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ATWINC3400A - Deriving Application Gain Table Application Note

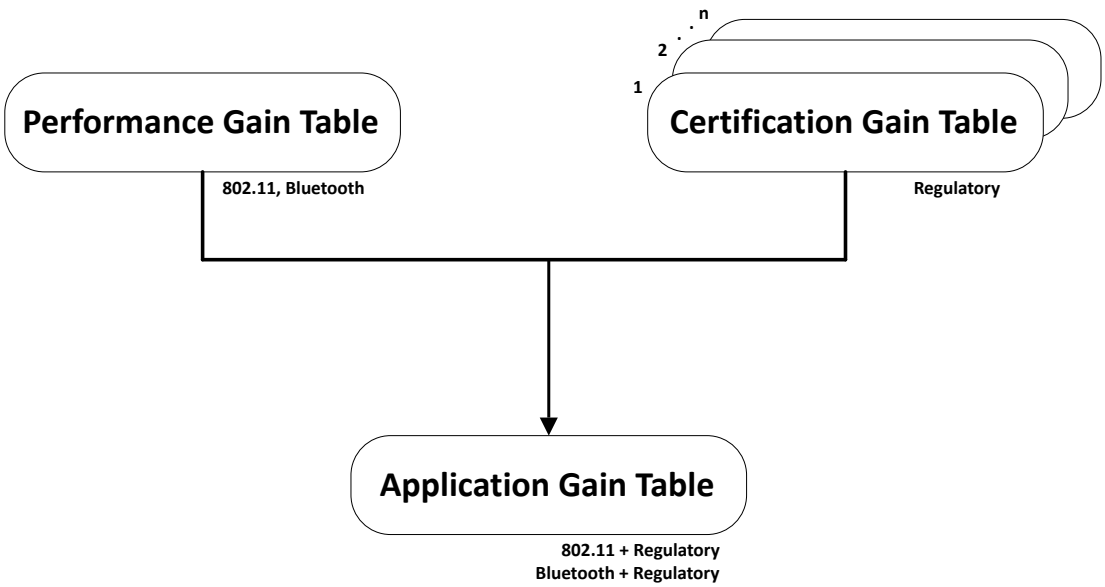
Introduction

The gain table controls the RF output power of the ATWINC3400A device. This application note describes the Wi-Fi® and Bluetooth Low Energy gain table structure and procedure to derive the Wi-Fi and Bluetooth Low Energy gain tables during the product development phase.

Perform the following steps to derive the Wi-Fi and Bluetooth Low Energy Application Gain Table:

1. Performance Gain Table: Verify the Digital Gain (DG) setting to meet IEEE 802.11 and Bluetooth specifications.
2. Certification Gain Table: Adjust the DG setting for the specific regulatory region compliance.
3. Application Gain Table: Combine step 1 and step 2 to produce a composite gain table, referred to as an "Application Gain Table", which can be used in the firmware for the product.

Figure 1. Deriving Wi-Fi and Bluetooth Low Energy Application Gain Table



Prerequisites

- MCHPRT2 Tool:
  - Radio test tool for configuring and testing the ATWINC3400A device
  - Refer to the MCHPRT2 user guide document for details on the MCHPRT2 Graphical User Interface (GUI) and Command Line Interface (CLI)
- ATWINC15x0/ATWINC3400 - Integrated Serial Flash and Memory Download Procedure - DS00002378:
  - This application note details the Gain Tables download procedure

Table of Contents

1. ATWINC3400A Gain Stages

The following are three stages of amplification in the ATWINC3400A transmitter:

