value. It is a signed number to allow the configuration of negative temperature
			  Default value: 0x80(Disable)

Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
			• TX_POWER_GAIN_OFFSET: Offset to be applied on the Tx power gain table for a specific temperature range. it's a signed number. Default value : 0x00 Associated offset from TX_POWER_GAIN_OFFSET will be applied if measured temperature is below the associated TX_POWER_UPPER_BOUND.

SNR_CALIB_CONSTANT_PER_ ANTENNA	0x68	1 + N*(2) Octets	SNR Calibration per RX Antenna
			 This parameter is channel dependent
			 Channel IDs
			 • Octet[0]: Number of Entries (Must be greater than 0)
			 • [
			    – 1 Octet : RX Antenna IDs as defind by ANTENNAS_RX_IDX_DEFINE
			    – 1 Octet : SNR Calibration (value in dB)
			    ] (Repeat)
			    Default value for all: 0x00

RSSI_CALIB_CONSTANT_PER_ ANTENNA	0x69	1 + (N*1) Octets	RSSI Offset per RX Antenna for High/Low Power
			 This parameter is channel dependent
			 channel_ID :
			 Channel IDs
			 • Octet[0]: Number of Entries (Must be greater than 0)
			 • [
			    – 1 Octet : RX Antenna IDs as defind by ANTENNAS_RX_IDX_DEFINE
			    – 1 Octet : RSSI Calib (value in dB)
			    ] (Repeat)
			    Default value for all: 0x00

Reserved for Vendor Specific	0x82 - 0xDF		Reserved for Vendor Specific
Reserved For Extension of ID's			
Extended Vendor Specific Parameters	0xE0	2 Octets	Parameter ID is 2 octets in length. Refer Extended Calibration Parameters.

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Table 102. Calibration Parameters...*continued*

Parameter name	Tag	Length	Value range/Description
RFU	0xE1-0xFF	N Octets	RFU

Recommendation while using Calibration Parameters

Host must follow the following recommendations for all calibration parameters applying to either a RX antenna or a RX antenna pair or a TX antenna.

Calibration parameters can be divided in 4 groups:

- Group 1: Calibration applying to RX antennas:
  - RX_ANT_DELAY_CALIB
  - RSSI_CALIB_CONSTANT_PER_ANTENNA
  - SNR_CALIB_CONSTANT_PER_ANTENNA

- Group 2: Calibration applying to RX antenna pairs:
  - PDOA_OFFSET_CALIB
  - PDOA_MANUFACT_ZERO_OFFSET_CALIB
  - AOA_ANTENNAS_PDOA_CALIB
- Group 3: Calibration applying to TX antennas:
  - TX_POWER_PER_ANTENNA
  - TX_TEMP_COMP_PER_ANTENNA
  - TX_ANT_DELAY_CALIB
- Group 4: Other general calibration parameters:
  - Below guidelines don't apply to this group

NXP recommendation is to use the same number of entries and order of IDs within each calibration group.

For instance, you can refer to below examples

- Example 1: Valid config - Host defines calibration with same number and order
  - SET_CALIB(RX_ANT_DELAY_CALIB, Ant.ID1, Ant.ID2, Ant.ID3)
  - SET_CALIB(RSSI_CALIB_CONSTANT_PER_ANTENNA, Ant.ID1, Ant.ID2, Ant.ID3)
  - SET_CALIB(PDOA_OFFSET_CALIB, Ant.PairID1, Ant.ID2)
  - ANTENNAS_CONFIGURATION_RX(Ant.PairID1, Ant.PairID2)
- Example 2: Invalid config - Host doesn't define same number of antennas within a group
  - SET_CALIB(RX_ANT_DELAY_CALIB, Ant.ID1, Ant.ID2, Ant.ID3)

– SET_CALIB(RSSI_CALIB_CONSTANT_PER_ANTENNA, Ant.ID1, Ant.ID2)
- Example 3: Invalid config - Host use an uncalibrated antenna pair
  – SET_CALIB(PDOA_OFFSET_CALIB, Ant.PairID1, Ant.PairID2)
  – ANTENNAS_CONFIGURATION_RX(Ant.PairID1, Ant.PairID3)

UWBS FW does not enforce a check to reject those mismatches b/w ANTENNAS_CONFIGURATION_RX vs SET_CALIBRATION_CMD and SET_CALIBRATION_CMD consistency within the same calibration group. Therefore Host configuration may ensure proper configuration is being defined.

Table 103. Extended Calibration Parameters

Parameter Name	Len (Octets)	Tag(Ext ID's)	Sub ID's	Description
AOA_ANTENNAS_PDOA_CALIB_ EXTENDED_SUPPORT	1 + N*(1 + S*S*2) Octets	0xE0	0x00	This parameter is used to set the PDoA Calibration Table Octet[0] : No of entries, it shall be set 1 for Set Calibration Cmd. Octet[1] : RX Pair Antennas ID as defined earlier by ANTENNAS_RA_PAIR_DEFINE Octet[2 - (S * S* 2)] : PDoA calibration table for specified RX Pair Antennas ID. S will have value of Octet[1] from PDOA_CALIB_TABLE_DEFINE. Allowed Range: 3<= S <= 17 (to include 0^o(default : 11) Refer the legacy 'AOA_ANTENNAS_PDOA_CALIB' parameter description for more details. Note: The Get Calibration Cmd response for this ID returns the total number of "RX Pair Antennas IDs" for which PDOA calibration table is set in Octet[0]. N = 1 Always ***Note:*** Refer ***Recommendation while using Calibration Parameters***

Table 104. Calibration Table for RSSI and SNR CALIB constants

Board Variant	Rx Antenna Pair	Table		RSSI CALIB CONSTANT1 or RSSI CALIB CONSTANT2 per CH		SNR CALIB CON STANT per CH	
			Index	RX1	RX2	RX1	RX2
BOARD_VARIANT_NXPREF_V1 BOARD_VARIANT_NXPREF_V2	0x01 - UWB_ANT0 & UWB_ANT1 (default = 1)	0	0	1 octet	1 octet	1 octet	1 octet

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Table 104. Calibration Table for RSSI and SNR CALIB constants...*continued*

Board Variant	Rx Antenna Pair	Table	Index	RSSI CALIB CONSTANT1 or RSSI CALIB CONSTANT2 per CH		SNR CALIB CONSTANT per CH	
				RX1	RX2	RX1	RX2
BOARD_VARIANT_RHODES_V1 BOARD_VARIANT_RHODES_V2							
BOARD_VARIANT_RHODES_V4	0x01 - UWB_ANT2 & UWB_ANT0 0x02 - UWB_ANT2 & UWB_ANT1 0x04 - UWB_ANT3 & UWB_ANT0 0x08 - UWB_ANT3 & UWB_ANT1	5	0	1 octet	1 octet	1 octet	1 octet
			1	1 octet	1 octet	1 octet	1 octet
			2	1 octet	1 octet	1 octet	1 octet
			3	1 octet	1 octet	1 octet	1 octet
	0x01 - UWB_ANT3 & UWB_ANT2 0x02 - UWB_ANT4 & UWB_ANT2 0x04 - UWB_ANT3 & UWB_ANT1 0x08 - UWB_ANT4 & UWB_ANT1 (default = 1)	3	0	1 octet	1 octet	1 octet	1 octet
			1	1 octet	1 octet	1 octet	1 octet
			2	1 octet	1 octet	1 octet	1 octet
			3	1 octet	1 octet	1 octet	1 octet

Table 105. Manual Tx Power Control parameter

Parameters	Size (Octet)	Description
PA GAIN	1	Assigns PA gain value to be used for Tx operation [31,15,7,3,1,0]
PA DRIVE GAIN	1	Assigns PA drive gain value to be used for Tx operation [7,3,1,0]
DIG GAIN	1	Assigns digital gain value to be used for Tx operation [127 - 64]
TX DAC GAIN	1	Assigns Tx DAC gain value [56, 28, 14]

Table 105. Manual Tx Power Control parameter *...continued*

Parameters	Size (Octet)	Description
RFU	1	RFU

Table 106. Calibration Table for PDoA offset

Board Variant	Rx Antenna Pair	Table	Index	PDOA Offset
BOARD_VARIANT_NXPREF_V1 BOARD_VARIANT_NXPREF_V2 BOARD_VARIANT_RHODES_V1 BOARD_VARIANT_RHODES_V2	0x01 - UWB_ANT0 & UWB_ANT1 (default = 1)	0	0	2 octets
	0x01 - UWB_ANT3 & UWB_ANT2 0x02 - UWB_ANT4 & UWB_ANT2 0x04 - UWB_ANT3 & UWB_ANT1 0x08 - UWB_ANT4 & UWB_ANT1 (default = 1)	3	0	2 octets
			1	2 octets
			2	2 octets
			3	2 octets

10.5 Write/Read Calibration Parameter Data to/from OTP

10.5.1 Calibration Parameters stored in OTP

Following are the calibration parameters stored in OTP. OTP size is allocated to accommodate the current and future requirements with respect to different boards and number of antennas.

Table 107. Calibration Parameters stored in OTP

Parameter Name	Total Size in Bytes	OTP Calibration Parameter ID
OTP_CHIP	8	0x00
OTP_TX_POWER_PER_ANTENNA	16	0x01
OTP_RF_CLK_ACCURACY_CALIB	3	0x02

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Table 107. Calibration Parameters stored in OTP...*continued*

Parameter Name	Total Size in Bytes	OTP Calibration Parameter ID
OTP_RSSI_CALIB_CONSTANT_PER_ANTENNA	32	0x03
OTP_MANUAL_TX_POW_CTRL	64	0x06
OTP_TX_TEMPERATURE_COMP_PER_ANT	64	0x09
OTP_RX_ANT_DELAY_CALIB	8	0x0B
OTP_PDOA_MFG_0_OFFSET_CALIB	8	0x0C
OTP_AOA_ANT_MULTIPOINT_CALIB	32	0x0D

10.5.2 UCI commands to Write/Read Calibration Parameters to/from OTP

10.5.2.1 WRITE_CALIB_DATA_CMD

WRITE_CALIB_DATA_CMD is used by the Host to configure the OTP with the calibration parameters. This command is supported only in Factory FW.

Table 108. WRITE_CALIB_DATA_CMD

Payload Fields	Length in Bytes	Value/Description
Channel ID	1	Channel for which the calibration needs to be written. Value- 5,6,8,9
OTP Write Option	1	Bit 0 : 1 Bit 1-7 : RFU
Length of Payload	1	Length of Payload of a particular calibration parameter Length of each parameter should be equal to Total Size specified in Section 10.5.1
Payload	m	If the 'OTP Write Option' is 1, Byte[0] of payload should contain OTP Calibration Parameter ID. Byte[1 to m-1] of payload bytes should contain "OTP Calibration Parameter ID" specific data as describde here.

In platforms where the feature is not supported, the WRITE_CALIB_DATA_RSP should reject the WRITE_CALIB_DATA_CMD via 'STATUS_FEATURE_NOT_SUPPORTED'.

