User's Guide

WiLink8™ Calibrator Tool User's Guide

ABSTRACT

WiLink8™ Linux driver provides an easy tool ***Calibrator*** to configure the WiLink8 devices for different TX operations and measure the output performance as well as measure the RX performance. The calibrator tool also provides an easy way to select the desired channel and power level. This enables the RF verification both in the lab and at certification test houses to perform the regulatory conformance tests and measure spectrum mask on the final product that is running WiLink8 drivers on Linux platform. The Calibrator tool can also be used for production line testing. The document also provides additional features offered by the calibrator tool to set the device MAC address.

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Trademarks

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1 Acronyms

Acronym	Definition
PLT	Production Line Testing
MAC	Medium Access Layer
WLAN	Wireless LAN
LAN	Local Area Network
NVS	Non Volatile Storage
TX	Transmit
RX	Receive
MIMO	Multiple Input Multiple Output
LO	Local Oscillator
BD_ADDR	Bluetooth Address (MAC address programmed in factory for BT)
PER	Packet Error Rate
NIC	Network Interface Card
OUI	Organizationally Unique Identifier (24bit unique number for each vendor of WLAN)

2 Prerequisites

The following settings/configuration are a prerequisite for the calibrator tool to work:

1. In order for the calibrator tool to operate, kernel and modules must be compiled with CONFIG_NL80211_TESTMODE=y. The same can be verified as follows:

   ```
   root@am335x-evm:/usr/share/wl18xx#  zcat /proc/config.gz | grep NL80211_TESTMODE
   CONFIG_NL80211_TESTMODE=y
   ```

   If the configuration is not enabled in the driver, you need to recompile kernel and kernel modules and install them to the device. For more informaiton on how to enable this flag and integrate the changes, see the *WiLink8 R8.8 Linux Wi-Fi Driver Release Build User's Guide*.
2. The wlan0 interface must be shut down. If the interface is already running then run `ifconfig wlan0 down` to disable wlan0 interface. Verify the wlan0 interface to be disabled by running the ifconfig command again.

3 Calibrator Tool Commands

The following sections detail the commands available as part of the calibrator tool.

3.1 Enable PLT Mode

Before running any of the commands, the device and the driver needs to be configured in Production Line Test (PLT) mode. Use the following commands to configure the device to PLT mode:

```
cd /usr/share/wl18xx/
calibrator wlan0 plt power_mode on
```

3.2 Disable PLT Mode

To exit PLT mode use the below command:

```
cd /usr/share/wl18xx/
calibrator wlan0 plt power_mode off
```

3.3 Tune Channel

The purpose of the tune_channel command is to configure the WL18xx device to operate in a specific Wi-Fi band and channel. The tune_channel command can be called using the following format:

```
calibrator wlan0 wl18xx_plt tune_channel  <channel> <band> <bandwidth>
```

Where,

Table 3-1. tune_channel Command Parameters

Parameter	Description
<channel>	Channel within the Wi-Fi band. See the table below for details
<band>	Wi-Fi band. Ex: 0 means we are in **b/g/n** band equal to 1 means we are in **a** band
<bandwidth>	Bandwidth allocation. Use one of the following values

Table 3-2. tune_channel Command Options

Channel	Band	Bandwidth
1-14	0 (2.4GHz)	0/1 (20MHz) 2 (40MHz Upper Primary) 3 (40MHz Lower Primary)
8(J8), 12(J12), 16(J16), 36, 40, 44, 48, 34(J34), 38(J38), 42(J42), 46(J46), 52, 56, 60, 64, 100, 104, 108, 112, 116, 120, 124,128, 132, 136, 140, 149, 153, 157, 161, 165	1 (5GHz)	0/1 (20MHz) 2 (40MHz Upper Primary) 3 (40MHz Lower Primary)
16(J1), 12(J2), 8(J3), 4(J4)	2 (4.9GHz)	0/1 (20MHz) 2 (40MHz Upper Primary) 3 (40MHz Lower Primary)

Note

Channel tune must be executed before any other calibrator activities. There is no default channel tuned.

Examples - The following *tune_channel* example configures the chip to operate in the 2.4 GHz band at channel 1 without high-throughput.

```
calibrator wlan0 wl18xx_plt tune_channel 1 0 0
```

3.4 Set TX Power

The *set_tx_power* command can be used to set the transmission power of the WL18xx device. To set TX power:

- Enable PLT Mode
- Tune Channel

The Command format is provided below:

```
calibrator wlan0 wl18xx_plt set_tx_power <output_power> <level> <band> <primary_channel>
<2nd_channel> <antenna> <non_serving_channel> <channel_limitation> <internal> <gain_calculation>
<analog_gain_control_id> <post_dpd_gain>
```

where:

Table 3-3. set_tx_power Command Parameters

Parameter	Options	Description
output_power	0: (0-20000)	According to parameter 10 (gain_calculation): 0 (Normal): Desired output power supplied in dBmX1000 at 125 resolution (1/8 dB) i.e. 16.125[dBm] = 16125
	1: (0-20000)	1 (Debug): Desired output power supplied in dBmX1000 at 125 resolution (1/8 dB) i.e. 16.125[dBm] = 16125
	2: (-15000 – (-4000))	2 (Override): Desired BO from PSAT supplied in dBmX1000 at 125 resolution (1/8 dB) i.e. -10.375[dBm] = -10375
level	0-3	System support for different pre-configurable power levels in operational mode. **For PLT usage power level should be configured to 0**
band	0: 2.4GHz 1: 5GHz 2: 4.9GHz (JP)	Operation Band
channel_number	Channel according to used band	Same channel as configured in of **tune channel** command
primary_channel_location	-1: 40MHz Lower Primary 0: 20MHZ 1: 40MHz Upper Primary	20/40MHz usage. Same as configured in bandwidth of tune channel command:
antenna	0-3	Used for TX antenna select: 0: Auto Mode: The FW will automatically selects which TX paths to calculate the power for (based on how many antennas are assembled, band, BW and etc.)
		1: TX1: Force TX power calculation for TX1 path
		2: TX2: Force TX power calculation for TX2 path
		3: Both TX1&TX2: Force TX power calculation for both TX paths
non_serving_channel	0: Serving 1: Non Serving	The power settings will be set only for non-serving rate groups (basic rates only)
channel_limitation	0: Disabled 1: Enabled	Disable/Enable whether to use the channel power limits from the ini file
internal	Not Supported	Internal Usage. Default 0

Table 3-3. set_tx_power Command Parameters (continued)

Parameter	Options	Description
gain_calculation_mode	0: Normal	The BO (digital gain) and the analog gain (VGA/iPA/mixer) are being calculated and set using FW defines
	1: Debug	No BO limits at max analog gain settings - at max gain combination there will be no limits for the available BO (digital gain)
	2: Override	The analog gain and the digital gain are overridden, i.e. the use can choose which of the analog gain combinations he wants to use (choose 1 of the 4 available combinations) and the user can set the digital gain (digital BO as required)
analog_gain_control_id	0-4	Analog settings index - For debug purpose only: This indicator is used to indicate the user's chosen analog gain
post_dpd_gain	Not Supported	Default 0

Note

There are no default values.

Examples - One example that matches the 'tune_channel' example above is:

```
calibrator wlan0 wl18xx_plt set_tx_power 16125 0 0 1 0 0 0 0 0 0 0 0
```

3.5 Enable Continuous TX Test Using start_tx Command

For WLAN transmission quality evaluation continuous transmission of packets may be desired. "*TX Continuous test*" can be used to configure the unit to send continuous transmission packets.

TX Continuous test sends packets of data to the air, where the data packets parameters are controlled by the PLT command and include parameters such as transmitted rate, transmitted power, destination MAC address, and so forth.

Where,

Table 3-4. start_tx Command Parameters

Parameter	Description
<delay>	Delay between packets in microseconds
<rate>	Tx rate, supported rates are given in table below
<size>	Size of data field in MPDU (in bytes, up to FW 8.9.0.0.19 and Calibrator 0.79: 0-2000, from FW 8.9.0.0.20 and Calibrator 0.80: 0-4065)
<mode>	Number of packets (0 - endless)
<data_type>	Not Supported - default 0
<gi>	Guard interval 0 – long 1 - short
<options1>	Unused Field - default 0
<options2>	Supported options according to bitmap: • Bit 1: Override CCA (FW 8.9.0.0.2: 0-Don't override, 1-Override) • Bit 2: Fixed/Incremental Sequence Number (FW 8.9.0.0.20: 0-Incremental, 1-Fixed)
<source MAC>	Source MAC address (xx:xx:xx:xx:xx:xx)
<dest MAC>	Destination MAC address (xx:xx:xx:xx:xx:xx)
<channel width>	Channel width: 0 – 20 MHz 1 – 40 MHz
<rate>	Transmission rate (see table below)

Table 3-5. WLAN PLT Configurable Rates

11b	11g	11n	MIMO / 40M
0 = 1.0 Mbps	4 = 6.0 Mbps	12 = 6.5 Mbps (MCS0)	20 = MCS8 / MCS4 at 40MHz
1 = 2.0 Mbps	5 = 9.0 Mbps	13 = 13.0 Mbps (MCS1)	21 = MCS9 / MCS5 at 40MHz
2 = 5.0 Mbps	6 = 12.0 Mbps	14 = 19.5 Mbps (MCS2)	22 = MCS10 / MCS6 at 40MHz
3 = 11.0 Mbps	7 = 18.0 Mbps	15 = 26.0 Mbps (MCS3)	23 = MCS11 / MCS7 at 40MHz
	8 = 24.0 Mbps	16 = 39.0 Mbps (MCS4)	24 = MCS12 / MCS7,40MHz SGI
	9 = 36.0 Mbps	17 = 52.0 Mbps (MCS5)	25 = MCS13
	10 = 48.0 Mbps	18 = 58.5 Mbps (MCS6)	26 = MCS14
	11 = 54.0 Mbps	19 = 65.0 Mbps (MCS7)	27 = MCS15

Examples - The following is an example on how to use the start_tx command (and other commands) to generate packets.

