

Regulatory Performance Test Reference Manual

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About this Document

This document describes the usage of the RS9113 n-Link® Driver for testing transmit & receive Regulatory Performance for Wi-Fi, Bluetooth and ZigBee protocols.

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Table Of Contents

| | | |
|----------|--|-----------|
| 1 | Introduction | 5 |
| 1.1 | Getting Started | 5 |
| 2 | WLAN Performance Test Application Usage | 7 |
| 2.1 | Transmit Tests | 7 |
| 2.1.1 | Transmit Command | 8 |
| 2.1.2 | Transmit Command Description | 8 |
| 2.1.3 | Examples | 10 |
| 2.2 | Receive Tests | 11 |
| 2.2.1 | Receive Command | 12 |
| 2.2.2 | Receive Command Description | 12 |
| 2.2.3 | Examples | 12 |
| 2.3 | Transmit Continuous Wave (CW) mode | 13 |
| 2.3.1 | Command Usage | 13 |
| 2.3.2 | Examples | 13 |
| 3 | Bluetooth Performance Test Application Usage | 15 |
| 3.1 | Transmit Tests | 16 |
| 3.1.1 | Transmit Command | 17 |
| 3.1.2 | Transmit Command Description | 17 |
| 3.2 | Receive Tests | 22 |
| 3.2.1 | Receive Command | 22 |
| 3.2.2 | Receive Command Description | 23 |
| 3.2.3 | bt_util | 23 |
| 3.3 | Continuous Wave Transmit Mode | 23 |
| 3.3.1 | Command Usage | 23 |
| 4 | ZigBee Performance Test Application Usage | 25 |
| 4.1 | Transmit Tests | 25 |
| 4.1.1 | Transmit Command | 26 |
| 4.1.2 | Transmit Command Description | 26 |
| 4.2 | Receive Tests | 27 |
| 4.2.1 | Receive Command | 27 |
| 4.2.2 | Receive Command Description | 27 |
| 5 | FCC and IC Declaration | 28 |
| 6 | Confirmation on Unlawful Usage of TX power with respect to Certified Antennas | 30 |
| 6.1 | Commands to Program Antenna Type | 30 |
| 6.1.1 | Command to Program Antenna Type for Wi-Fi | 30 |
| 6.1.2 | Command to Program Antenna Type for Bluetooth: | 31 |
| 6.1.3 | Command to Program Antenna Type for ZigBee: | 32 |
| 6.2 | Commands to Program Transmit Power | 33 |
| 6.2.1 | Command to Program Transmit Power for Wi-Fi | 33 |
| 6.2.2 | Command to Program Transmit Power for Bluetooth | 33 |
| 6.2.3 | Command to Program Transmit Power for ZigBee | 34 |
| 6.3 | Maximum Transmit Power and Attenuation Values | 34 |
| 6.3.1 | Maximum Transmit Power and Attenuation Values for Redpine Antenna | 35 |

| | | |
|-------|---|----|
| 6.3.2 | Maximum Transmit Power and Attenuation Values for Molex Antenna | 36 |
| 6.3.3 | Maximum Transmit Power and Attenuation Values for Fractus Antenna: | 37 |
| 6.3.4 | Maximum Transmit Power and Attenuation Values for Antenna Factor (Linx) Antenna: | 38 |

Table of Figures

No table of figures entries found.

Table of Tables

| | |
|---|-----------|
| Table 1: Channel Numbers and Corresponding Center Frequencies | 9 |
| Table 2: Rate Flags for Transmit Tests | 10 |
| Table 3: Regulatory Domain Input in Transmit Tests | 10 |
| Table 4: Channel Width Values..... | 12 |
| Table 5 : BT Classic Channel Index..... | 19 |
| Table 6 : BT LE Channel Index..... | 21 |
| Table 7 : Zigbee Channel Index..... | 27 |
| Table 8: List of Antennas Used for RS9113SB FCC/IC Certification..... | 30 |
| Table 9: Command to Program Antenna Type for Wi-Fi | 31 |
| Table 10: Command to Program Antenna Type for Bluetooth | 32 |
| Table 11: Command to Program Antenna Type for Bluetooth | 32 |
| Table 12: Command to Program Transmit Power for Wi-Fi..... | 33 |
| Table 13: Command to Program Transmit Power for Bluetooth | 34 |
| Table 14: Command to Program Transmit Power for ZigBee | 34 |
| Table 15: Low, Mid and High Channel Frequencies for Wi-Fi, Bluetooth and ZigBee..... | 35 |
| Table 16: Maximum Transmit Power and Attenuation Values for Redpine Antenna | 36 |
| Table 17: Maximum Transmit Power and Attenuation Values for Molex Antenna | 37 |
| Table 18: : Maximum Transmit Power and Attenuation Values for Fractus Antenna | 37 |
| Table 19: Maximum Transmit Power and Attenuation Values for Antenna Factor (Linx) Antenna..... | 38 |

1 Introduction

The software provided for the RS9113 n-Link® modules is named OneBox-Mobile. The software currently supports performance testing for Wi-Fi, Bluetooth Classic, Bluetooth Low Energy and ZigBee modes. OneBox-Mobile Coexistence software supports the following combinations:

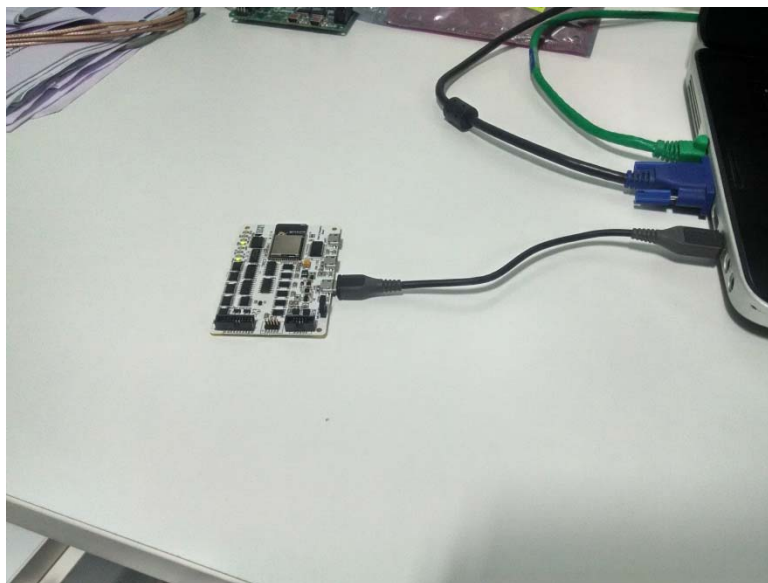
- 1) Wi-Fi only mode
- 2) Wi-Fi + Bluetooth Classic mode
- 3) Wi-Fi + Bluetooth Low Energy mode
- 4) Wi-Fi + ZigBee mode

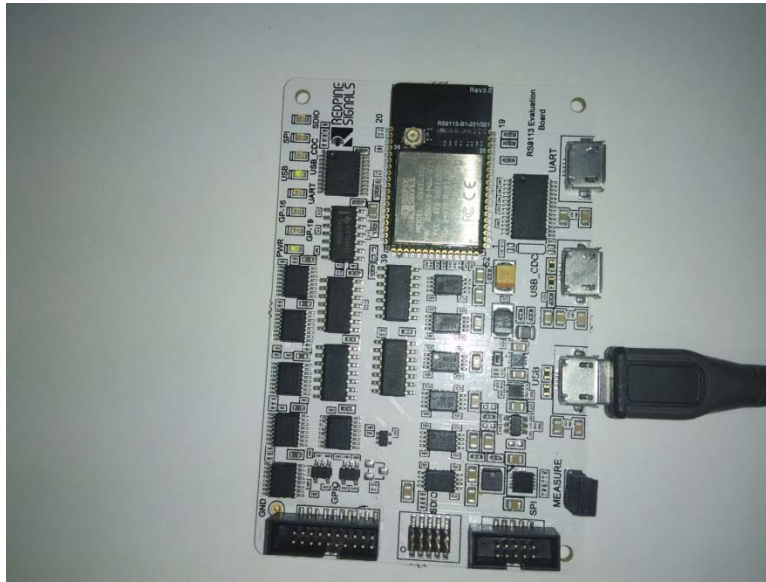
NOTE: The standard software package offers Coexistence modes (modes 2, 3, and 4 above) only when Wi-Fi is configured for Client mode operation. For other combinations, custom packages can be offered. Contact Redpine for more details.

