Regulatory Performance Test Reference Manual

Version 1.2.2

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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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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:

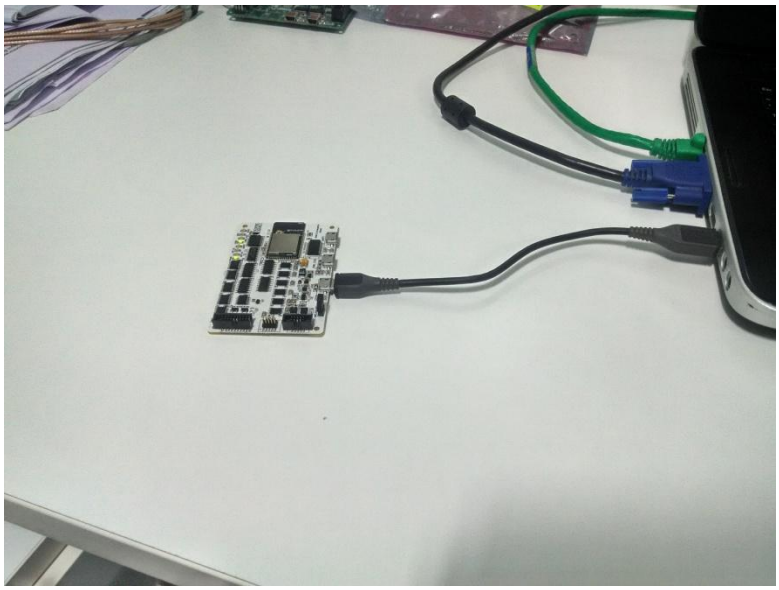
1) Wi-Fi only mode
2) Wi-Fi + Bluetooth Classic mode
3) Wi-Fi + Bluetooth Low Energy mode
4) Wi-Fi + ZigBee mode

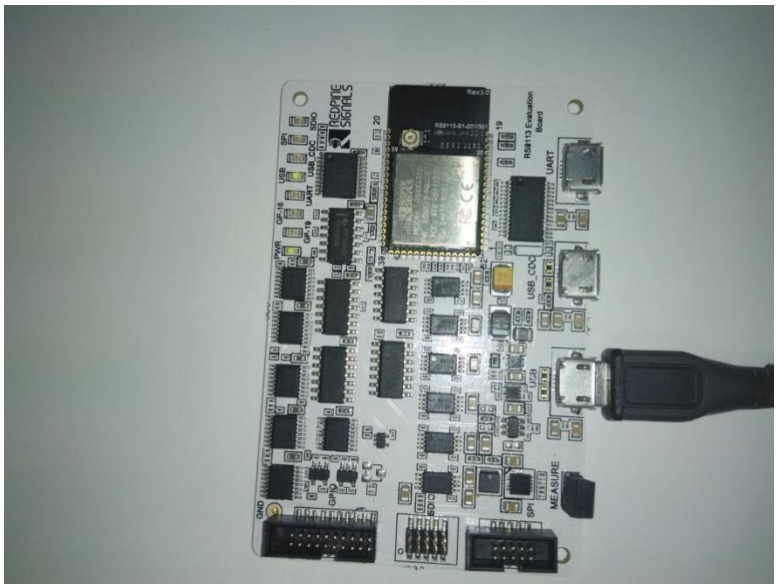
NOTE: The standard software package offers Coexistence modes (modes 2, 3, and 4 above) only when Wi-Fi is configured for Client mode operation. For other combinations, custom packages can be offered. Contact Redpine for more details.