- Set the system into PLT mode using Enable PLT Mode
- Use Tune Channel command to set the desired TX power
- Use start_tx command to generate packets

3.6 Disable Continuous TX Test Using stop_tx Command

It is important that each start_tx command is followed by the stop_tx command, which stops the transmission. Finally, use the Section 3.2 command to reset the system to operational mode.

3.7 Additional Notes Related to Continuous TX Test

Antenna settings are taken from loaded FW with INI settings. Make sure that these settings are as per the HW used in testing. For details on how to configure the antenna settings, see the *WiLink™ 8 Solutions WiLink8 – wlconf* and the *WiLink8 R8.8 Linux Wi-Fi Driver Release Build User's Guide*.

If needed for the test the antenna settings can be modified using on the target device as well. The following section details the same. For complete details of how to use wlconf utility, see *WiLink™ 8 Solutions WiLink8 – wlconf*.

To get the set antenna configuration use the following commands:

```
cd /lib/firmware/ti-connectivity/
wlconf -i /lib/firmware/ti-connectivity/wl18xx-conf.bin -get
```

If needed change the antenna configuration, for example, two antennas for 2.4 GHz (MIMO) and 1 antenna for 5 GHz, the below command can be used:

```
wlconf -i /lib/firmware/ti-connectivity/wl18xx-conf.bin --set
wl18xx.phy.number_of_assembled_ant2_4=0x02
wlconf -i /lib/firmware/ti-connectivity/wl18xx-conf.bin --set
wl18xx.phy.number_of_assembled_ant5=0x01
```

3.8 Example TX Output With Different Settings

The below section provides examples of using the commands for different modes of transmission and TX channel occupancy. All TX examples are 50% DC and include "channel limits" to compensate the limitations from INI file

Band 2.4 GHz, 11B

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 1

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 0 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 500 3 500 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

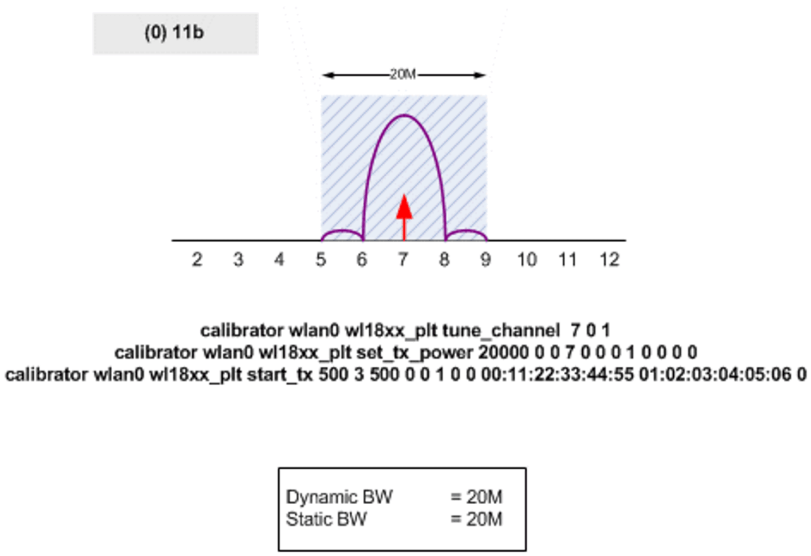


Figure 3-1. Band 2.4 GHz, 11B

Band 2.4 GHz, 20 MHz

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 1

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 0 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

