AN14282

RF Test Mode on FreeRTOS

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Document information

Information	Content
Keywords	RF test mode, production firmware, regulatory, compliance, Wi-Fi, Bluetooth, Bluetooth LE, 802.15.4
Abstract	Describes how to enable and use RF test mode for Wi-Fi, Bluetooth, Bluetooth LE, and 802.15.4 on FreeRTOS.

1 Introduction

This document provides an overview of how to enable and use the RF test mode on an RTOS-based host. Using RF test mode feature, the users can easily set RF parameters such as the operating channel, TX power, and channel bandwidth for regulatory compliance testing.

RF test mode is compatible with Wi-Fi, Bluetooth, and 802.15.4 radios. This document assumes that you have successfully brought up the radios on your device using the production firmware. For more information on device bring-up and importing, building, and flashing applications, refer to [1] and [2].

1.1 Supported devices

- 88W8987 [3]
- IW416 [4]
- IW611 [5]
- IW612 [6]
- RW610 [7]
- RW612 [8]

Note: *Refer to the software release notes of your device for more information on software compatibility.*

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2 RF test mode for Wi-Fi

This section describes the commands to use Wi-Fi RF test mode.

The *wifi_test_mode* application enables RF testing to set RF parameters, measure the transmit power, and transmit/receive standard 802.11 packets.

2.1 Enable RF test mode

Command to enable RF test mode:

```
# wlan-set-rf-test-mode
RF Test Mode configuration successful
```

2.2 Set/get RF frequency band

Command to set the RF frequency band:

```
# wlan-set-rf-band <band>
```

Table 1. Command parameters

Parameter	Description
band	RF frequency band 0 = 2.4 GHz 1 = 5 GHz

Example – Set the RF frequency band to 2.4 GHz:

```
# wlan-set-rf-band 0
```

Command to get the RF frequency band:

```
# wlan-get-rf-band
```

Example – Get the RF frequency band:

```
# wlan-get-rf-band
Configured RF Band is: 2.4G
```


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2.3 Set/get the RF channel

Command to set the RF channel:

```
# wlan-set-rf-channel <channel>
```

Table 2. Command parameters

Parameter	Description
`channel`	Wi-Fi channel

Example – Set the RF channel to 6:

```
# wlan-set-rf-channel 6
```

Command to get the RF channel:

```
# wlan-get-rf-channel
```

Example – Get the RF channel:

```
# wlan-get-rf-channel
Configured channel is: 6
```


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2.4 Set/get the channel bandwidth

Command to set the channel bandwidth:

```
# wlan-set-rf-bandwidth <bandwidth>
```

Table 3. Command parameters

Parameter	Description
bandwidth	RF channel bandwidth 0 = 20 MHz 1 = 40 MHz 4 = 80 MHz

Example – Set the channel bandwidth to 20 MHz:

```
# wlan-set-rf-bandwidth 0
```

Command to get the channel bandwidth:

```
# wlan-get-rf-bandwidth
```

Example – Get the RF channel bandwidth:

```
# wlan-get-rf-bandwidth
Configured RF bandwidth is: 20MHz
```


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2.5 Set/get the radio mode

Command to set the radio mode:

```
# wlan-set-rf-radio-mode <radio_mode>
```

Table 4. Command parameters

Parameter	Description
radio_mode	Radio mode 0: set the radio in power down mode 3: sets the radio in 5GHz band, 1x1 mode (RF path A) 4: sets the radio in 5GHz band, 1x1 mode (RF path B) 11: sets the radio in 2.4GHz band, 1x1 mode (RF path A) 14: sets the radio in 2.4GHz band, 1x1 mode (RF path B)

Example – Set the radio mode to 5 GHz 1x1 mode:

```
# wlan-set-rf-radio-mode 3
```

Command to get the radio mode:

```
# wlan-get-rf-radio-mode
```

Example – Get the radio mode:

```
# wlan-get-rf-radio-mode
Configured radio mode is: 3
```


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2.6 Display and clear the received Wi-Fi packet count

Command to clear the received packet count and display the received multi-cast and error packet counts:

```
# wlan-get-and-reset-rf-per
```

Example of command output:

```
# PER is as below:
Total Rx Packet Count : 20
Total Rx Multicast/Broadcast Packet Count: 20
Total Rx Packets with FCS error : 9
```


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2.7 Set/get the antenna configuration

Command to set the TX antenna configuration:

```
# wlan-set-rf-tx-antenna <antenna>
```

Table 5. Command parameters

Parameter	Description
antenna	TX antenna 1 = Main 2 = Aux

Example – Set the TX antenna configuration to the main antenna:

```
# wlan-set-rf-tx-antenna 1
```

Command to get the TX antenna configuration:

```
# wlan-get-rf-tx-antenna
```

Example – Get the TX antenna configuration:

```
# wlan-get-rf-tx-antenna
Configured Tx antenna is: Main
```

Command to set the RX antenna configuration:

```
# wlan-set-rf-rx-antenna <antenna>
```

Table 6. Command parameters

Parameter	Description
antenna	RX antenna 1 = Main 2 = Aux

Example – Set the RX antenna configuration to the main antenna:

```
# wlan-set-rf-rx-antenna 1
```

Command to get the RX antenna configuration:

```
# wlan-get-rf-rx-antenna
```

Example – Get the RX antenna configuration:

```
# wlan-get-rf-rx-antenna
Configured Tx antenna is: Main
```


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2.8 Set TX power

Command to set the TX power:

```
# wlan-set-rf-tx-power <tx_power> <modulation> <path_id>
```

