

WCT1011A/WCT1013A Automotive MP-A9 Run-Time Debugging User's Guide

1 Introduction

NXP provides the FreeMASTER GUI tool for WCT1011A/WCT1013A Automotive Medium Power wireless charging solution. The GUI based on the FreeMASTER tool can be used to fine-tune the parameters in running state. For the operations of setting up the FreeMASTER connection, see the *WCT1011A/WCT1013A Automotive MP-A9 V4.1 Wireless Charging Application User's Guide* (WCT101XAV41AUG).

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2 Runtime Tuning and Debugging

2.1 NVM parameters

This chapter describes the configuration and tuning of the NVM parameters. The NVM parameters are initially stored in the Flash memory and copied from there to the NvmParams structure in RAM. Some parameters of the NvmParams structure are passed to the Wireless Charging Transmitter (WCT) library during initialization. The initialization data for the Flash-memory structure are stored in the `EEdata_FlashDefaults.asm` file.

The WCT GUI based on the FreeMASTER tool can be used to fine-tune the parameters. You can use the same GUI to generate the assembler initialization data for the Flash-based configuration. Alternatively, you can use the WCT GUI to trigger the application and back up the actual RAM content of the data structure to flash.

The WCT GUI is prepared for the following application:

- 15W_MP/example/wct101xa/wct101xA.pmp

Section 3 “[NVM Structure Reference](#)” provides detailed information about each configuration parameter. The same reference information is also available directly in the GUI tool where the parameters can be changed at runtime.

2.1.1 Runtime access to NVM parameters

As outlined in the previous sections, the WCT GUI based on FreeMASTER tool can be used to read and modify the parameters at runtime. Calibration parameters of the structure are modified immediately, so FOD, Q-factor detection, and quick removal detection can be evaluated instantly. Other parameters for library and protection are modified by the WCT GUI, but they do not take effect immediately. You need to modify these parameters under debug mode. Then these parameters take effect when exiting debug mode.

The NVM parameters are split to several tabs in the GUI view:

- Operation Parameters
- Calibration

To make the fine-tuned configuration values permanent and default for the next application build, the whole structure is exported into assembler syntax of initialization data block. The generated data can be put to the `EEdata_FlashDefaults.asm` file directly and used as a new default configuration set.

In addition to the actual configuration values, the GUI also calculates proper checksum values to make the data block valid.

The exported initialization data block is available on the `NVMraw` tab in the GUI.

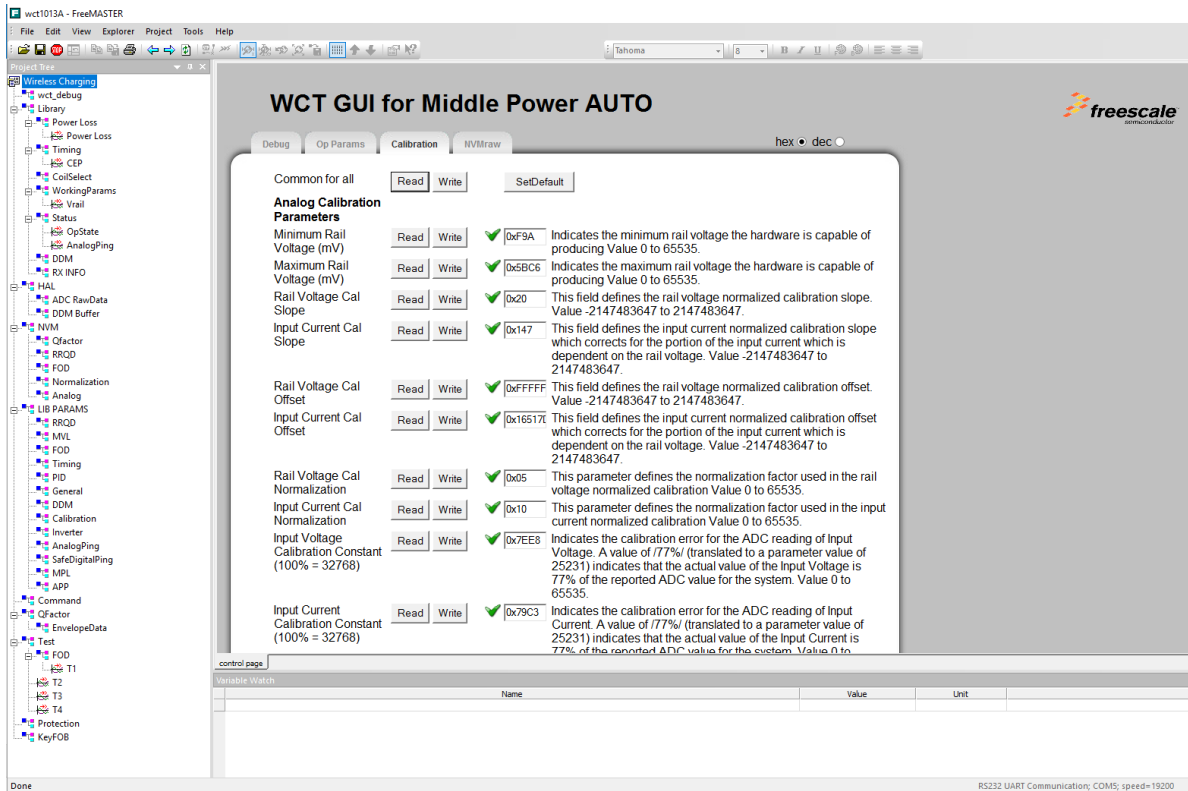


Figure 1. WCT GUI (1)

