

# AN14114

## RF Test Mode on Linux OS

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Application note

### Document information

| Information | Content                                                   |
|-------------|-----------------------------------------------------------|
| Keywords    | RF test mode, production firmware, regulatory, compliance |
| Abstract    | Describes how to enable and use RF test mode on Linux OS. |



## 1 Introduction

This document provides an overview of how to enable and use the RF test mode on a Linux host. RF test mode feature is used to set RF parameters for transmit and receive testing for regulatory compliance. The feature is available for use on the production software.

RF test mode is compatible with Wi-Fi, Bluetooth, and 802.15.4 radios.

**Note:** This document assumes that you are familiar with [\[2\]](#) and that you have used the production firmware to bring up the radios on your device.

### 1.1 Supported devices

- 88W8987
- 88W8997
- 88W9098
- AW611
- IW416
- IW610
- IW611
- IW612

**Note:** For more information on the software compatibility, refer to the software release notes of your device.

## 2 Wi-Fi RF test mode

This section describes the commands to use RF test mode for Wi-Fi on the i.MX 8M Quad EVK with Linux. The commands apply to any Linux-based host.

Wi-Fi RF test mode commands can be set by using the echo command to pass parameters to a configuration file located in the `/proc/mwlan/adapterX/config` directory.

**Note:** In the command examples, `adapter0` refers to the Wi-Fi device name. To check your device name, refer to the `/proc/mwlan/` directory for `adapterX` after loading the drivers and firmware. Adjust this parameter for your device.

### 2.1 List of commands for Wi-Fi RF test mode

[Table 1](#) lists the commands available for RF test mode of Wi-Fi.

Table 1. List of commands for Wi-Fi RF test mode

| Command                                                     |
|-------------------------------------------------------------|
| <a href="#">Enable RF test mode and check RF parameters</a> |
| <a href="#">Set TX/RX antenna configuration</a>             |
| <a href="#">Set the radio mode</a>                          |
| <a href="#">Set the operating RF band</a>                   |
| <a href="#">Set the channel bandwidth</a>                   |
| <a href="#">Set the RF channel</a>                          |
| <a href="#">Get and reset the packet error rate</a>         |
| <a href="#">Set TX power</a>                                |
| <a href="#">Set TX continuous mode</a>                      |
| <a href="#">Set TX frame</a>                                |
| <a href="#">Testing 802.11ax Uplink-OFDMA transmit</a>      |

## 2.2 Enable RF test mode and check RF parameters

RF test mode must be enabled before setting other RF test mode parameters.

Command to **enable** RF test mode:

```
echo "rf_test_mode=1" >> /proc/mwlan/adapter0/config
```

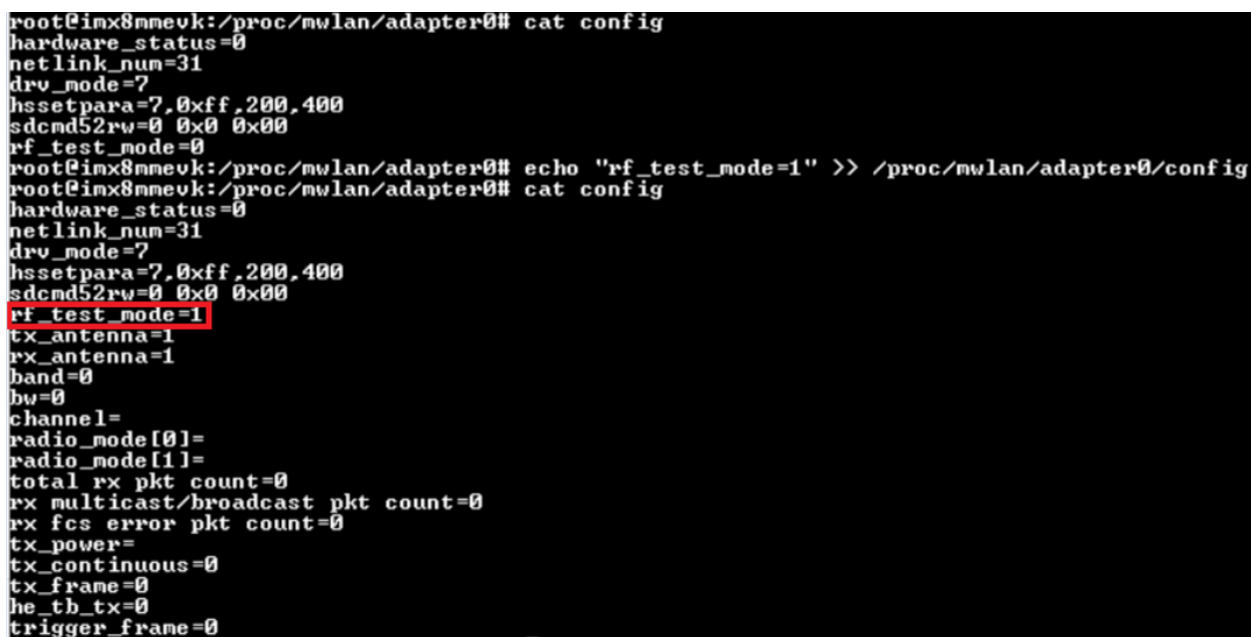
Command to **disable** RF test mode:

```
echo "rf_test_mode=0" >> /proc/mwlan/adapter0/config
```

Command to check your set RF test mode parameters by printing the contents of the configuration file:

```
cat /proc/mwlan/adapter0/config
```

[Figure 1](#) shows the example of RF test mode enabled, with the output value of `rf_test_mode=1` in the configuration file.



```
root@mx8mmevk:/proc/mwlan/adapter0# cat config
hardware_status=0
netlink_num=31
drv_mode=7
hssetpara=7,0xff,200,400
sdcmd52rw=0 0x0 0x00
rf_test_mode=0
root@mx8mmevk:/proc/mwlan/adapter0# echo "rf_test_mode=1" >> /proc/mwlan/adapter0/config
root@mx8mmevk:/proc/mwlan/adapter0# cat config
hardware_status=0
netlink_num=31
drv_mode=7
hssetpara=7,0xff,200,400
sdcmd52rw=0 0x0 0x00
rf_test_mode=1
tx_antenna=1
rx_antenna=1
band=0
bw=0
channel=
radio_mode[0]=
radio_mode[1]=
total rx pkt count=0
rx multicast/broadcast pkt count=0
rx fcs error pkt count=0
tx_power=
tx_continuous=0
tx_frame=0
he_tb_tx=0
trigger_frame=0
```

Figure 1. Example of command output with `rf_test_mode` enabled

2.3 Set TX/RX antenna configuration

Command to set the antenna configuration for **transmission mode**:

```
echo "tx_antenna=<mode>" >> /proc/mwlan/adapter0/config
```

Command to set the antenna configuration for **receive mode**:

```
echo "rx_antenna=<mode>" >> /proc/mwlan/adapter0/config
```

Table 2. Command parameters

| Parameter | Description                                                                                                 |
|-----------|-------------------------------------------------------------------------------------------------------------|
| TX mode   | TX antenna<br>1 = Path A<br>2 = Path B<br>3 = Paths A and B<br><b>Note:</b> For 1x1 devices, select Path A. |
| RX mode   | RX antenna<br>1 = Path A<br>2 = Path B<br>3 = Paths A and B<br><b>Note:</b> For 1x1 devices, select Path A. |

Example of command to set the antenna configuration for transmission mode (Path A):

```
echo "tx_antenna=1" >> /proc/mwlan/adapter0/config
```

Example of command to set the antenna configuration for receive mode (Path B):

```
echo "rx_antenna=2" >> /proc/mwlan/adapter0/config
```

2.4 Set the radio mode

Command to set the radio mode:

```
echo "radio_mode=<index for radio 0> <index for radio 1>" >> /proc/ mwlan/adapter0/config
```

**Note:** This command is only for 88W9098, AW611, IW611, and IW612.

[Table 3](#) lists the radio mode indexes for 88W9098.

Table 3. Radio mode index values for 88W9098

| Radio mode index | Band and antenna path configuration                                                                                           |
|------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 0                | Sets the radio in power down mode.<br><b>Note:</b> Radio mode index for devices with dual Wi-Fi radios only.                  |
| 1                | Sets the radio in 5 GHz band, 2x2 mode (Path A+B)<br><b>Note:</b> Radio mode index for devices with dual Wi-Fi radios only.   |
| 3                | Sets the radio in 5 GHz band, 1x1 mode (Path A)                                                                               |
| 4                | Sets the radio in 5 GHz band, 1x1 mode (Path B)                                                                               |
| 9                | Sets the radio in 2.4 GHz band, 2x2 mode (Path A+B)<br><b>Note:</b> Radio mode index for devices with dual Wi-Fi radios only. |
| 11               | Sets the radio in 2.4 GHz band, 1x1 mode (Path A)                                                                             |
| 14               | Sets the Radio in 2.4 GHz band, 1x1 mode (Path B)                                                                             |

Example of command to set the radio 0 in 5 GHz band with 2x2 mode, and radio 1 in power down mode:

```
echo "radio_mode=1 0" >> /proc/mwlan/adapter0/config
```

Example of command to set the radio 0 in power down mode, and radio 1 in 2.4 GHz band with 2x2 mode:

```
echo "radio_mode=0 9" >> /proc/mwlan/adapter1/config
```

[Table 4](#) lists the radio mode indexes for AW611, IW611, and IW612.

Table 4. Radio mode index values for AW611, IW611, and IW612

| Radio mode index | Description           |
|------------------|-----------------------|
| 3                | Radio in 5 GHz band   |
| 11               | Radio in 2.4 GHz band |

**Note:** In the following examples, the “radio index 1” is set to 0 as IW612 device has only one Wi-Fi radio.

Example of command to set the Wi-Fi radio in 5 GHz band for an IW612:

```
echo "radio_mode=3 0" >> /proc/mwlan/adapter0/config
```

Example of command to set the Wi-Fi radio in 2.4 GHz band for an IW612:

```
echo "radio_mode=11 0" >> /proc/mwlan/adapter0/config
```

2.5 Set the operating RF band

Command to set the RF band:

```
echo "band=<RF band>" >> /proc/mwlan/adapter0/config
```

Table 5. Command parameters

| Parameter | Definition                          |
|-----------|-------------------------------------|
| RF band   | RF band<br>0 = 2.4 GHz<br>1 = 5 GHz |

Example of command to set the RF band to 5 GHz:

```
echo "band=1" >> /proc/mwlan/adapter0/config
```

2.6 Set the channel bandwidth

Command to set the channel bandwidth:

```
echo "bw=<bandwidth>" >> /proc/mwlan/adapter0/config
```

Table 6. Command parameters

| Parameter | Definition                                                  |
|-----------|-------------------------------------------------------------|
| bandwidth | Channel bandwidth<br>0 = 20 MHz<br>1 = 40 MHz<br>4 = 80 MHz |

Example of command to set the channel bandwidth to 20 MHz:

```
echo "bw=0" >> /proc/mwlan/adapter0/config
```

2.7 Set the RF channel

Command to set the RF channel:

```
echo "channel=<ch>" >> /proc/mwlan/adapter0/config
```

Table 7. Command parameters

| Parameter | Definition                                                                                                                         |
|-----------|------------------------------------------------------------------------------------------------------------------------------------|
| ch        | RF channel of operation<br><b>Note:</b> For more information on the supported RF channels, refer to <a href="#">Section 2.14</a> . |

Example of command to set the RF channel to 6:

```
echo "channel=6" >> /proc/mwlan/adapter0/config
```

## 2.8 Get and reset the packet error rate

Command to get and reset the packet error rate in the configuration file:

```
echo "get_and_reset_per" >> /proc/mwlan/adapter0/config
```

Command to verify the packet count parameters:

```
cat /proc/mwlan/adapter0/config
```

Command output example:

```
hardware_status=0 netlink_num=31 drv_mode=7 sdcmd52rw=0 0x0 0x00 rf_test_mode=1
TX_antenna=1 RX_antenna=1
band=1 bw=0 channel=36
radio_mode[0]= radio_mode[1]=
total RX pkt count=500
RX multicast/broadcast pkt count=500
RX fcs error pkt count=0
TX_power=
TX_continuous=0
TX_frame=0
he_tb_TX=0
```

The bold text in the command output example shows the packet count data after 500 packets were received by the DUT. The command output includes the total packet count, the multicast/broadcast packet count, and the frame check sequence (FCS) error packet count.

