

BQ2515x Setup Guide

ABSTRACT

This guide was created to walk you through the use of the BQ2515x Setup Guide Excel tool. Using this guide and the Excel tool together allows you to configure your system and battery charger very quickly and easily. Although the guide provides a great starting point for new users to get set up, it is not intended to be an exhaustive tutorial into using the device to its full potential. For more details, refer to the BQ2515x datasheet.

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Trademarks

1 Overview

Upon opening the BQ2515x Setup Guide Excel tool, the home page is displayed as shown in [Figure 1](#). The home page serves a few different purposes. First, it serves as an index for the rest of the tool, allowing you to easily access any other page within the tool through the hyperlinks on the screen. Under each hyperlink is a brief description of the settings contained within every sheet. The home page also has several buttons to export or import the calculated register values. Since the tool automatically loads the power-on system defaults of the BQ2515x device upon being opened, these buttons can be useful for saving and loading workbook states. The buttons can also be used to quickly transfer the register values to BQ Studio or into a .C file for firmware code. In order to use BQ Studio with your EVM, you need to purchase an [EV2400 module](#).

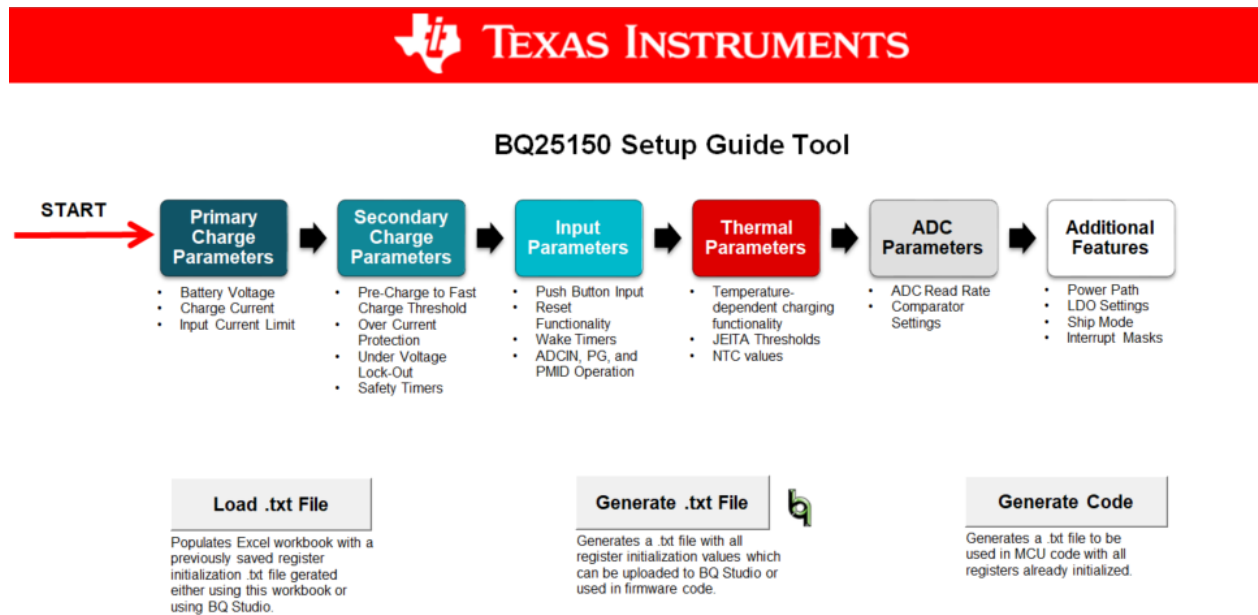


Figure 1. Home Page

Table 1. BQ2515x Register Settings Quick Access Guide

PAGE	REGISTER	SETTING
Primary Charge Parameters	VBAT_CTRL	Battery Regulation Voltage
	ICHG_CTRL	Fast Charge Current
	PCHRGCTRL	Pre-Charge Current
		Charge Current Step
	TERMCTRL	Termination Current
	ILIMCTRL	Input Current Limit
Secondary Charge Parameters	Rimax	Hardware Fast Charge Current Limit
	BUVLO	Pre Charge to Fast Charge Threshold
		Battery Over-Current Protection
		Battery Under Voltage Lock Out
	CHARGERCTRL0	TS Control Mode
		Recharge Voltage Threshold
		Watchdog Timer Enable
		Charger Safety Timer
		2X Safety Timer Enable
Input Parameters	MRCTRL	MR Reset Functionality
		Wake Timers
	ICCTRL1	MR Long Press Action
		ADCIN Mode of Operation
		PG Mode of Operation
		PMID Control

