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MT7612 K-free Information
&
ATE Flow

2013/12/05 V2

MT7612 K-free

- 什麼是K-free？
  - K-free代表IC出廠時,IC本身內部efuse內含部分RF校正參數,讓客戶在產線端可減少部分生產負擔.

- K-free就代表免測試嗎?
  - 不. K-free並不代表客戶端可以省略測試步驟.
  - K-free目標是減少客戶calibration階段所花費的時間,但有部分前提存在. 像是k-free TX power variation規格(+/-1.5dB)會比傳統方式(+/-0.5dB)來的大.

- 一定要採用k-free 方式嗎?
  - 不一定,客戶端也可以自行在產線上重新校正,像是重新校正頻偏或是TX power,但須針對項目重新寫入efuse(dongle產品)或是flash(AP產品).

MT7612 出廠k-free efuse 位子

- MT7612出廠時, 以下資料會預先寫入efuse位置
  - Crystal trim (k-free)
    - MTK FT產線會將cap ID寫入 efuse 0x3A[6:0]位置,其規格為**常溫+/- 10ppm**
    - 頻率規格有可能會受客戶用料(非MTK推薦料號)與layout影響
    - efuse 0x3A[7] : crystal type , FT預設為"1"
  - Thermal sensor (k-free)
    - MTK FT產線會將室溫thermal sensor寫入 efuse 0x55 [6:0]位置.
    - 溫度準確度為**常溫+/-5度**
    - efuse 0x55[7] : valid bit, FT預設為"1"
  - TSSI slope and offset (k-free)
    - MTK FT產線會將2/5GHz iPA TSSI/Slope寫入 efuse 0x56~0x9D位置.
    - iPA TSSI 規格為**+/- 1.5dB**, 其準確度會受PCB S11影響,建議其S11需< -15dB.
  - 2G RX gain (k-free)
    - MTK FT產線會依據IC 2G RX gain變化量寫入 efuse 0xF9位置.
  - MTK FT/CP流水號供內部產線辨識使用(0xF6)

- *量產程式須知道以上訊息,將其從efuse讀出後再重新套用,避免造成資料覆蓋問題.*

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MT7612 出廠k-free efuse 位子

|	
0x3A	Frequence offset (XTAL calibration)
0x55	Temperature sensor calibration
0x56	TX0 2.4G PA TSSI slope
0x57	TX0 2.4G PA TSSI offset
0x5C	TX1 2.4G PA TSSI slope
0x5D	TX1 2.4G PA TSSI offset
0x67	TX0 5G PA TSSI slope (5150~5250) (CH36 38 40 42 44 46 48)
0x68	TX0 5G PA TSSI offset (5150~5250)**(Group1)**
0x6C	TX0 5G PA TSSI slope (5250~5350) (CH52 54 56 58 60 62 64)
0x6D	TX0 5G PA TSSI offset (5250~5350)**(Group2)**
0x71	TX0 5G PA TSSI slope (5470~5570)(CH98 100 101 104 106 108 112 114)
0x72	TX0 5G PA TSSI offset (5470~5570)**(Group3)**
0x76	TX0 5G PA TSSI slope (5580~5700)(CH116 120 122 124 128 130 132 136 138 140 144)
0x77	TX0 5G PA TSSI offset (5580~5700)**(Group4)**
0x7B	TX0 5G PA TSSI slope (5725~5825)(CH149 153 155 156 157 161 162 165)
0x7C	TX0 5G PA TSSI offset (5725~5825)**(Group5)**
0x85	TX1 5G PA TSSI slope (5150~5250) (CH36 38 40 42 44 46 48)
0x86	TX1 5G PA TSSI offset (5150~5250)**(Group1)**
0x8A	TX1 5G PA TSSI slope (5250~5350) (CH52 54 56 58 60 62 64)
0x8B	TX1 5G PA TSSI offset (5250~5350)**(Group2)**
0x8F	TX1 5G PA TSSI slope (5470~5570)(CH98 100 101 104 106 108 112 114)
0x90	TX1 5G PA TSSI offset (5470~5570)**(Group3)**
0x94	TX1 5G PA TSSI slope (5580~5700)(CH116 120 122 124 128 130 132 136 138 140 144)
0x95	TX1 5G PA TSSI offset (5580~5700)**(Group4)**
0x99	TX1 5G PA TSSI slope (5725~5825)(CH149 153 155 156 157 161 162 165)
0x9A	TX1 5G PA TSSI offset (5725~5825)**(Group5)**
0xF6	CP_FT_version
0xF9	RF1 2.4G Rx High Gain + RF0 2.4G RX High Gain