Table 109. WRITE_CALIB_DATA_RSP

Payload Field	Length in Bytes	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK) Status value = 0x55 (PH_UCI_STATUS_FEATURE_NOT_SUPPORTED)

If the OTP write is completed successfully, the following WRITE_CALIB_DATA_NTF is sent by the UWBS,

Table 110. WRITE_CALIB_DATA_NTF

Payload Field	Length in Bytes	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK)

If the OTP write is not completed successfully, the following WRITE_CALIB_DATA_NTF is sent by the UWBS,

Table 111. WRITE_CALIB_DATA_NTF

Payload Field	Length in Bytes	Value/Description
Status	1	Status value = 2 (PH_UCI_STATUS_FAILED)

10.5.2.2 READ_CALIB_DATA_CMD

READ_CALIB_DATA_CMD is used by the Host to read the calibration parameters from the OTP. This command is supported both in Factory and Mainline FW.

Table 112. READ_CALIB_DATA_CMD

Payload Field	Length in Bytes	Value/Description
Channel ID	1	Channel ID for which calibration data needs to be read Values- 5,6,8,9
OTP Read Option	1	Bit 0 : 1 Bit 1-7 : RFU
Payload	1	If the "OTP Read option" is 1, Byte[0] of payload should contain OTP Calibration Parameter ID.

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In platforms where feature is not supported, the READ_CALIB_DATA_RSP should reject the READ_CALIB_DATA_CMD via "STATUS_FEATURE_NOT_SUPPORTED".

Table 113. READ_CALIB_DATA_RSP

READ_CALIB_DATA_RSP	Length in Bytes	Value/Description
Status	1	Status value = 0x55 (PH_UCI_STATUS_FEATURE_NOT_SUPPORTED)

If the OTP read is completed successfully, the following READ_CALIB_DATA_RSP and READ_CALIB_DATA_NTF are sent by the UWBS,

Table 114. READ_CALIB_DATA_RSP

READ_CALIB_DATA_RSP	Length in Bytes	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK)

Table 115. READ_CALIB_DATA_NTF

Payload Field	Length in Bytes	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK)
Length of Payload	1	Length of Payload of a particular calibration parameter
Payload	m	Calibration parameter value.

10.5.2.3 GID and OID updates

Following GID and OID to be used,

Table 116. GID and OID

GID	OID	Message Name	Description
1010 Proprietary group	0b000000 - 0b111111	RFU	Reserved for Proprietary

GID and OIDs for all platforms supporting OTP calibration storage for the new commands WRITE_CALIB_DATA and READ_CALIB_DATA are accommodated in the RFU sections as below,

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Table 117. GID and OID for SR150

GID	OID	Message Name	Description
1010	0b000000	WRITE_CALIB_DATA	WRITE_CALIB_DATA_CMD is to be used by the Host to configure the OTP with calibration parameters. This command is supported only in Factory FW.
1010	0b000001	READ_CALIB_DATA	READ_CALIB_DATA_CMD is used to read the calibration data from the OTP.

10.5.2.4 Length of the Calibration Parameters

Following length should be maintained while writing/reading to/from the OTP.

Table 118. Length of the Calibration Parameters

Parameter Name	Length of Payload in Bytes in UCI CMD (WRITE_CALIB_DATA_CMD or READ_CALIB_DATA_CMD)	Number of TX/RX Antennas supported	Total Memory allocated in OTP in Bytes
OTP_CHIP	02	NA	2B(CHIP) x 4 channels = 8
OTP_TX_POWER_PER_ANTENNA	04	2 TX antennas supported	4B(TX_POWER_PER_ANTENNA) x 4 channels = 16 Nomenclature to be followed by host to store and retreive is : • First 2 bytes corresponds TX Antenna ID 1 • the next 2 bytes corresponds to TX Antenna ID 2
OTP_RF_CLK_ACCURACY_CALIB	03	NA	3B (RF_CLK_ACCURACY_CALIB)
OTP_RSSI_CALIB_CONSTANT_PER_ANTENNA	08	8 RX antenna IDs supported	8B x 4 channels = 32 Nomenclature to be followed by host to store and retreive is : The Xth byte corresponds to RX Antenna ID 'X' Where the value of X ranges from 1 to 8 Example: 1st byte corresponds RX Antenna ID 1
OTP_MANUAL_TX_POW_CTRL	16	TX antenna IDs supported	4(Calib Bytes) x 4(channels) x 4(RFU to accommodate future extensions) = 64

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Table 118. Length of the Calibration Parameters*...continued*

Parameter Name	Length of Payload in Bytes in UCI CMD (WRITE_CALIB_DATA_CMD or READ_CALIB_DATA_CMD)	Number of TX/RX Antennas supported	Total Memory allocated in OTP in Bytes
OTP_TX_TEMPERATURE_COMP_PER_ANT	16	2 TX antenna IDs supported	8B(TX_TEMPERATURE_COMP) x 2(Num of TX Antenna) x 4(channels) = 64 Nomenclature to be followed by host to store and retreive is : • First 8 bytes corresponds to TX Antenna ID 1 • the next 8 bytes corresponds to TX Antenna ID 2
OTP_RX_ANT_DELAY_CALIB	02	1 RX antenna supported	2B x 4 channels = 8
OTP_PDOA_MFG_0_OFFSET_CALIB	04	2 RX Antenna Pairs supported	4b * 2 (channels) = 8 Nomenclature to be followed by host to store and retreive is • First 2 bytes corresponds to RX Antenna pair ID 1 • the next 2 bytes corresponds to RX Antenna pair ID 2
OTP_AOA_ANT_MULTIPOINT_CALIB	16	2 RX Antenna Pairs supported	16b * 2 (channels) = 32 (Each multipoint size is 4b and 2 points are supported per pair = 4b each mulipoint vlaue * 2 points *2 RX antenna pairs = 16) Nomenclature to be followed by host to store and retreive is : • First 8 bytes corresponds to RX Antenna pair ID 1 • the next 8 bytes corresponds to RX Antenna pair ID 2 Each RX Antenna pair has 8 bytes (4b multipoint-1 + 4b multipoint-2)

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11   Appendix A

11.1 SR150 Device Information Parameters

AP shall use CORE_GET_DEVICE_INFO_CMD command to retrieve the device information parameters.

Table 119. Device Information Parameters

Parameter Name	Len (Octets)	Tag (IDs)	Description
DEVICE_NAME	N	0x00	UWBS returns a string to indicate the IC version Refer the **Device Name Mapping** for details. Note: Read Only parameter
FIRMWARE_VERSION	3	0x01	Octet [0]: Major number Octet [1]: Minor number Octet [2]: RC version *Example: Major number 1, Minor number 2 and Patch version 3 are reported as 0x01 0x02 0x03 at UCI transport*
VENDOR_UCI_VERSION	3	0x02	NXP Platform UCI version Octet [0]: Major Version Octet [1]: Minor Version Octet [2]: Patch version, This octet also indicates the changes done for any specific customer. ***Note:*** *The NXP Platform UCI version is encoded in packed binary-coded decimal (BCD). e.g., UCI spec 01.10.20 (decimal) would be reported as major 0x01, minor 0x10 and patch version 0x20.*
UWB_CHIP_ID	16	0x03	Chip ID information
UWBS_MAX_PPM_VALUE	1	0x04	UWBS Max PPM value [100]
TX_POWER	2	0x05	TX Power value set using the SET_DEVICE_CALIBRATION_CMD Signed Q9.7 format in dB (e.g. 1.50dB)
FIRA_EXT_UCI_GENERIC_VERSION	3	0x60	FiRa UCI Generic Spec version implemented by UWBS FW: Octet[0] = Major Version; Octet[1] = Minor/Maintenance Version; - bit[7:4] = Minor version; - bit[3:0] = Maintenance version; Octet[2] = Patch version;
FIRA_EXT_UCI_TEST_VERSION	3	0x61	FiRa UCI Test Spec version implemented by UWBS FW: Octet[0] = Major Version; Octet[1] = Minor/Maintenance Version ; - bit[7:4] = Minor version;

Table 119. Device Information Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			- bit[3:0] = Maintenance version; Octet[2] = Patch version;
FW_BOOT_MODE	1	0x63	0x00: Factory Mode 0x01: User Mode
UCI_CCC_VERSION	2	0xA0	Version of the UCI CCC Specification followed.
CCC_VERSION	8	0xA1	Version of the CCC Specification followed. Octet [0]..Octet[7]: CCC version written in ASCII format
ALIRO_SPEC_VERSION	8	0xA2	Version of the Aliro Specification followed. Octet [0]..Octet[7]: Aliro specification version written in ASCII format

11.2 Device Capability Parameters

AP shall use CORE_GET_CAPS_INFO_CMD command to retrieve the device capability parameters.

Table 120. Device Capability Parameters

Parameter Name	Len (Octets)	Tag (IDs)	Description
UWBS_MAX_UCI_PAYLOAD_LENGTH	2	0xB1	Parameter to indicate the maximum UCI payload size can handle by UWBS Value = 2048
UWBS_INBAND_DATA_BUFFER_BLOCK_SIZE	1	0xB2	Parameter to indicate the block size in bytes which the UWBS manages for the overall in-band data transfer memory pool. *Note: UWBS shall report the most recent capability value as value may get vary on every release*
UWBS_INBAND_DATA_MAX_BLOCKS	1	0xB3	Parameter to indicate the number of blocks available in the overall in-band data transfer memory pool. *Note: UWBS shall report the most recent capability value as value may get vary on every release*

11.3 SR150 Device Configuration Parameters

AP shall use CORE_SET_CONFIG_CMD and CORE_GET_CONFIG_CMD to set and retrieve the device core configurations.

Table 121. Device Configuration Parameters

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
WIFI_COEX_FEATURE	2 + N*4	0x00	0xF0	This parameter is used to configure the WiFi CoEx feature. **Octet[0]: Enable/Disable WiFi CoEx feature** 0x00: Disable (default) • b[3:0]: Enable/Disable functionality CoEx − 0x1 : Enable CoEx Interface without Debug and without Warning Verbose − 0x2 : Enable CoEx Interface with Debug Verbose only − 0x3 : Enable CoEx Interface with Warnings Verbose only − 0x4 : Enable CoEx Interface with both Debug and Warning Verbose • b[7:4]: CoEx Interface (*GPIO/OneWire*) selection: − 0x2 : OneWire Interface − Rest of the values are Reserved **Octect[1]: Number of channels N Shall be >= 1 (0 will be rejected by UWBS)** **N*4 octets to follow** **Octet[2]: Channel ID** **Octet[3]: MIN_GUARD_DURATION** Minimum gap in milliseconds between the end of previous active grant duration and next medium access request RFU for OneWire interface **Octet[4]: *MAX_GRANT_DURATION / MAX_WIFI_BLOCK_DURATION (for OneWire CoEx)*** Maximum duration for which the UWB can request for medium access **Octet[5]: *ADVANCED GRANT DURATION / GUARD DURATION (for OneWire CoEx)*** Minimum preparation time in milliseconds required by the WLAN subsystem to relinquish the CoEx Medium for UWB subsystem usage. It shall be set to at least 6ms for GPIO based CoEx Interface.

