MT7681 IoT Wi-Fi

Calibration SOP

Version: 0.09

Release date: 2014-6-15

Revision History

Date	Revision	Author	Description
01.16.2014	First v0.01	Jinchuan	Initial draft for MT7681 IoT Calibration SOP.
03.11.2014	v0.02	Jinchuan	Modify Offset, TxPower operation Modify Flash/Efuse Write Operation
03.12.2014	v0.03	Jinchuan	Modify Offset, TxPower operation AddFlash/Efuse Read Write Operation
03.20.2014	v0.04	Jinchuan	Add parameter –r to control TX speed Add Flash ATCommand detail operation
03.20.2014	v0.05	Jinchuan	Correct string “AT#ATE” to “AT#ATECAL”
04.15.2014	v0.06	Jinchuan	Add “AT#ATE –S2 –C6” for Rx Mode calibration
04.18.2014	v0.07	Jinchuan	Add AT#ATECAL parameter(-t) for RX Cali Add AT#ATECAL parameter(-l) for TX Cali
05.16.2014	v0.08	Jinchuan	Table-1 Update Add AT#ATECAL parameter(-a) for RX/TX Cali Calibration process of Tx, how to enter into Calibration Mode Calibration process of Rx, count other Packet
06.15.2014	V0.09	Jinchuan	Add iwpriv ra0 command format
09.20.2014	V0.09	xThinkLab	Translate into English.

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1 The place for storage of the CALIBRATION parameter

11 Refer to files: MT7681_IoT_WIFI_Firmware_Programming_Guide.pdf

The Calibration relevant parameter will storage in the EEPROM Block of the Flash Partitions

	Flash Layout				
	Offest	Section	Size (KB)	HEX (Byte)	DEC Offset
1	0x0000	Loader	20	0x5000	0
	0x5000	reserved 1	4	0x1000	20480
2	0x6000	Recovery Mode FW	64	0x10000	24576
	0x16000	reserved 2	4	0x1000	90112
3	0x17000	EEPROM	4	0x1000	94208
	0x18000	Common config	4	0x1000	98304
	0x19000	Station Mode Config	4	0x1000	102400
	0x1A000	AP Mode Config	4	0x1000	106496
	0x1B000	User Config	4	0x1000	110592
	0x1C000	reserved 3	12	0x3000	114688
4	0x1F000	STA Mode FW	64	0x10000	126976
	0x2F000	reserved 4	4	0x1000	192512
5	0x30000	STA Mode-XIP FW	120	0x1E000	196608
	0x4E000	reserved 5	4	0x1000	319488
6	0x4F000	AP Mode FW	64	0x10000	323584
	0x5F000	reserved 6	4	0x1000	389120
7	0x60000	AP Mode-XIP FW	120	0x1E000	393216
	0x7E000	reserved 7	4	0x1000	516096
	0x7F000	Flash Write Buffer	4	0x1000	520192
	0x80000	reserved 8	0	0x0	524288

Note :the above is just an example, if you want to know the accurate Flash Partitions Table, you must refer to the newest Programming Guide

1.2 Preparing "default.bin" before calibration

Before Calibration , you should flash the default.bin (supported by Mediatek SA)to Flash EEPROM Block, it is better to integrate the default.bin into MT7681_all.bin and flash it before prepare the MT7681_all.bin((Firmware of MT7681)

The format of the default.bin Layout

52h	0000	Channel 2 TX0 power(ALC)	Channel 1 TX0 power(ALC)
54h	0000	Channel 4 TX0 power(ALC)	Channel 3 TX0 power(ALC)
56h	0000	Channel 6 TX0 power(ALC)	Channel 5 TX0 power(ALC)
58h	0000	Channel 8 TX0 power(ALC)	Channel 7 TX0 power(ALC)
5Ah	0000	Channel 10 TX0 power(ALC)	Channel 9 TX0 power(ALC)
5Ch	0000	Channel 12 TX0 power(ALC)	Channel 11 TX0 power(ALC)
5Eh	0000	Channel 14 TX0 power(ALC)	Channel 13 TX0 power(ALC)

XTAL trim (0x3A)

3Ah	012C	LED Mode	Frequency offset

TSSI(0x6E/0x6F/0x70/0x71)

