NRC7292 Evaluation Kit User Guide

(Transmit Power Control)

Ultra-low power & Long-range Wi-Fi

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NEWRACOM, Inc.

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Ultra-low power & Long-range Wi-Fi

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1 Overview

The transmit power control (TPC) scheme allows NRC modules to continuously adapt to varying channel conditions by dynamically adjusting the operating MCS (modulation coding scheme) index paired with a specified TX power level in real time. The scheme may be useful for:

- controlling the maximum TX power level to meet the regional regulatory requirements,
- reducing power consumption during operation, and
- adjusting the effective communication range between access points and stations.

MCS indices corresponding to higher throughput (e.g. MCS 6, 7) packets are less error-resistant and require higher SNR (signal-to-noise ratio) than MCS indices corresponding to lower throughput (e.g. MCS 10, 1, 2) packets due to their differing levels of information redundancy. For this reason, the IEEE 802.11ah specifications define the minimum signal quality requirements that transmitters are expected to meet in terms of the frequency-domain constellation error vector magnitude (EVM) of TX physical-layer (PHY) packets for each MCS index.

MCS	10	0	1	2	3	4	5	6	7
Required EVM (dB)	-4	-5	-10	-13	-16	-19	-22	-25	-27

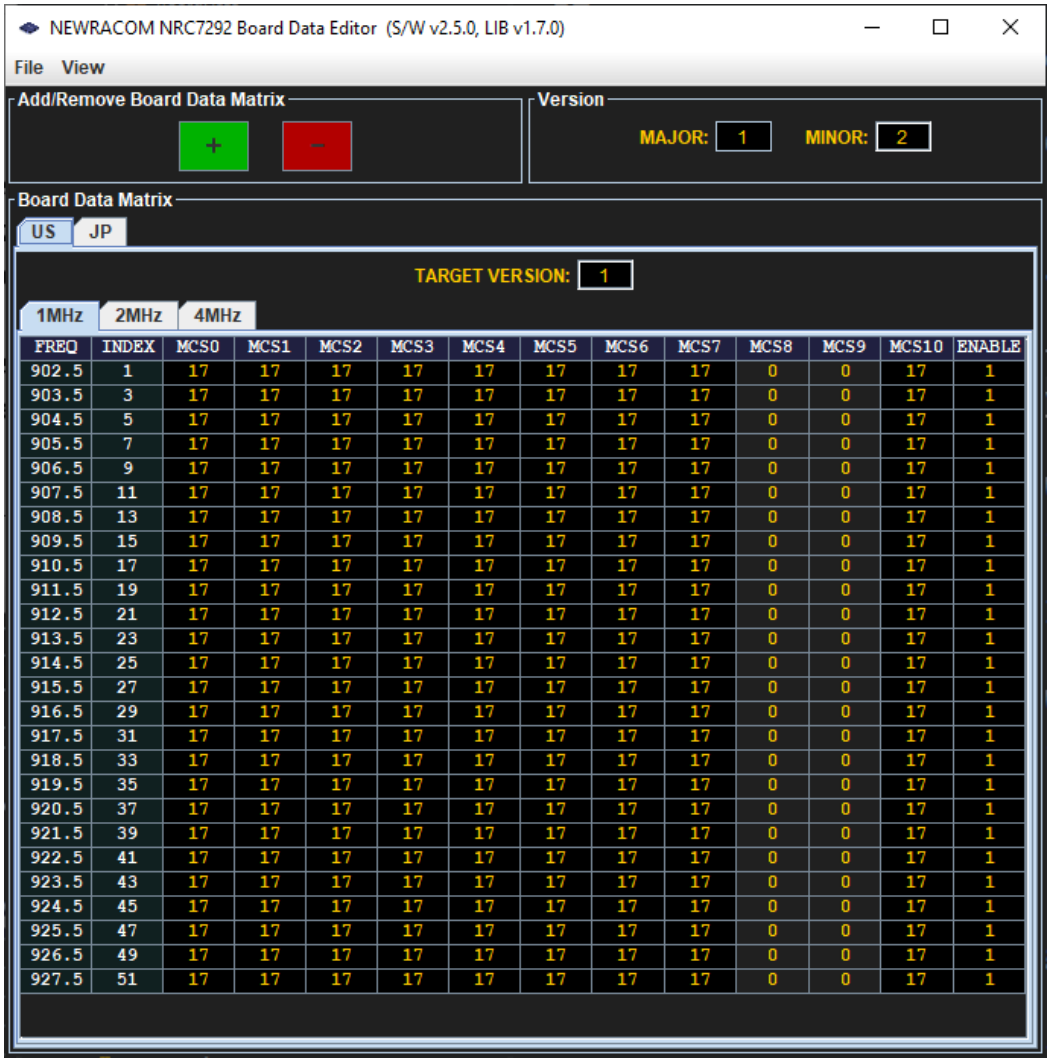
Figure 1.1 IEEE 802.11ah Required Minimum Sensitivity Levels

