P9261-3C-CRBv2

Q-Factor Tuning and Open FOD Thresholds Programming Guide

This document describes how to tune the Q parameters (Q-Factor) and program the open Foreign Objects Detection (FOD) thresholds function on the P9261-3C-CRBv2 solution through the use of APIs and a Windows GUI.

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1. Introduction

The P9261 Customer Reference Board 2.0 (CRB) Automotive Grade Wireless Power transmitter is designed to follow the Wireless Power Consortium (WPC) Extended Power Profile (EPP) and Baseline Power Profile (BPP) protocols depending on the type of WPC Rx that is placed onto the charging pad. The Open Foreign Object Detection (FOD) threshold and Q-Factor (Q) measurement is already tuned for the CRB per WPC V1.3 specifications. If needed, however, there are options to fine tune the Open FOD threshold and Q measurement.

As per the EPP specification, the P9261 must measure for the presence of Foreign Objects (FOs) before starting power transfer. This measurement is taken during the Q measurement test as part of the P9261 PING phase.
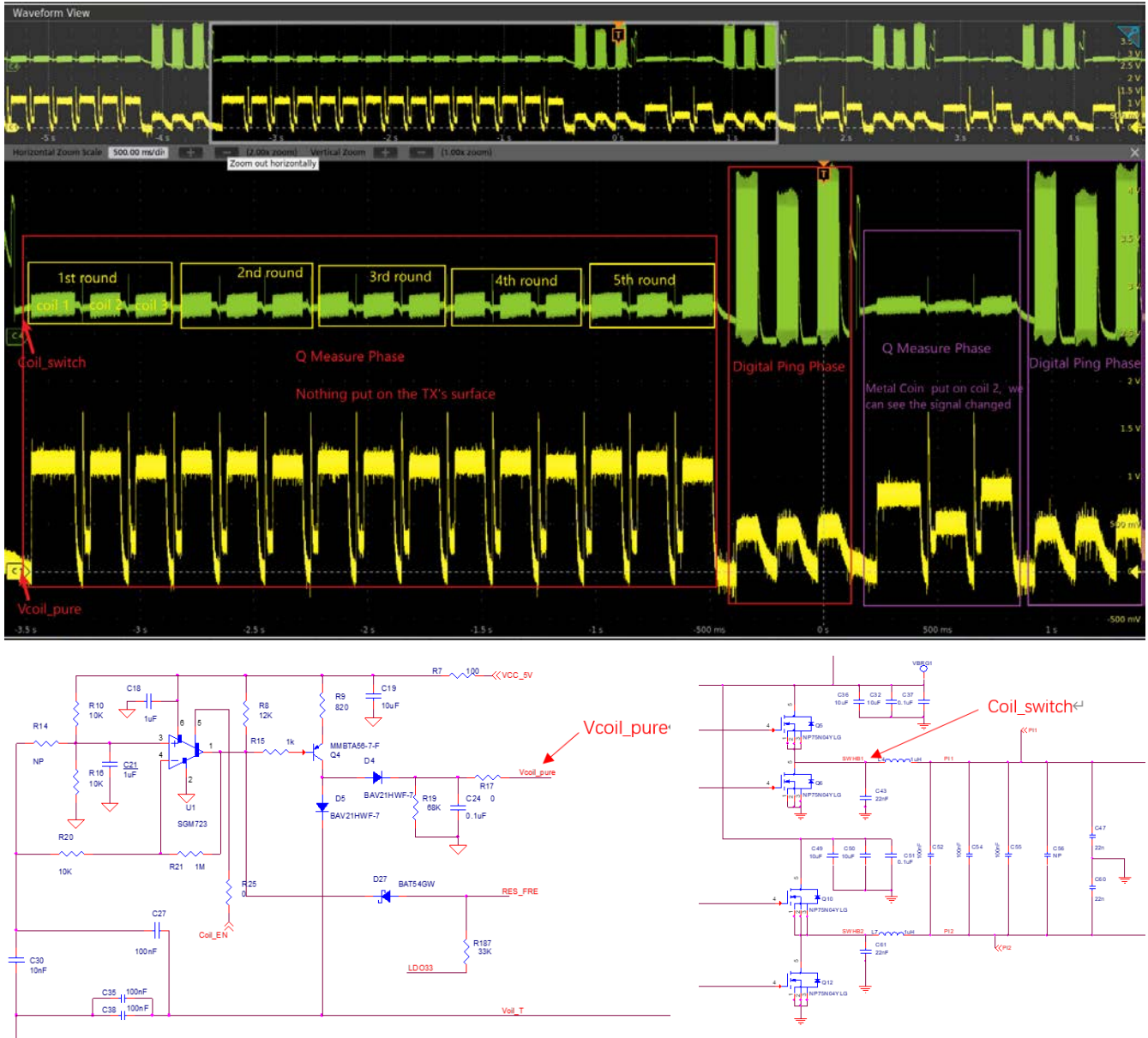
Figure 1. P9261 CRB 2.0 Typical PING Phase Events and Timing