Table 121. Device Configuration Parameters*...continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				Note: 1. *No default values for Octet[1] to Octet[1 + N*4]* 2. *Number of channel should be greater than zero else UWBS will reject config.* 3. *WIFI_COEX_FEATURE - Duplicate config for same channel should not present else UWBS will reject config.* 4. *WIFI_COEX_FEATURE - Number of channel should not exceed more than supported channel else UWBS will reject config.*
...				**Note:** • *Values for Advance Grant Duration and Minimum Guard Duration are only applicable for GPIO based CoEx interface.*
DPD_WAKEUP_SRC	1	0xE4	0x02	Refer : • DPD wakeup sources (Default: 0)
WTX_COUNT_CONFIG	1	0xE4	0x03	Configure WTX Count, where Min = 20 and Max = 180 (Default: 20)
DPD_ENTRY_TIMEOUT	2	0xE4	0x04	DPD entry timeout in ms where UWBS shall defer DPD attempt for configured timeout. This parameter is applicable only when UWBS is woken up due to any activity at • Host Interface. [20-2000] (Default: 500ms) *Note: DPD feature shall be disabled via LOW_POWER_MODE generic core device config*
GPIO_SELECTION_FOR_DUAL_AOA	1	0xE4	0x06	This config is required to choose either of EF2 or GPIO-14 for Dual AOA HW controlled antenna switching in case host antenna config is using both EF2 and GPIO-14 in ANTENNA_RX_IDX_DEFINE Values: 0 : EF2 based Antenna selection (Default) 1 : GPIO14 based Antenna selection.

Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				Note: *If Dual AoA is configured and host has set* • *GPIO_SELECTION_FOR_DUAL_AOA = 0x00 i.e., EF2 based Antenna selection. Then it is mandatory to configure the EF2 Mask and set any one RX_IDX_DEFINE with EF2 Pin value as zero and other RX_IDX_DEFINE with EF2 Pin value as one.* • *GPIO_SELECTION_FOR_DUAL_AOA = 0x01 i.e., GPIO14 based Antenna selection. Then it is mandatory to configure the GPIO14 Mask and set any one RX_IDX_DEFINE with GPIO14 Pin value as zero and other RX_IDX_DEFINE with GPIO14 Pin value as one.*

TX_BASE_BAND_CONFIG	1	0xE4	0x26	Allows to Enable/Disable Tx base band configurations
				• b[0]: Enable/Disable DDFS tone generation after Tx frame
				  – 0: Disable (default)
				  – 1: Enable
				• b[1]: Enable/Disable of DC suppression.
				  – 0: Disable (default)
				  – 1: Enable
				• b[7:2]: RFU

DDFS_TONE_CONFIG	18*4	0xE4	0x27	Direct Digital Frequency Synthesizer (DDFS) Tone configuration. **18 bytes value description:** Octet[0]: Channel Number Octet[1]: Tx antenna selection. Possible values are 1 or 2. Octet[5:2]: - Content of register TX_DDFS_TONE_0 Octet[9:6]: - Content of register TX_DDFS_TONE_1 *11 bits [0:2047] Increment of phase accumulator for frequency control (frequency = INC * 975 KHz).* Octet[13:10]: Duration of the spur, in 124.8 MHz resolution (~ 8 ns) Octet[14]: Content of register GAINVAL_SET

Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				Octet[15]: Content of register DDFS_GAINBYPASS_ENBL
				Octet[17:16]:
				- Periodicity of spur in terms of gap interval in the PER command. For example, if set to 0x64, it means spur will be generated at interval of every 100 packets. For ranging this will be set to 1 internally in FW, meaning spur will be there for every packet.
				4 Blocks:
				18 Octets repeated for each block
				Octets[17:0] correspond to Block1
				Octets[35:18] correspond to Block2
				Octets[53:36] correspond to Block3
				Octets[71:54] correspond to Block4
TX_PULSE_SHAPE_CONFIG	4	0xE4	0x28	Octet[0]: Preamble Tx pulse shape ID
				Octet[1]: Payload Tx pulse shape ID
				Note:*If DC suppression is enabled via TX_BASE_BAND_CONFIG then pulse shape ID 8 will be applied if preamble ID 10 is used*.
				Octet[2]: STS Tx pulse shape ID
				Octet[3]: DAC Stage Config
				Values:
				Octet[0:2] :
				- [2, 8, 30, 34, 36, 37, 38 and 47(default)]
				Octet[3] : Value is defined as below
				• bit[0]: To set the DAC gain
				– 0: Unchanged (UWBS Keeps previous assigned value)
				– 1: UWBS set to 0x24
				• bit[1]: To set LPF (Tx DAC C)
				– 0: UWBS shall set to 0
				– 1: UWBS shall set to 0x5F
				• bit[7:2]: RFU
CLK_CONFIG_CTRL	2	0xE4	0x30	**Octet[0]: Clock source option**

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description

				• b[0]: RF Clock option
				  – 0: Use on board crystal (default)
				  – 1: Use external Clock
				• b[1]: Slow clock option
				  – 0: Use on board crystal
				  – 1: Use external 32.768 KHz Clock
				• b[2:7]: RFU
				Octet[1]: Crystal Option for RF clock
				• b[0]: <u>Crystal Option</u>
				  – [0]: Use 38.4MHz crystal (default)
				  – [1]: Use 26 MHz crystal
				• b[1:7]: RFU
				Note: The value of octet 1 is not applicable and ignored by UWBS in case external 38.4MHz clock is used
				Refer *Clock Settings* section for more information

HOST_MAX_UCI_PAYLOAD_LENGTH	2	0xE4	0x31	Defines host capability of handling max UCI payload. UWBS shall use this parameter to send the UCI response / notification to host. FW shall use PBF bit if UCI payload goes more than HOST_MAX_UCI_PAYLOAD_LENGTH size. 255 <= HOST_MAX_UCI_PAYLOAD_LENGTH <= UWBS_MAX_UCI_PAYLOAD_LENGTH (capability parameter) (Default: 255) *Note: UWBS shall construct the UCI packet based on this parameter.*
UWB_CH5_WLAN_CHANNEL_INTERFERENCE_LIST	120	0xE4	0x32	RFU Problematic WLAN channels list management command for UWB channel 5 for future release. Channel 5 Problematic list where Coex is enabled by default [118, 120, 122, 124, 126, 128, 132, 134, 136, 138, 140, 142, 144, 149, 151, 153, 155, 157, 159, 161, 165, 169, 173]
NXP_EXTENDED_NTF_CONFIG	1	0xE4	0x33	0x00 : FIRA generic Response / Notification (Default)

Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				0x01 : Vendor extended Response / Notification. Note: *UWBS shall send response/notification as per* ***"FiRa Consortium - UCI Generic Specification"*** *if set to 0x00*
CLOCK_PRESENT_WAITING_TIME	2	0xE4	0x34	Maximum waiting time until clock is present. The value is given in microseconds and defaults to 1000us. If Octet [0] of CLK_CONFIG_CTRL is set to 0 (on board crystal), this time is indicating the maximum waiting time until XTAL oscillator becomes stable. If Octet [0] of CLK_CONFIG_CTRL is set to 1 (external clock), this time is indicating the guard time between clock request GPIO (GPIO1) going high until the platform has to provide a stable clock.
INITIAL_RX_ON_OFFSET_ABS	2	0xE4	0x35	Defines the negative offset when Rx should be enabled to receive the first message of a ranging round on Controlee compared to expected reception time. The time is given in microseconds and has to be combined with INITIAL_RX_ON_OFFSET_REL, i.e. actual offset time is INITIAL_RX_ON_OFFSET_ABS + INITIAL_RX_ON_OFFSET_REL * RANGING_INTERVAL (Default: 100us)
INITIAL_RX_ON_OFFSET_REL	2	0xE4	0x36	Defines the negative offset when Rx should be enabled to receive the first message of a ranging round on Controlee compared to expected reception time. The time is given in ppm relative to RANGING_INTERVAL and has to be combined with INITIAL_RX_ON_OFFSET_ABS, i.e. actual offset time is INITIAL_RX_ON_OFFSET_ABS + INITIAL_RX_ON_OFFSET_REL * RANGING_INTERVAL. (Default: 100ppm) Example: INITIAL_RX_ON_OFFSET_ABS = 100 (us) INITIAL_RX_ON_OFFSET_REL = 100 (ppm) RANGING_INTERVAL = 100 (ms) Actual Offset: 100us + 100ppm*100ms = 100us + 10us = 110us
RFU		0xE4	0x3D - 0x3F	Reserved for Future Use
PDOA_CALIB_TABLE_DEFINE	2	0xE4	0x46	PdoA Calibration Table Definition :

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description

				Octet[0] – Calibration Step Size : The calibration table step size in degrees which indicates the step size between two consecutive points.
				Allowed Range : 10° , 12°(default) and 15°
				Octet [1] – Number of Steps: The number of calibration steps needs to be an odd number.
				Allowed Range : 3<=M<=17(to include 0°)(default : 11)
				Note: For steps greater than 17, 'AOA_ANTENNAS_PDOA_CALIB_EXTENDED_ SUPPORT' calibration parameter should be used.
				Example : With number of step size as 12° and number of steps as 11, the achieved calibration span is -60, -48, -36, -24, -12, 0, 12, 24, 36, 48, 60.
				Note:
				• Total Calibration Span = ((Number of Steps – 1) * Step Size).
				  Example :
				  If steps are 11 and step size is 12° then total span is 120°(-60° to 60° including 0°).
				• Same configuration will be applied by UWBS for all supported channels
				• The command should be configured before setting any PdoA/AoA Calibration Parameters such as
				  – AOA_ANTENNAS_PDOA_CALIB
				  – AOA_MULTIPOINT_PDOA_CALIB
				  – AOA_ANTENNAS_MULTIPOINT_CALIB
				  – AOA_ANTENNAS_PDOA_CALIB_EXTENDED_SUPPORT

ANTENNA_RX_IDX_DEFINE (GPIO Configuration)	1 + N*6	0xE4	0x60	Define RX antenna Identifier
				• Octet[0] : Number of Entries. (N). This must be between 1 and "MAX_N".
				• Array of entries: [
				  – Octet[X + 0] : RX Antennas ID.
				    Index of the Antenna (0 is invalid).
				    Value shall be between 1 to MAX_N
				  – Octet[X + 1] : Receiver used.
				    0x01: *RX1 port*

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				0x02: *RX2* port 0x03 - 0xFF: RFU Value 0 shall be Invalid. – Octet[X + 3, X + 2]: GPIO Filter Mask This mask defines which GPIOs shall be changed during the state transition, if a GPIO bit is set to 0 the GPIO shall not change its state. It's a 2 byte value in Little Endian format. – Octet[X + 5 X + 4]: GPIO State / Value This mask defines the GPIO state, if the corresponding GPIO bit is 0 in the GPIO Filter mask, the state shall be ignored and not changed. It's a 2 byte value in Little Endian format.] See *ANTENNAS_SELECTION_GPIO_BIT_MASK* for bit masks and values. See Table 63 for max value of MAX_N
ANTENNA_TX_IDX_DEFINE	1 + N*5	0xE4	0x61	Define/Create all antenna Identifier for TX • Octet[0] : Number of Entries. (N). This must be between 1 and "MAX_N". • Array of entries: [– Octet[X + 0] : TX Antennas ID. Index of the Antennas. Value 0 shall be Invalid. Value shall be between 1 to MAX_N – Octet[X+2, X + 1]: GPIO Filter Mask This mask defines which GPIOs shall be changed during the state transition, if a GPIO bit is set to 0 the GPIO shall not change its state. It's a 2 byte value in Little Endian format. Set to "0" if not applicable. – Octet[X+4, X + 3]: GPIO State / Value This mask defines the GPIO state, if the corresponding GPIO bit is 0 in the GPIO Filter mask, the state shall be ignored and not changed