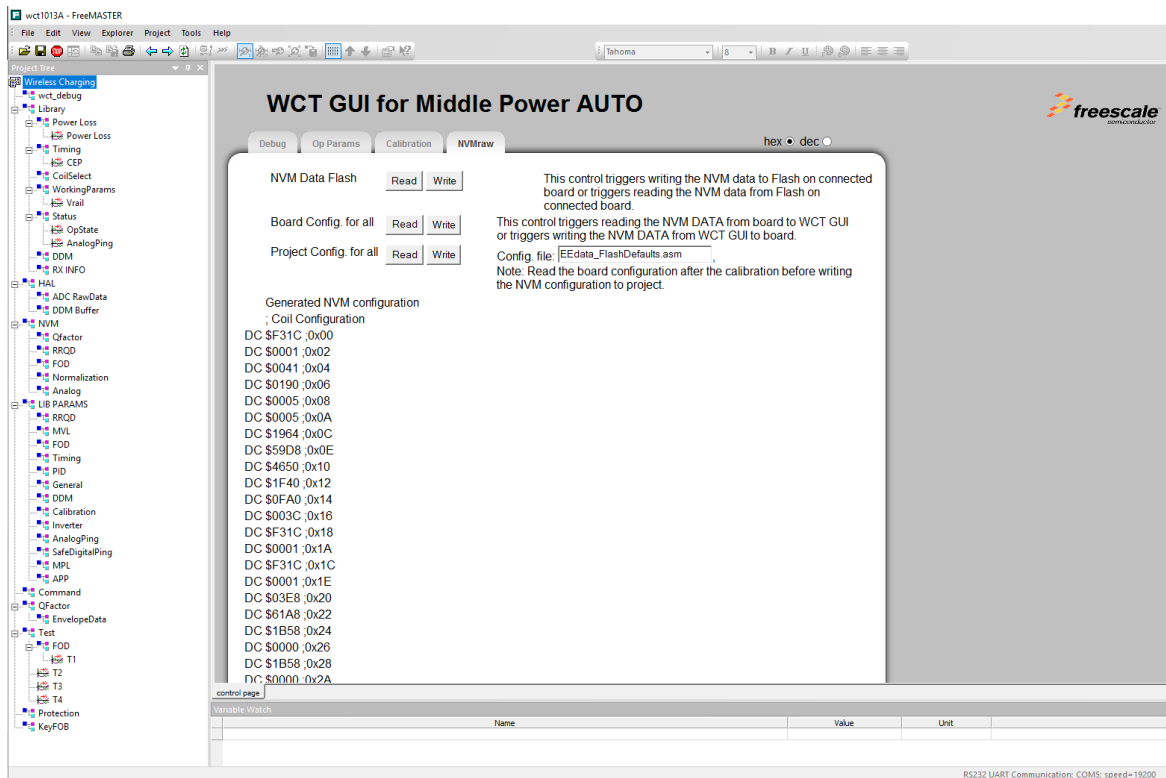


Figure 2. WCT GUI (2)

2.2 Tuning and debugging

The library is used together with the FreeMASTER visualization tool to calibrate input values and to observe behavior of the Wireless Charging transmitter. The FreeMASTER tool connects to the target board by using the UART or JTAG communication interface.

2.2.1 Data visualization

The FreeMASTER tool enables visualization of any variables or registers in the application running on the target system. This feature is useful with the Wireless Charging application to observe voltage and currents in real time by using a graphical representation.

The FreeMASTER project file that comes in the Library package contains pre-configured scope views with the most frequently used runtime parameters. The graphs and views are easily extended by more parameters or user-defined data.



Figure 3. Data visualization

2.2.2 Debugging console

In addition to FreeMASTER visualization, the WCT library provides an option to continuously dump the selected debugging information to the user console over the UART interface. The debug messages are sent to UART whenever an important event occurs, if the appropriate message type is enabled.

The console UART port must be different from the UART port used by the FreeMASTER communication. If only one UART port is available, consider the use of an alternative communication interface for the FreeMASTER connection. In addition to UART, the FreeMASTER also supports JTAG cable interface.

On the current WCT1011A/WCT1013A digital DCDC platform the digital DCDC module occupies one UART port. Only one of the debug consoles and FreeMASTER using SCI can work at a time.

If SCI is used for debugging console in MP demo, the settings are as follows:

```
#define DEBUG_CONSOLE_SUPPORTED (TRUE)
#define FREEMASTER_SUPPORTED (FALSE)
```

The macros are defined in `example->wct101xa->configure->appcfg.h`.

```
#define QSCI_CONSOLE_INDEX 0
#define QSCI_FREEMASTER_INDEX 1
```

The macros are defined in `example->wct101xa->driver->qsci.h`.

To use FreeMASTER and debug console at the same time, change the FreeMASTER communication interface to JTAG. The settings are as follows:

```
#define FMSTR_USE_SCI 0 /* To select SCI communication interface */
#define FMSTR_USE_JTAG 1 /* 56F8xxx: use JTAG interface */
```

The macros are defined in `example->wct101xa->configure->freemaster_cfg.h`.

```
#define FREEMASTER_SUPPORTED (TRUE)
```

The macro is defined in `example->wct101xa->configure->appcfg.h`.

2.3 Calibration

The library behavior and its parameters should be calibrated before the library can be successfully used.

The calibration procedure consists of four steps:

1. Rail voltage calibration
2. Input current calibration
3. Characterization parameters calibration
4. Normalization parameters calibration

All the steps require low power to be disabled and library running in debug mode except normalization parameters calibration.

All the calibration steps are used to get accurate power loss for Foreign Object Detection (FOD). Power loss is calculated by the following equation. If P_{Loss} is bigger than the threshold, there must be a foreign object.

$$P_{Loss} = T_{IN} - T_{Loss} - R_{IN}$$

- Rail Voltage Calibration and Input Current Calibration are used to get accurate T_{IN} .
- Characterization Parameters Calibration is used to estimate T_{Loss} .
- Normalization Parameters Calibration is used to get accurate R_{IN} .

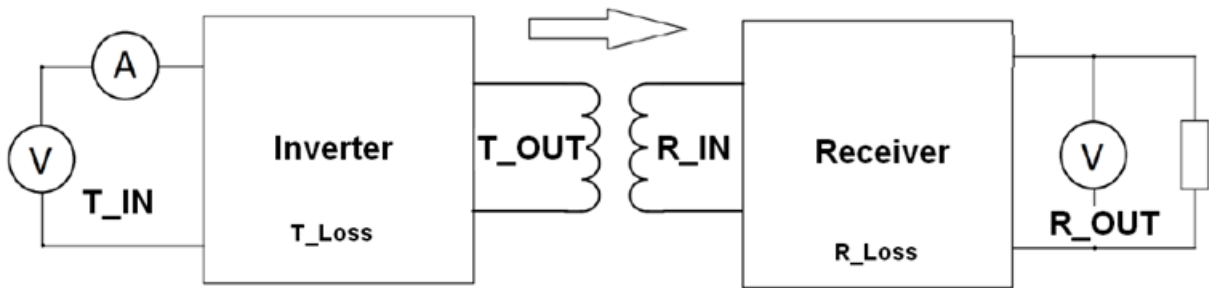


Figure 4. Calibration

NOTE

Before starting calibration, read all the values to the NVM data. Click the **Read** button of **Common for all** on the **Op Params** page and **Calibration** page.



Figure 5. Reading NVM value

2.3.1 Rail voltage calibration

The process of rail voltage calibration is as follows:

Before the calibration, set `LOW_POWER_MODE_ENABLE` to `FALSE` in the example code. Then, the MCU runs at full speed even without charging, and the FreeMASTER GUI can respond quickly when the user performs FOD calibration in debugging mode.

Before the TX is powered on, ensure that the RX is removed and load is disconnected.