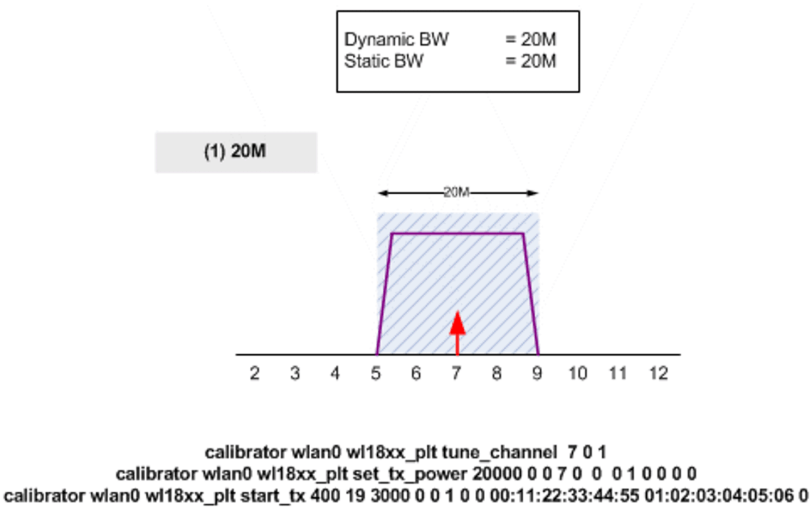


Figure 3-2. Band 2.4 GHz, 20 MHz

Band 2.4 GHz, 20 MHz Primary Upper

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 2

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 1 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

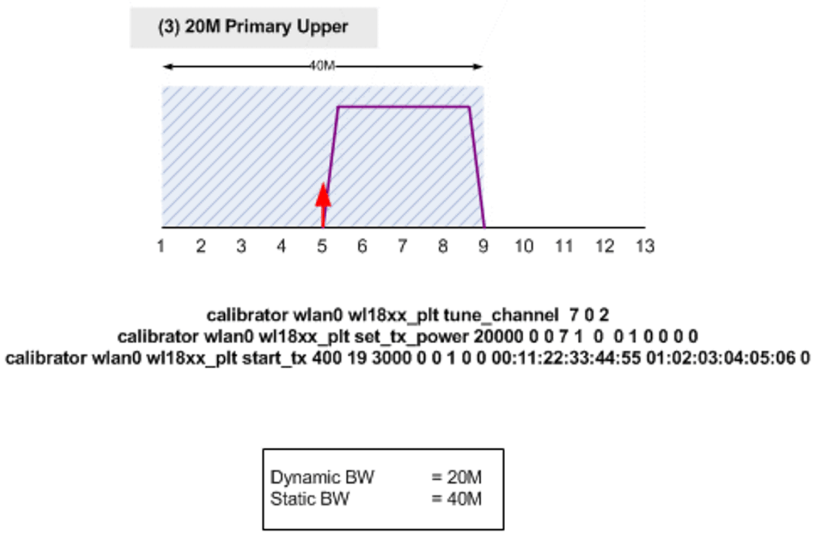


Figure 3-3. Band 2.4 GHz, 20 MHz Primary Upper

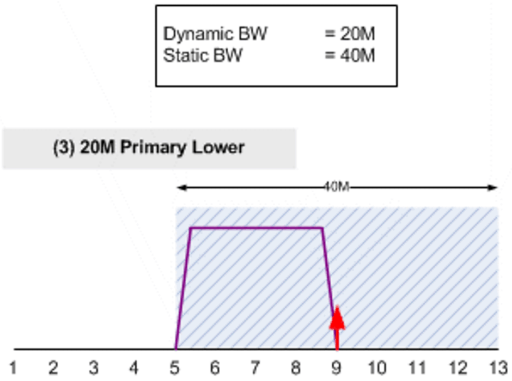
Band 2.4 GHz, 20 MHz Primary Lower

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 3

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 -1 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0



calibrator wlan0 wl18xx_plt tune_channel 7 0 3
calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 -1 0 0 1 0 0 0 0
calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

Figure 3-4. Band 2.4 GHz, 20 MHz Primary Lower

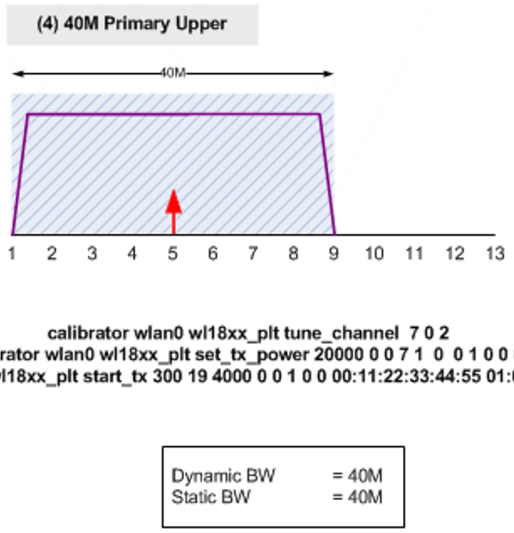
Band 2.4 GHz, 40 MHz Primary Upper

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 2

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 1 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 300 19 4000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 1



calibrator wlan0 wl18xx_plt tune_channel 7 0 2
calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 1 0 0 1 0 0 0 0
calibrator wlan0 wl18xx_plt start_tx 300 19 4000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 1