1. Digital Gain (DG)
2. Pre-Power Amplifier (PPA)
3. Power Amplifier (PA)

- **DG Stage:**
  - The DG stage is the one the user can adjust to set the desired output power. The DG values are configured with the negative sign.
  - The DG gain allows the user to adjust the output power to the desired output to meet standard specifications (IEEE 802.11 and Bluetooth 5.0) and to meet the required regulatory specification.
  - For Wi-Fi, the DG gain is controlled across all channels, 1 to 14, and across all data rates for b, g and n modes of transmissions.
  - For Bluetooth Low Energy, the DG gain is controlled across all channels, 0 to 39.
  - Each DG step is equivalent to approximately a 1 dB change in RF output power. For example, if DG is -7 for a given data rate and channel, and if there is a need to increase transmit power, DG must be configured with a value of -6 or higher.
- **PPA and PA Stage:**
  - For Wi-Fi, the PPA and PA gains are fixed at 15 and 18, respectively.
  - For Bluetooth Low Energy, both the PPA and PA gains are fixed at 6.
  - No changes must be made to the PPA and PA gain values.

2. Wi-Fi Gain Table

2.1 Wi-Fi Gain Table Format

The format of the Wi-Fi gain table displays below. This table needs to be filled with DG, PA and PPA values, which are unique for a given Wi-Fi channel and data rate. Microchip recommends using the default gain table and editing the gain values based on the user requirement. The default gain table can be accessed from the location mentioned in Section 7 (Gain Values Download) of the *ATWINC15x0/ATWINC3400 − Integrated Serial Flash and Memory Download Procedure Application Note* (DS00002378).

Note: The PPA and PA have a similar table to the DG gain table, but the values of PPA and PA gains are fixed at 15 and 18, respectively, for all channels and data rates.

The following table format is an example for the DG table.

Table 2-1. Wi-Fi DG Gain Table Format

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WiFi_Gain_1:														
WiFi_Gain_2:														
WiFi_Gain_5.5:														
WiFi_Gain_11:														
WiFi_Gain_6:														
WiFi_Gain_9:														
WiFi_Gain_12:														
WiFi_Gain_18:														
WiFi_Gain_24:														
WiFi_Gain_36:														
WiFi_Gain_48:														
WiFi_Gain_54:														
WiFi_Gain_MCS0:														
WiFi_Gain_MCS1:														
WiFi_Gain_MCS2:														
WiFi_Gain_MCS3:														
WiFi_Gain_MCS4:														
WiFi_Gain_MCS5:														
WiFi_Gain_MCS6:														
WiFi_Gain_MCS7:														

The following figure is an example of the sample DG gain table.

Figure 2-1. Sample DG Gain Table

```
# Number of Tables
1
# Table 0
T0:
# Define a WiFi DG Gain for each WIFI channel (1-14)
# Channels:      1    2    3    4    5    6    7    8    9    10   11   12   13   14
WiFi_Gain_1:    -15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15
WiFi_Gain_2:    -15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15
WiFi_Gain_5.5:  -14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-14
WiFi_Gain_11:   -14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-14,-15,-15,-15
WiFi_Gain_6:    -13,-10,-10,-10,-10,-10,-10,-10,-10,-10,-11,-10,-10,-30
WiFi_Gain_9:    -13,-10,-10,-10,-10,-10,-10,-10,-10,-10,-11,-10,-10,-30
WiFi_Gain_12:   -13,-10,-10,-10,-10,-10,-10,-10,-10,-10,-11,-10,-10,-30
WiFi_Gain_18:   -13,-10,-10,-10,-10,-10,-10,-10,-10,-10,-11,-10,-10,-30
WiFi_Gain_24:   -13,-10,-10,-10,-10,-10,-10,-10,-10,-10,-11,-10,-10,-30
WiFi_Gain_36:   -13,-12,-12,-12,-12,-12,-12,-12,-12,-12,-12,-12,-12,-30
WiFi_Gain_48:   -13,-13,-13,-13,-13,-13,-13,-13,-13,-13,-13,-13,-13,-30
WiFi_Gain_54:   -15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-15,-30
WiFi_Gain_MCS0: -14,-10,-10,-10,-10,-10,-10,-10,-10,-11,-11,-11,-11,-30
WiFi_Gain_MCS1: -14,-10,-10,-10,-10,-10,-10,-10,-10,-11,-11,-11,-11,-30
WiFi_Gain_MCS2: -14,-10,-10,-10,-10,-10,-10,-10,-10,-11,-11,-11,-11,-30
WiFi_Gain_MCS3: -14,-10,-10,-10,-10,-10,-10,-10,-10,-11,-11,-11,-11,-30
WiFi_Gain_MCS4: -14,-11,-11,-11,-12,-12,-12,-12,-12,-12,-12,-12,-12,-30
WiFi_Gain_MCS5: -14,-12,-12,-12,-13,-13,-13,-13,-13,-13,-13,-13,-13,-30
WiFi_Gain_MCS6: -14,-14,-14,-14,-15,-15,-15,-15,-15,-15,-15,-15,-15,-30
WiFi_Gain_MCS7: -15,-15,-15,-15,-16,-16,-16,-16,-16,-16,-16,-16,-16,-30
```