As shown in Figure 1, the P9261 will issue a series of Q-Measurements to detect for object placement. The Q-Measurements are shown in Channel 4 as five rounds. Once the Q-Measurement detects an interface change or the Q-Measurement expires (default setting is 5 rounds Q), then a Digital PING will occur.

2.   Open FOD Functional Description

Open FOD refers to foreign object detection before digital ping occurs (Q measurement). Just before digital ping, the P9261 measures the Q for all the coils and compares the result against the programmable Open FOD thresholds for each Tx coil (OPEN_FOD_THRESHOLD). If the Q is greater than the internal threshold, the P9261 will generate the digital ping to determine if the object is a WPC compatible Rx in an attempt to power the RX or test if some other random ferrous object is placed on the interface. If the Q reading is less than the open FOD threshold, the P9261 will go onto alarm state loop.

There are two ways for the P9261 to exit the alarm loop:

- Remove the foreign object
- The host controller may lower the open FOD threshold

The host controller can change the open FOD thresholds "on the fly" and force the P9261 to digital ping generation. This feature is useful for enabling the host controller to expand the Open FOD threshold to accommodate WPC Rx's that cause low Q value measurements due to having higher than normal coil impedance, or more than expected "friendly metal" associated with the device to be charged by the P9261 wireless power Tx.

In order to accommodate Rx devices with very low Q values, it is recommended to set the Open FOD values to less than the lowest Q with all supported phones.

3. Q FOD Functional Description

For EPP Rx's it will be necessary for the Tx to measure Q and match the result to the reported Q value. There is a register that can be used to adjust the Q FOD threshold based on Tx measured Q value and the Rx reported Q value. If the measured Q is less than the Q FOD threshold then the P9261 will go onto Q FOD alarm state loop.

There are two ways for the P9261 to exit the alarm loop:

- Remove the foreign object
- The host controller may lower the Q FOD threshold parameters.

If OPEN FOD and Q FOD did not detect FO. The P9261 will still rely on the power loss FOD method to reject charging based on possible presence of a foreign object in order to maintain a positive user experience.

4. Step-by-Step Open FOD Thresholds Tuning

1. Update the FW onto Flash memory, "filename.hex" or later version.
2. Use the P9261 CRB 2.0 GUI v1.1.7 or later. Ensure there is nothing placed on the Tx coils.
3. Ensure there is no wireless charging receiver or metal object on the top of the wireless charging transmitter coils.
4. In the "WPT Realtime Data" tab of the GUI, read the Q. Q measurement results will be displayed as shown in Figure 2. It is good practice to take an average of the Q results with several successive readings to verify whether the results are stable before proceeding.
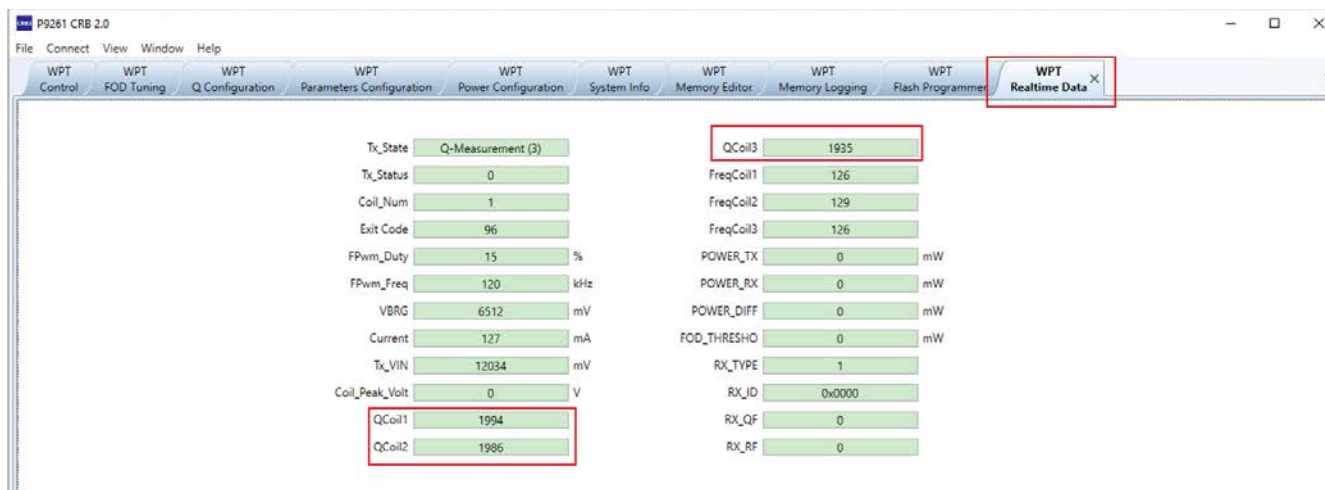