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Customer ATE Flow
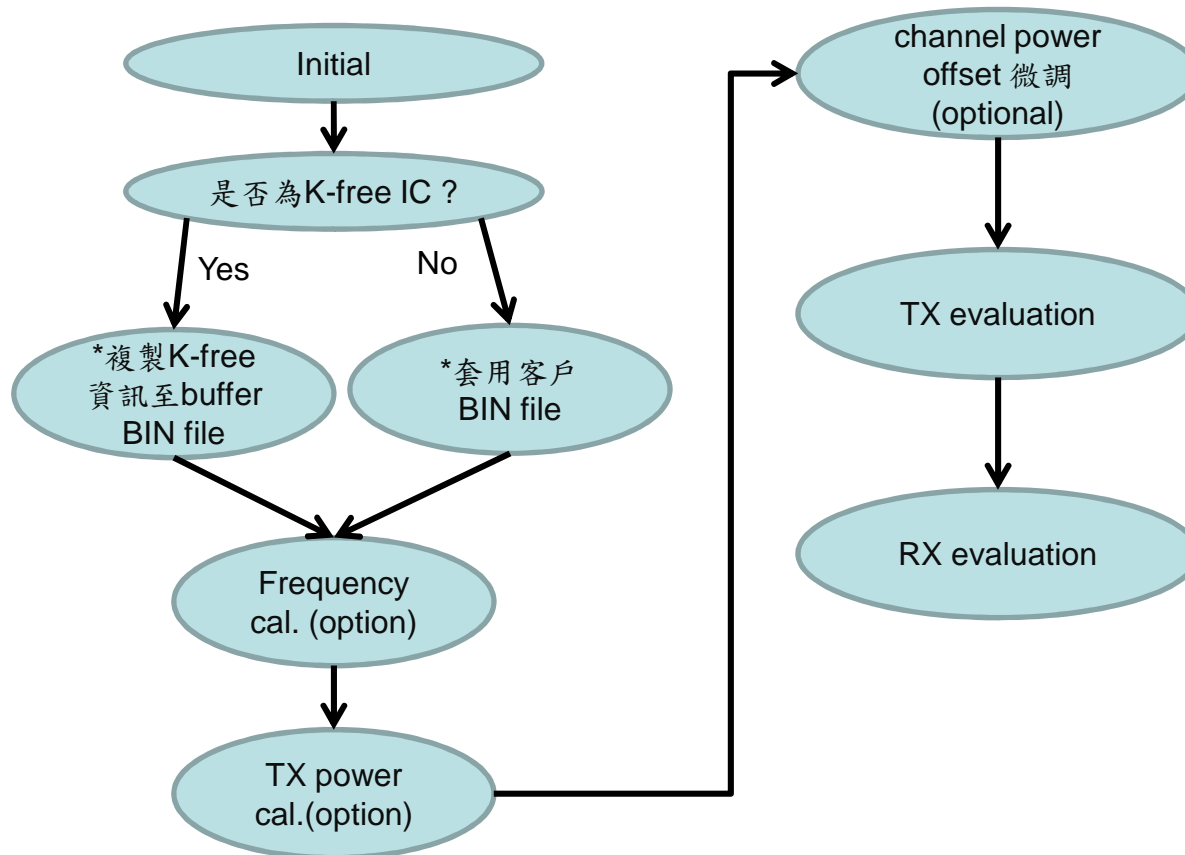
*請根據客戶硬體設計調整適當BIN file