The first row represents the Wi-Fi channel number and the first column represents the data rate. The Digital Gain (DG) value has to be determined by the user for all of the combinations of the Wi-Fi channel number and data rate.

The following table format is an example for the PA and PPA gain table.

Table 2-2. Wi-Fi PA and PPA Gain Table Format

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WiFi_PA_1:														
WiFi_PA_2:														
WiFi_PA_5.5:														
WiFi_PA_11:														
WiFi_PA_6:														
WiFi_PA_9:														
WiFi_PA_12:														
WiFi_PA_18:														
WiFi_PA_24:														
WiFi_PA_36:														
WiFi_PA_48:														
WiFi_PA_54:														
WiFi_PA_MCS0:														

.....continued

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
WiFi_PA_MCS1:														
WiFi_PA_MCS2:														
WiFi_PA_MCS3:														
WiFi_PA_MCS4:														
WiFi_PA_MCS5:														
WiFi_PA_MCS6:														
WiFi_PA_MCS7:														
WiFi_PPA_1:														
WiFi_PPA_2:														
WiFi_PPA_5.5:														
WiFi_PPA_11:														
WiFi_PPA_6:														
WiFi_PPA_9:														
WiFi_PPA_12:														
WiFi_PPA_18:														
WiFi_PPA_24:														
WiFi_PPA_36:														
WiFi_PPA_48:														
WiFi_PPA_54:														
WiFi_PPA_MCS0:														
WiFi_PPA_MCS1:														
WiFi_PPA_MCS2:														
WiFi_PPA_MCS3:														
WiFi_PPA_MCS4:														
WiFi_PPA_MCS5:														
WiFi_PPA_MCS6:														
WiFi_PPA_MCS7:														

The following figure is an example of the sample PA and PPA gain table.

Figure 2-2. Sample PA and PPA Gain Table

```
# Define a WiFi PA and PPA for each WIFI channel (1-14)
# Channels:      1    2    3    4    5    6    7    8    9    10   11   12   13   14
WiFi_PA_1:       18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_2:       18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_5.5:     18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_11:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_6:       18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_9:       18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_12:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_18:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_24:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_36:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_48:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_54:      18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS0:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS1:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS2:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS3:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS4:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS5:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS6:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PA_MCS7:    18,18,18,18,18,18,18,18,18,18,18,18,18,18
WiFi_PPA_1:      15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_2:      15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_5.5:    15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_11:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_6:      15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_9:      15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_12:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_18:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_24:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_36:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_48:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_54:     15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS0:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS1:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS2:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS3:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS4:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS5:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS6:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
WiFi_PPA_MCS7:   15,15,15,15,15,15,15,15,15,15,15,15,15,15
```

Note: Microchip recommends following the gain table template as it is in the WINC3400 Firmware Upgrade Project. If upgrading to the newer version of the firmware, use the gain table template from the latest firmware version package to update the gain table with the required DG values.