Table 7. Command parameters

Parameter	Description
`tx_power`	TX power in dBm
`modulation`	Modulation 0 = CCK 1 = OFDM 2 = MCS
`path_id`	Path 0 = RF path A 1 = RF path B

Example – Set the TX power to 8 dBm with OFDM modulation on Path B:

```
# wlan-set-rf-tx-power 8 1 1
Tx Power configuration successful Power : 8 dBm Modulation : OFDM
Path ID : PathB
```


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2.9 Set Wi-Fi transmitter in continuous carrier wave (CW) mode

Command to set the Wi-Fi transmitter into CW mode:

```
# wlan-set-rf-tx-cont-mode <enable_tx> <cw_mode> <payload_pattern> <cs_mode> <act_sub_ch>
<tx_rate>
```

Table 8. Command parameters

Parameter	Description
`enable_tx`	Enable TX 0 = disable 1 = enable
`cw_mode`	Carrier wave mode Set to 1
`payload_pattern`	Payload pattern (0 to 0xFFFFFFFF) (Enter hexadecimal value)
`cs_mode`	Carrier suppression (CS) mode Set to 0
`act_sub_ch`	Active sub channel 0 = lower 1 = upper 3 = both
`tx_rate`	TX rate index Set to 0

Example – Enable CW transmit:

```
# wlan-set-rf-tx-cont-mode 1 1 7FFFFFFF 0 3 0
Tx continuous configuration successful
Enable : enable
Continuous Wave Mode : enable Payload Pattern : 0x7FFFFFFF
CS Mode : disable Active SubChannel : both
Tx Data Rate : 0
```

Command to disable CW mode (issue both commands below sequentially):

```
# wlan-set-rf-tx-cont-mode 0 1 0 0 0 0
Tx continuous configuration successful
   Enable : disable
   Continuous Wave Mode : enable Payload Pattern : 0x00000000
   CS Mode : disable Active SubChannel : both
   Tx Data Rate : 0
# wlan-set-rf-tx-cont-mode 0
Tx continuous configuration successful
   Enable : disable
   Continuous Wave Mode : disable
   Payload Pattern : 0x00000000
   CS Mode : disable
   Active SubChannel : both
   Tx Data Rate : 0
```


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2.10 Transmit 802.11 packets

Command to transmit packets continuously with an adjustable time gap of 0 to 255 microseconds between packets:

```
# wlan-set-rf-tx-frame <start> <data_rate> <frame_pattern> <frame_len>
 <adjust_burst_sifs>
<burst_sifs_in_us> <short_preamble> <act_sub_ch> <short_gi> <adv_coding> <tx_bf>
<gf_mode> <stbc> <bssid>
```

Table 9. Command parameters

Parameter	Description
`start`	Enable TX 0 = disable 1 = enable
`data_rate`	Rate index (in hexadecimal) corresponding to legacy/HT/VHT rates Refer to Table 1 & 2 for the data rates
`frame_pattern`	Payload pattern (0 to 0xFFFFFFFF) (Enter hexadecimal value)
`frame_len`	Payload length (1 to 0x400) (Enter hexadecimal value)
`adjust_burst_sifs`	Adjust burst SIFS3 gap 0 = disable 1 = enable
`burst_sifs_in_us`	Burst SIFS3 in us (0 to 255us)
`short_preamble`	Short preamble 0 = disable 1 = enable
`act_sub_ch`	Active sub channel 0 = lower 1 = upper 3 = both
`short_gi`	Short guard interval 0 = disable 1 = enable
`adv_coding`	Advanced coding 0 = disable 1 = enable
`tx_bf`	Beamforming 0 = disable 1 = enable
`gf_mode`	GreenField mode 0 = disable 1 = enable

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Table 9. Command parameters*...continued*

Parameter	Description
`stbc`	STBC 0 = disable 1 = enable
`bssid`	BSSID (xx:xx:xx:xx:xx:xx)

Example – Enable TX frame:

```
# wlan-set-rf-tx-frame 1 1100 2730 256 0 0 0 3 0 0 0 0 0 38:E6:0A:C6:1A:EC
Tx Frame configuration successful Enable : enable
Tx Data Rate : 4352
Payload Pattern : 0x2730
Payload Length : 0x256 Adjust Burst SIFS3 Gap : disable Burst SIFS in us : 0 us
Short Preamble : disable
Active SubChannel : both
Short GI : disable
Adv Coding : disable
Beamforming : disable
GreenField Mode : disable
STBC : disable
BSSID : 38:E6:0A:C6:1A:EC
```

Command to disable TX frame:

```
# wlan-set-rf-tx-frame 0
Tx Frame configuration successful
```


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2.11 Data rates

Table 10. 802.11n/a/g/b data rate index

Data rate index	Data rate
0x1	1Mbits/sec
0x2	2Mbits/sec
0x3	5.5Mbits/sec
0x4	11Mbits/sec
0x5	Reserved
0x6	6Mbits/sec
0x7	9Mbits/sec
0x8	12Mbits/sec
0x9	18Mbits/sec
0xA	24Mbits/sec
0xB	36Mbits/sec
0xC	48Mbits/sec
0xD	54Mbits/sec
0xE	Reserved
0xF	HT_MCS 0
0x10	HT_MCS 1
0x11	HT_MCS 2
0x12	HT_MCS 3
0x13	HT_MCS 4
0x14	HT_MCS 5
0x15	HT_MCS 6
0x16	HT_MCS 7
0x17	HT_MCS 8
0x18	HT_MCS 9
0x19	HT_MCS 10
0x1A	HT_MCS 11
0x1B	HT_MCS 12
0x1C	HT_MCS 13
0x1D	HT_MCS 14
0x1E	HT_MCS 15