Figure 2. GUI – WPT Realtime Data Tab

5. Read the Q value for each coil and note it. Afterwards, place the foreign object (coin) on coil 1. Read and note the Q as described in step 4. Using a reference coin as the foreign object, the Q factor should drop. Repeat for coil 2 and coil 3.

| QCoil1 | 1115 |
| QCoil2 | 1505 |

Figure 3. Place Coin on Coil1 Q Value

6. On the GUI's "WPT Q Configuration" tab, "Open FOD Q Thresholds" are the minimum values 0, that the Q for each coil can reach before triggering an Open FOD alarm.

7. Enter the new value in the text box for coil 1 then click on the "Write All" button in the bottom right-hand corner. The new threshold value must be between the two Q values noted in step 4 and 5.
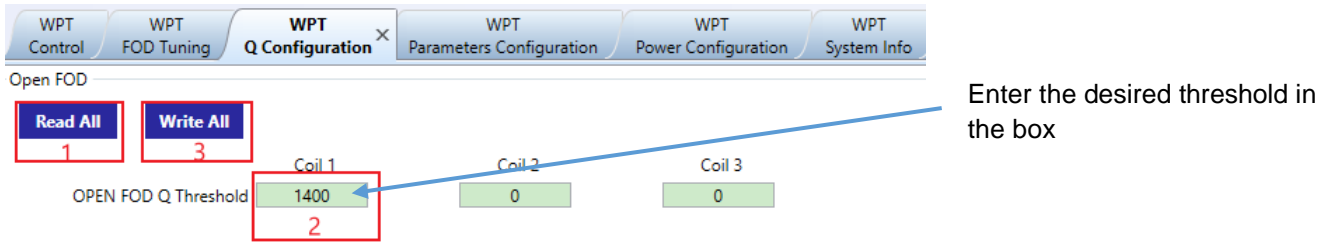

Enter the desired threshold in the box

Figure 4. GUI – OPEN FOD Threshold Update

8. Verify whether the new threshold has been set by clicking the "Read All" Button. The text box should display the new threshold value.

