Qualcomm Technologies, Inc.

QCC74x Hardware Training Guide

80-WL740-5 Rev. AF

Contents

Section 1

Overview

Introduction

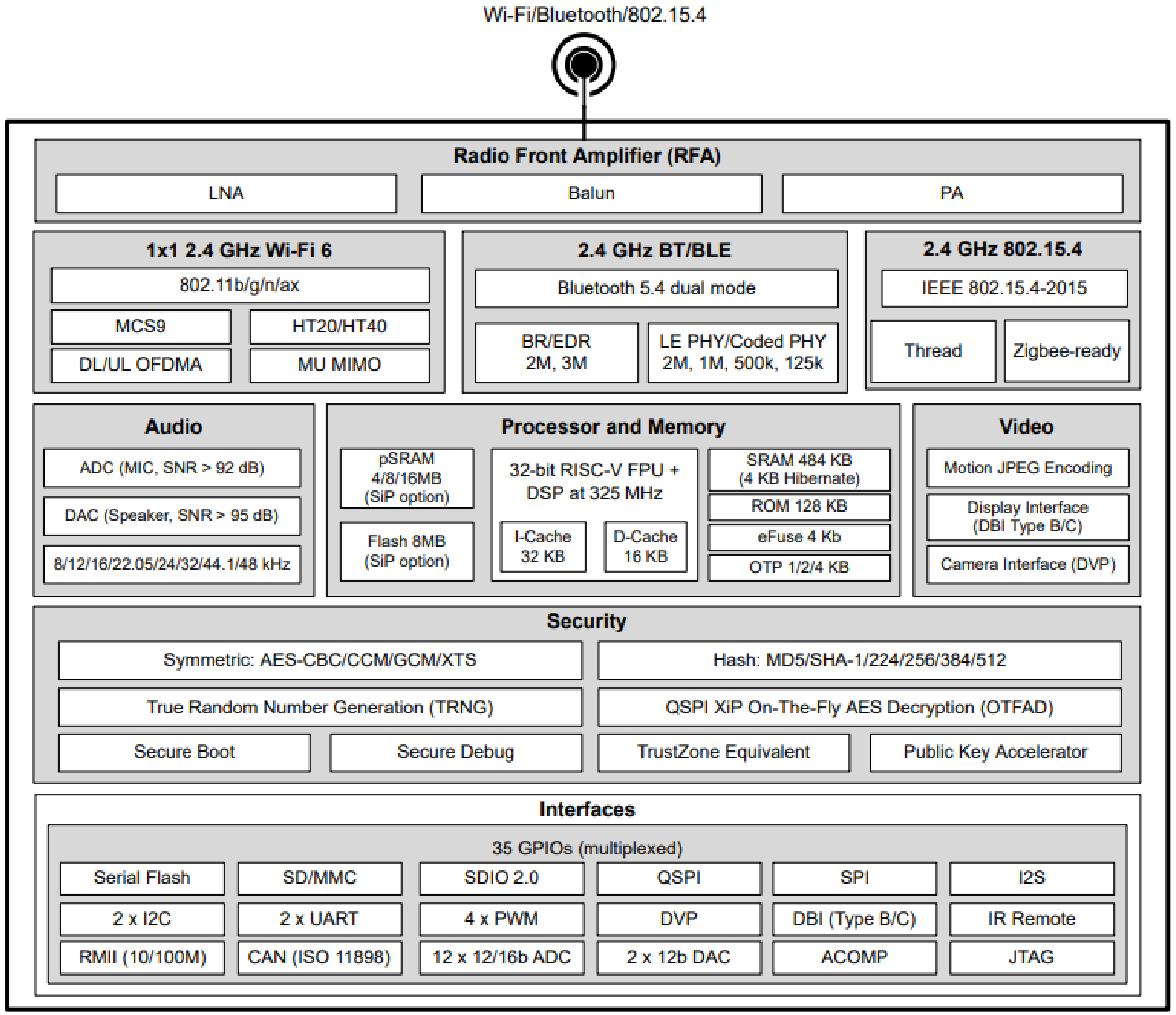
1x1 2.4 GHz Wi-Fi 6, Bluetooth 5.4 Dual Mode and IEEE 802.15.4 multi-mode connectivity SoC with integrated high-performance 32-bit RISC-V microcontroller.

QCC74x series chip-sets offer multi-mode wireless connectivity technology:

- 1x1 2.4 GHz Wi-Fi 6 supporting channel bandwidth 20 MHz and 40 MHz, MCS9, DL/UL-OFDMA, MU-MIMO, TWT (Target Wake Time), LDPC, STBC, Beamformee, DCM (Dual Carrier Modulation), ER (Extended Range)
- Bluetooth 5.4 Dual Mode supporting BT BR/EDR (classic) and Bluetooth Low Energy (BLE) with coded PHY
- 802.15.4 (Thread and Zigbee-ready)

To complement built-in multi-mode radio, QCC74x series also integrate high-performance 32-bit RISC-V microcontroller that can run all protocol stacks and user applications, eliminating the need for an external host for increased cost saving. It also has integrated multimedia capability with built-in audio and video CODEC as well as camera and display interface. QCC74x series can function in hostless and hosted modes, allowing great flexibility for diverse IoT applications, which includes smart home devices, smart appliances, industrial IoT, medical devices, and so on.

Functional Block and Feature Highlights



Processor:
- 32-bit RISC-V at 325 MHz with DSP and FPU
- 128 KB ROM, 4 Kb eFuse and 1/2/4 KB OTP
- 484 KB on-chip SRAM (32 KB I-Cache and 16 KB D-Cache)
- Optional 4 MB (QCC744-2/4)/8 MB (QCC744-3)/16 MB (QCC744-5) pSRAM SiP
- Optional 8 MB(QCC744-4) NOR flash

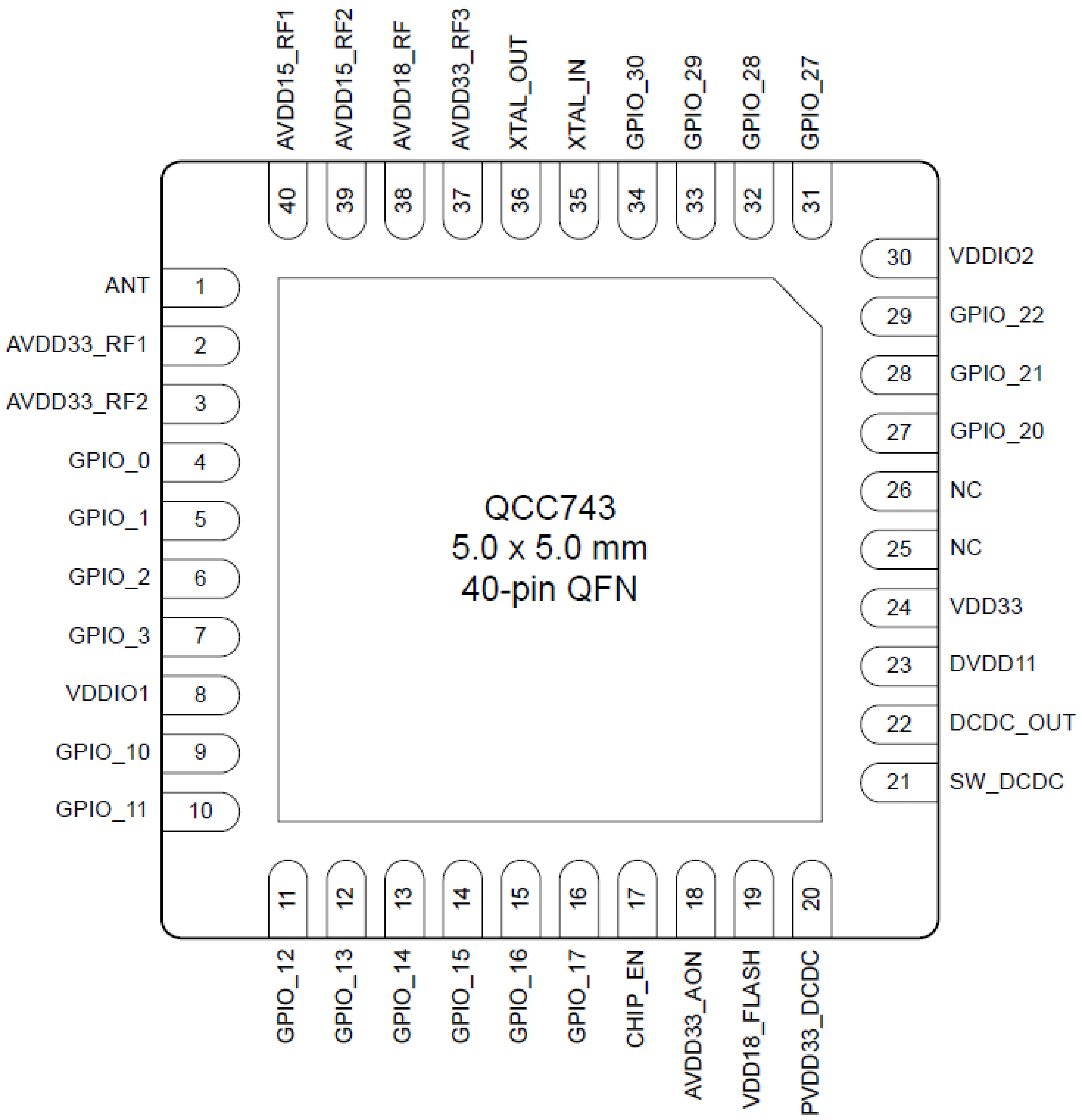
Wireless connectivity:
- 1x1 2.4 GHz 802.11b/g/n/ax (Wi-Fi 6), HT20/HT40, MCS9
- Bluetooth 5.3 Dual Mode
- 802.15.4 (Thread and Zigbee-ready)

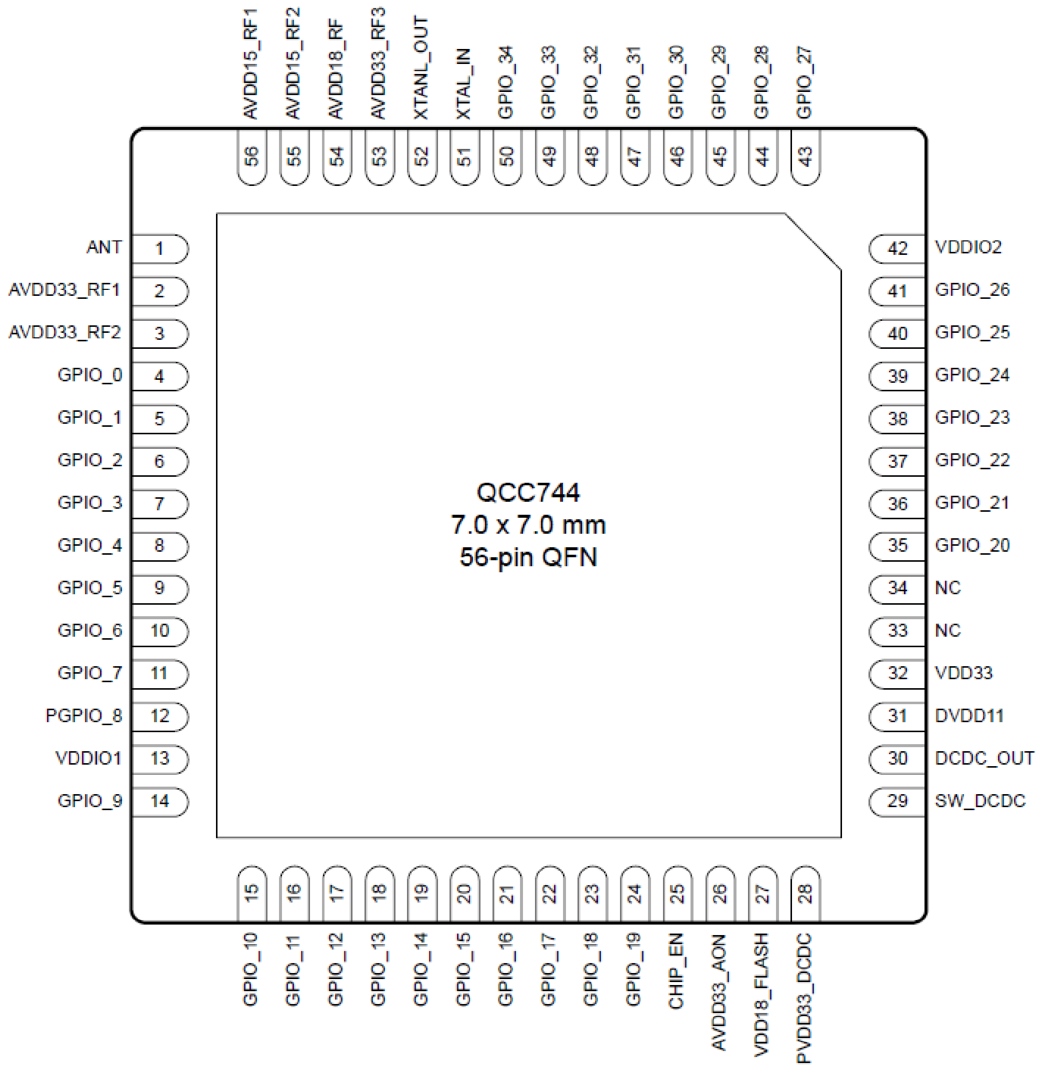
Advanced hardware security:
- Integrated hardware crypto acceleration
- Security services (secure boot, secure debug)
- PSA Certified Level 1

Peripherals:
- Up to 35 GPIOs (multiplexed)
- SD/MMC/SF, SDIO, QSPI, SPI, I2C, I2S, UART, PWM, ADC/DAC, CAN (ISO 11898), RMII

