User's Guide
SCPU036–October 2017

TIC12400 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TIC12400 Evaluation Module (EVM).

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1 Introduction

The TIC12400 is a multiple switch detection interface that is designed to detect the opening and closing of up to 24 switch contacts. 10 out of the 24 inputs are configurable to detect switch states that are either battery connected switches (BCS) or ground connected switches (GCS), which means it can either sink or source current from the channel. The remaining 14 channels are design to support ground connected switches only (source current). The wetting current can be preprogrammed to six available values, which accommodates for different application scenarios. Communication to and from the device is done using a 24-bit SPI protocol.

The TIC124000 and TIC12400-Q1 provide the same functionality and the TIC12400 Evaluation Module is used for both devices.

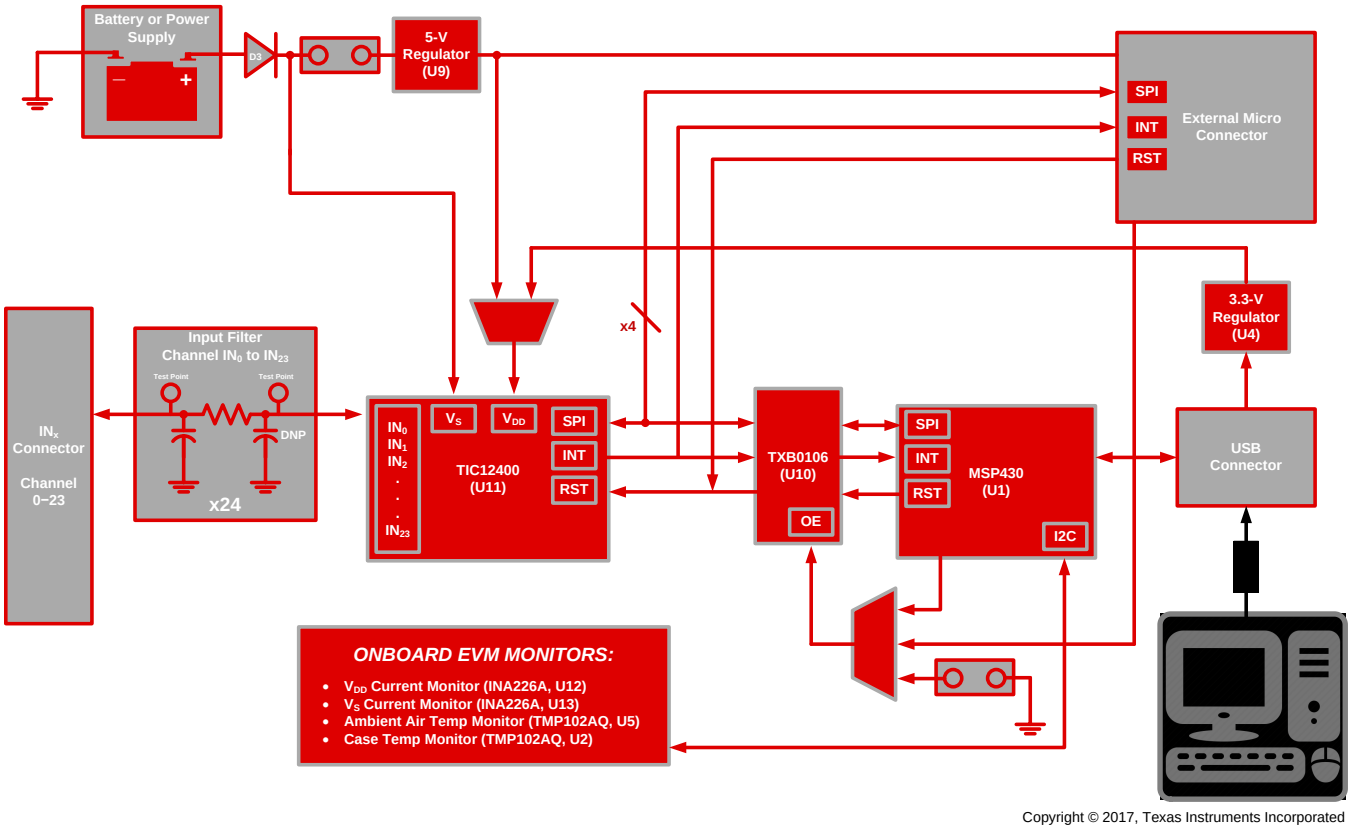


Figure 1. TIC12400 EVM Block Level Diagram

The TIC12400 EVM is an evaluation module for the Texas Instruments TIC12400 and it provides basic functionality evaluation for the device. When used together with the switch board, the EVM allows testing of its functionality via SPI communication established to the PC using the USB adaptor.

1.1 Warnings

CAUTION

This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in its supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, see the *Electrostatic Discharge (ESD)* application note (SSYA008).

Caution Hot surface.
Contact may cause burns.
Do not touch.

The DUT of the board can get hot when all channels are enabled at the highest wetting current settings in continuous mode

2 Hardware

2.1 Kit

Two boards, EVM (TIC12400EVM) and SWITCH BOARD (TIC12400_SWB), are provided with an USB to USB-MINI cable within the KIT; see Figure 2.