9. Repeat steps 7 and 8 for the remaining two coils.

10. Place the foreign object on each coil and check whether the Open FOD alarm is triggered by viewing the "Tx_Status" in the Main tab.
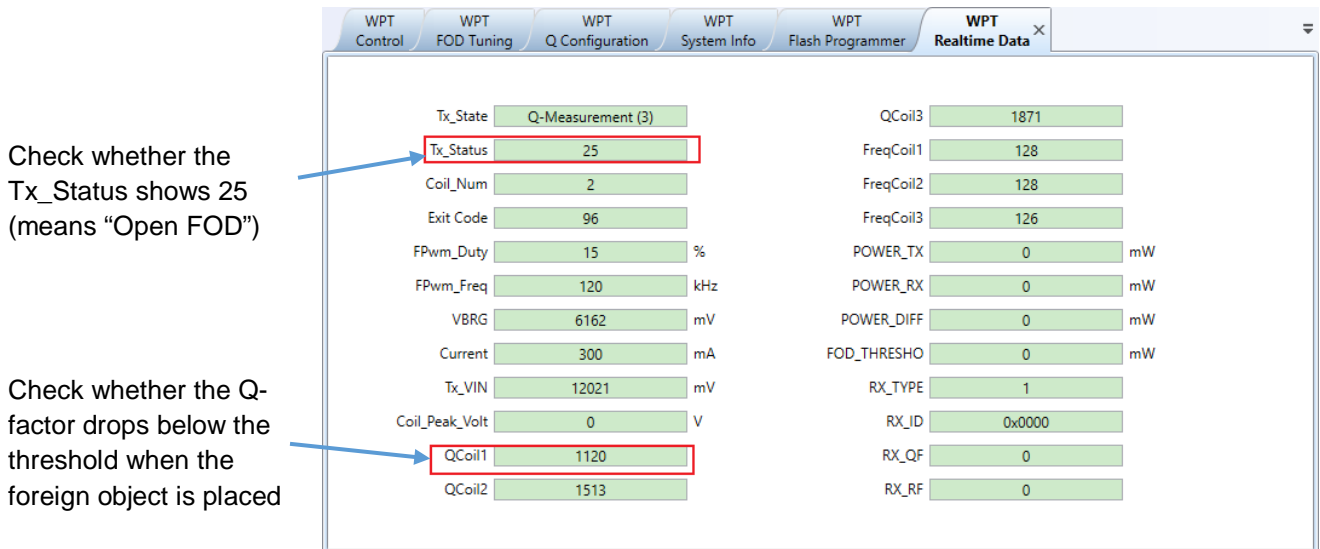

Check whether the Tx_Status shows 25 (means "Open FOD")

Check whether the Q-factor drops below the threshold when the foreign object is placed

Figure 5. Verify Open FOD

11. Save the FW onto a new hex file – go to the "WPT Flash Programmer" tab and click on the "Save to hex file" button (see Figure 6). A dialog box will open, and you will need to choose the name of the file and the location to save it.
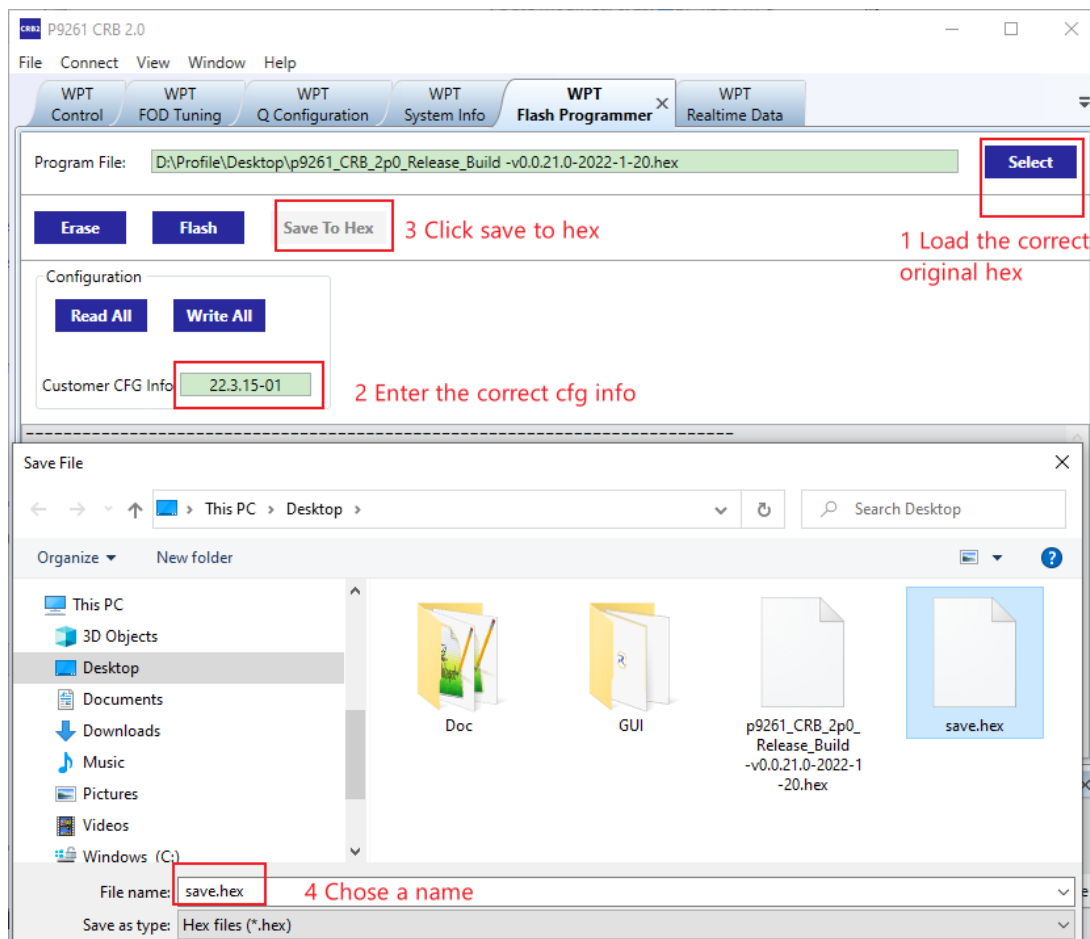
Figure 6. Windows Dialog Box for Saving 'save.hex' File under New User Defined Name