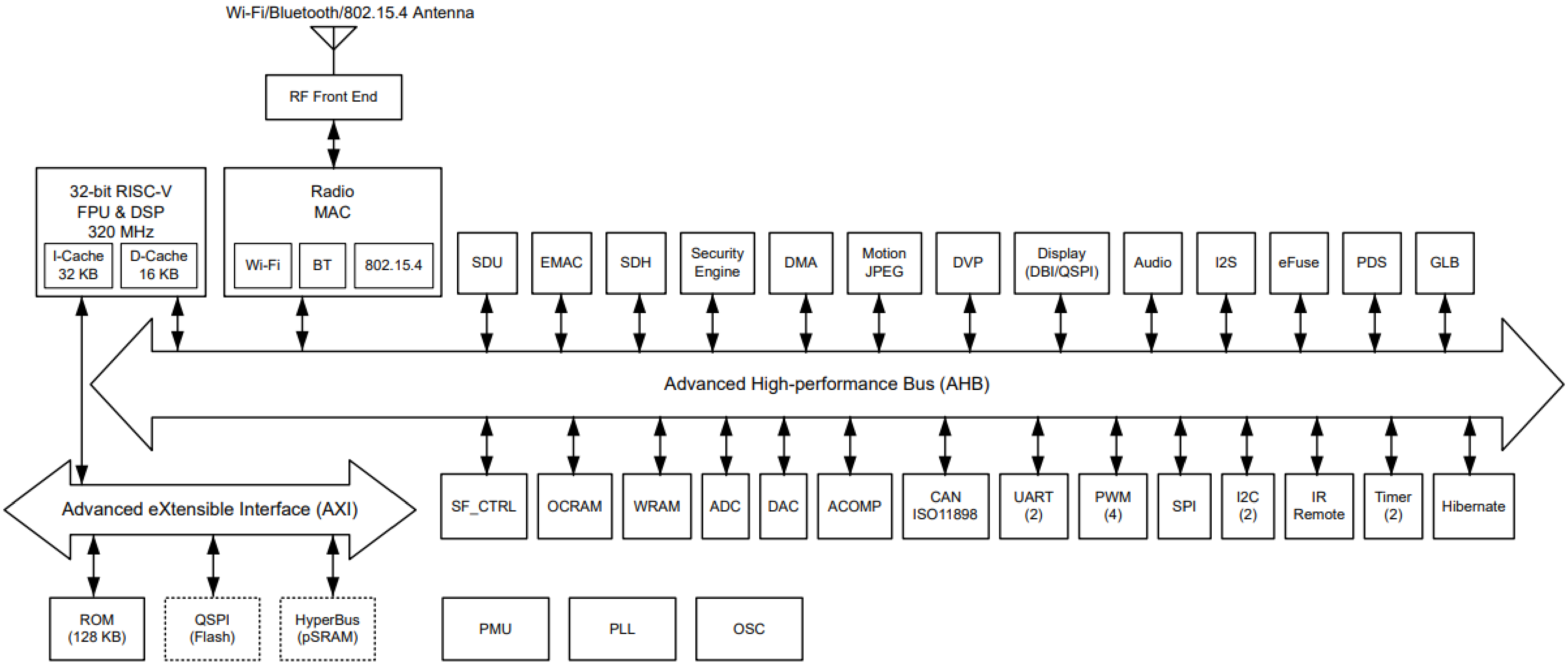
Multimedia:
- Motion JPEG at 720p (15-25 fps), DVP, MIPI DBI
- 1-channel ADC and 1-channel DAC at 8 k to 96 k sampling rate

Pin Assignments



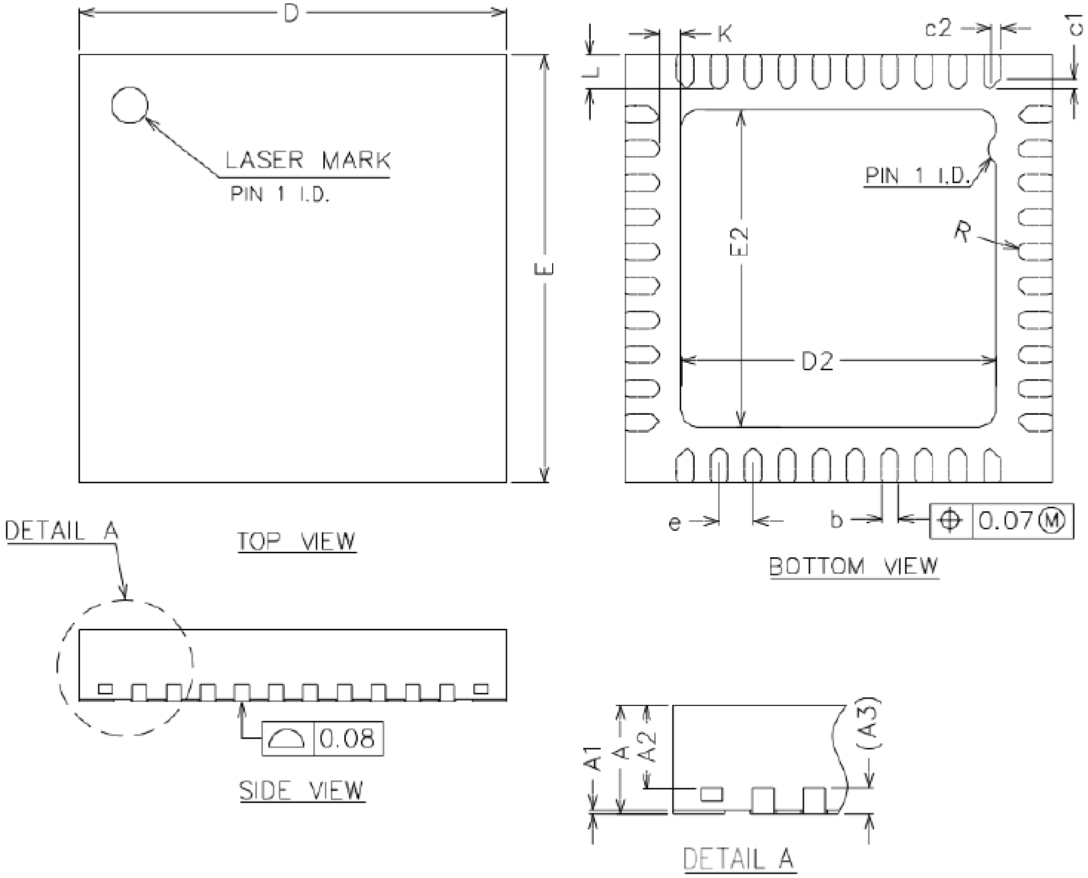


System Architecture

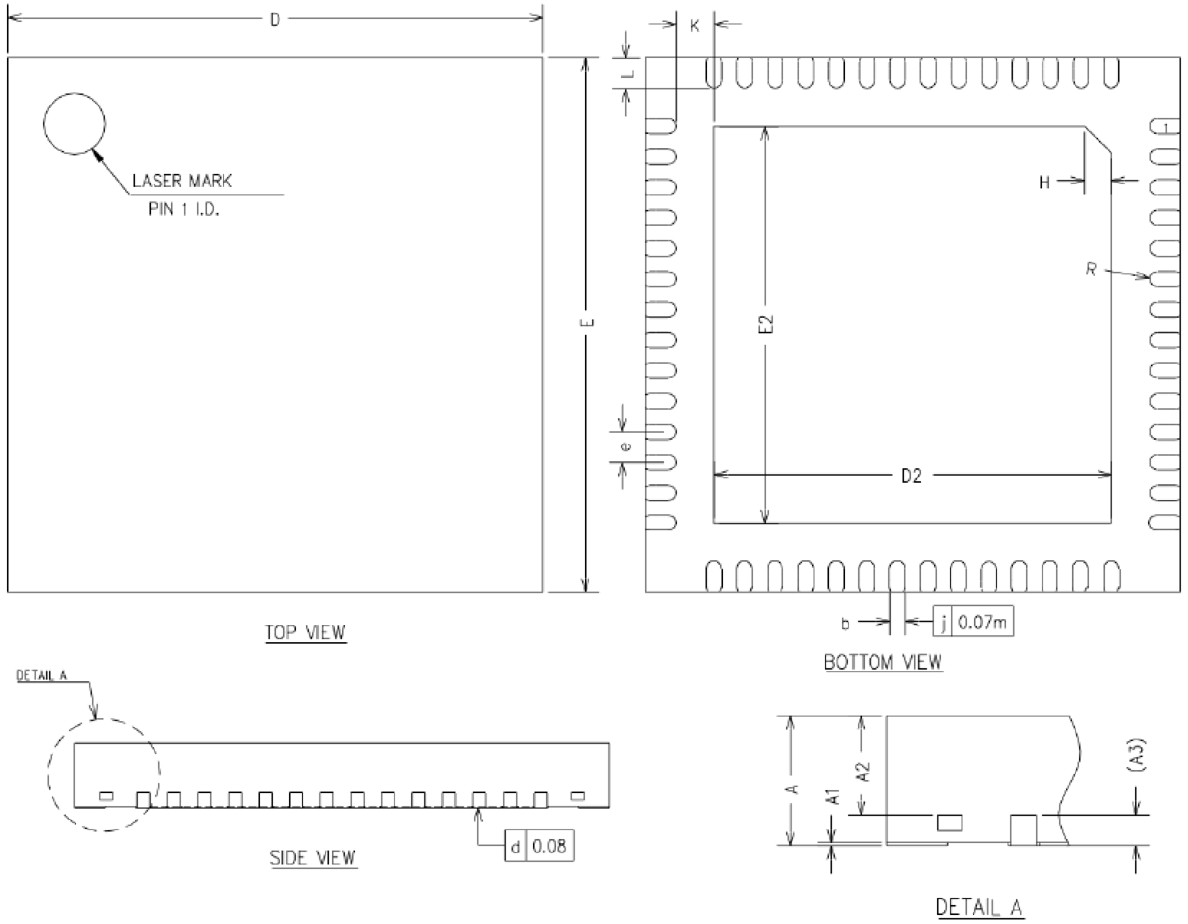


Package Configuration

- QFN-40 package drawing
- 5 mm x 5 mm x 0.9 mm



- QFN-56 package drawing
- 7 mm x 7 mm x 0.9 mm



Section 2

Supported Flash List

Supported Flash List

Brand	Model	JEDEC ID	Pin	Capacity	Voltage	tVSL MIN	Drive Support	Write Read Compare	Boot Support
Winbond	W25Q80DV	ef4014	8	1MB	3.3 V	10uS	OK	OK	OK
	W25Q16JV	ef4015	8	2MB	3.3 V	20uS	OK	OK	OK
	W25Q16JV	ef7015	8	2MB	3.3 V	20uS	OK	OK	OK
	W25Q32JV	ef4016	8	4MB	3.3 V	20uS	OK	OK	OK
	W25Q64JV	ef4017	8	8MB	3.3 V	20uS	OK	OK	OK
	W25Q128JV	ef4018	8	16MB	3.3 V	20uS	OK	OK	OK
	W25Q128JV	ef7018	8	16MB	3.3 V	20uS	OK	OK	OK
	W25Q256FV	ef4019	8	32MB	3.3 V	20uS	OK	OK	OK
	W25Q80EW	ef6014	8	1MB	1.8 V	10uS	OK	OK	OK
	W25Q16FW	ef6015	8	2MB	1.8 V	10uS	OK	OK	OK
	W25Q32FW	ef6016	8	4MB	1.8 V	20uS	OK	OK	OK
	W25Q64JW	ef6017	8	8MB	1.8 V	20uS	OK	OK	OK
	W25Q128FW	ef6018	8	16MB	1.8 V	10uS	OK	OK	OK
	W25Q32JW	ef8016	8	4MB	1.8 V	20uS	OK	OK	OK
	W25Q128JW	ef8018	8	16MB	1.8 V	20uS	OK	OK	OK
GigaDevice	MD25D40D	514013	8	512KB	3.3 V	500uS	OK	OK	OK
	GD25Q80E	c84014	8	1MB	3.3 V	1000uS	OK	OK	OK
	GD25Q16E	c84015	8	2MB	3.3 V	1000uS	OK	OK	OK
	GD25Q32E	c84016	8	4MB	3.3 V	1800uS	OK	OK	OK
	GD25Q64E	c84017	8	8MB	3.3 V	1800uS	OK	OK	OK
	GD25Q127C	c84018	8	16MB	3.3 V	2500uS	OK	OK	OK
	GD25LQ80C	c86014	8	1MB	1.8 V	1800uS	OK	OK	OK
	GD25LE16C	c86015	8	2MB	1.8 V	5000uS	OK	OK	OK
	GD25LQ32D	c86016	8	4MB	1.8 V	5000uS	OK	OK	OK
	GD25LQ64E	c86017	8	8MB	1.8 V	700uS	OK	OK	OK
	GD25LQ128E	c86018	8	16MB	1.8 V	2500uS	OK	OK	OK
	GD25WQ80E	c86514	8	1MB	1.8 V/3.3 V	1000uS	OK	OK	OK
	GD25WQ16E	c86515	8	2MB	1.8 V/3.3 V	1000uS	OK	OK	OK
	GD25WQ32E	c86516	8	4MB	1.8 V/3.3 V	1000uS	OK	OK	OK

Supported Flash List (cont.)

Brand	Model	JEDEC ID	Pin	Capacity	Voltage	tVSL MIN	Drive Support	Write Read Compare	Boot Support
MXIC	KH25V40	c22013	8	512KB	3.3 V	400uS	OK	OK	OK
	KH25V80	c22014	8	1MB	3.3 V	500uS	OK	OK	OK
	KH25V16	c22015	8	2MB	3.3 V	500uS	OK	OK	OK
	MX25V80	c22534	8	1MB	1.8 V	NA	OK	OK	OK
	MX25V16	c22535	8	2MB	1.8 V	800uS	OK	OK	OK
	MX25V32	c22536	8	4MB	1.8 V	NA	OK	OK	OK
	MX25L12845G	c22018	8	16MB	3.3 V	1200uS	OK	OK	OK
	MX25L25645G	c22019	8	32MB	3.3 V	NA	OK	OK	OK
	MX25U25643G	c22539	8	32MB	1.8 V	3000uS	OK	OK	OK
XTX	XT25F16B	0b4015	8	2MB	3.3 V	10uS	OK	OK	OK
	XT25F32B	0b4016	8	4MB	3.3 V	10uS	OK	OK	OK
	XT25F64B	0b4017	8	8MB	3.3 V	10uS	OK	OK	OK
	XT25F128B	0b4018	8	16MB	3.3 V	10uS	OK	OK	OK
	XT25Q80B	0b6014	8	1MB	1.8 V	10uS	OK	OK	OK
	XT25Q32B	0b6016	8	4MB	1.8 V	10uS	OK	OK	OK
Boya	BY25Q40B	684013	8	512KB	3.3 V	NA	OK	OK	OK
	BY25Q80B	684014	8	1MB	3.3 V	300uS	OK	OK	OK
	BY25Q16B	684015	8	2MB	3.3 V	300uS	OK	OK	OK
	BY25Q32B	684016	8	4MB	3.3 V	300uS	OK	OK	OK
	BY25Q64B	684017	8	8MB	3.3 V	NA	OK	OK	OK
	BY25Q128B	684018	8	16MB	3.3 V	NA	OK	OK	OK

Supported Flash List (cont.)