The subsequent sections explain the use of OneBox-Mobile software on an x86 platform. Installation and operation of the driver on specific representative processor platforms have been explained in the Appendix sections.

1.1 Getting Started

1. Login to user **"test"** with password **"test123"**
2. Open a Terminal
3. Type command **"su"** and press enter key
4. Enter password **"test123"**
5. Connect EUT to Laptop with USB cable as shown below





6. Please type “**dmesg**” on the terminal and press enter key and check for the below print

```
[ 3144.505576] usb 2-1.3: USB disconnect, device number 4
[ 3145.705471] usb 2-1.3: new high speed USB device number 5 using ehci_hcd
[ 3145.791837] usb 2-1.3: New USB device found, idVendor=1618, idProduct=9113
[ 3145.791845] usb 2-1.3: New USB device strings: Mfr=1, Product=2, SerialNumber=6
[ 3145.791851] usb 2-1.3: Product: Wireless USB Network Module
[ 3145.791857] usb 2-1.3: Manufacturer: Redpine Signals, Inc.
[ 3145.791862] usb 2-1.3: SerialNumber: 000000000001
```

7. Please go to directory /work/Regulatory_test/host/releases
8. Please read section 2 for performing WLAN Tests
9. Please read section 3 for performing BT Tests
10. Please read section 4 for performing Zigbee Tests

2 WLAN Performance Test Application Usage

The OneBox-Mobile software provides applications to test Transmit and Receive performance of the module. The Band of operation of the module needs to be configured before performing any tests.

NOTE: Open the **common_insert.sh** file present in the “release” folder using an editor like vim. Ensure that the DRIVER_MODE is set as below:

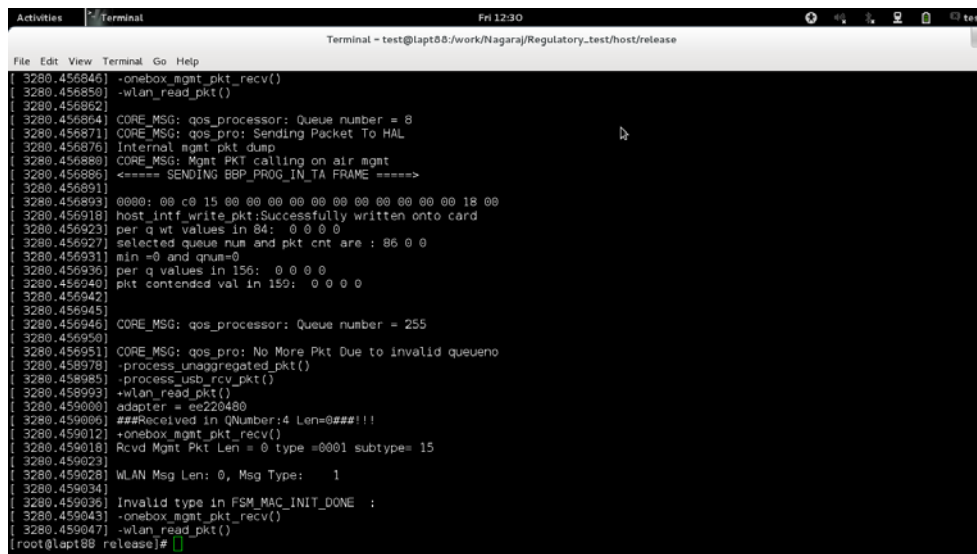
```
DRIVER_MODE = 2
```

```
COEX_MODE = 1
```

Run the following command to install the Driver in Performance Test mode:

```
# sh wlan_insert.sh
```

Please type “**dmesg**” in the terminal and press enter key and check for the below print for check if driver has been loaded properly.



```

[ 3280.456846] -onebox_mgmt_pkt_rcv()
[ 3280.456850] -wlan_read_pkt()
[ 3280.456862]
[ 3280.456864] CORE_MSG: qos_processor: Queue number = 8
[ 3280.456871] CORE_MSG: qos_pro: Sending Packet To HAL
[ 3280.456876] Internal mgmt pkt dump
[ 3280.456880] CORE_MSG: Mgmt PKT calling on air mgmt
[ 3280.456886] <==== SENDING BBP_PROG_IN_TA_FRAME =====>
[ 3280.456891]
[ 3280.456892] 0000: 00 c0 15 00 00 00 00 00 00 00 00 00 00 18 00
[ 3280.456918] host_intf_write_pkt: Successfully written onto card
[ 3280.456923] per q wt values in 84: 0 0 0 0
[ 3280.456927] selected queue num and pkt cnt are : 86 0 0
[ 3280.456931] min =0 and qnum=0
[ 3280.456936] per q values in 156: 0 0 0 0
[ 3280.456940] pkt contended val in 159: 0 0 0 0
[ 3280.456942]
[ 3280.456945]
[ 3280.456946] CORE_MSG: qos_processor: Queue number = 255
[ 3280.456950]
[ 3280.456951] CORE_MSG: qos_pro: No More Pkt Due to invalid queue no
[ 3280.458978] -process_unaggregated_pkt()
[ 3280.458980] -process_usb_rcv_pkt()
[ 3280.458992] +wlan_read_pkt()
[ 3280.459000] adapter = ee220480
[ 3280.459006] ###Received in QNumber:4 Len=0###!!!
[ 3280.459012] +onebox_mgmt_pkt_rcv()
[ 3280.459018] Rcvd Mgmt Pkt Len = 0 type =0001 subtype= 15
[ 3280.459023]
[ 3280.459028] WLAN Msg Len: 0, Msg Type: 1
[ 3280.459034]
[ 3280.459036] Invalid type in FSM_MAC_INIT_DONE :
[ 3280.459043] -onebox_mgmt_pkt_rcv()
[ 3280.459047] -wlan_read_pkt()
[ root@lapt88 release]#
  
```

Next, follow the instructions below to run the Transmit and Receive tests.

2.1 Transmit Tests

The “transmit” utility, present in the “release” folder allows the configuration of the following parameters and starts the transmission of packets.

- 1) Transmit Power
- 2) Transmit Data Rate
- 3) Packet Length
- 4) Transmit Mode
- 5) Channel Number

- 6) External PA Enable/Disable¹
- 7) Rate Flags like Short GI, Greenfield, etc.
- 8) Enable/Disable Aggregation
- 9) Number of packets to be transmitted in Burst Mode
- 10) Delay between packets in Burst Mode
- 11) Regulatory Domain

2.1.1 Transmit Command

```
./transmit
<tpow> <rate> <len> <mode> <chan> <expa> <rf> <aggr> <num> <delay>
> <reg>
```

2.1.2 Transmit Command Description

The command usage is explained below.

<tpow>: Transmit power in dBm for controlling transmit power. To set the transmit power value, enter a value either between -7 and 18. If a value of 127 is entered, the packet will be transmitted at the maximum power from the Transmit power table in the module.

<rate>: Transmit Data Rate. To set the transmit data rate, select a value from 1, 2, 5.5, 11, 6, 9, 12, 18, 24, 36, 48, 54, mcs0, mcs1, mcs2, mcs3, mcs4, mcs5, mcs6 and mcs7.

<len>: Transmit packet length in bytes. Enter a value between 24 and 1536 when aggregation is not enabled and between 24 and 30000 when aggregation is enabled.

<mode>: Transmit mode. Enter 0 for Burst mode and 1 for Continuous mode.

<chan>: Transmit channel number². The following table maps the channel numbers to the center frequencies for 20MHz and 40MHz bandwidth modes in 2.4 GHz band.

| Band (GHz) | Bandwidth (MHz) | Channel Number | Center Frequency (MHz) |
|------------|-----------------|----------------|------------------------|
| 2.4 | 20 | 1 | 2412 |
| 2.4 | 20 | 2 | 2417 |
| 2.4 | 20 | 3 | 2422 |
| 2.4 | 20 | 4 | 2427 |
| 2.4 | 20 | 5 | 2432 |

¹ This is not supported in the current release.

