MP Driver Document

Commands and Setup for 5G

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CHANGE HISTORY

VERSION	DATE	REMARKS
1.0	2013/08/16	FIRST RELEASE
1.2	2013/08/21	SECOND RELEASE
1.3	2013/08/26	INCLUDE 8812AR/AR-VN

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I. MP Commands

This chapter will introduce the basic MP commands(format, usage, examples…), then user can try to type these commands by console interface, in order to do MP operations without MP Tool program installed in PC.

1. Introduction

Realtek WiFi Linux driver supports driver based Mass Production functions. Customers can utilize these functions to do EMI test and other simple TX and RX test. Under Realtek WiFi turnkey, we use Linux utility *"iwpriv"* to get and set I/O control to WLAN driver. The following commands are executed under Linux command prompt. The MP functions will only operate after the WLAN interface is opened.

2. Usage

1. Start MP mode:

"iwpriv wlan0 mp_start"

After executing this command, WLAN driver enters MP mode and stops transmitting and receiving any packets. All connection with other stations will be broken. Beacon transmitting is also stopped. If the original state is client mode, the roaming will be stopped.

2. Stop MP mode:

"iwpriv wlan0 mp_stop"

After executing this command, WLAN driver will stops transmitting and receiving packets initialized by other commands. It will not return to normal operation mode. System should close the WLAN interface and open again to get WLAN work normally.

3. Set Tx rate:

"iwpriv wlan0 mp_rate rate"

- *rate* sets the rate of Tx packets (i.e., 2 for 1M, 4 for 2M, 11 for 5.5M, …, 108 for 54M, 128 for MCS0, 129 for MCS1, …, 143 for MCS15)

Set the data rate of continuous transmitting.

4. Set operational channel:

"iwpriv wlan0 mp_channel channel"

- *channel* sets the channel to send and receive packets

Set the operational channel of transmitting and receiving packets.

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5. Set operational bandwidth:

"iwpriv wlan0 mp_bandwidth [40M=40m,shortGI=sgi]"

- *40m* sets the operational bandwidth, 0 for 20M mode, 1 for 40M mode, 2 for 80M mode
- *sgi* sets guard interval of transmitting MCS packet, 1 for short GI, 0 for long GI

Set the operational bandwidth for transmitting and receiving packets. Set the guard interval for transmitting MCS packets. If the parameters are not given, the default action is set bandwidth to 20M mode and long GI to transmitting packets.

6. Set Tx power:

"iwpriv wlan0 mp_txpower [patha=x,pathb=y]"

- *x* sets Tx power level for path A
- *y* sets Tx power level for path B

Set the transmitting power level of path A and path B. If the parameters are not given, the driver will set Tx power according to the flash setting.

7. Set PHY related parameters:

"iwpriv wlan0 mp_phypara {xcap=x}"

- *x* sets the value of crystal capacitor

Set the PHY related parameters of crystal capacitor.

8. Set BSSID:

"iwpriv wlan0 mp_bssid bssid"

- *bssid* sets the BSSID of transmitting packets

Set the BSSID of transmitting packets. Its format is 802.3 MAC address. (eg: 000102030405)

9. Set antenna for Tx:

"iwpriv wlan0 mp_ant_tx ant"

- *ant* sets the operational antenna for Tx, a for antenna A, b for antenna B, ab for antenna A and B

Set the operational antenna for Tx on the target board.

10. Set antenna for Rx:

"iwpriv wlan0 mp_ant_rx ant"

- *ant* sets the operational antenna for Rx, a for antenna A, b for antenna B, ab for antenna A and B

Set the operational antenna for Rx on the target board.

11. Start air Rx mode:

"iwpriv wlan0 mp_arx start/stop"

- *start* clears counters and start to accumulate Rx packets

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- *stop* stops counts and show the statistics

This command is for air receiving test. Use *start* command to clear all the counters and start to accumulate the received packets. Use *stop* command to stop counting and show the statistics of correct packets and CRC-error packets.

12. Start continuous Tx mode:

"iwpriv wlan0 mp_ctx time=t,count=n,background,stop,pkt,cs,stone"

- *t* sets the number of seconds to send packets
- *n* sets the number of packets to send
- *background* sends packets in background mode
- *stop* stops the background sending
- *pkt* sends packet tx, i.e., not sent by hardware
- *cs* sends carrier suppression
- *stone* sends single tone

This command is for continuous transmitting test. Use *time* command to assign the time to send packets. Use *count* command to assign the number of packets to send. If both of *time* and *count* are not specified, the sending function will continue infinitely. It can be stopped when any key is pressed (should be specifically implemented in other platform) while *background* command is not specified. If *cs* is specified, the sending signal will be a carrier suppression signal. To use cs command, you need to set mp rate to CCK rate first. Use *stone* command to send single tone signal for frequency testing. If *stone* is specified, the sending signal will be single tone and not a distinguishable packet any more. Use *background* command to tell driver to send packets in background. The command line control will return and packet sending is continuous. It can be stopped by *stop* command. By default, packets will be sent by hardware for shorter duty cycle. If *pkt* is specified, packets will be sent by software.