Brand	Model	JEDEC ID	Pin	Capacity	Voltage	tVSL MIN	Drive Support	Write Read Compare	Boot Support
Zbit	ZB25WQ16A	5e3415	8	2MB	3.3 V	500uS	OK	OK	OK
	ZB25VQ40	5e6013	8	512KB	3.3 V	10uS	OK	OK	OK
	ZB25VQ80	5e6014	8	1MB	3.3 V	10uS	OK	OK	OK
	ZB25VQ16	5e6015	8	2MB	3.3 V	10uS	OK	OK	OK
	ZB25Q16B	5e4015	8	2MB	3.3 V	500uS	OK	OK	OK
	ZB25Q32B	5e4016	8	4MB	3.3 V	NA	OK	OK	OK
XMC	XM25QH80B	204014	8	1MB	3.3 V	10uS	OK	OK	OK
	XM25QH16C	204015	8	2MB	3.3 V	1000uS	OK	OK	OK
	XM25QH32C	204016	8	4MB	3.3 V	1000uS	OK	OK	OK
	XM25QH64C	204017	8	8MB	3.3 V	NA	OK	OK	OK
	XM25QW64	204217	8	8MB	1.8 V/3.3 V	1000uS	OK	OK	OK
Puya	P25Q80H	856014	8	1MB	3.3 V	70uS	OK	OK	OK
	P25Q32H	856016	8	4MB	3.3 V	70uS	OK	OK	OK
	P25Q64H	856017	8	8MB	3.3 V	70uS	OK	OK	OK
	P25Q128H	856018	8	8MB	3.3 V	200uS	OK	OK	OK
FM	FM25Q128	a14018	8	16MB	2.7 V~3.6 V	10uS	OK	OK	OK
	FM25W128	a12818	8	32MB	3.3 V	10uS	OK	OK	OK

NOTES:

- Flash supports list only represents that the peripheral driver supports this model and does not guarantee the quality of Flash. Flash quality must be confirmed by user testing.
- Flash supports Quad-SPI.

Section 3

Mass Production Guide

Mass Production Guide

This section applies to the production test guidance of QCC74x chips.

- DTS file (OEM must read this carefully)
- Production test plan and production test process (OEM must read this carefully)
- RF calibration parameter storage scheme (R&D/production testers must read this carefully)
- Frequency offset parameter (production testers must read it carefully)
- RF production test value writing interface (production testers must read this carefully)

Section 3.1

DTS File

DTS File

DTS file is used to set RF-related parameters, such as the maximum transmit power under each Wi-Fi/BLE standard. It also controls RF frequency offset calibration, power calibration loading position and sequence.

DTS files can pass parameters to the firmware without modifying the code.

The DTS file path is: ./bsp/board/qcc743_lp_dk/config/qcc74x_factory_params_IoTKitA_auto.dts

Wi-Fi firmware configures RF radio, Tx power, Tx power offset, frequency offset and other parameters through the RF parameters in DTS.

The configurable parameters of RF are as follows:

- Power parameters: Set the transmit power of Wi-Fi in the four modes of b/g/n/ax and the corresponding speed. You can also set the transmit power of BLE.
- Power calibration mode and value: There are two power calibration modes. You can load the power calibration value from eFuse or load the power calibration value from a DTS file.
- Frequency offset calibration mode and value: There are two frequency offset calibration modes. You can load the frequency offset calibration value from eFuse or load the frequency offset calibration value from a DTS file.

DTS TLV Description

The RF configuration parameters are detailed in the following table.

Parameter	Description
xtal_mode	Set the frequency offset calibration loading mode
xtal	Used for scenario 1 when no RF production testing is performed, setting the frequency calibration experience value
pwr_mode	Set the power calibration loading mode
pwr_table_11b	11b maximum transmit power
pwr_table_11g	11g maximum transmit power
pwr_table_11n_ht20	Maximum transmit power at 20 MHz for 11n
pwr_table_11n_ht40	Maximum transmit power at 40 MHz for 11n
pwr_table_11ax_he20	Maximum transmit power at HE20 for 11ax
pwr_table_11ax_he40	Maximum transmit power at HE40 for 11ax
pwr_table_ble	BLE maximum transmit power
pwr_table_bt	Bluetooth maximum transmit power
pwr_table_zigbee	802.15.4 maximum transmit power
pwr_offset_wifi	Wi-Fi power calibration experience value used for scenario 1 when no RF production testing is performed.
pwr_offset_bz	BLE/802.15.4 power calibration experience value used for scenario 1 when no RF production testing is performed.

Set Frequency Offset Calibration Loading Mode

The parameter that sets the frequency offset calibration loading mode is xtal_mode, as described in the following table.

xtal_mode	Description
M	Only load frequency offset calibration values from eFuse (The values in eFuse are generally written after RF production testing.)
F	Only load the frequency offset calibration value from DTS (This value is the empirical value set by the user, the same below.)
MF	First load the frequency offset calibration value from eFuse. If the loading fails, load the frequency offset calibration value from DTS.
FM	First load the frequency offset calibration value from DTS. If the loading fails, load the frequency offset calibration value from eFuse.

Set Power Calibration Loading Mode

The parameter to set the power calibration loading mode is pwr_mode, as described in the following table.

pwr_mode	Description
B	Only load power calibration values from eFuse (The values in eFuse are generally written after RF production testing)
F	Only load the power calibration value from DTS (This value is the experience value set by the user, the same below)
BF	Load the power calibration value from eFuse first. If the loading fails, load the power calibration value from DTS
FB	Load the power calibration value from DTS first. If the loading fails, load the power calibration value from eFuse

For specific parameter usage and precautions, please refer to the comments of each parameter in the DTS file.

Section 3.2

Production Test

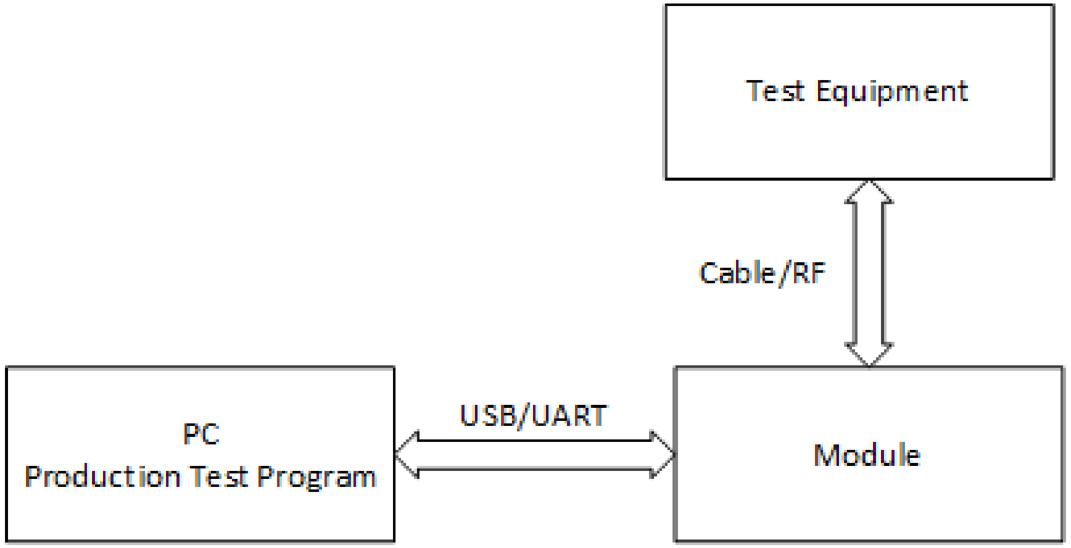
Production Test

The production test solution includes testing of multiple modules. For the software environment, we provide a series of command lines, including commands used for RF testing and other module testing. Users can use serial port tools to input commands for testing or integrate automation tools for testing.

Solution 1: Train Power and Frequency Offset Empirical Values

If RF power and frequency offset calibration are not required, MFG provides a method to set empirical values. Users can randomly inspect a batch of products by measuring each pwr_offset of this batch of products. Thus, the average Wi-Fi transmit power deviation value is found, and finally the average power error value is written into pwr_offset in DTS, and this Golden value is used as the default transmit power deviation. The frequency offset parameter can also be achieved by adjusting xtal.

The diagram of the test environment for training power and frequency offset empirical values is shown below.



Train Frequency Offset Empirical Value

The training frequency offset empirical value method is as follows:

1. Connect the module, test PC and RF test instrument according to the preceding diagram;
2. Complete MFG firmware programming or downloading. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20).
3. After the MFG firmware is running, enter the RF MFG test interface through QConn_RCT tool **MFG**, set the **Power** option in the basic configuration item to the target power Pset expected by the user (such as 17 dBm), and set the channel to be tested (such as channel 1). The **Auto** option of **CapCode** cannot be checked, and the default value is configured as 32. Set sending data packets (11n MCS7 recommended);
4. Use radio frequency instruments to measure the frequency deviation of the actual output signal;
5. If the frequency offset value is within the target range, the training is over, and the **CapCode** value at this time is the frequency offset value of the module;
6. If the frequency offset value exceeds the target range, adjust the **CapCode** value, click the **Misc Set** button, and repeat steps 4 and 5;
7. For each module to be randomly inspected, repeat steps 1-6 to obtain the **CapCode** of each module.
8. Calculate the average **CapCode** of this batch of modules, and then write the value into the first two items of the xtal array in the DTS file. For example, if the training result is 31, the written value is: xtal = <31 31 0 60 60 >;

Train Power Compensation Experience Value

The training power compensation experience value method is as follows:

1. Connect the module, test PC and RF test instrument according to the preceding diagram;
2. Complete MFG firmware programming or downloading. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20).
3. After the MFG firmware is running, enter the RF MFG test interface through QConn_RCT tool **MFG**, and set the **Power** option in the basic configuration item to the target power Pset expected by the user (such as 17 dBm);
4. Switch the channel to be tested (such as channel 1);
5. Set the data packet to be sent (11n MCS7 is recommended), and use a radio frequency instrument to measure the actual output power Pmea;
6. Calculate the power deviation value Perr = (Pset –Pmea)/0.25 (rounding is required), which is the power deviation value of the channel;
7. Calculate the power training result pwr_offset = 16 + Perr, which is the pwr_offset compensation value for the channel;
8. Repeat steps 4-7 for channels 1-14 to get the pwr_offset for each channel of this module.
9. For each module to be randomly inspected, repeat steps 1-8 to obtain the pwr_offset of each module.
10. Calculate the average pwr_offset for each channel of this batch of modules, and then write this value into the pwr_offset array in the DTS file.

Train Power Compensation Experience Value (cont.)

NOTE:

- When training the power compensation experience value, ensure that the correct frequency offset calibration value is filled in the **CapCode** and the **Auto** option is not checked.
- The pwr_offset array in the DTS file is used to adjust the power compensation value under different channels. The compensation unit is 0.25 dBm, and the compensation range is -4 dBm to 3.75 dBm, which facilitates the expression of negative numbers. Use 16 as base, that is, when pwr_offset=16, no compensation is performed. When pwr_offset=20, the power increases by 1 dBm. When pwr_offset=12, the power decreases by 1 dBm.

Verify Frequency Offset Empirical Values

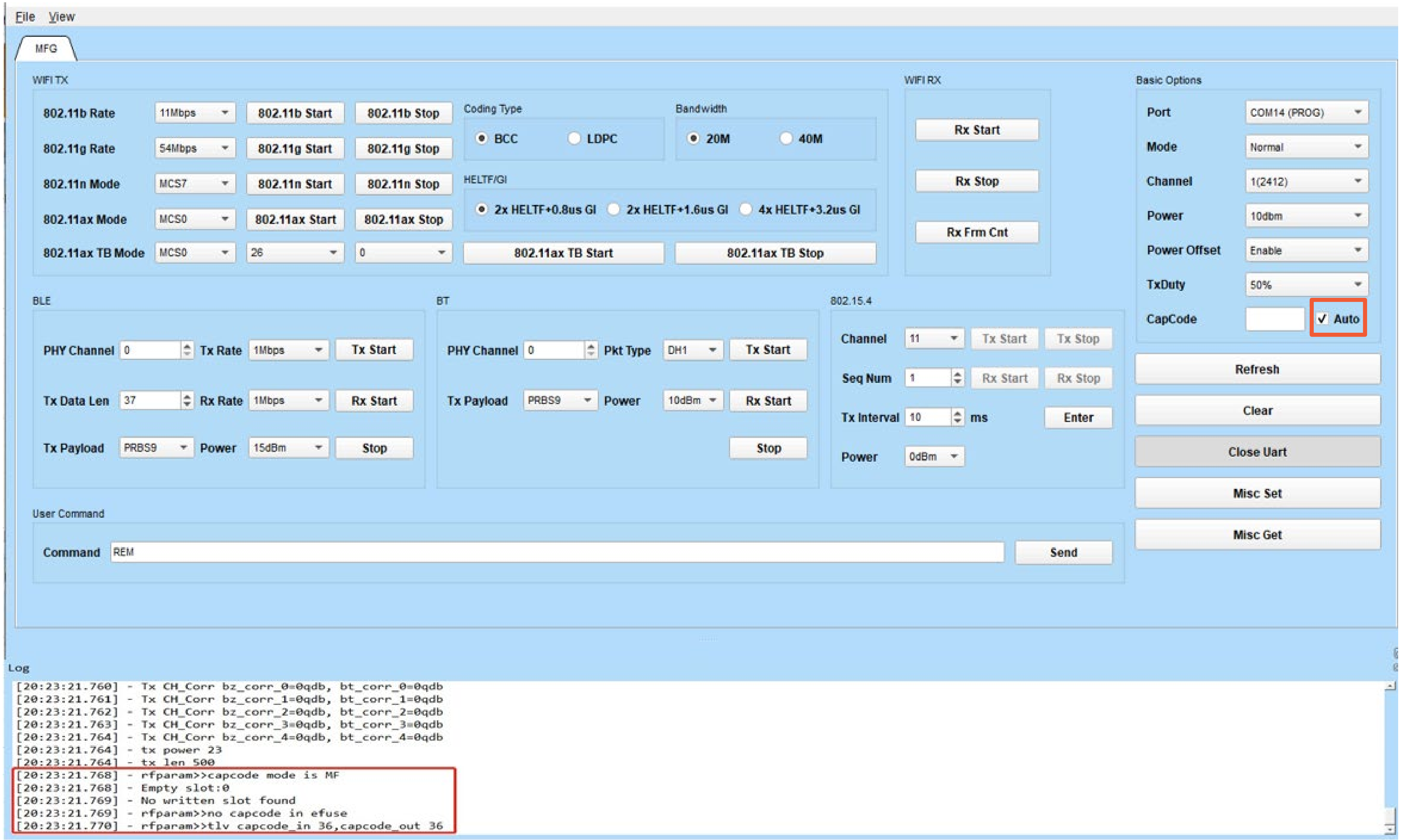
The method for verifying the frequency offset empirical value is as follows:

1. Prepare a module to be tested.
2. Ensure that xtal_mode in the DTS file is MF and xtal has been filled with the correct training value.
3. Complete MFG firmware programming or downloading. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20). At this time, the configuration in the DTS file will be burned into it.
4. After the MFG firmware is running, enter the RF MFG test interface through QConn_RCT tool **MFG**, and check the **Auto** option of **CapCode** in the basic configuration item. At this time, the MFG firmware loads the frequency offset value from DTS according to the mode set by xtal_mode in the DTS file. After the load fails from eFuse, it will be loaded from DTS.
5. Set the data packet to be sent and use the instrument to measure the actual output frequency.

