Certification Guide

Sterling-LWB/LWB5

Version 1.1

REVISION HISTORY

Version	Date	Notes	Contributors	Approver
1.0	3/20/2018	Initial release		Greg Gates
1.1	19 June 2018	Minor fixes to test commands and labeling	Mike Richter	Greg Gates

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CONTENTS

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1 Preface/Requirements

This document provides guidance in using the Cypress/Broadcom WL_Tool Linux-based commands and BlueZ HCI Tool commands for Linux-based host platforms and SOM manufacturers. Prior knowledge of the Linux operating system running on the host platform or SOM system is required. In-depth knowledge of configuring Wi-Fi under the Linux O/S and Wi-Fi in general is also required.

Prior experience with the Sterling-LWB Linux Integration Guide (330-0201) is also a requirement before using this document. Please see the Laird Sterling-LWB product webpage for the integration guide.

2 Background/Required Files

Once the Sterling-LWB module is successfully integrated with the SOM or host platform, the following files are used to put the radio into test modes.

The following three files are required to gain operation of the WL_Tool command:

- **wl** – This Cypress command has two variations available for download at Laird. Both files are binary executables; use them for appropriate permissions to ensure execution in Linux operating systems.
- **wlarm-hf** – Hard-float version
- **wlarm-sf** – Soft-float version

Note: These executable binaries have been built using the following libraries. These libraries should be on the host platform on which the binary is executed. If not, the binary may function but errors could occur. In many cases the errors can be ignored. If the errors prevent functionality, please contact Laird support for further guidance.

- /lib/ld-linux.so.3
- /lib/ld-linux-armhf.so.3
- /lib/arm-linux-gnueabihf/libnl-genl-3.so.200
- /lib/arm-linux-gnueabihf/libnl-3.so.200

Symbolic linking can be used to allow the binary to function correctly.
For example:

```
ln -sf /lib/ld-linux-armhf.so.3 /lib/ld-linux.so.3
```

2.1 Firmware

Laird makes production firmware with specific cal files available for download on the product webpage for each module. Please review the Laird or LSR websites for the appropriate firmware/cal file downloads. It is best to use the latest available revision that will be available on each product webpage.

There are two types of firmware available, manufacturing and production. For testing, only use the manufacturing firmware. For normal/product use, only use production firmware.

Please contact Laird support for the latest manufacturing firmware.

2.1.1 Sterling-LWB Firmware and Cal Files

The following are the Sterling-LWB firmware and cal files:

- **brcmfmac43430-sdio-mfg.bin** – This is the required manufacturing firmware, do not use the production firmware.
- **brcmfmac43430-sdio-etsi.txt** – Use this cal file worldwide outside of US/Canada
- **brcmfmac43430-sdio-fcc.txt** – Use this cal file in the US/Canada

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2.1.2 Sterling-LWB5 Firmware and Cal Files

- **brcmfmac4339-sdio-mfg.bin** – This is the required manufacturing firmware, do not use the production firmware.
- **brcmfmac4339-sdio-fcc.txt** – Use this cal file for the Unites States
- **brcmfmac4339-sdio-ic.txt** – Use this cal file for Canada
- **brcmfmac4339-sdio-jp.txt** – Use this cal file for Japan
- **brcmfmac4339-sdio-etsi.txt** – Use this cal file for the rest of the world

The LWB/LWB5 drivers look for specific file naming conventions of the firmware and cal file files. Figure 1 (Sterling-LWB) and Figure 2 (Sterling-LWB5) define these. Symbolic linking was used to satisfy the driver requirements. Use these as examples and note the filenames in blue.

```
drwxr-xr-x    2 root     root           744 Jan  1 00:03 .
drwxr-xr-x    4 root     root           760 Sep 20  2017 ..
-rw-r--r--    1 root     root         34496 Sep 20  2017 4343w.hcd
-rw-r--r--    1 root     root           718 Sep 20  2017 brcmfmac43430-sdio-etsi.txt
-rw-r--r--    1 root     root           718 Sep 20  2017 brcmfmac43430-sdio-fcc.txt
-rw-r--r--    1 root     root        363805 Sep 20  2017 brcmfmac43430-sdio-mfg.bin
-rw-r--r--    1 root     root        355514 Sep 20  2017 brcmfmac43430-sdio-prod.bin
lrwxrwxrwx    1 root     root            26 Jan  1 00:02 brcmfmac43430-sdio.bin -> brcmfmac43430-sdio-mfg.bin
lrwxrwxrwx    1 root     root            26 Jan  1 00:03 brcmfmac43430-sdio.txt -> brcmfmac43430-sdio-fcc.txt
#
```