5. Step-by-Step Q FOD Thresholds Tuning

1. Update the FW onto Flash memory, "filename.hex" or later version.
2. Use the P9261 CRB 2.0 GUI v1.1.7 or later. Ensure there is nothing placed on the Tx coils.
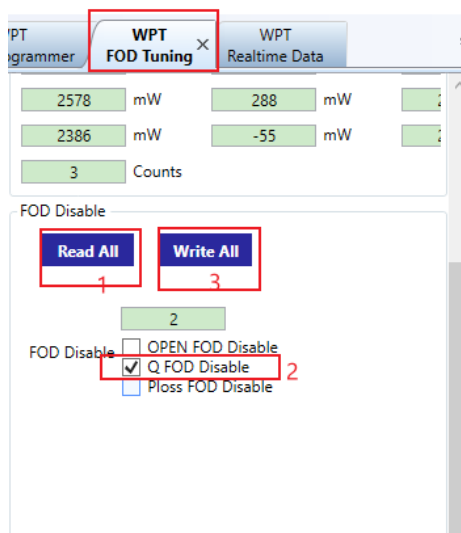3. Disable Q FOD function.

Figure 7. Disable Q FOD

4. In the "WPT Realtime Data" tab of the GUI, read the Q. Q measurement results will be displayed as shown in Figure 2. It is good practice to take an average of the Q results with several successive readings to verify whether the results are stable before proceeding. Place EPP Rx on coil 1, read the Q value, and repeat for coil 2 and coil 3.
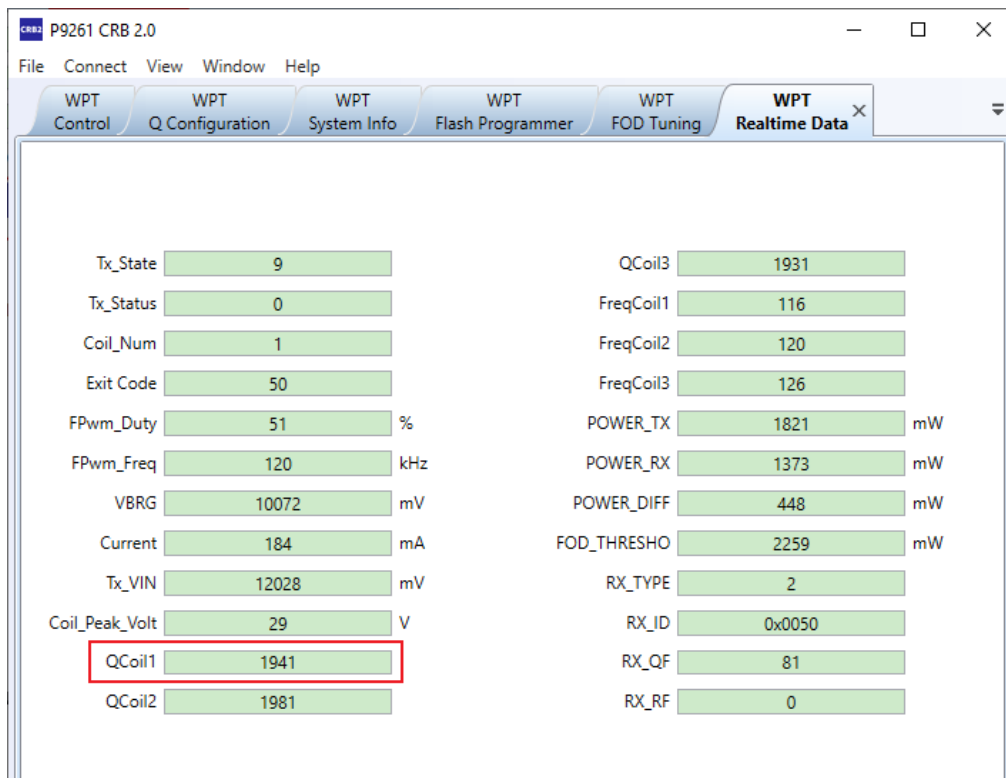