Due to hardware-related nonlinear characteristics in the RF signal path, there is a module-dependent TX power level beyond which the TX signal quality starts degrading. For NRC7292, this critical TX power level tends to be around 17~18 dBm with small variance among modules. The degree of degradation increases as the difference between the critical TX power level and the operating TX power level increases. Under the simplifying assumption that no other factor is a strong determinant of the TX signal quality, this relationship implies the existence of the maximum TX power level for each MCS at which a given module can guarantee the required signal quality.

2 Newracom Board Data Editor

2.1 TPC Board Data File

TPC board data files can be generated using **Newracom Board Data Editor** GUI utility, which is part of the NRC Tools package (refer to the web-based NRC tools usage documentation for more information). A board data file contains country-wise TPC look-up tables (LUT), which encode the TX power level as a function of the channel index (frequency / bandwidth) and the MCS index.



FREQ	INDEX	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	ENABLE
902.5	1	17	17	17	17	17	17	17	17	0	0	17	1
903.5	3	17	17	17	17	17	17	17	17	0	0	17	1
904.5	5	17	17	17	17	17	17	17	17	0	0	17	1
905.5	7	17	17	17	17	17	17	17	17	0	0	17	1
906.5	9	17	17	17	17	17	17	17	17	0	0	17	1
907.5	11	17	17	17	17	17	17	17	17	0	0	17	1
908.5	13	17	17	17	17	17	17	17	17	0	0	17	1
909.5	15	17	17	17	17	17	17	17	17	0	0	17	1
910.5	17	17	17	17	17	17	17	17	17	0	0	17	1
911.5	19	17	17	17	17	17	17	17	17	0	0	17	1
912.5	21	17	17	17	17	17	17	17	17	0	0	17	1
913.5	23	17	17	17	17	17	17	17	17	0	0	17	1
914.5	25	17	17	17	17	17	17	17	17	0	0	17	1
915.5	27	17	17	17	17	17	17	17	17	0	0	17	1
916.5	29	17	17	17	17	17	17	17	17	0	0	17	1
917.5	31	17	17	17	17	17	17	17	17	0	0	17	1
918.5	33	17	17	17	17	17	17	17	17	0	0	17	1
919.5	35	17	17	17	17	17	17	17	17	0	0	17	1
920.5	37	17	17	17	17	17	17	17	17	0	0	17	1
921.5	39	17	17	17	17	17	17	17	17	0	0	17	1
922.5	41	17	17	17	17	17	17	17	17	0	0	17	1
923.5	43	17	17	17	17	17	17	17	17	0	0	17	1
924.5	45	17	17	17	17	17	17	17	17	0	0	17	1
925.5	47	17	17	17	17	17	17	17	17	0	0	17	1
926.5	49	17	17	17	17	17	17	17	17	0	0	17	1
927.5	51	17	17	17	17	17	17	17	17	0	0	17	1

Figure 2.1 Newracom Board Data Editor

A board data file may have multiple LUTs associated with the same country code, as long as their target versions are distinct. In other words, each LUT included in a board data file must be uniquely identifiable by the corresponding pair {country code, target version}. During operation, the operating country code and one of the target versions in the board data file must match the system hardware version.