Offset	b15 ~b8	b7 ~ b0
6eh	Offset for Channel 1~4	TSSI slope
70h	Offset for Channel 9~14	Offset for Channel 5~8

25° C Temperature Sensor calibration register (0xD1H)

D0h	F920	25C Temp Sensor Calibration	2.4G Target Power

Note: the above is just an example, if you want to know the accurate default.bin Layout, you must refer to the newest EEPROM Content

1.3 Calibration method via Uart

Connect to MT7681 via UART, then transmits AT Command, execute Calibration

2 Calibration method of AT#ATECAL command

2.1 The step of TX Mode Calibration

2.1.1 Enter into Calibration Mode

Step1： Power on the MT7681

Step2： After the [RTask]*** is printed on terminal , type into **AT#ATECAL -S**, and then the 7681 will print "Enter into Calibration Mode", and get into the Calibration mode

Step3： Send Tx Packet by typing into command to serial port: AT#ATECAL -S1 -m1 -c7 -b0 -C1 -g0 -f95 -p0 -n1000 -r1 –l100 Or type into command to do the receiving test: AT#ATECAL –S2 -b0 -C1

Remark: In Calibration , the following parameters are used by default.

SourceMac: 00:aa:bb:cc:dd:ee

Dest Mac： 00:11:22:33:44:55

BSSID: 00:11:22:33:44:55

BandWidth: BW_20

PayLoadLength: 800 Bytes (not include MAC Header)

The calibration parameter is decimal system by default
The calibrated parameter can be write into Chip Efuse or Flash, but there is time limit for Efuse writing.

After completing write, is it Efuse or Flash for 7681 to use indiscriminately in the Normal Mode?
It can be decided by user in the MT7681 code(in the code,there is only one global variable **gCaliFrEufse**， [0:Flash, 1:Efuse])
After every AT# command , it must end with Carriage return

2.1.2 Calibrate the offset frequency by default.bin（XTAL trim）

Step1：send "AT#ATECAL -S1" //ATE process Tx Mode Start [0:Stop, 1:Tx , 2:Rx]

Step2：send "AT#ATECAL -m1" //TX Mode 11g [0:CCK, 1:OFDM, 2:HT Mixed, 3:HT Green]

Step3：send "AT#ATECAL -c5" //TXMCS Max rate [See: Table-1]

Step4：send "AT#ATECAL -b0" //Bandwidth 20M [0:BW20, 1:BW40]

Step5：send "AT#ATECAL –C1" //channel 1 [1~14]

Step6：send "AT#ATECAL –g0" //TXGI long guard interval [0:ShortGI, 1:FullGI]

Step7：send "AT#ATECAL –f65" //TX Freq Offset (XTAL) [0~256]

Step8：send "AT#ATECAL –p30" //TXpower (refer to value in default.bin) [0~39]

Step9：send "AT#ATECAL –n100000" //ATE TX Count [0~4294967295]

Step10：send "AT#ATECAL –r1000" //ATE TX Frame Speed(uint:1ms)[0~4294967295]

Step11：send "AT#ATECAL –l800" //ATE TX PayloadLength [0~800]

If you set –b1, it means entry the Bandwidth 40M mode, while the -C means Center Channel
You can also input the following command (notice the order must be kept)

AT#ATECAL -S1 -m1 -c5 -b0 -C1 -g0 -f65 -p30 -n10000 –r1000 –l800

Adjust the value of XTALL offset in red color, make the Feq Err(kHz) is in the -5~5

If you want to stop the adjustment, you can input the following AT Command

Step1： send "AT#ATECAL –S0" //ATE process End

Mode	BandWidth (-b)	MCS							
(0) CCK	0	0	1	2	3	8	9	10	11
(1) OFDM	0 ~~1(Duplicate mode)~~	0	1	2	3	4	5	6	7
(2) HTMIX	0 / 1	0	1	2	3	4	5	6	7
(3) HT GreenFiled	0 / 1	0	1	2	3	4	5	6	7

Table-1

2.1.3 Test the TXpower of Channelx

Step1：send "AT#ATECAL -S1" //ATE process Tx Mode Start [0:Stop, 1:Tx , 2:Rx]

Step2：send "AT#ATECAL -m1" //TX Mode 11g [0:CCK, 1:OFDM, 2:HT Mixed, 3:HT Green]