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13. Query air Rx statistics:

"iwpriv wlan0 mp_query"

This command is for packet counting. Under packet transmitting, use this command to get the number of packets being transmitted. Under receiving, use this command to get the statistics of correct packets and CRC-error packets.

14. Start air Rx mode:

"iwpriv wlan0 mp_dig on/off"

- *on* start mp dig.
- *off* stops mp dig.

This command is only for RTL8812 while receiving test. Use *on* command to start mp dig and it will change the initial gain setting depends on false alarm counter. Use *off* command to stop mp dig and it will set initial gain to default.

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3. Example

The standard procedure is,

1. config WiFi mibs to determine types of Band(5G/2.4G), Mode(A/B/G/N) and PA(extPA/intPA)
2. open WiFi driver and enter MP mode.
3. use mp commands to dynamically set channel, rate, antenna, power level…a
4. use mp commands to perform Tx/Rx verifications and query statistics.

After testing completed

Exit MP mode and re-open WiFi driver.

Below will introduce the command lists for examples.

1. Init and Open WiFi Driver

```
iwpriv wlan0 set_mib macPhyMode=0         //config Single MAC single PHY
iwpriv wlan0 set_mib phyBandSelect=2          //config band = 5G
iwpriv wlan0 set_mib mp_specific=1        //enable MP mode
ifconfig wlan0 down
ifconfig wlan0 up                         //close and open driver to activate mib setting.
iwpriv wlan0 mp_start                     //enter MP mode
```

2. Config Band Mode

2-1 Config Band Mode = 2.4G

```
iwpriv wlan0 set_mib phyBandSelect=1      //config band = 2.4G
iwpriv wlan0 set_mib mp_specific=1        //enable MP mode
ifconfig wlan0 down
ifconfig wlan0 up                         //close and open driver to activate mib setting.
iwpriv wlan0 mp_start                     //enter MP mode.
```

2-2 Config Band Mode = 5G

```
iwpriv wlan0 set_mib phyBandSelect=2      //config band = 5G
iwpriv wlan0 set_mib mp_specific=1        //enable MP mode
ifconfig wlan0 down
ifconfig wlan0 up                         //close and open driver to activate mib setting.
iwpriv wlan0 mp_start                     //enter MP mode
```

3. Config PA type

This command should be used in RTL8812 to set different external pa type.

3.1 config pa type to skyworks-5022

```
iwpriv wlan0 set_mib pa_type=0            // skyworks-5022
```

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ifconfig wlan0 down
ifconfig wlan0 up

3.1 config pa type to RFMD-4501/Skyworks-85703

```
iwpriv wlan0 set_mib pa_type=1          // RFMD-4501/Skyworks-85703
ifconfig wlan0 down
ifconfig wlan0 up
```

4. Config Other Settings

(These configurations can be applied immediately >> No need to down/up WiFi driver)

```
iwpriv wlan0 mp_channel 36                    //config channel = 36
iwpriv wlan0 mp_txpower patha=12,pathb=11     //config tx power indices of pathA=12, pathB=11
iwpriv wlan0 mp_ant_tx a                      //config antenna A to perform Tx
iwpriv wlan0 mp_ant_rx a                      //config antenna B to perform Rx
iwpriv wlan0 mp_rate 72                       //config data rate = 36 Mbps
iwpriv wlan0 mp_bandwidth 40M=0,shortGI=0     //config bandwidth = 40MHz, GI = long.
iwpriv wlan0 mp_phypara xcap=0                //config CrystalCap value = 0
```

5. Perform MP Testings

5-1. Test Item: Packets Tx

```
iwpriv wlan0 mp_ctx count=1000,background,pkt     //start sending 1000 packets
iwpriv wlan0 mp_query                             //get the statistics
iwpriv wlan0 mp_ctx stop                          //stop Tx test.
```

5-2. Test Item: Continuous Tx

```
iwpriv wlan0 mp_ctx background                    //start continuous Tx
iwpriv wlan0 mp_ctx stop                          //stop Tx test
```

5-3. Test Item: Continuous Tx Single Tone

```
iwpriv wlan0 mp_ctx background,stone              //start sending single stone signal
iwpriv wlan0 mp_ctx stop                          //stop Tx test
```

5-4. Test Item: Carrier Suppression Tx

```
iwpriv wlan0 mp_ctx background,cs                 //start sending carrier suppression signal
iwpriv wlan0 mp_ctx stop                          //stop Tx test
```

5-5. Test Item: Packets Rx

```
iwpriv wlan0 mp_arx start                         //start air Rx
iwpriv wlan0 mp_query                             //get the statistics
iwpriv wlan0 mp_arx stop                          //stop Rx Test
```

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6. Exit MP Mode

```
iwpriv wlan0 mp_stop        //exit MP mode
ifconfig wlan0 down         //close WLAN interface
ifconfig wlan0 up           //open again for normal operation
```

4. Flash commands

After finishing Mass Production test, the tester may need to save the calibration results in the flash for normal operation. There are some fields in flash to save the calibration results:

The following flash fields name start with HW_WLANX. The X is either 0 or 1 depends on which interface 8812 is plugged in.