² On-air testing in DFS channels should be avoided till the module is certified for DFS. Cabled tests can be run in these channels.

| Band (GHz) | Bandwidth (MHz) | Channel Number | Center Frequency (MHz) |
|------------|-----------------|----------------|------------------------|
| 2.4 | 20 | 6 | 2437 |
| 2.4 | 20 | 7 | 2442 |
| 2.4 | 20 | 8 | 2447 |
| 2.4 | 20 | 9 | 2452 |
| 2.4 | 20 | 10 | 2457 |
| 2.4 | 20 | 11 | 2462 |
| 2.4 | 40 | 3 | 2422 |
| 2.4 | 40 | 4 | 2427 |
| 2.4 | 40 | 5 | 2432 |
| 2.4 | 40 | 6 | 2437 |
| 2.4 | 40 | 7 | 2442 |
| 2.4 | 40 | 8 | 2447 |
| 2.4 | 40 | 9 | 2452 |
| 2.4 | 40 | 10 | 2457 |
| 2.4 | 40 | 11 | 2462 |

Table 1: Channel Numbers and Corresponding Center Frequencies

<expa>: Enable/Disable External PA. This parameter is not supported in the current release.

<rf>: Rate Flags. This parameter is used to enable/disable Short GI and Greenfield and also to set the channel width of the transmitted packets. The table below explains the flags that can be enabled and disabled. Multiple flags can be set at a time.

| Bit | Description |
|-------|--|
| 0 | Short GI 0 – Disable Short GI 1 – Enable Short GI |
| 1 | Greenfield transmission 0 – Disable Greenfield transmission 1 – Enable Greenfield transmission |
| [4:2] | Operating bandwidth of the channel (3 bits) |

| | |
|--|--|
| | 0 – 20MHz 2 (Bit 3 is set) – Upper 20MHz of 40MHz 4 (Bit 4 is set) – Lower 20MHz of 40MHz 6 (Bits 3 and 4 are set) – Full 40MHz |
|--|--|

Table 2: Rate Flags for Transmit Tests

<aggr>: Enable/Disable Aggregation. Enter 0 to disable aggregation and 1 to enable aggregation. The packet length is divided into chunks of size 1792 bytes and aggregated. This parameter applies only to the Burst mode transmission and is ignored in the case of Continuous mode of transmission.

<num>: Number of packets to be transmitted in Burst mode. The transmission stops after the number of packets specified by this parameter are transmitted in the Burst mode. If this value is 0, then the transmission will not stop until the user gives the “./transmit 0” command to stop the transmissions. This parameter is ignored in the case of Continuous mode of transmission.

<delay>: Delay between packets in Burst mode. This parameter is used to introduce a delay between any two packets. The delay has to be specified in microseconds. If this value is 0, then the packets will be transmitted without any delay. This parameter is ignored in the case of Continuous mode of transmission.

<reg>: Regulatory Domain. Refer the table below for the mapping of values to the regulatory domains.

| Input Value | Regulatory Domain |
|-------------|---|
| 0 | US (FCC) |
| 1 | Europe (ETSI) |
| 255 | World Domain(No Regulatory Restriction) |

Table 3: Regulatory Domain Input in Transmit Tests

NOTE: While doing Regulatory testing, Please use only World Domain option.

NOTE: After the transmission starts, the following commands need to be given to stop the transmissions.

Burst Mode: ./transmit 0

Continuous Mode: ./transmit 0

2.1.3 Examples

```
# ./transmit 254 1000 1 11 0 0 0 0 0 255
```

The above command starts continuous transmission with the following configuration:

Transmit gain – 2dbm

Data rate – 54Mbps

Packet Length – 1000 bytes

Transmit mode – 1 (continuous mode).

Channel number – 11

External PA – disabled

Rate flags – 0

Aggregation – disabled (ignored in continuous mode)

Number of packets to be transmitted – 0(ignored in continuous mode)

Delay between the packets – 0(ignored in continuous mode)

Regulatory Domain is set to – World Domain

```
# ./transmit 12 36 1000 0 6 0 25 0 0 1000 0 0
```

The above command starts burst mode transmission with the following configuration:

Transmit gain – 12dBm

Data rate – 36Mbps

Packet Length – 1000 bytes

Transmit mode – 0 (Burst mode).

Channel number – 6

External PA – disabled

Rate flags – 25 (Short GI with Full 40MHz Channel width)

Aggregation – disabled

Number of packets to be transmitted – 1000

Delay between the packets – 0

Regulatory Domain is set to – World Domain

2.2 Receive Tests

The “receive” utility, present in the “release” folder, can be invoked for displaying the following information

- Total number of CRC PASS packets
- Total number of CRC FAIL packets and
- Total number of FALSE CCAs

2.2.1 Receive Command

```
# ./receive <filename><channel_number><start/stop><channel_width>
```

2.2.2 Receive Command Description

<filename>: Name of the file into which the statistics will be logged, in addition to being displayed on the console.

<channel_number>³: Channel number in which the statistics need to be logged. Refer to the Table 1 in [Section 2.1.2](#) for more details.

<start/stop>: Parameter to start or stop logging the statistics. Enter 0 to start logging and 1 to stop logging.

<channel_width>: Operating bandwidth of the channel. Refer to the table below.

| Value | Channel Width |
|-------|----------------------|
| 0 | 20MHz |
| 2 | Upper 20MHz of 40MHz |
| 4 | Lower 20MHz of 40MHz |
| 6 | Full 40MHz |

Table 4: Channel Width Values

2.2.3 Examples

```
# ./receive stats 6 0 0
```

The above command starts the receive utility and logs statistics with the following parameters.

Filename – stats

Channel number – 6

Channel Width – 20MHz

The test utility displays the following information:

- Total number of packets received with correct CRC.
- Total number of packets received with incorrect CRC.
- Total number of False CCA's received.

```
# ./receive stats 6 1 0
```

The above command will stop the receive application

³ On-air testing in DFS channels should be avoided till the module is certified for DFS. Cabled tests can be run in these channels.

2.3 Transmit Continuous Wave (CW) mode

The OneBox-Mobile software provides applications to test Transmit and Receive performance of the module. The Band of operation of the module needs to be configured before performing any tests.

NOTE: Open the common_insert.sh file present in the "release" folder using an editor like vim. Ensure that the DRIVER_MODE is set as below:

```
DRIVER_MODE = 2
```

Run the following command to install the Driver in Performance Test mode:

```
# sh wlan_insert.sh
```

Next, follow the instructions below to run the Transmit and Receive tests.

The Continuous Wave mode is used to transmit a single tone – either a sine wave or a cosine wave.

2.3.1 Command Usage

```
./onebox_util <base_interface> cw_mode  
<channel><start/stop><type>
```

<base_interface>: Base Interface (string like rpine0)

<channel_number>: Channel number in which the transmission has to be done. Please refer to the Table 1 in [Section 2.1.2](#) for a mapping between the channel numbers and the center frequencies.

<start/stop>: Parameter to start or stop the transmission. Enter 0 to start transmission and 3 to stop transmission.

<type>: Parameter to select from among the different types of waves to be transmitted. Enter 1 for Single Tone. The transmit power for the CW mode transmission is set using the "transmit" utility. The "transmit" command has to be first issued to start transmission at the required transmit power level and then called again to stop the transmission before giving the "onebox_util" command to start the CW transmission.

'1': -2.5 MHz

'2': +5 MHz

'3': Two tone

'4': OFDM test symbol

'5': DC 200mV

2.3.2 Examples

```
# ./transmit 2 5.5 750 1 11 0 1 0 0 0 0
```

```
# ./transmit 0
```

```
# ./onebox_util rpine0 cw_mode 6 0 1
```

The above command starts continuous wave transmission with the following configuration.

Channel number – 6

Type – Single tone

Transmit Power – 2dBm

```
# ./onebox_util rpine0 cw_mode 6 3 1
```

The above command stops continuous wave transmission.

3 Bluetooth Performance Test Application Usage

The OneBox-Mobile software provides applications to test Transmit and Receive performance of the module.