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:

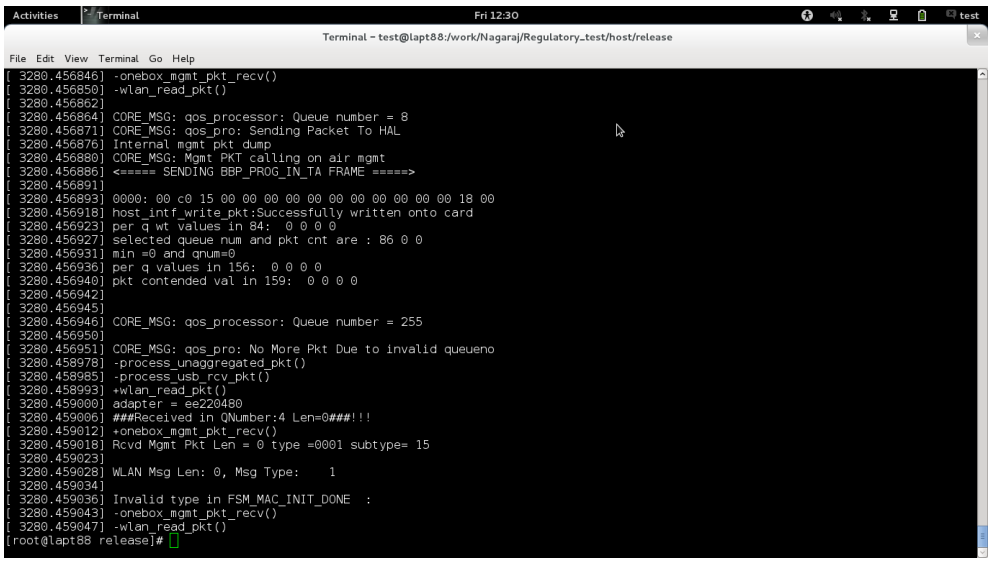
DRIVER_MODE = 2

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.



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/Disable[1]
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 and18.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 number[2]. The following table maps the channel numbers to the center frequencies for 20MHz and 40MHz bandwidth modes in 2.4GHz and 5GHz band.

Note: Module supports 40 MHz BW but for UNII 2A and UNII 2C 40 MHz is restricted.
Only DFS Slave mode without RADAR detection is supported. In Table 1 below the UNII 2A and UNII 2C channels are marked in bold.
On-air testing in DFS Master mode for these channels must not be done till the module is certified for DFS Master operation.

[1] This is not supported in the current release.

[2] Module is certified for DFS slave without RADAR detection. On-air testing in DFS Master mode for DFS channels must not be done till the module is certified for DFS Master operation. Cabled tests can be run in these channels. Module supports 40 MHz BW but for UNII 2A and UNII 2C 40 MHz is restricted.
Only DFS Slave mode without RADAR detection is supported.

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
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	20	12	2467
2.4	20	13	2472
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
5	20	36	5180
5	20	40	5200
5	20	44	5220
5	20	48	5240
5	**20**	**52**	**5260**

Band (GHz)	Bandwidth (MHz)	Channel Number	Center Frequency (MHz)
5	**20**	**56**	**5280**
5	**20**	**60**	**5300**
5	**20**	**64**	**5320**
5	**20**	**100**	**5500**
5	**20**	**104**	**5520**
5	**20**	**108**	**5540**
5	**20**	**112**	**5560**
5	**20**	**116**	**5580**
5	**20**	**120**	**5600**
5	**20**	**124**	**5620**
5	**20**	**128**	**5640**
5	**20**	**132**	**5660**
5	**20**	**136**	**5680**
5	**20**	**140**	**5700**
5	20	149	5745
5	20	153	5765
5	20	157	5785
5	20	161	5805
5	20	165	5825
5	40	38	5190
5	40	46	5230
5	40	151	5755
5	40	159	5795

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

[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.