Figure 1: Sterling-LWB

```
drwxr-xr-x    2 root     root           920 Sep 20  2017 .
drwxr-xr-x    4 root     root           760 Sep 20  2017 ..
-rw-r--r--    1 root     root         66896 Sep 20  2017 4339.hcd
-rw-r--r--    1 root     root          2360 Sep 20  2017 brcmfmac4339-sdio-etsi.txt
-rw-r--r--    1 root     root          2360 Sep 20  2017 brcmfmac4339-sdio-fcc.txt
-rw-r--r--    1 root     root          2360 Sep 20  2017 brcmfmac4339-sdio-ic.txt
-rw-r--r--    1 root     root          2360 Sep 20  2017 brcmfmac4339-sdio-jp.txt
-rw-r--r--    1 root     root        552057 Sep 20  2017 brcmfmac4339-sdio-mfg.bin
-rw-r--r--    1 root     root        565193 Sep 20  2017 brcmfmac4339-sdio-prod.bin
lrwxrwxrwx    1 root     root            26 Sep 20  2017 brcmfmac4339-sdio.bin -> brcmfmac4339-sdio-prod.bin
lrwxrwxrwx    1 root     root            25 Sep 20  2017 brcmfmac4339-sdio.txt -> brcmfmac4339-sdio-fcc.txt
#
```

Figure 2: Sterling-LWB5

Note: Manufacturing firmware should only reside in the Linux host filesystem during certification testing.

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3 In-country Testing Commands

Use the appropriate firmware and cal file. Testing can now be performed with the example commands provided in the following sections. It is important to note that each cal file was set up with the respective country codes. This information is useful in noting that each country code identifies specific radio power levels that have passed certification in each country for the LWB/LWB5. Changes in recommended module design or antenna selection may warrant the need for re-testing. In each case, selecting the right cal file can lower the effort to re-certify.

Sterling-LWB	**Sterling-LWB5**
US/911	US/911
EU/116	EU/116
JP/101	CA/938
	JP/101

Note: Other countries that require adjustments to the power tables of the LWB/LWB5 radios require custom cal file creation. If this is a requirement for your product, please consult with Laird Sales/Support to identify the requirements and additional steps to achieve the certification.

3.1 WL Command Overview

Below are the most typically-used WL commands in testing and the function of each variables. Use the -help option to learn more about the available command options and variables.

wl ver	Get wl and driver version information
wl mpc	Set minimum power consumption mode
wl down	Reset and mark adapter down (disabled)
wl up	Reinitialize and mark adapter up (operational)
wl txpwr1	Set TX power in various units. Choose one of (default:dbm)

d	dBm units
q	quarter dBm units
m	milliwatt units

Can be combined with:

o	Turn on override to disable regulatory and other limitations

Use **wl txpwr1** -1 to restore defaults

Note: Power setting values without command options in watts or dB do not represent decreases or increases in decibels; they are factors and must be used to increase measured results. Use the next four tables for power setting values.

Table 1: Sterling-LWB FCC WLAN power settings

	802.11b		802.11g		802.11n	
Channel	**1 Mbps**	**11 Mbps**	**6 Mbps**	**54 Mbps**	**MCS0**	**MCS7**
1	20	20	16	16	14	14
2	20	20	16	16	14	14
3	20	20	16	16	14	14

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	802.11b		802.11g		802.11n	
Channel	**1 Mbps**	**11 Mbps**	**6 Mbps**	**54 Mbps**	**MCS0**	**MCS7**
4	20	20	16	16	14	14
5	20	20	16	16	14	14
6	20	20	16	16	14	14
7	20	20	16	16	14	14
8	20	20	16	16	14	14
9	20	20	16	16	14	14
10	19	19	15	15	13	13
11	18	18	14	14	12	12
12	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A

Table 2: Sterling-LWB ETSI WLAN power settings

	802.11b		802.11g		802.11n	
Channel	**1 Mbps**	**11 Mbps**	**6 Mbps**	**54 Mbps**	**MCS0**	**MCS7**
1	18	18	16	16	14	14
2	18	18	16	16	14	14
3	18	18	16	16	14	14
4	18	18	16	16	14	14
5	18	18	16	16	14	14
6	18	18	16	16	14	14
7	18	18	16	16	14	14
8	18	18	16	16	14	14
9	18	18	16	16	14	14
10	18	18	16	16	14	14
11	18	18	16	16	14	14
12	18	18	16	16	14	14
13	18	18	16	16	14	14
14	N/A	N/A	N/A	N/A	N/A	N/A