1. CCK Tx Power value for 2.4G:

HW_WLAN0_TX_POWER_CCK_A
HW_WLAN0_TX_POWER_CCK_B

Ex.
flash set HW_WLAN0_TX_POWER_CCK_A 20 20 20 20 20 20 20 20 20 20 20 20 20 20

Note: There are 14 values for CCK mode of 14 channels for each path.

2. HT 40MHz 1S Tx Power value for 2.4G:

HW_WLAN0_TX_POWER_HT40_1S_A
HW_WLAN0_TX_POWER_HT40_1S_B

Ex.
flash set HW_WLAN0_TX_POWER_HT40_1S_A 10 10 10 10 10 10 10 10 10 10 10 10 10 10

Note: There are 14 values for HT 1 spatial stream in 40MHz mode of 14 channels for each path.

3. HT 20MHz and OFDM Tx Power difference for 2.4G:

HW_WLAN0_TX_POWER_DIFF_20BW1S_OFDM1T_A
HW_WLAN0_TX_POWER_DIFF_20BW1S_OFDM1T_B

Ex.
flash set HW_WLAN0_TX_POWER_DIFF_20BW1S_OFDM1T_A 23 23 23 23 23 23 23 23 23 23 23 23 23 23

Note:
There are 14 values for HT 20MHz 1S and OFDM 1T power difference of 14 channels. For each value, the lower 4 bits stands for difference of OFDM rates, and the higher 4 bits stands for difference of HT20 1S rates.

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4. HT 20/40MHz 2S Tx Power difference for 2.4G:
HW_WLAN0_TX_POWER_DIFF_40BW2S_20BW2S_A
HW_WLAN0_TX_POWER_DIFF_40BW2S_20BW2S_B

Ex.
flash set HW_WLAN0_TX_POWER_DIFF_40BW2S_20BW2S_A 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10

Note:
There are 14 values for HT 2 spatial streams in 40MHz mode and 20MHz mode of 14 channels. For each value, the lower 4 bits stands for difference of 20MHz 2S, and the higher 4 bits stands for difference between of 40MHz 2S.

5. HT 40MHz 1S Tx Power value for 5G:
HW_WLAN0_TX_POWER_5G_HT40_1S_A
HW_WLAN0_TX_POWER_5G_HT40_1S_B

Ex.
flash set HW_WLAN0_TX_POWER_5G_HT40_1S_A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 33 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 00

Note:
The format of 5G flash items are the same as 2G flash items. The only difference is 5G flash items have 196 values for 196 channels.

6. HT 20MHz and OFDM Tx Power difference for 5G:
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_B

7. HT 20/40MHz 2S Tx Power difference for 5G:
HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_A
HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_B

8. HT 80/160MHz 1S Tx Power difference for 5G:
HW_WLAN0_TX_POWER_DIFF_5G_80BW1S_160BW1S_A
HW_WLAN0_TX_POWER_DIFF_5G_80BW1S_160BW1S_B

9. HT 80/160MHz 2S Tx Power difference for 5G:
HW_WLAN0_TX_POWER_DIFF_5G_80BW2S_160BW2S_A
HW_WLAN0_TX_POWER_DIFF_5G_80BW2S_160BW2S_B

Ex:

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flash set HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A 01 01 01 01 01 01 01 01 01 01 01 01 01 01

Note:
The format of 5G power difference flash items are the same as 2G flash items. The only difference is 5G flash items have 196 values for 196 channels. And the 196 channels are separated into 14 groups. The group mapping is as follow:

Group#	**5G Channel**	
[1]	36-40	Band 1 5.15GHz-5.25GHz
[2]	41-48	
[3]	49-56	Band 2 5.25GHz-5.35GHz
[4]	57-64	
[5]	65-104	Band 3 5.4GHz-5.725GHz
[6]	105-110	
[7]	111-120	
[8]	121-128	
[9]	129-136	
[10]	137-144	
[11]	145-153	Band 4 5.725GHz-5.85GH
[12]	154-161	
[13]	162-169	
[14]	170-177	