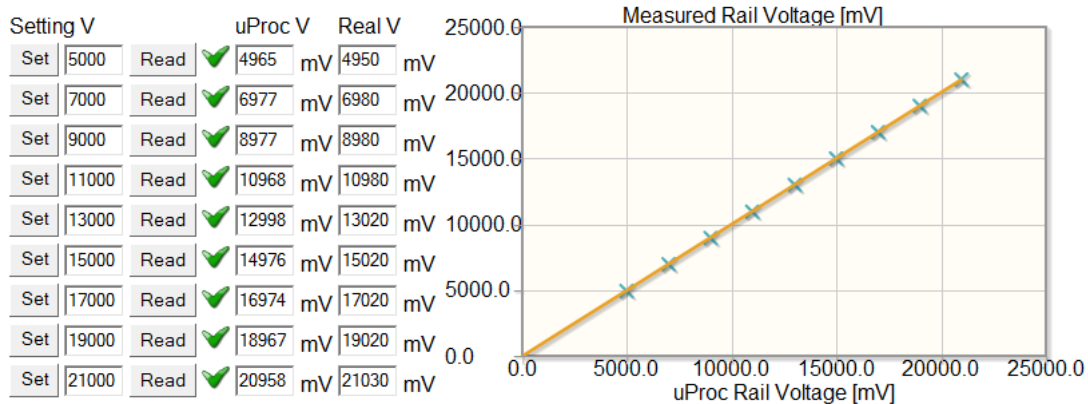
The calibration process of the rail voltage requires library to be running in debug mode, and without RX and load.

Use the FreeMASTER GUI to do the calibration, and save the constant to flash.

In the Rail Voltage Calibration area, click Reset and Enter. Set a different rail voltage value, click Read, measure rail voltage by multimeter and fill the actual value in the Real V column. Then click Move and Save.

Rail Voltage Calibration

- 1) Set Device ID:
- 2) Set the calibration constant to default before calibration: ✓
- 3) Enter to debug mode: ✓
- 4) Measure different rail voltage



- 5) Move Calibration Constant to NVM: ✓
- 6) Save final calibration constant to FLASH: ✓
- 7) Disconnect FreeMASTER and reset CPU

Figure 6. Rail voltage calibration

Read out the Rail Voltage Calibration Constant on the Calibration page of the FreeMASTER GUI to ensure that it is saved successfully.

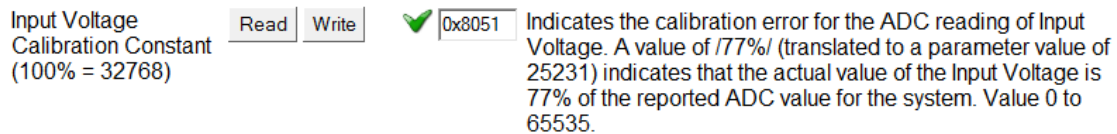


Figure 7. Read rail voltage calibration constant

2.3.2 Input current calibration

The process of input current calibration is as follows:

Power on the wireless charging TX board without load connected.

The calibration process of the input current requires the library to be running in debug mode, and without RX on.

Click Reset, Enter, and Calibr.

Input Current Calibration

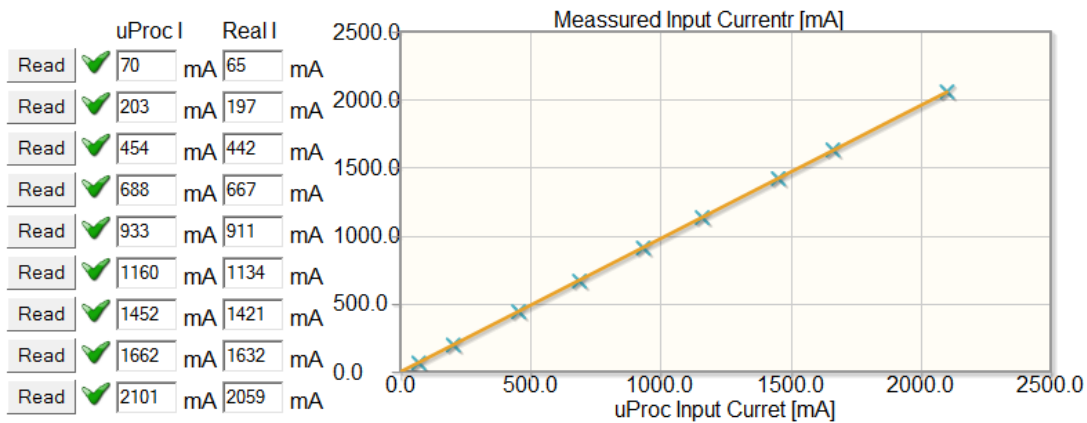
- 1) Set device ID:
- 2) Set the calibration constant to default before calibration: ✓
- 3) Enter to debug mode: ✓
- 4) Run Rail Voltage calibration: ✓

Figure 8. Input current calibration (1)

Add electronic load or resistors between VRILA and Ground to draw current. Make sure that the load is added after Step 4. Otherwise, the input current cannot be read correctly.

Measure the actual current by a multimeter and fill actual value in the Real I column. Then, click Read. Change load current from 50 mA to 2000 mA. Repeat for all the other rows and then click Move and Save.

5) Measure the input current for different loads



- 6) Move Calibration Constant to NVM: ✓
- 7) Save final calibration constant to FLASH: ✓
- 8) Disconnect FreeMASTER and reset CPU

Figure 9. Input current calibration (2)

Read out the Input Current Calibration Constant on the Calibration page of the FreeMASTER GUI to ensure that it is saved successfully.

Input Current Calibration Constant (100% = 32768)	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0x7D54"/>	----- Indicates the calibration error for the ADC reading of Input Current. A value of /77%/ (translated to a parameter value of 25231) indicates that the actual value of the Input Current is 77% of the reported ADC value for the system. Value 0 to 65535.
---	--	---------------------------------------	--

Figure 10. Read input current calibration constant

2.3.3 FOD calibration

The process of FOD calibration is as follows:

The calibration process of the foreign object detection algorithm requires library running in debug mode and finished calibration of the Rail Voltage and Input Current. The calibration must be done without RX and load.

Follow instruction of the Rail Voltage Calibration process.

Follow instruction of the Input Current Calibration process.

Enter the Coil ID, click Enter and On, and then click Set and Read for each row. Then press Off, Move and Save.