Table 1. BQ2515x Register Settings Quick Access Guide (continued)

PAGE	REGISTER	SETTING
Thermal Parameters	TSFASTCHGCTRL	Target Battery Voltage During Warm
		Fast Charge Current During Cool
	TS_COLD	TS Cold Threshold
	TS_COOL	TS Cool Threshold
	TS_WARM	TS Warm Threshold
	TS_HOT	TS Hot Threshold
	Thermal Schematic	Beta
		Ro
		Rparallel
		Rseries
ADC Parameters	ADCCTRL0	ADC Read Rate
		ADC Conversion Speed
		Comparator 1 Channel
	ADCCTRL1	Comparator 2 Channel
		Comparator 3 Channel
	ADC_ALARM_COMP1	Comparator 1 Threshold
		Comparator 1 Polarity
	ADC_ALARM_COMP2	Comparator 2 Threshold
		Comparator 2 Polarity
	ADC_ALARM_COMP3	Comparator 3 Threshold
		Comparator 3 Polarity
Additional Features	CHARGERCTRL1	ADC Channel Enable Select
		VINDPM Enable
		VINDPM Level Select
		DPPM Enable
	LDOCTRL	Thermal Charge Current Foldback Threshold
		LDO Enable
		LDO Output Voltage
	ICCTRL0	LDO/LS Configuration
		Ship Mode Enable
		Auto-wakeup Timer
		Global Interrupt Mask
		Hardware Reset Operation
	ICCTRL2	Software Reset Operation
		/PG GPO State Control
		14-second Watchdog Timer Enable
	MASK0	Charge Disable
		Interrupt Masks
		Interrupt Masks
		Interrupt Masks
		Interrupt Masks

2 Primary Charge Parameters

The “Primary Charge Parameters” page contains parameters which are most likely to change based on the battery being used and the system requirements. There are several drop-down boxes on the page as shown in [Figure 2](#), as well as on all other pages throughout the tool, which allow you to select from the available settings for parameters such as battery regulation voltage, charge current, and termination current. Other parameters, such as the hardware fast charge current limit, have open-ended boxes (as shown in [Figure 3](#)) which allow you to enter any number within the range supported by the device. All of these selections are used by the tool to calculate the register values and schematic requirements shown at the bottom of the page. At any point throughout using the tool, the “Reset to Page Defaults” button located on each page can be clicked to recover the system defaults for all registers on the current page.

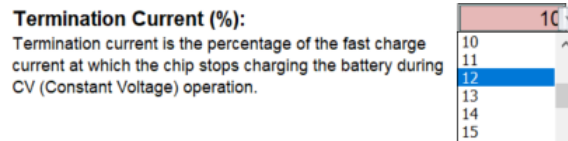


Figure 2. Drop-down Menu

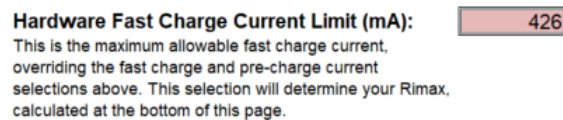


Figure 3. Free Response Box

After completing the first page, you can navigate to any other page within the workbook to use features such as battery temperature-dependent charging (that is the JEITA standard) and the on-chip ADC and LDO. Some of the functionality, such as using the ADC to measure temperature, requires that other parts of the workbook be completed. Not only is this noted when it occurs, but the ordering of the pages is also set up to avoid such conflicts. Therefore, if you are new to the device, it is important to follow the ordering in which the pages are placed to ensure that all required parameters are correctly entered.