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Table 11. 802.11ac/802.11ax data rate index

Data rate index	Data rate
0x1100	VHT_SS1_MCS0
0x1101	VHT_SS1_MCS1
0x1102	VHT_SS1_MCS2
0x1103	VHT_SS1_MCS3
0x1104	VHT_SS1_MCS4
0x1105	VHT_SS1_MCS5
0x1106	VHT_SS1_MCS6
0x1107	VHT_SS1_MCS7
0x1108	VHT_SS1_MCS8
0x1109	VHT_SS1_MCS9
0x1200	VHT_SS2_MCS0
0x1201	VHT_SS2_MCS1
0x1202	VHT_SS2_MCS2
0x1203	VHT_SS2_MCS3
0x1204	VHT_SS2_MCS4
0x1205	VHT_SS2_MCS5
0x1206	VHT_SS2_MCS6
0x1207	VHT_SS2_MCS7
0x1208	VHT_SS2_MCS8
0x1209	VHT_SS2_MCS9
0x2100	HE_SS1_MCS0
0x2101	HE_SS1_MCS1
0x2102	HE_SS1_MCS2
0x2103	HE_SS1_MCS3
0x2104	HE_SS1_MCS4
0x2105	HE_SS1_MCS5
0x2106	HE_SS1_MCS6
0x2107	HE_SS1_MCS7
0x2108	HE_SS1_MCS8
0x2109	HE_SS1_MCS9
0x2110	HE_SS1_MCS10
0x2111	HE_SS1_MCS11
0x2200	HE_SS2_MCS0
0x2201	HE_SS2_MCS1
0x2202	HE_SS2_MCS2
0x2203	HE_SS2_MCS3

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Table 11. 802.11ac/802.11ax data rate index*...continued*

Data rate index	Data rate
0x2204	HE_SS2_MCS4
0x2205	HE_SS2_MCS5
0x2206	HE_SS2_MCS6
0x2207	HE_SS2_MCS7
0x2208	HE_SS2_MCS8
0x2209	HE_SS2_MCS9
0x2210	HE_SS2_MCS10
0x2211	HE_SS2_MCS11

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2.12 Testing 802.11ax uplink-OFDMA transmit

This section shows how to run uplink-OFDMA (UL-OFDMA) test using Wi-Fi RF test mode commands. In the standard test setup, two boards are required to accomplish the test. One board known as the golden unit is used to transmit the trigger frame to the DUT. The other board is the DUT which responds to the trigger frame sent by the golden unit.

Note: *This section is for the devices that support 5GHz Wi-Fi 6.*

2.12.1 Test setup

Figure 1 shows the standard setup for the UL-OFDMA test in the test lab. One radio (Golden Unit) is used to send a trigger frame and a second radio (DUT) is used to respond to the trigger frame with a UL-OFDMA signal. A horn antenna receives the UL-OFDMA signal from the DUT and the signal is analyzed with a test receiver.

Note: *A standalone test setup with only one board (DUT) to test UL-OFDMA transmit can also be used.*

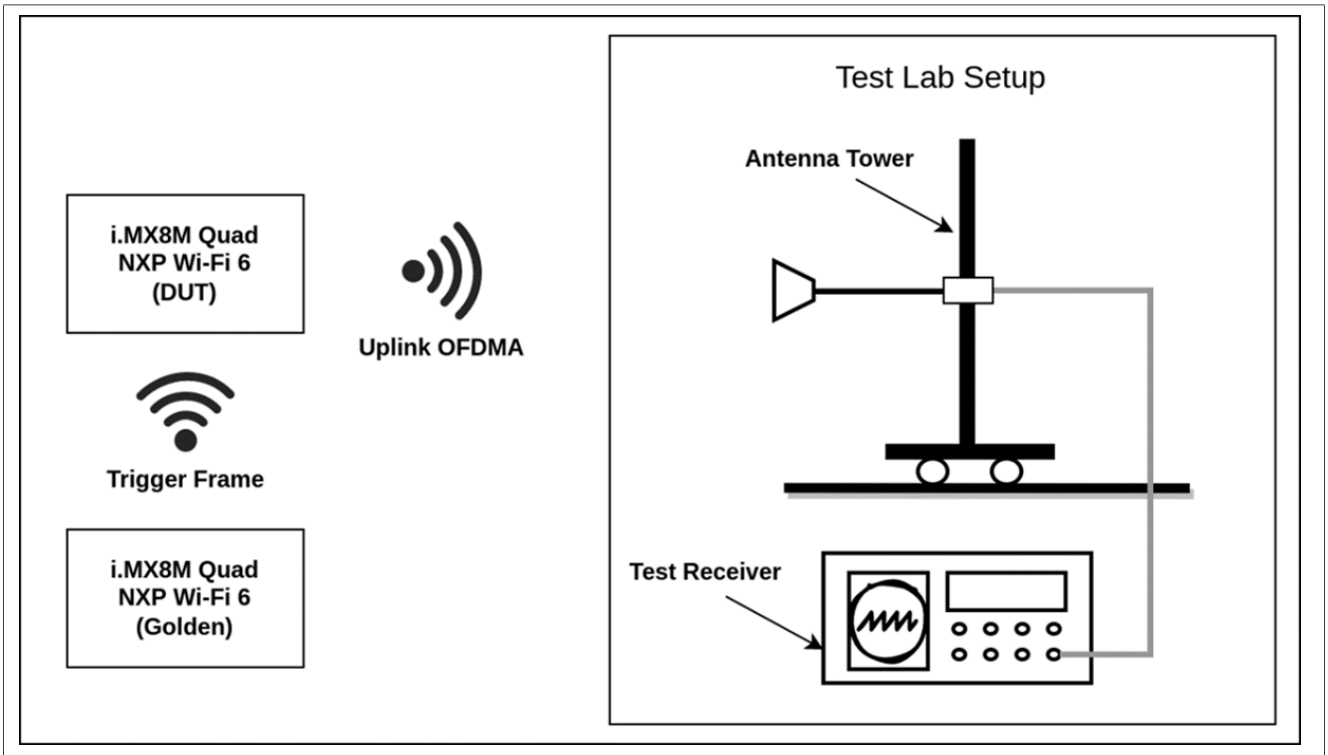

Figure 1. Uplink OFDMA test setup

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2.12.2 Configure the golden unit and DUT for UL-OFDMA transmission