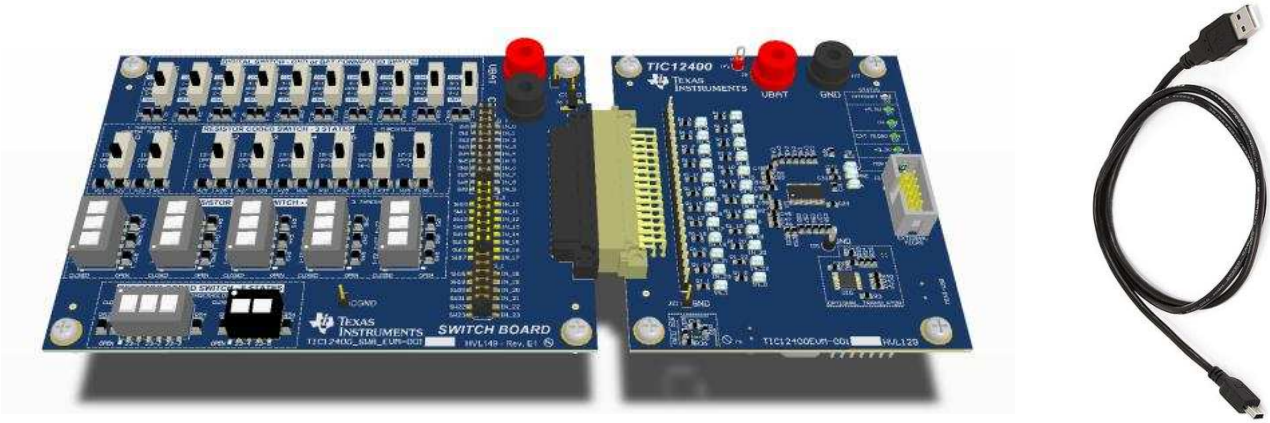


Figure 2. TIC12400 EVM, SWITCH BOARD, and USB to USB-Mini Cable

2.2 Connection to the PC and Powering up the EVM

A mini-USB cable is used to connect the EVM board to the PC. The VDD of the EVM is powered by the USB's VBUS. The positive terminal of the Power Supply is connected to the "VBAT" terminal of both the EVM and SWITCH BOARD. The negative terminal of the power supply is connected to the "GND" terminal of the EVM. Turn ON the power supply and set it to a nominal supply of +12 V, see Figure 3.

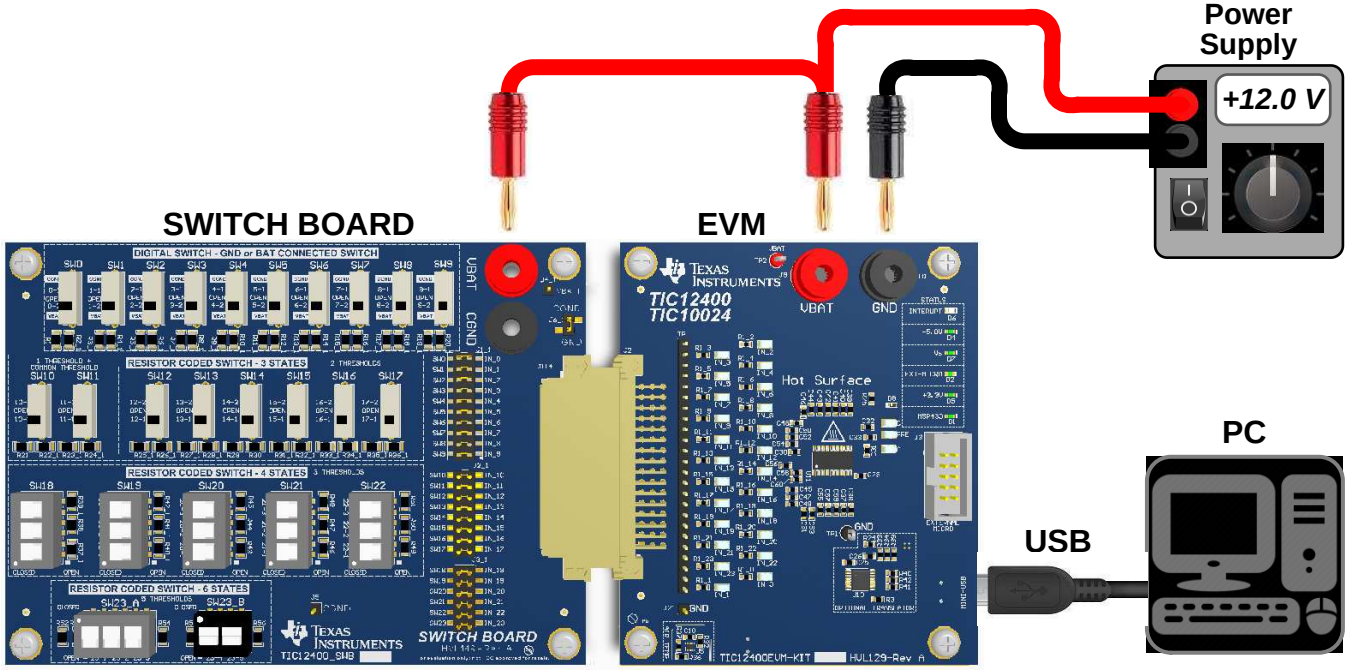


Figure 3. EVM, SWITCH BOARD, USB Cable, PC, and Power Supply Setup

2.3 EVM Hardware Description

The TIC12400 EVM is designed to allow the user to easily evaluate switch detection using the GUI. The break down of all the features and design of the EVM follow.