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

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: **User must do this test in Cabled Mode only.**

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)

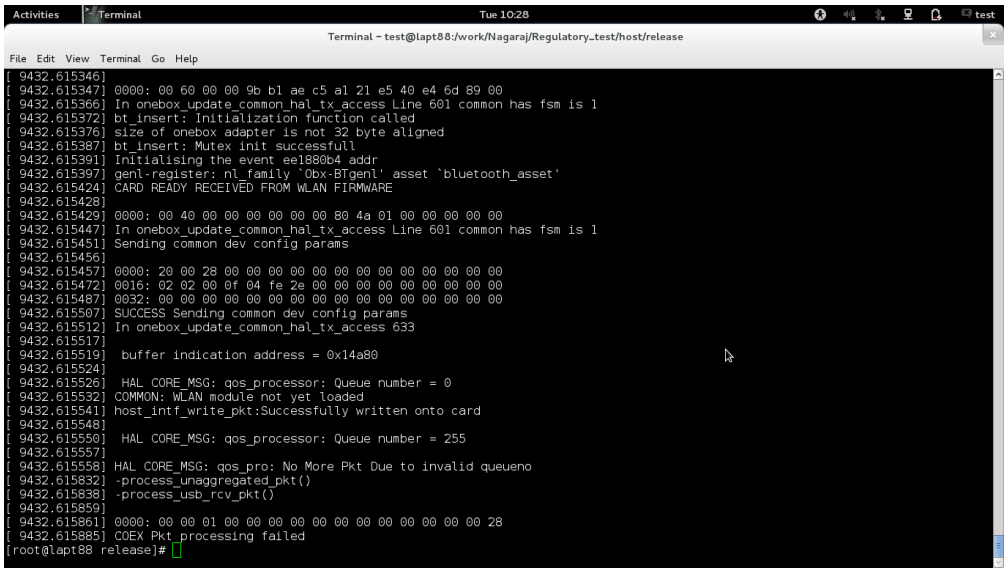
COEX_MODE = 4(for BT LE)

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

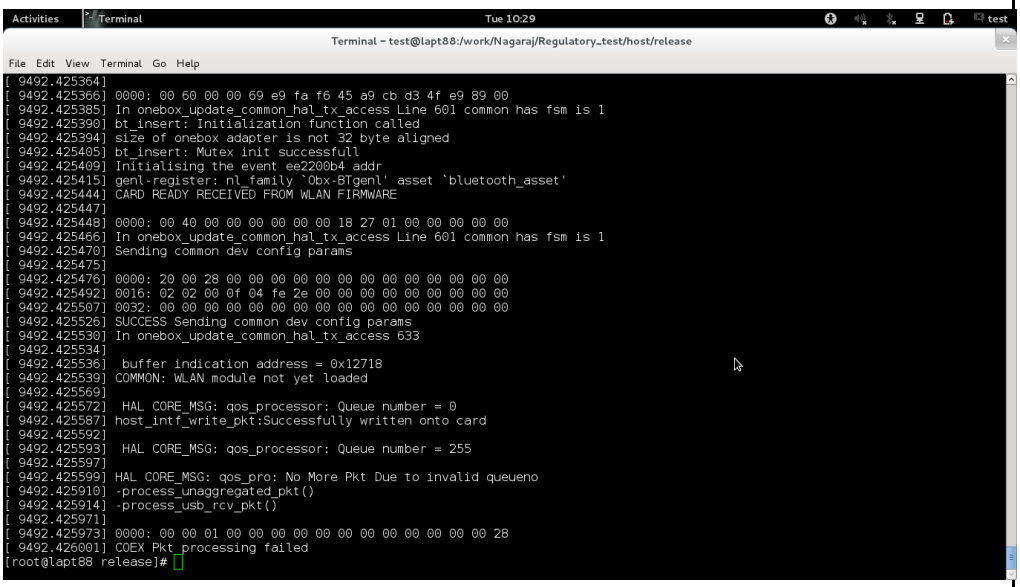
sh bt_insert.sh

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:



BT LE:



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><bdr_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><bdr_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.

rssi: 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:

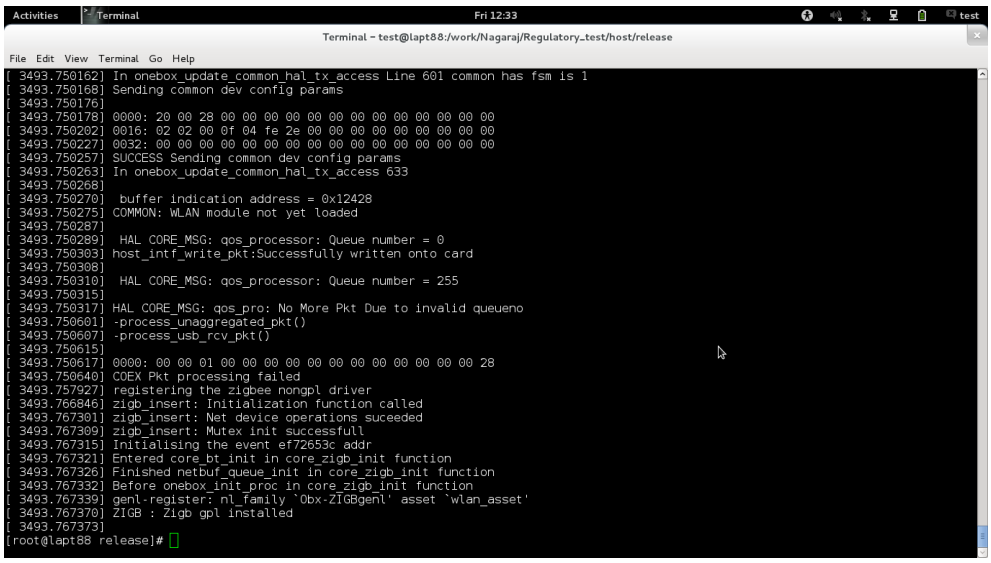
DRIVER_MODE = 2

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.



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.

rssi: 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 RSSstandard(s).Operation is subject to the Following two conditions:(1) This device may notcause 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 susceptibled'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-RS9113DB"

OR

"Contains FCC ID: XF6-RS9113DB"

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 our fournir une rotection 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 reception radio ou télévisée (ce qui peut être vérifi é en éteignant l'appareil puis en le remettant sous tension),

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

Réorienter ou déplacer l'antenne réceptrice.

ugmenter 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 technician radio/television expérimenté.

REMARQUE: Toute modifi cation non autorisée expressément par le fabricant responsable de la onformité 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-RS9113DB"

OR

"Contains IC ID: 8407A-RS9113DB"

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 RS9113DB (FCC ID: XF6-RS9113DB, IC ID: 8407A-RS9113DB) 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)	Antenna Gain at 5GHz (dBi)	Type of Antenna
Redpine Signals	-	0.99	4.42	Trace
Molex	PS-47950-001	3	4.6	External
Fractus	FR05-S1-NO-1-004	1.8	4.9	Chip

Table 8: List of Antennas Used for RS9113DB FCC/IC Certification

The RS9113DB 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 "./transmit" command in the Wi-Fi Performance Test mode.
Default Value	0
Input Parameters	Base Interface (string like rpine0) Integer value mapped as follows: 0 – Redpine Antenna 1 – Molex Antenna 2 – Fractus Antenna
Output Parameter	None
Reset Required	No
Usage	`# ./onebox_util <base_interface> ant_type <antenna_type>`
Example	The command below sets the Antenna type to Fractus Antenna for Wi-Fi: `# ./onebox_util rpine0 ant_type 2`

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 "./transmit" command in the Bluetooth Performance Test mode.
Default Value	0
Input Parameters	Base Interface (string like hci0) Integer value mapped as follows: 0 – Redpine Signals Antenna 1 – Molex Antenna 2 – Fractus 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
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 ZigBeetransmit 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 802.11a/b/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