2.9 Set TX power

Command to set the TX power:

```
echo "tx_power=<power> <modulatio> <path id>" >> /proc/mwlan/adapter0/config
```

Table 8. Command parameters

| Parameter  | Definition                                                                                                                                                                             |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| power      | Transmit power level in dBm<br>Integer range of -1 to 24<br>-1 = power level is determined by the firmware and accounts for country code restrictions<br>Else = user input power level |
| modulation | Signal modulation<br>0 = CCK<br>1 = OFDM<br>2 = MCS                                                                                                                                    |
| path id    | TX signal path name<br>0 = path A<br>1 = path B<br>2 = path A + path B<br><b>Note:</b> For 1x1 devices, select Path A.                                                                 |

Example of command to set the TX power to 16 dBm using MCS modulation on path A:

```
echo "tx_power=16 2 0" >> /proc/mwlan/adapter0/config
```

Example of command to determine the power level by firmware with OFDM modulation on path B:

```
echo "tx_power=-1 1 1" >> /proc/mwlan/adapter0/config
```

**Note:** If the power level is set to -1 and the current channel is not allowed in the set country code, the command returns an error.

2.10 Set TX continuous mode

Command to set the TX continuous mode parameters:

```
echo "tx_continuous=<start/stop> <continuous wave mode> <payload pattern> <cs mode>
<active subchannel> <TX data rate>" >> /proc/mwlan/adapter0/config
```

Table 9. Command parameters

| Parameter         | Definition                                                                                                             |
|-------------------|------------------------------------------------------------------------------------------------------------------------|
| start/stop        | Start/stop transmit<br>0 = disable<br>1 = enable                                                                       |
| transmit mode     | Transmit mode<br>0 = continuous packet mode<br>1 = continuous wave mode                                                |
| payload pattern   | Payload pattern value in the range of 0 to 0xFFFFFFFF.                                                                 |
| cs mode           | TX Carrier Suppression (CS) enable<br>*Applicable only when continuous packet mode is set<br>0 = disable<br>1 = enable |
| active subchannel | Active sub-channel<br>0 = low<br>1 = upper<br>3 = both                                                                 |
| TX data rate      | Transmit data rate index corresponding to legacy/HT/VHT rates<br>( <a href="#">Section 2.13</a> ).                     |

Example of command to start TX continuous mode in continuous packet mode with 0xAAA payload pattern, TX carrier suppression disabled, both subchannels active, and a data rate of 12 Mbps:

```
echo "tx_continuous=1 0 0xAAA 0 3 0x7" >> /proc/mwlan/adapter0/config
```

Example of command to stop TX continuous mode in continuous packet mode:

```
echo "tx_continuous=0" >> /proc/mwlan/adapter0/config
```

Example to start continuous wave mode:

```
echo "tx_continuous=1 1 0xAAA 0 3 0x7" >> /proc/mwlan/adapter0/config
```

Example of command to stop continuous wave mode:

```
echo "tx_continuous=0 1 0xAAA 0 3 0x7" >> /proc/mwlan/adapter0/config
```

## 2.11 Set TX frame

Command to set the TX frame parameters

```
echo "tx_frame=<start/stop> <TX data rate> <payload pattern> <payload length> <adjust
burst SIFS gap> <adjust SIFS> <short preamble> <active subchannel> <short GI> <adv
coding> <beamforming> <greenfield mode> <STBC> <Signal Bw> <NumPkt> <MaxPktExt>
<BeamChange> <DCM> <Doppler> <MidamblePeriod> <QNum> <BSSID>" >> /proc/mwlan/adapter0/
config
```

**Table 10. Command parameters**

| Parameter             | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| start/stop            | Start/stop transmit<br>0 = disable<br>1 = enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TX data rate          | Transmit the data rate index corresponding to the legacy/HT/VHT rates ( <a href="#">Section 2.13</a> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| payload pattern       | Payload pattern value in the range of 0 to 0xFFFFFFFF.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| payload length        | Payload length value in the range of 1 to 0x400.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| adjust burst SIFS gap | Adjust burst SIFS gap enable<br>0= disable (default)<br>1 = enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| adjust SIFS           | Burst SIFS duration in microseconds<br>range of 10 $\mu$ s (default) to 255 $\mu$ s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| short preamble        | Short preamble enable<br>0= disable (default)<br>1 = enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| active subchannel     | Active subchannel selection<br>0 = lower (default)<br>1 = upper<br>3 = both                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| short GI              | Enable short guard interval.<br><ul style="list-style-type: none"> <li>For 802.11ac: <ul style="list-style-type: none"> <li>0 = GI 0.4 <math>\mu</math>s</li> <li>1 = GI 0.8 <math>\mu</math>s</li> </ul> </li> <li>For 802.11ax: <ul style="list-style-type: none"> <li>0 = 1xHELTf + GI 0.8 <math>\mu</math>s</li> <li>1 = 2xHELTf + GI 0.8 <math>\mu</math>s</li> <li>2 = 2xHELTf + GI 1.6 <math>\mu</math>s</li> <li>3 = 4xHELTf + GI 0.8 <math>\mu</math>s (if DCM = 1 and STBC = 1)</li> <li>3 = 4xHELTf + GI 3.2 <math>\mu</math>s (if DCM = 0 and STBC = 0)</li> </ul> </li> <li>For 802.11ax HE MU PPDU: <ul style="list-style-type: none"> <li>0 = 4xHELTf + GI 0.8 <math>\mu</math>s</li> <li>1 = 2xHELTf + GI 0.8 <math>\mu</math>s</li> <li>2 = 2xHELTf + GI 1.6 <math>\mu</math>s</li> <li>3 = 4xHELTf + GI 3.2 <math>\mu</math>s<sup>[1]</sup></li> </ul> </li> </ul> |

Table 10. Command parameters...continued

| Parameter                | Definition                                                                                                                                        |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| adv coding               | Advanced coding<br>0 = disable (default)<br>1 = enable<br><b>Note:</b> Set 1 (enable) for 802.11ax MCS10/MCS11, 40 MHz/80 MHz configuration test. |
| beamforming              | Beamforming enable<br>0 = disable (default)<br>1 = enable                                                                                         |
| greenfield mode          | Greenfield mode enable<br>0 = disable (default)<br>1 = enable                                                                                     |
| STBC                     | Space time block coding enable<br>0 = disable (default)<br>1 = enable                                                                             |
| Signal Bw <sup>[2]</sup> | Signal bandwidth<br>0 = 20 MHz<br>1 = 40 MHz<br>4 = 80 MHz<br>-1 = Set to default                                                                 |
| NumPkt                   | Number of packets. Set to default value -1.                                                                                                       |
| MaxPktExt                | Max packet extension. Set to default value -1.                                                                                                    |
| BeamChange               | Beam change<br>Set to default value -1.                                                                                                           |
| DCM                      | DCM enable<br>Set to default value -1.                                                                                                            |
| Doppler                  | Doppler enable<br>Set to default value -1.                                                                                                        |
| MidamblePeriod           | Midamble periodicity Set to default value -1.                                                                                                     |
| QNum                     | Transmit queue number that holds the trigger-based response packets. Set to default value -1.                                                     |
| BSSID                    | Basic service set identifiers<br>Format: xx:xx:xx:xx:xx:xx                                                                                        |

[1] – The short preamble field should be set to 2 for HE MU 3.2 μs GI case, and to 0 for HE SU case.  
– The tx\_frame command parameters DCM and STBC fields must not be set to 1 for HE SU 3.2 μs. If DCM and STBC fields are set to 1, the short GI is set to 0.8 μs.

[2] The command in [Section 2.6](#) is used to set the channel bandwidth whereas the bandwidth set using tx\_frame parameter is for the signal. If the signal bandwidth is set to -1 or greater than the channel bandwidth, the signal bandwidth will be set to be the same as the channel bandwidth.

Example of command to start TX frame with at 12 Mbps, 0xAAA payload pattern, and a packet length of 0x256:

```
echo "tx_frame=1 0x7 0xAAA 0x256 0 20 0 0 0 0 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1  
05:43:3f:c4:51" >> /proc/mwlan/adapter0/config
```

Example of command to stop any ongoing TX frame:

```
echo "tx_frame=0" >> /proc/mwlan/adapter0/config
```

## 2.12 Testing 802.11ax Uplink-OFDMA transmit

This section shows how to run Uplink (UL)-OFDMA test by 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.

A standalone test setup with only one board (DUT) used to test UL-OFDMA transmit may also be used. See [Section 2.12.3](#).

**Note:** This section only applies to devices that support 5 GHz Wi-Fi 6.

### 2.12.1 Test setup

[Figure 2](#) shows the standard setup for the UL-OFDMA test in the test lab. One i.MX8M Quad (Golden) is used to send a trigger frame and a second i.MX8M Quad (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.

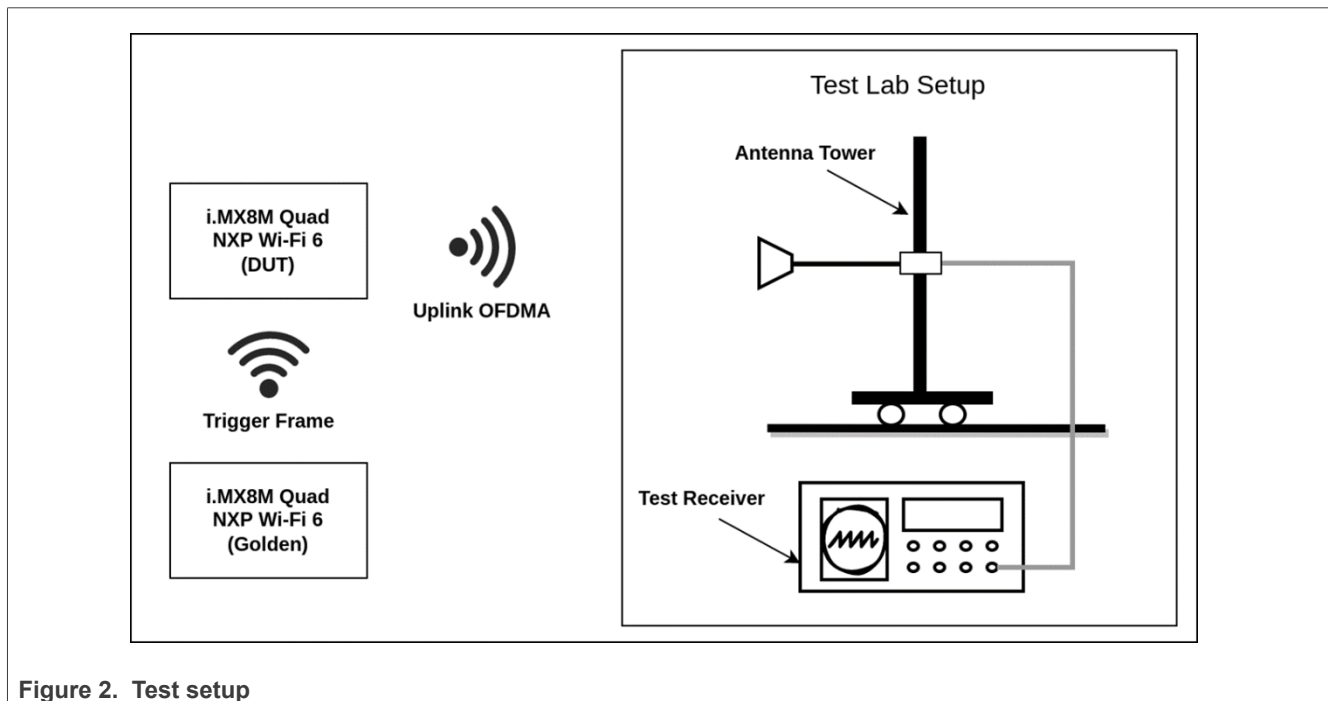


Figure 2. Test setup

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

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

```
echo "trigger_frame=<enable_TX> <standalone_hetb> <frame_ctrl_type> <frame_ctrl_subtype>
<frame_duration> <trigger_type> <ULLen> <MoreTF> <CSRequired> <ULBw> <LTFTType> <LTFTMode>
<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>" >> /proc/ mwlan/adapter0/config
```

**Table 11. Command parameters**

| Parameter          | Definition                                                                                                                                                  |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| enable_TX          | Enable transmit<br>0 = disable<br>1 = enable                                                                                                                |
| standalone_hetb    | Enable standalone UL-OFDMA ( <a href="#">Section 2.12.3</a> )<br>0 = disable<br>1 = Trigger based UL-OFDMA<br>2 = Standalone based UL-OFDMA<br>3 = SU-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               | Bandwidth<br>0 = 20 MHz<br>1 = 40 MHz<br>2 = 80 MHz                                                                                                         |
| LTFTType           | Set to 1                                                                                                                                                    |
| LTFTMode           | Set to 0                                                                                                                                                    |
| LTFSymbol          | Select the Long Training Field Symbol (LTFS)<br>0 = 1xHELTF for 1SS<br>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                                                                                                                                                  |

Table 11. Command parameters...continued

| Parameter    | Definition                                                                                                                                                                                   |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AID12        | Set to 5                                                                                                                                                                                     |
| RUAllocReg   | Set to 0                                                                                                                                                                                     |
| RUAlloc      | RU index. The RU index value for 20 MHz, 40 MHz, and 80 MHz channel bandwidths are shown in <a href="#">Figure 3</a> , <a href="#">Figure 4</a> , and <a href="#">Figure 5</a> respectively. |
| UlCodingType | Set to 1                                                                                                                                                                                     |
| UlMCS        | MCS data rate. Refer to <a href="#">Section 2.13</a> .                                                                                                                                       |
| UlDCM        | Set to 0                                                                                                                                                                                     |
| SSAlloc      | Select the spatial stream<br>0 = 1SS<br>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.