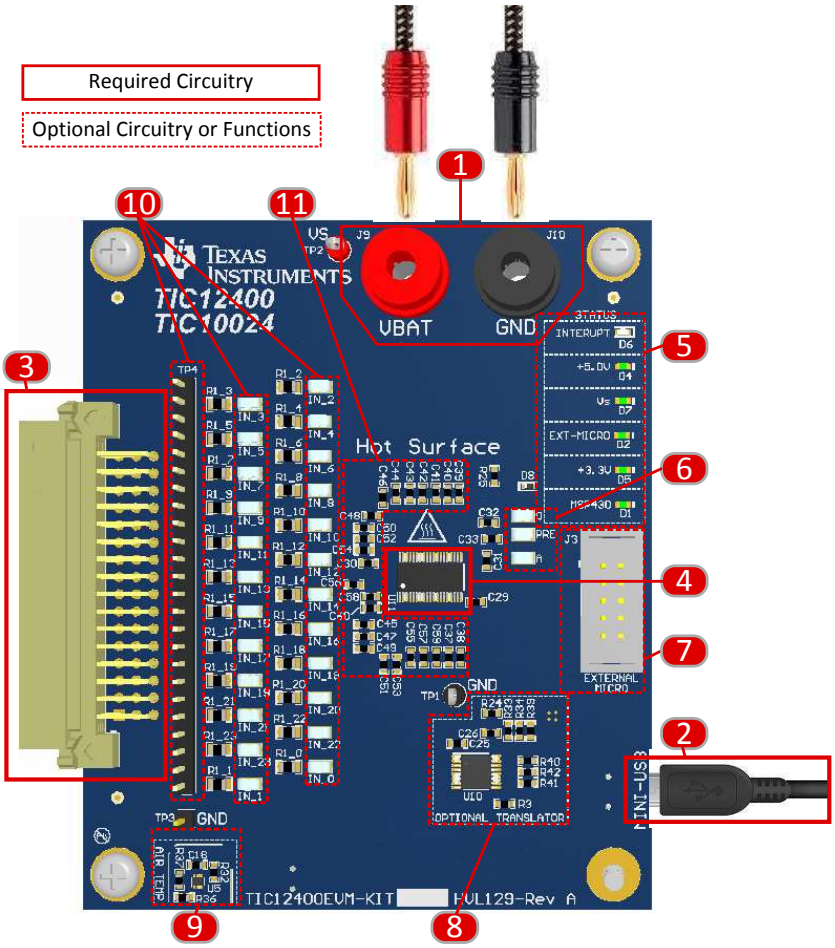
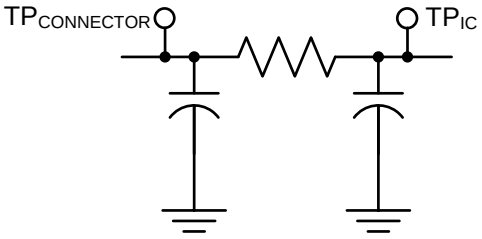


Figure 4. EVM Hardware Top Description

1. Connect the TIC12400EVM to a supply using VBAT (J9) as the positive terminal of the supply and GND (J10) to the negative terminal of the supply using standard banana cables. The supply can range from 4.5V to 35V, but is nominally at 12V.
2. Connect the TIC12400EVM to your computer via the mini-USB cable provided. The actual connector is located on the bottom side of the board. This will allow your computer to interface with the EVM and communicate to the device.
3. Connect the Switch Board or your own switches via a mating connector to J2, which connects the switches to the INx pins of the device.
4. U11 is the TIC12400 devices.
5. The EVM has several LED use to help the user indicate the status of the EVM
6. The device has three post regulator decoupling caps: V_{CAP_D}, V_{CAP_PRE}, and V_{CAP_A}. There are test points at each output capacitor for each of these three regulators.
7. The EVM facilitates the use of an external microcontroller by interfacing with SPI, INT, and RESET pins of the device.
8. There is an optional Translator/Level shifter (TXB0106) on the EVM to ensure the ability to interface with the device's SPI, INT, and RESET functions at various voltages set by VDD pin. The MSP430 is a 3.3-V device and does not support 5-V logic level without the TXB0106.
9. The EVM has the ability to do relative temperature measurements of the air using the TI TMP0104AQ

device.

10. There are place holders for a filter components on each channel of the EVM. There is a 100mil header along the edge of the connector to measure signal at connector, and SMT test points to measure the signal at the IC.
11. The filter capacitors at the pins of the device are not loaded by default and are there to allow the design of filters if needed.