Table 3: Sterling-LWB5 FCC power table

	802.11b	802.11g	802.11a/c/n		802.11a/c/n		802.11a/c
Channel	**DSSS**	**DFDM**	**20 MHz**	**Channel**	**40 MHz**	**Channel**	**80 MHz**
1	16	14	12	1	Disabled	1	Disabled
2	17	14	12	2	Disabled	2	Disabled
3	17	14	12	3	9	3	Disabled
4	17	14	12	4	9	4	Disabled
5	17	14	12	5	9	5	Disabled
6	17	14	12	6	9	6	Disabled
7	17	14	12	7	9	7	Disabled
8	17	14	12	8	9	8	Disabled
9	17	14	12	9	9	9	Disabled
10	16	13	12	10	9	10	Disabled
11	15	12	11	11	9	11	Disabled
12	Disabled	Disabled	Disabled	12	Disabled	12	Disabled
13	Disabled	Disabled	Disabled	13	Disabled	13	Disabled
14	Disabled	Disabled	Disabled	14	Disabled	14	Disabled
36-48	Disabled	16	14	38-46	10	42	10
52-60	Disabled	16	14	54	10	58	10

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	802.11b	802.11g	802.11a/c/n		802.11a/c/n		802.11a/c
Channel	**DSSS**	**DFDM**	**20 MHz**	**Channel**	**40 MHz**	**Channel**	**80 MHz**
64	Disabled	15	14	62	10	106	10
100	Disabled	15	14	102	10	122	10
104-116	Disabled	16	14	110	10	138	10
120-128	Disabled	16	14	118-126	10	155	10
132-136	Disabled	16	14	134-142	10	–	–
140	Disabled	16	14	151-159	10	–	–
144	Disabled	16	14	–	–	–	–
149-165	Disabled	16	14	–	–	–	–

Table 4: Sterling-LWB5 ETSI power table

	802.11b	802.11g	802.11a/c/n		802.11a/c/n		802.11a/c
Channel	**DSSS**	**DFDM**	**20 MHz**	**Channel**	**40 MHz**	**Channel**	**80 MHz**
1	14	14	12	1	Disabled	1	Disabled
2	14	14	12	2	Disabled	2	Disabled
3	14	14	12	3	9	3	Disabled
4	14	14	12	4	9	4	Disabled
5	14	14	12	5	9	5	Disabled
6	14	14	12	6	9	6	Disabled
7	14	14	12	7	9	7	Disabled
8	14	14	12	8	9	8	Disabled
9	14	14	12	9	9	9	Disabled
10	14	14	12	10	9	10	Disabled
11	14	14	12	11	9	11	Disabled
12	14	14	12	12	Disabled	12	Disabled
13	14	14	12	13	Disabled	13	Disabled
14	Disabled	Disabled	Disabled	14	Disabled	14	Disabled
36-48	Disabled	16	14	38-46	10	42	10
52-64	Disabled	16	14	54-62	10	58	10
100-140	Disabled	16	14	102-134	10	106	10
144	Disabled	Disabled	Disabled	144	Disabled	144	Disabled
149-165	Disabled	Disabled	Disabled	149-165	Disabled	149-165	Disabled

wl txpwr1 Set TX power in various units. Choose one of (default:dbm)

Auto	Auto-switch between available bands (default)
a	Force use of 802.11a band
b	Force use of 802.11b band

wl chanspec Get/set the channel using a chanspec

20 MHz	[2 g|5 g] <channel>[/20]
40 MHz	[2 g|5 g] <channel>/40 [u,l]
80 MHz	[5 g] <channel>/80

Optional band 2 g or 5 g, default to 2 g if channel ≤ 14
ex> wl chanspec 161/80

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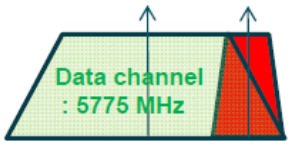