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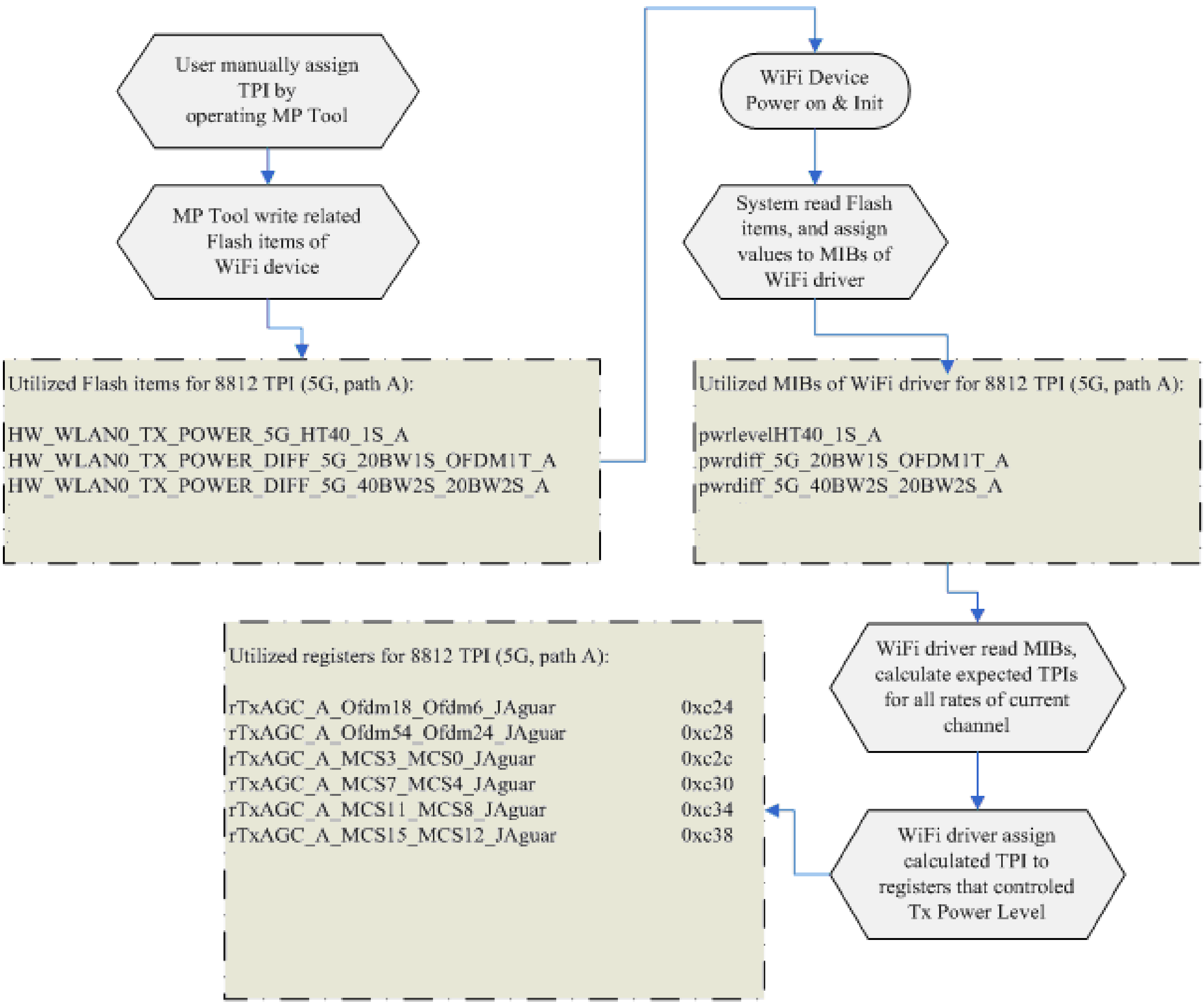
II. Tx Power Index for 8812AR-VN Chip

1. INTRODUCTION

There are registers of 8812 can control the tx power level for all rates, the bigger values of these registers, the bigger tx power level will achieve, these values were called Tx Power Index (TPI).

So, after Calibration, we can get a set of TPIs to match the expected Tx power level, and these TPIs can be stored in Flash of WiFi device by operating MP Tool.

If these TPIs were stored in Flash of WiFi device, WiFi driver can read these TPIs and assign to registers controls tx power level, and transmit packets with expected power level.



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2. FLASH ITEMS OF TPI

Below Table lists related Flash items for 8812 AR-VN TPI.

HW_WLAN0_TX_POWER_5G_HT40_1S_A[196] **HW_WLAN0_TX_POWER_5G_HT40_1S_B[196]**	Path A/B 5G BW40-1S Power Index
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[14] **HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_B[14]**	Pwower Index Difference between BW20-1S and BW40-1S. Bit[7:4]: Path A/B 5G Offset, Range –8~7. Pwower Index Difference between OFDM-1Tx and BW40-1S. Bit[3:0]: Path A/B 5G Offset, Range –8~7.
HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_A[14] **HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_B[14]**	Pwower Index Difference between BW40-2S and BW40-1S. Bit[7:4]: Path A/B 5G Offset, Range –8~7. Pwower Index Difference between BW20-2S and BW20-1S. Bit[3:0]: Path A/B 5G Offset, Range –8~7.