QA Tool Introduction – TX/RX
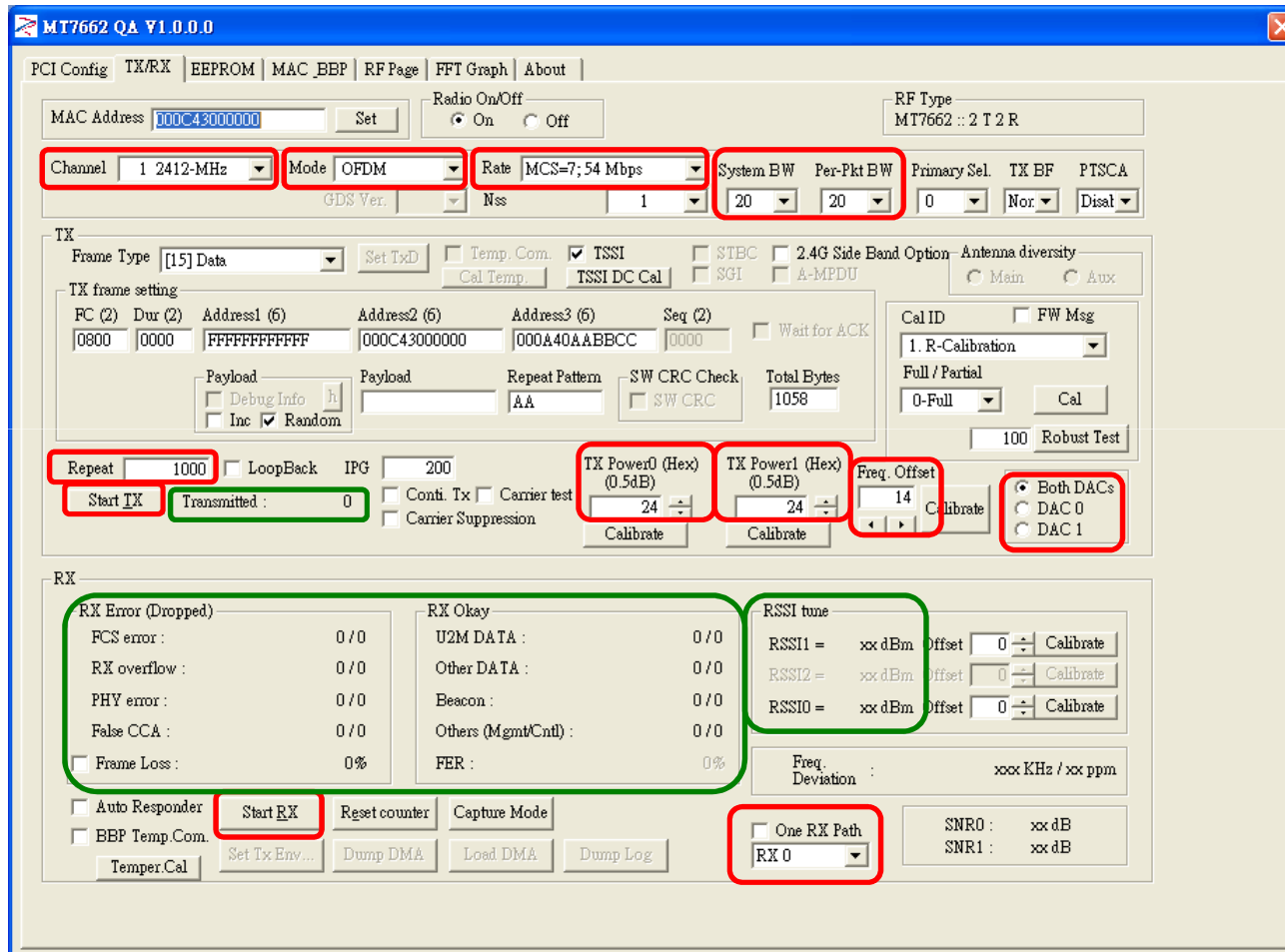
TX Power Calibration
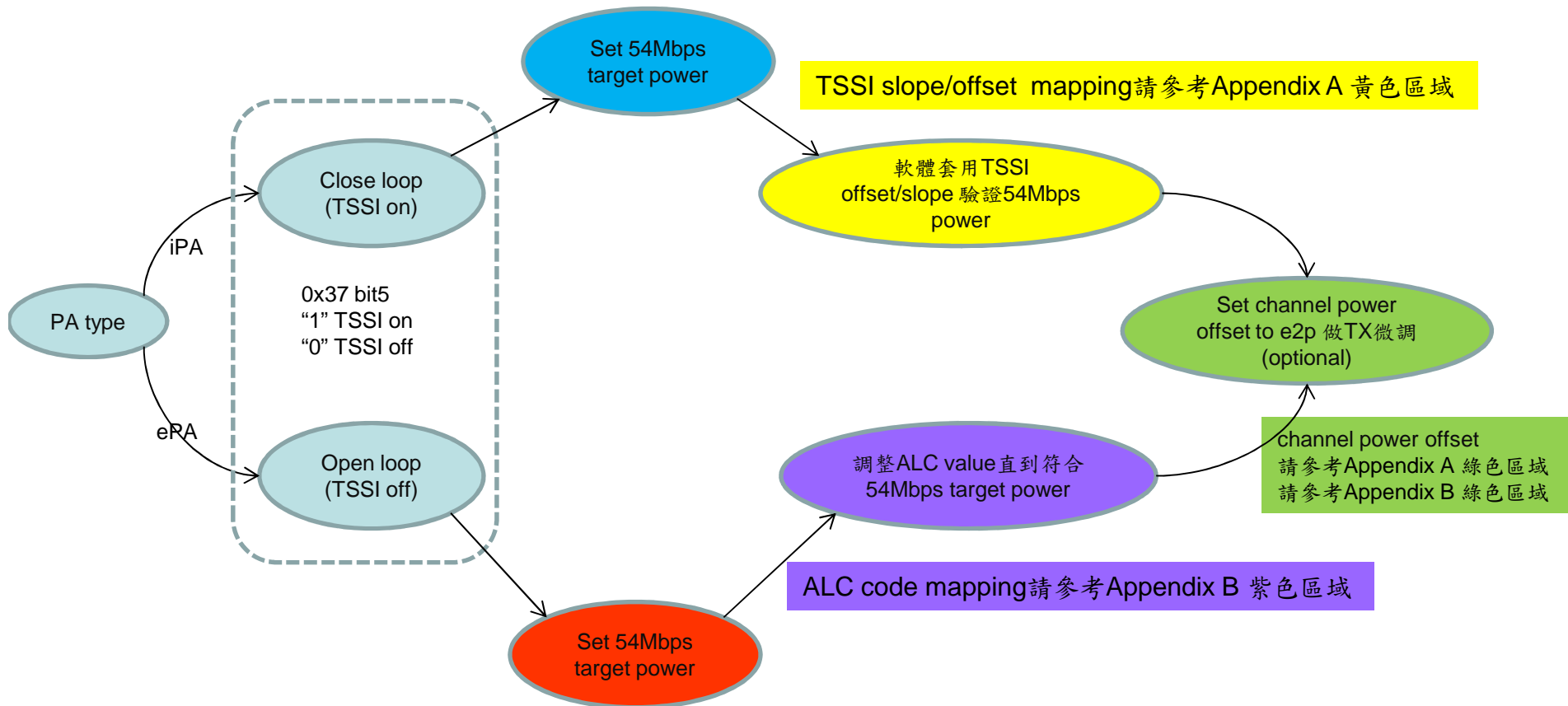
Appendix A : 2G Part (TSSI on)

Example:

假設ATE configure 54Mbps target power = 16dBm
請將 16dBm/0.5dB=32(dec)=0x20(hex) 寫入e2p 0x58 & 0x5E
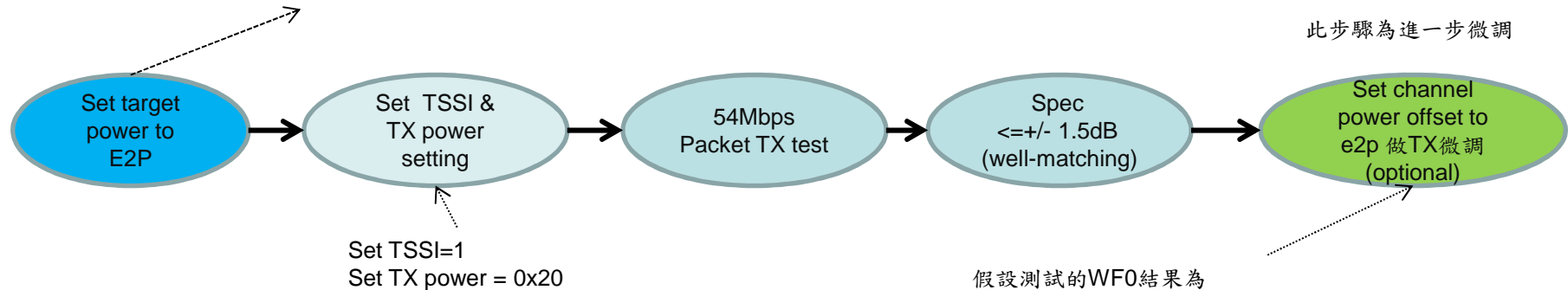
此步驟為進一步微調

Set target power to E2P → Set TSSI & TX power setting → 54Mbps Packet TX test → Spec <=+/- 1.5dB (well-matching) → Set channel power offset to e2p 做TX微調 (optional)

Set TSSI=1
Set TX power = 0x20

假設測試的WF0結果為
CH1 15dBm =>低了1dB,請在0x59填上0xC2補償
CH6 16dBm =>無須補償,請在0x5A填上0x00
CH11 17dBm =>高了1dB,請在0x5B填上0x82補償
WF1請重複相同動作
E2P定義請參考MT7612 E2P document

Offset	Description
0x56	TX0 2.4G PA TSSI slope
0x57	TX0 2.4G PA TSSI offset
0x58	TX0 2.4G TX power (54Mbps, dBm絕對值)
0x59	TX0 2.4G TX power offset low(CH1~5)(delta,dB)
0x5A	TX0 2.4G TX power offset middle(CH6~10)(delta,dB)
0x5B	TX0 2.4G TX power offset high(CH11~14)(delta,dB)
0x5C	TX1 2.4G PA TSSI slope
0x5D	TX1 2.4G PA TSSI offset
0x5E	TX1 2.4G TX power (54Mbps, dBm絕對值)
0x5F	TX1 2.4G TX power offset low(CH1~5)(delta,dB)
0x60	TX1 2.4G TX power offset middle(CH6~10)(delta,dB)
0x61	TX1 2.4G TX power offset high(CH11~14)(delta,dB)

TSSI slope/offset mapping請參考Appendix A 黃色區域

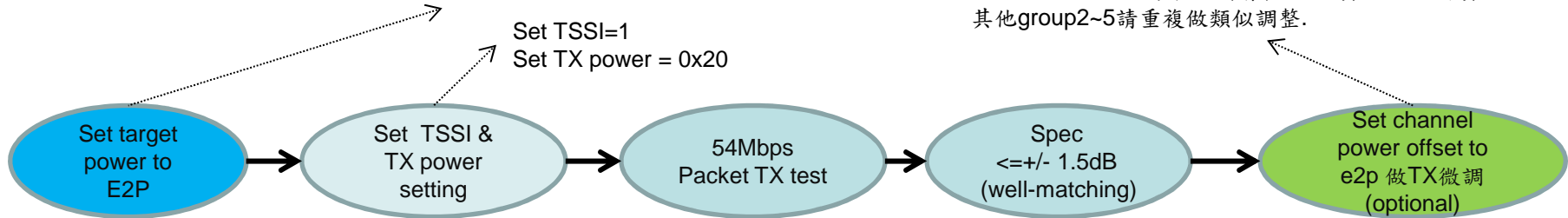TSSI on 54Mbps target power (絕對值) mapping請參考Appendix A藍色區

channel power offset 請參考Appendix A 綠色區域

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Appendix A : 5G Part (TSSI on)

Example:

假設ATE configure 54Mbps target power = 16dBm
請將 16dBm/0.5dB=32(dec)=0x20(hex) 寫入e2p 0x69,6E,73,78,7D,87,8C,91,96,9B位子

Set TSSI=1
Set TX power = 0x20

假設測試的WF0 group1 結果為
CH36 15dBm =>低了1dB,請在0x6A填上0xC2補償
CH42 16dBm
CH48 17dBm =>高了1dB,請在0x6B填上0x82補償
其他group2~5請重複做類似調整.

| Set target power to E2P | → | Set TSSI & TX power setting | → | 54Mbps Packet TX test | → | Spec <=+/- 1.5dB (well-matching) | → | Set channel power offset to e2p 做TX微調 (optional) |