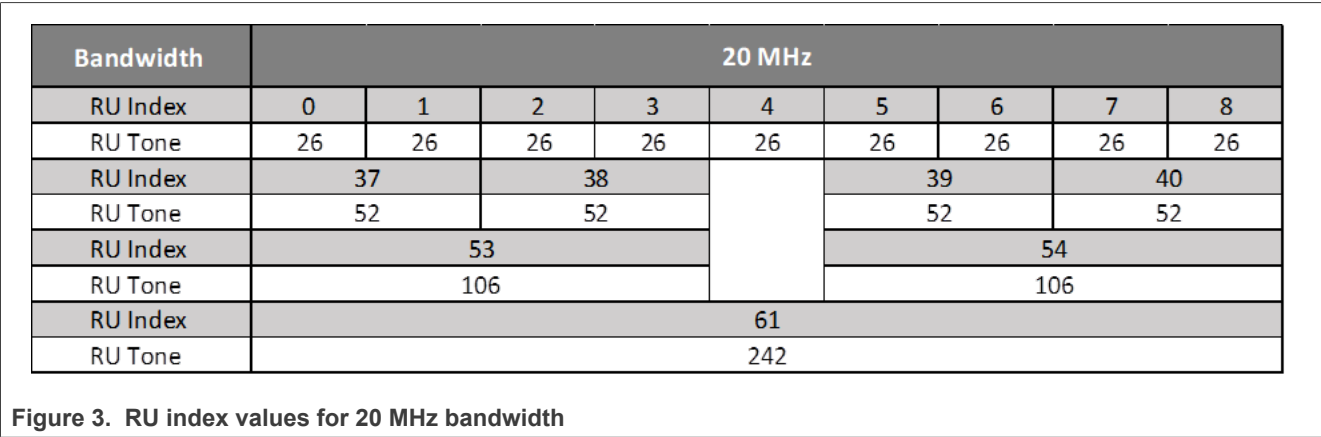
Table 12 lists the steps and commands for HE-trigger frame generation on the golden unit under the following conditions:

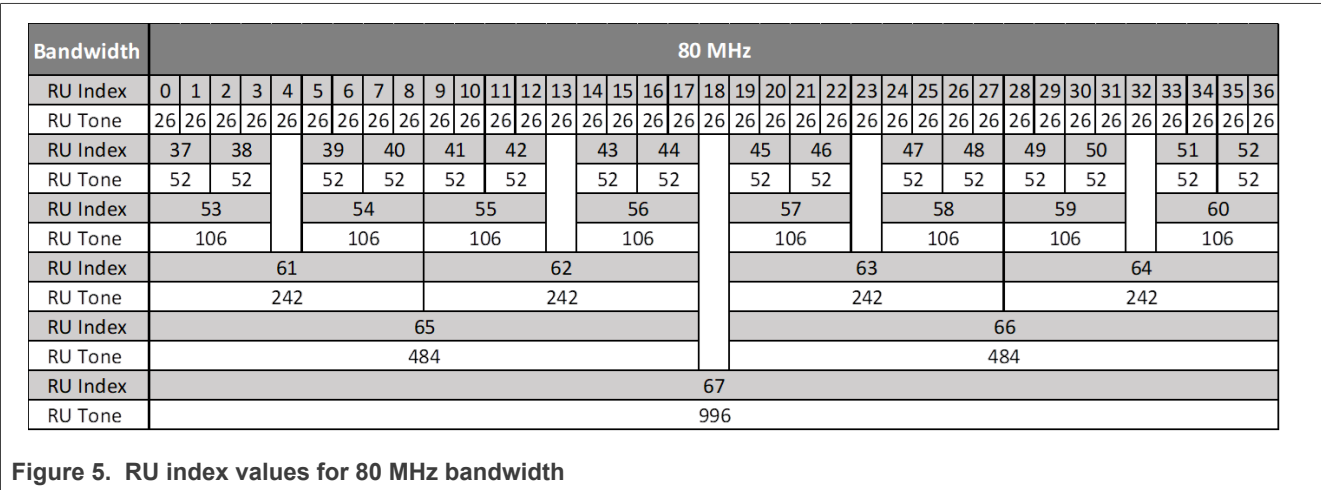
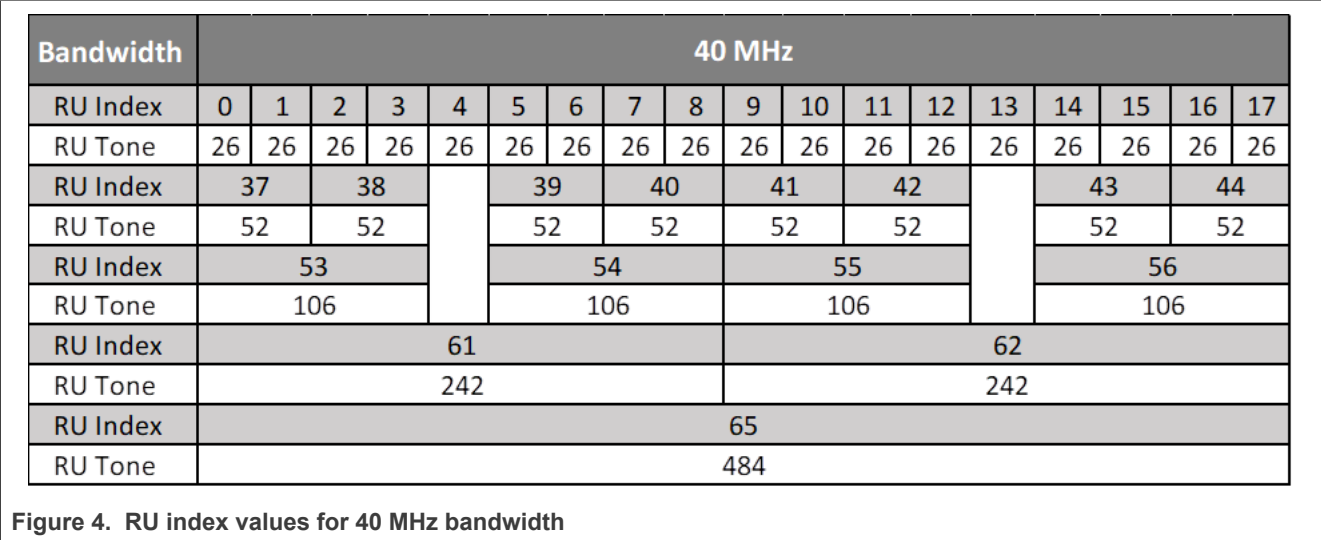
- 5 GHz path A+B
- Channel 36 and 20 MHz channel bandwidth

Table 12. Steps for HE-trigger frame generation on the golden unit

| Step | Operation                                                                     | Command                                                                                                                                    |
|------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable RF test mode                                                           | # echo "rf_test_mode=1" >> /proc/mwlan/adapter0/config                                                                                     |
| 2    | Set radio mode to 5 GHz (2x2 mode)                                            | # echo "radio_mode=1 0" >> /proc/mwlan/adapter0/config                                                                                     |
| 3    | Set the band to 5 GHz                                                         | # echo "band=1" >> /proc/mwlan/adapter0/config                                                                                             |
| 4    | Set the bandwidth to 20 MHz                                                   | # echo "bw=0" >> /proc/mwlan/adapter0/config                                                                                               |
| 5    | Set the channel to 36                                                         | # echo "channel=36" >> /proc/mwlan/adapter0/config                                                                                         |
| 6    | Enable trigger frame with RU index 0, data rate MCS2                          | # echo "trigger_frame=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 0x2102 0 0 90 0 0 0 0" >> /proc/mwlan/ adapter0/config |
| 7    | Start TX_frame<br>Refer to the TX_frame command descriptions in Section 2.11. | # echo "tx_frame=1 0x2102 0xabababab 0x256 0 20 0 0 0 0 0 0 0 -1 -1 -1 -1 -1 -1 -1 05:43:3f:c4:51" >> /proc/mwlan/ adapter0/config         |

Figure 3, Figure 4, and Figure 5 show the RU index values for the 20 MHz, 40 MHz, and 80 MHz bandwidths respectively.





Command to set the trigger frame response parameters on the DUT:

```
echo "he_tb_tx=<enable/exit> <Qnum> <AID> <AXQ0_MU_Timer> <TXPwr>" >> /proc/mwlan/
adapter0/config
```

**Table 13. Command parameters**

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

[Table 14](#) list the steps and Wi-Fi RF test mode commands for HE-Trigger response frame generation on the DUT.

**Table 14. Steps for HE-trigger response frame generation on the DUT**

| Step | Operation                                                                               | Command                                                      |
|------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------|
| 1    | Enable RF test mode                                                                     | # echo "rf_test_mode=1" >> /proc/mwlan/adapter0/config       |
| 2    | Set radio mode to 5 GHz (2x2 mode)                                                      | # echo "radio_mode=1 0" >> /proc/mwlan/adapter0/config       |
| 3    | Set the band to 5 GHz                                                                   | # echo "band=1" >> /proc/mwlan/adapter0/config               |
| 4    | Set the bandwidth to 20 MHz                                                             | # echo "bw=0" >> /proc/mwlan/adapter0/config                 |
| 5    | Set the channel to 36                                                                   | # echo "channel=36" >> /proc/mwlan/adapter0/config           |
| 6    | Start HE TB-TX with TX power set to 9 dBm.                                              | # echo "he_tb_tx=1 1 5 400 9" >> /proc/mwlan/adapter0/config |
| 7    | Measure the TX-power value and EVM for the HE trigger response frame using an RF tester |                                                              |

2.12.3 Testing standalone UL-OFDMA

The UL-OFDMA test can also be performed with just the DUT, 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 `trigger_frame` command.

**Note:** This test setup is not typically used compared to 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 15](#) lists the steps and Wi-Fi RF test mode commands for standalone UL-OFDMA on the DUT. The example applies to Wi-Fi 5 GHz, 1x1 path A, 80 MHz frequency band.

Table 15. Steps for standalone UL-OFDMA test example (Wi-Fi 5 GHz, 1x1 path A, 80 MHz frequency band)

| Step | Operation                                                               | Command                                                                                                                               |
|------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable RF test mode                                                     | # echo "rf_test_mode=1" >> /proc/mwlan/adapter0/config                                                                                |
| 2    | Set the radio mode in 5 GHz (1x1 mode)                                  | # echo "radio_mode=3" >> /proc/mwlan/adapter0/config                                                                                  |
| 3    | Set the band to 5 GHz                                                   | # echo "band=1" >> /proc/mwlan/adapter0/config                                                                                        |
| 4    | Set the bandwidth to 80 MHz                                             | # echo "bw=4" >> /proc/mwlan/adapter0/config                                                                                          |
| 5    | Set TX power to 10 dBm                                                  | # echo "tx_power=10 2 0" >> /proc/mwlan/adapter0/config                                                                               |
| 6    | Set the channel to 36                                                   | # echo "channel=36" >> /proc/mwlan/adapter0/config                                                                                    |
| 7    | Enable standalone trigger frame (enable RU index 67 and data rate MCS0) | # echo "trigger_frame=1 2 1 2 5484 0 1000 0 0 2 1 0 0 0 1 0 1 0 65535 0 511 5 0 67 1 0 0 0 90 0 0 0 0" >> /proc/mwlan/adapter0/config |
| 8    | Start TX_frame<br>Refer to <a href="#">Section 2.11</a> .               | # echo "tx_frame=1 0x2100 0xabababab 0x256 0 20 0 0 0 0 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 05:43:3f:c4:51" >> /proc/mwlan/adapter0/config  |

2.13 Data rates

[Table 16](#) shows 802.11n/a/g/b data rate IDs and data rates.