[196]=this flash item has 196 elements, each element maps to the number of channel from [1] to [196]

[14] .= this flash item has 14 elements, each element maps to the number of group. From [1] to [14], because 5G channels are split into 14 Groups,

Group#	5G Channel	
[1]	36-40	Band 1 5.15GHz-5.25GHz
[2]	41-48	
[3]	49-56	Band 2 5.25GHz-5.35GHz
[4]	57-64	
[5]	65-104	Band 3 5.4GHz-5.725GHz
[6]	105-110	
[7]	111-120	
[8]	121-128	
[9]	129-136	
[10]	137-144	
[11]	145-153	Band 4 5.725GHz-5.85GH
[12]	154-161	
[13]	162-169	
[14]	170-177	

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For example,
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[14]
has 14 elements, each element maps into 1 of 14 5G channel groups. (form Group #1 to Group #14)

HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A=0102030405060708090a0b0c0d0e

HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[1] = 0x01
➔ diff for channels 36-40 is 0x01
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[2] = 0x02
➔ diff for channels 41-48 is 0x02
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[3] = 0x03
➔ diff for channels 49-56 is 0x03
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[4] = 0x04
➔ diff for channels 57-64 is 0x04
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[5] = 0x05
➔ diff for channels 65-104 is 0x05
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[6] = 0x06
➔ diff for channels 105-110 is 0x06
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[7] = 0x07
➔ diff for channels 111-120 is 0x07
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[8] = 0x08
➔ diff for channels 121-128 is 0x08
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[9] = 0x09
➔ diff for channels 129-136 is 0x09
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[10] = 0x0a
➔ diff for channels 137-144 is 0x0a
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[11] = 0x0b
➔ diff for channels 145-153 is 0x0b
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[12] = 0x0c
➔ diff for channels 154-161 is 0x0c
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[13] = 0x0d
➔ diff for channels 162-169 is 0x0d
HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[14] = 0x0e
➔ diff for channels 170-177 is 0x0e

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For example,

HW_WLAN0_TX_POWER_5G_HT40_1S_A [196] has 196 elements,

each element maps into 1 of 196 5G channels. (form channel 1 to channel 196)

HW_WLAN0_TX_POWER_5G_HT40_1S_A=
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
0000000000000000000000000000000000000000
000000000000

Group 1

Band 1 : 5.15GHz-5.25GHz

HW_WLAN0_TX_POWER_5G_HT40_1S_A[36] = 0x1
➔ BW40-1S Power Index of channel 36 is 0x1
HW_WLAN0_TX_POWER_5G_HT40_1S_A[37] = 0x1
➔ BW40-1S Power Index of channel 37 is 0x1
HW_WLAN0_TX_POWER_5G_HT40_1S_A[38] = 0x1
➔ BW40-1S Power Index of channel 38 is 0x1
HW_WLAN0_TX_POWER_5G_HT40_1S_A[39] = 0x1
➔ BW40-1S Power Index of channel 39 is 0x1
HW_WLAN0_TX_POWER_5G_HT40_1S_A[40] = 0x1
➔ BW40-1S Power Index of channel 40 is 0x1

Group 2

Band 1 : 5.15GHz-5.25GHz

HW_WLAN0_TX_POWER_5G_HT40_1S_A[41] = 0x2
➔ BW40-1S Power Index of channel 41 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[42] = 0x2
➔ BW40-1S Power Index of channel 42 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[43] = 0x2
➔ BW40-1S Power Index of channel 43 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[44] = 0x2

→ BW40-1S Power Index of channel 44 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[45] = 0x2
→ BW40-1S Power Index of channel 45 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[46] = 0x2
→ BW40-1S Power Index of channel 46 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[47] = 0x2
→ BW40-1S Power Index of channel 47 is 0x2
HW_WLAN0_TX_POWER_5G_HT40_1S_A[48] = 0x2
→ BW40-1S Power Index of channel 48 is 0x2

Group 3
Band 2 : 5.25GHz-5.35GHz
HW_WLAN0_TX_POWER_5G_HT40_1S_A[49] = 0x3
→ BW40-1S Power Index of channel 49 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[50] = 0x3
→ BW40-1S Power Index of channel 50 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[51] = 0x3
→ BW40-1S Power Index of channel 51 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[52] = 0x3
→ BW40-1S Power Index of channel 52 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[53] = 0x3
→ BW40-1S Power Index of channel 53 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[54] = 0x3
→ BW40-1S Power Index of channel 54 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[55] = 0x3
→ BW40-1S Power Index of channel 55 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[56] = 0x3
→ BW40-1S Power Index of channel 56 is 0x3
HW_WLAN0_TX_POWER_5G_HT40_1S_A[57] = 0x3
→ BW40-1S Power Index of channel 57 is 0x3

Group 4
Band 2 : 5.25GHz-5.35GHz
HW_WLAN0_TX_POWER_5G_HT40_1S_A[58] = 0x4
→ BW40-1S Power Index of channel 58 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[59] = 0x4
→ BW40-1S Power Index of channel 59 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[60] = 0x4
→ BW40-1S Power Index of channel 60 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[61] = 0x4
→ BW40-1S Power Index of channel 61 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[62] = 0x4
→ BW40-1S Power Index of channel 62 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[63] = 0x4
→ BW40-1S Power Index of channel 63 is 0x4
HW_WLAN0_TX_POWER_5G_HT40_1S_A[64] = 0x4
→ BW40-1S Power Index of channel 64 is 0x4

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3. CALCULATION OF TPI

There are OFDM rates, HT rates& VHT rates for 8812AR-VN Tx, tx power level of these kinds of rates are controlled by different registers for Antenna A&B, and for HT rates, different bandwidth(20M/40M) & different numbers of spatial stream(1T/2T) may has different TPIs.