Command to set the trigger frame parameters on the golden unit:

```
# wlan-set-rf-trigger-frame-cfg <enable_TX> <standalone_hetb> <frame ctrl type> <frame
 ctrl subtype> <frame duration> <trigger type> <UlLen> <MoreTF> <CSRequired> <UlBw>
 <LTFType> <LTFMode> <LTFSymbol> <UlSTBC> <LdpcESS> <ApTXPwr> <PreFecPadFct> <PeDisambig>
 <SpatialReuse> <Doppler> <HeSig2> <AID12> <RUAllocReg> <RUAlloc> <UlCodingType> <UlMCS>
 <UlDCM> <SSAlloc> <UlTargetRSSI> <MPDU_MU_SF> <TID_AL> <AC_PL> <Pref_AC>
```

Table 12. Command parameters

Parameter	Definition
enable_TX	Enable transmit 0 = disable 1 = enable
standalone_hetb	Enable standalone UL-OFDMA 0 = disable 1 = Trigger-based UL-OFDMA 2 = Standalone UL-OFDMA
frame ctrl type	Set to 1
frame ctrl subtype	Set to 2
frame duration	Set to 5484
trigger type	Set to 0
UlLen	Set to 1000
MoreTF	Set to 0
CSRequired	Set to 0
UlBw	Channel bandwidth 0 = 20 MHz 1 = 40 MHz 2 = 80 MHz
LTFType	Set to 1
LTFMode	Set to 0
LTFSymbol	Select the long training field symbol (LTFS) 0 = 1xHELTF for 1SS 1 = 2xHELTF for 2SS
UlSTBC	Set to 0
LdpcESS	Set to 1
ApTXPwr	Set to 0
PreFecPadFct	Set to 1
PeDisambig	Set to 0
SpatialReuse	Set to 65535
Doppler	Set to 0
HeSig2	Set to 511
AID12	Set to 5

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Table 12. Command parameters*...continued*

Parameter	Definition
RUAllocReg	Set to 0
RUAlloc	RU index. The RU index value for 20 MHz, 40 MHz, and 80 MHz channel bandwidths are shown in Figure 2, Figure 3, and Figure 4 respectively.
UlCodingType	Set to 1
UlMCS	MCS rate Range of 0 to 11
UlDCM	Set to 0
SSAlloc	Select the spatial stream 0 = 1SS 1 = 2SS
UlTargetRSSI	Set to 90
MPDU_MU_SF	Set to 0
TID_AL	Set to 0
AC_PL	Set to 0
Pref_AC	Set to 0

Note: *The DUT transmits UL-OFDMA for each trigger frame it receives. Modify the transmit duty cycle by adjusting the TX time gap of the trigger frames on the golden unit. The RU index and MCS data rate of the UL-OFDMA transmission are based on the received trigger frame.*

Table 13 lists the example steps and commands for HE-trigger frame generation on the golden unit under the following conditions:

- 5 GHz path A
- Channel 36 and 20 MHz channel bandwidth

Table 13. Steps for HE-trigger frame generation on the golden unit

Step	Operation	Command
1	Enable RF test mode	`# wlan-set-rf-test-mode`
2	Set radio mode to 5 GHz (1x1 mode)	`# wlan-set-rf-radio-mode 3`
3	Set band to 5 GHz	`# wlan-set-rf-band 1`
4	Set bandwidth to 20 MHz	`# wlan-set-rf-bandwidth 0`
5	Set channel to 36	`# wlan-set-rf-channel 36`
6	Set trigger frame TX power to 20 dBm	`# wlan-set-rf-tx-power 20 1 0`
7	Configure trigger frame with RU index 0 and MCS2 data rate	`# wlan-set-rf-trigger-frame-cfg 1 1 1 2 5484 0 1000 0 0 0 1 0 0 0 1 0 1 0 65535 0 511 5 0 0 1 2 0 0 90 0 0 0 0`
8	Enable the trigger frame	`# wlan-set-rf-tx-frame 1 0x2100 0xabababab 0x200 1 20 0 0 0 0 0 0 0 00:00:00:00:00:00`

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Command to set the trigger frame response parameters on the DUT

```
# wlan-set-rf-he-tb-tx <enable/exit> <Qnum> <AID> <AXQ0_MU_Timer> <TXPwr>
```

Table 14. Command parameters

Parameter	Definition
`enable/exit`	Enter/exit trigger frame response mode 0 = exit trigger frame response mode (default) 1 = enter trigger frame response mode
`Qnum`	Transmit queue number that holds the trigger-based response packets. 1 = trigger-based test (default)
`AID`	Station ID Value set to 5.
`AXQ0_MU_Timer`	Arbitrary timer value to ensure SU packets are not transmitted. Units are in 8 ms. Set the value to be larger than the trigger frame interval. It is suggested to set the value to 400 (400 *8 = 3200 ms)
`TXPwr`	Transmit power in dBm.