2.2 IEEE 802.11 Performance Gain Table

The Performance Gain Table refers to the gain setting that allows the ATWINC3400A to be compliant to the limits set in the IEEE 802.11 specification.

- The product characterization of the TX and RX parameters as defined by IEEE 802.11 must be tested with a suitable WLAN test instrument, for example, IQxel-80.
- During the characterization, the user has to derive the Performance Gain Table by adjusting the Digital Gain (DG) value for all Wi-Fi channel and data rate combinations using the MCHPRT2 GUI tool for optimal performance and compliance to the IEEE 802.11 specification.

Note: During transmitter EVM measurements, the test equipment must use the “LTF” channel estimation, as required by the IEEE 802.11 specification.

- The product characterization can be done at a typical condition (3.3V, 25ºC) and at extreme voltages and temperature conditions. The ATWINC3400A device transmitter RF output power can vary by about 2 to 3 dB at extreme boundary conditions from its typical value.
- The final Performance Gain Table is derived after characterizing the product across operating voltage and temperature conditions.
  Notes: There is a trade-off between the transmitter RF output power and compliance to IEEE 802.11 specification. For example:
  1. Increasing the RF output power might impact the spectral mask requirements in the IEEE 802.11b signals.
  2. Increasing the RF output power might impact the EVM requirements of the IEEE 802.11g/n signals.
- Below is a sample gain table that can be used as a starting point by the user. The user has to derive the Performance Gain Table for their product.

Table 2-3. Sample IEEE 802.11 Performance Gain Table

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15
2	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15
5.5	-12	-12	-12	-12	-12	-12	-13	-13	-13	-13	-13	-14	-14	-14
11	-13	-13	-13	-13	-13	-13	-14	-14	-14	-14	-14	-15	-15	-15
6	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-10	-10	-10
9	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-10	-10	-10
12	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-10	-10	-10
18	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-10	-10	-10
24	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
36	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
48	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
54	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15
MCS0	-10	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-11	-11	-11
MCS1	-10	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-11	-11	-11
MCS2	-10	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-11	-11	-11
MCS3	-10	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-11	-11	-11
MCS4	-11	-11	-11	-11	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
MCS5	-12	-12	-12	-12	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
MCS6	-14	-14	-14	-14	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15
MCS7	-15	-15	-15	-15	-16	-16	-16	-16	-16	-16	-16	-16	-16	-16

2.3 Wi-Fi Regulatory Certification Gain Table

The Wi-Fi Certification Gain Table refers to the gain setting of the ATWINC3400A device that would allow it to be compliant to the specific regulatory region requirements such as FCC (USA), ISED (Canada), CE (Europe) and so on.

- The certification testing of the product for the relevant standard is done by external accredited test labs such as TuV, Compatible Electronics, etc.
- During certification, the Digital Gain value needs to be adjusted for compliance to the regulatory specifications.
- The final Wi-Fi Certification Gain Table must be determined after covering all of the different regulatory regions that the product is targeted for.
- In cases where multi-region compliance is desired with a single-product firmware, use the gain value with the minimum gain setting. For example, once the certification tables for FCC, ISED and CE are derived, and intended to serve all three regions, then the user needs to derive the final gain table by comparing each gain value for the given channel and data rate to choose the lower gain value for the selected channel and data rate. This has to be done for all of the channels and data rates in the gain table to derive the final Certification Gain Table.
- In cases where multi-region compliance is desired with a multiple-product firmware, the device can be loaded with a firmware specific to the intended destination (regulatory region), thereby ensuring that the maximum benefit can be achieved out of the regulatory limits of the intended destination.

Table 2-4. Sample Wi-Fi Regulatory Certification Gain Table (FCC/ISED)

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
2	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
5.5	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
11	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
6	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-30	-30	-30
9	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
12	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
18	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
24	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
36	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
48	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
54	-6	-8	-8	-8	-8	-8	-8	-8	-8	-8	-10	-30	-30	-30
MCS 0	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 1	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 2	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 3	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 4	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 5	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 6	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30
MCS 7	-11	-8	-8	-8	-8	-8	-8	-8	-8	-8	-11	-30	-30	-30

Note: This is only a sample. The customer has to derive the Wi-Fi Certification Gain Table for their product for each regulatory regions.