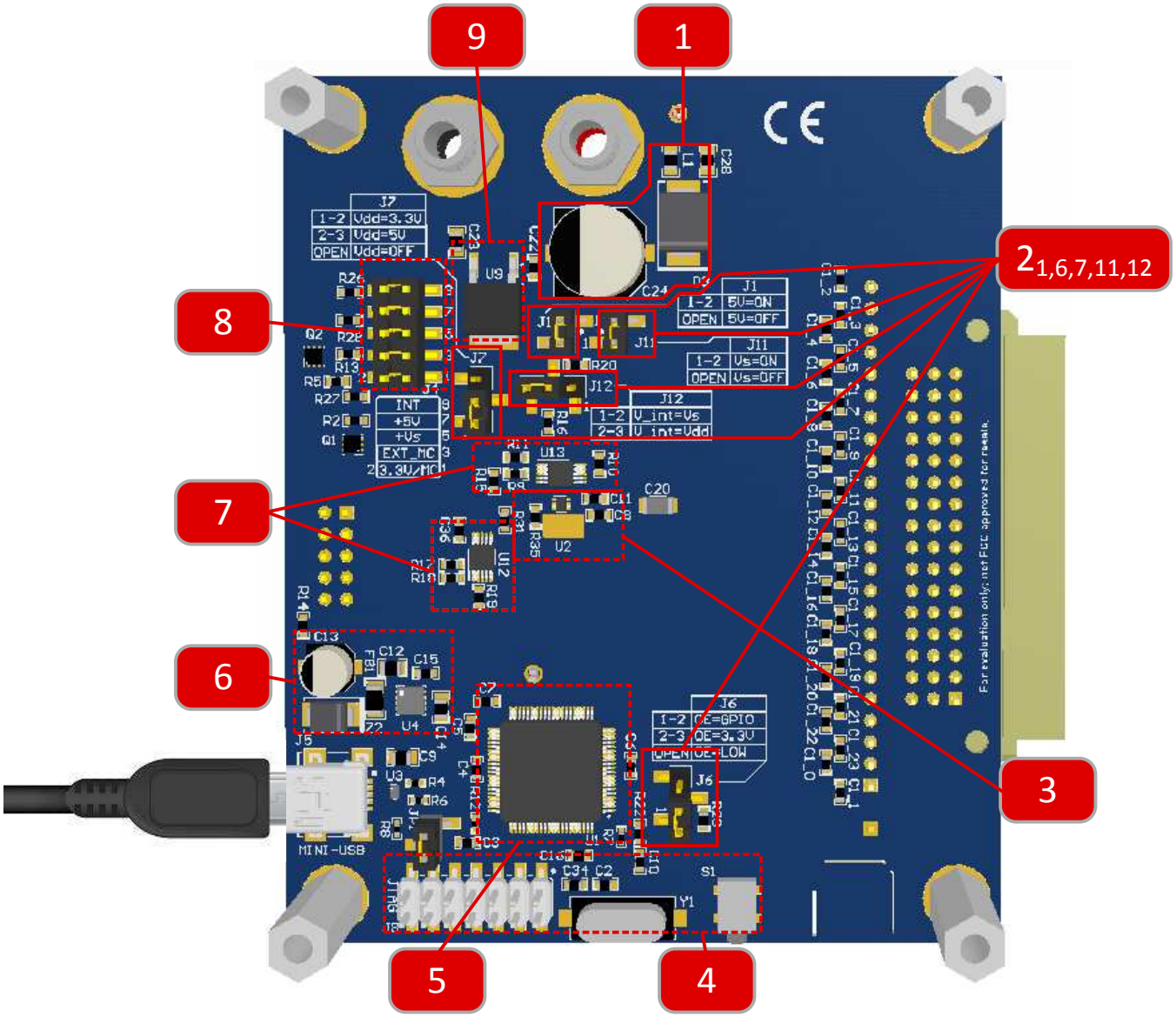
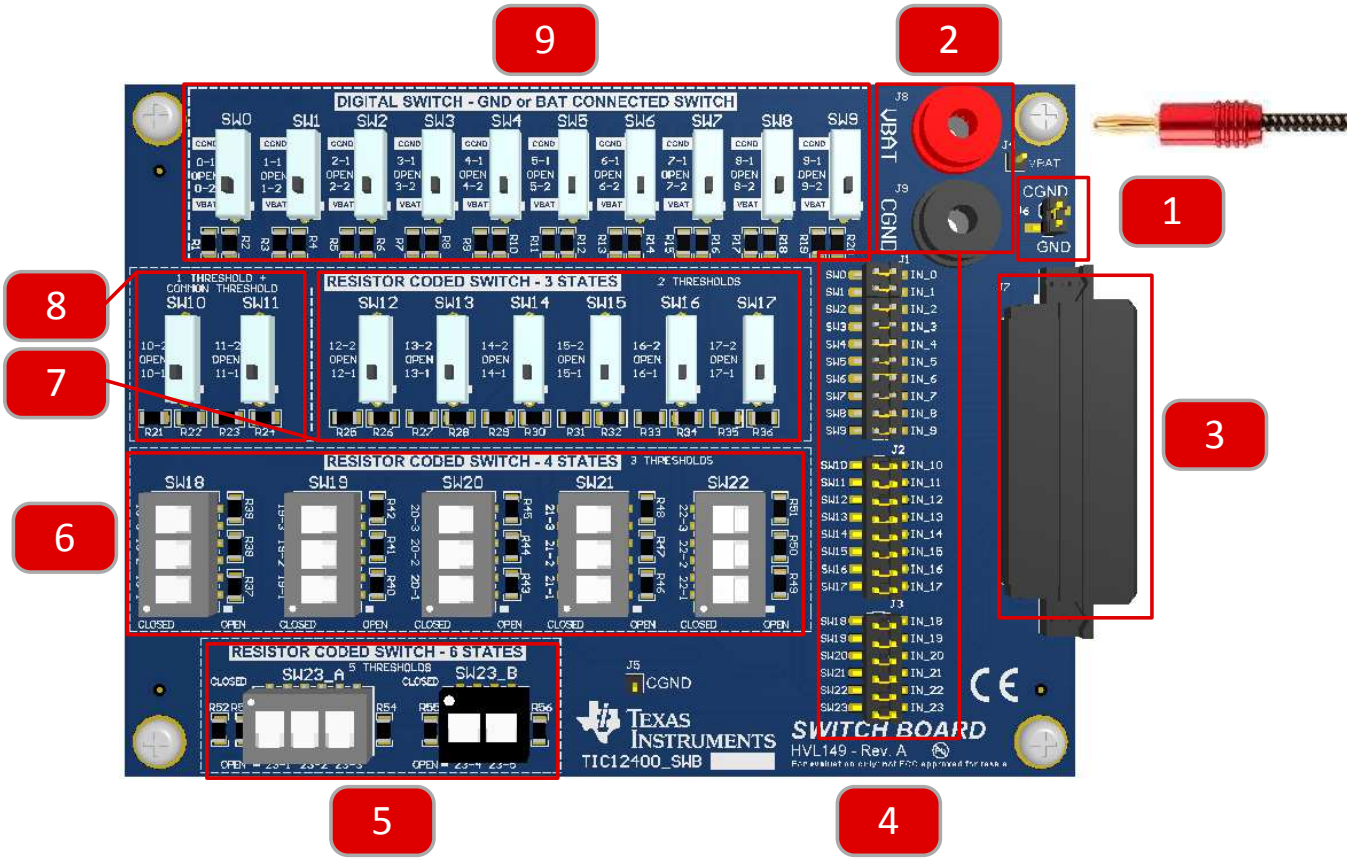