此步驟為進一步微調

Offset	Description
0x67	TX0 5G PA TSSI slope (5150~5250) (CH36 38 40 42 44 46 48)
0x68	TX0 5G PA TSSI offset (5150~5250)**(Group1)**
0x69	TX0 5G TX power (54M,dBm,絕對值) (5150~5250)
0x6A	TX0 5G TX power offset low(delta,dB) (CH36 38 40 42)
0x6B	TX0 5G TX power offset high(delta,dB) (CH**44** 46 48)
0x6C	TX0 5G PA TSSI slope (5250~5350) (CH52 54 56 58 60 62 64)
0x6D	TX0 5G PA TSSI offset (5250~5350)**(Group2)**
0x6E	TX0 5G TX power (54M,dBm,絕對值) (5650~5350)
0x6F	TX0 5G TX power offset low(delta,dB)(CH52 54 56)
0x70	TX0 5G TX power offset high(delta,dB)(CH58 60 62 64)
0x71	TX0 5G PA TSSI slope (5470~5570)(CH98 100 101 104 106 108 112 114)
0x72	TX0 5G PA TSSI offset (5470~5570)**(Group3)**
0x73	TX0 5G TX power (54M,dBm,絕對值) (5470~5570)
0x74	TX0 5G TX power offset low(delta,dB)(CH98 100 101 104)
0x75	TX0 5G TX power offset high(delta,dB)(CH106 108 112 114)
0x76	TX0 5G PA TSSI slope (5580~5700)(CH116 120 122 124 128 130 132 136 138 140 144)
0x77	TX0 5G PA TSSI offset (5580~5700)**(Group4)**
0x78	TX0 5G TX power (54M,dBm,絕對值) (5580~5700)
0x79	TX0 5G TX power offset low(delta,dB)(CH116 120 122 124 128)
0x7A	TX0 5G TX power offset high(delta,dB)(CH**130** 132 136 138 140 144)
0x7B	TX0 5G PA TSSI slope (5725~5825)(CH149 153 155 156 157 161 162 165)
0x7C	TX0 5G PA TSSI offset (5725~5825)**(Group5)**
0x7D	TX0 5G TX power (54M,dBm,絕對值) (5725~5825)
0x7E	TX0 5G TX power offset low(delta,dB) (CH149 153 155 156)
0x7F	TX0 5G TX power offset high(delta,dB)(CH157 161 162 165)

Offset	Description
0x85	TX1 5G PA TSSI slope (5150~5250) (CH36 38 40 42 44 46 48)
0x86	TX1 5G PA TSSI offset (5150~5250)**(Group1)**
0x87	TX1 5G TX power (54M,dBm,絕對值) (5150~5250)
0x88	TX1 5G TX power offset low(delta,dB) (CH36 38 40 42)
0x89	TX1 5G TX power offset high(delta,dB) (CH**44** 46 48)
0x8A	TX1 5G PA TSSI slope (5250~5350) (CH52 54 56 58 60 62 64)
0x8B	TX1 5G PA TSSI offset (5250~5350)**(Group2)**
0x8C	TX1 5G TX power (54M,dBm,絕對值) (5650~5350)
0x8D	TX1 5G TX power offset low(delta,dB)(CH52 54 56)
0x8E	TX1 5G TX power offset high(delta,dB)(CH58 60 62 64)
0x8F	TX1 5G PA TSSI slope (5470~5570)(CH98 100 101 104 106 108 112 114)
0x90	TX1 5G PA TSSI offset (5470~5570)**(Group3)**
0x91	TX1 5G TX power (54M,dBm,絕對值) (5470~5570)
0x92	TX1 5G TX power offset low(delta,dB)(CH98 100 101 104)
0x93	TX1 5G TX power offset high(delta,dB)(CH106 108 112 114)
0x94	TX1 5G PA TSSI slope (5580~5700)(CH116 120 122 124 128 130 132 136 138 140 144)
0x95	TX1 5G PA TSSI offset (5580~5700)**(Group4)**
0x96	TX1 5G TX power (54M,dBm,絕對值) (5580~5700)
0x97	TX1 5G TX power offset low(delta,dB)(CH116 120 122 124 128)
0x98	TX1 5G TX power offset high(delta,dB)(CH**130** 132 136 138 140 144)
0x99	TX1 5G PA TSSI slope (5725~5825)(CH149 153 155 156 157 161 162 165)
0x9A	TX1 5G PA TSSI offset (5725~5825)**(Group5)**
0x9B	TX1 5G TX power (54M,dBm,絕對值) (5725~5825)
0x9C	TX1 5G TX power offset low(delta,dB) (CH149 153 155 156)
0x9D	TX1 5G TX power offset high(delta,dB)(CH157 161 162 165)

TSSI slope/offset mapping請參考Appendix A 黃色區域

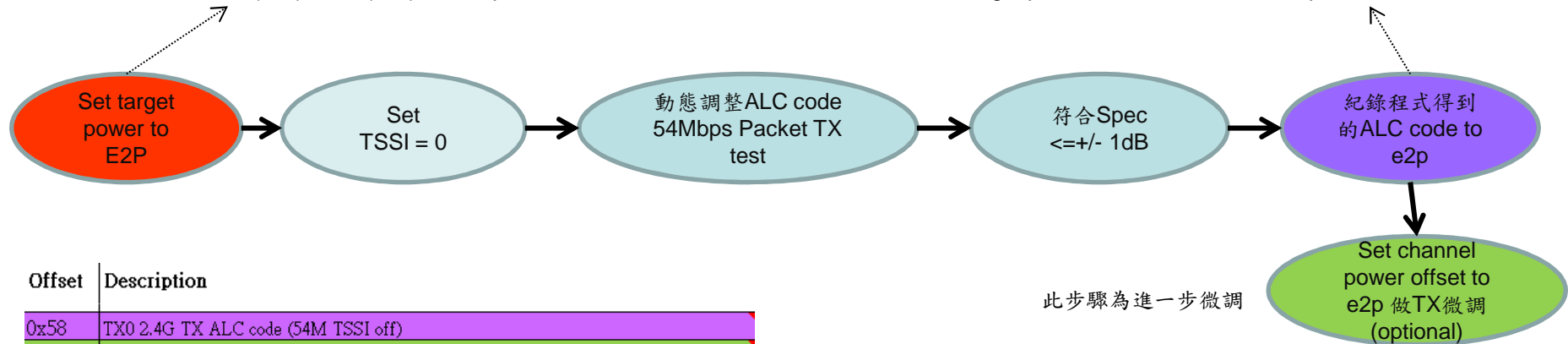TSSI on 54Mbps target power (絕對值) mapping請參考Appendix A藍色區域

channel power offset 請參考Appendix A 綠色區域

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Appendix B : 2G Part (TSSI off)