3 Secondary Parameters

The “Secondary Charge Parameters” page mainly contains charge parameters which are less likely for you to need to change from their defaults. These parameters contain some protection settings for both the IC and the battery, including overcurrent protection and undervoltage lock-out. By default, these settings are enabled and set to the recommended values, but you have the ability to disable or change their values based on your application. Additionally, the page contains the “TS Enable” and “TS Control Mode” settings. With TS enabled, the chip charges the battery differently based on how hot or cold it is. With the “TS Control Mode” setting, you can choose between JEITA and hot/cold only. In the JEITA control mode, the charger cuts off charging when the battery is considered “hot” or “cold,” decreases the battery regulation voltage when the battery is considered “warm,” and decreases fast charge current when the battery is considered “cool”. The thresholds for each of these temperatures and the voltage/current reductions all have default settings, but they can be changed in the “Thermal Parameters” page. On the other hand, selecting the hot/cold only control mode simply shuts off charging whenever the battery is determined to be either hot or cold.

4 Input Parameters

The settings under "Input Parameters" are used to control the ADCIN setting, the settings for the user input button, /MR, and the operation of PMID and PG. You have the ability to configure the ADCIN pin to output an 80 μ A bias current for measuring temperature with a 10 k Ω NTC or configure the pin as a general purpose analog measurement. Also configured on this page are parameters which configure the push-button controller for the /MR pin. The wake timers are used to dictate how long the MR Button must be held before sending an interrupt. The first interrupt is sent when the Wake 1 Timer condition is met and the second interrupt, which wakes the device from ship mode, is sent when the Wake 2 Timer condition is met. Finally, both the PMID and PG pins can be configured to perform different functionality based on the application.

5 Thermal Parameters

As noted in the Secondary Charge Parameters section, you can change the way the battery is charge based on its temperature by using the settings contained in the "Thermal Parameters" page. Not only can you change the thresholds at which the battery is considered "hot," "warm," "cool," and "cold," but you can also change the target battery voltage and fast charge current in the "warm" and "cool" conditions, respectively. An important part of this sheet is the schematic parameters as shown in Figure 4. If the recommended layout and NTC is used, then these parameters can be left as their default values. However, if a different parallel resistor, series resistor, or NTC is used, then these values should be modified so that the correct voltages are calculated for the different temperature thresholds.

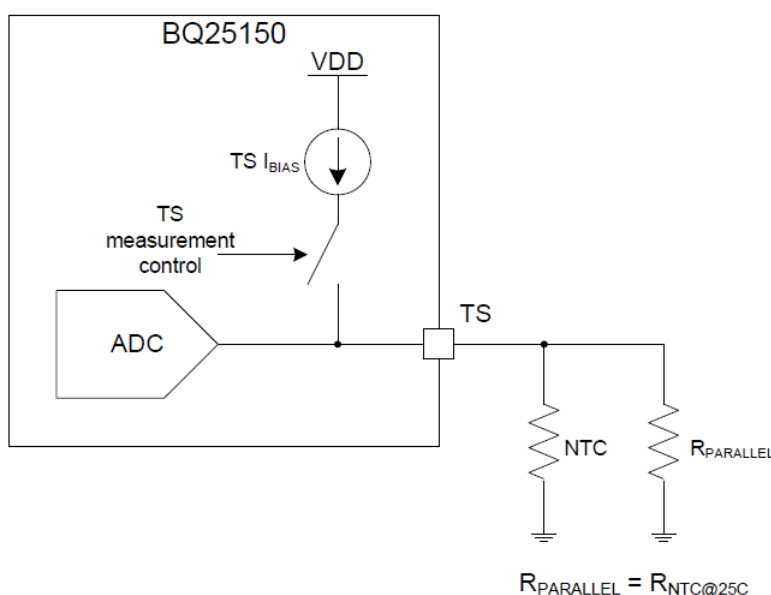


Figure 4. Temperature Sense Bias Functional Diagram

The temperature thresholds which you enter are not necessarily be the exact temperature thresholds which the ADC detects. If the exact temperature that the ADC sees after the corresponding binary value is calculated is needed, you can use the buttons on the home page. First, save the registers to a .txt file. Then, load the same .txt file into the tool and return to the Thermal Parameters page. The temperature thresholds can now be reverse-calculated to show the exact value in degrees Celsius measured by the ADC.