NOTE: Open the **common_insert.sh** file present in the “release” folder using an editor like vim. Ensure that the DRIVER_MODE and COEX_MODE is set as below:

DRIVER_MODE = 2

COEX_MODE = 2(for BT Classic)

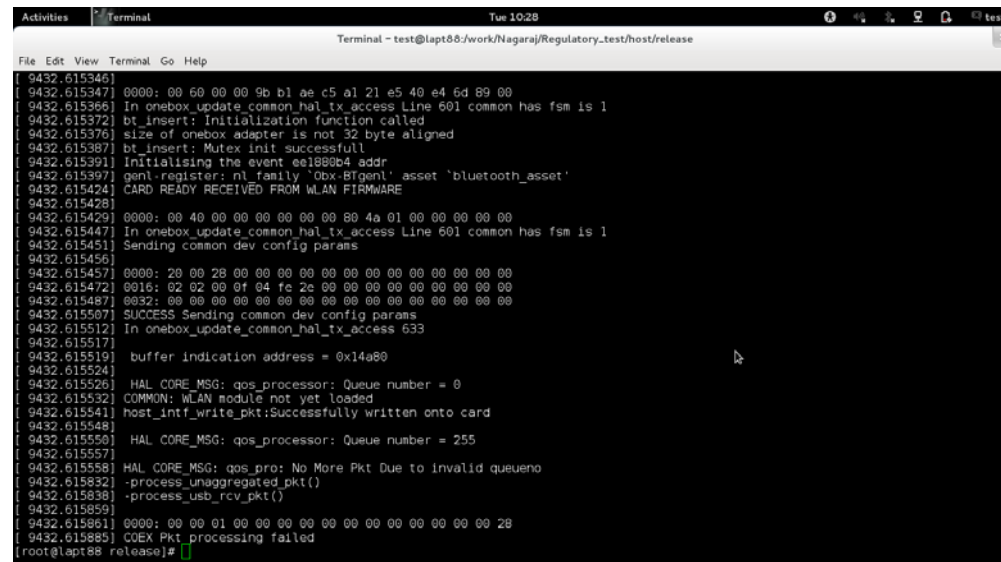
COEX_MODE = 4(for BT LE)

Run the following command to install the Driver in Performance Test mode:

```
# sh bt_insert.sh
```

Please type “**dmesg**” in the terminal and press enter key and check for the below print for check if driver has been loaded properly.

BT Classic:

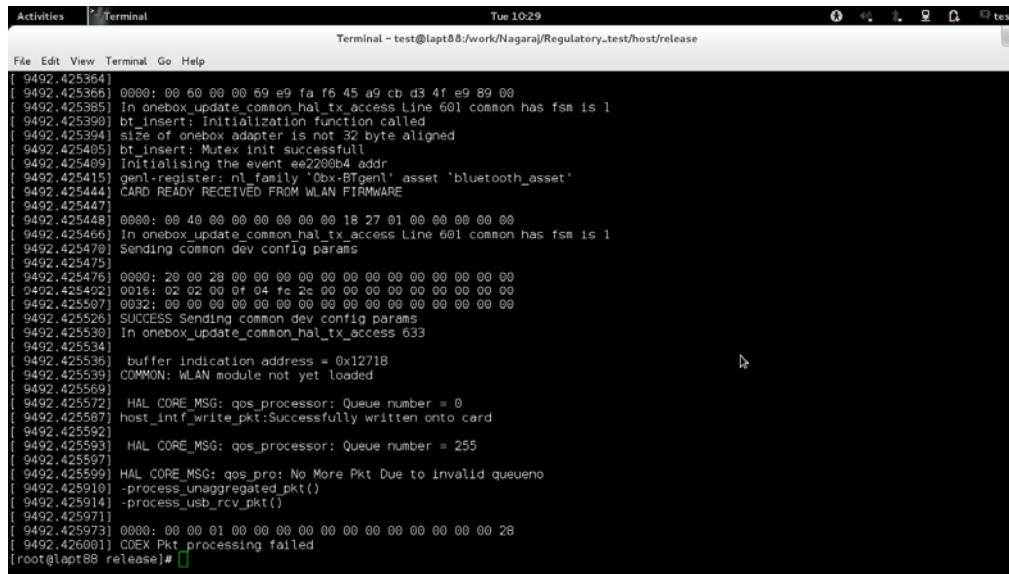


```

[ 9432.615346]
[ 9432.615347] 0000: 00 60 00 00 9b b1 ae c5 a1 21 e5 40 e4 6d 89 00
[ 9432.615366] In onebox_update_common_hal_tx_access Line 601 common has fsm is 1
[ 9432.615372] bt_insert: initialization function called
[ 9432.615376] size of onebox_adepter is not 32 byte aligned
[ 9432.615387] bt_insert: Mutex init successfull
[ 9432.615391] Initialising the event 0e1880b4 addr
[ 9432.615397] genl_register: nl_family 'obx-BTgenl' asset 'bluetooth_asset'
[ 9432.615424] CARD READY RECEIVED FROM WLAN FIRMWARE
[ 9432.615428]
[ 9432.615429] 0000: 00 40 00 00 00 00 00 00 00 4a 01 00 00 00 00 00
[ 9432.615447] In onebox_update_common_hal_tx_access Line 601 common has fsm is 1
[ 9432.615451] Sending common dev config params
[ 9432.615456]
[ 9432.615457] 0000: 20 00 28 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 9432.615472] 0016: 02 02 00 0f 04 fe 2e 00 00 00 00 00 00 00 00 00
[ 9432.615487] 0032: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 9432.615507] SUCCESS Sending common dev config params
[ 9432.615512] In onebox_update_common_hal_tx_access 633
[ 9432.615517]
[ 9432.615519] buffer indication address = 0x14080
[ 9432.615524]
[ 9432.615526] HAL CORE_MSG: qos_processor: Queue number = 0
[ 9432.615532] COMMON: WLAN module not yet loaded
[ 9432.615541] host_intf_write_pkt:Successfully written onto card
[ 9432.615548]
[ 9432.615550] HAL CORE_MSG: qos_processor: Queue number = 255
[ 9432.615557]
[ 9432.615558] HAL CORE_MSG: qos_pro: No More Pkt Due to invalid queue no
[ 9432.615832] -process_unaggregated_pkt()
[ 9432.615838] -process_usb_rcv_pkt()
[ 9432.615859]
[ 9432.615861] 0000: 00 00 01 00 00 00 00 00 00 00 00 00 00 00 00 28
[ 9432.615885] COEX Pkt processing failed
[root@lapt88 release]#

```

BT LE:



```

[ 9492.425364]
[ 9492.425366] 0000: 00 60 00 00 69 e9 fa f6 45 a9 cb d3 4f e9 89 00
[ 9492.425385] In onebox_update_common_hal_tx_access Line 601 common has fsm is 1
[ 9492.425390] bt_insert: initialization function called
[ 9492.425394] size of onebox adapter is not 32 byte aligned
[ 9492.425405] bt_insert: Mutex init successful
[ 9492.425409] Initialising the event ee2200b4 addr
[ 9492.425415] genl-register: nl_family 'Obx-BTgenl' asset 'bluetooth_asset'
[ 9492.425444] CARD READY RECEIVED FROM WLAN FIRMWARE
[ 9492.425447]
[ 9492.425448] 0000: 00 40 00 00 00 00 00 00 18 27 01 00 00 00 00 00
[ 9492.425466] In onebox_update_common_hal_tx_access Line 601 common has fsm is 1
[ 9492.425470] Sending common dev config params
[ 9492.425475]
[ 9492.425476] 0000: 20 00 28 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 9492.425492] 0016: 02 02 00 0f 04 fc 2c 00 00 00 00 00 00 00 00 00
[ 9492.425507] 0032: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 9492.425526] SUCCESS Sending common dev config params
[ 9492.425530] In onebox_update_common_hal_tx_access 633
[ 9492.425534]
[ 9492.425536] buffer indication address = 0x12718
[ 9492.425539] COMMON: WLAN module not yet loaded
[ 9492.425569]
[ 9492.425572] HAL CORE MSG: qos_processor: Queue number = 0
[ 9492.425587] host_intf_write_pkt:Successfully written onto card
[ 9492.425592]
[ 9492.425593] HAL CORE MSG: qos_processor: Queue number = 255
[ 9492.425597]
[ 9492.425599] HAL CORE MSG: qos_pro: No More Pkt Due to invalid queue no
[ 9492.425910] -process_unaggregated_pkt()
[ 9492.425914] -process_usb_rcv_pkt()
[ 9492.425971]
[ 9492.425973] 0000: 00 00 01 00 00 00 00 00 00 00 00 00 00 00 00 28
[ 9492.426001] COEX Pkt processing failed
[ root@lapt88 release]#
  
```

Next, follow the instructions below to run the Transmit and Receive tests.

3.1 Transmit Tests

The “bt_transmit” utility, present in the “release” folder, allows the configuration of the following parameters and starts the transmission of packets.

- 1) Device Address
- 2) Packet Type
- 3) Packet Length
- 4) BDR/EDR Mode
- 5) Receive Channel Index
- 6) Transmit Channel Index
- 7) Link Type
- 8) Scrambler Seed
- 9) Number of Packets
- 10) Payload Type
- 11) Classic/LE Mode
- 12) LE Channel Type
- 13) Transmit Power
- 14) Transmit Mode
- 15) Hopping Type
- 16) Antenna Select

3.1.1 Transmit Command

```
./bt_transmit
<dev_addr><pkt_type><pkt_length><bdr_edr_mode><rx_channel_index><tx_channel_index><link_type><scrambler_seed><no_of_packets>
<payload_type><classic_le_mode><le_channel_type><tx_power><tx_mode><hopping_type><ant_sel>
```

3.1.2 Transmit Command Description

The command description is explained below.