Example:

假設ATE configure 54Mbps target power = 16dBm
請將 16dBm/0.5dB=32(dec)=0x20(hex) 寫入e2p 0xF7位子

請將target power對應 ALC code寫入e2p 0x58 & 0x5E位子

Set target power to E2P → Set TSSI = 0 → 動態調整ALC code 54Mbps Packet TX test → 符合Spec <=+/- 1dB → 紀錄程式得到的ALC code to e2p

此步驟為進一步微調

↓

Set channel power offset to e2p 做TX微調 (optional)

Offset	Description
0x58	TX0 2.4G TX ALC code (54M TSSI off)
0x59	TX0 2.4G TX power offset low(CH1~5)(delta,dB)
0x5A	TX0 2.4G TX power offset middle(CH6~10)(delta,dB)
0x5B	TX0 2.4G TX power offset high(CH11~14)(delta,dB)
0x5E	TX1 2.4G TX ALC code (54M TSSI off)
0x5F	TX1 2.4G TX power offset low(CH1~5)(delta,dB)
0x60	TX1 2.4G TX power offset middle(CH6~10)(delta,dB)
0x61	TX1 2.4G TX power offset high(CH11~14)(delta,dB)
0xF7	TSSI off 2.4G TX power SKU (54Mbps, dBm絕對值)
0xF8	TSSI off 5G TX power SKU (54Mbps, dBm絕對值)

假設測試的WF0結果為
CH1 15dBm =>低了1dB,請在0x59填上0xC2補償
CH6 16dBm =>無須補償,請在0x5A填上0x00
CH11 17dBm =>高了1dB,請在0x5B填上0x82補償
WF1請重複相同動作
E2P定義請參考MT7612 E2P document

ALC code mapping請參考Appendix B 紫色區域

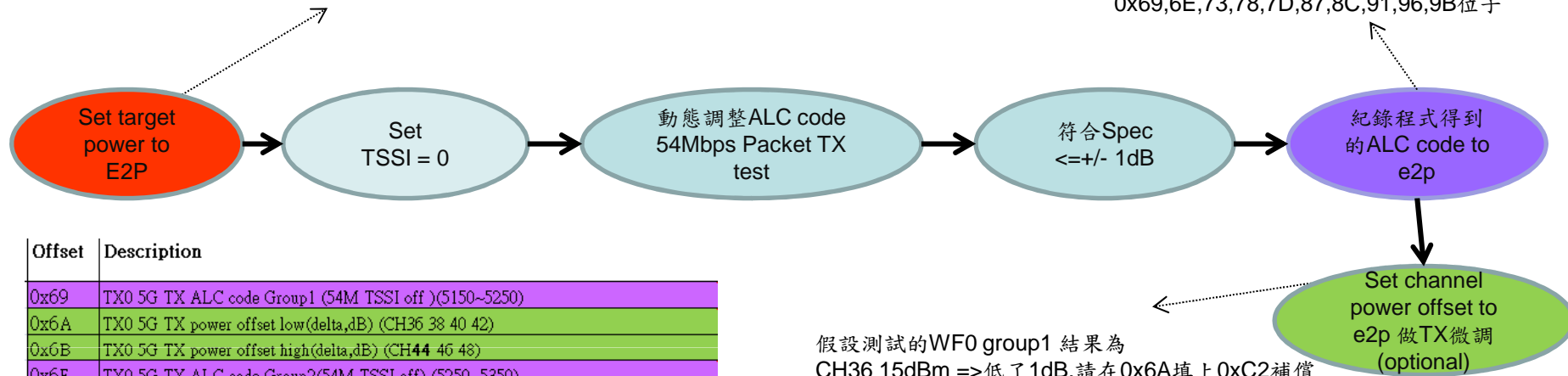channel power offset 請參考Appendix B 綠色區域

TSSI off 54Mbps target power 位子請參考Appendix B紅色區域

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Appendix B : 5G Part (TSSI off)

Example:

假設ATE configure 54Mbps target power = 16dBm
請 將 16dBm/0.5dB=32(dec)=0x20(hex) 寫入e2p 0xF8位子

請將target power對應 ALC code寫入e2p
0x69,6E,73,78,7D,87,8C,91,96,9B位子

Set target power to E2P → Set TSSI = 0 → 動態調整ALC code 54Mbps Packet TX test → 符合Spec <=+/- 1dB → 紀錄程式得到的ALC code to e2p

Set channel power offset to e2p 做TX微調 (optional)