Control channel
: 5805 MHz

Selective Channels

Band	2G			5G			
BW	HT20	HT40		HT20	HT40		VHT80
Channel	1 (0x1001)	5u (0x1903)	1l (0x1803)	34 (0xd022)	40u (0xd926)	36l (0xd826)	36/80 (0xe02a)
	2 (0x1002)	6u (0x1904)	2l (0x1804)	36 (0xd024)	48u (0xd92e)	44l (0xd82e)	52/80 (0xe03a)
	3 (0x1003)	7u (0x1905)	3l (0x1805)	38 (0xd026)	56u (0xd936)	52l (0xd836)	100/80 (0xe06a)
	4 (0x1004)	8u (0x1906)	4l (0x1806)	40 (0xd028)	64u (0xd93e)	60l (0xd83e)	116/80 (0xe07a)
	5 (0x1005)	9u (0x1907)	5l (0x1807)	42 (0xd02a)	104u (0xd966)	100l (0xd866)	132/80 (0xe08a)
	6 (0x1006)	10u (0x1908)	6l (0x1808)	44 (0xd02c)	112u (0xd96e)	108l (0xd86e)	149/80 (0xe09b)
	7 (0x1007)	11u (0x1909)	7l (0x1809)	46 (0xd02e)	120u (0xd976)	116l (0xd876)	40/80 (0xe12a)
	8 (0x1008)	12u (0x190a)	8l (0x180a)	48 (0xd030)	128u (0xd97e)	124l (0xd87e)	56/80 (0xe13a)
	9 (0x1009)	13u (0x190b)	9l (0x180b)	52 (0xd034)	136u (0xd986)	132l (0xd886)	104/80 (0xe16a)
	10 (0x100a)			56 (0xd038)	144u (0xd98e)	140l (0xd88e)	120/80 (0xe17a)
	11 (0x100b)			60 (0xd03c)	153u (0xd997)	149l (0xd897)	136/80 (0xe18a)
	12 (0x100c)			64 (0xd040)	161u (0xd99f)	157l (0xd89f)	153/80 (0xe19b)
	13 (0x100d)			100 (0xd064)			44/80 (0xe22a)
	14 (0x100e)			104 (0xd068)			60/80 (0xe23a)
				108 (0xd06c)			108/80 (0xe26a)
				112 (0xd070)			124/80 (0xe27a)
				116 (0xd074)			140/80 (0xe28a)
				120 (0xd078)			157/80 (0xe29b)
				124 (0xd07c)			48/80 (0xe32a)
				128 (0xd080)			64/80 (0xe33a)
				132 (0xd084)			112/80 (0xe36a)
				136 (0xd088)			128/80 (0xe37a)
				140 (0xd08c)			144/80 (0xe38a)
				144 (0xd090)			161/80 (0xe39b)
				149 (0xd095)			
				153 (0xd099)			
				157 (0xd09d)			
				161 (0xd0a1)			
				165 (0xd0a5)			

Figure 3: Selective channels

wl chanspecs

This returns a list of all available chanspecs for the current device. The list can be filtered down to just chanspecs for a specific band and bandwidth. Also, the list can be generated for a different country setting

wl 2g_rate

Set/Get the rate override for unicast data frames in the 2GHz band. If no arguments given, the command will display the current rate override for the 2GHz band, or “auto” if no override. The output format depends on the rate.

r R, --rate=R	Legacy rate (CCK, DSSS, OFDM)
h M, --ht=M	HT MCS index [0-23]
v M[[xS], --vht=M[xS]	VHT MCS index M [0-9], and optionally Nss S[1-8]
s S, --ss=S	VHT Nss [1-8], number of spatial streams, default 1
stbc	Use STBC expansion, otherwise no STBC
l, --ldpc	Use LDPC encoding, otherwise no LDPC
g, --sgi	SGI, Short Guard Interval, otherwise standard GI
b, --bandwidth	Transmit bandwidth MHz; 20, 40, 80

wl 5g_rate

Other than band, everything is compatible with 2g_rate

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wl scansuppress

Suppress all scans for testing

0	Allow scans
1	Suppress scans

wl country

Select Country code for use with 802.11d
Use “wl country list” for the list of supported countries

wl phy_forcecal

Force the PHY calibration to run immediately.

wl phy_watchdog

PHY watchdog can hit periodically to run some calibration tests. This is known to create trouble when we intend to run pkteng for several minutes. Hence it is recommended to disable watchdog before running test. (wl phy_watchdog 0)

wl pkteng_start

PKT Engine is a feature in driver+ucode.