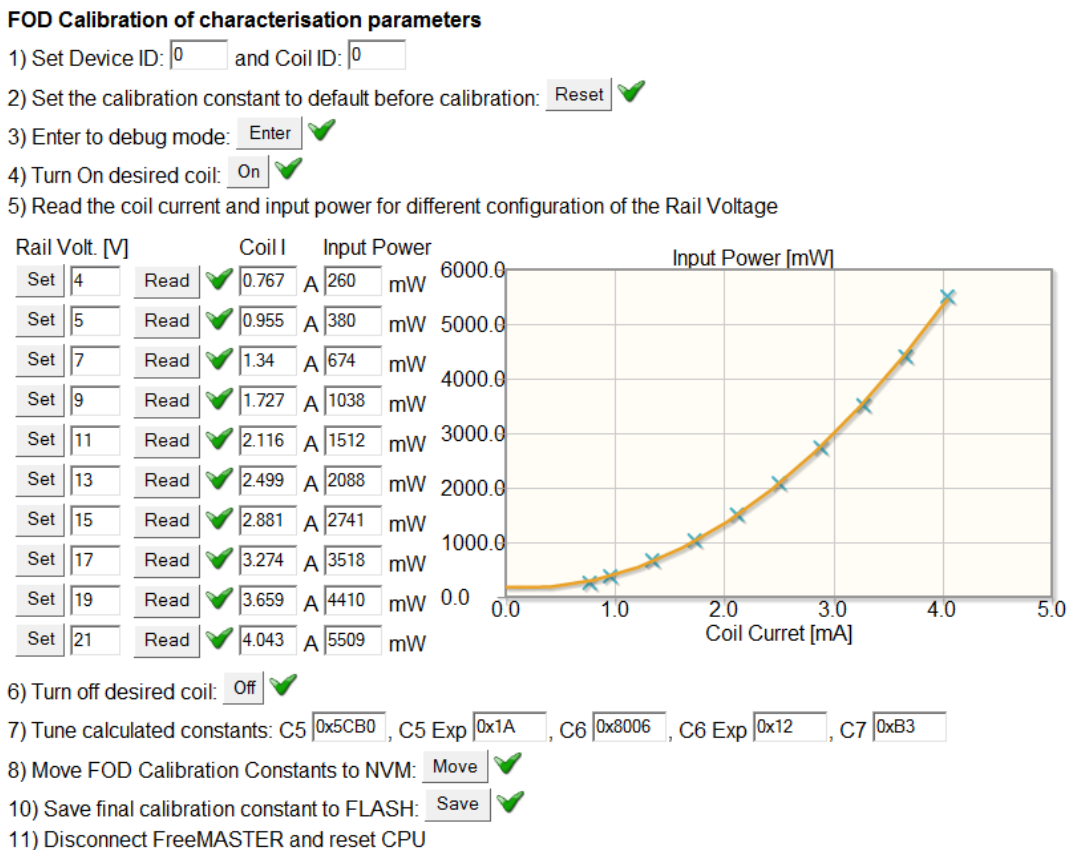


Figure 11. FOD calibration

NOTE

Pay attention to the coil current value. If it is larger than 4 A while the rail voltage is still under 21 V, do not raise the rail voltage any more. Just insert more rail voltage test points within the maximum rail voltage measured above to guarantee safety.

Read out the Power Loss Characterization Parameters on the Calibration page of the FreeMASTER GUI to ensure that it is saved successfully.

FOD Characterization Parameters - Coil 0			
C5 - Quadratic Coefficient (mW/mA ² x 2 ^{N5})	Read Write	✓ 0x5CB0	This parameter defines the quadratic coefficient of the equation used to calculate Tx losses represented in units of mW/mA ² multiplied by the value of 2 ^{N5} , where N5 is the exponent defined by the next parameter. Value -32768 to 32767.
C5 Exponent (N5)	Read Write	✓ 0x1A	This parameter is the value of the exponent used to scale the C5 coefficient to obtain an integer value in units of mW/mA ² . Value 0 to 65535.
C6 - Linear Coefficient (mW/mA x 2 ^{N6})	Read Write	✓ 0x8006	This parameter defines the linear coefficient of the equation used to calculate Tx losses represented in units of mW/mA multiplied by the value of 2 ^{N6} , where N6 is the exponent defined by the next parameter. Value -32768 to 32767.
C6 Exponent (N6)	Read Write	✓ 0x12	This parameter is the value of the exponent used to scale the C6 coefficient to obtain an integer value in units of mW/mA. Value 0 to 65535.
C7 - Constant Term (mW)	Read Write	✓ 0xB3	This parameter represents the constant term of the equation used to calculate Tx losses (represented in mW). This value equates to the static losses of the FET drive circuitry. Value -32768 to 32767.
Power Loss Calibration Offset (mW)	Read Write	✓ 0x00	This parameter represents the offset to be used with the calculation of system Power Loss to prevent negative results due to resolution on reported RX power received, curve-fit and other calibration errors. Value -30000 to 30000.

Figure 12. Read FOD characterization constants

Repeat the steps above for the remaining coils.

2.3.4 FOD normalization

The FOD normalization is to equalize the power loss curve, at which the loss value goes high as the load increasing, and it may be higher than the threshold even no foreign object is present. To resolve the issue, NXP provides the normalization tool through the FreeMASTER GUI to fine-tune the FOD of the performance customer board.

The process of FOD normalization is as follows:

Make sure that the rail voltage, input current, and FOD calibration are done.

Follow the normalization steps on the FreeMASTER GUI as shown in the following figure. Before the test, reset the parameter and exit debug mode. Do the test with a standard calibrated Qi 1.1 RX, like TPR#5. The load range is from 50 mA to 1000 mA.

FOD Calibration of normalization parameters

- 1) Set Device ID: and Coil ID:
- 2) Set the FOD Normalization parameters to default before the calibration: ✓
- 3) Exit debug mode: ✓
- 4) Put calibrated receiver on coil and Read the output power for different loads of RX

Load (mW)	Tx Power	Rx Power
500	526 mW	664 mW
1000	1120 mW	1250 mW
1500	1741 mW	1796 mW
2000	2383 mW	2421 mW
2500	3047 mW	3085 mW
3000	3676 mW	3671 mW
3500	4331 mW	4296 mW
4000	4972 mW	4921 mW
4500	5623 mW	5546 mW
5000	6243 mW	6132 mW

- 5) Tune calculated constants: CA1 , CA1 Exp , CA2 , CA2 Exp , CA3
- 6) Move FOD Calibration Constants to NVM: ✓
- 10) Save final calibration constant to FLASH: ✓
- 11) Disconnect FreeMASTER and reset CPU

Figure 13. FOD normalization

After the steps above on the GUI are finished, read out Power Loss Normalization Parameters on the Calibration page of the FreeMASTER GUI to ensure that it is saved successfully.

PLD / FOD Normalization Parameters.

CA1 - Quadratic Coefficient for region A (mW/mW ² x 2 ^{NA1})	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0x5DFA"/>	This parameter defines the quadratic coefficient of the equation used to calculate the normalization for system power losses represented in units of mW/mW ² multiplied by the value of 2 ^{NA1} , where NA1 is the exponent defined by the next parameter. Value -32768 to 32767.
CA1 Exponent (NA1)	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0x22"/>	This parameter is the value of the exponent used to scale the CA1 coefficient to obtain an integer value in units of mW/mW ² . Value 0 to 65535.
CA2 - Linear Coefficient for region A (mW/mW x 2 ^{NA2})	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0x91F4"/>	This parameter defines the linear coefficient of the equation used to calculate the normalization for system power losses represented in units of mW/mW multiplied by the value of 2 ^{NA2} , where NA2 is the exponent defined by the next parameter. Value -32768 to 32767.
CA2 Exponent (NA2)	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0x13"/>	This parameter is the value of the exponent used to scale the CA2 coefficient to obtain an integer value in units of mW/mW. Value 0 to 65535.
CA3 - Constant Term for region A (mW)	<input type="button" value="Read"/> <input type="button" value="Write"/>	✓ <input type="text" value="0xAD"/>	This parameter represents the constant term of the equation used to calculate the normalization for system power losses (represented in mW). Value -32768 to 32767.