After checking the **Auto** option of **CapCode**, the MFG firmware outputs the relevant log information as follows. The frequency offset calibration of **CapCode** is not found in eFuse, and the corresponding value of rftlv generated by dts is used:

At this time, the command sent by the host computer software to the firmware is X-1[\r\n], which means that the firmware loads the frequency offset values in the order set by xtal_mode in the DTS file. If **Auto** is not checked, the command sent by the host computer to the firmware is X + the value filled in by the user.

Log Information after Checking Auto (QConn_RCT)



Verify Power Compensation Experience Value

The method to verify the power compensation experience value is as follows:

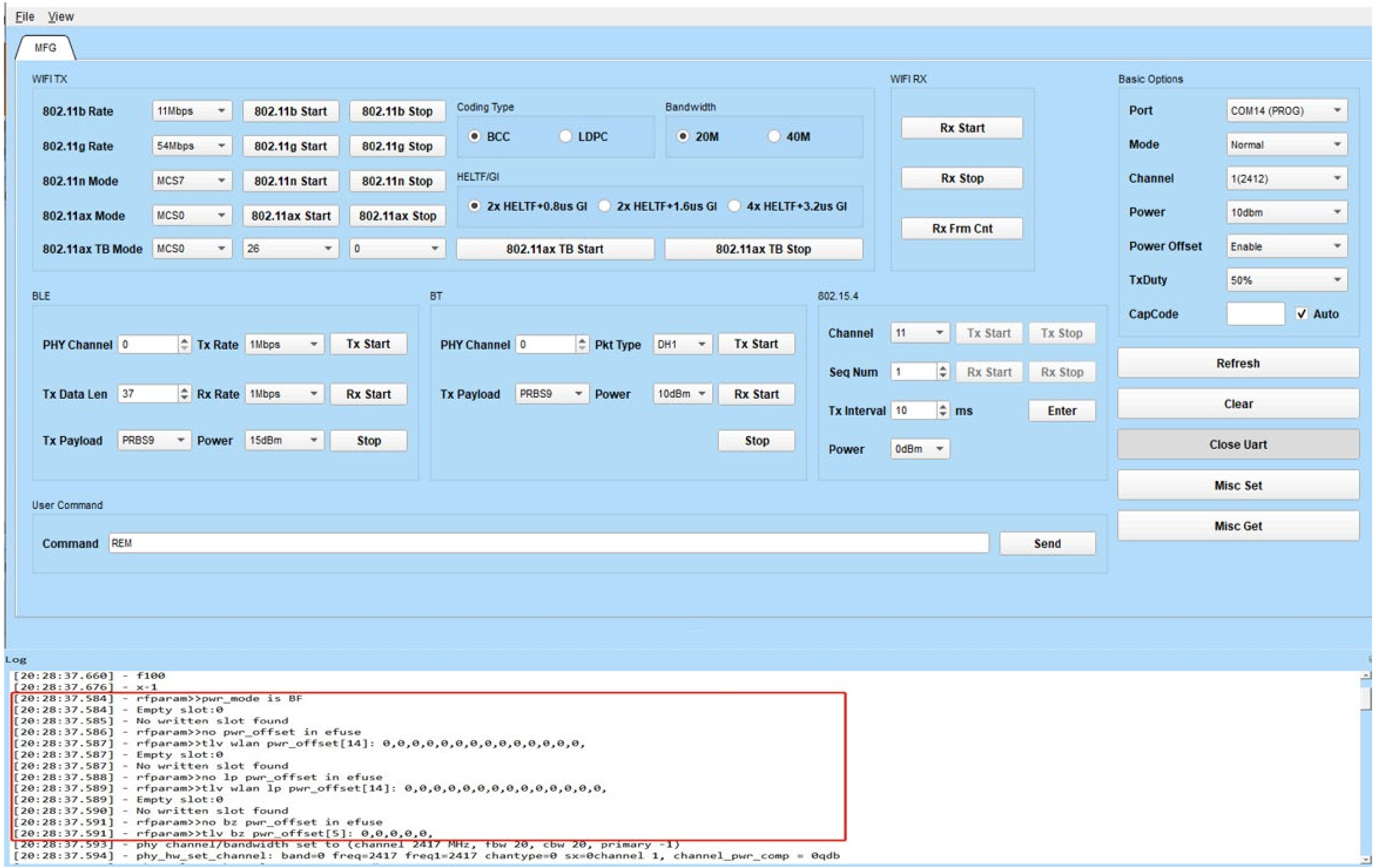
1. Prepare a module to be tested.
2. Ensure that the pwr_mode in the DTS file is BF and pwr_offset has been filled with the correct training value.
3. Complete MFG firmware programming or downloading. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20). At this time, the configuration in the DTS file may be burned into it.
4. After the MFG firmware is running, enter the RF MFG test interface through QConn_RCT tool **MFG**, and set the **Power Offset** in the basic configuration item to **Enable**. At this time, the MFG firmware loads the power calibration value from DTS according to the mode set by pwr_mode. After the loading fails from eFuse, it will be loaded from DTS.
5. Set the transmit power and use an instrument to measure the actual output power.

After enabling **Power Offset**, the MFG firmware outputs the relevant log information as follows for understanding.

NOTE:

- When verifying the power compensation experience value, if frequency offset calibration is performed, the **Auto** option of **CapCode** must be checked to use the frequency offset value after training.
- The command to enable Power Offset power compensation is V1[\r\n] or V-1[\r\n]. After receiving this command, the MFG firmware loads the power calibration according to the loading sequence set by pwr_mode in DTS. Load from eFuse. If eFuse fails, then read from the DTS file. If Power Offset selects Disable, the corresponding command is V0[\r\n]. At this time, the firmware will not add the power compensation calibration value in eFuse or DTS when setting the power.

Enable Power Offset Log Information (QConn_RCT)

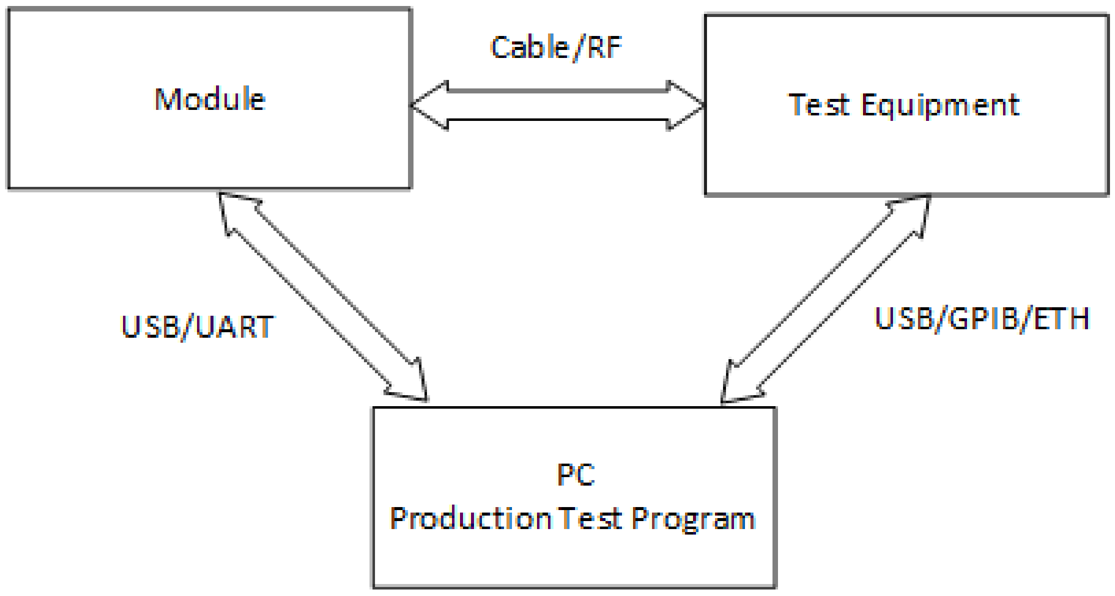


Solution 2: RF Performance Test/Calibration

For RF power and frequency offset calibration, MFG provides calibration methods. Users can test each product to obtain the power calibration value and frequency calibration value, and write the power calibration value and frequency calibration value into eFuse.

The diagram of the test environment for production testing/calibration is shown below.

NOTE: For DTS mode description, see pwr_mode and xtal_mode description in the DTS file.



RF Power Calibration

The RF power calibration method is as follows:

1. Connect the module, PC and RF test instrument according to the diagram.
2. Complete the programming or downloading of the MFG firmware. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20).
3. After the MFG firmware is running, the RF test host computer sets the channel, power, format and other parameters according to the communication protocol of the MFG firmware and starts sending.
4. Use an instrument to measure the actual output power, calculate the deviation between the set power and the actual power, and send the command WEPH/WEPL/WEPZ to write the power deviation value to eFuse.

RF Frequency Calibration

The RF frequency calibration method is as follows:

1. Connect the development board, PC and RF test instrument according to the diagram.
2. Complete the programming or downloading of MFG firmware. For detailed steps, see *QCC74x Evaluation Kit User Guide* (80-WL740-20).
3. After the MFG firmware is running, the RF test host computer sets the channel, power, format and other parameters according to the communication protocol of the MFG firmware and starts sending.
4. Use an instrument to measure the frequency offset of the signal, combine it with the frequency offset calibration algorithm to obtain the frequency offset calibration result, and send the command WEX to write the frequency offset calibration result to eFuse.

Comparison Between Solution 1 and Solution 2

Difference	Solution 1	Solution 2
Test equipment	PC/RF test equipment	PC/RF test equipment
Production equipment	PC	PC/RF test equipment
Test cost	High	High
Production cost	Low	High
Performance consistency	Low	High

Section 3.3

RF Calibration Parameter Storage

Calibration Parameter Storage Instructions in eFuse

The power calibration and frequency offset calibration values in RF production testing are stored in the eFuse inside the chip. The power calibration parameters include the power calibration value in Wi-Fi high-performance mode, the power value in low-power mode and the BLE/802.15.4 power calibration value. Since eFuse can only be written once and cannot be modified, we provide three locations for writing, that is, there are 3 writing opportunities. In addition, due to eFuse space limitations, for Wi-Fi power calibration, we only provide calibration values for the three channels (1/7/13) of high, middle and low channels (1/7/13) in eFuse. Calibration values for other channels must be calculated by software interpolation.

BLE has 40 channels and BT has 80 channels. For these two communication standards, it is recommended to select 5 channels for power calibration, which are 2412MHz/2432MHz/2448MHz/2464MHz/2476MHz. In the same way, the calibration values of other channels also must be calculated by software interpolation.

Power Calibration and Frequency Offset Calibration Values

Calibration value	Description	Number of writes allowed	Remark
xtal	Frequency offset calibration parameters	2	
power_offset_hp	Power calibration values in Wi-Fi high performance mode	3	Stores three channels: high, middle and low
power_offset_lp	Power calibration values in Wi-Fi low-power mode	3	Stores three channels: high, middle and low
power_offset_bz	BLE/802.15.4 power calibration values	3	Five channels are stored
mac	MAC address	2	

NOTE:

The frequency offset, power offset and mac address are reserved for writing three times in eFuse, which are slot0, slot1 and slot 2 respectively. The xtal and mac addresses are written once when they leave the factory, that is, slot 0, so the number of times the user is allowed to write is 2. The hardware environment of the chip manufacturer is different from the customer's hardware environment. If the slot 0 of xtal not written by the manufacturer, then mfg processes the "X-1" command and it will not read the slot 0 of xtal. Users can use the factory mac address, or write the mac address again according to needs.

Section 3.4

Frequency Offset Parameter

Frequency Offset Parameter

Regarding the load capacitance of the crystal, the QCC74x series chips have internal capacitance compensation. Different load capacitance requirements correspond to different capacitance compensation values.

NOTE: Actual PCB traces also have a certain amount of parasitic capacitance, so the best compensation value is based on actual test results.

The following table provides capacitor compensation reference values.

XTAL Loading Capacity (pF)	Capacity Code
10	27
12	32

Section 3.5

RF Production Test Value Writing Interface

Frequency Offset Calibration Writing Interface (WEX)

MFG firmware provides the WEX interface for programming frequency offset values to eFuse.

The specific usage is as follows:

```
WEX[Capcode]
```

Assume that the frequency offset value measured using the tool is 36, calling the command WEX36 can write the frequency offset value into eFuse.