Figure 8. GUI – Read Q only with Rx

5. Read the Q value for each coil with placing both the foreign object (coin) and EPP Rx on coil 1. Read and note the Q as described in step 4. Using a reference coin as the foreign object, the Q factor should drop. Repeat for coil 2 and coil 3.
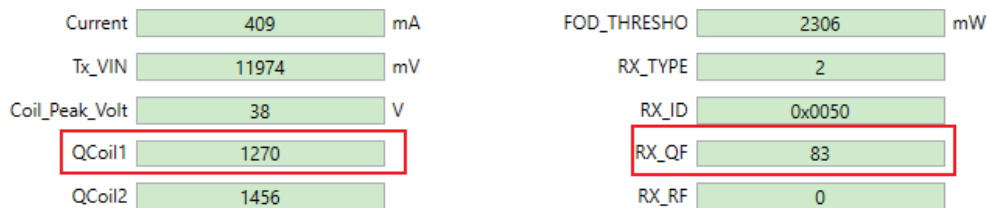

Figure 9. GUI – Read Q with both Rx and Coin

6. On the GUI's "WPT Q Configuration" tab, "QFOD" is the default value and is tuned for Qi.

7. Enter the new value in the text box for coil 1 then click on the "Write All" button in the bottom right-hand corner. The new threshold value must be between the two Q values noted in steps 4 and 5. Q FOD Q threshold, formula: THD = INT(RX_QF / 120) * Q_FOD_THD_GAIN[CoilNum] + Q_FOD_THD_OFFSET[CoilNum].
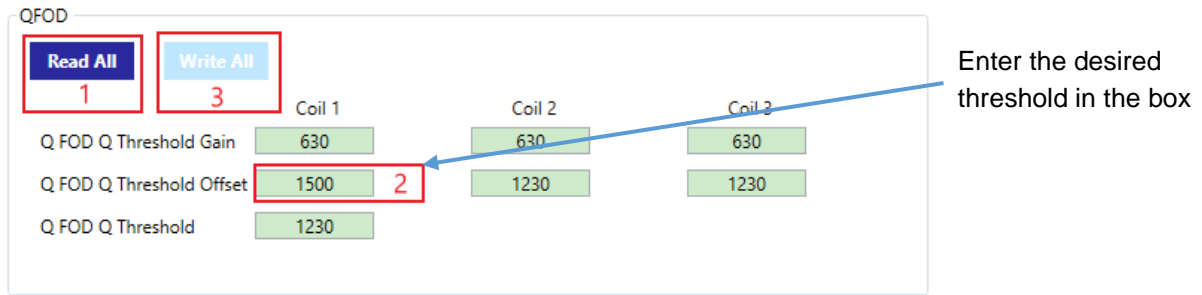
Figure 10. GUI – OPEN FOD Threshold Update

8. Verify whether the new threshold has been set by clicking the "Read All" button. The text box should display the new threshold value.

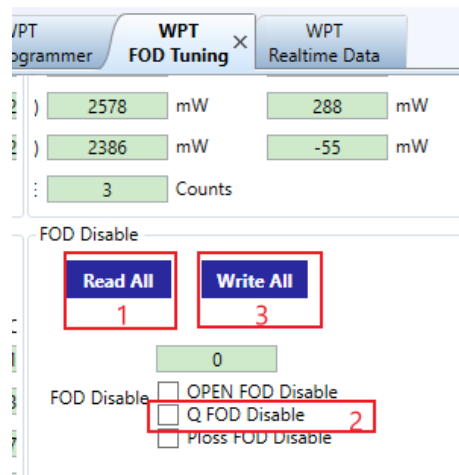9. Repeat steps 7 and 8 for the remaining two coils.