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				It's a 2 byte value in Little Endian format. Set to "0" if not applicable. •] See ANTENNAS_SELECTION_GPIO_BIT_MASK for bit masks and values. See Table 63 for max value of MAX_N
ANTENNAS_RX_PAIR_DEFINE	1 + N * 6	0xE4	0x62	Define identifiers for each RX antenna pairs.
...				This configuration is applicable for Antenna Rx Configuration Mode 1 • Octet[0] : N Entries. This must be between 1 and "MAX_N". • Array of entries. These may be H or V Combinations: – Octet[X + 0] : Antennas PAIR ID. Value 0 shall be Invalid. Value shall be between 1 to MAX_N This IDx is used along with ANTENNAS_CONFIGURATION_RX(Session Config) for AoA use case. – Octet[X + 1]: Antennas ID 1 as defined by ANTENNAS_RX_IDX_DEFINE for RX1 Port. – Octet[X + 2]: Antennas ID 2 as defined by ANTENNAS_RX_IDX_DEFINE for RX2 Port. – Octets[X + 5, X + 4]:*Relative FoV* Set to "0" if not applicable. FoV of the Antennas PAIR in unsigned Q9.7 format. Default 0. Value would be between 0 to 360. When this is set to 0, Host has to use RX Antennas ID info and derive the angle relative to the system.
...				**Relative FoV:** Assuming we have 4 Antennas pairs symmetrically placed on a UWB System. For a given selected Antennas pair, even if the peer counterpart may be at 0° relative to that Antennas Group, the perceived AoA relative to the system has to be either 0°, 90°, 180° or 270° depending on this relative Angle of View. **Relative FoV and Scan Phase of SR150:**

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				This relative Angle of View would assist FW during scanning to move to next Antennas during scan phase. Based on the value defined here, FW can derive a topology of the antenna and move to the next Antennas Group automatically when AoA from this antennas is out of good range.
...				See Table 63 for max value of MAX_N
DEFAULT_SESSION_VENDOR_APP_ CONFIG	Max 251 bytes	0xE4	0x65	The format will be exactly same as SET_VENDOR_APP_CONFIG as detailed below Refer DEFAULT_SESSION_VENDOR_APP_CONFIG Refer : **Recommendation for race condition handling b/w device and session configs** Note : • All error handling w.r.t vendor sessions configs provided as part of DEFAULT_ SESSION_VENDOR_APP_CONFIG shall be performed when CORE_SET_ CONFIG(DEFAULT_SESSION_VENDOR_APP_CONFIG) is received by FW, • FW will report CORE_SET_CONFIG_RSP(UCI_STATUS_SUCCESS) if all the vendor session parameters are valid, DEFAULT_SESSION_VENDOR_APP_ CONFIG configs are retained in FW and applied on every SESSION_INIT • FW will report CORE_SET_CONFIG_RSP(FAILED) with the same format of as of SET_VENDOR_APP_CONFIG_RSP if any of the vendor Vendor APP TLV validation fails, DEFAULT_SESSION_VENDOR_APP_CONFIG configs are NOT retained in FW • These configs received vai "DEFAULT_SESSION_VENDOR_APP_CONFIG" will be applied to all session's irrespective of session type. • UWBS has a constraint of nexted TLV payload for DEFAULT_SESSION_VENDOR_ APP_CONFIG as not to exceed 250 bytes. • Incase DEFAULT_SESSION_VENDOR_APP_CONFIG is the only TLV in CORE_ SET_CONFIG that has failed and leading to syntac error then FW will refect/not apply any of the nested TLV of DEFAULT_SESSION_VENDOR_APP_CONFIG and report CORE_SET_CONFIG_RSP(FAILED) as below. • Status - FAILED =0x02 • Number of params set to 0x01,

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				• Param Tag = 0xE465 • Status of parameter failure = 0x05- Status Invalid parameter • When 0xE465 = DEFAULT_SESSION_VEDNOR_APP_CONFIG tag is included as part of CORE_SET_CONFIG, in this scenario if any other core config tag apart from DEFAULT_SESSION_VEDNOR_APP_CONFIG tag fails, than UWBS will not process or apply any of the vendor app configuration specified as part of DEFAULT_SESSION_VEDNOR_APP_CONFIG i.e UWBS will reject DEFAULT_SESSION_VEDNOR_APP_CONFIG tag and hence this tag(DEFAULT_SESSION_VEDNOR_APP_CONFIG) will be included in response with status PH_UCI_STATUS_REJECTED.
AOA_CALIB_CTRL_RX_ANT_PAIR_1_CH5 (Not supported for unified antenna definition and calibration feature) (Used for reference Purpose)	x	0xE4	0x40	All are signed PDoA values in Q9.7 (2 bytes, little-endian) format PDoA is measured by sweeping horizontal and vertical angles from -60° to +60° in steps of 12°, i.e., 11 horizontal and 11 vertical angles, i.e., -60°, -48°, -36°, -24°, -12°, 0°, +12°, +24°, +36°, +48°, +60°. Angle sweep that's in the direction of an imaginary line drawn from one antenna to the other antenna of the antenna pair is the horizontal sweep and angle sweep that's perpendicular to this imaginary line is the vertical sweep. Both horizontal and vertical angles start from -60° and values are stored as horizontal angle sweeps for each vertical angle as shown below: Octet[21:0]: Horizontal sweep from -60° to +60° for vertical angle -60° Octet[43:22]: Horizontal sweep from -60° to +60° for vertical angle -48° Octet[65:44]: Horizontal sweep from -60° to +60° for vertical angle -32° Octet[87:66]: Horizontal sweep from -60° to +60° for vertical angle -24° Octet[109:88]: Horizontal sweep from -60° to +60° for vertical angle -12° Octet[131:110]: Horizontal sweep from -60° to +60° for vertical angle 0° Octet[153:132]: Horizontal sweep from -60° to +60° for vertical angle +12° Octet[175:154]: Horizontal sweep from -60° to +60° for vertical angle +24° Octet[197:176]: Horizontal sweep from -60° to +60° for vertical angle +36° Octet[219:198]: Horizontal sweep from -60° to +60° for vertical angle +48° Octet[241:220]: Horizontal sweep from -60° to +60° for vertical angle +60°

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Table 121. Device Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	PTY sub ID	Description
				(default = 0)
Reserved for Debug configurations				
COMMAND_TIMESTAMP_NTF	1 Octet	0xE5	0x01	Enable UCI command process timestamp notifications. 0x00: Disable (Default) 0x01: Enable

Table 122. DEFAULT_SESSION_VENDOR_APP_CONFIG

Payload Index	Payload Fields	Length	Description
Octet[0]	Number of Vendor App Configurations	1	The number (**n**) of APP Configuration Parameters (TLV) to follow. Each APP Configuration Parameter follows TLV structure as below.
Octet [1 to (2+m]*n]	Vendor Session Configuration Parameter [1...n] when Configuration Type = Vendor Session Config	(2+m)*n Octets	• Tag : 1 Octet Vendor APP configuration Parameter ID • Length : 1 Octet Length of Value(**m**) • Value : m Octets Value of the Vendor APP Configuration parameter

Example UCI cmd/rsp for DEFAULT_SESSION_VENDOR_APP_CONFIG to set ANTENNA_CONFIGURATION_RX :

Existing SET_VENDOR_APP_CONFIG_CMD

2f:00:00:0B:01:00:00:00:01:03:04:01:02:01:02

Parsed: {MT: CMD(0x1)}{PBF: 0x0}{GID: INTERNAL_USE(0xf)}{EXT_PL_LEN: 0x0}{RFU1: 0x0}{OID: SESSION_SET_VENDOR_APP_CONFIG(0x0)}{RFU2: 0x0}{PL_LEN: 0x13}{SESSION_ID: 0x1}{NUM_OF_PARAMS: 0x1}

{ANTENNAS_CONFIGURATION_RX(0x3): 01020102}

CORE_SET_CONFIG CMD encapsulating Vendor APP config

20:04:00:XX:

01= Num of Params for CORE_SET_CONFIG(in this example =1)

XX= Tag for CORE_SET_CONFIG(in this example tag value of DEFAULT_SESSION_VENDOR_APP_CONFIG)

04= Length of the CORE_SET_CONFIG TLV, Total length of DEFAULT_SESSION_VENDOR_APP_CONFIG

Value for CORE_SET_CONFIG = Following bytes

01= Num of Params for VENDOR_APP_CONFIG

03: Tag of VENDOR_APP_CONFIG = ANTENNAS_CONFIGURATION_RX=0x03 as per existing UCI

04: Length of VENDOR_APP_CONFIG, len of ANTENNAS_CONFIGURATION_RX as per existing UCI

01:02:01:02 Value of Vendor APP config(in this case value for ANTENNAS_CONFIGURATION_RX as per existing UCI)

Recommendation for race condition handling b/w device and session configs :

Scenario

1. CORE_SET_CONFIG(TAG=DEFAULT_SESSION_VENDOR_APP_CONFIG[vendor-app=ANTENNA_CONFIG_RX], ANTENNA_RX_IDX_DEFINE)

• 1a. ANTENNA_RX_IDX_DEFINE will be validated only for the received input payload

• 1b. ANTENNA_CONFIG_RX will be validated against already set/default ANTENNA_RX_IDX_DEFINE

In such scneario FW cannot ensure vlaidaiton of latest core config(ANTENNA_RX_IDX_DEFINE) vs session/app config(ANTENNA_CONFIG_RX)

To ovecome such issue we recommend below 2 seqeunce from host/MW,

Recomendation-1 Ensure DEFAULT_SESSION_VENDOR_APP_CONFIG is always the last TLV of core_set_config

CORE_SET_CONFIG(ANTENNA_RX_IDX_DEFINE, TAG=DEFAULT_SESSION_VENDOR_APP_CONFIG[vendor-app=ANTENNA_CONFIG_RX])

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• 1a. ANTENNA_RX_IDX_DEFINE will be validated for the received input payload

• 1b. ANTENNA_CONFIG_RX will be validated against latest received ANTENNA_RX_IDX_DEFINE from step 1a.