Wi-Fi Power Calibration Writing Interface (WEPH and WEPL)

MFG firmware provides WEPH and WEPL interfaces for programming Wi-Fi power calibration values to eFuse.

WEPH is used to program power calibration in Wi-Fi high-performance mode, and WEPL is used to program power calibration in Wi-Fi low-power mode.

The specific usage is as follows:

```
WEPH[Channel 1 power offset],[Channel 2 power offset]...[Channel 13 power offset],[Channel
  14 power offset]
```

14 of the parameters correspond to the power compensation values of Wi-Fi channel 1 ~ channel 14 respectively. The value range of power offset is -16~15, and the adjustment accuracy is 0.25 dBm/code.

It can be seen from the above that during actual calibration in the factory, only the power calibration of channel 1, 7, and 13 is performed, and other channels are supplemented with 0.

If the transmit power of channel 1 is set to 15 dBm, the measured transmit power is 14 dBm, the transmit power of channel 7 is 15 dBm, and the measured transmit power is 15.25 dBm. The transmit power of channel 13 is 15 dBm, and the measured transmit power is 15.5 dBm. Then the command sent should be:

```
WEPH4,0,0,0,0,0,-1,0,0,0,0,0,-2,0
```

WEPL is similar to WEPH.

BLE/802.15.4 Power Calibration Writing Interface (WEE)

MFG firmware provides the interface WEE for programming BLE power calibration values to eFuse.

The specific usage is as follows:

```
WEE[2412MHz power offset],[2432MHz power offset],[2448MHz power offset],[2464MHz power offset],[2476MHz power offset]
```

The value range of power offset is -16~15, and the adjustment accuracy is 0.25 dBm/code.

Assume that the power errors of each channel are 0.5 dBm, 0.5 dBm, 0.25 dBm, 0 dBm, -0.25 dBm, respectively. Then the command sent should be:

```
WEE2,2,1,0,-1
```

MAC Address Writing Interface (WEM)

MFG firmware provides the WEM interface for burning the MAC address to eFuse.

The specific usage is as follows:

```
WEM[mac_b0]:[mac_b1]:~[mac_b5]
```

Assume that the MAC address 8C:FD:F0:82:73:40 must be written, then call the command WEM 8C:FD:F0:82:73:40 to write the MAC address into eFuse. The MAC address can be written twice, and the MAC address used by the program is based on the last write.

Section 3.6

RF Test Command Usage

RF Test Command Usage

If users develop RF production test software, they must send commands through UART. The baud rate is 115200, the data bits are 8 bits, and there is no parity check. Before starting the test, you must ensure that the MFG firmware has been burned into the chip Flash, the module has been started from Flash, and the handshake with the MFG firmware through the “H” command is normal.

Frequency Offset Calibration Command Usage Process

1. Connect the development board, PC and RF test instrument according to the schematic diagram.
2. Complete the programming or downloading of MFG firmware.
3. After the MFG firmware is running, send the command as shown below.

```
V0  /*Do not load any power calibration values*/
c1  /*Switch to channel1*/
p15 /*Power  15dBm*/
d50 /*50% duty*/
l500  /*Packet length 500*/
f100  /*Packet sending frequency 100*/
mlm27 /*11n,MCS7*/
t1  /*Enable sending*/
```

4. At this time, the production test chip is in the transmitting state, and an instrument is used to measure the signal frequency offset, and the CapCode value is adjusted according to the frequency offset. Assume that the initial judgment setting value is 31, and then send the command:

```
X31
```

5. Use the instrument again to measure the signal frequency offset, and adjust and set the CapCode value according to the frequency offset. Assume that the value set is 32, and then send the command:

```
X32
```

Frequency Offset Calibration Command Usage Process (cont.)

6. Repeat steps 4 and 5 until the final frequency offset value is found. Assume that the final confirmed frequency offset value is 32, use the WEX command to write the frequency offset calibration value, and the frequency offset calibration is completed.

```
WEX32  /*Pre-write  frequency  offset  32*/
LEX/*Read  the  frequency  offset  and  confirm  whether  it  is  32*/
SEX/*Confirm  writing*/
REX/*Read the frequency offset again to confirm whether it is 32*/
```

Wi-Fi Power Calibration Command Usage Process

Taking the measurement of the power calibration value of each channel in high-performance mode as an example, the command usage process of power calibration is as follows:

1. Connect the development board, PC and RF test instrument.
2. Complete the programming or downloading of the MFG firmware.
3. After the MFG firmware is running, send the command as shown below.

```
V0 /*Do not load any power calibration values*/
c1 /*Switch to channel1*/
p16 /*Power 16dBm, customers can set the target power according to their needs */
d50 /*50% duty*/
l500  /*Packet length 500*/
f100  /*Packet sending frequency 100*/
mlm27 /*11n,MCS7*/
t1 /*Enable sending*/
```

4. Use an instrument to measure the actual power output and calculate the power offset value for set channel according the calibration procedure.
5. Stop Tx, then change the channel to intended frequency, and start Tx to measure the power offset value.

```
t0
c7 /* Customers can change the channels to be calibrated in sequence according to their needs */
t1
```

Wi-Fi Power Calibration Command Usage Process (cont.)

6. Repeat steps 4-5. After testing channel 1/7/13, 3 power deviation values are obtained. Assume that the deviation value is 1/-0.25/-0.5 dBm, use the WEPH command to write the power calibration value, and the power calibration is completed.

```
WEPH4,0,0,0,0,0,-1,0,0,0,0,0,-2,0 /*Pre-written power calibration value*/
LEPH /*Read the power calibration value to determine whether it is correct*/
SEPH /*Confirm writing*/
REPH /*Read the power calibration value again to determine whether it is correct*/
```

BLE Power Calibration Command Usage Process

The command usage process of BLE power calibration is as follows:

1. Connect the development board, PC and RF test instrument.
2. Complete the programming or downloading of the MFG firmware.
3. After the MFG firmware is running, send the command as shown below.

   ```
   V0  /*Do not load any power calibration values*/
   ETE032500010f   /*Power 15dBm, customers can set the target power according to their needs */
   ```

4. Use an instrument to measure the actual power output and calculate the power offset value for set channel according the calibration procedure.
5. Stop Tx, then change the channel to intended frequency, and start Tx to measure the power offset value.

   ```
   EE  /*Stop BLE sending*/
   ETE052500010f   /*Customers can change the channels to be calibrated in sequence according to their
      needs.*/
   ```

6. Repeat steps 4-5. After testing channel 6/16/24/32/38, 5 power deviation values are obtained. Assume that the deviation value is 1/-0.25/-0.5/0.25/0.5 dBm, use the WEE command to write the power calibration value, power calibration completed

   ```
   WEE4,-1,-2,1,2, /*Pre-written power calibration value*/
   
   LEE/*Read the power calibration value to determine whether it is correct*/
   
   SEE/*Confirm writing*/
   
   REE/*Read the power calibration value again to determine whether it is correct*/
   ```

802.15.4 Power Calibration Command Usage Process

The command usage process of 802.15.4 power calibration is as follows:

1. Connect the development board, PC and RF test instrument according to the schematic diagram.
2. Complete the programming or downloading of the MFG firmware.
3. After the MFG firmware is running, send the command as shown below

```
V0 /*Do not load any power calibration values*/
m154_enter /*Enter 802.15.4 test mode*/
c13 /*Set channel index*/
q1 /*Set sequence number*/
f500 /*Set Tx packet frequency*/
p15 /*Power 15dBm, customers can set the target power according to their needs*/
t1 /*Start Tx test*/
```

4. Use an instrument to measure the actual power output and calculate the power offset value for set channel according the calibration procedure
5. Stop Tx, then change the channel to intended frequency, and start Tx to measure the power offset value.

```
t0 /*Stop Tx test*/
c17 /*Customers can change the channels to be calibrated in sequence according to their needs*/
t1 /*Start Tx test*/
```

802.15.4 Power Calibration Command Usage Process (cont.)

6. Repeat steps 4-5. After testing channel 13/17/20/23/26, 5 power deviation values are obtained. Assume that the deviation value is 1/-0.25/-0.5/0.25/0.5dBm, use the WEE command to write the power calibration value, power calibration completed.

```
t0 /*Stop Tx test*/
m154_exit /*Exit 802.15.4 test mode*/

WEE4,-1,-2,1,2, /*Pre-written power calibration value*/
LEE /*Read the power calibration value to determine whether it is correct*/
SEE /*Confirm writing*/
REE /*Read the power calibration value again to determine whether it is correct*/
```

Section 3.7

I/O Test Command Usage

I/O Test Command Usage

During the RF production testing stage, module I/O testing is generally performed, so MFG also provides module I/O testing functions. The I/O test requires that the number of I/O being tested is an even number and divided into two groups. The GPIOs in each group are connected to the other groups in a one-to-one correspondence. The basic principle of I/O testing is that one group of I/O is used as output, outputting high level and low level respectively; the other group of I/O reads the corresponding input pins respectively. Determine whether the read level is correct, and then exchange the input group and output group to test whether the other group of I/O outputs is normal.

Take GPIO1, 3, 5, 7, 11 as one group and GPIO2, 4, 6, 8, 16 as another example. After the test fixture is pressed down, GPIO1 is connected to GPIO2, GPIO3 is connected to GPIO4, GPIO5 is connected to GPIO6, GPIO7 is connected to GPIO8, and GPI11 is connected to GPIO16.

Send an IoT command to understand MFG about I/O grouping status and conduct testing.

```
IOT1,3,5,7,11+2,4,6,8,16
```

If the I/O test passes, MFG prints

```
"IO Test Pass\r\n"
```

Otherwise, MFG prints the following log with detailed error information.

```
"IO Test Fail\r\n"
```

Section 3.8

RF Test Command Description

RF Test Command Description

The host computer program and the test firmware communicate through UART. The baud rate used is 115200, the data bits are 8 bits, and there is no parity check. Both send commands and return commands end with the characters “\r\n”.

Shakehand

- Command: H
- Return: mfg

The host tool should first send the “H” command to detect whether the MFG firmware is already running. If the MFG firmware is already running, it will respond with “mfg” after receiving the “H” command. If MFG is not running:

1. The host sends the “mfg” command at the baud rate used by the normal firmware (default 2000000) to switch the normal firmware to the MFG firmware.
2. The host sends the “H” command using the baud rate of 115200 and checks whether it can receive the “mfg” response.
3. If the host cannot receive “mfg”, repeat step 1.
4. The host can perform normal testing after receiving “mfg”.

Wi-Fi

- Wi-Fi Tx On/Off
  - On: t1/T1
  - Off: t0/T0
- Wi-Fi Tx Modulation 2.4G 11ax
  - coding type = 0 – 1, 0: BCC 1: LDPC
  - HELTF/GI = 0 – 2, 0: 2x HELTF+0.8us GI 1: 2x HELTF+1.6us GI 2: 4x HELTF+3.2us GI
  - mcs idx = 00 – 18, 00: MCS0 01: MCS1 02: MCS2 03: MCS3 04: MCS4 05: MCS5 06: MCS6 07: MCS7 08: MCS8 09: MCS9 12: DCM-MCS0 13: DCM-MCS1 14: DCM-MCS3 15: DCM-MCS4 16: ER-MCS0 17: ER-MCS1 18: ER-MCS2
  - bw idx = 0 – 3, 0: 20 MHz 1: 40 MHz 2: 80 MHz 3: 160 MHz
  - Command: Q[Coding Type][HELTF/GI][mcs idx][bw idx]
- Wi-Fi Tx Modulation 2.4G 11n
  - mcs idx = 0 - 7
  - coding type = 0 – 1, 0: BCC 1: LDPC
    - short GI + HT-GF + HT20: msg2[mcs idx][coding type]
    - short GI + HT-MF + HT20: msm2[mcs idx][coding type]
    - long GI + HT-GF + HT20: mlg2[mcs idx][coding type]
    - long GI + HT-MF + HT20: mlm2[mcs idx][coding type]
    - short GI + HT-GF + HT40: msg4[mcs idx][coding type]
    - short GI + HT-MF + HT40: msm4[mcs idx][coding type]
    - long GI + HT-GF + HT40: mlg4[mcs idx][coding type]
    - long GI + HT-MF + HT40: mlm4[mcs idx][coding type]

Wi-Fi (cont.)

- Wi-Fi Tx Modulation 2.4G 11g
  - rate idx = 0 - 7, 0: 6Mbps 1: 9Mbps 2: 12Mbps 3: 18Mbps 4: 24Mbps 5: 36Mbps 6: 48Mbps 7: 54Mbps
    - Long Preamble: G[rate idx]
    - Short Preamble: g[rate idx]
- Wi-Fi Tx Modulation 2.4G 11b
  - rate idx = 0 - 3, 0: 1Mbps 1: 2Mbps 2: 5.5Mbps 3: 11Mbps
    - Long Preamble: B[rate idx]
    - Short Preamble: b[rate idx]
- Wi-Fi 2.4G Channel
  - channel idx = 1 - 14
  - Command: c[channel idx]
- Wi-Fi 2.4G Tx Power
  - power dbm = -15 - 24dbm
  - Command: p[power dbm]
  - NOTE: p-1 means loading the power parameters from the DTS TLV parameters and setting the power according to the rules defined in DTS.

Wi-Fi (cont.)

- Wi-Fi Tx Frame Length
  - Command: l[length]
- Wi-Fi Tx Frequency
  - max value=1000
  - Command: f[freq]
- Wi-Fi Rx
  - start lp rx r:le
    - Enter Wi-Fi low-power receiving state, currently only supports receiving current measurement
  - exit lp rx exit_lpfw
    - Exit Wi-Fi low-power reception state
- Wi-Fi LP Rx
  - start lp rx r:le
    - Enter Wi-Fi low-power receiving state, currently only supports receiving current measurement
  - exit lp rx exit_lpfw
    - Exit Wi-Fi low-power reception state

PDS

Enter PDS mode

- set pds mode sl[mode]
  - The mode can be 1/3/7/15, and the default in the firmware is 15. If you are testing the power consumption of PDS15, you do not need to send this command.
  - Return: pds mode=[mode]
- set device sleep forever sa
  - This command can keep the chip in sleep state
  - This command has no return.
- set device sleep for a specified time. Unit is microsecond s[sleep time in ms]
  - This command can make the chip wake up after sleeping for a period of time. For example, s5000 makes the chip wake up after sleeping for 5 seconds.
  - This command has no return.