Step3：send "AT#ATECAL -c5" //TXMCS Max rate [See: Table-1]

Step4：send "AT#ATECAL -b0" //Bandwidth 20M [0:BW20, 1:BW40]

Step5：send "AT#ATECAL -C**x**" //channel 1 [1~14]

Step6：send "AT#ATECAL –g0" //TXGI long guard interval [0:ShortGI, 1:FullGI]

Step7：send "AT#ATECAL –f65" //TX Freq Offset (XTAL) [0~256]

Step8：send "AT#ATECAL –**p30**" //TXpower (refer to value in default.bin) [0~39]

Step9：send "AT#ATECAL –n100000" //ATE TX Count [0~4294967295]

Step10：send "AT#ATECAL –r1000" //ATE TX Frame Speed(uint:1ms)[0~4294967295]

Step11：send "AT#ATECAL –l800" //ATE TX PayloadLength [0~800]

You can also input the following command (notice the order must be kept)

AT#ATECAL -S1 -m1 -c5 -b0 -C**x** -g0 -f65 -p**30** -n10000 –r1000 –l800

D0h is OFDM 54M target power. Unit is 0.5 dBm.

e.g. For target power 16 dBm, set D0h as 0x20

Set the channel **x** , adjust the value of TXpower according to customers' requirements

reference values：AVg Pow（dBm） between target power -1~target power +1，evm:<-25

11n=11g-1 evm<-28

After adjust the channel x, record the adjusting value, and then adjust the channel x+1

After adjust the whole channel, write the value into Chip Efuse using the following ATE Command(the red value is the channle TxPower for adjusting)

2.1.4 Save the calibration parameter(take Tx Power for an example)

2.1.4.1.1 Write the TXPOWER into CHIP EFUSE from the position of 0X52~0X5A

AT#EFUSE –s**82** –v**17** //set Decimal Value:17 to Efuse offset **0x52**(Dec:82)

。 。 。 。

AT#EFUSE –s**90** –v**20** //set Decimal Value:20 to Efuse offset **0x5A**(Dec:90)

Read the value of what is wrote into the Efuse TxPower by using the following command

AT#EFUSE –r**82** //read TxPower **0x52**(Hex:82) value on Efuse

2.1.4.1.2 Write the TXPOWER intoFLASH EEPROM BLOCK from the position of 0X52~0X5A

AT#FLASH –s**94290** –v**17** //set Decimal Value:17 to Flash EEPROM offset 0x52(Dec:82)

。 。 。 。

AT#FLASH –s**94298** –v**20** //set Decimal Value:20 to Flash EEPROM offset 0x5A(Dec:90)

Read the value of TxPower which is wrote into the Flash EEPROM Block by using the following command

AT#FLASH –r**94290** //read TxPower 0x52(Dec:82) value on Flash EEPROM Block

The method of calculating the Flash –s –r parameter , for example, the above 94290 :
0x17000 is the address of FLASH EEPROM (Refer to FlashLayout table),0x52 is the TxPower address in EEPROM Block.

0x17000 + 0x52 = 0x17052= 94290 (Decimal format)

2.2 The step of RX Mo de Calibration

2.2.1 Preparation of Rx Calibration

For testing purpose, There will be difference in the Source MAC of Calibration Rx, Tx mode.

a：TX Test Mode

Source MAC is： 00:aa:bb:cc:dd:ee

dest Mac is： 00:11:22:33:44:55

b：RX Test Mode

Source MAC is： 00:11:22:33:44:55

In the 7681 Rx Test, it need to notice the set of Dest Mac, it should be 00:11:22:33:44:55(SourceMac of 7681 Rx Mode), so that the unicast packet which not for me is not dropped by MT7681.