2.2 File Menu

The **File** menu contains the following menu items:

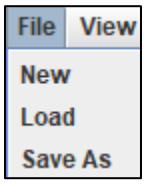


Figure 2.2 File Menu

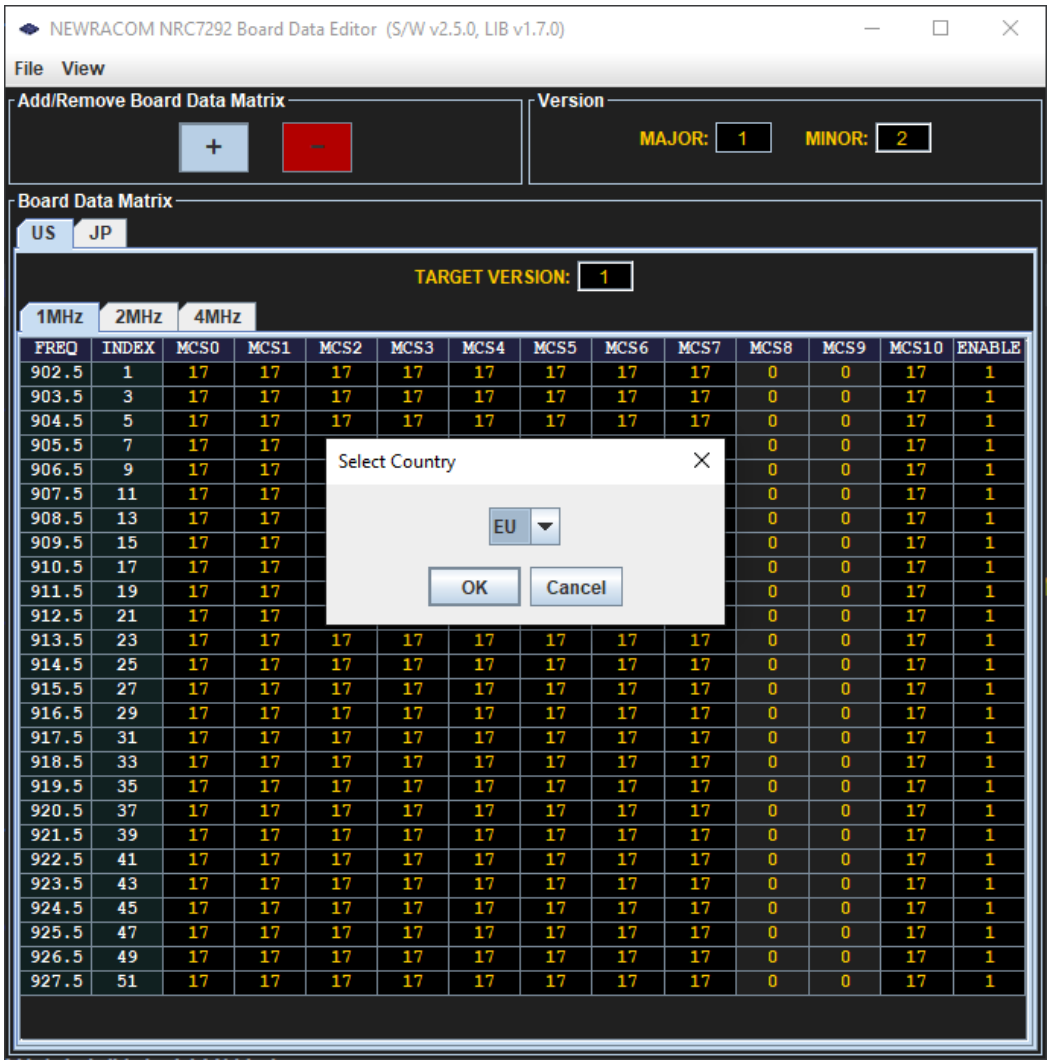
1. **New:**
   - Start a new program instance.

2. **Load:**
   - Load an existing board data file.

3. **Save As:**
   - Save the current board data file as another file.

2.3 Adding and removing TPC LUT data groups

The **+ button** or the **– button** can be used to add or remove a data group. A data group is identified by its country code, its target version number (0~2047) and its three bandwidth-wise data matrices (1MHz, 2MHz and 4MHz). The entries in the MCS columns of each data matrix can be modified to configure the desired TX power levels. The entries under the ENABLE column can be used to either enable (1) or disable (0) the usage of certain channels. The background of a given cell in the matrix will turn red if an invalid value is provided. All power levels must be given as integers between 0 and 30, which represent the desired power levels in dBm.