Figure 3-5. Band 2.4 GHz, 40 MHz Primary Upper

Band 2.4 GHz, 40 MHz Primary Lower

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 3

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 -1 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 300 19 4000 0 0 1 0 0 00:11:22:33:44:55 01:02:03:04:05:06 1

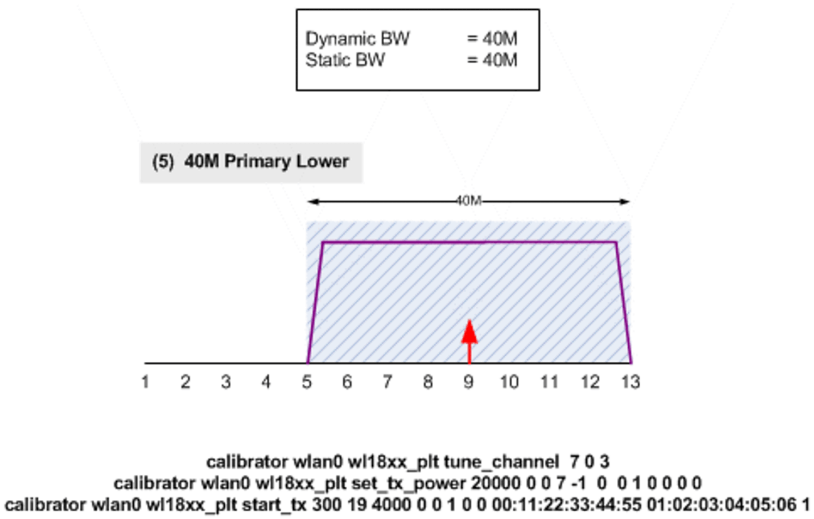


Figure 3-6. Band 2.4 GHz, 40 MHz Primary Lower

Band 2.4 GHz, 20 MHz MIMO

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 7 0 1

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 0 7 0 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 300 27 4065 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

Band 5 GHz TX:20 MHz

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 36 1 1

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 1 36 0 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

Band 5 GHz 40 MHz Upper Primary

calibrator wlan0 wl18xx_plt stop_tx

calibrator wlan0 wl18xx_plt tune_channel 36 1 2

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 1 36 1 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 1

3.9 Continuous Wave TX or TX Tone Test Command

The purpose of the tx_tone command is to create and transmit a carrier wave that can be modulated with a fixed audio tone.

The tx_tone command can be called using the following format.

where:

Table 3-6. TX Tone Test Command Parameters

Parameter	Description	Comments
Mode	0 – Transmit silence	TX chain is ON and operational but no signal is transmitted
	1 – Transmit carrier feed through	TX chain is ON and operational and the LO leakage is transmitted
	2- Transmit single tone	TX chain is ON and operational and a sinusoidal signal is transmitted with the following configuration options: • Analog Gain Step • Offset from carrier frequency (in OFDM bins)
Bin index	-32 to +32 in OFDM bins	
Antenna Mode	0 – automatic antenna selection	
	1 – use TC chain 1	
	2 – Use TX chain 2	
Gain Index	2.4 GHz - 0-4	
	5 GHz - 0-1	

Examples - The following examples show how to use the tone test:

Table 3-7. Example Test Tones

Tone	Example
2.4 GHz Transmit Silence	calibrator wlan0 plt power_mode on calibrator wlan0 wl18xx_plt tune_channel 6 0 0 calibrator wlan0 wl18xx_plt tx_tone_start 0 0 0 0 calibrator wlan0 wl18xx_plt tx_tone_stop
2.4GHz Transmit Carrier Feed Through	calibrator wlan0 plt power_mode on calibrator wlan0 wl18xx_plt tune_channel 6 0 0 calibrator wlan0 wl18xx_plt tx_tone_start 1 0 0 0 calibrator wlan0 wl18xx_plt tx_tone_stop
2.4 GHz Transmit Single Tone	calibrator wlan0 plt power_mode on calibrator wlan0 wl18xx_plt tune_channel 6 0 0 calibrator wlan0 wl18xx_plt tx_tone_start 2 0 0 0 calibrator wlan0 wl18xx_plt tx_tone_stop
2.4 GHz Transmit Single Tone with -5 MHz offset from the LO	calibrator wlan0 plt power_mode on calibrator wlan0 wl18xx_plt tune_channel 6 0 0 calibrator wlan0 wl18xx_plt tx_tone_start 2 -5 0 0 calibrator wlan0 wl18xx_plt tx_tone_stop
2.4 GHz Transmit Single Tone with -5MHz offset from the LO on lowest PA gain step	calibrator wlan0 plt power_mode on calibrator wlan0 wl18xx_plt tune_channel 6 0 0 calibrator wlan0 wl18xx_plt tx_tone_start 2 -5 0 4 calibrator wlan0 wl18xx_plt tx_tone_stop

4 Calibrator Tool RX Command

Similar to TX commands there are RX commands that can be used to receive the packets and obtain statistics on the same. The WL18xx firmware is able to capture packets from the air and report RF statistics. This functionality can be used to make sure the calibration, antennas, and radio on the device are working properly. This section shows how to use the RX statistics command for receiving (RX) testing on the WL18xx.