10. Re-enable the Q FOD.

Figure 11. Enable Q FOD

11. Place the foreign object and Rx on each coil and check whether the Open FOD alarm is triggered by viewing the "Tx_Status" in the Main tab.

Check whether the TX Status shows 1 (means "Q FOD")

Check whether the Q-factor drops below the threshold when the foreign object is placed

Figure 12. Verify Q FOD and Threshold

12. Save the FW onto a new hex file – go to the "WPT Flash Programmer" tab and click on the "Save to hex file" button. When the dialog box opens, choose the name of the file and the location to save it.
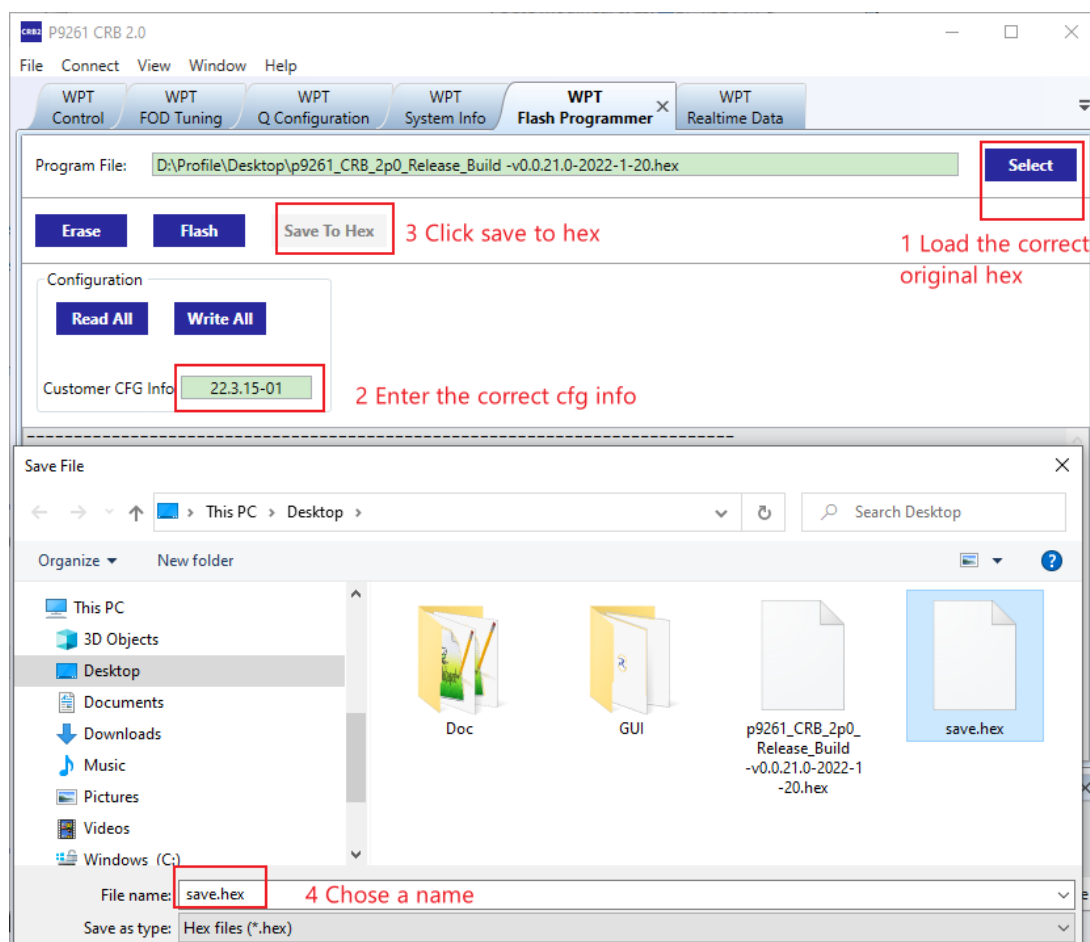
Figure 13. Windows Dialog Box for Saving 'save.hex' File under New User Defined Name

6. P9261 CRB 2.0 Q Applicable Registers

For register information, go to the <u>P9261-3C-CRBv2 product page</u> and refer to the document *P9261-3C-CRB2.0 Command/Status Registry*, "Table 7.Q-Factor Management and Data" in section "4.4 Q-Factor Management and Data".

7. Revision History

Revision	Date	Description
1.00	May 4, 2022	Initial release.

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