<table>
<tr><th>Rates</th><th>BandWidth</th><th>Flash Items</th><th>Registers</th></tr>
<tr><td>OFDM</td><td>ALL</td><td>5G_HT40_1S
+
DIFF_5G_OFDM1T</td><td>rTxAGC_A_Ofdm18_Ofdm6_JAguar 0xc24
rTxAGC_A_Ofdm54_Ofdm24_JAguar 0xc28
rTxAGC_B_Ofdm18_Ofdm6_JAguar 0xe24
rTxAGC_B_Ofdm54_Ofdm24_JAguar 0xe28</td></tr>
<tr><td>HT - 1T</td><td>20M</td><td>5G_HT40_1S
+
DIFF_5G_20BW1S</td><td rowspan="2">rTxAGC_A_MCS3_MCS0_JAguar 0xc2c
rTxAGC_A_MCS7_MCS4_JAguar 0xc30
rTxAGC_A_Nss1Index3_Nss1Index0_JAguar 0xc3c
rTxAGC_A_Nss1Index7_Nss1Index4_JAguar 0xc40
rTxAGC_A_Nss2Index1_Nss1Index8_JAguar 0xc44
rTxAGC_B_MCS3_MCS0_JAguar 0xe2c
rTxAGC_B_MCS7_MCS4_JAguar 0xe30</td></tr>
<tr><td>HT - 1T</td><td>40M</td><td>5G_HT40_1S</td></tr>
<tr><td>HT - 2T</td><td>20M</td><td>5G_HT40_1S
+
DIFF_5G_20BW1S
+
DIFF_5G_20BW2S</td><td rowspan="2">rTxAGC_A_MCS11_MCS8_JAguar 0xc34
rTxAGC_A_MCS15_MCS12_JAguar 0xc38
rTxAGC_A_Nss1Index3_Nss1Index0_JAguar 0xc3c
rTxAGC_A_Nss2Index5_Nss2Index2_JAguar 0xc48
rTxAGC_A_Nss2Index9_Nss2Index6_JAguar 0xc4c
rTxAGC_B_MCS11_MCS8_JAguar 0xe34
rTxAGC_B_MCS15_MCS12_JAguar 0xe38</td></tr>
<tr><td>HT - 2T</td><td>40M</td><td>5G_HT40_1S
+
DIFF_5G_40BW2S</td></tr>
</table>

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<Example 1>

Primary channel = 36, bandwidth = 20M,
working channel (center frequency) = 36, belongs to Group#1

[PATH A]

HW_WLAN0_TX_POWER_5G_HT40_1S_A[36] = 0x20
5G_HT40_1S = 0x20 = 32

HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[1] = 0x38
DIFF_5G_20BW1S = convert_diff(0x3) = 3
DIFF_5G_OFDM1T = convert_diff(0x8) = -8

HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_A[1] = 0xf2
DIFF_5G_20BW2S = convert_diff(0x2) = 2

<Calculate OFDM rates>
5G_HT40_1S + DIFF_5G_OFDM1T = 32 + (-8) = 24 (0x18)

<Calculate 20M-1T for HT rates>
5G_HT40_1S + DIFF_5G_20BW1S = 32 + 3 = 35 (0x23)

<Calculate 20M-2T for HT rates>
5G_HT40_1S + DIFF_5G_20BW1S + DIFF_5G_20BW2S = 32 + 3 + 2 = 37 (0x25)

<Expected values of registers control tx power level>
0xc24 = 0x18181818 // {18M 12M 9M 6M}
0xc28 = 0x18181818 // {54M 48M 36M 24M}
0xc2c = 0x23232323 // HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 = 0x23232323 // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x25252525 // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x25252525 // HT_{MCS15 MCS14 MCS13 MCS12}

<Example 2>

Primary channel = 36, bandwidth = 40M,
working channel = 36+2 = 38, belongs to Group#1

[PATH A]

HW_WLAN0_TX_POWER_5G_HT40_1S_A[38] = 0x20
5G_HT40_1S = 0x20 = 32

HW_WLAN0_TX_POWER_DIFF_5G_20BW1S_OFDM1T_A[1] = 0x38
DIFF_5G_OFDM1T = convert_diff(0x8) = -8

HW_WLAN0_TX_POWER_DIFF_5G_40BW2S_20BW2S_A[1] = 0xf2
DIFF_5G_40BW2S = convert_diff(0xf) = -1