4.1 Enable PLT Mode

Before running any of the commands, the device and the driver needs to be configured in Production Line Test (PLT) mode. Use the following commands to configure the device to PLT mode:

```
cd /usr/share/wl18xx/
calibrator wlan0 plt power_mode on
```

4.2 Enable/Start RX Statistics Test

To start calculations of RX statistics, use the start_rx command:

```
calibrator wlan0 wl18xx_plt start_rx <source address> <destination address>
```

Note

Using broadcast MAC (FF:FF:FF:FF:FF:FF) instead of source or destination addresses causes it to be ignored.

4.3 Collect RX Statistics

To receive RX statistics, use the get_rx_stats command:

```
calibrator wlan0 wl18xx_plt get_rx_stats
```

4.4 Disable/Stop RX Statistics Test

Following command will stop the RX statistics test. It is important to finish the test with stop_rx command

```
calibrator wlan0 wl18xx_plt stop_rx
```

4.5 RX Statistics Examples

4.5.1 Example 1 – No Incoming Signal, Verify No Noise and Zero Packets Received

```
root@am335x-evm:~# calibrator wlan0 plt power_mode on
root@am335x-evm:~# calibrator wlan0 wl18xx_plt tune_channel 6 0 0
root@am335x-evm:~# calibrator wlan0 wl18xx_plt start_rx 00:00:00:00:00:01 00:00:00:00:00:02
root@am335x-evm:~# calibrator wlan0 wl18xx_plt get_rx_stats

RX statistics (status 0)
Total packets:          0
FCS errors:             0
MAC mismatch:           0
Good packets:           0
Average RSSI (SOC):     0
Average RSSI (ANT):     0
PER:                    N/A     # PER = Total Bad / Total Received

calibrator wlan0 wl18xx_plt stop_rx
```

4.5.2 Example 2 – 1000 Packets Burst Signal Level -75dBm (approximately 98% reception)

```
root@am335x-evm:~# calibrator wlan0 plt power_mode on
root@am335x-evm:~# calibrator wlan0 wl18xx_plt tune_channel 6 0 0
root@am335x-evm:~# calibrator wlan0 wl18xx_plt start_rx 00:00:00:00:00:01 00:00:00:00:00:02
root@am335x-evm:~# calibrator wlan0 wl18xx_plt get_rx_stats

RX statistics (status 0)
Total packets:          1000
FCS errors:             15
MAC mismatch:           0
Good packets:           985
Average RSSI (SOC):     -75
Average RSSI (ANT):     -72
PER:                    0.015     # PER = Total Bad / Total Received

calibrator wlan0 wl18xx_plt stop_rx
```

4.5.3 Example 3 - 1000 Packets Burst Signal Level -76.5dBm (approximately 90% reception)

```
root@am335x-evm:~# calibrator wlan0 plt power_mode on
root@am335x-evm:~# calibrator wlan0 wl18xx_plt tune_channel 6 0 0
root@am335x-evm:~# calibrator wlan0 wl18xx_plt start_rx 00:00:00:00:00:01 00:00:00:00:00:02
root@am335x-evm:~# calibrator wlan0 wl18xx_plt get_rx_stats

RX statistics (status 0)
Total packets:          2000
FCS errors:             169
MAC mismatch:           0
Good packets:           1831
Average RSSI (SOC):     -77
Average RSSI (ANT):     -74
PER:                    0.0845    # PER = Total Bad / Total Received

calibrator wlan0 wl18xx_plt stop_rx
```

Note

- FCS error is frame corrupted in PHY level
- MAC Mismatch is good Wi-Fi frame not addressed to device
- PER = Total Bad / Total Received

5 ANT1 and ANT2 Assembly Validation for Production

The following method provides a simple, fast and cheap solution to assure both RF paths are functional on the device either in lab or in production line environment. The goal is to establish connection with remote AP once using SISO scheme, first on ANT1 and later on ANT2. The procedure is provided below:

- Change wlconf (INI) parameter that modified the main antenna to be (ANT2 SISO, BG1)
- Establish connection with AP using BG2 (ANT2 - MIMO)
- Configure the platform back to the original configuration
- Establish Connection with AP after booting using the main antenna (ANT1 SISO, BG2)

The following sequence will be required for the testing procedure. For details on using the provided scripts with the R8.8 release, see the *WiLink8 R8.8 Linux Wi-Fi Driver Release Build User's Guide*.