<dev_addr>: This is the device address in Classic mode and Access Code in LE mode. It is a 48-bit address in hexadecimal format with colon separation. e.g., **00:23:A7:01:02:03**.

<pkt_type>: This is the type of packet to be transmitted, as per the Bluetooth standard.

Classic:

BDR-1Mbps: **15**

EDR-2Mbps: **14**

EDR-3Mbps: **15**

LE: **6**

<pkt_length>: This is the length of the packet, in bytes, to be transmitted.

Classic:

BDR – 1Mbps: MIN: 20; MAX: 339

EDR – 2Mbps: MIN: 20; MAX: 679

EDR – 3Mbps: MIN: 20; MAX: 1021

LE: MIN: 10; MAX: 37

<bdr_edr_mode>: This parameter decides whether the transmission has to happen in Basic Data Rate or Enhanced Data Rate in Classic mode. This parameter is invalid in LE-mode.

'1' – Basic Data Rate

'2' – Enhanced Data Rate

'3' – Enhanced Data Rate

<rx_channel_index>: This parameter indicates the Receive channel index, as per the Bluetooth standard.

BT Classic Channel Index:

| Channel Number | Center Frequency (MHz) |
|----------------|------------------------|
| 0 | 2402 |
| 1 | 2403 |

| | |
|----|------|
| 2 | 2404 |
| 3 | 2405 |
| 4 | 2406 |
| 5 | 2407 |
| 6 | 2408 |
| 7 | 2409 |
| 8 | 2410 |
| 9 | 2411 |
| 10 | 2412 |
| 11 | 2413 |
| 12 | 2414 |
| 13 | 2415 |
| 14 | 2416 |
| 15 | 2417 |
| 16 | 2418 |
| 17 | 2419 |
| 18 | 2420 |
| 19 | 2421 |
| 20 | 2422 |
| 21 | 2423 |
| 22 | 2424 |
| 23 | 2425 |
| 24 | 2426 |
| 25 | 2427 |
| 26 | 2428 |
| 27 | 2429 |
| 28 | 2430 |
| 29 | 2431 |
| 30 | 2432 |
| 31 | 2433 |
| 32 | 2434 |
| 33 | 2435 |
| 34 | 2436 |
| 35 | 2437 |
| 36 | 2438 |
| 37 | 2439 |
| 38 | 2440 |
| 39 | 2441 |
| 40 | 2442 |
| 41 | 2443 |

| | |
|----|------|
| 42 | 2444 |
| 43 | 2445 |
| 44 | 2446 |
| 45 | 2447 |
| 46 | 2448 |
| 47 | 2449 |
| 48 | 2450 |
| 49 | 2451 |
| 50 | 2452 |
| 51 | 2453 |
| 52 | 2454 |
| 53 | 2455 |
| 54 | 2456 |
| 55 | 2457 |
| 56 | 2458 |
| 57 | 2459 |
| 58 | 2460 |
| 59 | 2461 |
| 60 | 2462 |
| 61 | 2463 |
| 62 | 2464 |
| 63 | 2465 |
| 64 | 2466 |
| 65 | 2467 |
| 66 | 2468 |
| 67 | 2469 |
| 68 | 2470 |
| 69 | 2471 |
| 70 | 2472 |
| 71 | 2473 |
| 72 | 2474 |
| 73 | 2475 |
| 74 | 2476 |
| 75 | 2477 |
| 76 | 2478 |
| 77 | 2479 |
| 78 | 2480 |

Table 5 : BT Classic Channel Index

BT LE Channel Index:

| Channel Number | Center Frequency (MHz) |
|----------------|------------------------|
| 0 | 2402 |
| 1 | 2404 |
| 2 | 2406 |
| 3 | 2408 |
| 4 | 2410 |
| 5 | 2412 |
| 6 | 2414 |
| 7 | 2416 |
| 8 | 2418 |
| 9 | 2420 |
| 10 | 2422 |
| 11 | 2424 |
| 12 | 2426 |
| 13 | 2428 |
| 14 | 2430 |
| 15 | 2432 |
| 16 | 2434 |
| 17 | 2436 |
| 18 | 2438 |
| 19 | 2440 |
| 20 | 2442 |
| 21 | 2444 |
| 22 | 2446 |
| 23 | 2448 |
| 24 | 2450 |
| 25 | 2452 |
| 26 | 2454 |
| 27 | 2456 |
| 28 | 2458 |
| 29 | 2460 |
| 30 | 2462 |
| 31 | 2464 |
| 32 | 2466 |

| | |
|----|------|
| 33 | 2468 |
| 34 | 2470 |
| 35 | 2472 |
| 36 | 2474 |
| 37 | 2476 |
| 38 | 2478 |
| 39 | 2480 |

Table 6 : BT LE Channel Index

<tx_channel_index>: This parameter indicates the Transmit channel index, as per the Bluetooth standard.

Classic: 0:1:78 -> 2402:1:2480

LE: 0:1:39 -> 2402:2:2480

<link_type>: This parameter indicates the Link Type – ACL, SCO, eSCO. This parameter is valid only in the Classic mode and invalid in LE mode.

'0' – SCO

'1' – **ACL**

'2' – eSCO

<scrambler_seed>: This parameter is the initial seed to be used for whitening. It should be set to '100' to disable whitening.

<no_of_packets>: This is the number of packets to be transmitted. This is valid only when the <tx_mode> is set to Burst mode (0).

<payload_type>: This parameter indicates the type of payload to be transmitted.

'0' – Payload consists of zero

'1' – Payload consists of 0xFF's

'2' – Payload consists of 0x55's

'3' – Payload consists of 0xF0's

'4' – **Payload consists of PN9 sequence**

<classic_le_mode>: This parameter is used to choose between Bluetooth Classic and LE modes for the packet transmission.

'1' – **Classic mode**

'2' – **LE Mode**

<le_channel_type>: This parameter indicates the channel type in LE-mode.

'0' – **Advertising channel**

'1' – Data channel

<tx_power>: This is the transmit power (in dBm) to be used by the module. The value should be between 0 and 18.

<tx_mode>: This parameter is used to choose between Burst and Continuous modes of transmission.

'0' – Burst mode

'1' – **Continuous mode**

<hopping_type>: This parameter is used to choose the hopping pattern.

'0' – **No hopping**

'1' – Fixed hopping

'2' – Random hopping

<ant_sel>: This parameter is used to select one of the two RF ports connecting to antennas. For the modules without integrated antenna, it is used to select between pins RF_OUT_1 and RF_OUT_2. For the modules with integrated antenna and U.FL connector, it used to select between the two.

'2' – **RF_OUT_2/Antenna**

'3' – **RF_OUT_1/U.FL**

3.2 Receive Tests

The Receive tests are performed by using two commands – “bt_receive” and “bt_util”. The “bt_receive” utility, present in the “release” folder, allows the configuration of the parameters below. The “bt_util” command is used to collect the receive statistics.

- 1) Device Address
- 2) Link Type
- 3) Packet Type
- 4) Packet Length
- 5) Scrambler Seed
- 6) BDR/EDR Mode
- 7) Receive Channel Index
- 8) Transmit Channel Index
- 9) Classic/LE Mode
- 10) LE Channel Type
- 11) Hopping Type
- 12) Antenna Select

3.2.1 Receive Command

```
./bt_receive  
<dev_addr><link_type><pkt_type><pkt_length><scrambler_seed><bd  
r_edr_mode><rx_channel_index><tx_channel_index><classic_le_mode  
><le_channel_type><hopping_type><ant_sel>
```

```
./bt_util bt_stats <filename>
```

3.2.2 Receive Command Description

The receive command usage is explained below.

```
./bt_receive  
<dev_addr><link_type><pkt_type><pkt_length><scrambler_seed><bd  
r_edr_mode><rx_channel_index><tx_channel_index><classic_le_mode  
><le_channel_type><hopping_type><ant_sel>
```

The parameters for the “bt_receive” command have the same definition as the ones for the “bt_transmit” command.