Table 15 lists the steps and RF test mode commands for HE-Trigger response frame generation on the DUT.

Table 15. Steps for HE-trigger response frame generation on the DUT

Step	Operation	Command
1	Enable RF test mode	`# wlan-set-rf-test-mode`
2	Set radio mode to 5 GHz (1x1 mode)	`# wlan-set-rf-radio-mode 3`
3	Set band to 5 GHz	`# wlan-set-rf-band 1`
4	Set bandwidth to 20 MHz	`# wlan-set-rf-bandwidth 0`
5	Set channel to 36	`# wlan-set-rf-channel 36`
6	Start HE TB-TX with TX power set to 9 dBm.	`# wlan-set-rf-he-tb-tx 1 1 5 400 9`
7	Measure the TX power value and EVM for the HE trigger response frame using an RF tester	
8	Stop the HE TB-TX	`# wlan-set-rf-he-tb-tx 0 1 5 400 9`

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2.12.3 Testing standalone UL-OFDMA

A UL-OFDMA test can be performed with the DUT only and without the golden unit.

In the standalone OFDMA test:

- The DUT sends UL-OFDMA signals directly without the golden unit.
- The parameter `<standalone_hetb>` is set to `2` for `wlan-set-rf-trigger-frame-cfg` command.

Note: *This test setup is not used as much as the standard setup at the test lab. Consult with your test lab to determine if this test setup can be used for regulatory compliance testing.*

Table 16 lists the steps and Wi-Fi RF test mode commands for standalone UL-OFDMA on the DUT.

Table 16. Steps for standalone UL-OFDMA test

Step	Operation	Command
1	Enable RF test mode	`# wlan-set-rf-test-mode`
2	Set the radio mode in 5 GHz (1x1 mode)	`# wlan-set-rf-radio-mode 3`
3	Set the band to 5 GHz	`# wlan-set-rf-band 1`
4	Set the bandwidth to 20 MHz	`# wlan-set-rf-bandwidth 0`
5	Set the channel to 36	`# wlan-set-rf-channel 36`
6	Set the TX power of the response frame to 20 dBm	`# wlan-set-rf-tx-power 20 1 0`
7	Configure the response frame with RU index 0, data rate MCS2	`# wlan-set-rf-trigger-frame-cfg 1 2 1 2 5484 0 1000 0 0 0 1 0 0 0 1 0 1 0 65535 0 511 5 0 8 1 2 0 0 90 0 0 0 0`
8	Start transmitting the response frame	`# wlan-set-rf-tx-frame 1 0x2100 0xabababab 0x200 1 20 0 0 0 0 0 0 0 00:00:00:00:00:00`
9	Measure the TX power value and EVM for the HE trigger response frame using an RF tester	
10	Stop transmitting the response frame	`# wlan-set-rf-tx-frame 0 0x2100 0xabababab 0x200 1 20 0 0 0 0 0 0 0 00:00:00:00:00:00`

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2.12.4 UL-OFDMA RU index

Bandwidth	20 MHz								
RU Index	0	1	2	3	4	5	6	7	8
RU Tone	26	26	26	26	26	26	26	26	26
RU Index	37		38			39		40	
RU Tone	52		52			52		52	
RU Index	53					54			
RU Tone	106					106			
RU Index	61								
RU Tone	242								

Figure 2. RU index values for 20 MHz channel bandwidth

Bandwidth	40 MHz																
RU Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RU Tone	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
RU Index	37		38			39		40		41		42			43		44	
RU Tone	52		52			52		52		52		52			52		52	
RU Index	53					54				55					56			
RU Tone	106					106				106					106			
RU Index	61									62								
RU Tone	242									242								
RU Index	65																	
RU Tone	484																	

Figure 3. RU index values for 40 MHz channel bandwidth

Bandwidth	80 MHz																																	
RU Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
RU Tone	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
RU Index	37		38			39		40		41		42			43		44			45		46			47		48		49		50			51		52	
RU Tone	52		52			52		52		52		52			52		52			52		52			52		52		52		52			52		52	
RU Index	53					54				55					56					57					58				59					60			
RU Tone	106					106				106					106					106					106				106					106			
RU Index	61									62										63									64								
RU Tone	242									242										242									242								
RU Index	65																			66																
RU Tone	484																			484																
RU Index	67																																			
RU Tone	996																																			

Figure 4. RU index values for 80 MHz channel bandwidth

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2.13 Examples of RF test mode command sequences

2.13.1 Command sequence for 2.4 GHz TX

TX configured for 2.4 GHz, RF channel 6, 20 MHz bandwidth, 15 dBm target power with OFDM modulation.

Table 17. Command sequence using TX_continuous for 2.4 GHz TX

Step	Operation	Command
1	Enable the RF test mode	`# wlan-set-rf-test-mode`
2	Set the radio mode	`# wlan-set-rf-radio-mode 11`
3	Set RF band to 2.4 GHz	`# wlan-set-rf-band 0`
4	Set channel to 6	`# wlan-set-rf-channel 6`
5	Set 20 MHz bandwidth	`# wlan-set-rf-bandwidth 0`
6	Set TX power to 15 dBm OFDM on Path A	`# wlan-set-rf-tx-power 15 1 0`
7	Enable TX frames	`# wlan-set-rf-tx-frame 1 7 2730 256 0 0 0 0 0 0 0 0 0 11:22:33:44:55:66`
8	Stop TX	`# wlan-set-rf-tx-frame 0`

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2.13.2 Command sequence for 5 GHz RX

RX configured for 5 GHz, RF channel 36, 20 MHz bandwidth.