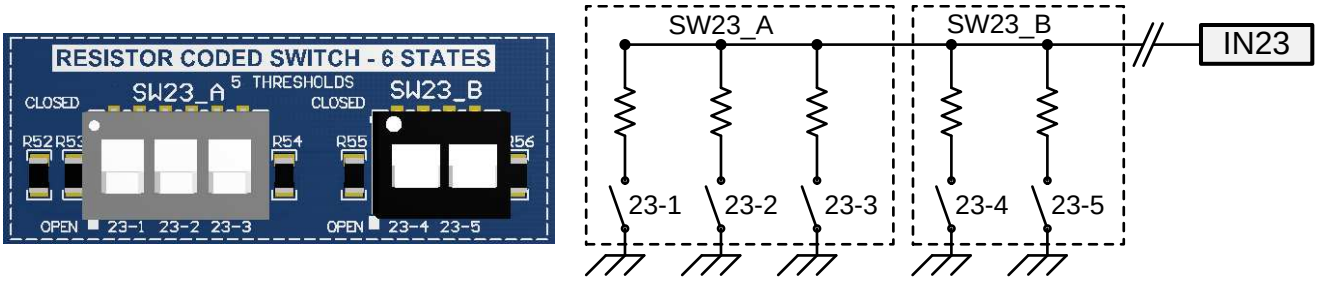
Figure 5. EVM Hardware Bottom Description

1. The EVM has a blocking diode and large bulk capacitor. The blocking diode (D3) protects the EVM in case the terminals of the battery are switched accidentally. The bulk capacitor (C24) adds a delay between a battery disconnect and the device shutting down.
   a. 2.1 There EVM has several jumpers for configuring the EVM in a variety of ways. J1: This jumper connects the input of the 5V regulator to VS if inserted. (Default: Not Loaded)
   b. 2.6 J6: This jumper connects a GPIO from the EVM micro (MSP430) to the output enable (OE) of the TXB0106 level shifter by placing the jumper between pins 1 and 2. Placing the jumper between pins 2 and 3 forces the translator to be on. If there is no jump on J7 then the pull down resistor turns it off (OE=LOW) and places the level shifter in high impedance mode, preventing bus contention between two possible masters on the SPI bus.
   c. 2.7 J7: This jumper connects VDD pin of the device to either the onboard +3.3V supply generated from the USB bus or connects to the onboard +5V regulator that is supplied from the battery. Connecting pin 1 and 2 with a jumper connects VDD to +3.3V and connecting 2 and 3 with a jumper connects VDD to +5V (this assumes J1 is also loaded). (Default: jumper across pin 1 and 2)
   d. 2.11 J11: This jumper connects VS pin of the device to the bulk capacitor after the protection diode.
   e. 2.12 J12: This jumper gives the option of having the pull up resistor come from either VDD or VS. Connecting pin 1 and 2 with a jumper, references the INT pin to VS. Connecting pin 2 and 3 with a jumper references the INT pin to VDD.
2. The EVM has the ability to do relative temperature measurements of the device's case temperature using TI’s TMP0104AQ device.
3. The MSP430's support devices, such as JTAG interface, crystal, programming button, and so forth.
4. The MSP430 bridges the communication from the computer’s USB cable to the device's SPI, $\overline{\text{INT}}$, and RESET lines. The MSP430 also interfaces with several supports circuits for measuring temperature for air and case, measuring current to VDD, and measuring current to VS. The MSP430 also has the ability to control OE pin of TXB0106 to facilitate control of the device by an external microcontroller.
5. The TPS73533 receives power from the VBUS of the USB, which is 5 V. It then regulates that to the +3.3V output on the TIC12400 EVM.
6. There are two INA226A Current Monitors for measuring current in VDD (U12) and for measuring th current going into VS (U13). The MSP430 interfaces with these devices using I2C and relays the information through the UBS cable to the GUI on the computer.
7. There are four status LED on the EVM that take up power when in use. The header (J4) facilitates removing the LED’s in the circuit to do system level power measurements accurately.
8. The TPS7A6650Q is a high voltage regulator that is able to take high voltage and regulate it down to 5V for use with higher voltage micro controllers. When J1 is removed the regulator’s input voltage is removed and therefore it is disabled.

