User's Guide

SimpleLink CC33xx Calibrator Tool User's Guide

ABSTRACT

The CC33xx Linux driver provides an easy tool ***Calibrator*** to configure the CC33xx device for various transmit and receive operations enabling measurement of RF performance of the device-under-test. 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 the CC33xx driver on a Linux platform. The Calibrator tool can also be used for production line testing.

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Trademarks

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
OFDM	Orthogonal frequency-division multiplexing
NIC	Network Interface Card
OUI	Organizationally Unique Identifier (24bit unique number for each vendor of WLAN)
LTF	Long Training Field
GI	Guard Interval
DCM	Dual Carrier Modulation
CCA	Clear Channel Assessment
SU ER BW	Single User Extended Range Bandwidth
VHT	Very High Throughput
AID	Association ID
HE TB NDP FB	High Efficiency Trigger Based Null Data Packet Feedback

2 Prerequisites

The following kernel configuration is a prerequisite for correct Calibrator Tool operation:

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/cc33xx#  zcat /proc/config.gz | grep NL80211_TESTMODE
   ```

   Where the output is:

   ```
   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 *CC33xx Linux Getting Started User's Guide* in the CC33xx Linux Software Package.
2. The wlan0 interface must be shut down. If the interface is already running then run `ifconfig wlan0 down` to disable the wlan0 interface. Verify the wlan0 interface is disabled by running the `ifconfig` command again.

   There should not be any mention of `wlan0` on the output of `ifconfig`.

3 Calibrator Tool Commands

The following sections detail the Calibrator tool commands available.

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:

```
calibrator wlan0 plt power_mode on
```

To exit PLT mode use the below command:

```
calibrator wlan0 plt power_mode off
```

3.2 Tune Channel

The purpose of the tune_channel command is to configure the CC33xx device to operate in a specific Wi-Fi band and channel. The tune_channel command can be called using the following format:

```
calibrator wlan0 cc33xx_plt tune_channel <CHAN> <BAND> <BANDWIDTH>
```

Where each argument is defined as the following:

Table 3-1. tune_channel Command Parameters

Parameter	Option	Description
CHAN	1 - 14	Wi-Fi Channel
BAND	0	Wi-Fi band. Only b/g/n is supported
BANDWIDTH	0	Bandwidth allocation

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 on channel 6.

```
calibrator wlan0 cc33xx_plt tune_channel 6 0 0
```

3.3 Transmit Chain Parameters

This section describes the various parameters within the transmit chain and trigger based transmission.

3.3.1 TX Parameters

The *set_tx* command can control the entire TX datapath and front-end on the CC33xx device. This command is able to set preamble types, phy datarates, output power, control the number of data packets to transmit and the data value within the packets, and many other functions.

Default TX settings can be enabled with:

```
calibrator wlan0 cc33xx_plt set_tx -default 0
```

The default settings are provided in Appendix A. The full command format is provided below. It is not necessary to include every argument in the `set_tx` command.

```
calibrator wlan0 cc33xx_plt set_tx -preamble_type <PREAMBLE_TYPE> -phy_rate <PHY_RATE> -tx_power
<TX_POWER> -gi_ltf_type <GI_LTF_TYPE> -dcm <DCM> -length <LENGTH> -delay <DELAY> -pkt_mode
<PACKET_MODE> -num_pkts <NUM_PACKETS> -data_mode <DATA_MODE> -data_const_val <DATA_VALUE> -cca
<CCA> -bss_color <BSS_COLOR> -su_er_bw <SU_ER_BW> -partial_aid <PARTIAL_AID> -src_addr <SRC_ADDR>
-dst_addr <DST_ADDR> -nominal_pkt_ext <PKT_EXT> -feed_status <FEED_STATUS> -aid <AID> -group_id
<G_ID>
```

Each argument is defined in Table 3-2.