Table 18. Command sequence for 5 GHz RX

Step	Operation	Command
1	Enable the RF test mode	`# wlan-set-rf-test-mode`
2	Set RF band to 5 GHz	`# wlan-set-rf-band 1`
3	Set channel to 36	`# wlan-set-rf-channel 36`
4	Set 20 MHz bandwidth	`# wlan-set-rf-bandwidth 0`
5	Reset the packet error rate	`# wlan-get-and-reset-rf-per`
6	Send a number of packets to the DUT	
7	Get and reset the packet error rate	`# wlan-get-and-reset-rf-per`

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3 RF test mode for Bluetooth

This section describes the commands to use Bluetooth RF test mode.

The *edgefast_bluetooth_shell* application demonstrates the interactive shell mode of Bluetooth commands and APIs, and provides direct access to the host command interface (HCI).

3.1 Initialize the Bluetooth interface

Before using any RF test mode commands, issue the command to enable the Bluetooth interface:

```
@bt> bt.init
```


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3.2 RF test mode for Bluetooth BDR/EDR

This section describes RF test mode commands, and the usage of Bluetooth BR/EDR RF test mode feature.

3.2.1 Enable Bluetooth BDR/EDR TX test

Command to enable a Bluetooth BDR/EDR TX test:

```
@bt> bt_test.tx_test <TestScenario> <HoppingMode> <TxChannel> <RxChannel>
 <TxTestInterval> <PacketType> <Length> <Whitening> <Number of Test Packets> <TX Power>
```

Table 19. Command parameters

Name	Length (byte)	Description
`TestScenario`	1	Test scenario 0x01 = PATTERN_00 (data pattern: 0x00) 0x02 = PATTERN_FF (data pattern: 0xFF) 0x03 = PATTERN_55 (data pattern: 0x55) 0x04 = PATTERN_PRBS (data pattern: 0xFE) 0x09 = PATTERN_0F (data pattern: 0x0F) 0xFF = exit test
`HoppingMode`	1	Hopping mode 0x00 = fixed frequency 0x01 = hopping set
`TxChannel`	1	TX channel Transmit frequency = (2402+k) MHz, where k is the value of `TxChannel`
`RxChannel`	1	RX channel Receive frequency = (2402+k) MHz, where k is the value of `RxChannel`
`TxTestInterval`	1	Poll interval for each frame in units of 1.25 ms
`PacketType`	1	Transmit packet type 0x03 = DM1 0x04 = DH1 0x0A = DM3 0x0B = DH3 0x0E = DM5 0x0F = DH5 0x14 = 2-DH1 0x18 = 3-DH1 0x1A = 2-DH3 0x1B = 3-DH3 0x1E = 2-DH5 0x1F = 3-DH5
`Length`	2	Length of test data
`Whitening`	1	Whitening 0x00 = disabled 0x01 = enabled
`Number of Test Packets`	4	Number of test packets 0 = infinite (default)

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Table 19. Command parameters*...continued*

Name	Length (byte)	Description
`Tx Power`	1	Signed value of TX power (dBm) Range = -20 dBm to 12 dBm (default = 4 dBm)

Example – Enable a transmit test with DM1 packets on channel 1 at 4 dBm

```
@bt> bt_test.tx_test 01 00 01 01 0D 03 0F 00 00 00 00 00 00 04
@bt> HCI Command Response : 00
```

Use the command below to stop the transmit test:

```
@bt> bt_test.tx_test FF 00 01 01 0D 03 0F 00 00 00 00 00 00 04
@bt> HCI Command Response : 00
```


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3.2.2 Enable Bluetooth BDR/EDR RX test

Command to enable a Bluetooth BDR/EDR TX test:

```
@bt> bt_test.rx_test <TestScenario> <TxChannel> <RxChannel> <TestPacketType> <Expected
 Number of Packets> <Length of Test Data> <TX AM Address> <TX BD Address> <Report Error
 Packets>
```

Table 20. Command parameters

Name	Length (byte)	Description
`TestScenario`	1	Test scenario 0x01 = receiver test, 0–pattern 0x02 = receiver test, 1–pattern 0x03 = receiver test, 1010–pattern 0x04 = receiver test, PRBS–pattern 0x09 = receiver test, 1111 0000–pattern 0xFF = abort test
`TxChannel`	1	TX channel Transmit frequency = (2402+k) MHz, where k is the value of `TxChannel`
`RxChannel`	1	RX channel Receive frequency = (2402+k) MHz, where k is the value of `RxChannel`
`TestPacketType`	1	Test packet type 0x03 = DM1 0x04 = DH1 0x0A = DM3 0x0B = DH3 0x0E = DM5 0x0F = DH5 0x14 = 2-DH1 0x18 = 3-DH1 0x1A = 2-DH3 0x1B = 3-DH3 0x1E = 2-DH5 0x1F = 3-DH5
`Expected Number of Packets`	4	Expected number of packets
`Length of Test Data`	2	Length of test data Should not be longer than the maximum size of the specified test packet type
`Tx AM Address`	1	TX AM Address Default = 0x01
`Transmitter BD Address`	6	BD address ff the transmitter This is used to derive the access code
`Report Error Packets`	1	Report error packets 0x00 = none (default) 0x01 to 0xFE = number of packets to report

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Example – Enable a receive test on with DM1 packets on channel 1, from transmitter BD address 20:4E:F6:EC:1F:26

```
@bt> bt_test.rx_test 01 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00
@bt> HCI Command Response : 00
```

Command to stop the receive test:

```
@bt> bt_test.rx_test FF 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00
@bt> HCI Command Response : 00
```


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3.3 RF test mode for Bluetooth LE

This section describes RF test mode commands for Bluetooth LE.