Figure 14. Read FOD normalization constants

NOTE

FOD normalization in this section is for baseline RX (5 W). As for Middle Power RX (extension), normalization is not necessary, because the power loss FOD extension method is with online calibration for accuracy.

2.3.5 Saving new NVM parameters to EEdata

After calibration, the NVM parameters are updated; these new parameters need to be used to update the file “EEdata_FlashDefaults.asm”, so that they could be flashed.

Set the QF calibration init check to 0 on the Op Params page, and then click the Write button, as shown in Figure 15 to make sure the auto-calibration for Q factor conversion is done at the first time the TX runs after the flashed image. So, ensure that there is no object on the TX surface at the first time the TX runs after the flashed image.

Auto Calibration Init Check

Calibration init check (need to reset to 0 if any parameters changes)

This parameter should be write to 0 before writing parameters to configuration files(EEdata).This parameter indicates if auto calibration is done. Value 0 to 1.

Figure 15. Setting auto calibration check to 0

Before saving the NVM parameters, read all the values to the NVM data as shown in Figure 16.

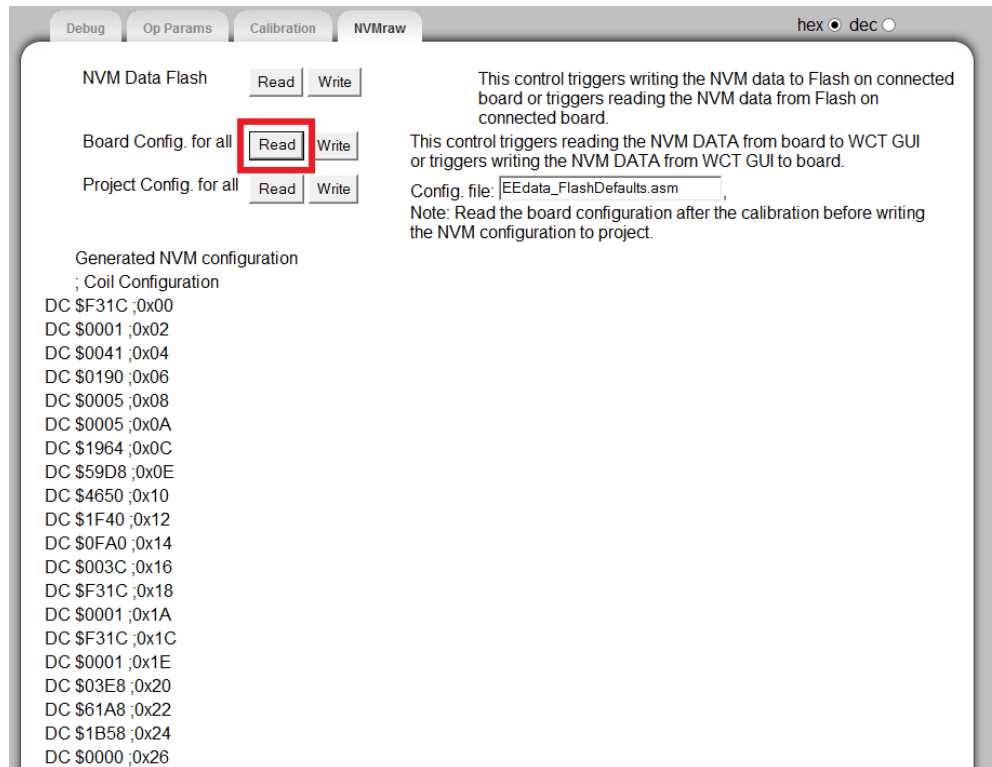


Figure 16. Copy updated NVM data

Write the NVM data to EEdata_FlashDefaults.asm. This feature is supported by the FreeMASTER tool v1.4 or later. After you click **Write** as Figure 17 shows, CodeWarrior prompts that the EEdata_FlashDefaults.asm file has been replaced. Click **Yes** and rebuild the project for next flashing.

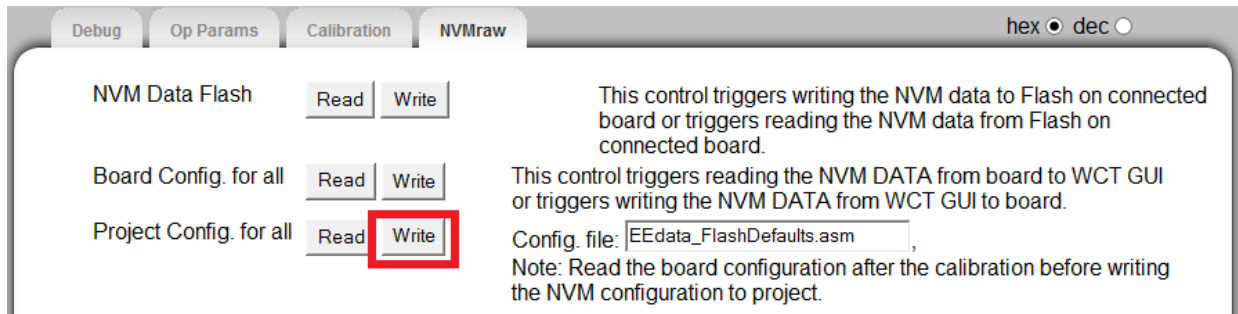


Figure 17. Write NVM data

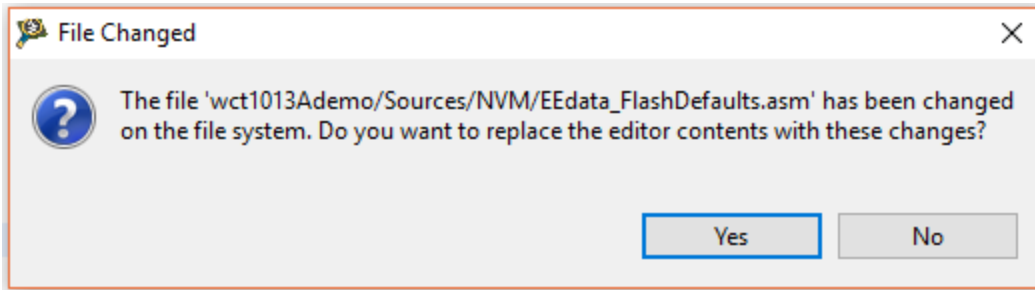


Figure 18. Replace EEdata_FlashDefaults.asm file

2.4 Q factor temperature calibration

Q factor detection is affected by temperature. The following calibration steps are used to get accurate Q factor at different temperatures.

Before doing calibration, ensure that there is no object on the TX surface. TX should do auto-calibration at first time power-on after firmware downloaded. Check the following variable for auto-calibration, if its value is 1, skip Step 1 and Step 2, and go to Step 3.

Auto Calibration Init Check

Calibration init check (need to reset to 0 if any parameters changes)

This parameter should be write to 0 before writing parameters to configuration files(EEdata).This parameter indicates if auto calibration is done. Value 0 to 1.