Get

- Get MFG Tx Duty
  - Command: y:i
  - Return: #*#*duty:[tx duty]
- Get MFG Firmware Version
  - Command: y:v
  - Return: #*#*version:[version]
- Get MFG Firmware Building Information
  - Command: y:d
  - Return: #*#*date:[building date] time:[building time]
- Get Current Power Level
  - Command: y:p
  - Return: #*#*power:[power level dbm]
- Get Current Channel
  - Command: y:c
  - Return: #*#*channel:[channel freq]

Get (cont.)

- Get Current Tx Status
  - Command: y:t
  - Return: #*#*tx:[0 or 1]
- Get Tx Frequency
  - Command: y:f
  - Return: #*#*freq:[tx frequency]
- Get CapCode
  - Command: y:x
  - Return: #*#*capcode:[capcode value]
- Get MFG Mode
  - Command: y:M
  - Return: #*#*mfgmode:[MFG mode]

Set

- Set CapCode
  - cap code:
    - 0 - 63, set value to PHY RF
    - -1 for applying cap code which is loaded from eFuse
    - -2 for applying cap code which is loaded from eFuse buffer
  - Command: X[cap code]
- Set MFG Test (CW) Mode
  - 0 for normal mode
  - 1 for CW test mode
  - Command: M[MFG mode]
- Set Power Offset Mode
  - 0 for clear power offset
  - 1 for applying power offset which is loaded from eFuse
  - 2 applying power offset which is loaded from eFuse buffer for hp
  - 3 for applying power offset which is loaded from eFuse buffer for lp
  - 4 applying power offset which is loaded from eFuse buffer for BT
  - Command: V[power offset mode]

Save Parameter to eFuse

Note that eFuse cannot be modified after writing. When using eFuse to set parameters, ensure that the chip correctly receives the parameters sent by the host. Therefore, the host must be set according to the following process:

1. The host uses the WEX/WEPH/WEPL/WEE/WEM command to send the data to be written to MFG's firmware. At this time, the firmware only temporarily stores the data and does not write it to eFuse.
2. The host uses the LEX/LEPH/LEPL/LEE/LEM command to read the set parameters from the eFuse temporary storage area and determine whether the firmware has received it correctly. If it has not received it correctly, repeat step 1.
3. After the host determines that the set parameters are correct, use the SEX/SEPH/SEPL/SEE/SEM command to actually write the parameters into eFuse.
4. The host uses the REX/REPH/REPL/REE/REM command to read the set parameters from eFuse. If the verification is correct, it can be considered that the writing to eFuse is successful.

Save Parameter to eFuse (cont.)

- Write Cap Code to eFuse Buffer
  - Command: WEX[cap code]
- Load Cap Code from eFuse Buffer
  - Command: LEX
  - Return: Cap code2:[cap code]
- Program Cap Code to eFuse
  - Command: SEX
- Read Cap Code from eFuse
  - Command: REX
  - Return: Cap code2:[cap code]

Save Parameter to eFuse (cont.)

- Write High-Performance Mode Power Offset to eFuse Buffer
  - Command: WEPH[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset],[Channel 14 power offset]
  - Example: Write the power calibration of Channel 1-14: -1,2,3,3,3,2,1,0,-1,-2,-3,-4,1,3
  - WEPH-1,2,3,3,3,2,1,0,-1,-2,-3,-4,1,3
  - NOTE: If the power calibration uses the linear interpolation method, for example, only the calibration of channels 1, 7, and 13 is performed, but the values of 14 channels still must be passed when using the WEP command, and the calibration values of other channels can be written as 0. In the same way, if you only calibrate certain two channels, you also must transfer the values of 14 channels. The power calibration value of the channel you don't care about can be set to 0.
- Load High-Performance Mode Power Offset from eFuse Buffer
  - Command: LEPH
  - Return: Power offset:[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset], [Channel 14 power offset]
- Program High-Performance Mode Power Offset to eFuse
  - Command: SEPH
- Read High-Performance Mode Power Offset from eFuse
  - Command: REPH
  - Return: Power offset:[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset], [Channel 14 power offset]

Save Parameter to eFuse (cont.)

- Write Low-Power Mode Power Offset to eFuse Buffer
  - Command: WEPL[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset],[Channel 14 power offset]
  - Example: Write the power calibration of Channel 1-14: -1,2,3,3,3,2,1,0,-1,-2,-3,-4,1,3

    ```
    WEPL-1,2,3,3,3,2,1,0,-1,-2,-3,-4,1,3
    ```
  - Note: If the power calibration uses the linear interpolation method, for example, only the calibration of channels 1, 7, and 13 is performed, but the values of 14 channels still must be passed when using the WEP command, and the calibration values of other channels can be written as 0. In the same way, if you only calibrate certain two channels, you also must transfer the values of 14 channels. The power calibration value of the channel you don't care about can be set to 0.
- Load Low-Power Mode Power Offset from eFuse Buffer
  - Command: LEPL
  - Return: Power offset:[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset], [Channel 14 power offset]
- Program Low-Power Mode Power Offset to eFuse
  - Command: SEPL
- Read Low-Power Mode Power Offset from eFuse
  - Command: REPL
  - Return: Power offset:[Channel 1 power offset],[Channel 2 power offset]...[Channel 12 power offset], [Channel 14 power offset]

Save Parameter to eFuse (cont.)

- Write bz Power Offset to eFuse Buffer
  - Command: WEE[2412MHz power offset],[2432MHz power offset],[2448MHz power offset],[2464MHz power offset],[2476MHz power offset]
  - Example: Write power calibration -1,2,3,3,3
  - WEE-1,2,3,3,3
- Load bz Power Offset from eFuse Buffer
  - Command: LEE
  - Return: bz Power offset:[2412MHz power offset],[2432MHz power offset],[2448MHz power offset],[2464MHz power offset],[2476MHz power offset]
- Program bz Power Offset to eFuse
  - Command: SEE
- Read bz Power Offset from eFuse
  - Command: REE
  - Return: bz Power offset:[2412MHz power offset],[2432MHz power offset],[2448MHz power offset],[2464MHz power offset],[2476MHz power offset]

Save Parameter to eFuse (cont.)

- Write MAC Address to eFuse Buffer
  - Command: WEM[MAC0 hex string]:[MAC1 hex string]:[MAC2 hex string]:[MAC3 hex string]:[MAC4 hex string]:[MAC5 hex string]
  - Example: WEM 18:b9:05:de:6c:75
- Check MAC Address in eFuse Buffer
  - Command: LEM
  - Return: MAC:[MAC0 hex string]:[MAC1 hex string]:[MAC2 hex string]:[MAC3 hex string]:[MAC4 hex string]:[MAC5 hex string]
- Program MAC Address to eFuse
  - Command: SEM
- Reboot the DUT and Confirm the MAC Address
  - Command: REM
  - Return: MAC:[MAC0 hex string]:[MAC1 hex string]:[MAC2 hex string]:[MAC3 hex string]:[MAC4 hex string]:[MAC5 hex string]

NOTE:

MAC addresses should be programmed with an increment step of 3.

Firmware uses the MAC in eFuse for Wi-Fi (STA), MAC + 1 for Wi-Fi (SAP), MAC + 2 for BT. No change for 802.15.4.

For one chip, three MAC addresses are used and should never be used again.

Save Parameter to eFuse (cont.)

- Write Data to eFuse Buffer
  - Command: WEB[addr]=[data hex string]
  - Example:
  - WEB0x00000100=8CFDF0827340
  - NOTE: The written data is in the form of a byte stream, with a maximum length of 256 bytes.
- Load Data from eFuse Buffer
  - Command: LEB[addr]L[len]
  - Example:
  - Read 32 bytes from address 0x00000100
  - LEB0x00000100L0x20
- Program Data to eFuse
  - Command: SEB
- Read Data from eFuse
  - Command: REB[addr]L[len]
  - Example:
  - Read 32 bytes from address 0x00000100
  - REB0x00000100L0x20

BLE Test Commands

- BLE Tx
  - NOTE: The parameters of the ETE command are expressed in hexadecimal
  - channel idx = 00 - 27
  - data len = 01 - ff
  - payload type = 00 - 07,00:PRBS9 01:11110000 02:10101010 03:PRBS15 04:11111111 05:00000000 06:00001111 07:01010101
  - rate idx = 01 - 04,01:1Mbps 02:2Mbps 03:125kbps 04:500kbps
  - power = 00 - 14
  - Command: ETE[channel idx][data len][payload type][rate idx][power]
- BLE Rx
  - NOTE: The parameters of the ERE command are expressed in hexadecimal
  - channel idx = 00 - 27
  - rate idx = 01 - 04,01:1Mbps 02:2Mbps 03:125kbps 04:500kbps
  - Command: ERE[channel idx][rate idx]
- BLE Test Stop
  - Command: EE

BT Test Commands

- BT Tx
  - NOTE: The parameters of the EBTB command are expressed in hexadecimal
  - channel idx = 00 - 4e
  - payload type = 00 - 07,00:PRBS9 01:11110000 02:10101010 03:PRBS15 04:11111111 05:00000000 06:00001111 07:01010101
  - packet type = 01 - 0b,01:DH1 03:DH3 05:DH5 06:2DH1 07:3DH1 08:2DH3 09:3DH3 0a:2DH5 0b:3DH5
  - power = 00 - 0a,0xff:Auto
  - Command: EBTB[channel idx][payload type][packet type][power]
- BT Rx
  - NOTE: The parameters of the EBRB command are expressed in hexadecimal
  - channel idx = 00 - 4e
  - packet type = 01 - 0b,01:DH1 03:DH3 05:DH5 06:2DH1 07:3DH1 08:2DH3 09:3DH3 0a:2DH5 0b:3DH5
  - Command: EBRB[channel idx][packet type]
- BT Test Stop
  - Command: EBE

802.15.4 Test Commands

- 802.15.4 Test Mode Enter
  - Command: m154_enter
  - All the 802.15.4 related commands are available only after enter the 802.15.4 test mode
- 802.15.4 Test Mode Exit
  - Command: m154_exit
  - All the 802.15.4 related commands are not available after exit the 802.15.4 test mode
- 802.15.4 Set Channel
  - channel idx = 11 - 26
  - Command: c[channel idx]
- 802.15.4 Set Sequence Number
  - sequence number = 0 - 255
  - Command: q[sequence number]
- 802.15.4 Set Tx Packet Frequency
  - freq = 10 - 500
  - Command: f[freq]
- 802.15.4 Set Tx Power
  - power dbm = 0 - 20
  - Command: p[power dbm]
- 802.15.4 Tx Test Start
  - Command: t1
- 802.15.4 Tx Test Stop
  - Command: t0
- 802.15.4 Rx Test Start
  - Command: r:s
- 802.15.4 Rx Test Stop
  - Command: r:p

Chip Reset

- Command: Reset

IOT Test

- Command: IOT[Group1_PINA0][Group1_PINA2]...[Group1_PINAN]+[Group2_PINB0][Group2_PINB2]...[Group2_- PINBN]

Section 4

Module Production Test Calibration Algorithm

Module Production Test Calibration Algorithm

This section explains the production test calibration algorithm, which mainly includes three aspects: frequency offset calibration, power calibration and power verification.

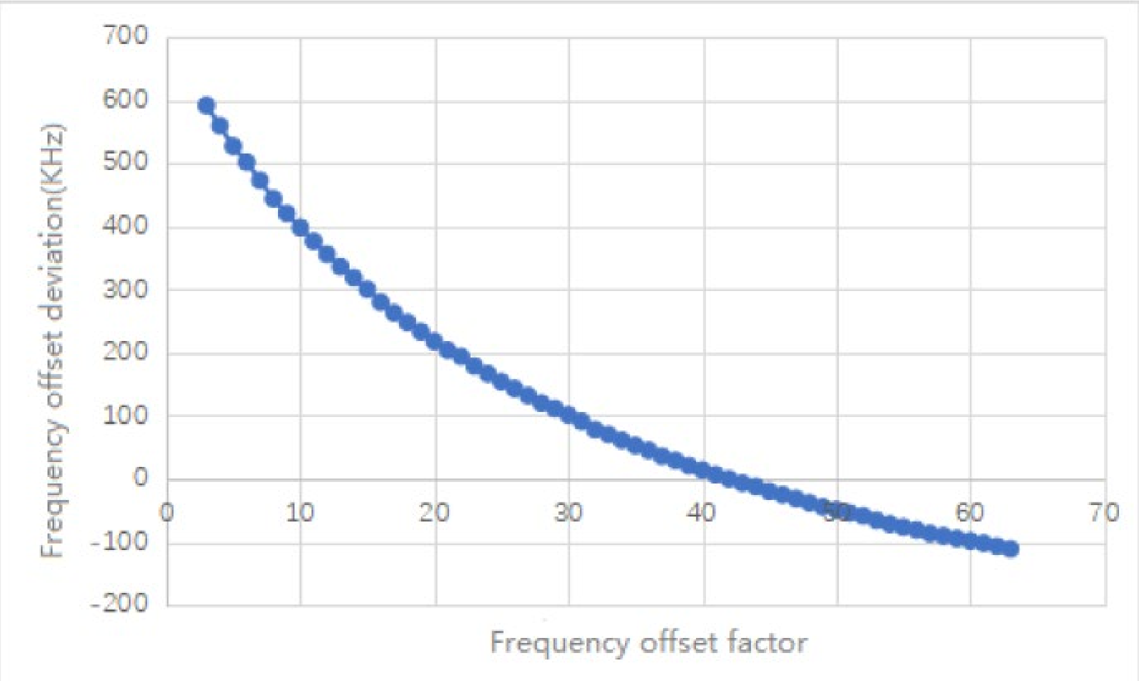
Section 4.1

Frequency Offset Calibration

Frequency Offset Calibration

The QCC74x series chips are integrated with compensation capacitors internally, which can be used to adjust the frequency deviation of the external crystal. The interface for adjusting the frequency offset in the following text is referred to as the frequency offset factor. The frequency offset factor ranges from 0 to 63, and there is a roughly linear and monotonically decreasing relationship between the frequency offset factor and the frequency offset value.

Please refer to the diagram below for a specific example.



Frequency Offset Calibration (cont.)

Frequency offset calibration algorithm recommendation: binary search method.