Technology	Low Channel Frequency (MHz)	Mid Channel Frequency (MHz)	High Channel Frequency (MHz)
802.11g	2412	2437	2462
802.11n 20MHz Bandwidth	2412	2437	2462
802.11n 40MHz Bandwidth	2422	2442	2457
802.11a (5GHz U-NII- 1)	5180	5200	5240
802.11n 20MHz Bandwidth(5GHz U-NII- 1)	5180	5200	5240
802.11n 40MHz Bandwidth(5GHz U-NII- 1)	5190	--	5230
802.11a (5GHz U-NII- 2A)	5260	--	5320
802.11n 20MHz Bandwidth(5GHz U-NII- 2A)	5260	--	5320
802.11a (5GHz U-NII- 2C)	5500	--	5700
802.11n 20MHz Bandwidth(5GHz U-NII- 2C)	5500	--	5700
802.11a (5GHz U-NII- 3)	5745	5785	5825
802.11n 20MHz Bandwidth (U-NII- 3)	5745	5785	5825
802.11n 40MHz Bandwidth(5GHz U-NII- 3)	5755	---	5795
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 Signals 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	18	0	20	0	18	0
	11	19	0	20	0	19	0
802.11 g	6	13	0	20	0	12	0
	24	13	0	20	0	12	0
	54	13	0	20	0	12	0
802.11 n_20MHz	MCS0	11	0	20	0	10	0
	MCS4	11	0	20	0	10	0
	MCS7	11	0	20	0	10	0
802.11 n_40MHz	MCS0	6	2	8	2	5	1
	MCS4	6	2	8	2	5	1
	MCS7	6	2	8	2	5	1
802.11a (5GHz U-NII-1)	6	20	0	20	0	20	0
	24	20	0	20	0	20	0
	54	20	0	20	0	20	0
802.11n 20MHz (5GHz U-NII-1)	MCS0	20	0	20	0	20	0
	MCS4	20	0	20	0	20	0
	MCS7	20	0	20	0	20	0

802.11n 40MHz (5GHz U-NII-1)	MCS0	6	0	-	-	7	0
	MCS4	6	0	-	-	7	0
	MCS7	6	0	-	-	7	0
802.11a (5GHz U-NII-3)	6	5	0	10	0	9	0
	24	5	0	10	0	9	0
	54	5	0	10	0	9	0
802.11n 20MHz (5GHz U-NII-2A)	6	13	0	13	0	10	0
	24	13	0	13	0	10	0
	54	13	0	13	0	10	0
802.11n 20MHz (5GHz U-NII-2A)	MCS0	12	0	12	0	10	0
	MCS4	12	0	12	0	10	0
	MCS7	12	0	12	0	10	0
802.11n 20MHz (5GHz U-NII-2C)	6	7	0	12	0	12	0
	24	7	0	12	0	12	0
	54	7	0	12	0	12	0
802.11n 20MHz (5GHz U-NII-2C)	MCS0	5	0	11	0	11	0
	MCS4	5	0	11	0	11	0
	MCS7	5	0	11	0	11	0
802.11n 20MHz (5GHz U-NII-3)	MCS4	4	0	9	0	7	0
	MCS7	4	0	9	0	7	0
	MCS7	4	0	9	0	7	0
802.11n 40MHz (5GHz U-NII-3)	MCS0	2	0	-	-	6	0
	MCS4	2	0	-	-	6	0
	MCS7	2	0	-	-	6	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	16	0	16	0	16	0

Table 16: Maximum Transmit Power and Attenuation Values for Redpine signals 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	16	4	16	4	16	4
	11	16	4	16	4	16	4
802.11 g	6	11	2	18	2	10	2
	24	11	2	18	2	10	2
	54	11	2	18	2	10	2
802.11 n_20MHz	MCS0	10	2	18	3	9	2
	MCS4	10	2	18	3	9	2
	MCS7	10	2	18	3	9	2
802.11 n_40MHz	MCS0	6	2	8	3	5	2
	MCS4	6	2	8	3	5	2
	MCS7	6	2	8	3	5	2
802.11a (5GHz U-NII-1)	6	11	0	14	0	14	0
	24	11	0	14	0	14	0
	54	11	0	14	0	14	0
802.11n 20MHz (5GHz U-NII-1)	MCS0	10	0	14	0	14	0
	MCS4	10	0	14	0	14	0
	MCS7	10	0	14	0	14	0
802.11n 40MHz (5GHz U-NII-1)	MCS0	6	0	-	-	7	0
	MCS4	6	0	-	-	7	0
	MCS7	6	0	-	-	7	0