ANTENNA_CONFIG_RX validation considers udpated ANTENNA_RX_IDX_DEFINE,no issue

Recomendation-2- Ensure DEFAULT_SESSION_VENDOR_APP_CONFIG is always sent after all core configs are udpated via a seperate core set config cmd

CORE_SET_CONFIG(ANTENNA_RX_IDX_DEFINE, TLV2, etc)

CORE_SET_CONFIG(TAG=DEFAULT_SESSION_VENDOR_APP_CONFIG[vendor-app=ANTENNA_CONFIG_RX])

ANTENNA_CONFIG_RX validation considers udpated ANTENNA_RX_IDX_DEFINE,no issue

11.4 Vendor Application Configurations

AP shall use SET_VENDOR_APP_CONFIG_CMD and GET_NXP_VENDOR_CONFIG_CMD to set and retrieve the APP configurations

Table 123. Vendor App Configuration Parameters

Parameter Name	Len (Octets)	Tag (IDs)	Description
MAC_PAYLOAD_ENCRYPTION	1	0x00	This parameter shall enable disable encryption of Payload data 0x00 - Plain Text 0x01 - Encrypted(default)
ANTENNAS_CONFIGURATION_TX (*)	1+N	0x02	The antenna used for TX. If Octet[0] of ANTENNAS_CONFIGURATION_TX is 0 and Octet[1] of ANTENNAS_ CONFIGURATION_RX is 0, FW automatically enters Scan Phase. Octet[0] - Define number of TX Antennas to follow (default value is 1). Octet[1] - Tx Antennas ID as defined by ANTENNA_TX_DEFINE (default value is 1). So we transmit by default with Antennas ID 1 (As a pre requisite: an antenna with ID 1 using ANTENNA_TX_IDX_DEFINE must be explicitly pre-defined). Octet[2] - Tx Antennas ID as defined by ANTENNA_TX_DEFINE *Must be 0 for SR100T, SR150 & SR160..* ...
ANTENNAS_CONFIGURATION_RX (*)	1 + 1 + N	0x03	The session specific antenna configuration for Rx

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Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description

			If Octet[0] of ANTENNAS_CONFIGURATION_TX is 0,and Octet[0] of ANTENNAS_ CONFIGURATION_RX is 0, FW automatically enters Scan Phase.
			
			• Octet [0] : Mode of RX operation
			  – 0 : Configuration ToA Mode
			    – ToF Only Mode
			  – 1 : Configuration AoA Mode
			    – Dual / Single AoA usecase
			    – ToA Mode with implicit Rx mode as per ANTENNAS_RX_PAIR_DEFINE
			    – **Recommended for TEST_LOOPBACK test mode, Optionally TEST_PER, TEST_ RX, TEST_SSTWR test modes**
			  – 3 : Configuration Mode 3: ToA usecase using different Rx antenna pair for RFM
			• Octet [1] : Number of Antennas or Antenna pairs to follow
			Default Value:
			• For all Sessions
			  Octet[0] : 0x00 = ToA Mode
			  Octet[1] : 0x01 = Number fo RX Antenna

If session is for
Single RX:
• Octet[1] is equal to 1
• Octet[2] is equal to Antenna ID
Dual RX:
• Octet[1] is equal to 2
• Octet[2] is equal to Antenna ID applicable to RX1 or RX2
• Octet[3] is equal to Antenna ID applicable to RX2
	Configuration Mode 0		Mode(s):
			• ToF *only* configuration mode
			, number of Octets should be based on the size field
			• Octet[2] : Antenna ID - *Any Rx (mandatory)*
			  – Antenna ID as defined by ANTENNA_RX_IDX_DEFINE
			• Octet[3] : Antenna ID - *Any Rx (optional)*
			  – Antenna ID as defined by ANTENNA_RX_IDX_DEFINE (Not supported for SR100S)
			• Octet[4] : Antenna ID - *Any Rx (optional)*
			  – Antenna ID as defined by ANTENNA_RX_IDX_DEFINE (Not supported for SR100S, RFU for SR150 set to 0)
			Notes:
			• Estimate First Path using any single Rx specified in Octet[3]

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Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			• Estimate First Path using both the Rx: Octet[2], Octet[3], based on minimum distance reported at Rx ports

		Configuration Mode 1	• Configuration Mode for 3D / 2D AoA,
			• Recommended for TEST_LOOPBACK test mode, Optionally TEST_PER, TEST_RX, TEST_SSTWR test modes
			• Octet [2] : Antennar Pair 1 (Generally Horizontal Pair)
			  – Antennas Pair ID as defined by ANTENNAS_RX_PAIR_DEFINE
			  – Appropriate value shall be set if AoA azimuth result is requested
			• Octet [3] : Antennar Pair 2 (Generally Vertical Pair)
			  – Antennas Pair ID as defined by ANTENNAS_RX_PAIR_DEFINE
			  – Appropriate value shall be set if AoA elevation result is requested

		Configuration Mode 3	Configuration Mode for ToA which will switch RX Antenna during RFM. This configuration mode applies only to DS-TWR responder. • Octet[2] : RX antenna ID 1 for ranging • Octet[3] : RX antenna ID 2 for ranging • Octet[4] : Rx antenna ID 1 for RFM (used for distance measurement during RFM) • Octet[5] : Rx antenna ID 2 for RFM (used for distance measurement during RFM)
		Configuration Mode 5	ToA mode for CSA Octet[1] : Number of antennas to follow for both active RRs. If Octet[1] : 2 Octet[2] : ANT_RX_ID_1 (RR1) Octet[3] : ANT_RX_ID_2 (RR2) If Octet[1] : 4 Octet[2] : ANT_RX_ID_1 (RR1) Octet[3] : ANT_RX_ID_2 (RR1) Octet[4] : ANT_RX_ID_3 (RR2) Octet[5] : ANT_RX_ID_4 (RR2) This configuration shall be only applicable for the responder side.

Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
		Configuration Mode 6	AoA mode for CSA Octet[1] : Number of antenna pairs to follow for both active RRs. If Octet[1] : 2 Octet[2] : ant_rx_pair1 (RR1) Octet[3] : ant_rx_pair2 (RR2) If Octet[1] : 4 Octet[2] : ant_rx_pair1 (RR1) Octet[3] : ant_rx_pair2 (RR1) Octet[4] : ant_rx_pair3 (RR2) Octet[5] : ant_rx_pair4 (RR2) This configuration shall be only applicable for the responder side.
RAN_MULTIPLIER (read access only)	1	0x20	Return the possible RAN multiplier value for a new session
STS_LAST_INDEX_USED (read access only)	1	0x21	Parameter used to get the STS index of the UWB session. When GET_VENDOR_APP_CONFIG_CMD issued for this config during SESSION_STATE_ ACTIVE the UWBS shall return the last
CIR_LOG_NTF	1	0x30	0x00: Disable (default) 0x01: Enable *Note: CIR_LOG_NTF is not supported/rejected when any sessions are active*
PSDU_LOG_NTF	1	0x31	0x00: Disable (default) 0x01: Enable
RSSI_AVG_FILT_CNT	4	0x40	This parameter is used to filter out the outliers in RSSI measurements in PER RX Test. If the RSSI filtering count is set to N and total packet count is set to M then UWBS shall report the average of (M-2N) RSSI values in TEST_PER_RX_NTF excluding(N) maximum and (N) minimum RSSI values. *Note: M is the total packet count to be received in PER Rx test* (default = 0)
CIR_CAPTURE_MODE	2	0x60	CIR sampling position for incoming UWB packet

Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			Octet[0] *(default is 0x11)* bits[7:4] - CIR1 capture mode bits[3:0] - CIR0 capture mode Octet[1] (default is 0x00) bits[7:0] - RFU CIR capture modes: 0x0 - SYNC 0x1 - STS 0x2 - Both SYNC and STS 0x3 - 0xF - RFU
RX_ANTENNA_POLARIZATION_OPTION	1	0x61	This parameter is used to choose the antenna polarization option when AOA measurement is enabled (AOA_RESULT_REQ = 1). This parameter is not applicable when AOA_RESULT_REQ = 0. bit[0]: Polarization option to be used for the first AoA computation [0]: Straight (Default) [1]: Reverse bit[1]: Polarization option to be used for the second AoA computation when enabled either via DUAL_AOA_PREAMBLE_STS or NUMBER_OF_STS_SEGMENTS = 2. The value is not applicable when second AoA computation is not enabled [0]: Straight (Default) [1]: Reverse bit[7:2]: RFU
SESSION_SYNC_ATTEMPTS	1	0x62	Number of times scheduler shall attempt to sync in controlee session before reporting error notification. This config is applicable for controlee session only. Range: [3 : 255] (Default: 3)
SESSION_SHED_ATTEMPTS	1	0x63	Number of times scheduler shall attempt to schedule ranging round before reporting error notification Range: [1 : 255] (Default: 3)
SCHED_STATUS_NTF	1	0x64	Enable/disable SCHEDULER_STATUS_NTF 0x00 - Disable (default)

Table 123. Vendor App Configuration Parameters*...continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			0x01 - Enable for including all the sessions information in notification 0x02 - Enable for include only failure sessions information in notification 0x03-0xFF: RFU
TX_POWER_DELTA_FCC	1	0x65	Session specific Tx power ID offset applied on top of Tx POWER calibration parameter. configured via SET_DEVICE_CALIBRATION_CMD. 0:No offset (default) 1 to 127: Attenuation (0.25 dB per steps) 128 to 255: RFU
TEST_KDF_FEATURE	1	0x66	This parameter is used to enable/disable KDF notification generation. 0x00: Disable (default) 0x01: Enable
TX_POWER_TEMP_COMPENSATION	1	0x67	This parameter is used to enable/disable Tx power temperature compensation 0x00: Disable (Default) 0x01: Enable
WIFI_COEX_MAX_TOLERANCE_COUNT	1	0x68	WiFi-CoEx maximum tolerance count, after the expiry of the number of count the UWBS shall make the **"Medium Grant Request"** with priority field set to **"Critical"**. This parameter can be modified when session is in SESSION_STATE_ACTIVE Session State. Range: [1 : 25] (Default: 3)
ADAPTIVE_HOPPING_THRESHOLD	1	0x69	This parameter can be used to configure the required number of successful responses(T) from Responders to conclude a successful ranging round. If numbers of responses is less than this given threshold(T) when Initiator device acting as Controller then initiator device triggers a hop to a different round index within the next block. Range: [0<T<= NUMBER_OF_CONTROLEES] (Default: NUMBER_OF_CONTROLEES) *Note: This parameter is applicable when HOPPING_MODE = 0xA0 (NXP Adaptive Hopping mode is Enabled)*
CONTENTION_PHASE_UPDATE_LENGTH	1	0x6D	This parameter is used to set contention phase update value in number of slots. Contention Phase is increased / decreased with integer multiple of this parameter. Minimum Contention Phase is 2 X CONTENTION_PHASE_UPDATE_LENGTH

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Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			(Default: 5)
AUTHENTICITY_TAG	1	0x6E	Config to enable/disable authenticity tag in SESSION_INFO_NTF. This config is applicable when STS_CONFIG is set to Dynamic STS. 0x00 = Disable (Default) 0x01 = Enable

RX_NBIC_CONFIG	2	0x6F	**Octet [0] : Used to configure NBIC settings**
			• b[0]: Enable / Disable NBIC.
			  0 = Disable (default)
			  1 = Enable
			• b[1:2]: Content of register MA_FILTER_BW_SET. Filter bandwidth setting (default: 0x3)
			• b[3:4]: Content of register MA_FILTER_BW_START_SET. Starting filter bandwidth setting for estimation (default: 0x3)
			• b[5:7]: RFU
			Octet [1]: Content of register PSD_WEIGHT_SET
			(Default: 0x14)
			(Default: 0x40 only applicable when NBIC is enabled)

MAC_CFG	1	0x70	Config is used to configure the MAC Header and MAC Footer b[0]: MAC Header present b[1]: MAC Footer present b[7:2]: RFU • (Default value: 0x03 for FIRA Session) • (Default value: 0x00 for Test Mode Session)
SESSION_INBAND_DATA_TX_BLOCKS	1	0x71	Amount of blocks which should be reserved for the given session for inband data transfer for transmitting data. If set to 0, transmitting inband data is not allowed for this session. Note: The sum of this value for all active session must not exceed UWBS_INBAND_DATA_MAX_BLOCKS and will prevent the first session which is causing to exceed the limit to get started. **If the session types are Ranging and in-band data session, Data transfer session, In-band data phase and Ranging-with-data phase**, SESSION_INBAND_DATA_TX_BLOCKS/SESSION_INBAND_DATA_RX_BLOCKS is **set to 1.**

Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			If the session types are NOT the Ranging and in-band data session, Data transfer session, In-band data phase and Ranging-with-data phase, SESSION_INBAND_DATA_ TX_BLOCKS/SESSION_INBAND_DATA_RX_BLOCKS is **set to 0**.
SESSION_INBAND_DATA_RX_BLOCKS	1	0x72	Amount of blocks which should be reserved for the given session for inband data transfer for receiving data. If set to 0, receiving inband data is not allowed for this session.
			Note: The sum of this value for all active session must not exceed UWBS_INBAND_DATA_ MAX_BLOCKS and will prevent the first session which is causing to exceed the limit to get started.
			If the session types are Ranging and in-band data session, Data transfer session, In-band data phase and Ranging-with-data phase, SESSION_INBAND_DATA_TX_ BLOCKS/SESSION_INBAND_DATA_RX_BLOCKS is **set to 1**.
			If the session types are NOT the Ranging and in-band data session, Data transfer session, In-band data phase and Ranging-with-data phase, SESSION_INBAND_DATA_ TX_BLOCKS/SESSION_INBAND_DATA_RX_BLOCKS is **set to 0**.
ANTENNAS_SCAN_CONFIGURATION	3*N	0x74	List of scanning pairs for Antennas.
			Assuming we have Anteannes East, West, North, South(E, W, N, S)
			Octet[0 + 0] E-TX for 1st Round Octet[0 + 1] E-RX1 for 1st Round Octet[0 + 2] W-RX2 for 1st Round Octet[3 + 0] N-TX for 2nd Round Octet[3 + 1] N-RX1 for 2nd Round Octet[3 + 2] S-RX2 for 2nd Round … More entries as needed.
			Antennas IDs as defined by ANTENNA_TX_IDX_DEFINE and ANTENNA_RX_IDX_ DEFINE.
			Once FW detects which Antenna has the best RSSI, FW Reverse looks up that Antennas within IDs defined by ANTENNAS_RX_PAIR_DEFINE
			In case of 3D AoA, Even IDs of RX Pair are for H and Odd IDs are for V Configuration as an enforced convention.

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Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
DATA_TRANSFER_TX_STATUS_CONFIG	1	0x75	This configuration shall be used to configure DATA_TRANSMISSION_STATUS_NTF indication 0x00 : Always ON 0x01 : Always OFF 0x02 : Notify when error (Default: 0x00) Note: The UWBS shall always send DATA_TRANSMISSION_STATUS_NTF whenever it receives DATA_MESSAGE_SND, the subsequent DATA_TRANSFER_TX_STATUS_NTF on RF transmit shall be sent based on DATA_TRANSFER_TX_STATUS_CONFIG configuration
RFU		0x76	
Wrapped RDS	N	0x79	Session ID (4 octets) || Random (12 octets) || Wrapped RDS from SE (Maximum 56 octets) **Note:** *Random Octets[0-3] is 0xB5B5B5B5 consider 'Wrapped RDS from SE' to be Plain Text Session Key.* **Note:** *Random Octets[0-3] is not 0xB5B5B5B5 consider 'Wrapped RDS from SE' to be Encrypted Session Key*
RFRAME_LOG_NTF	1	0x7B	0x00 : Disable (Default) 0x01 : Enable
TX_ADAPTIVE_PAYLOAD_POWER	1	0x7F	This configuration is used to enable/disable adaptive payload power for TX. 0x00 = Disable 0x01 = Enable (default) Values 0x02 to 0xFF = RFU **Note:** *Default value is equal to 1 except for FIRA Test session (Default value is equal to 0 for FIRA Test Session).*
SWAP_ANTENNA_PAIR_3D_AOA	1	0x80	0x00 = not swap (Both pairs are used for all message reception) (Default) 0x01 = (Swap Enabled) Pair1 is used in the POLL FRAME and PAIR 2 is used in FINAL FRAME When SWAP_ANTENNA_PAIR_3D_AOA is set to 0x01 then RSSI measurements shall be report for all pairs in the RANGE_DATA_NTF

Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			Note: **1. SWAP_ANTENNA_PAIR_3D_AOA is applicable only to SR150 variant and Device Role is set to Responder.**
RML_PROXIMITY_CONFIG	2	0x81	The devices are considered for adding to the RML is list which are in the Near and Far configured zone. The devices once added in to RML list and later the measured distance is less than the Near value such devices are retained in the RML list. Octet 0: RML_NEAR_PROXIMITY This parameter sets the lower bound in meters where the discovered devices are added into the RML list. Should be less than or equal to RML_FAR_CONFIG value. (default = 0x00) Octet 1: RML_FAR_PROXIMITY This parameter sets the upper bound in meters above which the RML list is not added with the discovered devices. Should be greater than or equal to RML_NEAR_CONFIG value. (default = 0xFF)
CSA_MAC_MODE	1	0x82	This configuration is used to configure- 1. The number of active ranging rounds in a RANGING_DURATION. 2. Offset from the first active ranging round in a RANGING_DURATION. [b5-b0] : Offset from the first active ranging round. 1 to (Nround – 1) [b7-b6] : Number of active ranging round(s) 0 = One active ranging round (default). 1 = Two active ranging rounds (CSA use case). 2 and 3 = RFU. Note: Bits [b5, b0] shall be set if [b7, b6] set to decimal value 1. Otherwise, bits [b5, b0] will be ignored.

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Table 123. Vendor App Configuration Parameters...*continued*

Parameter Name	Len (Octets)	Tag (IDs)	Description
			Nround is calculated based on RANGING_DURATION, SLOTS_PER_RR and SLOT_DURATION.
ENABLE_FOV	1	0x84	This parameter decides whether to enable or disable 2D AoA FoV Processing. 0x00 : 2D AoA FoV Processing Disabled (Default) 0x01 : 2D AoA FoV Processing Enabled
AZIMUTH_FIELD_OF_VIEW	2	0x85	This parameter indicates if the peer device is in the configured FoV of the device or not. Octet[0] : Horizontal RX Antenna Pair ID as defined in 'ANTENNAS_RX_PAIR_DEFINE UCI parameter'. Value 0 shall be rejected.(Default : 0x01) Octet[1] : FoV Coverage in degrees.(Default : 60) Note: The maximum FoV range supported is within [-90, 90] degrees.
SESSION_INFO_NTF_FILTER_NUM(*)	1	0x86	Represents a single byte number: 1~255 (default: 1) 0 = Invalid Range 1 = No filtering applied. Host is notified immediately with SESSION_INFO_NTF upon PROXIMITY criteria being met 2~255 = The number of consecutive Ranging Rounds which must meet the PROXIMITY criteria before a Notification is sent to the Host This can be applied to either an Initiator device or Responder device ***Note:** Applicable for SESSION_INFO_NTF_CONFIG = 0x02, 0x05.*
CSA_FINAL_DATA2_CONFIG	1	0x90	Configuration to enable/disable transmission of Final Data 2 from Responder to Initiator. 0x00 = Responder shall not transmit Final Data 2 message (default). 0x01 = Responder shall transmit the Final Data 2 message

11.4.1 Proprietary extension for Generic Application Configurations

Below section defines the extended values for FiRa generic Application configuration parameters

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Table 124. Extension for Generic Application Configuration

Parameter Name *(*): Can be applied during session active state as well*	Length (Octets)	Tag (IDs)	Description
SFD_ID	1	0x15	Identifier for SFD sequence Possible values are { 0, 2 and 5 (Proprietary) } for BPRF Mode
PREAMBLE_DURATION	1	0x17	0xA0: RFU 0xA1: 128 symbols
HOPPING_MODE	1	0x2C	This parameter is used to enable/disable the hopping 0xA0: NXP Adaptive Hopping Enable

Note: Refer FiRa Generic UCI specification for more information

11.4.1.1 UL-TDOA specific Proprietary extension

Table 125. UL-TDOA specific Extension for Generic Application Configurations

Parameter Name *(*): Can be applied during session active state as well*	Length (Octets)	Tag (IDs)	Description
UL_TDOA_DEVICE_ID	1/3/5/9	0x38	Note: In case of Legacy / Vendor specific UL-TDOA Tag session, this configuration parameter is NOT applicable.
UL_TDOA_TX_TIMESTAMP	1	0x39	Note: In case of Legacy / Vendor specific UL-TDOA Tag session, this configuration parameter is NOT applicable.

11.4.2 Proprietary extension for CCC specific Application Configurations

Table 126. Extension for CCC specific Application Configurations

Parameter Name	Length (Octets)	Tag (IDs)	Description
RESPONDER_SLOT_INDEX	1 Octet	0xA2	This Parameter will NOT BE APPLICABLE in case of ALIRO Session Type.

11.5 Configuring GPIO PIN(s) state

This section tells how to configure and read GPIO PIN state

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11.5.1 Setting GPIO PIN state

Host shall use SET_GPIO_PIN_STATE_CMD to drive the state of the GPIO Manually based on the GPIO_MASK.

A) Set the Pin state to High or Low based on the GPIO Mask being set by the HOST.

B) If the Pin state is Hi-Z state: Don't set the pin state to zero or one. Retain the defaults.

Table 127. SET_GPIO_PIN_STATE_CMD

Payload Field	Length (Octets)	Description
GPIO_PIN_DIRECTION	1	Value: 0x00: Pin Direction Input 0x01: Pin Direction Output ***Note:*** *Host will not set the Pin state to High/Low using SET_GPIO_PIN_STATE_CMD if the pin direction is Input.*
GPIO_MASK	2	GPIO Filter Mask Refer **GPIO Bit Masks** This mask defines which GPIOs shall be changed during the state transition, if a GPIO bit is set to 0 the GPIO shall not change its state. It's a 2-byte value in Little Endian format
GPIO_VALUE	1	Value: 0x00: Set GPIO Pin state to Low (as per GPIO_MASK set by Host Refer: **GPIO Bit Masks** 0x01: Set GPIO Pin state to High. 0x02: Hi-Z state (FW will not change the GPIO Pin state. Default state will be retained. No Manual control over the GPIO)

- SET_GPIO_PIN_STATE_CMD command is allowed in factory FW,
- Command is allowed only in DEVICE_STATE_READY.

Table 128. SET_GPIO_PIN_STATE_RSP

Payload Filed	Length (Octets)	Value/Description
Status	1	Status values. Refer **Status Codes**

11.5.2 Reading GPIO PIN state

Host shall use GET_GPIO_PIN_STATE_CMD to get the state of the GPIO Pin based on the GPIO Mask set by the Host

Table 129. GET_GPIO_PIN_STATE_CMD

Payload Filed	Length (Octets)	Value/Description
GPIO_MASK	2	GPIO Filter Mask Refer **GPIO Bit Masks** This mask defines which GPIOs state shall be notified to the Host. It's a 2-byte value in Little Endian format

- GET_GPIO_PIN_STATE_CMD is allowed in factory FW.
- Command is allowed only in DEVICE_STATE_READY.