1. Set the frequency offset factor Capcode to 0x20.
2. Set the algorithm loop index to 4.
3. Read the frequency offset value Freq_Offset from the instrument.
4. If the frequency offset value Freq_Offset is within the calibration range, calibration is complete. Record the current frequency offset factor. Otherwise, proceed to step 5.
5. If the frequency offset value Freq_Offset is positive, modify the frequency offset factor Capcode by adding 2^ index. Otherwise, modify the frequency offset factor Capcode by subtracting 2^ index. Also, decrement the algorithm loop index by 1.
6. Repeat steps 3 to 5 until the algorithm loop index becomes 0.

Section 4.2

Power Calibration

Power Calibration

The transmission power of the QCC74x series chips can be adjusted using power factors. Power calibration primarily focuses on calibrating power deviations across different channels. For Wi-Fi and BT/BLE modes, the power factors remain the same for the same channel. Therefore, power calibration only requires selecting one mode and calibrating it across different channels.

Wi-Fi Power Calibration

The Wi-Fi power calibration for the QCC74x series chips involves adjusting the power levels with a step size of 1 dB and an accuracy of 0.25 dBm. For Wi-Fi power calibration, it is recommended to perform separate calibrations for high-power and low-power modes across three different channels: high, medium, and low. For the remaining channels, a linear interpolation algorithm is used to calculate the calibration values.

The QCC74x series chips reserve an array space of length 3 (Power_Offset_HP[3] and Power_Offset_LP[3]) for compensating power deviations in Wi-Fi high-power and low-power modes, respectively. Each element in the array is 5 bits long, with the most significant bit representing the sign. The allowed power deviation range is -16 to 15, and the power compensation unit corresponding to the deviation factor is 0.25 dB (that is, the power compensation range of -4 dB to 3.75 dB). Calibration fails if the values exceed this range. The specific power calibration algorithm, described below, is provided as an example for 11n mode, but the steps are the same for other modes.

High-Power Mode Power Calibration

1. Set the power factor to the user-defined target power for the respective mode. For example, if the user sets the target power for 11n mode as Power_Target = 16 dBm, set the power factor Power_Code as 16.
2. Measure the actual output power, Pout, and calculate the power deviation for the corresponding channel as Delta_Power = Power_Target - Pout.
3. If the absolute value of Delta_Power is greater than 1, adjust the power factor as Power_Code += Delta_Power (rounding to the nearest integer is required in the actual algorithm). Repeat step 2. If not, proceed to step 4.
4. Calculate the power compensation value for the corresponding channel as Power_Offset_HP[Channel] = (Power_- Code - Pout) * 4 (rounding to the nearest integer is required in the actual algorithm).
5. Repeat steps 1 to 4 for the high, medium, and low channels to obtain Power_Offset_HP[3].

Low-Power Mode Power Calibration

1. The target power for the low-power mode, Power_Target, is fixed at -3 dBm (not changeable). Set the power factor, Power_Code, to -3.
2. Measure the actual output power, Pout, and calculate the power deviation for the corresponding channel as Delta_Power = Power_Target - Pout.
3. Calculate the power compensation value for the corresponding channel as Power_Offset_LP[Channel] = (Power_Code - Pout) * 4 (rounding to the nearest integer is required in the actual algorithm).
4. Repeat steps 1 to 3 for the high, medium, and low channels to obtain Power_Offset_LP[3].

NOTE:

1. It is recommended to perform Wi-Fi high-power mode calibration first and then proceed with Wi-Fi low-power mode calibration.
2. The target power for Wi-Fi high-power mode can be adjusted based on the specific requirements, but it should be set higher than 12 dBm. It is suggested to choose 16 dBm as the target power.
3. The target power for Wi-Fi low-power mode is recommended to be set at -3 dBm (cannot be higher than -3 dBm).
4. During Wi-Fi low-power mode calibration, it is necessary to clear the power compensation values for Wi-Fi high-power mode (using command V3).

BLE Power Calibration

QCC74x supports BLE at different data rates including 1Mbps, 2Mbps, and Coded PHY. It also supports BT (BR, EDR). For different data rate modes, power control is the same within the same channel. Therefore, it is sufficient to perform power calibration for one of the data rate modes. For BLE power calibration, the 40 channels are divided into 5 groups, where each group shares the same calibration results. The BT and 802.15.4 modes reuse the calibration results of the nearest BLE channel. The 40 channels are divided into the following five groups: 2402 MHz~2424 MHz, 2426 MHz~2440 MHz, 2442 MHz~2456 MHz, 2458 MHz~2472 MHz, 2474 MHz~2480 MHz.

QCC74x series chips have a power deviation adjustment step of 1 dB and an accuracy of 0.25 dBm for BLE mode. The reserved array space in the memory is of length 5 (Power_Offset_BLE[5]). Each element of the array is 5 bits, with the most significant bit representing the sign. The allowed power deviation range is -16 to 15, and the power compensation unit corresponding to the deviation factor is 0.25 dB (that is, the power compensation range is -4 dB to 3.75 dB). Calibration fails if the value is outside this range. The specific calibration algorithm is described as follows (the following steps are illustrated using 1 Mbps as an example, but the same applies to other modes):

BLE Power Calibration (cont.)

1. Set the power factor to the user-defined target power for the respective mode. For example, if the user sets the target power for 1Mbps mode as Power_Target = 10 dBm, set the power factor Power_Code as 10.
2. Measure the actual output power, Pout, and calculate the power deviation for the corresponding channel as Delta_Power = Power_Target - Pout.
3. Calculate the power compensation value for the corresponding channel as Power_Offset_BLE[Channel] = (Power_Code - Pout) * 4 (rounding to the nearest integer is required in the actual algorithm).
4. Repeat steps 1 to 3 for all channels 5, 15, 23, 31, and 37 to obtain the power factor compensation array for the corresponding group of channels, Power_Offset_BLE[5].

NOTE:

For BLE/BT/802.15.4 modes, it is recommended to set the Power_Code during calibration to be no lower than 8 when the actual target power Power_Target is greater than 5 dBm. This ensures sufficient margin for power adjustment during calibration. When the actual target power Power_Target is less than or equal to 5 dBm, it is recommended to set the Power_Code during calibration to be no higher than 2.

Section 4.3

Power Verification

Power Verification

The main purpose of power verification is to validate the output signal of channels and modes that have not undergone calibration. The specific algorithm for power verification is described as follows:

1. Set the power factor to the user-defined target power for the respective mode.
2. Enable power compensation values using the serial command (command V1).
3. Switch to the corresponding channel and measure the actual output power, Pout. If Pout falls within the tolerance range of the target power, the verification for that channel is successful. Otherwise, the verification for that channel fails.

Section 4.4

Command/Pseudocode

Tx Command

- 11b Tx Command

```
V1 // Enable power compensation
c1 // Set channel, set to channel 1
p16 // Set power, target power is 16dBm
d50 // Set TX duty cycle, duty cycle is 50%
l101 // Set payload length, length is 101 bytes
f500 // Set packet transmission frequency, frequency is 500Hz
x32 // Set frequency offset compensation factor, capcode is 32
B0 // Select packet mode and rate, 11b 1Mbps
t1 // Enable TX mode
```

- 11g Tx Command

```
V1 // Enable power compensation
c6 // Set channel, set to channel 6
p16 // Set power, target power is 16dBm
d50 // Set TX duty cycle, duty cycle is 50%
l3240 // Set payload length, length is 3240 bytes
f1000 // Set packet transmission frequency, frequency is 1000Hz
x32 // Set frequency offset compensation factor, capcode is 32
G7 // Select packet mode and rate, 11g 54Mbps
t1 // Enable TX mode
```

Tx Command (cont.)

- ## 11n Tx Command

```
V1 // Enable power compensation
c7 // Set channel, set to channel 7
p16 // Set power, target power is 16dBm
d50 // Set TX duty cycle, duty cycle is 50%
l3835 // Set payload length, length is 3835 bytes
f1000 // Set packet transmission frequency, frequency is 1000Hz
x32 // Set frequency offset compensation factor, capcode is 32
mlm270 // Select packet mode and rate, 11n/ Long GI/ MF/ 20M BW/ MCS7/ BCC
t1 // Enable TX mode
```

- ## 11ax Tx Command

```
V1 // Enable power compensation
c10 // Set channel, set to channel 10
p15 // Set power, target power is 15dBm
d50 // Set TX duty cycle, duty cycle is 50%
l4096 // Set payload length, length is 4096 bytes
f500 // Set packet transmission frequency, frequency is 500Hz
x32 // Set frequency offset compensation factor, capcode is 32
Q00090 // Select packet mode and rate, 11ax/0.8us GI/ 20M BW/ MCS9/ BCC
t1 // Enable TX mode
```

Tx Command (cont.)

- BLE Tx Command

```
V1 // Enable power compensation
x32 // Set frequency offset compensation factor, capcode is 32
ETE0125000109 // Set channel, power, rate, payload length, and type
// Channel 1, 1Mbps, power 9dBm, payload length 37 bytes (PRBS9)
```

- BT Tx Command

```
V1 // Enable power compensation
x32 // Set frequency offset compensation factor, capcode is 32
EBTB02000108 // Set channel, power, mode and rate, payload type
// Channel 2, 1DH1, power 8dBm, payload type PRBS9
```

NOTE: For Wi-Fi Tx testing, to achieve a packet duty cycle close to 50% across different modes and rates, there are some variations in payload length and packet transmission frequency for different modes and rates. Specific configuration methods can be referenced from the tool, which provides the sending command format for different modes and rates.

Rx Command

- Wi-Fi Rx Command

```
c6 // Set channel, set to channel 6
x32 // Set frequency offset compensation factor, capcode is 32
r:s2 // Set receive bandwidth, BW 20MHz
r:g // Gather and report the received packet count and related information
r:p // Stop RX receive mode
```

- BLE Rx Command

```
x32 // Set frequency offset compensation factor, capcode is 32
ERE0101 // Set channel and rate, channel 1/ 1Mbps
EE // Stop RX receive mode and report the received packet count
```

- BT Rx Command

```
x32 // Set frequency offset compensation factor, capcode is 32
EBRB0201 // Set channel and rate, channel 2/ 1DH1
EBE // Stop RX receive mode and report the received packet count
```

Frequency Offset Calibration Pseudocode

```
set DUT to TX state // Refer to TX command example
set capcode = 0x20 // x32
measure Freq_Offset // Measure current frequency offset
for (index = 4; index >= 0; index--) // Set loop factor
{
if (Freq_Offset is within the desired range) return capcode;
else if (Freq_Offset > 0) capcode += 2^index;
else capcode -= 2^index;
update capcode; // x+capcode command
measure Freq_Offset; // Measure current frequency offset
}
return capcode;
```

Wi-Fi High-Power Mode Calibration Pseudocode

```
channel_list[3] = {1, 7, 13};
set DUT to TX state // Refer to TX command example
V0 // Clear power compensation
for (index = 0; index < 3; index++) // Set loop factor
{
set channel at channel_list[index]; // c+ channel_list[index] command
set Power_Code = 16; // p16
t1; // Turn on TX state
measure Pout; // Measure current power
t0; // Turn off TX state
Power_offset_HP[index] = round((Power_Code - Pout) * 4); // Calculate power calibration value
}
return Power_offset_HP[];
```

Wi-Fi Low-Power Mode Calibration Pseudocode

```
channel_list[3] = {1, 7, 13};
set DUT to TX state // Refer to TX command example
V0 // Clear power compensation
for (index = 0; index < 3; index++) // Set loop factor
{
set channel at channel_list[index]; // c+ channel_list[index] command
set Power_Code = -3; // p-3
t1; // Turn on TX state
measure Pout; // Measure current power
t0; // Turn off TX state
Power_offset_LP[index] = round((Power_Code - Pout) * 4); // Calculate power calibration value
}
return Power_offset_LP[];
```

BLE/BT Power Calibration Pseudocode

```
channel_list[5] = {5, 15, 23, 31, 37};
V0 // Clear power compensation
for (index = 0; index < 5; index++) // Set loop factor
{
set Power_Code = 10; // Configure target power based on customer␣
↪requirements
set DUT to TX state // Refer to BLE/BT TX command examples,␣
↪including channel
// For channel_list[index], power is set to Power_Code,
// rate and payload are not specified
measure Pout; // Measure current power
EE/EBE; // Turn off TX state
Power_offset_BZ[index] = round((Power_Code - Pout) * 4); // Calculate power calibration value
}
return Power_offset_BZ[];
```

Section 5

Factory/Prelab Entry RF Performance Checklist

Factory/Prelab Entry RF Performance Checklist

- It is highly recommended to complete this minimum test set to ensure that all WLAN RF systems are functioning properly and as expected, or to catch any issues before they become larger. Carrier and regulatory labs will not catch all potential RF performance issues.
- Testing can be separated into two categories: FTM (Test mode) and Mission Mode (Signaling mode).

FTM tests

Tx testing

- Pout/EVM curves (rate/channel)
  - EVM targets can be met
  - EVM floor is expected
- Target power accuracy (rate/channel/power)
- Spectral Emission Mask (SEM) compliance (power/channel)
- Local oscillator leakage (power/channel)
- Spectral flatness (power/channel)
- Spurious emissions (power/channel)
  - 2nd and 3rd harmonics, band edge regulatory compliance

Rx testing

- Minimum sensitivity (rate/channel)
- Maximum sensitivity (rate/channel)
- PER bathtub sweep (rate/channel)

WLAN Tx EVM

Mode	Rate	Channel	QC KPI	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
				Target power	EVM	Target power	EVM	Target power	EVM
11b	1Mbps	2412	21						
		2437	21						
		2472	21						
	11Mbps	2412	21						
		2437	21						
		2472	21						
11g	6M	2412	18						
		2437	18						
		2472	18						
	54M	2412	20						
		2437	20						
		2472	20						
11n	MCS0	2412	19						
		2437	19						
		2472	19						
	MCS7	2412	18						
		2437	18						
		2472	18						
802.11ax HE20	MCS0	2412	19						
		2437	19						
		2472	19						
802.11ax HE40	MCS0	2422	19						
		2442	19						
		2462	19						
802.11ax HE20	MCS9	2412	17						
		2437	17						
		2472	17						
802.11ax HE40	MCS9	2422	15						
		2442	15						
		2462	15						

WLAN TPC

Mode	Rate	Channel	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
			Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)
11b	1Mbps	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
	11Mbps	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	

WLAN TPC (cont.)