Offset	Description
0x69	TX0 5G TX ALC code Group1 (54M TSSI off)(5150~5250)
0x6A	TX0 5G TX power offset low(delta,dB) (CH36 38 40 42)
0x6B	TX0 5G TX power offset high(delta,dB) (CH44 46 48)
0x6E	TX0 5G TX ALC code Group2(54M TSSI off) (5250~5350)
0x6F	TX0 5G TX power offset low(delta,dB)(CH52 54 56)
0x70	TX0 5G TX power offset high(delta,dB)(CH58 60 62 64)
0x73	TX0 5G TX ALC code Group3 (54M TSSI off)(5480~5570)
0x74	TX0 5G TX power offset low(delta,dB)(CH98 100 101 104)
0x75	TX0 5G TX power offset high(delta,dB)(CH106 108 112 114)
0x78	TX0 5G TX ALC code Group4(54M TSSI off) (5580~5700)
0x79	TX0 5G TX power offset low(delta,dB)(CH116 120 122 124 128)
0x7A	TX0 5G TX power offset high(delta,dB)(CH130 132 136 138 140 144)
0x7D	TX0 5G TX ALC code Group5 (54M TSSI off)(5725~5825)
0x7E	TX0 5G TX power offset low(delta,dB) (CH149 153 155 156)
0x7F	TX0 5G TX power offset high(delta,dB)(CH157 161 162 165)

| 0xF7 | TSSI off 2.4G TX power SKU (54Mbps, dBm絕對值) |
| 0xF8 | TSSI off 5G TX power SKU (54Mbps, dBm絕對值) |

ALC code mapping請參考Appendix B 紫色區域

channel power offset 請參考Appendix B 綠色區域

TSSI off 54Mbps target power 位子請參考Appendix B紅色區域

假設測試的WF0 group1 結果為
CH36 15dBm =>低了1dB,請在0x6A填上0xC2補償
CH42 16dBm
CH48 17dBm =>高了1dB,請在0x6B填上0x82補償
其他group2~5請重複做類似調整.
E2P定義請參考MT7612 E2P document

0x87	TX1 5G TX ALC code Group1 (54M TSSI off)(5150~5250)
0x88	TX1 5G TX power offset low(delta,dB) (CH36 38 40 42)
0x89	TX1 5G TX power offset high(delta,dB) (CH44 46 48)
0x8C	TX1 5G TX ALC code Group2(54M TSSI off) (5250~5350)
0x8D	TX1 5G TX power offset low(delta,dB)(CH52 54 56)
0x8E	TX1 5G TX power offset high(delta,dB)(CH58 60 62 64)
0x91	TX1 5G TX ALC code Group3 (54M TSSI off)(5480~5570)
0x92	TX1 5G TX power offset low(delta,dB)(CH98 100 101 104)
0x93	TX1 5G TX power offset high(delta,dB)(CH106 108 112 114)
0x96	TX1 5G TX ALC code Group4(54M TSSI off) (5580~5700)
0x97	TX1 5G TX power offset low(delta,dB)(CH116 120 122 124 128)
0x98	TX1 5G TX power offset high(delta,dB)(CH130 132 136 138 140 144)
0x9B	TX1 5G TX ALC code Group5 (54M TSSI off)(5725~5825)
0x9C	TX1 5G TX power offset low(delta,dB) (CH149 153 155 156)
0x9D	TX1 5G TX power offset high(delta,dB)(CH157 161 162 165)

TEK

Frequency Calibration

Example:
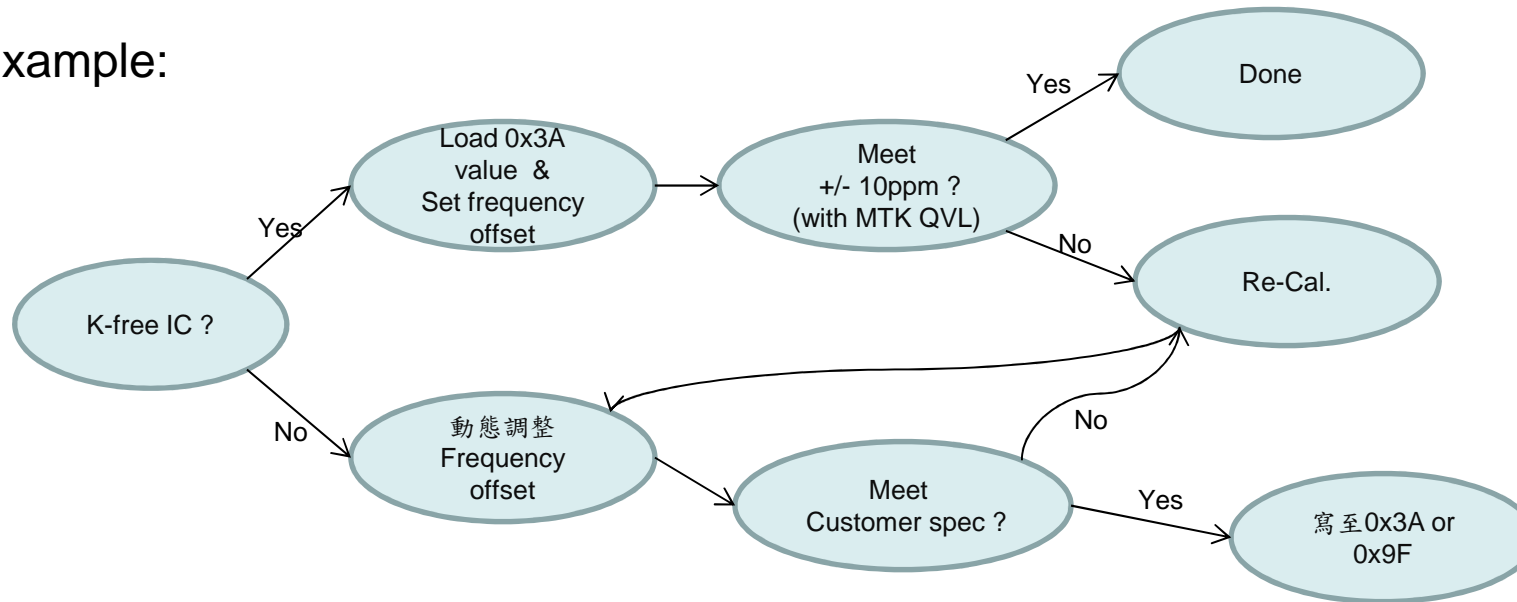
Offset	Description
0x3A	Frequence offset (XTAL calibration)
0x9E	Xtal Frequency offset compensation
0x9F	XTAL trim 2 (cap ID)