Table 16. 802.11n/a/g/b data rate ID

| Data rate ID (in hex) | Data rate | Data rate ID (in hex) | Data rate |
|-----------------------|-----------|-----------------------|-----------|
| 0x0                   | 1 Mbps    | 0xe                   | HT_MCS 0  |
| 0x1                   | 2 Mbps    | 0xf                   | HT_MCS 1  |
| 0x2                   | 5.5 Mbps  | 0x10                  | HT_MCS 2  |
| 0x3                   | 11 Mbps   | 0x11                  | HT_MCS 3  |
| 0x4                   | Reserved  | 0x12                  | HT_MCS 4  |
| 0x5                   | 6 Mbps    | 0x13                  | HT_MCS 5  |
| 0x6                   | 9 Mbps    | 0x14                  | HT_MCS 6  |
| 0x7                   | 12 Mbps   | 0x15                  | HT_MCS 7  |
| 0x8                   | 18 Mbps   | 0x16                  | HT_MCS 8  |
| 0x9                   | 24 Mbps   | 0x17                  | HT_MCS 9  |
| 0xa                   | 36 Mbps   | 0x18                  | HT_MCS 10 |
| 0xb                   | 48 Mbps   | 0x19                  | HT_MCS 11 |
| 0xc                   | 54 Mbps   | 0x1a                  | HT_MCS 12 |
| 0xd                   | Reserved  | 0x1b                  | HT_MCS 13 |
|                       |           | 0x1c                  | HT_MCS 14 |
|                       |           | 0x1d                  | HT_MCS 15 |
|                       |           | 0x2e                  | HT_MCS 32 |
|                       |           |                       |           |

[Table 17](#) shows 802.11ac data rate IDs and data rates.

Table 17. 802.11ac data rate ID

| Data rate ID (in hex) | Data rate    |
|-----------------------|--------------|
| 0x100                 | VHT_SS1_MCS0 |
| 0x101                 | VHT_SS1_MCS1 |
| 0x102                 | VHT_SS1_MCS2 |
| 0x103                 | VHT_SS1_MCS3 |
| 0x104                 | VHT_SS1_MCS4 |
| 0x105                 | VHT_SS1_MCS5 |
| 0x106                 | VHT_SS1_MCS6 |
| 0x107                 | VHT_SS1_MCS7 |
| 0x108                 | VHT_SS1_MCS8 |
| 0x109                 | VHT_SS1_MCS9 |
| 0x110                 | VHT_SS2_MCS0 |
| 0x111                 | VHT_SS2_MCS1 |
| 0x112                 | VHT_SS2_MCS2 |
| 0x113                 | VHT_SS2_MCS3 |
| 0x114                 | VHT_SS2_MCS4 |
| 0x115                 | VHT_SS2_MCS5 |
| 0x116                 | VHT_SS2_MCS6 |
| 0x117                 | VHT_SS2_MCS7 |
| 0x118                 | VHT_SS2_MCS8 |
| 0x119                 | VHT_SS2_MCS9 |

Table 18 shows 802.11ac/802.11ax data rate IDs and data rates.

Table 18. 802.11ac/802.11ax data rate ID

| Rate number format : (XYRR)<br>X : 1 - 11ac VHT MCS rates, 2 - 11ax HE MCS rates<br>Y: Number of streams. 1 - SS1, 2 - SS2<br>RR : MCS rate number |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Data rate ID<br>XYRR                                                                                                                               | Data rate    |
| 802.11ac VHT MCS rates <sup>[1]</sup>                                                                                                              |              |
| 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 |
| 802.11ax HE MCS rates                                                                                                                              |              |
| 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  |

Table 18. 802.11ac/802.11ax data rate ID ...continued

| Rate number format : (XYRR)<br>X : 1 - 11ac VHT MCS rates, 2 - 11ax HE MCS rates<br>Y: Number of streams. 1 - SS1, 2 - SS2<br>RR : MCS rate number |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Data rate ID<br>XYRR                                                                                                                               | Data rate    |
| 0x2109                                                                                                                                             | HE_SS1_MCS9  |
| 0x210a                                                                                                                                             | HE_SS1_MCS10 |
| 0x210b                                                                                                                                             | HE_SS1_MCS11 |
| 0x2200                                                                                                                                             | HE_SS2_MCS0  |
| 0x2201                                                                                                                                             | HE_SS2_MCS1  |
| 0x2202                                                                                                                                             | HE_SS2_MCS2  |
| 0x2203                                                                                                                                             | HE_SS2_MCS3  |
| 0x2204                                                                                                                                             | HE_SS2_MCS4  |
| 0x2205                                                                                                                                             | HE_SS2_MCS5  |
| 0x2206                                                                                                                                             | HE_SS2_MCS6  |
| 0x2207                                                                                                                                             | HE_SS2_MCS7  |
| 0x2208                                                                                                                                             | HE_SS2_MCS8  |
| 0x2209                                                                                                                                             | HE_SS2_MCS10 |
| 0x220a                                                                                                                                             | HE_SS2_MCS11 |

[1] Not all VHT rates are available for all the bandwidths and Tx antenna configurations. The error code 0xE means that the rate and hardware combination is not supported.

2.14 Wi-Fi channels

Table 19. Wi-Fi channel list

| Channel number  | Frequency | Channel number | Frequency | Channel number | Frequency |
|-----------------|-----------|----------------|-----------|----------------|-----------|
| 2.4 GHz channel |           |                |           |                |           |
| 1               | 2412      | 2              | 2417      | 3              | 2422      |
| 4               | 2427      | 5              | 2432      | 6              | 2437      |
| 7               | 2442      | 8              | 2447      | 9              | 2452      |
| 10              | 2457      | 11             | 2462      | 12             | 2467      |
| 13              | 2472      | —              | —         | —              | —         |
| 5 GHz channel   |           |                |           |                |           |
| 36              | 5180      | 38             | 5190      | 40             | 5200      |
| 42              | 5210      | 44             | 5220      | 46             | 5320      |
| 48              | 5420      | 52             | 5260      | 54             | 5270      |
| 56              | 5280      | 58             | 5290      | 60             | 5300      |
| 62              | 5310      | 64             | 5320      | 100            | 5500      |
| 102             | 5510      | 104            | 5520      | 106            | 5530      |
| 108             | 5540      | 110            | 5550      | 112            | 5560      |
| 116             | 5580      | 118            | 5590      | 120            | 5600      |
| 122             | 5610      | 124            | 5620      | 126            | 5630      |
| 128             | 5640      | 132            | 5660      | 134            | 5670      |
| 136             | 5680      | 138            | 5690      | 140            | 5700      |
| 142             | 5710      | 144            | 5720      | 149            | 5745      |
| 151             | 5775      | 153            | 5765      | 155            | 5775      |
| 157             | 5785      | 159            | 5795      | 161            | 5805      |
| 165             | 5825      | 167            | 5835      | 169            | 5845      |
| 171             | 5855      | 173            | 5865      | 175            | 5875      |
| 177             | 5885      | —              | —         | —              | —         |

2.15 RF test mode command sequence examples

2.15.1 2.4 GHz TX command sequence using TX\_continuous

TX on radio 1 configured for 2.4 GHz, RF channel 6, 20 MHz bandwidth, 8 dBm target power with MCS modulation, HE SS1 MCS8 rate, and 1x1 mode (path A).

Table 20. 2.4 GHz TX command sequence using TX\_continuous

| Step | Operation                                                                   | Command                                                                                     |
|------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                                     | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                     |
| 2    | Set radio mode 1 in 2.4 GHz band with 1x1 mode (path A):                    | <code>echo "radio_mode=0 11" &gt;&gt; /proc/mwlan/adapter1/config</code>                    |
| 3    | Set TX antenna mode (path A)                                                | <code>echo "tx_antenna=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                       |
| 4    | Set 20 MHz bandwidth                                                        | <code>echo "bw=0" &gt;&gt; /proc/mwlan/adapter1/config</code>                               |
| 5    | Set RF channel 6                                                            | <code>echo "channel=6" &gt;&gt; /proc/mwlan/adapter1/config</code>                          |
| 6    | Set TX power to 8 dBm, MCS modulation and TX signal path A                  | <code>echo "tx_power=8 2 0" &gt;&gt; /proc/mwlan/adapter1/config</code>                     |
| 7    | Start TX with continuous wave mode at HE SS1 MCS8 rate with a 0xAAA pattern | <code>echo "tx_continuous=1 1 0xAAA 0 3 0x2108" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 8    | Stop TX continuous wave                                                     | <code>echo "tx_continuous=0 1 0xAAA 0 3 0x2108" &gt;&gt; /proc/mwlan/adapter1/config</code> |

2.15.2 5 GHz RX command sequence

RX on radio 0 configured for 5 GHz, RF channel 36, 40 MHz bandwidth, and 2x2 path A+B.

Table 21. 5 GHz RX command sequence

| Step | Operation                                                | Command                                                                                                                                                                                         |
|------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                  | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                         |
| 2    | Set radio mode 0 in 5 GHz band with 2x2 mode (Path A+B): | <code>echo "radio_mode=1 0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                         |
| 3    | Set 5 GHz band                                           | <code>echo "band=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                                 |
| 4    | Set 40 MHz bandwidth                                     | <code>echo "bw=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                                   |
| 5    | Set RX antenna mode (both path)                          | <code>echo "rx_antenna=3" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                           |
| 6    | Set channel 36                                           | <code>echo "channel=36" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                             |
| 7    | Reset the packet error rate                              | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                      |
| 8    | Send a number of packets to the DUT                      |                                                                                                                                                                                                 |
| 9    | Get and reset the packet error rate                      | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                                                      |
| 10   | Verify the packet-related parameters                     | <div><code>cat /proc/mwlan/adapter0/config</code></div> <div>Output:</div> <div><pre>... total rx pkt count=1500 rx multicast/broadcast pkt count=1500 rx fcs error pkt count=0 ...</pre></div> |

2.16 RF test mode command sequence examples for 88W9098

2.16.1 5 GHz TX command sequence using tx\_frame

TX on radio 0 configured for 5 GHz RF channel 44, 20 MHz bandwidth, 10 dBm target power with MCS modulation, HE SS1 MCS11 rate, and 1x1 mode (path A).

Table 22. 5 GHz TX command sequence using tx\_frame

| Step | Operation                                                   | Command                                                                                                                                          |
|------|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                     | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                          |
| 2    | Set radio mode 0 in 5 GHz band with 1x1 mode (path A)       | <code>echo "radio_mode=3 0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                          |
| 3    | Set TX antenna mode (path A)                                | <code>echo "tx_antenna=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                            |
| 4    | Set 20 MHz bandwidth                                        | <code>echo "bw=0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                    |
| 5    | Set RF channel 44                                           | <code>echo "channel=44" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                              |
| 6    | Set TX power to 10 dBm, MCS modulation and TX signal path A | <code>echo "tx_power=10 2 0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                         |
| 7    | Start TX at HE SS1 MCS11 rate                               | <code>echo "tx_frame=1 0x210b 0xAAA 0x100 1 20 0 0 0 1 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 05:43:3f:c4:51" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 8    | Stop TX                                                     | <code>echo "tx_frame=0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                              |

### 2.16.2 5 GHz TX command sequence using tx\_frame for HE-ER SU

TX on radio 0 configured for 5 GHz RF channel 44, 20 MHz bandwidth, 10 dBm target power with MCS modulation, HE SS1 MCS1 rate, short preamble, and 1x1 mode (path A) for HE-ER SU.

**Table 23. 5 GHz TX command sequence using tx\_frame for HE-ER SU**

| Step | Operation                                                                   | Command                                                                                                                                          |
|------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                                     | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                          |
| 2    | Set radio mode 0 in 5 GHz band with 1x1 mode (path A)                       | <code>echo "radio_mode=3 0 " &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                         |
| 3    | Set TX antenna mode (path A)                                                | <code>echo "tx_antenna=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                            |
| 4    | Set 20 MHz bandwidth                                                        | <code>echo "bw=0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                                    |
| 5    | Set RF channel 44                                                           | <code>echo "channel=44" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                              |
| 6    | Set TX power to 10 dBm, MCS modulation and TX signal path A                 | <code>echo "tx_power=10 2 0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                         |
| 7    | Start TX at HE SS1 MCS1 rate and short preamble for HE-ER SU <sup>[1]</sup> | <code>echo "tx_frame=1 0x2101 0xAAA 0x100 1 20 1 0 0 0 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 05:43:3f:c4:51" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 8    | Stop TX                                                                     | <code>echo "tx_frame=0" &gt;&gt; /proc/mwlan/adapter0/config</code>                                                                              |

- [1]
- 242 tones RU: MCS supported are MCS0-2. Set signalBw to 0 and MCS to 0, 1 or 2.
  - 106 tone RU: MCS supported is MCS0. Set signalBw to 1 and MCS to 0
  - Set short preamble to 0x1 in tx\_frame command for HE-ER SU in RF\_TEST\_MODE
  - preambleType: Use the default value (-1) unless required.
    - For legacy 802.11b: preamble type
      - 0 = long
      - 1 = short
    - For legacy 802.11g: not valid
    - For 802.11n: GreenField PPDU indicator
      - 0 = HT-mix
      - 1 = HT-GF
    - For 802.11ac: not valid
    - For 802.11ax: PPDU type
      - 0 = HE-SU
      - 1 = HE-EXT-SU
      - 2 = HE-MU
      - 3 = HE-Trigger-based

### 2.16.3 2.4 GHz TX command sequence using tx\_frame

TX on radio 1 configured for 2.4 GHz RF channel 11, 40 MHz bandwidth, 9 dBm target power with MCS modulation, HE SS1 MCS4 rate, and 1x1 mode (path B).