Figure 19. Check auto-calibration

1. Make the board at temperature T1, enter 1 to gCMD_eCommand in FreeMASTER variable watch window. This step is to stop WCT library.

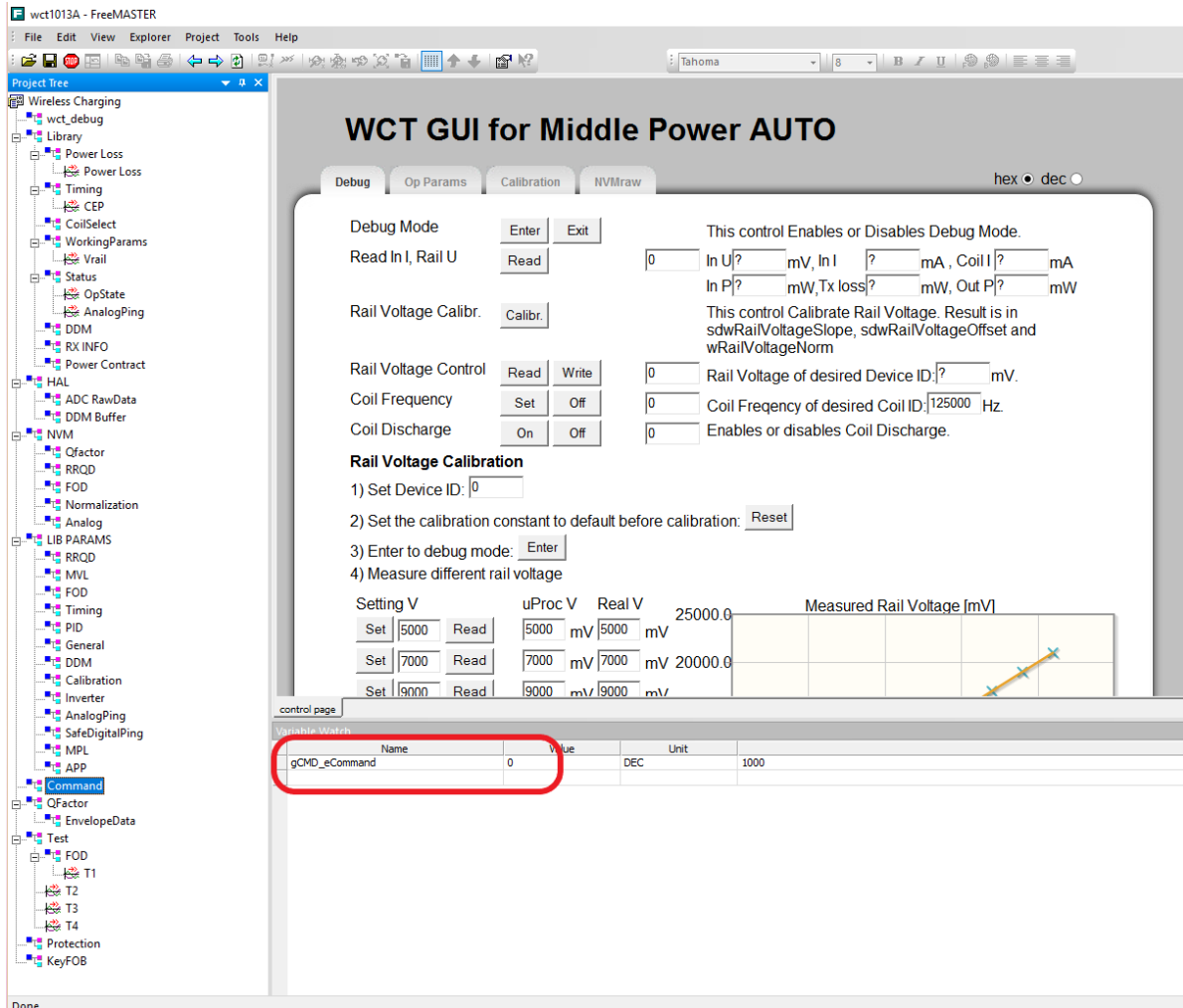


Figure 20. Set gCMD_eCommand

2. Enter 3 to gCMD_eCommand in FreeMASTER variable watch window, which will redo auto-calibration.
3. Make the board at temperature T2, make sure the difference between T1 and T2 is more than 20 centigrade. Otherwise, the calibration coefficient accuracy cannot be guaranteed.
4. Enter 1 to gCMD_eCommand in FreeMASTER variable watch window, which stops WCT library.
5. Enter 4 to gCMD_eCommand in FreeMASTER variable watch window, which generates the calibration coefficient and writes the coefficient to flash.
6. Enter 2 to gCMD_eCommand in FreeMASTER variable watch window, which re-starts WCT library.

3 NVM Structure Reference

3.1 Operation parameters

Auto-calibration check

Details:

This parameter indicates if the initial Q factor calibration and quick removal calibration have been done. Initially it is 0 and becomes 1 after the initial Q factor calibration and quick removal calibration are done and written to NVM parameters online.

Default Value: 0

Min Value: 0

Max Value: 1

Member: NvmParams.OpParams. OpStateParams. dwAutoCalibrated

Ping Frequency (Hz)

Details:

This parameter defines the coil frequency to be used during Digital Ping operations.

Default Value: 127772

Min Value: 120000

Max Value: 130000

Member: NvmParams.OpParams.OpStateParams.dwPingFrequency

Ping Pulse Duration (ms)

Details:

This parameter defines the amount of time the Ping frequency should be applied while waiting for device detection.

Default Value: 65

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.wPingPulseDurationTimeMs

Ping Interval (ms)

Details:

This parameter defines the amount of time between attempts to Ping the secondary for device detection.

Default Value: 400

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.wPingIntervalMs

Coil Current Threshold (% change)

Details:

This parameter defines the threshold above, which an Analog Ping may have detected a changed in device presence.

Default Value: 5

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.OpStateParams.wAnalogPingCoilCurrentThreshold`

Digital Ping Retry Interval (seconds)

Details:

This parameter defines the interval at which a digital ping is forced.

Default Value: 5

Min Value: 0

Max Value: 65

Member: `NvmParams.OpParams.OpStateParams.byDigitalPingRetryIntervalSeconds`

Over Coil Current Threshold (mA)

Details:

This parameter defines the maximum allowable current on the coil (in mA). If coil current exceed this threshold, power transfer is aborted.

Default Value: 6500

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.OpStateParams.wOverCoilCurrentThreshold`

Over Rail Voltage Threshold (mV)

Details:

This parameter defines the maximum allowable rail voltage (in mV). If rail voltage exceed this threshold, the operational state machine will shut down.

Default Value: 23000

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.OpStateParams.wOverRailVoltageThreshold`

Over Input Voltage Threshold (mV)

Details:

This parameter defines the maximum allowable input voltage (in mV). If the input voltage exceed this threshold, the operational state machine will shut down.