3.2.3 bt_util

The “bt_util” command usage is explained below.

```
./bt_util bt_stats <filename>
```

The <filename> parameter above is the file to which the statistics are saved. The following statistics are returned every second.

crc_pass: The number of packets received which passed CRC check.

crc_fail: The number of packets received which failed CRC check.

id_pkt_rcvd: The number of ID packets received.

rss: The RSSI value of the last received packet.

3.3 Continuous Wave Transmit Mode

The “bt_util” command is used to configure the device to transmit a continuous wave. The following parameters can be configured.

- 1) Channel Index
- 2) Start/Stop
- 3) Antenna Select

3.3.1 Command Usage

The command usage is explained below.

```
./bt_util cw_mode <channel_index><start/stop><ant_sel>
```

<channel_index>: This parameter indicates the channel index, as per the Bluetooth standard.

<start/stop>: This parameter is used to Start or Stop the Continuous Wave mode transmission.

<ant_sel>: This parameter is used to select one of the two RF ports connecting to antennas. For the modules without integrated antenna, it is used to select between pins RF_OUT_1 and RF_OUT_2. For the modules with integrated antenna and U.FL connector, it used to select between the two.

'2' – RF_OUT_2/Antenna

'3' – RF_OUT_1/U.FL

4 ZigBee Performance Test Application Usage

The OneBox-Mobile software provides applications to test ZigBee Transmit and Receive performance of the module.

NOTE: Open the **common_insert.sh** file present in the “release” folder using an editor like vim. Ensure that the DRIVER_MODE and COEX_MODE is set as below:

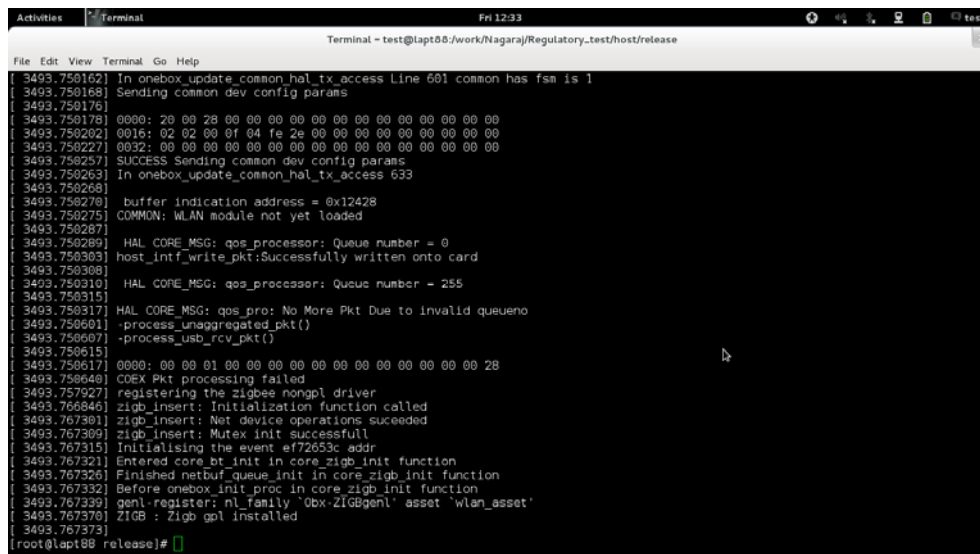
```
DRIVER_MODE = 2
```

```
COEX_MODE = 3(for ZigBee)
```

Run the following command to install the Driver in Performance Test mode:

```
# sh zigb_insert.sh
```

Please type “**dmesg**” in the terminal and press enter key and check for the below print for check if driver has been loaded properly.



```

[ 3493.750162] In onebox_update_common_hal_tx_access Line 601 common has fsm is 1
[ 3493.750168] Sending common dev config params
[ 3493.750178]
[ 3493.750178] 0000: 20 00 28 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 3493.750202] 0016: 02 02 00 0f 04 fe 00 00 00 00 00 00 00 00 00
[ 3493.750227] 0032: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
[ 3493.750257] SUCCESS Sending common dev config params
[ 3493.750263] In onebox_update_common_hal_tx_access 633
[ 3493.750268]
[ 3493.750270] buffer indication address = 0x12428
[ 3493.750275] COMMON: WLAN module not yet loaded
[ 3493.750287]
[ 3493.750289] HAL CORE_MSG: qos_processor: Queue number = 0
[ 3493.750303] host_intf_write_pkt:Successfully written onto card
[ 3493.750308]
[ 3493.750310] HAL CORE_MSG: qos_processor: Queue number = 255
[ 3493.750316]
[ 3493.750317] HAL CORE_MSG: qos_pro: No More Pkt Due to invalid queue no
[ 3493.750601] -process_unaggregated_pkt()
[ 3493.750607] -process_usb_rcv_pkt()
[ 3493.750615]
[ 3493.750617] 0080: 00 00 01 00 00 00 00 00 00 00 00 00 00 00 00 2B
[ 3493.750648] COEX Pkt processing failed
[ 3493.757927] registering the zigbee nongpl driver
[ 3493.766846] zigb_insert: Initialization function called
[ 3493.767301] zigb_insert: Net device operations succeeded
[ 3493.767309] zigb_insert: Mutex init successfull
[ 3493.767315] Initialising the event ef72653c addr
[ 3493.767321] Entered core_bt_init in core_zigb_init function
[ 3493.767325] Finished netBuf_queue_init in core_zigb_init function
[ 3493.767332] Before onebox_init_proc in core_zigb_init function
[ 3493.767339] genl_register: nl_family 'Qbx-ZIGBgenl' asset 'wlan_asset'
[ 3493.767370] ZIGB : Zigb gpl installed
[ 3493.767373]
[root@lapt88 release]#

```

Next, follow the instructions below to run the Transmit and Receive tests.

4.1 Transmit Tests

The “zb_transmit” utility, present in the “release” folder, allows the configuration of the following parameters and starts the transmission of packets.

- 1) Transmit Power
- 2) Packet Length
- 3) Transmit Mode
- 4) Channel Index
- 5) Number of Packets
- 6) Delay

4.1.1 Transmit Command

```
./zb_transmit
<tx_power> <pkt_length> <tx_mode> <channel_index> <no_of_packets>
<delay>
```

4.1.2 Transmit Command Description

The “zb_transmit” command description is explained below.

<tx_power>: This is the transmit power (in dBm) to be used by the module. The value should be between **0 and 18**.

<pkt_length>: This is the length of the packet, in bytes, to be transmitted.

Length - Min: 20 Max: 127

<tx_mode>: This parameter is used to choose between Burst and Continuous modes of transmission.

'0' – Burst mode

'1' – Continuous mode

<channel_index>: This parameter indicates the channel index, as per the ZigBee standard.

| Channel Number | Center Frequency (MHz) |
|----------------|------------------------|
| 11 | 2405 |
| 12 | 2410 |
| 13 | 2415 |
| 14 | 2420 |
| 15 | 2425 |
| 16 | 2430 |
| 17 | 2435 |
| 18 | 2440 |
| 19 | 2445 |
| 20 | 2450 |
| 21 | 2455 |
| 22 | 2460 |
| 23 | 2465 |
| 24 | 2470 |

| Channel Number | Center Frequency (MHz) |
|----------------|------------------------|
| 25 | 2475 |
| 26 | 2480 |

Table 7 : Zigbee Channel Index

<no_of_packets>: This is the number of packets to be transmitted. This is valid only when the <tx_mode> is set to Burst mode (0).

<delay>: Delay between packets in Burst mode. This parameter is used to introduce a delay between any two packets. The delay has to be specified in microseconds. If this value is 0, then the packets will be transmitted without any delay. This parameter is ignored in the case of Continuous mode of transmission.

4.2 Receive Tests

The “zb_util” utility, present in the “release” folder, allows the configuration of the channel and collection of the receive statistics in that channel.

4.2.1 Receive Command

```
./zb_util set_channel <channel_index>
```

```
./zb_util zb_stats <filename>
```

4.2.2 Receive Command Description

The “zb_util” command usage is explained below. It has to be issued twice – first to set the channel and then to start/stop the collection of statistics. The statistics are reported once every second.

```
./zb_util set_channel <channel_index>
```

<channel_index>: This parameter indicates the channel index, as per the ZigBee standard.

```
./zb_util zb_stats <filename>
```

<filename>: This parameter indicates the file to which the statistics are saved.

The following statistics are returned every second.

crc_pass: The number of packets received which passed CRC check.

crc_fail: The number of packets received which failed CRC check.

rss: The RSSI value of the last received packet.