**Table 24. 2.4 GHz TX command sequence using tx\_frame**

| Step | Operation                                                  | Command                                                                                                                                        |
|------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                    | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                        |
| 2    | Set radio mode 1 in 2.4 GHz band with 1x1 mode (path B):   | <code>echo "radio_mode=0 14" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                       |
| 3    | Set TX antenna mode (path B)                               | <code>echo "tx_antenna=2" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                          |
| 4    | Set 40 MHz bandwidth                                       | <code>echo "bw=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                                  |
| 5    | Set RF channel 11                                          | <code>echo "channel=11" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                            |
| 6    | Set TX power to 9 dBm, MCS modulation and TX signal path B | <code>echo "tx_power=9 2 1" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                        |
| 7    | Start TX at HE SS1 MCS4 rate                               | <code>echo "tx_frame=1 0x2104 0xAAA 0x100 1 20 0 0 0 0 0 0 -1 -1 -1 -1 -1 -1 -1 -1 05:43:3f:c4:51" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 8    | Stop TX                                                    | <code>echo "tx_frame=0" &gt;&gt; /proc/mwlan/adapter1/config</code>                                                                            |

2.16.4 5 GHz TX command sequence using tx\_continuous

TX on radio 0 configured for 5 GHz RF channel 36, 40 MHz bandwidth, 11 dBm target power with MCS modulation, HE SS1 MCS9 rate, and 2x2 mode (both paths).

Table 25. 5 GHz TX command sequence using tx\_continuous

| Step | Operation                                                            | Command                                                                                     |
|------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                              | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                     |
| 2    | Set radio mode 0 in 5 GHz band with 2x2 mode (Path A+B)              | <code>echo "radio_mode=1 0" &gt;&gt; /proc/mwlan/adapter0/config</code>                     |
| 3    | Set TX antenna mode (both path)                                      | <code>echo "tx_antenna=3" &gt;&gt; /proc/mwlan/adapter0/config</code>                       |
| 4    | Set 40 MHz bandwidth                                                 | <code>echo "bw=1" &gt;&gt; /proc/mwlan/adapter0/config</code>                               |
| 5    | Set RF channel 36                                                    | <code>echo "channel=36" &gt;&gt; /proc/mwlan/adapter0/config</code>                         |
| 6    | Set TX power to 11 dBm, MCS modulation and TX signal path A + path B | <code>echo "tx_power=11 2 2" &gt;&gt; /proc/mwlan/adapter0/config</code>                    |
| 7    | Start TX at HE SS1 MCS9 rate                                         | <code>echo "tx_continuous=1 0 0xAAA 0 3 0x2109" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 8    | Start TX continuous wave mode at HE SS1 MCS9 rate                    | <code>echo "tx_continuous=1 1 0xAAA 0 3 0x2109" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 9    | Stop TX continuous wave mode                                         | <code>echo "tx_continuous=0 1 0xAAA 0 3 0x2109" &gt;&gt; /proc/mwlan/adapter0/config</code> |

**Note:** For TX, refer to either step 7 or step 8 based on whether the continuous wave mode is enabled or disabled.

2.16.5 2.4 GHz TX command sequence using tx\_continuous

TX on radio 1 configured for 2.4 GHz RF channel 6, 20 MHz bandwidth, 8 dBm target power with MCS modulation, HE SS1 MCS8 rate, and 1x1 mode (path A).

Table 26. 2.4 GHz TX command sequence using tx\_continuous

| Step | Operation                                                  | Command                                                                                     |
|------|------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                    | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                     |
| 2    | Set radio mode 1 in 2.4 GHz band with 1x1 mode (path A):   | <code>echo "radio_mode=0 11" &gt;&gt; /proc/mwlan/adapter1/config</code>                    |
| 3    | Set TX antenna mode (path A)                               | <code>echo "tx_antenna=1" &gt;&gt; /proc/mwlan/adapter1/config</code>                       |
| 4    | Set 20 MHz bandwidth                                       | <code>echo "bw=0" &gt;&gt; /proc/mwlan/adapter1/config</code>                               |
| 5    | Set RF channel 6                                           | <code>echo "channel=6" &gt;&gt; /proc/mwlan/adapter1/config</code>                          |
| 6    | Set TX power to 8 dBm, MCS modulation and TX signal path A | <code>echo "tx_power=8 2 0" &gt;&gt; /proc/mwlan/adapter1/config</code>                     |
| 7    | Start TX at HE SS1 MCS8 rate                               | <code>echo "tx_continuous=1 0 0xAAA 0 3 0x2108" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 8    | Start TX with continuous wave mode at HE SS1 MCS8 rate     | <code>echo "tx_continuous=1 1 0xAAA 0 3 0x2108" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 9    | Stop TX continuous wave mode                               | <code>echo "tx_continuous=0 1 0xAAA 0 3 0x2108" &gt;&gt; /proc/mwlan/adapter1/config</code> |

**Note:** For TX, refer to either step 7 or step 8 based on whether continuous wave mode is enabled or disabled.

2.16.6 5 GHz RX command sequence

RX on radio 0 configured for 5 GHz RF channel 36, 40 MHz bandwidth, and 2x2 path A+B.

Table 27. 5 GHz RX command sequence

| Step | Operation                                                     | Command                                                                    |
|------|---------------------------------------------------------------|----------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                       | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter0/config</code>    |
| 2    | Set radio mode 0 in 5 GHz band with 2x2 mode (Path A+B):      | <code>echo "radio_mode=1 0" &gt;&gt; /proc/mwlan/adapter0/config</code>    |
| 3    | Set 5 GHz band                                                | <code>echo "band=1" &gt;&gt; /proc/mwlan/adapter0/config</code>            |
| 4    | Set 40 MHz bandwidth                                          | <code>echo "bw=1" &gt;&gt; /proc/mwlan/adapter0/config</code>              |
| 5    | Set RX antenna mode (both path)                               | <code>echo "rx_antenna=3" &gt;&gt; /proc/mwlan/adapter0/config</code>      |
| 6    | Set channel 36                                                | <code>echo "channel=36" &gt;&gt; /proc/mwlan/adapter0/config</code>        |
| 7    | Reset the packet error rate                                   | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 8    | Inject a definite number of packets at a specific power level |                                                                            |
| 9    | Get and reset the packet error rate                           | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter0/config</code> |
| 10   | Verify the packet-related parameters                          | <code>cat /proc/mwlan/adapter0/config</code>                               |

2.16.7 2.4 GHz RX command sequence

RX on radio 1 configured for 2.4 GHz RF channel 6, 20 MHz bandwidth, and 1x1 path A.

Table 28. 2.4 GHz RF command sequence

| Step | Operation                                                     | Command                                                                    |
|------|---------------------------------------------------------------|----------------------------------------------------------------------------|
| 1    | Enable the RF test mode                                       | <code>echo "rf_test_mode=1" &gt;&gt; /proc/mwlan/adapter1/config</code>    |
| 2    | Set radio mode 1 in 2.4 GHz band with 1x1 mode (Path A):      | <code>echo "radio_mode=0 11" &gt;&gt; /proc/mwlan/adapter1/config</code>   |
| 3    | Set 2.4 GHz band                                              | <code>echo "band=0" &gt;&gt; /proc/mwlan/adapter1/config</code>            |
| 4    | Set 20 MHz bandwidth                                          | <code>echo "bw=0" &gt;&gt; /proc/mwlan/adapter1/config</code>              |
| 5    | Set RX antenna mode (path A)                                  | <code>echo "rx_antenna=1" &gt;&gt; /proc/mwlan/adapter1/config</code>      |
| 6    | Set channel 6                                                 | <code>echo "channel=6" &gt;&gt; /proc/mwlan/adapter1/config</code>         |
| 7    | Reset the packet error rate                                   | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 8    | Inject a definite number of packets at a specific power level |                                                                            |
| 9    | Get and reset the packet error rate                           | <code>echo "get_and_reset_per" &gt;&gt; /proc/mwlan/adapter1/config</code> |
| 10   | Verify the packet-related parameters                          | <code>cat /proc/mwlan/adapter1/config</code>                               |

### 3 Bluetooth RF test mode

This section describes the commands to use RF test mode for Bluetooth Classic and Bluetooth Low Energy on the i.MX 8M Quad EVK with Linux. The commands apply to any Linux-based host.

Bluetooth RF test mode parameters use HCI commands following Bluetooth Core Specification v5.3 ([1]) and vendor-specific commands. For more information on vendor-specific commands, refer to the Bluetooth software user manual of your device.

The command parameters in this section are entered in hexadecimal little endian format.

In the command examples, `hci0` refers to the Bluetooth device.

Command to check the name of your device:

```
hciconfig -a
```

**Note:** In this section, the bolded hex value 00 in the example command outputs means that the command was set successfully.

#### 3.1 List of commands for Bluetooth RF test mode

Table 29 lists the commands for Bluetooth RF test mode.

Table 29. List of commands for Wi-Fi RF test mode

| Command                                                       |
|---------------------------------------------------------------|
| Bluetooth Classic                                             |
| <a href="#">Enable test mode for qualification</a>            |
| <a href="#">Set the receive test parameters</a>               |
| <a href="#">End the receive test</a>                          |
| <a href="#">Set the transmit test parameters</a>              |
| <a href="#">End the transmit command</a>                      |
| <a href="#">Update the parameter settings for RF TX test</a>  |
| Bluetooth LE                                                  |
| <a href="#">Test Bluetooth LE receiver</a>                    |
| <a href="#">End the receive test and get the packet count</a> |
| <a href="#">Set Bluetooth LE TX power</a>                     |
| <a href="#">Test Bluetooth LE transmitter</a>                 |
| <a href="#">End Bluetooth LE test</a>                         |

## 3.2 Bluetooth Classic

This section describes how to use RF test mode commands for Bluetooth Classic.

### 3.2.1 Enable test mode for qualification

Sequence of commands to enable test mode for qualification.