802.11n 20MHz (5GHz U-NII-2A)	6	13	0	13	0	10	0
	24	13	0	13	0	10	0
	54	13	0	13	0	10	0
802.11n 20MHz (5GHz U-NII-2A)	MCS0	12	0	12	0	10	0
	MCS4	12	0	12	0	10	0
	MCS7	12	0	12	0	10	0
802.11n 20MHz (5GHz U-NII-2C)	6	7	0	12	0	12	0
	24	7	0	12	0	12	0
	54	7	0	12	0	12	0
802.11n 20MHz (5GHz U-NII-2C)	MCS0	5	0	11	0	11	0
	MCS4	5	0	11	0	11	0
	MCS7	5	0	11	0	11	0
802.11a (5GHz U-NII-3)	6	5	0	10	0	9	0
	24	5	0	10	0	9	0
	54	5	0	10	0	9	0
802.11n 20MHz (5GHz U-NII-3)	MCS0	4	0	9	0	8	0
	MCS4	4	0	9	0	8	0
	MCS7	4	0	9	0	8	0
802.11n 40MHz (5GHz U-NII-3)	MCS0	2	0	-	-	7	0
	MCS4	2	0	-	-	7	0
	MCS7	2	0	-	-	7	0
Bluetooth	1	15	0	15	0	15	0
	2	16	0	16	0	16	8
	3	16	0	16	0	16	7
	LE	15	0	15	0	15	0
ZigBee	250kbps	15	0	15	0	15	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	16	3	16	3	16	3
	11	16	3	16	3	16	3
802.11 g	6	11	3	18	3	10	3
	24	11	3	18	3	10	3
	54	11	3	18	3	10	3
802.11 n_20MHz	MCS0	10	3	18	4	9	3
	MCS4	10	3	18	4	9	3
	MCS7	10	3	18	4	9	3
802.11 n_40MHz	MCS0	6	1	8	2	5	1
	MCS4	6	1	8	2	5	1
	MCS7	6	1	8	2	5	1
802.11a (5GHz U-NII-1)	6	12	0	14	0	14	0
	24	12	0	14	0	14	0
	54	12	0	14	0	14	0
802.11n 20MHz (5GHz U-NII-1)	MCS0	12	0	14	0	14	0
	MCS4	12	0	14	0	14	0
	MCS7	12	0	14	0	14	0
802.11n 40MHz (5GHz U-NII-1)	MCS0	7	0	-	-	7	0
	MCS4	7	0	-	-	7	0
	MCS7	7	0	-	-	7	0

802.11n 20MHz (5GHz U-NII-2A)	6	13	0	13	0	10	0
	24	13	0	13	0	10	0
	54	13	0	13	0	10	0
802.11n 20MHz (5GHz U-NII-2A)	MCS0	12	0	12	0	10	0
	MCS4	12	0	12	0	10	0
	MCS7	12	0	12	0	10	0
802.11n 20MHz (5GHz U-NII-2C)	6	7	0	12	0	12	0
	24	7	0	12	0	12	0
	54	7	0	12	0	12	0
802.11n 20MHz (5GHz U-NII-2C)	MCS0	5	0	11	0	11	0
	MCS4	5	0	11	0	11	0
	MCS7	5	0	11	0	11	0
802.11a (5GHz U-NII-3)	6	5	0	10	0	10	0
	24	5	0	10	0	10	0
	54	5	0	10	0	10	0
802.11n 20MHz (5GHz U-NII-3)	MCS0	4	0	9	0	9	0
	MCS4	4	0	9	0	9	0
	MCS7	4	0	9	0	9	0
802.11n 40MHz (5GHz U-NII-3)	MCS0	3	0	-	-	8	0
	MCS4	3	0	-	-	8	0
	MCS7	3	0	-	-	8	0
Bluetooth	1	15	0	15	0	15	0
	2	16	0	16	0	16	8
	3	16	0	16	0	16	8
	LE	15	0	15	0	15	0
ZigBee	0.25	15	0	15	0	15	0

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

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