Mode	Rate	Channel	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
			Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)
11g	6M	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
	54M	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	

WLAN TPC (cont.)

Mode	Rate	Channel	Low temperature (-40°C) Target power (dBm)	Low temperature (-40°C) Measured power (dBm)	Room temperature (25°C) Target power (dBm)	Room temperature (25°C) Measured power (dBm)	High temperature (85°C) Target power (dBm)	High temperature (85°C) Measured power (dBm)
11n	MCS0	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
	MCS7	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	

WLAN TPC (cont.)

Mode	Rate	Channel	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
			Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)
802.11ax HE20	MCS0	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
802.11ax HE40	MCS0	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	

WLAN TPC (cont.)

Mode	Rate	Channel	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
			Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)	Target power (dBm)	Measured power (dBm)
802.11ax HE20	MCS9	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
802.11ax HE40	MCS9	2412	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2437	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	
		2472	5		5		5	
			10		10		10	
			15		15		15	
			20		20		20	

WLAN SEM Margins

Mode	Rate	Channel	QC KPI	Low temperature (-40°C)		Room temperature (25°C)		High temperature (85°C)	
				Power level	Mask margin	Power level	Mask margin	Power level	Mask margin
11b	1Mbps	2412	17.5						
		2437	17.5						
		2472	17.5						
	11Mbps	2412	17.5						
		2437	17.5						
		2472	17.5						
11g	6M	2412	17.5						
		2437	17.5						
		2472	17.5						
	54M	2412	15.5						
		2437	15.5						
		2472	15.5						
11n	MCS0	2412	17.5						
		2437	17.5						
		2472	17.5						
802.11ax HE20	MCS0	2412	17.5						
		2437	17.5						
		2472	17.5						
802.11ax HE40	MCS0	2422	16.5						
		2442	16.5						
		2462	16.5						

WLAN Rx Sensitivity

Mode	Channel	Rate	QC KPI	Sensitivity		
				-40°C	25°C	85°C
11b	2412	1M	-99			
		11M	-90			
	2437	1M	-99			
		11M	-90			
	2472	1M	-99			
		11M	-90			
11g	2412	6M	-93			
		54M	-77.5			
	2437	6M	-93			
		54M	-77.5			
	2472	6M	-93			
		54M	-77.5			
11n	2412	MSC0	-93			
		MCS7	-75			
	2437	MSC0	-93			
		MCS7	-75			
	2472	MSC0	-93			
		MCS7	-75			
11ax-HE20	2412	MSC0	-93			
		MCS9	-70			
	2437	MSC0	-93			
		MCS9	-70			
	2472	MSC0	-93			
		MCS9	-70			
11ax-HE40	2422	MSC0	-89			
		MCS9	-67			
	2442	MSC0	-89			
		MCS9	-67			
	2462	MSC0	-89			
		MCS9	-67			

BT Tx

Test name		QC KPI	2402 MHz			2440 MHz			2480 MHz		
			-40°C	25°C	85°C	-40°C	25°C	85°C	-40°C	25°C	85°C
	Tx Output Power DH5	10									
	Tx Output Power 2DH5	8									
	Tx Output Power 3DH5	8									
Modulation Characteristics	BR 1Mbps, Δf1avg	160KHz									
	BR 1Mbps, Δf2max > 115KH	100%									
	BR 1Mbps, Δf2avg/Δf1avg	> 0.85									
	EDR 2Mbps, RMS DEVM	< 2.5									
	EDR 2Mbps, Peak DEVM	< 6.0									
	EDR 2Mbps, 99% DEVM	< 4.0									
	EDR 3Mbps, RMS DEVM	< 2.5									
	EDR 3Mbps, Peak DEVM	< 6.0									
	EDR 3Mbps, 99% DEVM	< 4.0									
	EDR 2Mbps, F = F0± 2 MHz	-37									
	EDR 2Mbps, F = F0± 3 MHz	-43									
	EDR 3Mbps, F = F0± 2 MHz	-36									
	EDR 3Mbps, F = F0± 3 MHz	-43									
	BR 1Mbps, F = F0± 2 MHz	-48									
	BR 1Mbps, F = F0± 3 MHz	-48									

BLE Tx

Test name		QC KPI	2402 MHz			2440 MHz			2480 MHz		
			-40°C	25°C	85°C	-40°C	25°C	85°C	-40°C	25°C	85°C
	Tx Output Power BLE	10									
In-Band Emission	1Mbps, F = F0± 2 MHz	-41									
	1Mbps, F = F0± 3 MHz	-41									
	2Mbps, F = F0± 4 MHz	-41									
	2Mbps, F = F0± 5 MHz	-42									
	2Mbps, F = F0± 6 MHz	-42									
Modulation Characteristics	1Mbps, Δf1avg	251 KHz									
	1Mbps, Δf2max > 185KH	100%									
	1Mbps, Δf2avg/Δf1avg	0.89									
	2Mbps, Δf1avg	502 KHz									
	2Mbps, Δf2max > 370KH	100%									
	2Mbps, Δf2avg/Δf1avg	0.89									
	S8 (125 Kbps), Δf1avg	251									
	S8 (125 Kbps), Δf1max > 185KH	100%									

BT/BLE Rx

Test area	Channel	Test name	Modulation	QC KPI	Sensitivity		
					-40°C	25°C	85°C
Receiver performance	2402	Rx Sensitivity BR/EDR	BR 1Mbps	-94			
			EDR 2Mbps	-96			
			EDR 3Mbps	-90			
	2438	Rx Sensitivity BR/EDR	BR 1Mbps	-94			
			EDR 2Mbps	-96			
			EDR 3Mbps	-90			
	2480	Rx Sensitivity BR/EDR	BR 1Mbps	-94			
			EDR 2Mbps	-96			
			EDR 3Mbps	-90			
	BLE						
	2402	Rx Sensitivity BLE	LE 1M	-99			
			LE 2M	-96.5			
			S=2	-102			
			S=8	-105			
	2438	Rx Sensitivity BLE	LE 1M	-99			
			LE 2M	-96.5			
			S=2	-102			
			S=8	-105			
	2474	Rx Sensitivity BLE	LE 1M	-99			
			LE 2M	-96.5			
			S=2	-102			
			S=8	-105			

802.15.4 Rx

Channel	Test area	QC KPI	Sensitivity		
			-40°C	25°C	85°C
2405 (Ch11)	Receiver performance	-105			
2440 (Ch18)	Receiver performance	-105			
2480 (Ch26)	Receiver performance	-105			

802.15.4 Tx

Channel	-40°C			25°C			85°C		
	Target	Power	EVM	Target	Power	EVM	Target	Power	EVM
2405 (Ch11)	0			0			0		
	10			10			10		
	20			20			20		
2440 (Ch18)	0			0			0		
	10			10			10		
	20			20			20		
2480 (Ch26)	0			0			0		
	10			10			10		
	20			20			20		

Section 6

eFuse Mapping

eFuse Mapping

Item	Address/Offset	Comments
Module part number	0x100-114	This is a 24-byte string. Value should be left justified. End of string indicated by 03.
Manufacturing Year/Week	0x118 [15:0]	[7:0] Week number, per ISO 8601 [15:8] Last 2 digits of the year
BOM Configuration #	0x118 [31:16]	To track any BOM changes for modules. Could be leveraged for other purposes if unused.
MAC Address1	0x14 [31:0]	MAC Address1 [31:0]
MAC Address1	0x18[15:0]	MAC Address1 [47:32]
CRC for MAC Address1	0x18[21:16]	Read only address bits; for information purpose. It is automatically written by the software when the MAC ID is set using the WEM command or an equivalent API.
MAC Address2	0x64 [31:0]	MAC Address2 [31:0]
MAC Address2	0x68[15:0]	MAC Address2 [47:32]
CRC for MAC Address2	0x68[21:16]	Read only address bits; for information purpose. It is automatically written by the software when the MAC ID is set using the WEM command or an equivalent API.
MAC Address3	0x70 [31:0]	MAC Address3 [31:0]
MAC Address3	0x74[15:0]	MAC Address3 [47:32]
CRC for MAC Address3	0x74[21:16]	Read only address bits; for information purpose. It is automatically written by the software when the MAC ID is set using the WEM command or an equivalent API.

eFuse Mapping (cont.)

Item	Address/Offset	Comments
Wi-Fi TCP High Power factory calibration option1	0xC0[0:4]	Wi-Fi ch1 HP Tx Power offset compensation value 1/4dB step size
	0xC0[9:5]	Wi-Fi ch7 HP Tx Power offset compensation value 1/4dB step size
	0xC0[14:10]	Wi-Fi ch13 HP Tx Power offset compensation value 1/4dB step size
Wi-Fi TCP High Power factory calibration option2	0xC0[20:16]	Wi-Fi ch1 HP Tx Power offset compensation value 1/4dB step size
	0xC0[25:21]	Wi-Fi ch7 HP Tx Power offset compensation value 1/4dB step size
	0xC0[30:26]	Wi-Fi ch13 HP Tx Power offset compensation value 1/4dB step size
Wi-Fi TCP High Power factory calibration option3	0xC4[0:4]	Wi-Fi ch1 HP Tx Power offset compensation value 1/4dB step size
	0xC4[9:5]	Wi-Fi ch7 HP Tx Power offset compensation value 1/4dB step size
	0xC4[14:10]	Wi-Fi ch13 HP Tx Power offset compensation value 1/4dB step size
Wi-Fi TCP Low Power factory calibration option1	0xC4[20:16]	Wi-Fi ch1 LP Tx Power offset compensation value 1/4dB step size
	0xC4[25:21]	Wi-Fi ch7 LP Tx Power offset compensation value 1/4dB step size
	0xC4[30:26]	Wi-Fi ch13 LP Tx Power offset compensation value 1/4dB step size
Wi-Fi TCP Low Power factory calibration option2	0xC8[0:4]	Wi-Fi ch1 LP Tx Power offset compensation value 1/4dB step size
	0xC8[9:5]	Wi-Fi ch7 LP Tx Power offset compensation value 1/4dB step size
	0xC8[14:10]	Wi-Fi ch13 LP Tx Power offset compensation value 1/4dB step size
Wi-Fi TCP Low Power factory calibration option3	0xC8[20:16]	Wi-Fi ch1 LP Tx Power offset compensation value 1/4dB step size
	0xC8[25:21]	Wi-Fi ch7 LP Tx Power offset compensation value 1/4dB step size
	0xC8[30:26]	Wi-Fi ch13 LP Tx Power offset compensation value 1/4dB step size

eFuse Mapping (cont.)

Item	Address/Offset	Comments
BT/BLE/802.15.4 factory calibration option1	0xCC[4:0]	BT/BLE/15.4 2412MHz Tx Power offset compensation value 1/4dB step size
	0xCC[9:5]	BT/BLE/15.4 2432MHz Tx Power offset compensation value 1/4dB step size
	0xCC[14:10]	BT/BLE/15.4 2448MHz Tx Power offset compensation value 1/4dB step size
	0xCC[19:15]	BT/BLE/15.4 2464MHz Tx Power offset compensation value 1/4dB step size
	0xD0[24:20]	BT/BLE/15.4 2476MHz Tx Power offset compensation value 1/4dB step size
BT/BLE/802.15.4 factory calibration option2	0xD0[4:0]	BT/BLE/15.4 2412MHz Tx Power offset compensation value 1/4dB step size
	0xD0[9:5]	BT/BLE/15.4 2432MHz Tx Power offset compensation value 1/4dB step size
	0xD0[14:10]	BT/BLE/15.4 2448MHz Tx Power offset compensation value 1/4dB step size
	0xD0[19:15]	BT/BLE/15.4 2464MHz Tx Power offset compensation value 1/4dB step size
	0xD0[24:20]	BT/BLE/15.4 2476MHz Tx Power offset compensation value 1/4dB step size
BT/BLE/802.15.4 factory calibration option3	0xD4[4:0]	BT/BLE/15.4 2412MHz Tx Power offset compensation value 1/4dB step size
	0xD4[9:5]	BT/BLE/15.4 2432MHz Tx Power offset compensation value 1/4dB step size
	0xD4[14:10]	BT/BLE/15.4 2448MHz Tx Power offset compensation value 1/4dB step size
	0xD4[19:15]	BT/BLE/15.4 2464MHz Tx Power offset compensation value 1/4dB step size
	0xD4[24:20]	BT/BLE/15.4 2476MHz Tx Power offset compensation value 1/4dB step size

eFuse Mapping (cont.)

Item	Address/Offset	Comments
xtal frequency calibration	0xF4[31:26]	xtal_capcode inout value option1
	0xF4[25:20]	xtal_capcode inout value option2
Reserved, available	0xBC[31:0]	Reserved location for customer use
Reserved, available	0xE8[31:16]	Reserved location for customer use
Reserved, available	0xEC[31:20]	Reserved location for customer use
Reserved, available	0xF8[31:16]	Reserved location for customer use

Section 7

References

Hardware Documentation

- https://www.qualcomm.com/products/technology/wi-fi/qcc740

Title	DCN
QCC741/QCC742 Data Sheet	80-WL741-1
QCC743/QCC744 Data Sheet	80-WL743-1
QCC74x Layout Design Guidelines	80-WL740-3
QCC74x Hardware Training Guide	80-WL740-5
QCC74x Hardware Design Guidelines	80-WL740-8
QCC74x Evaluation Kit User Guide	80-WL740-20
QCC74x Reference Schematic	80-WL740-41
QCC743 Thermal Analysis Standard JEDEC Thermal Simulation Report	80-WL740-12
QCC744 Thermal Analysis Standard JEDEC Thermal Simulation Report	80-WL740-13
QCC74x Manufacturing User Guide	80-WL740-7
QCC74x Design Verification Test Report	80-WL740-71
Design Package, QCC743 QCC744 Hostless Sample Design	DP25-WL740-1

Software Documentation

- https://www.qualcomm.com/products/technology/wi-fi/qcc740

Title	DCN
QCC74x Programming Guide	80-58740-1
QCC74x API Specification	80-58740-4
QCC74x Software Tool User Guide	80-58740-7
QCC740.OR.1.0 CS Release Notes	80-73442-1

Questions?

For additional information or to submit technical questions, go to: https://www.qualcomm.com/support