2.4 Wi-Fi Application Gain Table

The gain table setting that the product uses in its Application mode is called the Application Gain Table.

- The Application Gain Table setting is the composite table derived from both the IEEE 802.11 Performance Gain Table and the final Regulatory Certification Gain Table by comparing each gain value for the given channel and data rate and choosing the lower gain value for the selected channel and data rate. Perform this for all of the channels and data rates in the gain table.

Table 2-5. Sample Wi-Fi Application Gain Table (IEEE 802.11 and FCC/ISED)

Data Rate	Channel													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-30	-30	-30
2	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-30	-30	-30
5.5	-12	-12	-12	-12	-12	-12	-13	-13	-13	-13	-13	-30	-30	-30
11	-13	-13	-13	-13	-13	-13	-14	-14	-14	-14	-14	-30	-30	-30
6	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-30	-30	-30
9	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-30	-30	-30
12	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-30	-30	-30
18	-8	-8	-8	-8	-9	-9	-9	-9	-9	-10	-10	-30	-30	-30
24	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-30	-30	-30
36	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
48	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-30	-30	-30
54	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-30	-30	-30
MCS0	-11	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-30	-30	-30
MCS1	-11	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-30	-30	-30
MCS2	-11	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-30	-30	-30
MCS3	-11	-10	-10	-10	-10	-10	-10	-10	-10	-11	-11	-30	-30	-30
MCS4	-11	-11	-11	-11	-12	-12	-12	-12	-12	-12	-12	-30	-30	-30
MCS5	-12	-12	-12	-12	-13	-13	-13	-13	-13	-13	-13	-30	-30	-30
MCS6	-14	-14	-14	-14	-15	-15	-15	-15	-15	-15	-15	-30	-30	-30
MCS7	-15	-15	-15	-15	-16	-16	-16	-16	-16	-16	-16	-30	-30	-30

Note: This is only a sample. The customer has to derive the Wi-Fi Application Gain Table for their product.

3. Bluetooth Low Energy Gain Table

For Bluetooth Low Energy, both the PPA and PA gains are fixed at 6 and no changes must be made to the PPA and PA gains.

The Bluetooth Low Energy DG gain allows the user to adjust the output power to the desired output to meet the Bluetooth 5.0 standard and the required regulatory specification.

There is no separate Bluetooth Low Energy Application Table. Typically, the Bluetooth Low Energy Performance Gain Table meets the Regulatory limits without any change. The Bluetooth Low Energy Performance Gain Table configuration displays in the following table.

However, in some cases of the chip-down design, a change to the DG gain value may be required to pass the regulatory specifications. In such a case, the user has to derive the Bluetooth Low Energy Application Gain Table by comparing each gain value for the given channel in the Bluetooth Low Energy Performance Gain Table and the Bluetooth Low Energy Certification Gain Table and choose the lower gain value for the selected channel.