- Perform an HCI reset.

```
hcitool -i hci0 cmd 0x03 0x0003
```

Command output example:

```
< HCI Command: ogf 0x03, ocf 0x0003, plen 0  
> HCI Event: 0x0e plen 4  
01 03 0C 00
```

- Enable BR/EDR scan.

```
hcitool -i hci0 cmd 0x03 0x001a 0x3
```

Command output example:

```
< HCI Command: ogf 0x03, ocf 0x001a, plen 1  
03  
> HCI Event: 0x0e plen 4  
01 1A 0C 00
```

- Set event filter.

```
hcitool -i hci0 cmd 0x03 0x0005 0x02 0x00 0x02
```

Command output example:

```
< HCI Command: ogf 0x03, ocf 0x0005, plen 3  
02 00 02  
> HCI Event: 0x0e plen 4  
01 05 0C 00
```

- Enable test mode for qualification

```
hcitool -i hci0 cmd 0x06 0x0003
```

Command output example:

```
< HCI Command: ogf 0x06, ocf 0x0003, plen 0  
> HCI Event: 0x0e plen 4  
01 03 18 00
```

**Note:** The HCI reset command is used to resume normal Bluetooth operation after enabling test mode.

### 3.2.2 Set the receive test parameters

Command to set the receive test parameters:

```
hcitool -i hci0 cmd 0x3F 0x0018 <TestScenario> <TXFrequency> <RXFrequency>
<TestPacketType> <Expected Number of Packets> <Length of Test Data> <TX AM Address> <BD
Address> <Report error packets>
```

where:

**Table 30. Command parameters**

| Parameter                  | Length (bytes) | Definition                                                                                                                                                                                                                                                                                                                                    |
|----------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OGF                        | 1              | 0x3F                                                                                                                                                                                                                                                                                                                                          |
| OCF                        | 2              | 0x0018                                                                                                                                                                                                                                                                                                                                        |
| TestScenario               | 1              | Test scenario <ul style="list-style-type: none"> <li>• 0x01 = receiver test, 0–pattern</li> <li>• 0x02 = receiver test, 1–pattern</li> <li>• 0x03 = receiver test, 1010–pattern</li> <li>• 0x04 = receiver test, PRBS–pattern</li> <li>• 0x09 = receiver test, 1111 0000–pattern</li> <li>• 0xFF = abort test mode</li> </ul>                 |
| TXFrequency                | 1              | Transmit Frequency = (2402+k) MHz, where k is the value of TXChannel<br>k range: 0x00 to 0x4F                                                                                                                                                                                                                                                 |
| RXFrequency                | 1              | Receive Frequency = (2402+k) MHz, where k is the value of RXChannel<br>k range: 0x00 to 0x4F                                                                                                                                                                                                                                                  |
| TestPacketType             | 1              | Test Packet Type <ul style="list-style-type: none"> <li>• 0x03 = DM1</li> <li>• 0x04 = DH1</li> <li>• 0x0A = DM3</li> <li>• 0x0B = DH3</li> <li>• 0x0E = DM5</li> <li>• 0x0F = DH5</li> <li>• 0x14 = 2-DH1</li> <li>• 0x18 = 3-DH1</li> <li>• 0x1A = 2-DH3</li> <li>• 0x1B = 3-DH3</li> <li>• 0x1E = 2-DH5</li> <li>• 0x1F = 3-DH5</li> </ul> |
| Expected Number of Packets | 4              | The expected number of RX packets                                                                                                                                                                                                                                                                                                             |
| Length of Test Data        | 2              | The length of the test data<br><b>Note:</b> This value should not be bigger than the maximum size of the specified test packet type                                                                                                                                                                                                           |
| TX AM Address              | 1              | Default = 0x01                                                                                                                                                                                                                                                                                                                                |
| Transmitter BD Address     | 6              | Transmitter's BD address                                                                                                                                                                                                                                                                                                                      |
| Report error packets       | 1              | Report Error Packets <ul style="list-style-type: none"> <li>• 0x00 = none (default)</li> <li>• 0x01 to 0xFE = number of packets to report</li> </ul>                                                                                                                                                                                          |

Example of command to set the receive test with the following parameters:

- RX Frequency: 2402 MHz
- Test Scenario: 0-pattern
- Test Packet Type: DH5
- Expected Number of Packets: 1500
- Transmitter BD Address: 00:26:1F:EC:F6:4E

```
hcitool -i hci0 cmd 0x3F 0x0018 0x01 0x00 0x00 0x0F 0xDC 0x05 0x00 0x00 0x25 0x00 0x01  
0x4E 0xF6 0xEC 0x1F 0x26 0x00
```

Command output example:

```
< HCI Command: ogf 0x3f, ocf 0x0018, plen 18  
01 00 00 0F DC 05 00 00 25 00 01 4E F6 EC 1F 26 00 00  
> HCI Event: 0xfe plen 4  
01 18 FC 00
```

### 3.2.3 End the receive test

Command to end the receive test:

```
hcitool -i hci0 cmd 0x3F 0x0018 0xFF
```

Command output example:

```
< HCI Command: ogf 0x3f, ocf 0x0018, plen 1  
FF  
> HCI Event: 0xff plen 70  
01 00 DC 05 00 00 4C 04 00 00 90 01 00 00 90 01 00 00 90 01  
00 00 00 00 00 00 00 00 00 00 90 01 00 00 00 00 00 00 4C 04  
00 00 64 00 00 00 60 C6 06 00 70 DA 05 00 30 00 00 00 D0 39  
00 00 90 E2 00 00 D4 FF FF FF
```

**Note:** The bolded hex value (0x0190) indicates 400 packets were received by the DUT.

### 3.2.4 Set the transmit test parameters

Command to set the transmit test parameters.

```
hcitool -i hci0 cmd 0x3F 0x0019 0x80 0x80 0x80 0x80 <TestScenario> <HoppingMode>
<TXChannel> <RXChannel> <TXTestInterval> <PacketType> <Length> <Whitening> <Number of
Test Packets> <TX Power>
```

where:

**Table 31. Command parameters**

| Parameter      | Length (bytes) | Definition                                                                                                                                                                                                                                                                                                                                        |
|----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OGF            | 1              | 0x3F                                                                                                                                                                                                                                                                                                                                              |
| OCF            | 2              | 0x0019                                                                                                                                                                                                                                                                                                                                            |
| RXOnStart      | 1              | Set to 0x80.                                                                                                                                                                                                                                                                                                                                      |
| SyntOnStart 1  | 1              |                                                                                                                                                                                                                                                                                                                                                   |
| TXOnStart      | 1              |                                                                                                                                                                                                                                                                                                                                                   |
| PhdOffStart    | 1              |                                                                                                                                                                                                                                                                                                                                                   |
| TestScenario   | 1              | Test scenario <ul style="list-style-type: none"> <li>• 0x01 = PATTERN_00 (data pattern: 0x00)</li> <li>• 0x02 = PATTERN_FF (data pattern: 0xFF)</li> <li>• 0x03 = PATTERN_55 (data pattern: 0x55)</li> <li>• 0x04 = PATTERN_PRBS (data pattern: 0xFE)</li> <li>• 0x09 = PATTERN_0F (data pattern: 0x0F)</li> <li>• 0xFF = exit test</li> </ul>    |
| HoppingMode    | 1              | <ul style="list-style-type: none"> <li>• 0x00 = fix frequency</li> <li>• 0x01 = hopping set</li> </ul>                                                                                                                                                                                                                                            |
| TXChannel      | 1              | Transmit Frequency = (2402+k) MHz, where k is the value of TXChannel<br>k range: 0x00 to 0x4F                                                                                                                                                                                                                                                     |
| RXChannel      | 1              | Receive Frequency = (2402+k) MHz, where k is the value of RXChannel<br>k range: 0x00 to 0x4F                                                                                                                                                                                                                                                      |
| TXTestInterval | 1              | Poll interval in frames for the link (In units per 1.25 ms)                                                                                                                                                                                                                                                                                       |
| PacketType     | 1              | Transmit Packet Type <ul style="list-style-type: none"> <li>• 0x03 = DM1</li> <li>• 0x04 = DH1</li> <li>• 0x0A = DM3</li> <li>• 0x0B = DH3</li> <li>• 0x0E = DM5</li> <li>• 0x0F = DH5</li> <li>• 0x14 = 2-DH1</li> <li>• 0x18 = 3-DH1</li> <li>• 0x1A = 2-DH3</li> <li>• 0x1B = 3-DH3</li> <li>• 0x1E = 2-DH5</li> <li>• 0x1F = 3-DH5</li> </ul> |
| Length         | 2              | Length of test data                                                                                                                                                                                                                                                                                                                               |
| Whitening      | 1              | <ul style="list-style-type: none"> <li>• 0x00 = disabled</li> </ul>                                                                                                                                                                                                                                                                               |

Table 31. Command parameters...continued

| Parameter              | Length (bytes) | Definition                                                                                                                                                                                         |
|------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |                | <ul style="list-style-type: none"><li>• 0x01 = enabled</li></ul>                                                                                                                                   |
| Number of Test Packets | 4              | Number of packets to transmit <ul style="list-style-type: none"><li>• 0 = infinite</li></ul>                                                                                                       |
| TX Power               | 1              | Signed value of TX power (dBm) <ul style="list-style-type: none"><li>• For IW612: range = -20 dBm to 19 dBm<sup>[1]</sup></li><li>• For all the other modules: range = -20 dBm to 12 dBm</li></ul> |

[1] Depends on Bluetooth class

Example of command to the transmit test with the following parameters:

- TX Frequency: 2403 MHz
- Test Scenario: 0-pattern
- Hopping Mode: Fixed Frequency
- Packet Type: DM1
- TX power: 4 dBm

```
hcitool -i hci0 cmd 0x3F 0x0019 0x80 0x80 0x80 0x80 0x01 0x00 0x01 0x01 0x0D 0x03 0x0F
0x00 0x00 0x00 0x00 0x00 0x00 0x04
```

Command output example:

```
< HCI Command: ogf 0x3f, ocf 0x0019, plen 18
80 80 80 80 01 00 01 01 0D 03 0F 00 00 00 00 00 00 04
> HCI Event: 0x0e plen 4 01 19 FC 00
```

3.2.5 End the transmit command

Issue the command to end the transmit test:

```
hcitool -i hci0 cmd 0x3F 0x0019 0x80 0x80 0x80 0x80 0xFF
```

Command output example:

```
< HCI Command: ogf 0x3f, ocf 0x0019, plen 18
80 80 80 80 FF 00 01 01 0D 03 0F 00 00 00 00 00 00 04
> HCI Event: 0xff plen 6
19 01 2F 0F 00 00
```

3.2.6 Update the parameter settings for RF TX test

[Table 32](#) lists the parameters settings when testing Bluetooth TX hopping mode dwell time using different Bluetooth ACL link packet types.

Table 32. Parameter settings to test Bluetooth TX hopping mode dwell time

| Packet type | TX test interval<br>(units, 1.25ms) | Data packet type | Maximum payload size (byte) |
|-------------|-------------------------------------|------------------|-----------------------------|
| DH1         | 0x01                                | 0x04             | 0x001B                      |
| DH3         | 0x02                                | 0x0B             | 0x00B7                      |
| DH5         | 0x03                                | 0x0F             | 0x0153                      |
| 2DH1        | 0x01                                | 0x14             | 0x0036                      |
| 2DH3        | 0x02                                | 0x1A             | 0x016F                      |
| 2DH5        | 0x03                                | 0x1E             | 0x02A7                      |
| 3DH1        | 0x01                                | 0x18             | 0x0053                      |
| 3DH3        | 0x02                                | 0x1B             | 0x0228                      |
| 3DH5        | 0x03                                | 0x1F             | 0x03FD                      |

**Note:** In the transmit test command, pass the arguments in little endian format. For example, pass the value 0x001B as 0x1B 0x00.

3.3 Bluetooth Low Energy (LE)

This section describes how to use RF test mode commands for Bluetooth LE.

3.3.1 Test Bluetooth LE receiver

To start a test where the DUT receives test reference packets at a fixed interval, use the `LE Receiver Test[V2]`

command. For more details on the command, refer to *section 7.8.28* of [\[1\]](#).

```
hcitool -i hci0 cmd 0x08 0x0033 <RX Channel> <PHY> <Modulation Index>
```

Where:

Table 33. Command parameters

| Parameter        | Length (bytes) | Description                                                                                                                                                           |
|------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OGF              | 1              | OGF for the LE Controller commands set to 0x08                                                                                                                        |
| OCF              | 1              | OCF to write the Bluetooth LE receiver test set to 0x0033                                                                                                             |
| RX Channel       | 1              | RF Channel to be used by the receiver Channel number = (F-2402) / 2<br>Input range: 0x00 to 0x27                                                                      |
| PHY              | 1              | PHY to be used by the receiver<br>0x01 = Receiver set to use the LE 1M PHY<br>0x02 = Receiver set to use the LE 2M PHY<br>0x03 = Receiver set to use the LE Coded PHY |
| Modulation Index | 1              | Modulation Index<br>0x00 = Assume transmitter will have a standard modulation index<br>0x01 = Assume transmitter will have a stable modulation index                  |

Command example to the receive test with the following parameters:

- RX channel: 2404 MHz
- PHY: LE 2M
- Standard modulation index for the transmitter

```
hcitool -i hci0 cmd 0x08 0x0033 0x01 0x02 0x00
```

Command output example:

```
< HCI Command: ogf 0x08, ocf 0x0033, plen 3
01 02 00
> HCI Event: 0x0e plen 4
01 33 20 00
```

### 3.3.2 End the receive test and get the packet count

To stop any ongoing test, use the Bluetooth LE Test End command. For more details on the command, refer to section 7.8.30 of [\[1\]](#).

```
hcitool -i hci0 cmd 0x08 0x001F
```

Command output example:

```
< HCI Command: ogf 0x08, ocf 0x001f, plen 0  
> HCI Event: 0x0e plen 6  
01 1F 20 00 20 03
```

**Note:** The hex value in bold (0x0320) indicates that the DUT received 800 packets.

3.3.3 Set Bluetooth LE TX power

Command to set the Bluetooth LE transmit power level:

```
hcitool -i hci0 cmd 0x3F 0x87 <TX_power> <front-end loss>
```

Where:

Table 34. Command parameters

| Parameter      | Length (bytes) | Description                                                                                                                                           |
|----------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| ogf            | 1              | OGF for vendor specific command set to 0x3F                                                                                                           |
| ocf            | 2              | OCF to write Bluetooth LE transmit power set to 0x0087                                                                                                |
| TX_power       | 1              | Transmit power level for Bluetooth LE in dBm.<br>Default value = 0x00<br>0x04 = 4 dBm<br>Minimum value = 0xE2 (-30 dBm) Maximum value = 0x14 (20 dBm) |
| front-end loss | 1              | Front-end (FE) loss<br>0x00: ignore FE loss.<br>0x01: consider FE loss.                                                                               |

```
hcitool -i hci0 cmd 0x3F 0x87 0x04 0x00
```

Command output example:

```
< HCI Command: ogf 0x3f, ocf 0x0087, plen 1
04
> HCI Event: 0x0e plen 4
01 87 FC 00
```

3.3.4 Test Bluetooth LE transmitter

To start a test where the DUT generates test reference packets at a fixed interval, use the `LE Transmitter Test[V2]` command. For more details on the command, refer to [section 7.8.29 of \[1\]](#).

```
hcitool -i hci0 cmd 0x08 0x0034 <TX Channel> <Test Data Length> <Packet Payload>
```

Where:

Table 35. Command parameters

| Parameter        | Length (bytes) | Description                                                                                                                                                                                                                                                                |
|------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OGF              | 1              | OGF for the LE Controller commands set to 0x08                                                                                                                                                                                                                             |
| OCF              | 1              | OCF to write the Bluetooth LE transmit test set to 0x0034                                                                                                                                                                                                                  |
| TX Channel       | 1              | Transmit Channel N = (F-2402) / 2<br>Range: 0x00 to 0x27<br>Frequency Range: 2402 MHz to 2480 MHz                                                                                                                                                                          |
| Test_Data_Length | 1              | 0x00 to 0xFF<br>Length in bytes of payload data in each packet                                                                                                                                                                                                             |
| Packet_Payload   | 1              | Packet payload. Refer Bluetooth Core Spec v5.3 for more details.                                                                                                                                                                                                           |
| PHY              | 1              | PHY to be used by the receiver<br>0x01 - Transmitter set to use the LE 1M PHY<br>0x02 - Transmitter set to use the LE 2M PHY<br>0x03 - Transmitter set to use the LE Coded PHY with S=8 data coding<br>0x04 - Transmitter set to use the LE Coded PHY with S=2 data coding |

Example of command to set the transmit test with the following parameters:

- TX Channel: 2404 MHz
- Test Data Length: 1 Byte
- Packet Payload: PRBS9 sequence '11111111100000111101...'
- PHY: LE 2M

Command output example:

```
< HCI Command: ogf 0x08, ocf 0x0034, plen 4
01 01 00 02
> HCI Event: 0x0e plen 4
01 34 20 00
```

### 3.3.5 End Bluetooth LE test

To stop any test which is in progress, use the `LE Test End` command. For more details on the command, refer to *section 7.8.30* of [\[1\]](#).

```
hcitool -i hci0 cmd 0x08 0x001F
```

Command output example:

```
< HCI Command: ogf 0x08, ocf 0x001f, plen 0  
> HCI Event: 0x0e plen 6  
01 1F 20 00 00 00
```

3.4 RF test mode command sequence examples

3.4.1 Bluetooth Classic TX test

TX test with DM1 packets on RF channel 0 at 4 dBm.

Table 36. Bluetooth Classic TX command sequence

| Step | Operation                                                     | Command                                                                                                                                |
|------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Perform an HCI reset                                          | <code>hcitool -i hci0 cmd 0x03 0x0003</code>                                                                                           |
| 2    | Transmit 4 dBm DM1 packets at 2402 MHz with data pattern 0x00 | <code>hcitool -i hci0 cmd 0x3F 0x0019 0x80 0x80 0x80 0x80 0x01 0x00 0x00 0x00 0x0D 0x03 0x0F 0x00 0x00 0x00 0x00 0x00 0x00 0x04</code> |
| 3    | End transmit                                                  | <code>hcitool -i hci0 cmd 0x3F 0x0019 0x80 0x80 0x80 0x80 0xFF</code>                                                                  |

3.4.2 Bluetooth Classic RX Test

RX test with 3-DH5 packets on RF channel 0

Table 37. Bluetooth Classic RX command sequence

| Step | Operation                                                                     | Command                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Perform an HCI reset                                                          | <code>hcitool -i hci0 cmd 0x03 0x0003</code>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2    | Enable receive at 2402 MHz for 3-DH5 packets from TX device 00:26:1F:EC:F6:4E | <code>hcitool -i hci0 cmd 0x3F 0x0018 0x01 0x00 0x00 0x00 0x0F 0xDC 0x05 0x00 0x00 0x25 0x00 0x01 0x4E 0xF6 0xEC 0x1F 0x26 0x00 0x00</code>                                                                                                                                                                                                                                                                                                                                                               |
| 3    | Transmit packets to the DUT with an RF tester                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4    | End receive test and get packet count                                         | <div><code>hcitool -i hci0 cmd 0x3F 0x0018 0xFF</code><br/>Output:<br/>&lt; HCI Command: ogf 0x3f, ocf 0x0018, plen 1<br/>FF<br/>&gt; HCI Event: 0xff plen 70<br/>01 00 DC 05 00 00 4C 04 00 00 90 01 00 00 90 01 00 00 90 01<br/>00 00 00 00 00 00 00 00 00 00 00 00 90 01 00 00 00 00 4C 04<br/>00 00 64 00 00 00 60 C6 06 00 70 DA 05 00 30 00 00 00 D0 39<br/>00 00 90 E2 00 00 D4 FF FF FF<br/><br/><b>Note:</b> The bolded hex value (0x0190) indicates 400 packets were received by the DUT.</div> |

3.4.3 Bluetooth LE TX test

TX test with 2M LE packets on RF channel 0 at 4 dBm.

Table 38. Bluetooth LE TX command sequence

| Step | Operation                                | Command                                                          |
|------|------------------------------------------|------------------------------------------------------------------|
| 1    | Perform an HCI reset                     | <code>hcitool -i hci0 cmd 0x03 0x0003</code>                     |
| 2    | Set TX power to 4 dBm                    | <code>hcitool -i hci0 cmd 0x3F 0x87 0x04</code>                  |
| 3    | Transmit 4 dBm 2M LE packets at 2402 MHz | <code>hcitool -i hci0 cmd 0x08 0x0034 0x00 0x01 0x00 0x02</code> |
| 4    | End transmit                             | <code>hcitool -i hci0 cmd 0x08 0x001F</code>                     |

3.4.4 Bluetooth LE RX test

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

Table 39. Bluetooth LE RX command sequence

| Step | Operation                                     | Command                                                                                                                                                                                                                                                                                 |
|------|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Perform an HCI reset                          | <code>hcitool -i hci0 cmd 0x03 0x0003</code>                                                                                                                                                                                                                                            |
| 2    | Enable RX at 2402MHz LE 1M                    | <code>hcitool -i hci0 cmd 0x08 0x0033 0x00 0x01 0x00</code>                                                                                                                                                                                                                             |
| 3    | Transmit packets to the DUT with an RF tester |                                                                                                                                                                                                                                                                                         |
| 4    | End receive test and get packet count         | <div><code>hcitool -i hci0 cmd 0x08 0x001F</code><br/>Output:<br/><pre>&lt; HCI Command: ogf 0x08, ocf 0x001f, plen 0 &gt; HCI Event: 0x0e plen 6 01 1F 20 00 <b>20 03</b></pre><p><b>Note:</b> The bolded hex value (0x0320) indicates 800 packets were received by the DUT.</p></div> |

4 RF test mode for 802.15.4

This section describes the commands to use RF test mode for IEEE 802.15.4 on the i.MX 8M Quad EVK with Linux. The commands apply to any Linux-based host.

**Note:** The commands use the *ot-ctl* utility, which needs to be cross-compiled with the *ot-daemon* tool. For more information on building *ot-ctl* utility, refer to [2].

4.1 List of commands for 802.15.4 RF test mode

Table 40 lists the commands available for RF test mode of Wi-Fi.

Table 40. List of commands for Wi-Fi RF test mode

| Command                                                     |
|-------------------------------------------------------------|
| <a href="#">Enable or disable 802.15.4 RF test mode</a>     |
| <a href="#">Reset 802.15.4 radio</a>                        |
| <a href="#">Get the RF channel</a>                          |
| <a href="#">Set the RF channel</a>                          |
| <a href="#">Get TX power level value</a>                    |
| <a href="#">Set TX power level value</a>                    |
| <a href="#">Continuous TX</a>                               |
| <a href="#">Get TX payload size</a>                         |
| <a href="#">Set TX packet payload size</a>                  |
| <a href="#">802.15.4 TX burst packet</a>                    |
| <a href="#">Set 802.15.4 TX duty cycle</a>                  |
| <a href="#">Set 802.15.4 PHY TX test packet information</a> |
| <a href="#">Start 802.15.4 RX test</a>                      |
| <a href="#">Get 802.15.4 RX test result</a>                 |

## 4.2 Enable or disable 802.15.4 RF test mode

Command to enable 802.15.4 RF test mode:

```
ot-ctl mfgcmd 1
```

**Return data:** Done

Command to disable 802.15.4 RF test mode:

```
ot-ctl mfgcmd 0
```

**Return data:** Done

## 4.3 Reset 802.15.4 radio

Command to reset 802.15.4 RF block:

```
ot-ctl mfgcmd 80 0
```

**Return data:** Done

## 4.4 Get the RF channel

Command to get the RF channel.

```
ot-ctl mfgcmd 11
```

**Return data:** Currently set channel

4.5 Set the RF channel

Command to set the RF channel.

```
ot-ctl mfgcmd 12 <Channel Number>
```

Where:

Table 41. Command parameters

| Parameter      | Description                                             |
|----------------|---------------------------------------------------------|
| Channel Number | RF Channel<br>Input integer range of 11 (default) to 26 |

Return data: Done

Example of command to set the 802.15.4 channel to 20

```
ot-ctl mfgcmd 12 20
```

4.6 Get TX power level value

Command to get TX power level value:

```
ot-ctl mfgcmd 15
```

Return data: Target power level value in dBm

4.7 Set TX power level value

Command to set TX power level value:

```
ot-ctl mfgcmd 16 <Pwr>
```

Where:

Table 42. Command parameters

| Parameter | Description                                               |
|-----------|-----------------------------------------------------------|
| Pwr       | TX power level in dBm<br>Input integer range of -20 to 15 |

Example of command to set TX power level to 11 dBm:

```
ot-ctl mfgcmd 16 11
```

Return data: Done

4.8 Continuous TX

Command to transmit a continuous modulated signal:

```
ot-ctl mfgcmd 17 <Enable>
```

Where:

Table 43. Command parameters

| Parameter | Description                                             |
|-----------|---------------------------------------------------------|
| Enable    | Enable the continuous transmission<br>0 = off<br>1 = on |

Return data: Done

Example of command to set continuous TX mode:

```
ot-ctl mfgcmd 17 1
```

4.9 Get TX payload size

Command to get the TX packet payload size (17-116 bytes).

```
ot-ctl mfgcmd 20
```

Return data: 802.15.4 TX packet payload size in bytes

4.10 Set TX packet payload size

Command to set the TX packet payload size in bytes (17-116 bytes):

```
ot-ctl mfgcmd 21 <Size>
```

Where:

Table 44. Command parameters

| Parameter | Description                                                     |
|-----------|-----------------------------------------------------------------|
| Size      | Packet payload size in bytes<br>Input integer range of 17 - 116 |

Return data: Done

Example of command to set the TX payload size to 100 bytes:

```
ot-ctl mfgcmd 21 100
```

4.11 802.15.4 TX burst packet

Command to transmit a specific number of packets with a specific packet gap:

```
ot-ctl mfgcmd 33 <count option> <packet gap>
```

Where:

Table 45. Command parameters

| Parameter    | Description                                                                                                                                                                                                                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| count option | The number of packet(s)<br>0 = 1 (default)<br>1 = 25<br>2 = 100<br>3 = 500<br>4 = 1000<br>5 = 2000<br>6 = 5000<br>7 = 10000                                                                                                                                                                   |
| Packet gap   | Packet gap in milliseconds<br>Input integer range of 6 – 20<br>Minimum packet gap for a given payload size<br>6: For payload size 17 - 44 bytes<br>7: For payload size 45 - 76 bytes<br>8: For payload size 77 - 107 bytes<br>9: For payload size 108 - 116 bytes<br>The maximum gap is 20 ms |