FREQ	INDEX	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9	MCS10	ENABLE
902.5	1	17	17	17	17	17	17	17	17	0	0	17	1
903.5	3	17	17	17	17	17	17	17	17	0	0	17	1
904.5	5	17	17	17	17	17	17	17	17	0	0	17	1
905.5	7	17	17							0	0	17	1
906.5	9	17	17							0	0	17	1
907.5	11	17	17							0	0	17	1
908.5	13	17	17							0	0	17	1
909.5	15	17	17							0	0	17	1
910.5	17	17	17							0	0	17	1
911.5	19	17	17							0	0	17	1
912.5	21	17	17							0	0	17	1
913.5	23	17	17	17	17	17	17	17	17	0	0	17	1
914.5	25	17	17	17	17	17	17	17	17	0	0	17	1
915.5	27	17	17	17	17	17	17	17	17	0	0	17	1
916.5	29	17	17	17	17	17	17	17	17	0	0	17	1
917.5	31	17	17	17	17	17	17	17	17	0	0	17	1
918.5	33	17	17	17	17	17	17	17	17	0	0	17	1
919.5	35	17	17	17	17	17	17	17	17	0	0	17	1
920.5	37	17	17	17	17	17	17	17	17	0	0	17	1
921.5	39	17	17	17	17	17	17	17	17	0	0	17	1
922.5	41	17	17	17	17	17	17	17	17	0	0	17	1
923.5	43	17	17	17	17	17	17	17	17	0	0	17	1
924.5	45	17	17	17	17	17	17	17	17	0	0	17	1
925.5	47	17	17	17	17	17	17	17	17	0	0	17	1
926.5	49	17	17	17	17	17	17	17	17	0	0	17	1
927.5	51	17	17	17	17	17	17	17	17	0	0	17	1

Figure 2.3 Adding a TPC LUT data group

3 Updating the Board Data File

3.1 Host Mode

Before starting the host operation mode, replace the original board data file located at (nrc_pkg/sw/firmware/nrc7292_bd.dat) in the host package with the new board data file.

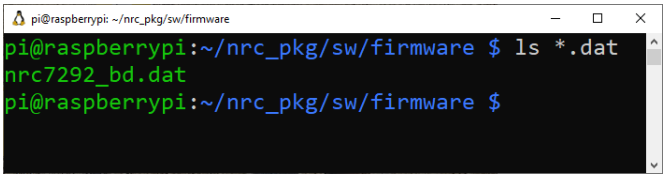


Figure 3.1 Board Data File Path (host package)

3.2 Standalone Mode

Before compiling the standalone firmware binary, replace the original board data file located at (standalone/bdf/nrc7292/nrc7292_bd.dat) in the standalone package with the new board data file.

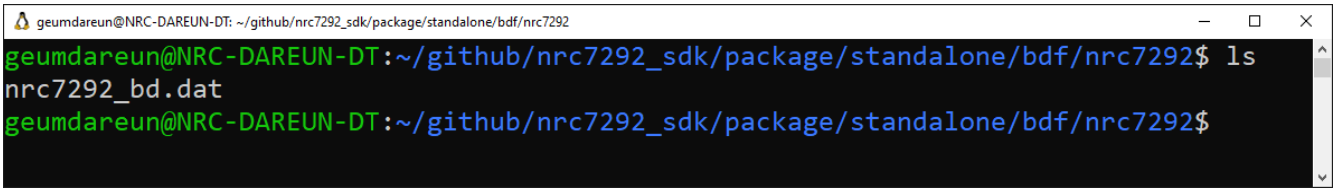


Figure 3.2 Board Data File Path (standalone package)

Building a standalone firmware binary will automatically generate the corresponding board data binary header file in the board data file directory (standalone/bdf/bd.h). The header file is used by the compiler to build the firmware binary.

For more information about building, refer to the document **UG-7292-004-Standalone SDK.pdf**.

4 Revision History

Revision No	Date	Comments
Ver 1.0	08/21/2020	First version
Ver 1.1	11/09/2020	Contents of the document modified
Ver 1.2	01/11/2021	Update Figure 2.1 and description board data editor for standalone
Ver 1.3	05/18/2022	Document overhaul