Default Value: 18000

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.wOverInputVoltageThreshold

Under Input Voltage Threshold (mV)

Details:

This parameter defines the minimum allowable input voltage (in mV). If the input voltage is lower than this threshold, the operational state machine will shut down.

Default Value: 8000

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.wUnderInputVoltageThreshold

Over Input Current Threshold (mA)

Details:

This parameter defines the maximum allowable input current (in mA). If input current exceed this threshold, the power transfer is aborted.

Default Value: 4000

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.wOverInputCurrentThreshold

Over Temperature Threshold (Celsius)

Details:

This parameter defines the maximum temperature. If temperature exceed this threshold, the operational state machine will shut down.

Default Value: 60

Min Value: 0

Max Value: 65535

Member: NvmParams.OpParams.OpStateParams.swOverTemperatureThreshold

Minimum Frequency (Hz)

Details:

This parameter defines the absolute minimum allowable frequency used during charging. If the power transfer algorithm attempts to set the “Active Frequency” below this value, the coil is turned OFF.

Default Value: 127772

Min Value: 120000

Max Value: 130000

Member: NvmParams.OpParams.OpStateParams.dwMinFreq

Maximum Frequency (Hz)

Details:

This parameter defines the maximum allowable frequency used during power transfer. If the power transfer algorithm attempts to set the “Active Frequency” above this value, the coil is turned OFF.

Default Value: 127772

Min Value: 120000

Max Value: 130000

Member: NvmParams.OpParams.OpStateParams.dwMaxFreq

Minimum Rail Voltage (mV)

Details:

This parameter defines the minimum operating Rail Voltage for the output drive – specified in mV. A value of 10000 corresponds to 10.0 V.

Default Value: 1000

Min Value: 0

Max Value: 25000

Member: NvmParams.OpParams.OpStateParams.wMinRailVoltageMv

Maximum Rail Voltage (mV)

Details:

This parameter defines the maximum operating Rail Voltage for the output drive – specified in mV. A value of 10000 corresponds to 10.0 V.

Default Value: 25000

Min Value: 0

Max Value: 25000

Member: NvmParams.OpParams.OpStateParams.wMaxRailVoltageMv

Coil 0 Default Rail Voltage (mV)

Details:

This parameter defines the operating Rail Voltage for the Coil0 output drive – specified in mV. When in Rail Control, this value corresponds to the rail voltage used at Ping. A value of 1000 corresponds to 1.0 V.

Default Value: 7000

Min Value: 1000

Max Value: 25000

Member: NvmParams.OpParams.OpStateParams.wDefaultRailVoltageMv[0]

Coil 1 Default Rail Voltage (mV)

Details:

This parameter defines the operating Rail Voltage for the Coil1 output drive – specified in mV. When in Rail Control, this value corresponds to the rail voltage used at Ping. A value of 1000 corresponds to 1.0 V.

Default Value: 7000

Min Value: 1000

Max Value: 25000

Member: `NvmParams.OpParams.OpStateParams.wDefaultRailVoltageMv[1]`

Coil 2 Default Rail Voltage (mV)

Details:

This parameter defines the operating Rail Voltage for the Coil2 output drive – specified in mV. When in Rail Control, this value corresponds to the rail voltage used at Ping. A value of 1000 corresponds to 1.0 V.

Default Value: 7000

Min Value: 1000

Max Value: 25000

Member: `NvmParams.OpParams.OpStateParams.wDefaultRailVoltageMv[2]`

Power Loss Indication To Power Cessation (ms)

Details:

This parameter defines how long the FOD indication is permitted to be active before removal of power.

Default Value: 4500

Min Value: 0

Max Value: 4294967295

Member: `NvmParams.OpParams.PowerLossParams.dwPowerLossIndicationToPwrCessationMs`

Power Loss Threshold for BPP Low Power RX (mW)

Details:

This parameter defines the power loss FOD threshold for BPP RX in mW.

Default Value: 400

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.PowerLossParams.wPowerLossBPPLPThreshold`

Power Loss Threshold for EPP Middle Power RX (mW)

Details:

This parameter defines the power loss FOD threshold for EPP MP RX in mW.

Default Value: 800

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.PowerLossParams.wPowerLossEPPMPThreshold`

Power Loss Threshold for EPP Low Power RX (mW)

Details:

This parameter defines the power loss FOD threshold for EPP LP RX in mW.

Default Value: 450

Min Value: 0

Max Value: 65535

Member: `NvmParams.OpParams.PowerLossParams.wPowerLossEPPLPThreshold`

Number of Trips to Indication

Details:

This parameter defines how many consecutive threshold breaches are required to trigger an FOD indication.

Default Value: 1

Min Value: 0

Max Value: 255

Member: `NvmParams.OpParams.PowerLossParams.byNumFodTripsToIndication`

3.2 Calibration parameters

Minimum Rail Voltage (mV)

Details:

Indicates the minimum rail voltage the hardware can produce.

Default Value: 3609

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.AnalogParams[0].wMinRailVoltageMv`

Maximum Rail Voltage (mV)

Details:

Indicates the maximum rail voltage the hardware is capable of producing.

Default Value: 25109

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.AnalogParams[0].wMaxRailVoltageMv`

Rail Voltage Cal Slope

Details:

This field defines the rail voltage normalized calibration slope.

Default Value: -4654

Min Value: -2147483647

Max Value: 2147483647

Member: NvmParams.CalParams.AnalogParams[0].sdwRailVoltageSlope

Rail Voltage Cal Offset

Details:

This field defines the rail voltage normalized calibration offset.

Default Value: 14352870

Min Value: -2147483647

Max Value: 2147483647

Member: NvmParams.CalParams.AnalogParams[0].sdwRailVoltageOffset

Input Current Cal Slope

Details:

This field defines the input current normalized calibration slope, which corrects for the portion of the input current that is dependent on the rail voltage.

Default Value: 718

Min Value: -2147483647

Max Value: 2147483647

Member: NvmParams.CalParams.AnalogParams[0].sdwInputCurrentSlope

Input Current Cal Offset

Details:

This field defines the input current normalized calibration offset, which corrects for the portion of the input current that is dependent on the rail voltage.

Default Value: 1391144

Min Value: -2147483647

Max Value: 2147483647

Member: NvmParams.CalParams.AnalogParams[0].sdwInputCurrentOffset

Rail Voltage Cal Normalization

Details:

This parameter defines the normalization factor used in the rail voltage normalized calibration.

Default Value: 9

Min Value: 0

Max Value: 65535

Member: NvmParams.CalParams.AnalogParams[0].wRailVoltageNorm

Input Current Cal Normalization

Details:

This parameter defines the normalization factor used in the input current normalized calibration.

Default Value: 18

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.AnalogParams[0].wInputCurrentNorm`

Input Voltage Calibration Constant (100 % = 32768)

Details:

Indicates the calibration error for the ADC reading of Input Voltage. A value of /77 %/ (translated to a parameter value of 25231) indicates that the actual value of the Input Voltage is 77 % of the reported ADC value for the system.