Return data: Done

Example of command to transmit 25 packets at 10 ms packet gap:

```
ot-ctl mfgcmd 33 1 10
```

4.12 Set 802.15.4 TX duty cycle

Command to set 802.15.4 transmitter in duty cycle TX mode:

```
ot-ctl mfgcmd 35 <Enable>
```

Where:

Table 46. Command parameters

| Parameter | Description                                                       |
|-----------|-------------------------------------------------------------------|
| Enable    | Enable TX with duty cycle<br>0 = disable (default)<br>1 = enables |

Return data: Done

Example of command to enable transmit with duty cycle:

```
ot-ctl mfgcmd 35 1
```

4.13 Set 802.15.4 PHY TX test packet information

Command to set 802.15.4 PHY transmitter test packet information:

```
ot-ctl mfgcmd 59 <Seq Number> <PAN ID> <Destination ID> <Source ID>
```

Where:

Table 47. Command parameters

| Parameter      | Description                                                                                                                                                                |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Seq Number     | Sequence number<br>Set to 1.                                                                                                                                               |
| PAN ID         | Personal Area Network (PAN) identifier<br>Valid input range: 0x0000 to 0xFFFF<br><b>Note:</b> The transmitting device and the receiving device must share the same PAN ID. |
| Destination ID | Destination identifier of the receiving device<br>Valid input range: 0x0000 to 0xFFFF                                                                                      |
| Source ID      | Source identifier of the transmitting device<br>Valid input range: 0x0000 to 0xFFFF                                                                                        |

Return data: Done

Example of command to set the PHY TX test packet information:

```
ot-ctl mfgcmd 59 1 0x1234 0x2354 0x3456
```

#### 4.14 Start 802.15.4 RX test

Command to start 802.15.4 RX test:

```
ot-ctl mfgcmd 32
```

**Return data:** Done

#### 4.15 Get 802.15.4 RX test result

Command the extended RX test result report for 802.15.4 radio.

```
ot-ctl mfgcmd 31
```

**Return data:** Extended RX test result report for 802.15.4.

4.16 Command sequence examples to test 802.15.4 radio

This section provides example of commands for 802.15.4 transmit and receive RF performance tests.

4.16.1 Command sequence to test 802.15.4 radio transmit duty cycle mode

Table 48. 802.15.4 radio transmit duty cycle mode command sequence

| Step | Operation                           | Command                          |
|------|-------------------------------------|----------------------------------|
| 1    | Enable the RF test mode             | <code>ot-ctl mfgcmd 1</code>     |
| 2    | Set the RF channel to 20 (2450 MHz) | <code>ot-ctl mfgcmd 12 20</code> |
| 3    | Set the power to 4 dBm              | <code>ot-ctl mfgcmd 16 4</code>  |
| 4    | Enable TX in duty cycle mode        | <code>ot-ctl mfgcmd 35 1</code>  |
| 5    | Stop TX                             | <code>ot-ctl mfgcmd 35 0</code>  |

4.16.2 Command sequence to test 802.15.4 radio in receive mode

Table 49. 802.15.4 radio receive mode command sequence

| Step | Operation                                             | Command                                                                                                                                                                                                   |
|------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enable 802.15.4 RF test mode                          | <code>ot-ctl mfgcmd 1</code>                                                                                                                                                                              |
| 2    | Set the RF channel to 11                              | <code>ot-ctl mfgcmd 12 11</code>                                                                                                                                                                          |
| 3    | Get the channel setting                               | <code>ot-ctl mfgcmd 11</code>                                                                                                                                                                             |
| 4    | Set the PAN identifier and the destination identifier | <code>ot-ctl mfgcmd 59 1 0xface 0xabcd 0xef12</code>                                                                                                                                                      |
| 3    | Start RX                                              | <code>ot-ctl mfgcmd 32</code>                                                                                                                                                                             |
| 4    | Transmit packets to the DUT with an RF tester         |                                                                                                                                                                                                           |
| 5    | Return the extended RX result report                  | <code>ot-ctl mfgcmd 31</code><br><br>Output:<br><br><code>status: 0</code><br><code>rx_pkt_count : 500</code><br><code>total_pkt_count : 500</code><br><code>rss_i : -53</code><br><code>lqi : 118</code> |

## 5 Abbreviations

Table 50. Abbreviations

| Abbreviation | Definition                                 |
|--------------|--------------------------------------------|
| BR           | basic rate (Bluetooth terminology)         |
| BT           | Bluetooth                                  |
| CS           | carrier suppression                        |
| DH           | data high rate (Bluetooth terminology)     |
| DM1          | data medium 1 (Bluetooth terminology)      |
| DUT          | device under test                          |
| EDR          | enhanced data rate (Bluetooth terminology) |
| FW           | firmware                                   |
| HCI          | Host command interface                     |
| LE           | low energy (Bluetooth terminology)         |
| PAN          | personal area network                      |
| RF           | radio frequency                            |
| RX           | receive                                    |
| TX           | transmit                                   |

## 6 References

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- [1] Bluetooth Core Specification v5.3 ([link](#))
- [2] UM11483 – Getting Started with NXP-based Wireless Modules on i.MX 8M Quad EVK Running Linux OS ([link](#))

## 7 Note about the source code in the document

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## 8 Revision history

Table 51. Revision history

| Document ID   | Release date      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AN14114 v.5.0 | 7 February 2025   | <ul style="list-style-type: none"> <li>• <a href="#">Section 1.1 "Supported devices"</a>: added AW611 and IW610.</li> </ul> <b>Wi-Fi RF test mode</b> <ul style="list-style-type: none"> <li>• <a href="#">Section 2.4 "Set the radio mode "</a>: added AW611 to the list of supported products.</li> <li>• <a href="#">Section 2.11 "Set TX frame"</a>: updated the definition of <code>short GI</code> parameter.</li> </ul> <b>Bluetooth RF test mode</b> <ul style="list-style-type: none"> <li>• <a href="#">Section 3.3.3 "Set Bluetooth LE TX power"</a>: added <code>front-end-loss</code> parameter.</li> </ul> <b>802.15.4 RF test mode</b> <ul style="list-style-type: none"> <li>• <a href="#">Section 4.13 "Set 802.15.4 PHY TX test packet information"</a>: added.</li> <li>• <a href="#">Section 4.16.2 "Command sequence to test 802.15.4 radio in receive mode"</a>: updated.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| AN14114 v.4.0 | 24 September 2024 | <b>Wi-Fi RF test mode</b> <ul style="list-style-type: none"> <li>• <a href="#">Section 2.1 "List of commands for Wi-Fi RF test mode"</a>: added.</li> <li>• <a href="#">Section 2.4 "Set the radio mode "</a>: added a note to radio mode index 9.</li> <li>• <a href="#">Section 2.10 "Set TX continuous mode"</a>: added an example for continuous wave mode.</li> <li>• <a href="#">Section 2.11 "Set TX frame"</a>: <ul style="list-style-type: none"> <li>– Updated the range of values for <code>adjust SIFS</code> parameter.</li> <li>– Added a note to the description of <code>adv coding</code> parameter.</li> <li>– Updated the example of command to start TX frame.</li> </ul> </li> <li>• <a href="#">Section 2.12.2 "Configure the golden unit and DUT for UL-OFDMA transmission"</a>: <ul style="list-style-type: none"> <li>– Updated the definition of <code>standalone_hetb</code> parameter.</li> <li>– Updated the commands for step 6 and step 7 in the table <i>Steps for HE trigger frame generation</i>.</li> </ul> </li> <li>• <a href="#">Section 2.12.3 "Testing standalone UL-OFDMA"</a>: <ul style="list-style-type: none"> <li>– Updated the value of <code>standalone_hetb</code> for <code>trigger_frame</code> command.</li> <li>– Added a step for TX power setting in <a href="#">Table 15</a>.</li> <li>– Changed the bandwidth value changed to 20 MHz for step 4 in <a href="#">Table 15</a>.</li> <li>– Updated the command for step 7, enable standalone trigger frame in <a href="#">Table 15</a>.</li> <li>– Updated the command for step 8, start TX frame in <a href="#">Table 15</a>.</li> </ul> </li> <li>• <a href="#">Section 2.13 "Data rates"</a>: updated <a href="#">Table 18</a>.</li> <li>• <a href="#">Section 2.16.1 "5 GHz TX command sequence using tx_frame"</a>: updated the command for step 7 "Start TX at HE SS1 MCS11 rate".</li> <li>• <a href="#">Section 2.16.3 "2.4 GHz TX command sequence using tx_frame"</a>: <ul style="list-style-type: none"> <li>– Updated the example for 1x1 mode.</li> <li>– Updated step 2 "Set radio mode in 2.4 GHz band with 1x1 mode"</li> <li>– Updated step 7 "Start TX at HE SS1 MCS4 rate".</li> </ul> </li> <li>• <a href="#">Section 2.15.1 "2.4 GHz TX command sequence using TX_continuous"</a>: updated the command for step 8 "stop TX".</li> </ul> <p>———— (continues) ————</p> |

Table 51. Revision history...continued

| Document ID   | Release date      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AN14114 v.4.0 | 24 September 2024 | <p>———— (continued) ————</p> <ul style="list-style-type: none"> <li>• <a href="#">Section 2.16.1 "5 GHz TX command sequence using tx_frame"</a>: <ul style="list-style-type: none"> <li>– Updated the example for 1x1 mode.</li> <li>– Updated step 2 "Set radio mode in 2.4 GHz band with 1x1 mode"</li> <li>– Updated step 7 "Start TX at HE SS1 MCS11 rate".</li> </ul> </li> <li>• <a href="#">Section 2.16.2 "5 GHz TX command sequence using tx_frame for HE-ER SU"</a>: <ul style="list-style-type: none"> <li>– Updated the example for 1x1 mode.</li> <li>– Updated step 2 "Set radio mode 0 in 5 GHz band with 1x1 mode"</li> <li>– Updated step 7 "Start TX at HE SS1 MCS1 rate".</li> </ul> </li> <li>• <a href="#">Section 2.16.3 "2.4 GHz TX command sequence using tx_frame"</a>: <ul style="list-style-type: none"> <li>– Updated the example for 1x1 mode.</li> <li>– Updated step 2 "Set radio mode 1 in 2.4 GHz band with 1x1 mode"</li> <li>– Updated step 7 "Start TX at HE SS1 MCS1 rate".</li> </ul> </li> <li>• <a href="#">Section 2.16.4 "5 GHz TX command sequence using tx_continuous"</a>: updated step 9 " stop continuous wave mode".</li> <li>• <a href="#">Section 2.16.5 "2.4 GHz TX command sequence using tx_continuous"</a>: <ul style="list-style-type: none"> <li>– Updated the example for 1x1 mode.</li> <li>– Updated step 2 "Set radio mode 1 in 2.4 GHz band with 1x1 mode"</li> <li>– Updated step 9 "Start TX continuous wave mode".</li> </ul> </li> </ul> <p><b>Bluetooth RF test mode</b></p> <ul style="list-style-type: none"> <li>• <a href="#">Section 3.1 "List of commands for Bluetooth RF test mode"</a>: added.</li> </ul> <p><b>RF test mode for 802.15.4 radio</b></p> <ul style="list-style-type: none"> <li>• <a href="#">Section 4.1 "List of commands for 802.15.4 RF test mode"</a>: added.</li> </ul> |
| AN14114 v.3.0 | 28 June 2024      | <ul style="list-style-type: none"> <li>• <a href="#">Section 2.4 "Set the radio mode "</a>: extended the applicability of the content to IW611.</li> <li>• <a href="#">Section 2.11 "Set TX frame"</a>: added <code>signal Bw</code> parameter.</li> <li>• <a href="#">Section 2.13 "Data rates"</a>: updated the table listing 802.11n/a/g/b data rate ID.</li> <li>• <a href="#">Section 2.16 "RF test mode command sequence examples for 88W9098"</a>: added.</li> <li>• <a href="#">Section 3.2.6 "Update the parameter settings for RF TX test"</a>: added.</li> <li>• <a href="#">Section 3.3.2 "End the receive test and get the packet count"</a>: added.</li> <li>• <a href="#">Section 3.4.1 "Bluetooth Classic TX test"</a>: updated.</li> <li>• <a href="#">Section 3.4.2 "Bluetooth Classic RX Test"</a>: updated.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| AN14114 v.2.0 | 15 April 2024     | <ul style="list-style-type: none"> <li>• <a href="#">Section 2.13 "Data rates"</a>: added the table with 802.11ac data rate ID.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| AN14114 v.1.0 | 7 February 2024   | <ul style="list-style-type: none"> <li>• Initial version</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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