Although all of the calculations needed to utilize battery temperature-dependent charging are done in the background by the tool, you may also want to refer to the [NTC calculator](#) on the BQ2515x page. The calculator may be especially useful for calculating the ADC values used to measure temperature through the ADCIN pin, which is not mentioned in the User Guide tool.

6 ADC Parameters

Within the “ADC Parameters” page, you have the ability to easily set all ADC comparator values without having to do any calculations or binary conversions as shown in [Figure 5](#). All you have to do is select the channel you wish to measure with each comparator and set its threshold value and polarity. When setting a comparator to measure “TS”, the NTC values must be entered in the “Thermal Parameters” page in order for the calculation to be correct. The checkbox of the desired channel must also be checked under the “Enable ADC Read” section of the same sheet as shown in [Figure 6](#). Note that in order to avoid a false interrupt from the comparators, you must first make sure that a valid ADC measurement has been made on the channel the comparator is monitoring before configuring the comparator.

Comparator 1 Channel:	<input type="text" value="TS"/>	
Comparator 1 Threshold:	<input type="text" value="65"/>	Comparator 1 Polarity:
Enter temperature value in C. Ensure you have entered your TS schematic parameters on the previous page.		<input type="text" value="Less than"/>
		This determines when the comparator flag will be set. For example, if the polarity is set to "Greater than," the flag will be set as soon as the ADC value is larger than that of the comparator channel.

Figure 5. Comparator Settings

Enable ADC Read:	☐ IIN
	☐ PMID
	☐ ICHG
	☐ VIN
	☐ VBAT
	☐ TS
	☐ ADCIN

Figure 6. ADC Enable Checkboxes

7 Additional Features

The “Additional Features” sheet contains various miscellaneous settings which are most likely to be configured in the final stage of development, such as when developing firmware. A series of checkboxes also appear on this page to control the masking of every possible interrupt as shown in [Figure 7](#). By default, most of the interrupts are unmasked, corresponding to an unchecked box. However, when writing firmware to communicate with the device, it is likely that only a handful of these interrupts are needed, and the rest can be masked to avoid undesired program interruption. In addition, several control settings appear on this sheet that you can set to define extra functionality for the chip. For example, the LDO/LS pin can be configured, the LDO output voltage can be selected, and the PG pin (when configured as a general purpose output) can be changed between high impedance and pulldown states.

Select Interrupt Masks:	☐ CHRG_CV	☐ CHARGE_DONE	☐ IINLIM_ACTIVE	☐ VDPPM_ACTIVE
	☐ VINDPM_ACTIVE	☐ THERMREG_ACTIVE	☐ VIN_PGOOD	☐ VIN_OVP_FAULT
	☐ BAT_OCP_FAULT	☐ BAT_UVLO_FAULT	☐ TS_COLD	☐ TS_COOL
	☐ TS_WARM	☐ TS_HOT	☐ ADC_READY	☒ COMP1_ALARM
	☒ COMP2_ALARM	☒ COMP3_ALARM	☒ TS_OPEN	☐ WD_FAULT
	☐ SAFETY_TMR_FAULT	☐ LDO_OCP_FAULT	☐ IMAX_FAULT	☐ MRWAKE1_TIMEOUT
	☐ MRWAKE2_TIMEOUT	☐ MRRESET_WARN		

Figure 7. Interrupt Masks

8 File I/O

When all necessary parameters are set based on the your application, the file can be exported using the buttons on the home page. Specifically, the register initializations can be exported to a format which is readable by BQ Studio. To import the registers into BQ Studio, you must first make sure "Auto Read" is set to "OFF". Then click "Load Registers" and choose the file which was output by the Excel tool. Using the BQ Studio .txt file format also allows you to save the workbook state and load it at a later time, using the "Load .txt File" button," to continue making changes.