TX Start

Usage	wl pkteng_start [addr] [tx/txwithack][(async)|sync][ipg][len][nframes][src]
Addr	tx txwithack – The destination address
Tx	Transmit packets
Txwithack	Transmit packets and wait for ACK
Sync	Synchronous mode
Ipg	Inter packet gap – Used only for Tx, ignored if RIFS is enabled
Len	Specifies the length of packet to be sent from DUT, used only for Tx
Nframes	Specifies the number of packets to be transmitted from DUT; zero indicates continuous transmission, used only for Tx

Rx Start

Usage	wl pkteng_start [addr][rx/rxwithack][(async)|sync][rxframes][rxtimeout]
Addr	Rx – DUT accepts frames with this destination address Rxwithack – DUT accepts frames with this destination address and sends ACK to this address
Rx	Receive packets and don’t transmit ACK
Rxwithack	Receive packets and transmit ACK
Rxframes	Number of receive frames (sync mode only)
Rxwithout	Maximum timeout in msec (sync mode only)

Usage Examples

- Transmit 1000 data frames of 200 bytes with 30 micro-seconds IFS
  wl pkteng_start 10:20:30:40:50:60 tx 30 200 1000
- Receive frames without ACK
  wl pkteng_start 10:20:30:40:50:60 rx

Limitation – Packet engine must be used when not associated

wl pkteng_stop

Used to stop the Tx/Rx mode
Usage – wl pkteng_stop *tx/rx*

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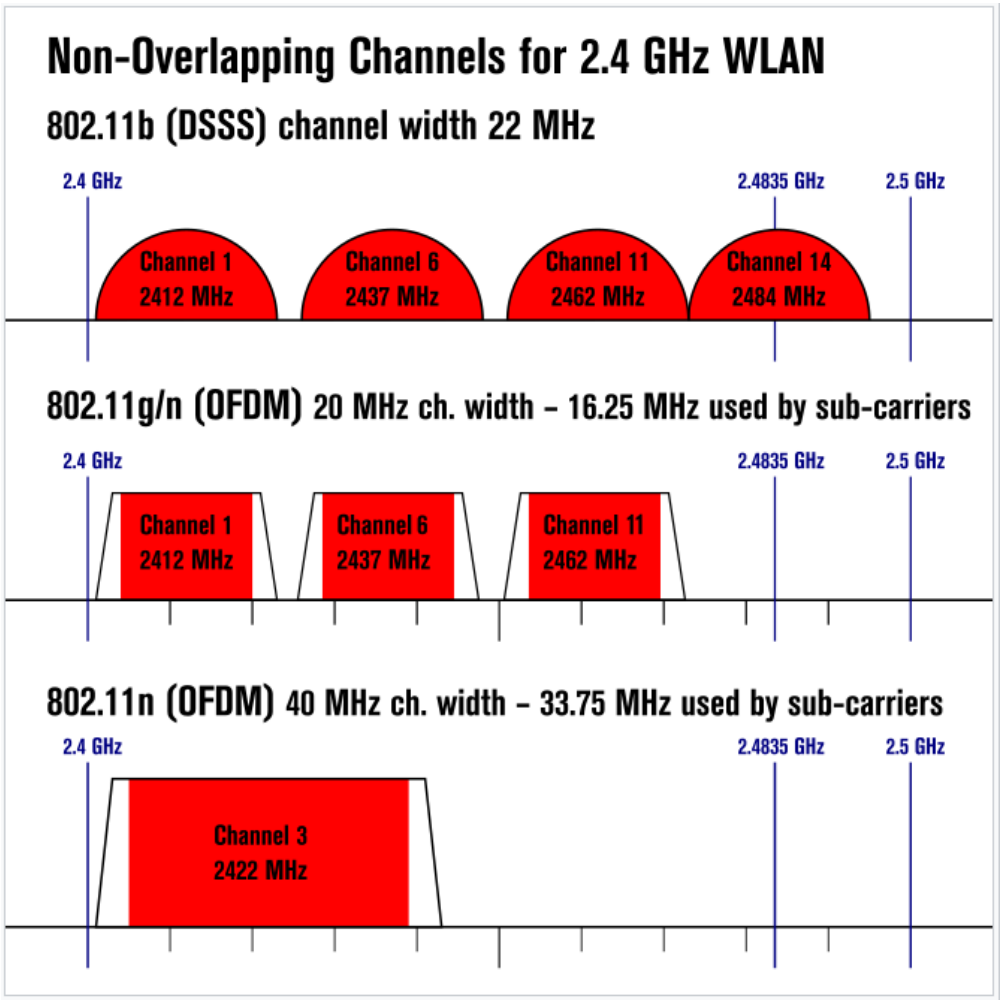
3.2 Graphical Overview of Available Channels and Frequencies to be Tested



Graphical representation of Wireless LAN channels in 2.4 GHz band. Note "channel 3" in the 40 MHz diagram above is often labelled with the 20MHz channel numbers "1+5" or "1" with "+ Upper" or "5" with "+ Lower" in router interfaces.