<Calculate OFDM rates>
5G_HT40_1S + DIFF_5G_OFDM1T = 32 + (-8) = 24 (0x18)

<Calculate 40M-1T for HT rates>
5G_HT40_1S = 32 (0x20)

<Calculate 40M-2T for HT rates>
5G_HT40_1S + DIFF_5G_40BW2S = 32 + (-1) = 31 (0x1f)

<Expected values of registers control tx power level>
0xc24 = 0x18181818 // {18M 12M 9M 6M}
0xc28 = 0x18181818 // {54M 48M 36M 24M}
0xc2c = 0x20202020 // HT_{MCS3 MCS2 MCS1 MCS0}

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0xc30 = 0x20202020 // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x1f1f1f1f // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x1f1f1f1f // HT_{MCS15 MCS14 MCS13 MCS12}

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III. Calculate Tx Power Index of Normal Driver

After calibration, calibrated Tx Power Index will be stored for WiFi products, but in Normal driver, there is a function “Power By Rate” that can effect real Tx Power, and may make Tx power level be different between MP mode & Normal Mode. This chapter will describe how to calculate the final Tx Power Index assigned to WiFi registers in Normal driver.

1. INTRODUCTION

Tx Power Index (TPI), is the value to control the power level of Tx, the bigger the value of TPI, the bigger the power level of Tx.

This chapter will introduce how to calculate the final TPI for different rates (cck, ofdm, mcs…) from these elements: flash data and power by rate tables.

In normal case, one WiFi product only needs to reach one target power (like 13dBm) for all rates.

Real Tx Power Level depends on TPI values input into specific WiFi registers (ex: 0xe08, 0x838, 0x86c, 0xe00, 0xe04…), and these values were calculated from these items:

1. Tx Power Index stored in FLASH (or Efuse)
2. Power By Rate Tables from WLAN driver

2. Tx Power Index Stored in FLASH

After calibrations, we store TPIs for all rates and all available channels in flash. In section II, we already explained how to calculate TPI read from flash. Please refer that section for more detail. In addition, the TPI is adjusted according to power by rate table in normal driver.

3. Power By Rate Tables

WiFi Caliberation is performed under MP mode, in order to get the correct TPI for expected power level (ex: 13dBm). In Normal mode, developers can try to increase additional TPI by editing ‘Power By Rate’ tables.

3.1 Power by Rate Table Format

Power By Rate tables existed in WiFi Driver, in \rtl8192cd_wifi\data_8812\, there is a file for Power by Rate table of 8812AR chip: PHY_REG_PG_8812_new.txt

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The Format of Power By Rate Table is like this:

// 2.4G

0xc20	17.0 18.0 19.0 20.0 // TXAGC codeword (H-byte->L-byte)={11M 5.5M 2M 1M}
0xc24	21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xc28	15 16 18 19 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xc2c	20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xc30	14 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5 MCS4}
0xc34	19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}
0xc38	13 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}

0xe20	17 18 19 20 // TXAGC codeword (H-byte->L-byte)={11M 5.5M 2M 1M}
0xe24	21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xe28	15 16 18 19 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xe2c	20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xe30	14 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5 MCS4}
0xe34	19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}
0xe38	13 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}

// 5G

0xc24	21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xc28	15 16 18 20 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xc2c	20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xc30	14 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5 MCS4}
0xc34	19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}
0xc38	13 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}
0xc3c	20 21 22 22 // TXAGC codeword (H-byte->L-byte)=VHT1SS_{MCS3 MCS2 MCS1 MCS0}
0xc40	14 15 16 18 // TXAGC codeword (H-byte->L-byte)=VHT1SS_{MCS7 MCS6 MCS5 MCS4}
0xc44	21 21 12 13 // TXAGC codeword (H-byte->L-byte)={VHT2SS{MCS1 MCS0} VHT1SS_{MC9 MCS8}}
0xc48	15 17 19 20 // TXAGC codeword (H-byte->L-byte)=VHT2SS_{MCS5 MCS4 MCS3 MCS2}
0xc4c	11 12 13 14 // TXAGC codeword (H-byte->L-byte)=VHT2SS_{MCS9 MCS8 MCS7 MCS6}

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0xe24 21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xe28 15 16 18 20 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xe2c 20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xe30 14 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5 MCS4}
0xe34 19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}
0xe38 13 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}
0xe3c 20 21 22 22 // TXAGC codeword (H-byte->L-byte)=VHT1SS_{MCS3 MCS2 MCS1 MCS0}
0xe40 14 15 16 18 // TXAGC codeword (H-byte->L-byte)=VHT1SS_{MCS7 MCS6 MCS5 MCS4}
0xe44 21 21 12 13 // TXAGC codeword (H-byte->L-byte)={VHT2SS{MCS1 MCS0} VHT1SS_{MC9 MCS8}}
0xe48 15 17 19 20 // TXAGC codeword (H-byte->L-byte)=VHT2SS_{MCS5 MCS4 MCS3 MCS2}
0xe4c 11 12 13 14 // TXAGC codeword (H-byte->L-byte)=VHT2SS_{MCS9 MCS8 MCS7 MCS6}
0xffff 0xffff

In 8812 AR-VN, we only focus on the 5G part. There are 2 groups in the table, one is from 0xc24 to 0xc4c. This group stands for target power of path A. The other group is from 0xe24 to 0xe4c. This group stands for target power of path B.