Table 3-2. set_tx Command Parameters

Parameter	Options	Description
PREAMBLE_TYPE	0	11b short preamble
	1	11b long preamble
	2	11a/g legacy OFDM
	3	11n mixed mode
	4	11n GF (Not Supported)
	5	11ax SU
	6	11ax MU (Not Supported)
	7	11ax SU ER
	8	11ax TB
	9	11ax TB NDP FB
	10	11ac VHT (Not Supported)
PHY_RATE	1	1 Mbps
	2	2 Mbps
	3	5.5 Mbps
	4	11 Mbps
	5	6 Mbps
	6	9 Mbps
	7	12 Mbps
	8	18 Mbps
	9	24 Mbps
	10	36 Mbps
	11	48 Mbps
	12	54 Mbps
	13	MCS0
	14	MCS1
	15	MCS2
	16	MCS3
	17	MCS4
	18	MCS5
	19	MCS6
	20	MCS7
TX_POWER	0 - 30	Integer value with range of -10 dBm to 20 dBm at 1dB steps
GI_LTF_TYPE	0	1xLTF + 1.6 µs GI
	1	2xLTF + 1.6 µs GI
	2	4xLTF + 3.2 µs GI
	3	2xLTF + 0.8 µs GI
	4	1xLTF + 0.8 µs GI
	5	4xLTF + 0.8µs GI
DCM	0	Disable DCM
	1	Enable DCM
LENGTH: range <start_length> <end_length>	100 - 3500	Number of data bytes excluding MAC 802.11 header. "range" string in LENGTH requires arguments of <start_length> to <end_length>. Only supported in Continuous mode or PACKET_MODE <0>. `-length range 0 100`

Table 3-2. set_tx Command Parameters (continued)

Parameter	Options	Description
LENGTH: const packet <length>	Non MCS rate: 0 - 3500 MCS rate: 0-16000	Number of data bytes excluding MAC 802.11 header. "const packet" string in LENGTH requires argument of <length> `-length const packet 2000`
DELAY	50 - 1000000	Delay between packets (µs)
PACKET_MODE	0	Continuous mode - Transmits packets continuously until tx_stop command is sent
	1	Transmits a single packet
	2	<NUM_PKTS> is required if using this packet mode Transmits <NUM_PKTS> packets
NUM_PACKETS	1 - 10000	Used when <PKT_MODE> = 2 Number of packets to send
DATA_MODE	0	<DATA_VAL> is required if using this data mode Constant value
	1	Increment value
	2	Random value
DATA_VALUE	0 - 255	Required if <DATA_MODE> is 0 Data value used in all packets
CCA	0	Disable CCA
	1	Enable CCA
BSS_COLOR	0 - 63	This field is relevant for HE_SU and HE_SU_ER
SU_ER_BW	0	242-tone RU
	1	106-tone RU
PARTIAL_AID	0 - 1023	This field is relevant for VHT transmission
SRC_ADDR	xx:xx:xx:xx:xx:xx	Source MAC Address
DEST_ADDR	xx:xx:xx:xx:xx:xx	Destination MAC Address
PKT_EXT	0	0 µs
	1	8 µs
	2	16 µs
FEED_STATUS	0 / 1	Indicates the value of the one bit used to modulate the tones in each tone set. This field is relevant for HE TB NDP FB transmissions only.
AID	0 - 16383	AID of station can be up to 16383 (14 bits)
G_ID	0	(Not Supported)

3.3.2 TX Trigger-Based Parameters

The *set_tb_tx* command is used to set the trigger based transmission parameters in the CC33xx device.

The *set_tb_tx* command is formatted as such:

```
calibrator wlan0 cc33xx_plt set_tb_tx -mimo_ltf_mode <MIMO_MODE> -he_ltf_num <NUM_HE_LTF> -disamb
<DISAMB> -pre_fec_padding_factor <PRE_FACTOR> -common_info_len <COMMON_LEN> -ru_alloc <RU_ALLOC>
-ul_bw <UL_BW> -starts_sts_num <STS_NUM> -tb_auto <TB_AUTO>
```

Each argument is defined in Table 3-3.

Table 3-3. set_tx_tb Parameters

Parameter	Option	Description
MIMO_MODE	0	Single stream mode
	1	Masked mode
NUM_HE_LTF	0	1 HE LTF
	1	2 HE LTF
	2	4 HE LTF
	3	6 HE LTF
	4	8 HE LTF
DISAMB	0	No disambiguity
	1	With disambiguity
PRE_FACTOR	0 - 7	
COMMON_LEN		PSDU Length
RU_ALLOC	0 - 60	Resource Unit allocation
UL_BW	0	20 MHz
	1	40 MHz
	2	80 MHz
STS_NUM	0 - 3	
TB_AUTO	0	Disabled
	1	Enabled

3.3.3 TX Tone Start and Stop

The purpose of the `tx_start_tone` command is to create and transmit a carrier wave that can be modulated with a fixed tone. `tx_tone_stop` can be used to stop the continuous wave transmission.