Figure 4: Non-overlapping channels for 2.4 GHz WLAN (Source: https://en.wikipedia.org/wiki/List_of_WLAN_channels)

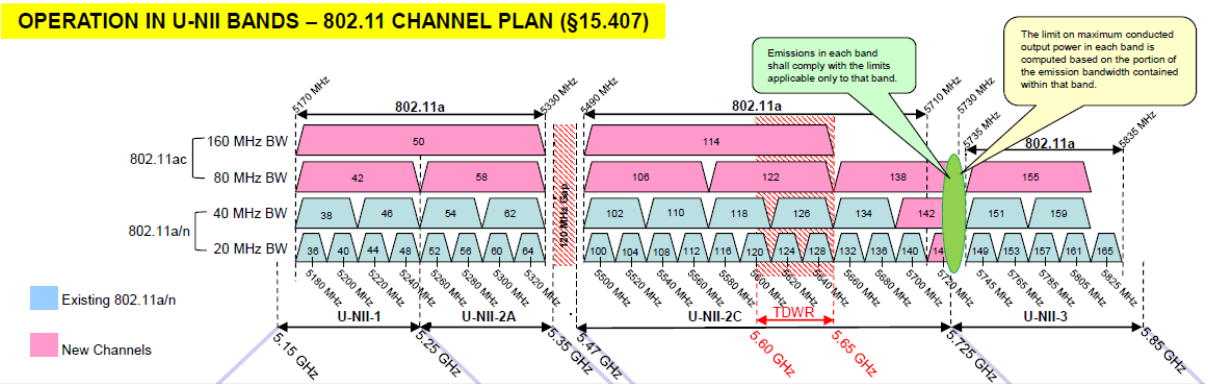


Figure 5: Operation in U-NII bands
(Full image is available from the FCC website: https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=27155)

3.3 Commands to Perform Testing

The following is an example of a set of commands to put the Sterling-LWB into test mode for band B (2.4 GHz) MCS7 20 MHz channel 2412 MHz:

```
./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0
./wl country US/911
./wl band b
./wl chanspec 1          Note: (1 = 0x1001, chanspec can be set from 1–14 here following HT20 table)
./wl 2g_rate -h 7 -b 20
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

Note: Use the 2G/HT20 data only in the Selective Channel table image above for the Sterling-LWB. The Sterling-LWB is not compatible with 2G/HT40 channels.

Note: While switching between tests, always issue the following command before changing variables.

```
./wl  pkteng_stop tx
```

The following are examples for TX testing legacy 802.11 b, g, and n:

802.11b

```
./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0
./wl country US/911
./wl band b
./wl chanspec 1  Note: (0x1001, can be any HT20 channel 1 – 14)
./wl 2g_rate -r 1 Note: (where r can be 1, 2, 5.5 or 11)
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

802.11g

```
./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0
./wl country US/911
./wl band b
./wl chanspec 1  Note: (0x1001)
```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./wl 2g_rate -r 6 **Note:** (where r can be 6, 9, 12, 18, 24, 36, 48, 54)
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

802.11n

./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0
./wl country US/911
./wl band b
./wl chanspec 1 Note: (0x1001)
./wl 2g_rate -h 0 -b 20 Note: (where h can be 0, 1, 2, 3, 4, 5, 6 or 7)
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

To select desired channels for the Sterling-LWB5, use any of the channels desired from the Selective Channel table (Figure 3).