2.2.2 The method of RX Test

Step1：AT#ATECAL -S2 -b0 -C6 –t2000

[-S2: start RxMode, -b0:Bandwidth20M -C6 :switch to Channel 6, -t2000：count RxFrame in two seconds]

-t ,default is 1000 (unit:1ms)

Step2：printed by every 2s

LOG SM=0, Sub=0

TEPeriodicExec: Rx cnt = (U2M : 2 /ToTal:2)
(Other : 2 /ToTal:2)
(Mgmt/Cntl : 0 /Total:0)
AvgRssi0= -69

the above indicate respectively：

[the number of unicast packet received in 2 seconds / the total received unicast packet]

[the number of B/M/NU packet received in 2 seconds / the total received B/M/NU packet]

[the t number of management/control packet received in 2 seconds/ the total received management/control packet] (B/M/NU = BroadCast+Multicast+NotToMeUnicast)

ATEPeriodicExec: RxU2M AvgRssi0=-37,
it means RSSI average for the received total Packet .

Step3：Stop Rx Mode： AT#ATECAL –S0

3 The method of adjusting IWPRIV RA0

3.1 The step of TX Mode calibration

3.1.1 Enter into Calibration Mode

Step1： Power on MT7681

Step2： After the [RTask]*** is printed, input **'iwpriv ra0 set' by serial port, and then the MT7681 will print 'Enter** into Calibration Mode', enter the Calibration mode

Remark: in the adjusting, the following
parameters are used by default.

SourceMac: 00:aa:bb:cc:dd:ee
Dest Mac： 00:11:22:33:44:55
BSSID: 00:11:22:33:44:55
BandWidth: BW_20
PayLoadLength: 800 Bytes (not include MAC Header)

The adjusting parameter is decimal format by default
The adjusted parameter can be write into Chip Efuse or Flash, but there is time limit for Efuse writing.

After completing write, is it Efuse or Flash for 7681 to use indiscriminately in the Normal Mode?
It can be decided by customer in the MT7681 code(in the code,there is a global variable **gCaliFrEufse**， [0:Flash, 1:Efuse])
After every AT# command , it must end with Carriage return

3.1.2 Calibrate the offset frequency by default.bin(XTAL trim)

```
iwpriv ra0 set ATE=ATESTART                 //ATE process Start
iwpriv ra0 set ATECHANNEL=1                 //channel 1                 [1~14]
iwpriv ra0 set ATETXMODE=0                  //TX Mode 11g               [0:CCK, 1:OFDM, 2:HT Mixed, 3:HT Green]
iwpriv ra0 set ATETXMCS=1                   //TXMCS Max rate            [See: Table-1]
iwpriv ra0 set ATETXBW=0                    //Bandwidth 20M             [0:BW20,    1:BW40]
iwpriv ra0 set ATETXGI=0                    //TXGI long guard interval  [0:ShortGI,  1:FullGI]
iwpriv ra0 set ATETXLEN=800                 //ATE TX PayloadLength      [0~800]
iwpriv ra0 set ATETXFREQOFFSET=95           //TX Freq Offset (XTAL)     [0~256]
iwpriv ra0 set ATETXCNT=1000                //ATE TX Count              [0~4294967295]
iwpriv ra0 set ATETXPOW0=0                  //TXpower (refer to value in default.bin) [0~39]
iwpriv ra0 set ATE=TXFRAME
```

If you set –b1, it means entry the Bandwidth 40M mode, while the -C means Center Channel

Adjust the value of XTALL offset in red color, make the Feq Err(kHz) is in the -5~5
If you want to stop the adjustment, you can input the following AT Command

```
iwpriv ra0 set ATE=ATESTOP                  //ATE process End
```

Mode	BandWidth (-b)	MCS							
(0) CCK	0	0	1	2	3	8	9	10	11
(1) OFDM	0 ~~1(Duplicate mode)~~	0	1	2	3	4	5	6	7
(2) HTMIX	0 / 1	0	1	2	3	4	5	6	7
(3) HT GreenFiled	0 / 1	0	1	2	3	4	5	6	7

Table-1

3.1.3 Test the TXpower of Channelx

iwpriv ra0 set ATE=ATESTART //ATE process Start
iwpriv ra0 set ATECHANNEL=**1** //channel 1 [1~14]
iwpriv ra0 set ATETXMODE=0 //TX Mode 11g [0:CCK, 1:OFDM, 2:HT Mixed, 3:HT Green]
iwpriv ra0 set ATETXMCS=1 //TXMCS Max rate [See: Table-1]
iwpriv ra0 set ATETXBW=0 //Bandwidth 20M [0:BW20, 1:BW40]
iwpriv ra0 set ATETXGI=0 //TXGI long guard interval [0:ShortGI, 1:FullGI]
iwpriv ra0 set ATETXLEN=800 //ATE TX PayloadLength [0~800]
iwpriv ra0 set ATETXFREQOFFSET=95 //TX Freq Offset (XTAL) [0~256]
iwpriv ra0 set ATETXCNT=1000 //ATE TX Count [0~4294967295]
iwpriv ra0 set ATETXPOW0=**0** //TXpower (refer to default.bin) [0~31]
iwpriv ra0 set ATE=TXFRAME