The other generate button on the home page exports the initializations to a .txt file with the contents in C code format. This code contains an I2C write command implemented as a C function, which requires the StdI2C library to also be included. It then uses the write command to initialize all registers contained within the Excel tool. The code, either in its entirety or some portion thereof depending on your needs, can either be copied and pasted into the your own main file, or it can be directly called by the main file by changing the file extension to ".c" and using the function "BQ2515x_init_all();".

9 Application Example

This section provides several examples containing common application requirements and how to leverage the setup guide tool to take advantage of the BQ2515x functionality to fulfill these requirements.

Example 1: The battery you are charging is a 4.2-V battery rated at 50 mAh, and you would like to charge it at 1C (50 mA fast charge current). You also want to limit the maximum programmable fast charge current to 2C (100 mA fast charge current).

1. Change the battery voltage to 4.2 V using the drop-down menu on the Primary Charge Parameters page.
2. Select a charge current step of 1.25 mA and a fast charge current of 50 mA.
3. Enter 100 mA in the Hardware Fast Charge Current Limit box.
4. Find the required R_{imax} resistor at the bottom of the Primary Charge Parameters page and connect a resistor of the same value between the I_{max} pin and ground.
5. Set the BQ2515x registers as the tool has calculated by using the file I/O described above.

Example 2: You would like to use the JEITA standard battery temperature-dependent charging, but you would like to change the "cold" threshold to -10°C, disable any changes during "warm" operation, and change the fast charge current in the "cool" region to 75% of the normal fast charge current.

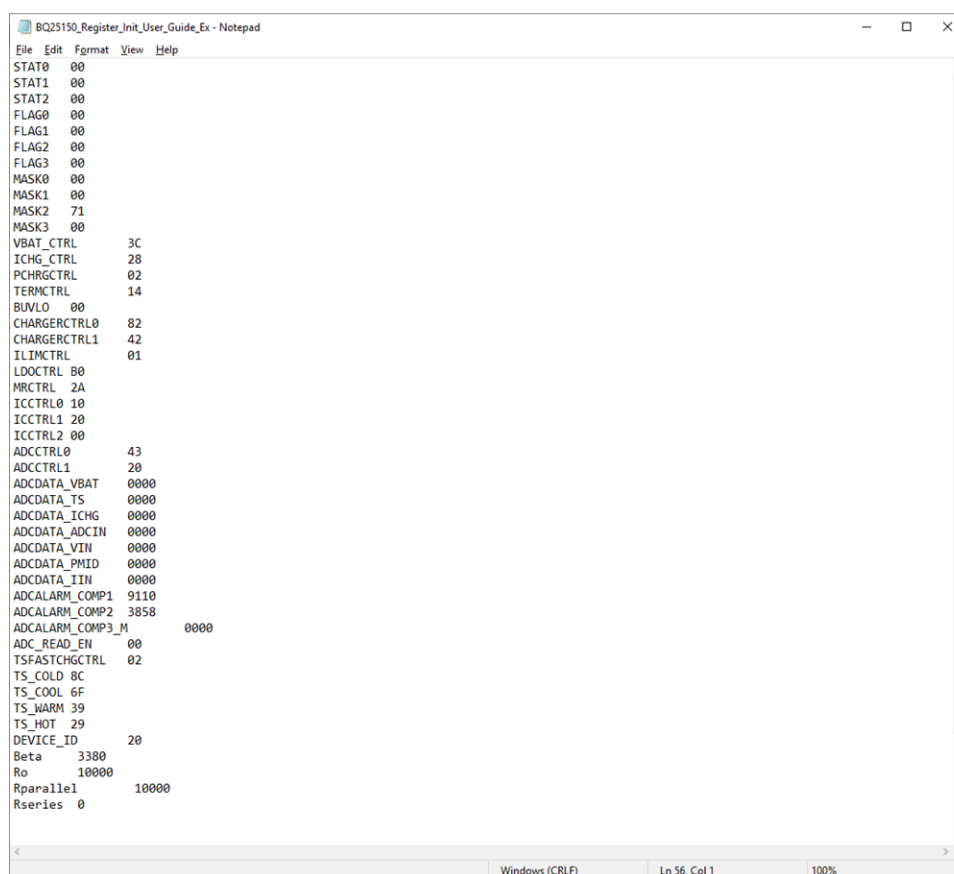
1. Navigate to the Secondary Charge Parameters page and choose "Yes" for "TS Enable" and "JEITA" for "TS Control Mode".
2. In the Thermal Parameters page, first make sure that the Schematic parameters match your setup. If the NTC recommended in the BQ2515x datasheet is being used, then no changes to this section are necessary.
3. Change the input box for T_{cold} to -10°C.
4. Change "Battery Voltage During Warm" to "No Reduction".
5. Choose "0.750 * ICHG" in the "Charge Current During Cool" setting.
6. Set the BQ2515x registers as the tool has calculated by using the file I/O described above.