3.3.1 Set Bluetooth LE TX power

Command to set the BLE TX power:

```
@bt> le_test.set_tx_power <TX power>
```

Table 21. Command parameters

Parameter	Description
`TX power`	Bluetooth LE TX power (dBm) in hex

Example – Set the Bluetooth LE TX power to 4 dBm.

```
@bt> le_test.set_tx_power 4
tx_power= 4
@bt> HCI Command Response : 00
```


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3.3.2 Enable Bluetooth LE TX Test

Command to enable a Bluetooth LE TX test:

```
@bt> le_test.tx_test <channel> <data_len> <pkt_payload> <phy>
```

Table 22. Command parameters

Parameter	Description
`channel`	Bluetooth LE Channel in hex Input = (frequency-2402) / 2 Range: 0x00 to 0x27 Frequency range: 2402 MHz to 2480 MHz
`data_len`	Length in bytes of payload data in each packet 0x00 to 0xFF
`pkt_payload`	Payload Pattern 0x00 PRBS9 sequence '1111111100000111101…' 0x01 Repeated '11110000' sequence 0x02 Repeated '10101010' sequence 0x03 PRBS15 sequence 0x04 Repeated '11111111' sequence 0x05 Repeated '00000000' sequence 0x06 Repeated '00001111' sequence 0x07 Repeated '01010101' sequence
`phy`	Phy rate 1 = LE 1M 2 = LE 2M 3 = S=8 data coding 4 = S=2 data coding

Example – Enable a transmit test on channel 1, data length of 255 bytes, payload pattern of PRBS9, and Bluetooth LE 1M PHY:

```
@bt> le_test.tx_test 01 FF 00 01
@bt> HCI Command Response : 00
```

Use the command below to stop the transmit test:

```
@bt> le_test.end_test
@bt> HCI Command Response : 00
```


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3.3.3 Enable Bluetooth LE RX test

Command to enable a Bluetooth LE RX test:

```
@bt> le_test.rx_test <channel> <phy> <modulation_index>
```

Table 23. Command parameters

Parameter	Description
`channel`	Bluetooth LE channel in hex Input = (frequency-2402) / 2 Range: 0x00 to 0x27 Frequency range: 2402 MHz to 2480 MHz
`phy`	Phy rate 01 = LE 1M 02 = LE 2M 03 = Coded PHY
`modulation_index`	Modulation index 0 = standard modulation index 1 = stable modulation index

Example – Enable a receive test on channel 0 LE 2M PHY with standard modulation.

```
@bt> le_test.rx_test 00 01 00
@bt> HCI Command Response : 00
```

Command to stop the receive test:

```
@bt> le_test.end_test
@bt> HCI Command Response : 00
```


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3.4 Examples of RF test mode command sequences

3.4.1 Command sequence for Bluetooth Classic TX

TX test with DM1 packets on channel 1 at 4 dBm.

Table 24. Command sequence for Bluetooth Classic TX

Step	Operation	Command
1	Initialize Bluetooth	`@bt> bt.init`
2	Transmit 4 dBm DM1 packets at 2404 MHz with data pattern 0x00	`@bt> bt_test.tx_test 01 00 01 01 0D 03 0F 00 00 00 00 00 00 04`
3	End transmit	`@bt> bt_test.tx_test FF 00 01 01 0D 03 0F 00 00 00 00 00 00 04`

3.4.2 Command sequence for Bluetooth Classic RX

RX test with DM1 packets on RF channel 1.

Table 25. Command sequence for Bluetooth Classic RX

Step	Operation	Command
1	Initialize Bluetooth	`@bt> bt.init`
2	Enable receive at 2404MHz for DM1 packets from TX device 20:4 E:F6:EC:1F:26	`@bt> bt_test.rx_test 01 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00`
3	Transmit packets to the DUT with an RF tester	
4	End receive test and get packet count	`@bt> bt_test.rx_test FF 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00`
5	Check packet count in HCI log	

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3.4.3 Command sequence for Bluetooth LE TX

TX test with 1M LE packets on RF channel 0 at 4 dBm.

Table 26. Command sequence for Bluetooth LE TX

Step	Operation	Command
1	Initialize Bluetooth	`@bt> bt.init`
2	Set TX power to 4 dBm	`@bt> le_test.set_tx_power 4`
3	Transmit LE 1M packets on 2402 MHz	`@bt> le_test.tx_test 00 FF 00 01`
4	End transmit	`@bt> le_test.end_test`

3.4.4 Command sequence for Bluetooth LE RX

RX test with 1M LE packets on RF channel 0.

Table 27. Command sequence for Bluetooth LE RX

Step	Operation	Command
1	Initialize Bluetooth	`@bt> bt.init`
2	Enable receive for LE 1M packets on 2402 MHz	`@bt> le_test.rx_test 00 01 00`
3	Transmit packets to the DUT with an RF tester	
4	End receive test	`@bt> le_test.end_test`
5	Check packet count in HCI log	

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4 RF test mode for 802.15.4

This section describes the commands for 802.15.4 RF test mode.

The *ot-cli* application demonstrates OpenThread features and can be used to configure the radio for 802.15.4 RF parameters. The application is based on the open source OpenThread CLI application and uses additional vendor-specific commands.