Each group is categorized into small group in addition. For example, in path A
OFDM – 0xc24 and 0xc28, the highest data rate is 54M
HT 1S – 0xc2c and 0xc30, the highest data rate is MCS7
HT 2S – 0xc34 and 0xc38, the highest data rate is MCS15

<Example>
[OFDM rate]
0xe28 15 16 18 20 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}

[1st row] 0xe28
Target register to add TPIr
[2nd row] 15 16 18 20
The target power of each data rate

0xe28 is the register to control Tx Power of rates 54M, 48M, 36M, 24M. It has 4 bytes, each bytes represents its specific rates separately.

Since this format presents the absolute value of Tx power, the power index to add is the difference from the power of highest data rate.

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A power index stands for 0.5 dbm.

For example,
the power by rate index of 54M is (15 – 15)*2 = 0
the power by rate index of 48M is (16 – 15)*2 = 2
the power by rate index of 36M is (18 – 15)*2 = 6
the power by rate index of 24M is (20 – 15)*2 = 10

>> which means that the final value of register 0xe2c = original value + 0x0002060a
>> that is, TPI of 54M = original TPI + 0x00
TPI of 48M = original TPI + 0x02
TPI of 36M = original TPI + 0x06
TPI of 24M = original TPI + 0x0a

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3.2 Calculate Final TPI from Power by Rate Table

In Normal Driver, the final TPI is Calculated from

'Data stored from FLASH' + 'Power by Rate'

The current TPI can be get by command:

iwpriv wlan0 reg_dump

We can also try this debug command to get the expected TPI for all Groups.

iwpriv wlan0 reg_dump tx

We need to use 'Working Channel' as parameter to determine TPI.

Channel Width	Control Sideband	Working Channel
20MHz		= Channel Number
40MHz	Lower	= Channel Number + 2
40MHz	Upper	= Channel Number — 2

3.3 Examples

We use the example provided in section II part 3, and add power by rate to get the target TPI.

<Example 1>

The TPI calculate from Flash is as below: (A path)

<Expected values of registers control tx power level>
0xc24 = 0x18181818 // {18M 12M 9M 6M}
0xc28 = 0x18181818 // {54M 48M 36M 24M}
0xc2c = 0x23232323 // HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 = 0x23232323 // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x25252525 // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x25252525 // HT_{MCS15 MCS14 MCS13 MCS12}

The power by rate table is
0xc24 21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xc28 **15** 16 18 20 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xc2c 20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 **14** 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 **13** 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}

The final TPI in register is:
0xc24 = 0x24242626 // {8M 12M 9M 6M}
0xc28 = 0x**18**1a1e22 // {54M 48M 36M 24M}
0xc2c = 0x2f313333 // HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 = 0x**23**25272b // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x31333535 // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x**25**27292d // HT_{MCS15 MCS14 MCS13 MCS12}

<Example 2>

<Expected values of registers control tx power level>
0xc24 = 0x18181818 // {18M 12M 9M 6M}
0xc28 = 0x18181818 // {54M 48M 36M 24M}
0xc2c = 0x20202020 // HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 = 0x20202020 // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x1f1f1f1f // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x1f1f1f1f // HT_{MCS15 MCS14 MCS13 MCS12}

The power by rate table is
0xc24 21 21 22 22 // TXAGC codeword (H-byte->L-byte)={18M 12M 9M 6M}
0xc28 **15** 16 18 20 // TXAGC codeword (H-byte->L-byte)={54M 48M 36M 24M}
0xc2c 20 21 22 22 // TXAGC codeword (H-byte->L-byte)=HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 **14** 15 16 18 // TXAGC codeword (H-byte->L-byte)=HT_{MCS7 MCS6 MCS5

MCS4}

0xc34 19 20 21 21 // TXAGC codeword (H-byte->L-byte)=HT_{MCS11 MCS10 MCS9 MCS8}

0xc38 **13** 14 15 17 // TXAGC codeword (H-byte->L-byte)=HT_{MCS15 MCS14 MCS13 MCS12}

The final TPI in register is:

0xc24 = 0x24242626 // {8M 12M 9M 6M}
0xc28 = 0x**18**1a1e22 // {54M 48M 36M 24M}
0xc2c = 0x2c2e3030 // HT_{MCS3 MCS2 MCS1 MCS0}
0xc30 = 0x**20**222428 // HT_{MCS7 MCS6 MCS5 MCS4}
0xc34 = 0x2b2d2f2f // HT_{MCS11 MCS10 MCS9 MCS8}
0xc38 = 0x**1f**212327 // HT_{MCS15 MCS14 MCS13 MCS12}

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