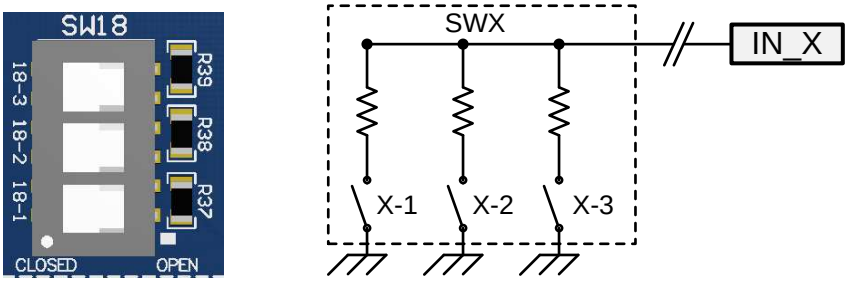
3 SWITCH BOARD Hardware Description



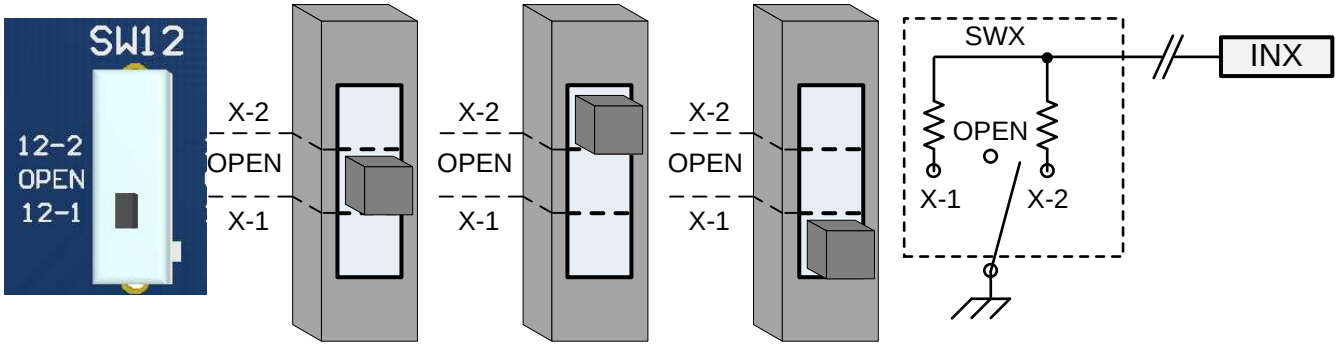
1. The SWITCH BOARD (SWB) is designed such that ground offsets can be tested by removing J6, which disconnects the Chassis Ground (CGND) from the EVM ground (GND). A supply can be placed between GND and CGND to create the offset. If not testing this feature, then J6 is by default in place and therefore CGND and GND are shorted together.
2. VBAT provides the power to the battery connected switches. Switch 0 to 9 are battery connected switches.
3. J114 connects all the switches from the SWB to the inputs of the EVM.
4. J1, J2, and J3 are jumpers that connect SW0 to SW23 to IN0 to IN23 of the EVM. These jumpers allow the user to disconnect the SW's on the Switch Board to the EVM and provide a 0.1" head to connect their own switch of their choosing to the EVM.
5. SW23A and SW23B are provided to test the device's ability to detect multi-resistor coded ground referenced switch transitions. SW23A relate directly to the mapped thresholds for 3A, 3B, and 3C. SW23B relate directly to thresholds 8 and 9 of the device. Switch 23-1-5 are designed to coincide with one state for each instance of one switch being in the "CLOSED" position. Channel 23 of the device has the ability to set up to 5 thresholds, which means there are 6 states. Each switch represents one state and all switches in the "OPEN" position represents the 6th state.



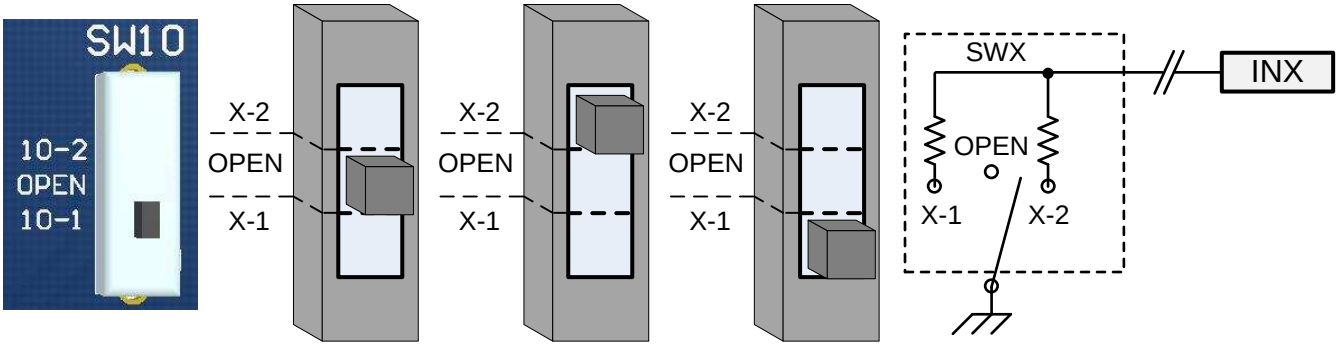
6. SW18 – SW22 are used to test up to 4 state resistor coded ground referenced switches. Each of the channels have three ground connected switches labeled X-1, X-2, and X-3, which coincides with a mapped threshold for 3A, 3B, and 3C. Each individual switch represents one of the three states and the fourth state is when all switches are “OPEN”.



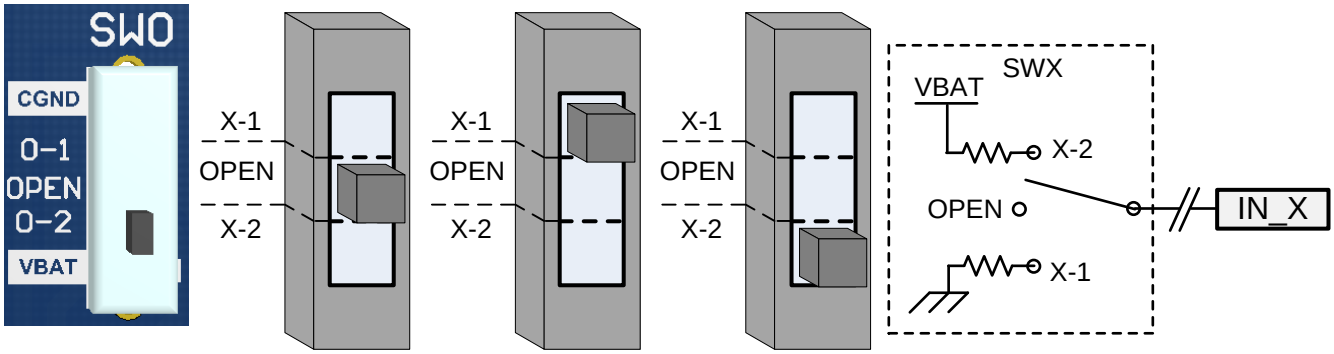
7. SW12 – SW17 are used when up to two thresholds (three states) is needed for the switch application. Each of the channels have two ground connected switches labeled X-1 and X-2, which coincides with a mapped threshold for 2A and 2B, and a switch position called “OPEN” to represent the third state.



8. SW10 and SW11 are used when up to two thresholds (three states) is needed for the switch application. Each channel from 0 to 11, has one unique threshold mapping for each channel and one common threshold (THRES_COM) that is shared for all the channels (0-11). These switches are setup to illustrate this feature.



9. SW0 to SW9 are designed to test the device ability to detect digital switches that are either referenced to a battery connected switch or ground connected switch. There are two state, “OPEN” and either chassis Ground Connected Switch (GCS) or Battery Connected Switch (BCS).