0x3A為FT K-free 寫入位置
0x9F[6:0]為第二組 frequency offset位置

若0x9F & 0x3A同時有值時(非0x00 or 0xFF),軟體會
以0x9F為主

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Linux ATE Command

- ## For TX Calibration

  - iwpriv rai0 set ATE=ATESTART

  - iwpriv rai0 set ATEAUTOALC=1   // 1 TSSI on ; 0 TSSI off

  - iwpriv rai0 set ATEDA=FF:FF:FF:FF:FF:FF

  - iwpriv rai0 set ATECHANNEL=138   // RF channel

  - iwpriv rai0 set ATETXBW=2   // 0 20M ; 1 40M ; 2 80M

  - iwpriv rai0 set ATETXMODE=4   // 0 CCK ; 1 OFDM ; 2 HT ; 4 VHT

  - iwpriv rai0 set ATETXMCS=9   // HT MCS 0~7 1ss , 8~15 2ss; VHT: 0 ~ 9 1ss 16 ~ 25 2ss

  - iwpriv rai0 set ATETXGI=0

  - iwpriv rai0 set ATETXLEN=1058

  - iwpriv rai0 set ATETXANT=1   // 0 DAC both) ; 1 DAC 0 ; 2 DAC 1

  - iwpriv rai0 set ATETXCNT=1000000

  - iwpriv rai0 set ATETXFREQOFFSET=52   // Crytal cap ID

  - iwpriv rai0 set ATETXPOW0=30   // TSSI on時, 此數值單位為0.5dB, 30代表15dBm

  - iwpriv rai0 set ATETXPOW1=30   // TSSI off時,此數值代表ALC code

  - iwpriv rai0 set ATE=TXFRAME

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Linux ATE Command

- **For TX Evaluation (舊image)**

- iwpriv rai0 set ATE=ATESTART

- iwpriv rai0 set ATEAUTOALC=1   // 1 TSSI on ;   0 TSSI off

- iwpriv rai0 set ATEDA=FF:FF:FF:FF:FF:FF

- iwpriv rai0 set ATECHANNEL=138   // RF channel

- iwpriv rai0 set ATETXBW=2   // 0 20M ; 1 40M ; 2 80M

- iwpriv rai0 set ATETXMODE=4   // 0 CCK ; 1 OFDM ; 2 HT ; 4 VHT

- iwpriv rai0 set ATETXMCS=9   // HT MCS 0~7 1ss , 8~15 2ss; VHT: 0 ~ 9 1ss 16 ~ 25 2ss

- iwpriv rai0 set ATETXGI=0

- iwpriv rai0 set ATETXLEN=1058

- iwpriv rai0 set ATETXANT=1   // 0 DAC both) ; 1 DAC 0 ; 2 DAC 1

- iwpriv rai0 set ATETXCNT=1000000

- iwpriv rai0 set ATETXFREQOFFSET=52   // Crystal   frequency

- iwpriv rai0 set ATETXPOW0=30   // TSSI on時, 此數值單位為0.5dB, 30代表15dBm

- iwpriv rai0 set ATETXPOW1=30   // TSSI off時,此數值代表ALC code

- iwpriv rai0 set ATE=TXFRAME

舊image ATETXPOWE命令driver只會自動帶入TX rate delta係數,
若須加入channel power offset / BW delta需要請量產程式自行加入

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Linux ATE Command

- For TX Evaluation (新image)

  - iwpriv rai0 set ATE=ATESTART

  - iwpriv rai0 set ATEAUTOALC=1   // 1 TSSI on ;   0 TSSI off

  - iwpriv rai0 set ATEDA=FF:FF:FF:FF:FF:FF

  - iwpriv rai0 set ATECHANNEL=138   // RF channel

  - iwpriv rai0 set ATETXBW=2   // 0 20M ; 1 40M ; 2 80M

  - iwpriv rai0 set ATETXMODE=4   // 0 CCK ; 1 OFDM ; 2 HT ; 4 VHT

  - iwpriv rai0 set ATETXMCS=9   // HT MCS 0~7 1ss , 8~15 2ss; VHT: 0 ~ 9 1ss 16 ~ 25 2ss

  - iwpriv rai0 set ATETXGI=0

  - iwpriv rai0 set ATETXLEN=1058

  - iwpriv rai0 set ATETXANT=1   // 0 DAC both) ; 1 DAC 0 ; 2 DAC 1

  - iwpriv rai0 set ATETXCNT=1000000

  - iwpriv rai0 set ATETXFREQOFFSET=52   // Crystal   frequency

  - iwpriv rai0 set ATETXPOWEVAL=1

  - iwpriv rai0 set ATE=TXFRAME

新image此命令driver會自動帶入TX rate delta, ,channel power offset 與 BW delta係數.

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TSSI Slope and Offset

- 若客戶想自行重新校正TSSI slope/offset,請與支援窗口拿取相關文件.

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