Application Note

CC33xx Production Line Guide

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ABSTRACT

Texas Instruments™ provides many resources in order to assist users in quickly examining the functionality and performance of their devices. This document provides the necessary information to guide the user in production line testing for CC33xx. The device's functions can be checked using tools and software provided by Texas Instruments. Performance testing is more involved as external equipment is required for thorough examination.

Table of Contents

List of Figures

List of Tables

Trademarks

1 Introduction

In some production type environments, manufacturers will implement sanity checks on their products to ensure the system is operating correctly. Production line testing enables the user to ensure the functionalities of the CC33xx device are working as expected. This guide will make use of the CC33xx Calibrator Tool to confirm both the functionality and the performance of the CC33xx device. The device does not require any flashing and can be tested through the Linux® host.

2 Functional Test

The Calibrator Tool from the CC33xx Linux driver provides a quick way to spot check the functionality of your SDIO interface and also allows for swift evaluation of the radio. This document covers the TX function, since RX functionality utilizes the same SDIO interface. By executing these directives properly, the tool validates the systems communication to the CC33xx device through SDIO.

2.1 SDIO Interface

1. Install Calibrator Tool on Linux host. For the Calibrator Tool installation package for the Linux environment, see the 'CC33xx Linux design resources' located on the CC33xx product page.

   Once installed, follow the instructions below within the Linux kernel:
2. Shutdown wlan0 interface. This can be done using the code below:

```
ifconfig wlan0 down
```

   Sample output:

```
[  118.019356] wlcore: down
```

   You can ensure wlan0 is disabled by executing the *'ifconfig'* command. Verify that there is no mention of wlan0 interface in the output.

   Sample output:

```
eth0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500  metric 1
        ether 68:5e:1c:01:c3:35  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536  metric 1
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 82  bytes 6220 (6.0 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 82  bytes 6220 (6.0 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

3. Enter product line test (PLT) mode from running the below command:

```
calibrator wlan0 plt power_mode on
```

   Sample output:

```
[  170.304600] wlcore: PLT start
[  170.333052] wlcore: PLT init Role Start succeed!, PLT roleID is: 2
```

4. Start setting up the receiving function by tuning the specifying the band and channel. In this guide, channel six is used check functionality.

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

5. Set TX parameters. Sample code is provided below with the used parameters defined in the Table 3-1. For more information and other parameter options, see the *SimpleLink™ CC33xx Calibrator Tool User's Guide*.

```
calibrator wlan0 cc33xx_plt set_tx -preamble_type 1 -phy_rate 1 -tx_power 30 -delay 1000
-pkt_mode 0
```

6. Start TX transmission.

```
calibrator wlan0 cc33xx_plt start_tx
```

Sample Output:

```
Starting TX Simulation
```

If this sample output matches, then functionality of the SDIO interface can be accepted.

7. Stop TX transmission.

```
calibrator wlan0 cc33xx_plt stop_tx
```

2.2 UART Interface

1. Install the pre-built CC33xx Image on Linux host. The image and instructions for this can be found in the *C33xx Linux User's Guide* (CC33xx Secure Resources). For more information, see the *Getting Started Guide* section, which can be found in the secure resources on the CC33xx product page. This is the same process seen in Step 1 of the SDIO Interface.
2. Once installed, change the working directory by entering the command below into the Linux kernel:

```
cd /usr/share/cc33xx
```

3. Execute the script to enable Bluetooth Low Energy.

```
./ble_enable.sh
```

4. The installed image contains BlueZ, which grants accessibility to BlueZ utility commands. This guide will run the 'hciconfig' command as an example. First, run the command below to enable the hci0 interface.