Default Value: 33430

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.AnalogParams[0].wInputVoltageCalibration`

Input Current Calibration Constant (100 % = 32768)

Details:

Indicates the calibration error for the ADC reading of Input Current. A value of /77 %/ (translated to a parameter value of 25231) indicates that the actual value of the Input Current is 77 % of the reported ADC value for the system.

Default Value: 31980

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.AnalogParams[0].wInputCurrentCalibration`

C5 – Quadratic Coefficient (mW/mA² x 2^{N5})

Details:

This parameter defines the quadratic coefficient of the equation used to calculate transmission (TX) losses represented in units of mW/mA² multiplied by the value of 2^{N5}, where N5 is the exponent defined by the next parameter.

Default Value: 0x6B79

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.swQuadCoefficient`

C5 Exponent (N5)

Details:

This parameter is the value of the exponent used to scale the C5 coefficient to obtain an integer value in units of mW/mA².

Default Value: 0x1A

Min Value: 0

Max Value: 65535

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.wQuadExponent`

C6 – Linear Coefficient (mW/mA x 2^{N6})

Details:

This parameter defines the linear coefficient of the equation used to calculate TX losses represented in units of mW/mA multiplied by the value of 2^{N6}, where N6 is the exponent defined by the next parameter.

Default Value: 0x5291

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.swLinearCoefficient`

C6 Exponent (N6)

Details:

This parameter is the value of the exponent used to scale the C6 coefficient to obtain an integer value in units of mW/mA.

Default Value: 0x11

Min Value: 0

Max Value: 65535

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.wLinearExponent`

C7 – Constant Term (mW)

Details:

This parameter represents the constant term of the equation used to calculate TX losses (represented in mW). This value equates to the static losses of the FET drive circuitry.

Default Value: 0x16

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.swConstantCoefficient`

Power Loss Calibration Offset (mW)

Details:

This parameter represents the offset to be used with the calculation of system Power Loss to prevent negative results due to resolution on reported RX power received, curve-fit and other calibration errors.

Default Value: 0

Min Value: -30000

Max Value: 30000

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodCharacterizationParams.swPowerLossCalibrationOffset`

CA1 – Quadratic Coefficient for region A ($\text{mW/mW}^2 \times 2^{\text{NA1}}$)

Details:

This parameter defines the quadratic coefficient of the equation used to calculate the normalization for system power losses represented in units of mW/mW^2 multiplied by the value of 2^{NA1} , where NA1 is the exponent defined by the next parameter.

Default Value: -28814

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodNormalizationParams.swQuadCoefficient`

CA1 Exponent (NA1)

Details:

This parameter is the value of the exponent used to scale the CA1 coefficient to obtain an integer value in units of mW/mW^2 .

Default Value: 38

Min Value: 0

Max Value: 65535

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodNormalizationParams.wQuadExponent`

CA2 – Linear Coefficient for region A ($\text{mW/mW} \times 2^{\text{NA2}}$)

Details:

This parameter defines the linear coefficient of the equation used to calculate the normalization for system power losses represented in units of mW/mW multiplied by the value of 2^{NA2} , where NA2 is the exponent defined by the next parameter.

Default Value: 21477

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodNormalizationParams.swLinearCoefficient`

CA2 Exponent (NA2)

Details:

This parameter is the value of the exponent used to scale the CA2 coefficient to obtain an integer value in units of mW/mW.

Default Value: 22

Min Value: 0

Max Value: 65535

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodNormalizationParams.wLinearExponent`

CA3 – Constant Term for region A (mW)

Details:

This parameter represents the constant term of the equation used to calculate the normalization for system power losses (represented in mW).

Default Value: -2

Min Value: -32768

Max Value: 32767

Member:

`NvmParams.CalParams.PowerLossParams[0][CoilId][0].FodNormalizationParams.swConstantCoefficient`

Ca – Linear coefficient of input current calibration for quick removal

Details:

This parameter represents the linear coefficient of the equation used to calculate input current value based on rail voltage value for quick removal.

Default Value: 216

Min Value: -2147483647

Max Value: 2147483647

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].InCurFrmRailVol.sdwslope`

Cb – Constant coefficient of input current calibration for quick removal

Details:

This parameter represents the constant coefficient of the equation used to calculate input current value based on rail voltage value for quick removal.

Default Value: 42265

Min Value: -2147483647

Max Value: 2147483647

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].InCurFrmRailVol.sdwoffset`

Exponent of input current calibration for quick removal

Details:

This parameter is the value of the exponent used to scale the Ca and Cb to obtain an integer value.

Default Value: 11

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].InCurFrmRailVol.wNorm`

Ca – Linear coefficient of coil current calibration for quick removal

Details:

This parameter represents the linear coefficient of the equation used to calculate coil current value based on rail voltage value for quick removal.

Default Value: 243

Min Value: -2147483647

Max Value: 2147483647

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].CoilCurFrmRailVol.sdwSlope`

Cb – Constant coefficient of coil current calibration for quick removal

Details:

This parameter represents the constant coefficient of the equation used to calculate coil current value based on rail voltage value for quick removal.

Default Value: -1244

Min Value: -2147483647

Max Value: 2147483647

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].CoilCurFrmRailVol.sdwOffset`

Exponent of coil current calibration for quick removal

Details:

This parameter is the value of the exponent used to scale the Ca and Cb to obtain an integer value.

Default Value: 7

Min Value: 0

Max Value: 65535

Member: `NvmParams.CalParams.QuickRemovalParams[0][CoilId].CoilCurFrmRailVol.wNorm`

Init Resonance Freq

Details:

This parameter represents the resonance frequency of the initial Q factor calibration (represented in Hz).

Default Value: 79936

Min Value: 0

Max Value: 4294967295

Member: `NvmParams.CalParams.QfCalibParams[0][CoilId].dwInitResonanceFreq`

Init Resonance Q Factor

Details:

This parameter represents the Q factor of the initial Q factor calibration.

Default Value: 3126

Min Value: 0

Max Value: 4294967295

Member: `NvmParams.CalParams.QfCalibParams[0][CoilId].dwInitQlc`

Q Factor Temperature Calibration

Details:

This parameter represents the coil temperature of the initial Q factor calibration (represented in Celsius degree)

Default Value: 25

Min Value: -65535

Max Value: 65535

Member: `NvmParams.CalParams.QfCalibParams[0][CoilId].swCalibrationTemperature`

Impedance Change per Celsius Degree

Details:

This parameter represents the impedance change per temperature (represented in $\mu\Omega$)

Default Value: 0

Min Value: -65535

Max Value: 65535

Member: `NvmParams.CalParams.QfCalibParams[0][CoilId].swImpedanceChangePerCelsius`

4 Revision History

The following table provides the revision history.

Table 1. Revision history

Revision number	Date	Substantive changes
GA 3.1	10/2017	Initial release
GA 4.0	05/2018	Update according to WCT SW v4.0
GA 4.1	03/2019	Update according to WCT SW v4.1

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