1. Configuration changed to BG1 primary #.

   sh sta_stop.sh

   sh unload_wlcore.sh

   cd /usr/sbin/wlconf

   ./wlconf -i /lib/firmware/ti-connectivity/wl18xx-conf.bin -o /lib/firmware/ti-connectivity/wl18xx-conf.bin --set wl18xx.phy.spare0=0x08
2. Connect to the AP with SSID = "AP_NAME" using BG1 #.

   cd /usr/share/wl18xx

   sh load_wlcore.sh

   sh sta_start.sh

   sh sta_connect-ex.sh "AP_NAME"
3. Configuration changed back to BG2 primary #.

   sh sta_stop.sh

   sh unload_wlcore.sh

   cd /usr/sbin/wlconf

   ./wlconf -i /lib/firmware/ti-connectivity/wl18xx-conf.bin -o /lib/firmware/ti-connectivity/wl18xx-conf.bin --set wl18xx.phy.spare0=0x00
4. Re-connect to AP with default SISO on ANT1.

6 Additional Commands Using Calibrator

The following section details additional commands for calibrator tool. It is assumed that the device is put into the PLT mode using Section 3.1.

6.1 Set Antenna Mode

The purpose of the set antenna mode command is to configure the WL18xx chip to operate in a specific Wi-Fi band.

The set antenna mode command for 2.4G can be called using the following format:

```
calibrator wlan0 wl18xx_plt set_antenna_mode_24G <mac_prim_rx_chain> <mac_prim_tx_chain>
<mac_rx_chain1_en> <mac_rx_chain2_en> <mac_tx_chain1_en> <mac_tx_chain2_en>
```

Where:

Parameter	Values	Description
mac_prim_rx_chain	1 or 2	Primary RX chain to use. In MIMO mode it has no meaning and in SISO mode only BG2 RX is allowed. See supported configurations table
mac_prim_tx_chain	1 or 2	Primary TX chain to use. Always set according to the tx_chain1_en and tx_chain2_en fields. See supported configurations table
mac_rx_chain1_en	0 – Chain enable 1 – Chain Disable	
mac_rx_chain2_en	0 – Chain enable 1 – Chain Disable	
mac_tx_chain1_en	0 – Chain enable 1 – Chain Disable	
mac_tx_chain2_en	0 – Chain enable 1 – Chain Disable	

Supported modes and corresponding configurations are provided in the table below:

Mode	2.4GHz SISO	MIMO BG2 TX Primary	MIMO BG1 TX Primary (PLT Only)
mac_prim_rx_chain	2	2	DC (Set 1 for consistence with TX)
mac_prim_tx_chain	2	2	1
mac_rx_chain1_en	0	1	1
mac_rx_chain2_en	1	1	1
mac_tx_chain1_en	0	1	1
mac_tx_chain2_en	1	1	1

The set antenna mode command for 5G can be called using the following format:

Parameter	Values	Description
mac_prim_rx_chain	1 or 2	Primary RX chain to use
mac_rx_chain1_en	0 – Chain enable 1 – Chain Disable	
mac_rx_chain2_en	0 – Chain enable 1 – Chain Disable	
mac_tx_chain1_en	0 – Chain enable 1 – Chain Disable	

Supported modes and corresponding antenna configuration parameters are listed below:

Mode	mac_prim_rx_chain	mac_rx_chain1_en	mac_rx_chain2_en	mac_tx_chain1_en
5GHz SISO	1	1	0	1

Examples –

2.4GHz band (SISO)	calibrator wlan0 wl18xx_plt set_antenna_mode_24G 2 2 0 1 0 1
5GHz band (SISO)	calibrator wlan0 wl18xx_plt set_antenna_mode_5G 1 1 0 1

6.2 Set Antenna Diversity 5 GHz

The purpose of the set antenna diversity command is to select which one of the 5 GHz antennas the device should operate on. The set antenna diversity command can be called using the following format:

```
calibrator wlan0 wl18xx_plt set_antenna_diversity_5G <mode>
```

Parameter	Description
<mode>	is the required antenna to work on

Examples -

antenna diversity set to work on the main antenna	calibrator wlan0 wl18xx_plt set_antenna_diversity_5G 1
antenna diversity set to work on the secondary antenna	calibrator wlan0 wl18xx_plt set_antenna_diversity_5G 0

The following transmit data on the main antenna and the secondary antenna alternatively:

Tuning the radio to channel 44 (5220MHz)

calibrator wlan0 plt power_mode on

calibrator wlan0 wl18xx_plt set_antenna_mode_5G 1 1 0 1

calibrator wlan0 wl18xx_plt tune_channel 44 1 1

Transmit from main antenna

calibrator wlan0 wl18xx_plt set_tx_power 20000 0 1 44 0 0 0 1 0 0 0 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

Stop Tx

calibrator wlan0 wl18xx_plt stop_tx

Transmit from secondary antenna

calibrator wlan0 wl18xx_plt set_antenna_diversity_5G 0

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

Stop Tx

calibrator wlan0 wl18xx_plt stop_tx

Transmit back from main antenna

calibrator wlan0 wl18xx_plt set_antenna_diversity_5G 1

calibrator wlan0 wl18xx_plt start_tx 400 19 3000 0 0 0 0 0 00:11:22:33:44:55 01:02:03:04:05:06 0

6.3 Read Device Registers

The purpose of the read registers command is to read a specific address content.