```
hciconfig hci0 up
```

If no errors are given after submitting this command, then UART functionality can be confirmed. However, the next step can be performed to sanity check this process.

5. Utilize the hciconfig command to verify the hci0 interface:

```
hciconfig -a
```

Sample Output:

```
hci0:   Type: Primary  Bus: UART
        BD Address: A4:34:F1:B2:91:24  ACL MTU: 255:10  SCO MTU: 0:0
        UP RUNNING
        RX bytes:563 acl:0 sco:0 events:46 errors:0
        TX bytes:309 acl:0 sco:0 commands:46 errors:0
        Features: 0x00 0x00 0x00 0x00 0x60 0x00 0x00 0x00
        Packet type: DM1 DH1 HV1
        Link policy:
        Link mode: SLAVE ACCEPT
```

2.3 Other Functional Applications

Texas Instruments has also documented a few functional tests using a Linux host. For more information, see the *CC33xx Linux Software Examples* section of the *CC33XX Linux User's Guide* (CC33xx Secure Resources), which can be found in the secure resources on the CC33xx product page.

Examples include:

- Wi-Fi™ Fundamentals
- Bluetooth Low Energy Fundamentals

3 Performance Test

This section of the document covers examining the RF performance of the CC33xx device. The Calibrator Tool is used to simplify the process. Procedures for TX and RX operations are provided depending on what performance needs to be tested.

3.1 TX Performance

To closely audit the radio frequency performance, Wi-Fi demodulator is used to analyze data from the CC33xx device. A LitePoint® is utilized in this scenario to observe the PHY performance, but any 802.11 vector signal analyzer should work.

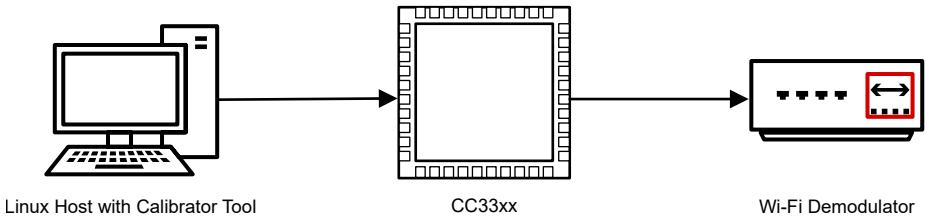


Figure 3-1. Example Setup for Performance Testing

1. Refer to 1 through 3 in the 'SDIO Interface' section to set up Calibrator Tool.
2. Start setting up the transmitting functions by tuning the specifying the band and channel. For this example, channel 6 is used.

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

3. Set TX parameters. Sample code is provided below with the used parameters defined in the Table 3-1. For more information and other parameter options, see the *SimpleLink™ CC33xx Calibrator Tool User's Guide* (SWRU602).

Table 3-1. 'set_tx' Command Specifications

Parameter	Setting	Calibrator Tool Code
Preamble Type	11b Long	1
Phy Rate	DSSS (1 Mbps)	1
TX Power	20 dBm	30
Delay	1000 µS	1000
Packet Mode	Continuous	0

```
calibrator wlan0 cc33xx_plt set_tx -preamble_type 1 -phy_rate 1 -tx_power 30 -delay 1000
-pkt_mode 0
```

Sample output:

```
set_tx_params has been called with: 5 Parameters
Calibrator:: Setting TX Parameters
```

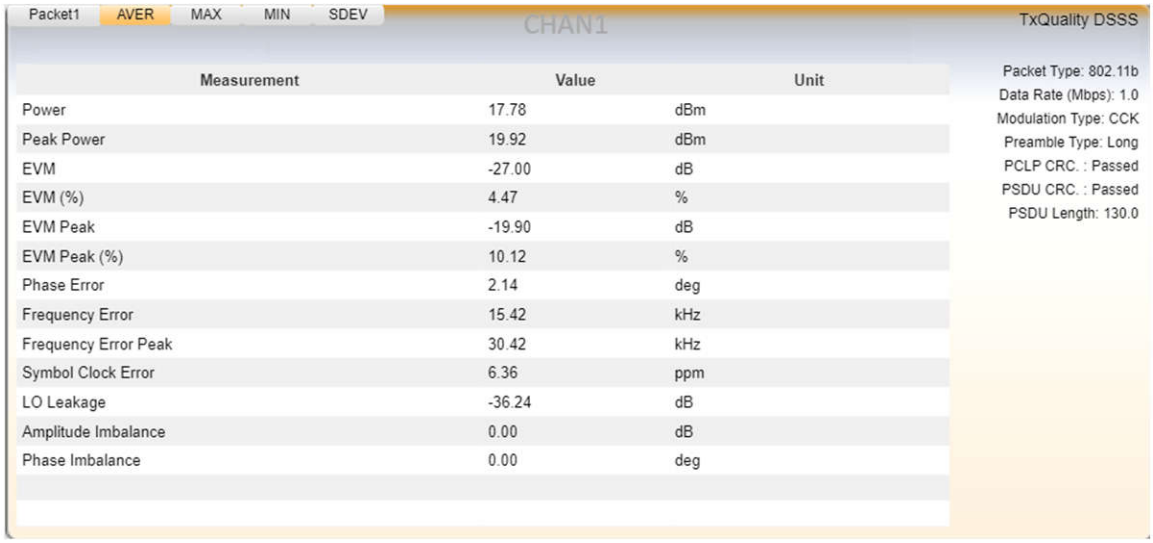
4. Start TX transmission.