D0h is OFDM 54M target power. Unit is 0.5 dBm.
e.g. For target power 16 dBm, set D0h as 0x20

Set the channel **x** , adjust the value of TXpower according to the command of customer

Reference value ：AVg Pow（dBm） 在 target power -1~target power +1 ，evm:<-25
11n=11g-1 evm<-28

After the channel x calibration , record the adjusting value, and then adjust the channel x+1
After the whole channel calibration , write the value into Chip Efuse using the following ATE Command(the red value is the channle TxPower for adjusting)

3.1.4 Save the calibration parameter(take Tx Power for an example)

3.1.4.1.1 Write the TXPOWER into CHIP EFUSE from the position of 0X52~0X5A

iwpriv ra0 set e2p **0x52=0x11** //set Decimal Value:17 to Efuse offset **0x52**
。。。。
iwpriv ra0 set e2p **0x5A=0x14** //set Decimal Value:20 to Efuse offset **0x5A**

Read the value of what is wrote into the Efuse TxPower by using the following command
iwpriv ra0 set e2p **0x52** //read TxPower **0x52** value on Efuse

3.1.4.1.2 Write the TXPOWER into FLASH EEPROM BLOCK from the position of 0X52~0X5A

iwpriv ra0 set flash **0x17052**=0x11 //set Decimal Value:17 to Flash EEPROM offset 0x52(Dec:82)
。。。。

iwpriv ra0 set flash **0x1705A**=0x14 //set Decimal Value:20 to Flash EEPROM offset 0x5A(Dec:90)

Read the value of TxPower which is wrote into the Flash EEPROM Block by the following command.

iwpriv ra0 set flash **0x17052** //read TxPower 0x52(Dec:82) value on Flash EEPROM Block

0x17000 is the address of FLASH EEPROM (Refer to FlashLayout table),0x52 is the TxPower address in EEPROM Block.

0x17000 + 0x52 = 0x17052

3.2 The process of Rx Mode calibration

3.2.1 Preparation of Rx calibration

For testing purpose, There will be difference in the Source MAC of Calibration Rx, Tx mode

a：TX Test Mode

Source MAC is： 00:aa:bb:cc:dd:ee

dest Mac is： 00:11:22:33:44:55

b：RX Test Mode

Source MAC is： 00:11:22:33:44:55

In the 7681 Rx Test, it need to notice the set of Dest Mac, it should be 00:11:22:33:44:55(SourceMac of 7681 Rx Mode), so that the unicast packet which not for me is not dropped by MT7681.

3.2.2 Method of RX Test

iwpriv ra0 set ATE=ATESTART

iwpriv ra0 set ATECHANNEL=1

iwpriv ra0 set ATETXMODE=0

iwpriv ra0 set ATETXMCS=0

iwpriv ra0 set ATETXBW=0

iwpriv ra0 set ATETXGI=0

iwpriv ra0 set ATETXFREQOFFSET=65

iwpriv ra0 set ATE=RXFRAME

iwpriv ra0 set ResetCounter=1 /*Clean Counter*/

The corresponding Rx statistic will be printed after the following command is entered at every time.

iwpriv ra0 stat

Rx success = 17

Rx with CRC = 12

Rx drop due to out of resource = 0

Rx duplicate frame = 0

False CCA (total) = 1112

False CCA (one second) = 212

RSSI = -55

RSSI(U2M average) = -60

Rx U2M = 0

Rx other Data = 17

Rx others(Mgmt+Cntl) = 0
Rx U2M (one second) = 0
Rx other Data (one second) = 1
Rx others(Mgmt+Cntl)(one second) = 0

If you want to stop it, you can input the following AT Command
iwpriv ra0 set ATE=ATESTOP //ATE process End