4 GUI Software Installation

The GUI software is required to establish the communication between the EVM boards and the PC and it also provides the GUI interface to read/write registers information on device. The following section described the software installation procedure.

Step 1. Download the GUI software

The software can be downloaded on TI server at link goes here. Please inquiry with a TI representative if you don't have access to the files.

Step 2. Software installation

Go to location that the executable was downloaded to and either double-click the Setup_TIC12400-0.4.0_EVM.exe file to begin software installation or right click and select "Run as administrator". The software will install two applications, "App Center" software and the TIC12400 GUI App software. If the "App Center" software isn't already installed on the PC then additional steps will be needed. Those steps are outlines in the following figures.

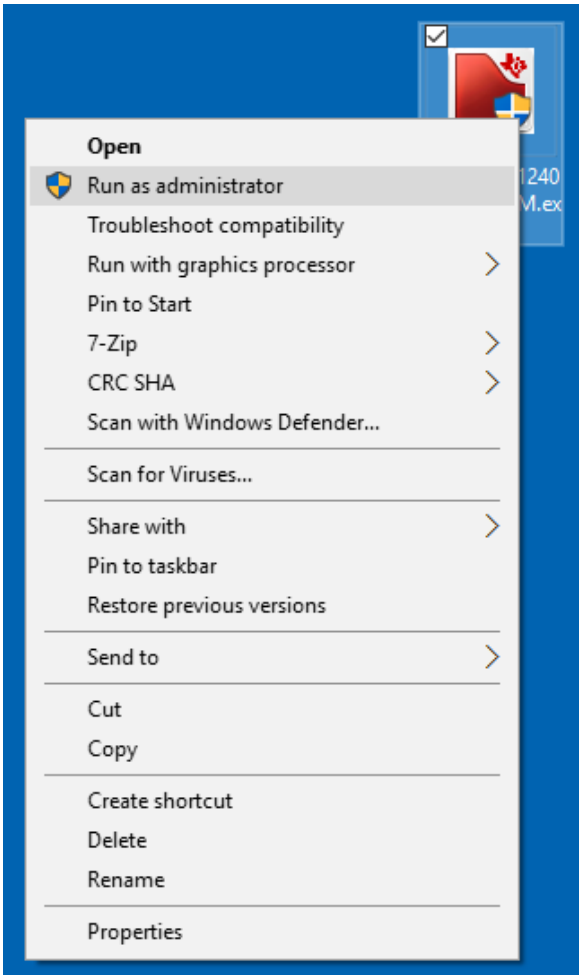


Figure 6. Setup_TIC12400-0.4.0_EVM.exe

Follow the on-screen instructions to complete the setup. The process may take up to 10 minutes depending on your computer speed.