```
calibrator wlan0 cc33xx_plt start_tx
```

Sample output:

```
Calibrator:: Starting TX Simulation
```

5. Evaluate TX results and compare results to datasheet specification. Figure 3-2 shows example results when the CC33xx device is transmitting DSSS (1 Mbps) at 20 dBm (these settings were established in 3). Every system is different, so it is advised to understand the amount of potential power loss that can occur within the system under test. In this scenario, a loss of 2.2dB is expected. If the measured results meet requirements for the product line, then the TX performance for both Wi-Fi and *Bluetooth*® can be ensured.



Measurement	Value	Unit
Power	17.78	dBm
Peak Power	19.92	dBm
EVM	-27.00	dB
EVM (%)	4.47	%
EVM Peak	-19.90	dB
EVM Peak (%)	10.12	%
Phase Error	2.14	deg
Frequency Error	15.42	kHz
Frequency Error Peak	30.42	kHz
Symbol Clock Error	6.36	ppm
LO Leakage	-36.24	dB
Amplitude Imbalance	0.00	dB
Phase Imbalance	0.00	deg

Figure 3-2. LitePoint Example Results From TX Performance Testing

6. After review, stop the device transmission to complete testing.

```
calibrator wlan0 cc33xx_plt stop_tx
```

3.2 RX Performance

Similar to TX, receiver performance operations can be analyzed using external equipment. The setup is identical to 'Figure 3-1', except the Wi-Fi Demodulator is replaced with the signal generator. Any Wi-FI signal that is supported by CC33XX can be used for testing. By using RX commands, performance of the receiver can be examined.

1. Refer to 1 through 3 in the 'SDIO Interface' section to set up Calibrator Tool. Start setting up the receiving functions by tuning the specifying the band and channel. For this example, channel 6 is used. This depends on the signal being generated from the equipment being utilized.

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

2. Start the radio to start evaluating the receiving operation. In this command, a dummy source MAC address of 'FF:FF:FF:FF:FF:FF' is provided. This can be altered to match the source address of the equipment if required.

```
calibrator wlan0 cc33xx_plt start_rx -source_mac FF:FF:FF:FF:FF:FF -ack_enable 1
```

   Sample output:

```
Calibrator:: Starting RX Simulation (Note that statistics counters are being reset)...
```

3. Retrieve receiver statistics by utilizing the code below:

```
calibrator wlan0 cc33xx_plt get_rx_stats
```

Sample output:

```
[  280.360585] wlcore: testmode cmd: radio status=0
Total Received Packets: 3003
FCS Errors:             829
MAC Mismatch:           0
Good Packets:           2174
Average RSSI (SOC):     -91
Average RSSI (ANT):     -188
status: 1
PER:                    0.276057     # PER = Total Bad / Total Received
```

Review the obtained data. The device should be picking up several packets from the provided signal. By confirming these parameters given by this output, performance can be reviewed for RX operation.

4. After review, stop the receiver.

```
calibrator wlan0 cc33xx_plt stop_rx
```

4 References

- Texas Instruments: *SimpleLink CC33xx Calibrator Tool User's Guide*
- Texas Instruments: *CC33XX Linux User's Guide* (CC33xx Secure Resources)

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (September 2023) to Revision A (December 2023)	Page
• Updated Section 2.2	3
• Updated Section 2.3	3
• Updated Section 3	4

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