The following is an example of a set of commands to put the LWB5 into test mode for band B(2.4 GHz) MCS7 40 MHz channel 2422 MHz:

./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0
./wl country US/911
./wl band b
./wl chanspec 3l
./wl 2g_rate -h 7 -b 40
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

The following is an example of a set of commands to put the LWB5 into test mode for band A (5 GHz) MCS7 40 MHz channel 5190 MHz:

./wl ver
./wl down
./wl mpc 0
./wl phy_watchdog 0

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```
./wl country US/911
./wl band a
./wl chanspec 36l
./wl 5g_rate -h 7 -b 40
./wl up
./wl phy_forcecal 1
./wl phy_activecal
./wl txpwr1 -1
./wl scansuppress 1
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

Note: When changing test frequencies between 2.4 GHz and 5 GHz, the *wl* band command must be manipulated as defined below. Failure to change this yields errors from the WL command. Below is a summary of how these must work together.

wl band b = 2.4GHz = wl 2g_rate
wl band a = 5 GHz = wl 5g_rate

While switching between tests, always issue the following command before changing variables.

```
./wl  pkteng_stop tx
```

The following are additional examples of WL command options to use for certain band A (5GHz) chanspecs. Review the 5g_rate -v that is required to test MCS8 and MCS9 on the LWB5:

MCS8 20 MHz

```
./wl pkteng_stop tx
./wl chanspec 36/20
./wl 5g_rate -v 8 -s 1 -b 20
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

MCS8 40 MHz (mcs9)

```
./wl pkteng_stop tx
./wl chanspec 36l
./wl 5g_rate -v 8 -s 1 -b 40
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

MCS8 80 MHz (mcs9)

```
./wl pkteng_stop tx
./wl chanspec 40/80
./wl 5g_rate -v 8 -s 1 -b 80
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

Additional 5 GHz 80 MHz Channels

```
./wl chanspec 40/80
Chanspec set to 0xe12a
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 56/80
Chanspec set to 0xe13a
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```


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```
./wl chanspec 104/80
Chanspec set to 0xe16a
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 120/80
Chanspec set to 0xe17a
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 136/80
Chanspec set to 0xe18a
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 153/80
Chanspec set to 0xe19b
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```

Additional Channels 5 GHz 40 MHz Bandwidth

```
./wl chanspec 44l
Chanspec set to 0xd82e
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 52l
Chanspec set to 0xd836
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 60l
Chanspec set to 0xd83e
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 100l
Chanspec set to 0xd866
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 108l
Chanspec set to 0xd86e
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 116l
Chanspec set to 0xd876
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 124l
Chanspec set to 0xd87e
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 132l
Chanspec set to 0xd886
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 140l
```

```
Chanspec set to 0xd88e
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 149l
Chanspec set to 0xd897
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0

./wl chanspec 157l
Chanspec set to 0xd89f
./wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0
```


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4 BLUETOOTH

Below are the necessary commands to perform Bluetooth testing. The HCITool is used here, so the host Linux platform must have the hcitool executable available and support for it from the stack. There are two sets of commands, one with hexadecimal op-codes and one without. Please use the one that is compatible with your host platform operating system.

Note: The Sterling-LWB and LWB5 require a firmware patch for Bluetooth. This patch file must be loaded for the radio to produce proper results.

4.1 Bluetooth Classic

BTC TX Packet channel 0 (2402 MHz) power table index 0 payload 339

hcitool cmd 0x3F 0x051 0xee 0xff 0xc0 0x88 0x00 0x00 0x01 0x00 0x04 0x01 0x0F 0x53 0x01 0x09 0x00 0x00
hcitool cmd 3F 051 ee ff c0 88 00 00 01 00 04 01 0F 53 01 09 00 00

BTC TX Packet channel 0 (2402 MHz) power table index 0 payload 339 (Hopping)

hcitool cmd 0x3F 0x051 0xee 0xff 0xc0 0x88 0x00 0x00 0x00 0x00 0x04 0x01 0x0F 0x53 0x01 0x09 0x00 0x00
hcitool cmd 3F 051 ee ff c0 88 00 00 00 00 04 01 0F 53 01 09 00 00

EDR3 TX Packet channel 0 (2402 MHz) power table index 0 payload 1021

hcitool cmd 0x3F 0x051 0xee 0xff 0xc0 0x88 0x00 0x00 0x01 0x00 0x04 0x00 0x0F 0xfd 0x03 0x09 0x00 0x00
hcitool cmd 3F 051 ee ff c0 88 00 00 01 00 04 00 0F FD 03 09 00 00

EDR3 TX Packet channel 0 (2402 MHz) power table index 0 payload 1021 (Hopping)

hcitool cmd 0x3F 0x051 0xee 0xff 0xc0 0x88 0x00 0x00 0x00 0x00 0x04 0x00 0x0F 0xfd 0x03 0x09 0x00 0x00
hcitool cmd 3F 051 ee ff c0 88 00 00 00 00 04 00 0F FD 03 09 00 00