Table 3-1. Recommended Bluetooth Low Energy Gain Table Configuration

Channel	0	1	2	3	4	5	6	7	8	9
BLE_Gain:	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5
Channel	10	11	12	13	14	15	16	17	18	19
BLE_Gain:	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
Channel	20	21	22	23	24	25	26	27	28	29
BLE_Gain:	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
Channel	30	31	31	33	34	35	36	37	38	39
BLE_Gain:	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
Channel	0	1	2	3	4	5	6	7	8	9
BLE_PA:	6	6	6	6	6	6	6	6	6	6
Channel	10	11	12	13	14	15	16	17	18	19
BLE_PA:	6	6	6	6	6	6	6	6	6	6
Channel	20	21	22	23	24	25	26	27	28	29
BLE_PA:	6	6	6	6	6	6	6	6	6	6
Channel	30	31	31	33	34	35	36	37	38	39
BLE_PA:	6	6	6	6	6	6	6	6	6	6
Channel	0	1	2	3	4	5	6	7	8	9
BLE_PPA:	6	6	6	6	6	6	6	6	6	6
Channel	10	11	12	13	14	15	16	17	18	19
BLE_PPA:	6	6	6	6	6	6	6	6	6	6
Channel	20	21	22	23	24	25	26	27	28	29
BLE_PPA:	6	6	6	6	6	6	6	6	6	6
Channel	30	31	31	33	34	35	36	37	38	39
BLE_PPA:	6	6	6	6	6	6	6	6	6	6

Note: The DG value can be adjusted from -5 to lower values like -6, -7, -8 to achieve the required power levels.

4. Updating Application Gain Table into ATWINC3400A Device Flash

Update the Application Gain Table in the ATWINC3400A device Flash using the procedures mentioned in the *ATWINC15x0/ATWINC3400 − Integrated Serial Flash and Memory Download Procedure Application Note* (DS00002378). This application note details the download procedures of firmware, TLS/SSL root certificates and TX power gain values into the WINC serial Flash through different supported serial interfaces like SPI/UART. Refer to Chapter 7 in the *ATWINC15x0/ATWINC3400 − Integrated Serial Flash and Memory Download Procedure Application Note* (DS00002378) for the Gain Values Download.

For Firmware versions after 1.3.1 (not inclusive), the following are the steps to update the Application Gain Table in the ATWINC3400A device Flash.