4.1 Initialize the 802.15.4 interface

Command to enable the 802.15.4 interface:

```
> ifconfig up
```

4.2 Enable/disable 802.15.4 RF test mode

Command to enable 802.15.4 RF test mode:

```
> radio_nxp mfgcmd 1
```

Command to disable 802.15.4 RF test mode:

```
> radio_nxp mfgcmd 0
```

4.3 Set the channel

Command to set 802.15.4 channel:

```
> radio_nxp mfgcmd 12 <Channel>
```

Table 28. Command parameters

Parameter	Description
`Channel`	RF Channel Input integer range of 11 (default) to 26

Example – Set the channel to 13:

```
> radio_nxp mfgcmd 12 13
```

4.4 Get the channel

Command to get 802.15.4 current channel:

```
> radio_nxp mfgcmd 11
```

Example – Get the channel:

```
> radio_nxp mfgcmd 11
13
```


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4.5 Set TX power

Command to set the TX power:

```
> radio_nxp mfgcmd 16 <TX power>
```

Table 29. Command parameters

Parameter	Description
TX power	TX power in dBm

Example – Set the TX power to 10 dBm:

```
> radio_nxp mfgcmd 16 10
```

4.6 Get TX power

Command to get the TX power:

```
> radio_nxp mfgcmd 15
```

Example – Get the TX power:

```
> radio_nxp mfgcmd 15
10
```

4.7 Set TX payload size

Command to set the TX payload size.

```
> radio_nxp mfgcmd 21 <payload>
```

Table 30. Command parameters

Parameter	Description
payload	TX payload in bytes Input integer range of 17 to 116

Example – Set the TX payload to 17 bytes:

```
> radio_nxp mfgcmd 21 17
```

4.8 Get TX payload size

Command to get the TX payload size in bytes:

```
> radio_nxp mfgcmd 20
```

Example – Command to get the payload size:

```
> radio_nxp mfgcmd 20
17
```


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4.9 Start RX test

Command to start an RX test and receive frames:

```
> radio_nxp mfgcmd 32
```

4.10 Get RX test results

Command to get the RX test results:

```
> radio_nxp mfgcmd 31
```

Example – Get the RX test results:

```
> radio_nxp mfgcmd 31
status : 0
rx_pkt_count : 500
total_pkt_count : 500
rssi : -32
lqi : 0
```

4.11 Enable/disable TX continuous

Command to start a continuous transmission:

```
> radio_nxp mfgcmd 17 <enable/disable>
```

Table 31. Command parameters

Parameter	Description
`enable/disable`	Enable or disable continuous TX 0 = disable 1 = enable

Example – Enable continuous TX:

```
> radio_nxp mfgcmd 17 1
```

Example – Disable continuous TX:

```
> radio_nxp mfgcmd 17 0
```


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4.12 Start burst TX test

Command to start a burst TX test and send a number of frames:

```
> radio_nxp mfgcmd 33 <mode> <packet gap>
```

Table 32. Command parameters

Parameter	Description
`mode`	Number of packets to send 0=1 1=25 2=100 3=500 4=1000 5=2000 6=5000 7=10000
`Packet gap`	Packet gap in milliseconds (ms) Must be >5ms

Example – Enable a 500 packet burst TX with a 10ms packet gap:

```
> radio_nxp mfgcmd 33 3 10
```

4.13 Enable/disable TX with duty cycle

Command to start a transmission with a duty cycle of ~27%:

```
> radio_nxp mfgcmd 35 <enable/disable>
```

Table 33. Command parameters

Parameter	Description
`enable/disable`	Enable or disable TX with duty cycle 0 = disable 1 = enable

Example – Enable TX with duty cycle:

```
> radio_nxp mfgcmd 35 1
```

Example – Disable TX with duty cycle:

```
> radio_nxp mfgcmd 35 0
```


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4.14 Examples of RF test mode command sequences

4.14.1 Command sequence for 802.15.4 TX

Continuous TX test with on channel 11 at 10 dBm.

Table 34. Continuous TX test command sequence

Step	Operation	Command
1	Initialize 802.15.4 interface	`> ifconfig up`
2	Enable RF test mode	`> radio_nxp mfgcmd 1`
3	Set RF channel to channel 11	`> radio_nxp mfgcmd 12 11`
4	Set TX power to 10 dBm	`> radio_nxp mfgcmd 16 10`
5	Enable continuous TX	`> radio_nxp mfgcmd 17 1`
6	Disable continuous TX	`> radio_nxp mfgcmd 17 0`

4.14.2 Command sequence for 802.15.4 RX

RX test with on channel 11.

Table 35. Continuous RX test command sequence

Step	Operation	Command
1	Initialize 802.15.4 interface	`> ifconfig up`
2	Enable RF test mode	`> radio_nxp mfgcmd 1`
3	Set RF channel to channel 11	`> radio_nxp mfgcmd 12 11`
4	Start RX test	`> radio_nxp mfgcmd 32`
5	Get RX test results	`> radio_nxp mfgcmd 31`

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5 Abbreviations

Table 36. Abbreviations

Abbreviation	Definition
CS	Carrier suppression
CW	Carrier wave
DUT	Device under test
FW	Firmware
HCI	Host command interface
RF	Radio frequency
RX	Receive
TX	Transmit
UL-OFDMA	Uplink OFDMA

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6 References

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[7] Webpage – RW610: Wireless MCU with Integrated Radio: 1x1 Wi-Fi® 6 + Bluetooth® Low Energy Radios (link)
[8] Webpage – RW612: Wireless MCU with Integrated Tri-radio: 1x1 Wi-Fi® 6 + Bluetooth® Low Energy / 802.15.4 (link)

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8 Revision history

Table 37. Revision history

Document ID	Release date	Description
AN14282 v.1.0	7 February 2025	• Initial version

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