BTC HCI Reset

hcitool cmd 0x03 0x003
hcitool cmd 03 003

BTC connectionless RX test for Bluetooth packets

hcitool cmd 3f 52 FC 0e ee ff c0 88 00 00 f4 01 00 04 01 0f 53 01

BTC & EDR RX Receive (Requires the radio to be in DUT – Device Under Test mode)

hcitool cmd 03 05 02 00 03 (Set Event Filter)
hcitool cmd 03 1a 03 (Write Scan Enable)
hcitool cmd 06 03 (Enable Device Under Test Mode)
Use Bluetooth test instrument to control module in DUT and measure BER performance
(Example: R&S CBT Bluetooth Tester)

4.2 Bluetooth Low Energy

BLE TX Packet 2402 MHz

hcitool cmd 0x08 0x01e 0x00 0x25 0x00
hcitool cmd 08 01e 00 25 00

BLE TX Packet 2440 MHz

hcitool cmd 0x08 0x01e 0x13 0x25 0x00
hcitool cmd 08 01e 13 25 00

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BLE TX Packet 2480 MHz

hcitool cmd 0x08 0x01e 0x27 0x25 0x00
hcitool cmd 08 01e 27 25 00

BLE TX End

hcitool cmd 0x08 0x01f
hcitool cmd 08 01f

BLE RX

hcitool cmd 0x08 0x01d 0x00 (Start Receiving)
hcitool cmd 08 01d 00
Start transmit packets (Lightpoint or other BLE packet generator)
Hcitool cmd 0x08 0x01f (Stop receiving)
01 1f 20 00 xx yy – (Output, determine the number of successful packets from yy xx)

4.3 Frequency Analyzer Suggestions

Using a frequency analyzer to review output signals and power levels is common practice in performing tests with BT and Wi-Fi radios. Figure 6 is a screen snapshot of a frequency analyzer while measuring a BLE signal. This is displayed to present a correct waveform being measured by the frequency analyzer.

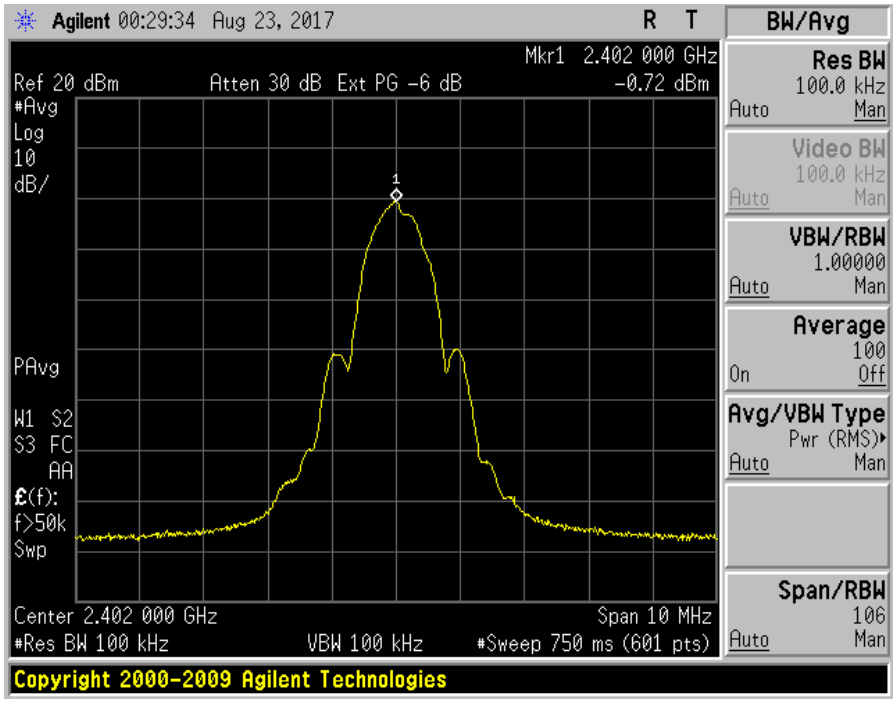

Figure 6: Frequency analyzer

We suggest that you adjust the MAX HOLD and SWEEP functions to achieve proper measured power output. Power output is averaged on these instruments but increasing sweep and locking onto a waveform with correct max hold settings provides proper power output.

Observed output power is also a function of resolution bandwidth. Higher resolution bandwidth loses graphical side-bands but increases power output representation.

Notice that this waveform has side-bands displayed because of a lower resolution bandwidth on the frequency analyzer.