The `tx_start_tone` command is formatted as such:

```
calibrator wlan0 cc33xx_plt tx_start_tone <MODE> <OFFSET>
```

Where,

Table 3-4. tx_start_tone Command Parameters

Parameter	Options	Description
MODE	2	Single tone: TX chain is on and a sinusoidal signal is outputted
OFFSET	-40 - 40	Integer value with range of -10 MHz to +10 MHz in steps of 0.25 MHz

The `tx_tone_stop` command is formatted as such:

```
calibrator wlan0 cc33xx_plt tx_tone_stop
```

3.3.4 Example TX Commands

The below section provides examples of using the commands for different modes of transmission and TX channel occupancy.

```
calibrator wlan0 plt power_mode on
calibrator wlan0 cc33xx_plt tune_channel 6 0 0
calibrator wlan0 cc33xx_plt set_tx -default 0
calibrator wlan0 cc33xx_plt set_tx -preamble_type 3 -phy_rate 20 -num_pkts 1000 -pkt_mode 2
-src_addr 04:05:05:05:05:04 -dst_addr 06:07:07:07:07:06
calibrator wlan0 cc33xx_plt start_tx
calibrator wlan0 cc33xx_plt stop_tx
calibrator wlan0 cc33xx_plt set_tx -length const packet 500
calibrator wlan0 cc33xx_plt start_tx
calibrator wlan0 cc33xx_plt stop_tx
```

3.4 Receive Chain Parameters

This section describes the various parameters in the RX Chain. A command to collect RX data is also provided.

3.4.1 Enable/Start RX Statistics Test

Similar to TX commands there are RX commands that can be used to receive the packets and obtain statistics on the same. The CC33xx device's firmware is able to capture packets from the air and report RF statistics. This feature can be used to enure the calibration, antennas, and radio on the device are working properly. This section shows how to use the RX statistics command for receiver (RX) testing.

Use the `start_rx` command to start the receive RF chain:

```
calibrator wlan0 cc33xx_plt start_rx -source_mac <SRC_ADDR> -ack_enable <ACK_ENABLE>
```

To print out the received statistics, use the `get_rx_stats` command:

```
calibrator wlan0 cc33xx_plt get_rx_stats
```

After receiving packets, this command will print statistics of the received packets to the command in a format similar to the following:

```
Total Received Packets:    0
FCS Errors:        0
MAC Mismatch:        0
Good Packets:        0
Average RSSI (SOC):    45
Average RSSI (ANT):    0
status: 19
PER:            N/A     # PER = Total Bad / Total Received
```

The following is an example sequence of how to start collecting packets with the receiver:

```
calibrator wlan0 plt power_mode on
calibrator wlan0 cc33xx_plt tune_channel 6 0 0
calibrator wlan0 cc33xx_plt start_rx -source_mac 04:05:05:05:05:04  -ack_enable 1
calibrator wlan0 cc33xx_plt get_rx_stats
```

3.4.2 Disable/Stop RX Statistics Test

The following command will stop the RX statistics test. It is crucial to finish the test with this command:

```
calibrator wlan0 cc33xx_plt stop_rx
```

A Set_TX Default Parameters

The following table lists the default settings

Parameter	Value	Description
PREAMBLE_TYPE	2	11a/g legacy OFDM
PHY_RATE	5	6 Mbps
TX_POWER	0	-10 dBm
GI_LTF_TYPE	2	4xLTF + 3.2 µs GI
DCM	0	Disable DCM
LENGTH	100	100 data bytes
DELAY	3000	3000 µs delay between packets
PACKET_MODE	0	Continuous mode
NUM_PACKETS	300	N/A when PACKET_MODE = 0 (Continuous Mode)
DATA_MODE	2	Random Value
DATA_VALUE	0x55	N/A when DATA_MODE = 2 (Random Value)
CCA	1	Enable CCA
BSS_COLOR	13	
SU_ER_BW	0	242-tone RU
P_AID	15	
SRC_ADDR	0x665544332222	
DEST_ADDR	0x060504030202	
PACKET_EXT	1	8 µs
FEED_STATUS	0	
AID	11	
G_ID	0	

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265