Example 3: You would like to continuously measure your battery voltage and board temperature and send an interrupt to your host device when the battery voltage reaches below 3.4 V and when the circuit board temperature is greater than 40°C.

1. Navigate to the Input Parameters page and select "10K NTC" under the "ADCIN Mode" setting. This provides an 80 µA bias current with which the pin measures the voltage over the NTC.
2. Navigate to the ADC Parameters page.
3. Choose "Continuous" for the ADC Read Rate. Depending on the application and the required power consumption, you may also want to change the ADC Conversion Speed.
4. Choose any of the three comparators to measure battery voltage by selecting "VBAT" under the channel selection for any comparator.
5. Enter the threshold for the comparator that should send the interrupt, which is 3.4 in this case.
6. Select the polarity "Less than". This indicates that the interrupt is sent as the battery voltage crosses

- from greater than 3.4 V to less than 3.4 V.
7. Choose any of the remaining two comparators to measure the board temperature by selecting the "ADCIN" channel.
 8. Calculate the voltage over your NTC which will correspond to 40°C. You need the value of R_0 and β for your NTC, as well as any parallel or series resistance connected to the ADCIN pin. Use 80 μ A as the bias current. Enter the calculated voltage as the comparator threshold.
 9. Choose the polarity "Greater than," which triggers an interrupt when the temperature of the board crosses from less than 40°C to greater than 40°C.
 10. Set the BQ2515x registers as the tool has calculated by using the file I/O described above.

As an example, the .txt file has been generated using all constraints provided in each of the three examples and is displayed below:



```

BQ25150_Register_Init_User_Guide_Ex - Notepad
File Edit Format View Help
STAT0 00
STAT1 00
STAT2 00
FLAG0 00
FLAG1 00
FLAG2 00
FLAG3 00
MASK0 00
MASK1 00
MASK2 71
MASK3 00
VBAT_CTRL 3C
ICHG_CTRL 28
PCHRGCTRL 02
TERMCTRL 14
BUVALO 00
CHARGERCTRL0 82
CHARGERCTRL1 42
ILIMCTRL 01
LDOCTRL 00
MRCTRL 2A
ICCCTRL0 10
ICCCTRL1 20
ICCCTRL2 00
ADCCTRL0 43
ADCCTRL1 20
ADCDATA_VBAT 0000
ADCDATA_TS 0000
ADCDATA_ICHG 0000
ADCDATA_ADCIN 0000
ADCDATA_VIN 0000
ADCDATA_PMIID 0000
ADCDATA_IIN 0000
ADCALARM_COMP1 9110
ADCALARM_COMP2 3858
ADCALARM_COMP3_M 0000
ADC_READ_EN 00
TSFASTCHGCTRL 02
TS_COLD 8C
TS_COOL 6F
TS_WARM 39
TS_HOT 29
DEVICE_ID 20
Beta 3380
Ro 10000
Rparallel 10000
Rseries 0
Windows (CRLF) Ln 56, Col 1 100%

```

Figure 8. Text File Output Example

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