5 FCC and IC Declaration

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the Following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

End Product Labeling

This Module is labeled with its own FCC ID. If the FCC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

“Contains Transmitter Module FCC ID: XF6-RS9113SB”

OR

“Contains FCC ID: XF6-RS9113SB”

The OEM should not provide information to the end user regarding installation or removal of this RF module or change RF related parameters in the user manual of the end product.

The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

énoncé de la FCC (états-Unis seulement) Cet équipement a été testé et jugé conforme aux limites de Classe B pour un appareil numérique, en vertu de l'article 15 de la réglementation de la FCC. Ces limites ont été instaurées pour fournir une protection raisonnable contre toute interférence nuisible dans une installation résidentielle. Cet équipement génère, utilise et peut émettre de l'énergie radiofréquence. S'il n'est pas installé et utilisé conformément aux instructions, il peut provoquer des interférences sur les communications radio. Cependant, il n'est pas garanti que des interférences ne se produiront pas dans certaines installations. Si cet équipement cause des interférences à la réception radio ou télévisée (ce qui peut être vérifié en éteignant l'appareil puis en le remettant sous tension),

l'utilisateur peut tenter de résoudre en suivant une ou plusieurs des mesures ci-après :

Réorienter ou déplacer l'antenne réceptrice.

Augmenter l'espace entre l'appareil et le récepteur. Brancher l'appareil à une prise de courant différente de celle sur laquelle le récepteur est branché. Pour obtenir de l'aide, contacter le vendeur ou un technicien radio/television expérimenté.

REMARQUE: Toute modification non autorisée expressément par le fabricant responsable de la conformité peut annuler le droit de l'utilisateur à faire fonctionner le produit.

This Module is labeled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

“Contains Transmitter Module IC ID: 8407A-RS9113SB”

OR

“Contains IC ID: 8407A-RS9113SB”

6 Confirmation on Unlawful Usage of TX power with respect to Certified Antennas

This is to confirm that Redpine Signals, Inc., will ensure that the following information is included in the RS9113SB (FCC ID: XF6-RS9113SB, IC ID: 8407A-RS9113SB) Module's Programming Manual for customers who use this module with different antennas to help them comply with the FCC/IC regulatory requirements for products which use the module's modular approval.

The list of antennas with which the module has been tested with and certified for FCC/IC are given in Table 1 below.

| Antenna Make | Model/Part # | Antenna Gain at 2.4GHz (dBi) | Type of Antenna |
|-----------------------|-------------------|------------------------------|-----------------|
| Redpine | - | 0.99 | Trace |
| Molex | PS-47950-001 | 3 | External |
| Fractus | FR05-S1-NO-1-004 | 1.8 | Chip |
| Antenna Factor (Linx) | ANT-2.4-CW-RCT-RP | 2.2 | Whip |

Table 8: List of Antennas Used for RS9113SB FCC/IC Certification

The RS9113SB Module's Programming Reference Manual will include the information listed below. The Manual is provided to customers as part of the module's collateral which also includes the module's software and firmware. The module's firmware applies the attenuations required to comply with the regulatory requirements based on the type of antenna programmed. The commands required to program the transmit power and the antenna type and the attenuations applied are given in the tables that follow.

- 1) Commands to program the antenna being used for Wi-Fi, Bluetooth and ZigBee – see Tables 9, 10 and 11.
- 2) Commands to set transmit power of the module for Wi-Fi, Bluetooth and ZigBee – see Tables 12, 13 and 14.
- 3) Transmit power and attenuation values used during testing with different Antennas – see Tables 16, 17, 18 and 19.

6.1 Commands to Program Antenna Type

6.1.1 Command to Program Antenna Type for Wi-Fi

| | |
|--------------|--------------------------------|
| Command Name | Program Antenna Type for Wi-Fi |
|--------------|--------------------------------|

| | |
|------------------|--|
| Description | This command is used to program antenna being used by the module for Wi-Fi out of the list of certified antennas. This command needs to be given before creating the VAP in the normal mode and before the <code>./transmit</code> command in the Wi-Fi Performance Test mode. |
| Default Value | 0 |
| Input Parameters | Base Interface (string like <code>rpine0</code>) Integer value mapped as follows: 0 – Redpine Antenna 1 – Molex Antenna 2 – Fractus Antenna 3 – Antenna Factor (Linx) Antenna |
| Output Parameter | None |
| Reset Required | No |
| Usage | # <code>./onebox_util<base_interface>ant_type<antenna_type></code> |
| Example | The command below sets the Antenna type to Antenna Factor (Linx) Antenna for Wi-Fi: # <code>./onebox_util rpine0 ant_type 3</code> |

Table 9: Command to Program Antenna Type for Wi-Fi

6.1.2 Command to Program Antenna Type for Bluetooth:

| | |
|------------------|--|
| Command Name | Program Antenna Type for Bluetooth |
| Description | This command is used to program antenna being used by the module for Bluetooth out of the list of certified antennas. This command needs to be given before creating the HCI interface in the normal mode and before the <code>./transmit</code> command in the Bluetooth Performance Test mode. |
| Default Value | 0 |
| Input Parameters | Base Interface (string like <code>hci0</code>) Integer value mapped as follows: 0 – Redpine Antenna |

| | |
|------------------|--|
| | 1 – Molex Antenna 2 – Fractus Antenna 3 – Antenna Factor (Linx) Antenna |
| Output Parameter | None |
| Reset Required | No |
| Usage | # hcitool -i <hciX> cmd 0x3F 0x0008 <antenna_type> |
| Example | The command below sets the Antenna type to Molex for Bluetooth: # hcitool -i hci0 cmd 0x3F 0x0008 1 |

Table 10: Command to Program Antenna Type for Bluetooth

6.1.3 Command to Program Antenna Type for ZigBee:

| | |
|------------------|---|
| Command Name | Program Antenna Type for ZigBee |
| Description | This command is used to program antenna being used by the module for ZigBee out of the list of certified antennas. This command needs to be given before creating the base interface (like zigb0) in the normal mode and before the “./transmit” command in the ZigBee Performance Test mode. |
| Default Value | 0 |
| Input Parameters | Base Interface (string like zigb0) Integer value mapped as follows: 0 – Redpine Antenna 1 – Molex Antenna 2 – Fractus Antenna 3 – Antenna Factor (Linx) Antenna |
| Output Parameter | None |
| Reset Required | No |
| Usage | # ./zb_utilant_type<antenna_type> |
| Example | The command below sets the Antenna type to Fractus for ZigBee: # ./zb_utilant_type 2 |

Table 11: Command to Program Antenna Type for Bluetooth

6.2 Commands to Program Transmit Power

6.2.1 Command to Program Transmit Power for Wi-Fi

| | |
|------------------|--|
| Description | This command is used to program the transmit power of the module for Wi-Fi. If the value of transmit power exceeds the maximum allowed power supported by the channel specified by the regulatory domain, then the minimum of the two values will be used. |
| Default Value | - |
| Input Parameters | VAP Name (string like wifi0, wifi1, etc.) Integer value in dBm |
| Output Parameter | None |
| Reset Required | No. |
| Usage | # iwconfig <vap_name> txpower <val_in_dBm> |
| Example | The command below sets the Wi-Fi transmit power to 15dBm: # iwconfig wifi0 txpower 15 |
| Output Parameter | None |

Table 12: Command to Program Transmit Power for Wi-Fi

6.2.2 Command to Program Transmit Power for Bluetooth

| | |
|------------------|--|
| Description | This command is used to program the transmit power of the module for Bluetooth. If the value of transmit power exceeds the maximum allowed power supported by the channel specified by the regulatory domain, then the minimum of the two values will be used. |
| Default Value | 10 – For Bluetooth 2.1+EDR 8 – For Bluetooth LE |
| Input Parameters | Base Interface (string like hci0) Integer value mapped as follows: 1 – Bluetooth 2.1+EDR 2 – Bluetooth LE |

| | |
|------------------|--|
| | Integer value in dBm |
| Output Parameter | None |
| Reset Required | No. |
| Usage | # hcitool -i <hciX> cmd 0x3F 0x0006 <protocol> <tx_power> |
| Example | The command below sets the Bluetooth 2.1+EDR transmit power to 7dBm: # hcitool -i hci0 cmd 0x3F 0x0006 0x01 7 |
| Output Parameter | None |