The read register command can be called using the following format:

wl18xx_plt phy_reg_read < address to read from >

Examples - The following read registers example reads the content of address 0x30600:

calibrator wlan0 wl18xx_plt phy_reg_read 0x30600

Register Address: 0x30600 is: 0x0

6.4 Write Device Registers

The purpose of the write registers command is to write data to a specific address.

The write register command can be called using the following format:

calibrator wlan0 wl18xx_plt phy_reg_write < required address to write to > < required content to write >

Examples - The following write registers example writes 0x1 to address 0x30600.

calibrator wlan0 wl18xx_plt phy_reg_write 0x30600 0x1

6.5 Read MAC Address

The purpose of the read MAC address command is to read the BD_ADDR from fuse and each interface address. The read MAC address command can be called using the following format:

calibrator wlan0 plt get_mac

Example output

```
calibrator wlan0 plt get_mac
BD_ADDR from fuse:      0x34:0xb1:0xf7:0xe1:0xee:0x9b
First WLAN MAC:         0x34:0xb1:0xf7:0xe1:0xee:0x9c
Second WLAN MAC:        0x34:0xb1:0xf7:0xe1:0xee:0x9d
```

7 WL18xx Writing MAC Address Using Calibrator Tool

The following section explains the procedure to set the device MAC address other than the default as needed by customers during production. The section also explains a method to derive the two WLAN MAC addresses using the Bluetooth device address (BD_ADDR). The two addresses after the BD_ADDR are reserved for WLAN and can be derived automatically from the BD_ADDR at runtime.

7.1 Deriving the WLAN Addresses

The WLAN MAC addresses for the supported devices are derived as follows:

BD_ADDR: 08:00:28:00:00:00

WLAN 1: 08:00:28:00:00:01

WLAN 2: 08:00:28:00:00:02

When deriving the WLAN addresses from the BD_ADDR, ensure that the organizational unique identifier (OUI) is not changed. The OUI (first 3 bytes) is pre-assigned by the IEEE to different companies (for example, the TI OUI is 08:00:28). The company that owns the OUI assigns the network identification card (NIC) addresses (last 3 bytes).

7.2 Addresses Assigned by the Customers

Customers can use either the TI MAC addresses assigned to the device or their own addresses, in which case the OUI represents their own company's address. The nvs file includes a MAC address field to support the assignments. If a MAC address is available in the .nvs file, the address overrides the addresses assigned by TI during production. The MAC address written in the .nvs file represents the first WLAN address (WLAN 1); incrementing this first address derives the second address. Thus, when customers assign their own MAC addresses, they must assign two consecutive MAC addresses per device, writing the first one in the .nvs file.

Note

If an overflow occurs while deriving the second MAC address, wrap around the NIC part without changing the OUI in the same way as described in Section 7.1.

7.3 Setting a Permanent MAC Address in the NVS File

In order to set a permanent MAC address to the device uses the calibrator tool as follows:

calibrator set nvs_mac /lib/firmware/ti-connectivity/wl1271-nvs.bin <mac addr>

Note

To use the MAC addresses assigned to the device by TI, set the MAC address in the nvs file to be blank (00:00:00:00:00:00).

In order to get the permanent MAC address that was written to the nvs file use the calibrator tool as follows:

calibrator get nvs_mac /lib/firmware/ti-connectivity/wl1271-nvs.bin

Note

Unloading and loading the driver is required in order for the change to take effect.

To verify that the MAC address was properly changed, use the *ifconfig* command as follows:

```
root@am37x-evm:~# ifconfig wlan0
wlan0     Link encap:Ethernet  HWaddr 08:20:00:33:65:29
          inet addr:192.168.3.10  Bcast:0.0.0.0  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:14048740 errors:0 dropped:0 overruns:0 frame:0
          TX packets:20805996 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:3296646156 (3.0 GiB)  TX bytes:1748711212 (1.6 GiB)
```

8 References

- Texas Instruments: *WiLink8 R8.8 Linux Wi-Fi Driver Release Build User's Guide*
- Texas Instruments: *WiLink™ 8 Solutions WiLink8 – wlconf*

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