1. The `.csv` file in the `..\WINC3400_FIRMWARE_UPDATE_PROJECT\src\firmware\Tools\gain_builder\gain_sheets` folder holds the gain values. The values can be changed in this `.csv` file.
2. Run the `prepare_image.cmd 3400` command from the `\firmware\` folder location of the firmware upgrade project.
3. The *ATWINC15x0/ATWINC3400 Integrated Serial Flash and Memory Download Procedure Application Note* (DS00002378) is part of the firmware upgrade project and is available inside the folder *\WINC3400_FIRMWARE_UPDATE_PROJECT\doc*. For a more detailed step-by-step procedure of the Serial Flash Download using the Serial Bridge application or Serial Flash Download via Built-in UART, refer to the *ATWINC15x0/ATWINC3400 Integrated Serial Flash and Memory Download Procedure Application Note* (DS00002378).
4. Review the pass log to ensure that there are no errors generated during the execution of the `prepare_image.cmd` command. For example, see the following pass log:

```
..\firmware>prepare_image.cmd 3400
Converting gain table
Default gain table specified as Tools\gain_builder\gain_sheets\samd21_gain_setting_hp.csv
Change this script if different gain sheet is required!
python gain_converter.py Tools\gain_builder\gain_sheets\samd21_gain_setting_hp.csv -o
new_gain.config
Building flash images for 3400 variant (prog and OTA format)
Device Image Creation Tool 1.0.2 [r708] (Jul 28 2020)
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processing region '[boot firmware]'
WINCFirmwareImageBuild: opening firmware file 'boot_firmware/release3400/
boot_firmware.bin'
written 1488 of 4096 bytes to image (37%)
processing region '[control sector]'
WINC3400ControlSectorBuild: creating control sector
written 72 of 4096 bytes to image (2%)
processing region '[backup sector]'
written 0 of 4096 bytes to image (0%)
processing region '[pll table]'
Creating WiFi channel lookup table for PLL with xo_offset = 0.0000.
Creating frequency lookup table for PLL with xo_offset = 0.0000.
written 796 of 2048 bytes to image (39%)
processing region '[gain table]'
WINC3400GainBuild: creating gain tables
written 3448 of 6144 bytes to image (57%)
processing region '[root certificates]'
found certificate: Baltimore CyberTrust Root
found certificate: DigiCert High Assurance EV Root CA
found certificate: DigiCert SHA2 High Assurance Server CA
found certificate: Entrust Root Certification Authority
found certificate: GeoTrust Global CA
found certificate: GlobalSign Root CA
found certificate: GlobalSign
found certificate: Google Internet Authority G3
found certificate: QuoVadis Root CA 2
found certificate: VeriSign Class 3 Public Primary Certification Authority - G5
found certificate: Amazon Root CA 1
written 3532 of 4096 bytes to image (87%)
processing region '[tls certificates]'
written 0 of 8192 bytes to image (0%)
processing region '[connection parameters]'
```

```
written 0 of 4096 bytes to image (0%)
processing region '[downloader firmware]'
WINCFirmwareImageBuild: opening firmware file 'downloader_firmware/release3400/
downloader_firmware.bin'
written 3384 of 8192 bytes to image (42%)
processing region '[wifi firmware]'
WINCFirmwareImageBuild: opening firmware file 'firmware/wifi_v111/ASIC_3400/
wifi_firmware.bin'
written 223152 of 303104 bytes to image (74%)
processing region '[http files]'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/default.html'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/style.css'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/favicon.ico'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/logo.png'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/error.json'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/scanresults.json'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/ok.json'
written 7756 of 8192 bytes to image (95%)
processing region '[ble firmware]'
WINCFirmwareImageBuild: opening firmware file 'ble/bt_firmware/fw.bin'
written 129700 of 163840 bytes to image (80%)
processing region '[blank]'
written 0 of 4096 bytes to image (0%)
processing region '[ate firmware]'
WINCFirmwareImageBuild: opening firmware file 'ate_firmware/
burst_tx_firmware_winc3400.bin'
written 148436 of 524288 bytes to image (29%)
Device Image Creation Tool 1.0.2 [r708] (Jul 28 2020)
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processing region '[downloader firmware]'
WINCFirmwareImageBuild: opening firmware file 'downloader_firmware/release3400/
downloader_firmware.bin'
written 3384 of 8192 bytes to image (42%)
processing region '[wifi firmware]'
WINCFirmwareImageBuild: opening firmware file 'firmware/wifi_v111/ASIC_3400/
wifi_firmware.bin'
written 223152 of 303104 bytes to image (74%)
processing region '[http files]'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/default.html'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/style.css'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/favicon.ico'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/logo.png'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/error.json'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/scanresults.json'
HTTPFileSystemAddFile: opening HTTP file 'provisioning_webpage/ok.json'
written 7756 of 8192 bytes to image (95%)
processing region '[ble firmware]'
WINCFirmwareImageBuild: opening firmware file 'ble/bt_firmware/fw.bin'
written 129700 of 163840 bytes to image (80%)
************************************************************
Success
Created: firmware\m2m_image_3400.bin
Created: ota_firmware\m2m_ota_3400.bin
```

Note: While updating the gain table for the first time, the user can read back the gain table using the commands listed in the 5. Verifying the Gain Value.

5. Verifying the Gain Value

After downloading the firmware with the updated gain table, the new gain table values from the Flash memory can be verified by reading back the same table using the MCHPRT2 CLI tool with the help of the following commands:

- `MCHPRT 0` (with Aardvark I^2C test interface) or `MCHPRT 0_UART` (with host serial bridge UART interface)
- `MCHPRT 11 2` (Change to Flash mode)
- `MCHPRT 19` (Read Gain Table based on the selected mode)

For more details, refer to the *MCHPRT2 User Guide* (DS50002893).

6. Document Revision History

Revision	Date	Section	Description
B	03/2022	Document	Minor updates
		2.1. Wi-Fi Gain Table Format	• Minor updates • Added Figure 2-1 and Figure 2-2
		4. Updating Application Gain Table into ATWINC3400A Device Flash	Updated section
		5. Verifying the Gain Value	Updated section
A	11/2020	Document	Initial Release

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