Table 130. GET_GPIO_PIN_STATE_RSP

Payload Filed	Length (Octets)	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK). Below fields are applicable only if UCI status is OK.
GPIO_STATUS	N * (2 + 1 + 1)	N refers to number of GPIO Mask being set by the Host via GET_GPIO_PIN_STATE_CMD Octet[0:1] = GPIO_MASK1 Refer: **GPIO Bit Masks** Octet [2] = GPIO_MASK1 Pin direction (0: Refers to Pin Direction Input, 1: Refers to Pin Direction Output) Octet [3] = GPIO_MASK1 Pin State (0: Pin State Low, 1: Pin State High) Octet [((N*4) - 4) : ((N*4) - 3)] = GPIO_MASKN Octet [(N*4) - 2] = GPIO_MASKN Pin direction Octet [(N*4) - 1] = GPIO_MASKN Pin State

11.6 Debug Configurations

11.6.1 Generic proprietary debug notification

Debug NTF sent if an incorrect/corrupted cmd is received by the UWBS. The Data part of this NTF holds the header information of the received incorrect/corrupted CMD sent by the Host.

Table 131. PROP_GEN_DEBUG_NTF

Payload Field(s)	Length	Value/ Description
PROP_GEN_DEBUG_NTF		

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Table 131. PROP_GEN_DEBUG_NTF...*continued*

Payload Field(s)	Length	Value/ Description
Status	1 Octet	Status values. Refer Status Codes
Data	4 Octets	Header of the received incorrect/corrupted cmd.

11.7 Configuring GPIO PIN(s) state

This section tells how to configure and read GPIO PIN state

11.7.1 Setting GPIO PIN state

Host shall use SET_GPIO_PIN_STATE_CMD to drive the state of the GPIO Manually based on the GPIO_MASK.

A) Set the Pin state to High or Low based on the GPIO Mask being set by the HOST.

B) If the Pin state is Hi-Z state: Don't set the pin state to zero or one. Retain the defaults.

Table 132. SET_GPIO_PIN_STATE_CMD

Payload Field	Length (Octets)	Description
GPIO_PIN_DIRECTION	1	Value: 0x00: Pin Direction Input 0x01: Pin Direction Output ***Note:*** *Host will not set the Pin state to High/Low using SET_GPIO_PIN_STATE_CMD if the pin direction is Input.*
GPIO_MASK	2	GPIO Filter Mask Refer **GPIO Bit Masks** This mask defines which GPIOs shall be changed during the state transition, if a GPIO bit is set to 0 the GPIO shall not change its state. It's a 2-byte value in Little Endian format
GPIO_VALUE	1	Value: 0x00: Set GPIO Pin state to Low (as per GPIO_MASK set by Host Refer: **GPIO Bit Masks** 0x01: Set GPIO Pin state to High. 0x02: Hi-Z state (FW will not change the GPIO Pin state. Default state will be retained. No Manual control over the GPIO)

- SET_GPIO_PIN_STATE_CMD command is allowed in factory FW,
- Command is allowed only in DEVICE_STATE_READY.

Table 133. SET_GPIO_PIN_STATE_RSP

Payload Filed	Length (Octets)	Value/Description
Status	1	Status values. Refer **Status Codes**

11.7.2 Reading GPIO PIN state

Host shall use GET_GPIO_PIN_STATE_CMD to get the state of the GPIO Pin based on the GPIO Mask set by the Host

Table 134. GET_GPIO_PIN_STATE_CMD

Payload Filed	Length (Octets)	Value/Description
GPIO_MASK	2	GPIO Filter Mask Refer **GPIO Bit Masks** This mask defines which GPIOs state shall be notified to the Host. It's a 2-byte value in Little Endian format

- GET_GPIO_PIN_STATE_CMD is allowed in factory FW.
- Command is allowed only in DEVICE_STATE_READY.

Table 135. GET_GPIO_PIN_STATE_RSP

Payload Filed	Length (Octets)	Value/Description
Status	1	Status value = 0 (PH_UCI_STATUS_OK). Below fields are applicable only if UCI status is OK.
GPIO_STATUS	N * (2 + 1 + 1)	N refers to number of GPIO Mask being set by the Host via GET_GPIO_PIN_STATE_CMD Octet[0:1] = GPIO_MASK1 Refer: **GPIO Bit Masks** Octet [2] = GPIO_MASK1 Pin direction (0: Refers to Pin Direction Input, 1: Refers to Pin Direction Output) Octet [3] = GPIO_MASK1 Pin State (0: Pin State Low, 1: Pin State High) Octet [((N*4) - 4) : ((N*4) - 3)] = GPIO_MASKN Octet [(N*4) - 2] = GPIO_MASKN Pin direction Octet [(N*4) - 1] = GPIO_MASKN Pin State

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11.8 RDS set for Secure Data transfer and Secure Ranging

The section explains about setting the RDS when UWB session is in Active State.

Host shall use **SESSION_SET_RDS_PARAM_CMD** command to set the RDS parameters for given UWB session. The commands shall be accepted in any UWB session state. If the Host sends **SESSION_SET_RDS_PARAM_CMD** when the Session state is SESSION_ACTIVE_STATE, then the UWBS shall use the new RDS parameters in the upcoming block.

Table 136. SESSION_SET_RDS_PARAM_CMD

Payload Field(s)	Length	Value/ Description		
RDS Param List Size	1 Octets	Number of elements in RDS Param List		
RDS Param List	N*(10+M) Octets	Session Handle	4 Octets	Session Handle to which RDS parameters belongs
		MAC Address	2 Octets	16-bit MAC address to which Secure Ranging or Data Transfer to be performed. This command is applicable only for Controller Initiator
		RDS	M Octets	Ranging Data Set Session ID (4 octets) || Random (12 octets) || Wrapped RDS from SE (Maximum 40 octets).
		LAST_PHY_STS_INDEX	4 Octets	If the value is set to 0xFFFFFFFF then the MAC implementation shall derive the phyStsIndex value For any other value, the MAC implementation shall use that as the Initialization value for the phyStsIndex

Table 137. SESSION_SET_RDS_PARAM_RSP

Payload Field(s)	Length	Value/Description
Status	1 Octets	For various status values refer Table 51 in FiRa Generic UCI specification.
LAST_PHY_STS_INDEX	4 Octets	phyStsIndex for the last RDS provided.

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Table 137. SESSION_SET_RDS_PARAM_RSP...*continued*

Payload Field(s)	Length	Value/Description
		If there was no RDS provided before then the value shall be set to 0xFFFFFFFF

Table 138. SESSION_SET_RDS_PARAM_NTF

Payload Field(s)	Payload Field(s)	Value/Description
Session Handle	4 Octets	Session Handle for which RDS parameter is set
Status	1 Octet	0x00: Key derivation is success at both Gate Anchor and Mobile/Tag 0x01: Key derivation is failed either at gate anchor or Mobile/Tag Note: SESSION_SET_RDS_PARAM_NTF shall besent when key derivation is successful at both Gate Anchor and Mobile. The key derivation status at mobile will be informed to the gate anchor over in-band.

11.9 Debug Configurations

11.9.1 Generic proprietary debug notification

Debug NTF sent if an incorrect/corrupted cmd is received by the UWBS. The Data part of this NTF holds the header information of the received incorrect/corrupted CMD sent by the Host.

Table 139. PROP_GEN_DEBUG_NTF

Payload Field(s)	Length	Value/ Description
PROP_GEN_DEBUG_NTF		
Status	1 Octet	Status values. Refer Status Codes
Data	4 Octets	Header of the received incorrect/corrupted cmd.

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11.10 Command to set Localization Zone

The Host shall use SESSION_SET_LOCALIZATION_ZONE_CMD command to set the localization Zone information which shall be sent in Final Data 2 message in the following Ranging Blocks.

The UWBS shall respond with SESSION_SET_LOCALIZATION_ZONE_RSP with STATUS_OK if the command is accepted successfully.

This Command is applicable only for a device with DEVICE_TYPE set to "Controlee" (Reader), Otherwise the UWBS shall respond SESSION_SET_LOCALIZATION_ZONE_RSP with STATUS_REJECTED.

The computation of Location Zone is out of the scope of this document.

Table 140. SESSION_SET_LOCALIZATION_ZONE_CMD

Payload Field(s)	Length	Value/Description
Session Handle	4 Octets	Session for which localization zone is estimated
Ranging Block Index	2 Octets	Ranging Block Index for which localization zone is estimated. ***Note:*** *UWBS shall compute the zone offset and send in Zone_Block_Offset field of Final_Data2 Message*
Localization Zone	1 Octet	The estimated localization zone calculated by the Application, based on the measurement results for given ranging block index. • 1 = Frontside • 2 = Backside ***Note:*** *The command is only applicable for Controlee*

Table 141. SESSION_SET_LOCALIZATION_ZONE_RSP

Payload Field(s)	Length	Value/Description
Status	1 Octet	Refer Status Codes

11.11 Proprietary Test Configurations

Below configuration shall be set using TEST_CONFIG_SET_CMD command which is defined in **"FiRa Consortium - UCI Test Specification"**. All Extended APP configuration are starts with **"0xE5"**.

Table 142. TEST_CONFIG_SET_CMD

Parameter Name	Len (Octets)	Tag (Ext. IDs)	Proprietary sub ID	Description
RSSI_CALIBRATION_ OPTION	1	0xE5	0x01	This parameter is used to adjust the receive gain index for AGC. This parameter to be set before performing PER Rx Test. 0x00 - Calibration level 1 0x01 - Calibration level 2 (default = 0x01)

AGC_GAIN_VAL_RX	2	0xE5	0x02	This parameter is used for AGC gain setting of Rx during RSSI calibration. This config is applicable only when RSSI_CALIBRATION_OPTION = 0.
				Octet[0]: Gain index override enable/disable
				• bit[0]: Override control flag
				  – 0: Override disable
				  – 1: Override enable (default)
				• bit[1-7]: RFU
				Octet[1]:Gain index value
				• bit[0-5] : AGC gain index value (default = 0x2)
				• bit[6-7]: RFU

TEST_SESSION_STS_ KEY_OPTION	1	0xE5	0x03	This parameter is used to choose between the IEEE or proprietary key and data input for DRBG (Deterministic Random bit generator) used for STS generation in test sessions.
				Octet[0]:
				• bit[0]: values as below
				  – 0: Proprietary option for key, data values
				  – 1: IEEE option for key, data set values as mentioned in Annex H of P802.15.4z-D8 specification (default)
				• bit[1-7]: RFU

CARRIER_ FREQUENCY_OFFSET	4	0xE5	0x11	Adds the given offset in Hz to the configured Carrier Frequency (which depends on selected RF Channel) during test mode. The value is encoded as signed 32bit integer with a range from -250000000 (-250MHz) up to 250000000 (250MHz). Default is 0 (no offset added). ***Note:*** • *Only applicable on Factory FW*

Table 142. TEST_CONFIG_SET_CMD...*continued*

Parameter Name	Len (Octets)	Tag (Ext. IDs)	Proprietary sub ID	Description
				• *This parameter is applicable only in Continuous wave mode (i.e., TEST_PERIODIC_TX_CMD with NUM_PACKETS is set to 0) and it will be ignored for other test modes.*