Table 13: Command to Program Transmit Power for Bluetooth

6.2.3 Command to Program Transmit Power for ZigBee

| | |
|------------------|---|
| Description | This command is used to program the transmit power of the module for ZigBee. If the value of transmit power exceeds the maximum allowed power supported by the channel specified by the regulatory domain, then the minimum of the two values will be used. |
| Default Value | 12 |
| Input Parameters | Integer value in dBm |
| Output Parameter | None |
| Reset Required | No. |
| Usage | # ./zb_utiltx_power <value_in_dBm> |
| Example | The command below sets the ZigBee transmit power to 9dBm: # ./zb_utiltx_power 9 |
| Output Parameter | None |

Table 14: Command to Program Transmit Power for ZigBee

6.3 Maximum Transmit Power and Attenuation Values

The transmit power and attenuation value settings in the following tables are mentioned for IEEE 802.11b/g/n, Bluetooth and ZigBee for the Low, Mid and High channel frequencies. The table below lists the actual frequencies for each technology corresponding to the Low, Mid and High columns in subsequent tables.

| Technology | Low Channel Frequency (MHz) | Mid Channel Frequency (MHz) | High Channel Frequency (MHz) |
|-------------------------------|-----------------------------|-----------------------------|------------------------------|
| 802.11b | 2412 | 2437 | 2462 |
| 802.11g | 2412 | 2437 | 2462 |
| 802.11n 20MHz Bandwidth | 2412 | 2437 | 2462 |
| 802.11n 40MHz Bandwidth | 2422 | 2442 | 2457 |
| Bluetooth | 2402 | 2440 | 2480 |
| ZigBee | 2405 | 2440 | 2480 |

Table 15: Low, Mid and High Channel Frequencies for Wi-Fi, Bluetooth and ZigBee

6.3.1 Maximum Transmit Power and Attenuation Values for Redpine Antenna

| Mode | Data Rate (Mbps) | Channels | | | | | |
|----------------|------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | | Low | | Mid | | High | |
| | | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) |
| 802.11 b | 1 | 14 | 0 | 19 | 0 | 14 | 0 |
| | 11 | 14 | 0 | 19 | 0 | 17 | 0 |
| 802.11 g | 6 | 10 | 0 | 19 | 0 | 10 | 0 |
| | 24 | 10 | 0 | 19 | 0 | 10 | 0 |
| | 54 | 10 | 0 | 19 | 0 | 10 | 0 |
| 802.11 n_20MHz | MCS0 | 9 | 0 | 19 | 0 | 9 | 0 |
| | MCS4 | 9 | 0 | 19 | 0 | 9 | 0 |
| | MCS7 | 9 | 0 | 19 | 0 | 9 | 0 |
| | MCS0 | 6 | 0 | 6 | 0 | 5 | 0 |

| | | | | | | | |
|----------------|---------|----|---|----|---|----|---|
| 802.11 n_40MHz | MCS4 | 6 | 0 | 6 | 0 | 5 | 0 |
| | MCS7 | 6 | 0 | 6 | 0 | 5 | 0 |
| Bluetooth | 1 | 15 | 0 | 15 | 0 | 15 | 0 |
| | 2 | 15 | 0 | 15 | 0 | 15 | 0 |
| | 3 | 15 | 0 | 15 | 0 | 15 | 0 |
| | LE | 15 | 0 | 15 | 0 | 15 | 0 |
| ZigBee | 250kbps | 14 | 0 | 14 | 0 | 12 | 0 |

Table 16: Maximum Transmit Power and Attenuation Values for Redpine Antenna

6.3.2 Maximum Transmit Power and Attenuation Values for Molex Antenna

| Mode | Data Rate (Mbps) | Channels | | | | | |
|----------------|------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | | Low | | Mid | | High | |
| | | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) |
| 802.11 b | 1 | 14 | 4 | 14 | 4 | 14 | 4 |
| | 11 | 14 | 1 | 14 | 0 | 14 | 1 |
| 802.11 g | 6 | 8 | 1 | 18 | 2 | 8 | 1 |
| | 24 | 8 | 1 | 18 | 2 | 8 | 1 |
| | 54 | 8 | 1 | 18 | 2 | 8 | 1 |
| 802.11 n_20MHz | MCS0 | 7 | 1 | 18 | 2 | 7 | 1 |
| | MCS4 | 7 | 1 | 18 | 2 | 7 | 1 |
| | MCS7 | 7 | 1 | 18 | 2 | 7 | 1 |
| 802.11 n_40MHz | MCS0 | 8 | 2 | 10 | 4 | 7 | 3 |
| | MCS4 | 8 | 2 | 10 | 4 | 7 | 3 |
| | MCS7 | 8 | 2 | 10 | 4 | 7 | 3 |
| Bluetooth | 1 | 15 | 0 | 15 | 0 | 15 | 0 |
| | 2 | 16 | 0 | 16 | 0 | 16 | 6 |
| | 3 | 16 | 0 | 16 | 0 | 16 | 6 |

| | | | | | | | |
|--------|---------|----|---|----|---|----|---|
| | LE | 15 | 0 | 15 | 0 | 15 | 0 |
| ZigBee | 250kbps | 12 | 0 | 12 | 0 | 12 | 0 |

Table 17: Maximum Transmit Power and Attenuation Values for Molex Antenna

6.3.3 Maximum Transmit Power and Attenuation Values for Fractus Antenna:

| Mode | Data Rate (Mbps) | Channels | | | | | |
|----------------|------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | | Low | | Mid | | High | |
| | | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) |
| 802.11 b | 1 | 14 | 4 | 14 | 4 | 14 | 4 |
| | 11 | 14 | 0 | 14 | 0 | 14 | 0 |
| 802.11 g | 6 | 8 | 0 | 18 | 4 | 8 | 0 |
| | 24 | 8 | 0 | 18 | 4 | 8 | 0 |
| | 54 | 8 | 0 | 18 | 4 | 8 | 0 |
| 802.11 n_20MHz | MCS0 | 7 | 0 | 18 | 4 | 7 | 0 |
| | MCS4 | 7 | 0 | 18 | 4 | 7 | 0 |
| | MCS7 | 7 | 0 | 18 | 4 | 7 | 0 |
| 802.11 n_40MHz | MCS0 | 8 | 2 | 10 | 3 | 7 | 1 |
| | MCS4 | 8 | 2 | 10 | 3 | 7 | 1 |
| | MCS7 | 8 | 2 | 10 | 3 | 7 | 1 |
| Bluetooth | 1 | 15 | 0 | 15 | 0 | 15 | 0 |
| | 2 | 16 | 1 | 16 | 1 | 16 | 7 |
| | 3 | 16 | 1 | 16 | 1 | 16 | 7 |
| | LE | 15 | 0 | 15 | 0 | 15 | 0 |
| ZigBee | 250kbps | 12 | 0 | 12 | 0 | 12 | 0 |

Table 18: : Maximum Transmit Power and Attenuation Values for Fractus Antenna

6.3.4 Maximum Transmit Power and Attenuation Values for Antenna Factor (Linx) Antenna:

| Mode | Data Rate (Mbps) | Channels | | | | | |
|----------------|------------------|---------------------|-------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | | Low | | Mid | | High | |
| | | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) | Max. Tx Power (dBm) | Attenuation Value (dBm) |
| 802.11 b | 1 | 14 | 4 | 14 | 4 | 14 | 4 |
| | 11 | 14 | 1 | 14 | 0 | 14 | 1 |
| 802.11 g | 6 | 8 | 1 | 18 | 2 | 8 | 1 |
| | 24 | 8 | 1 | 18 | 2 | 8 | 1 |
| | 54 | 8 | 1 | 18 | 2 | 8 | 1 |
| 802.11 n_20MHz | MCS0 | 7 | 1 | 18 | 2 | 7 | 1 |
| | MCS4 | 7 | 1 | 18 | 2 | 7 | 1 |
| | MCS7 | 7 | 1 | 18 | 2 | 7 | 1 |
| 802.11 n_40MHz | MCS0 | 8 | 2 | 10 | 4 | 7 | 3 |
| | MCS4 | 8 | 2 | 10 | 4 | 7 | 3 |
| | MCS7 | 8 | 2 | 10 | 4 | 7 | 3 |
| Bluetooth | 1 | 15 | 0 | 15 | 0 | 15 | 0 |
| | 2 | 16 | 0 | 16 | 0 | 16 | 6 |
| | 3 | 16 | 0 | 16 | 0 | 16 | 6 |
| | LE | 15 | 0 | 15 | 0 | 15 | 0 |
| ZigBee | 250kbps | 12 | 0 | 12 | 0 | 12 | 0 |

Table 19: Maximum Transmit Power and Attenuation Values for Antenna Factor (Linx) Antenna