11.12 GID and OID Definitions

Table 143. Proprietary GID and GID Definition

OID	Message Name	Description
GID: 0010 (FiRa Generic UWB Ranging Session Control Group)		
0b100000	CCC_RANGE_DATA_NTF	While the UWB session is ongoing, the UWBS shall send ranging result with the CCC_RANGE_DATA_NTF notification to the Host when the ranging round is complete.
GID: 1001 (Proprietary group)		
GID: 1010(IOT Proprietary group)		
0b000000	WRITE_CALIB_DATA_CMD WRITE_CALIB_DATA_RSP	WRITE_CALIB_DATA_CMD is to be used by the Host to configure the OTP with calibration parameters. This command is supported only in Factory FW.
0b000001	READ_CALIB_DATA_CMD READ_CALIB_DATA_RSP	READ_CALIB_DATA_CMD is used to read the calibration data from the OTP.
0b000010	TRNG_DATA_CMD TRNG_DATA_RSP	TRNG_DATA commmand is used for True Random Number generation.
0b000011	WRITE_MODULE_MAKER_INFO_CMD WRITE_MODULE_MAKER_INFO_RSP	WRITE_MODULE_MAKER_INFO command is used to write module maker info.
0b000100	READ_MODULE_MAKER_INFO_CMD READ_MODULE_MAKER_INFO_RSP	READ_MODULE_MAKER_INFO command is used to read module maker info.
0b000101	PROP_SET_PROFILE_CMD PROP_SET_PROFILE_RSP	Used to set the specific UCI parameters received from MW and 'Profile'.
0b001000	SE_BIND_GET_INIT_DATA_CMD SE_BIND_GET_INIT_DATA_RSP	Command is used by DH to get initialize data for binding.
0b001001	SE_BIND_SET_SE_DATA_CMD SE_BIND_SET_SE_DATA_RSP	Command used by DH to set SE secrets to compute SCP03 keys in SR150.
0b001010	SE_BIND_COMMIT_BDI_CMD SE_BIND_COMMIT_BDI_RSP	Command used by DH to commit the computed BDI to OTP.
0b001100	SE_GET_EXTERNAL_AUTH_APDU_CMD SE_GET_EXTERNAL_AUTH_APDU_RSP	Command used by DH to get the external authentication from SR150.
0b001011	SE_GET_HOST_CHALLENGE_APDU_ CMD SE_GET_HOST_CHALLENGE_APDU_RSP	Command used by DH to get the host challenge APDU from SR150.
0b001101	SE_DO_ENC_APDU_CMD SE_DO_ENC_APDU_RSP	Command used by DH to encrypt the APDU and respond encrypted APDU in response.
0b001110	SE_RESP_APDU_VALIDATE_REQ_CMD SE_RESP_APDU_VALIDATE_REQ_RSP	Command used by DH to validate SE response APDU.

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Table 143. Proprietary GID and GID Definition...*continued*

OID	Message Name	Description
0b001111	SE_SET_BDI_DEBUG_CMD SE_SET_BDI_DEBUG_RSP	Command used by DH to restore BDI (used only for development purposes - no used in production).
0b010010	SESSION_SET_LOCALIZATION_ZONE_CMD SESSION_SET_LOCALIZATION_ZONE_RSP	Command used by DH to set the localization Zone information.
0b111010	DEBUG_CFX_LAST_EVENTS_NTF	DSP last events notification
0b111011	DEBUG_ARM_LAST_EVENTS_NTF	ARM MCU last events notification
GID: 1110 *(Customer Proprietary 1 group)*		
0b000000	CORE_DEVICE_INIT_CMD CORE_DEVICE_INIT_RSP	Command is used to initialize the UWBS for specific platform
0b000010	DBG_GET_ERROR_LOG_CMD DBG_GET_ERROR_LOG_RSP	Command used to dump the crash log
0b000011	SE_GET_BINDING_COUNT_CMD SE_GET_BINDING_COUNT_RSP	Command to fetch the available binding count *Applicable to factory FW only*
0b000101	SE_COMM_ERROR_NTF	Report SE communication failure
0b000110	BINDING_STATUS_NTF	Notify the binding status between SR150 and SE
0b000111	SCHEDULER_STATUS_NTF	To notify Schedule status for sessions
0b001000	UWB_SESSION_KDF_NTF	To notify KDF output values
0b001011	QUERY_TEMPERATURE_CMD QUERY_TEMPERATURE_RSP	Query current temperature in UWBS
0b010011	UWB_WLAN_COEX_NTF	Send warning NTF when WLAN max grant duration is exceeded
0b010100	UWB_WLAN_COEX_DATA_NTF	Notify UWB WLAN CoEx related information to host
0b010101	UWB_WLAN_COEX_EXCEPTION_NTF	Notify UWB WLAN CoEx related Exceptions (warning/error) to host.
0b011010	SET_GPIO_PIN_STATE_CMD	Drive the state of the GPIO Manually based on the GPIO_MASK. Applicable to factory FW only
0b011011	GET_GPIO_PIN_STATE_CMD	Get the state of the GPIO Pin based on the GPIO Mask set by the Host
0b100100	DATA_DOWNLOAD_START_CMD DATA_DOWNLOAD_START_RSP	Command sent to start the Data Download refer Section 5.1
0b100101	DATA_DOWNLOAD_CMD DATA_DOWNLOAD_RSP	Command sent to download the data refer Section 5.2

Table 143. Proprietary GID and GID Definition...*continued*

OID	Message Name	Description
	DATA_DOWNLOAD_NTF	
0b100110	DATA_DOWNLOAD_STOP_CMD DATA_DOWNLOAD_STOP_RSP	Command sent to stop the data download refer Section 5.3
0b100111	DATA_DOWNLOAD_QUERY_CMD DATA_DOWNLOAD_QUERY_RSP	Command sent to Query all the downloaded Data. refer Section 5.6
0b101000	DATA_DOWNLOAD_DELETE_CMD DATA_DOWNLOAD_DELETE_RSP	Command sent to delete downloaded Data. refer Section 5.5
0b101001	DATA_DOWNLOAD_COMPLETE_NTF	Notification sent to indicate the Data Download is complete refer Section 5.4
0b101011	SESSION_SET_RDS_PARAM_CMD SESSION_SET_RDS_PARAM_RSP SESSION_SET_RDS_PARAM_NTF	Used to set the RDS when UWB session is in Active State.
GID: 1111 *(Customer Proprietary 2 group)*		
0b000000	SET_VENDOR_APP_CONFIG_CMD SET_VENDOR_APP_CONFIG_RSP	Set NXP proprietary session app configurations
0b000010	GET_ALL_UWB_SESSIONS_CMD GET_ALL_UWB_SESSIONS_RSP	Retrieve all UWB sessions
0b000011	GET_VENDOR_APP_CONFIG_CMD GET_VENDOR_APP_CONFIG_RSP	Get NXP proprietary session app configurations
0b100000	DO_CHIP_CALIBRATION_CMD DO_CHIP_CALIBRATION_RSP DO_CHIP_CALIBRATION_NTF	Calibrate the Chip of UWBS *Applicable to factory FW only*
0b100001	SET_DEVICE_CALIBRATION_CMD SET_DEVICE_CALIBRATION_RSP	Set the calibrated value for requested parameter
0b100010	GET_DEVICE_CALIBRATION_CMD GET_DEVICE_CALIBRATION_RSP	Get the calibrated value for requested parameter
0b110011	PSDU_LOG_NTF	Notification used by SR150 to notify PSDU payload
0b110100	CIR_LOG_NTF	Notification used by SR150 to notify the CIR logs
0b111001	UWB_WLAN_IND_STATUS_NTF	To notify the UWB_WLAN_IND GPIO toggle status
0b111010	WLAN_UWB_IND_STATUS_NTF	To notify the WLAN_UWB_IND GPIO status during ranging round
0b111011	UWB_WLAN_COEX_MAX_GRANT_ DURATION_EXCEEDED_WRN_NTF	Send warning NTF when WLAN max grant duration is exceeded

11.13 Status Codes

Table 144. Status Codes

Status Codes	Description	
Status Codes		
0x00-0x4F	[UCI-FORUM] Status Codes	
Proprietary status code		
0x53	STATUS_CALIBRATION_IN_PROGRESS	If calibration process is ongoing
0x54	STATUS_DEVICE_TEMP_REACHED_THERMAL_RUNAWAY	Over temperature detected
0x55	STATUS_FEATURE_NOT_SUPPORTED	Status to indicate feature not supported.
0x56	STATUS_NUM_PACKET_EXCEEDS_1000_FOR_TEST_PER_RX	NUM_PACKETS > 1000 packet for TEST_PER_RX if Vendor extended notifications enabled
0x57	STATUS_CAILBRATION_NOT_CONFIGURED	Status to indicate precondition is not set during set calibration
0x81	STATUS_RANGING_PHY_RX_SECDEC_FAILED	Rx SECDEC decoder failed
0x82	STATUS_RANGING_PHY_RX_RSDEC_FAILED	Rx RS decoder failed
0x83	STATUS_RANGING_PHY_RX_DEC_FAILED	Rx decode chain failed
0x84	STATUS_RANGING_PHY_RX_ERR_FAILED	RX data buffer overflow happened
0x85	STATUS_RANGING_PHY_RX_PHR_DECODE_FAILED	PHR decoder failed
0x86	STATUS_RANGING_PHY_RX_SYNC_SFD_TIMEOUT	SYNC or SFD timeout
0x87	STATUS_RANGING_PHY_RX_PHR_DATA_RATE_ERROR	In PHR, Data rate error
0x88	STATUS_RANGING_PHY_RX_PHR_RANGING_ERROR	In PHR, Ranging error
0x89	STATUS_RANGING_PHY_RX_PHR_PREAMBLE_DUR_ERROR	In PHR, Preamble duration error
0x8A	STATUS_MAX_ACTIVE_GRANT_DURATION_EXCEEDED	MAX Active Grant Duration Exceeded Warning Notification
0x8B	STATUS_RANGING_PHY_RX_PROCESSING_TIME_ERROR	Processing time is not sufficient for PER RX TEST
0x8C-0x9F	RFU	
0xE1	STATUS_REJECTED_BUFFER_IN_USE	Indicates that the UCI buffer is already in use

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Table 145. SE Status Codes

Status Codes	Description
Proprietary SE status code	
0x70	STATUS_NO_SE
0x71	RFU
0x72	STATUS_SE_RECOVERY_FAILURE
0x73	STATUS_SE_RECOVERY_SUCCESS
0x74	STATUS_SE_APDU_CMD_FAIL
0x75	STATUS_SE_AUTH_FAIL

11.14 Pulse Shape configuration

The mapping table at firmware:

Table 146. Pulse Shape Config Default values

Pulse Shape ID \ Pulse Shape Config	Octet[0]	Octet[1]	Octet[2]
2 *(HELIOS1)*	2	2	2
8 *(HELIOS1)*	8	8	8
30 *(HELIOS1)*	30	30	30
34 *(HELIOS1)*	34	34	34
36 *(HELIOS1)*	36	36	36
37 *(HELIOS1)*	37	37	37
38 *(HELIOS1)*	38	38	38
47 *(HELIOS1)*	47	47	47

12 References

Table 147. References

Reference	Description / Link
UWBS HBCI commands	[HBCI commands]
[UCI-FORUM]	FiRa Consortium - UCI Generic Specification

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