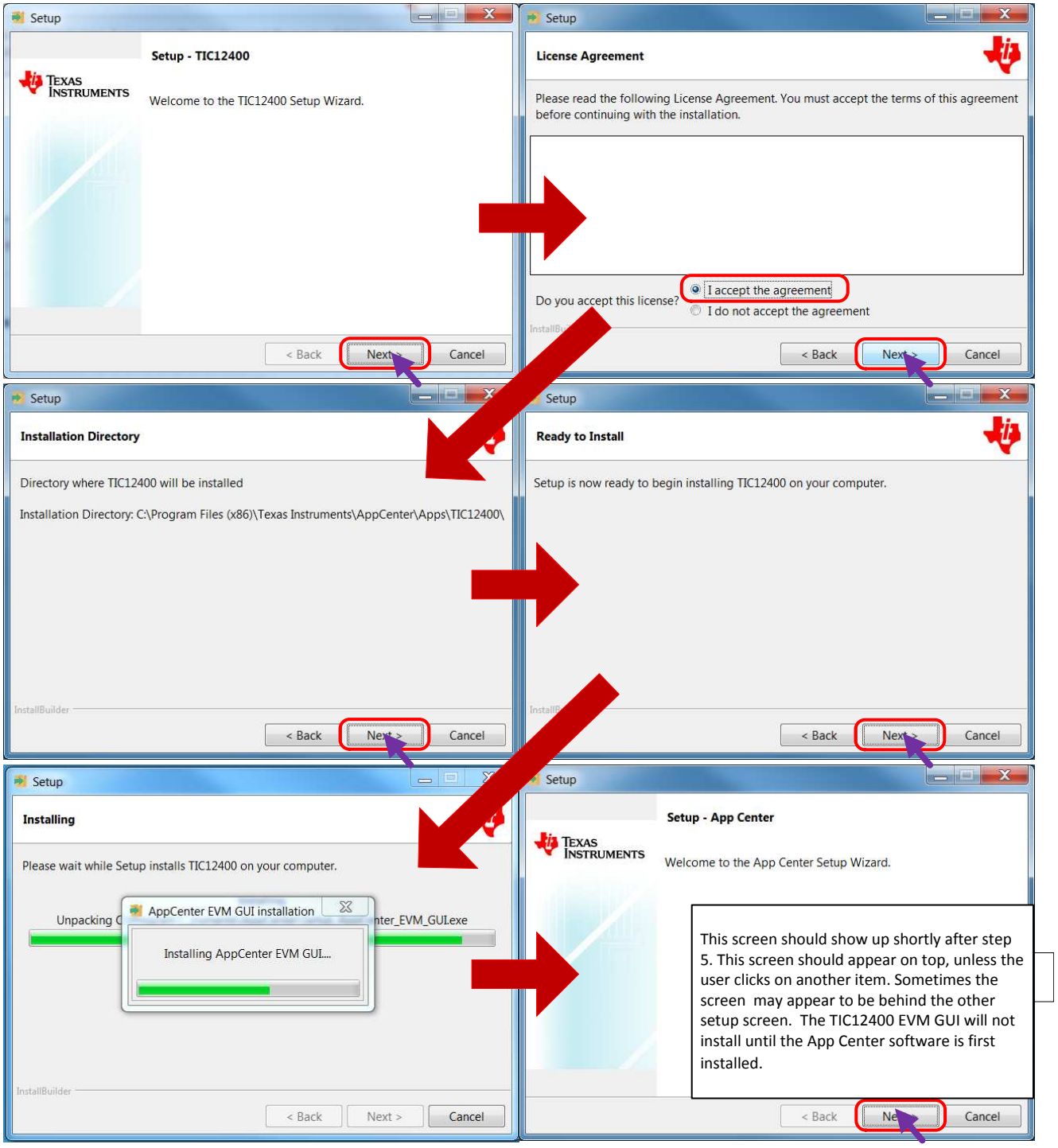


Figure 7. Installation Steps 1–6

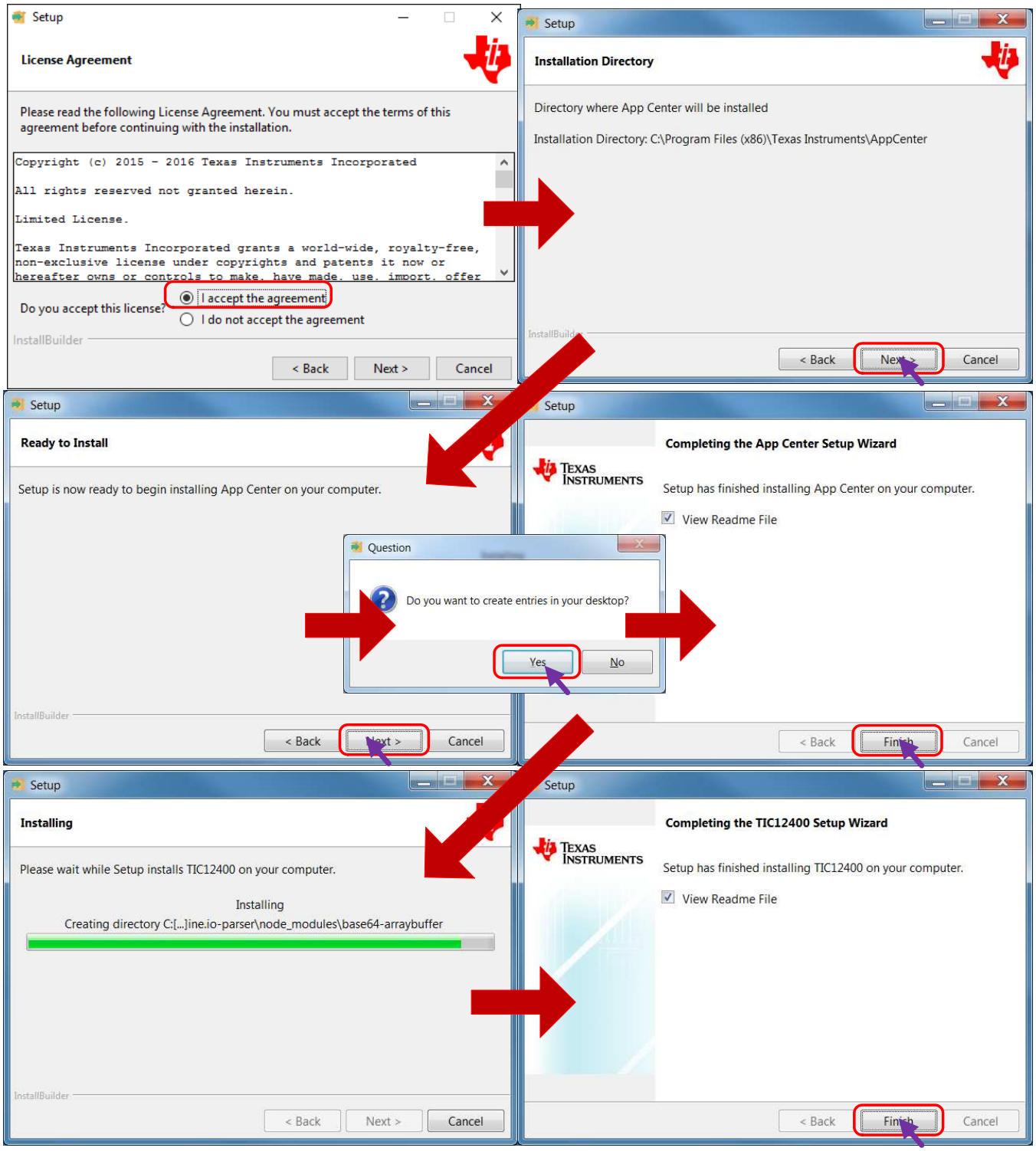


Figure 8. Figure 3. Installation Steps 7–13

The EVM GUI can either be opened before or after the EVM is setup and power is applied.

5 TIC12400 GUI Application

5.1 Starting the GUI

After the EVM and SWITCH BOARD are connected and then the cables are connected the Power Supply and PC via USB cable, the GUI can be run by double clicking the shortcut icon on the desktop, see Figure 9.

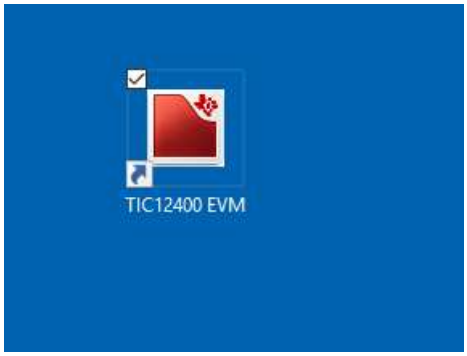


Figure 9. Double Click on "App Center EVM GUI" Shortcut to Open

5.2 TIC12400 Info Page

The "Info" page (Home) of the TIC12400 GUI has a short summary of the features of the TIC12400. See the following map of features of the "Info" page in Figure 10.

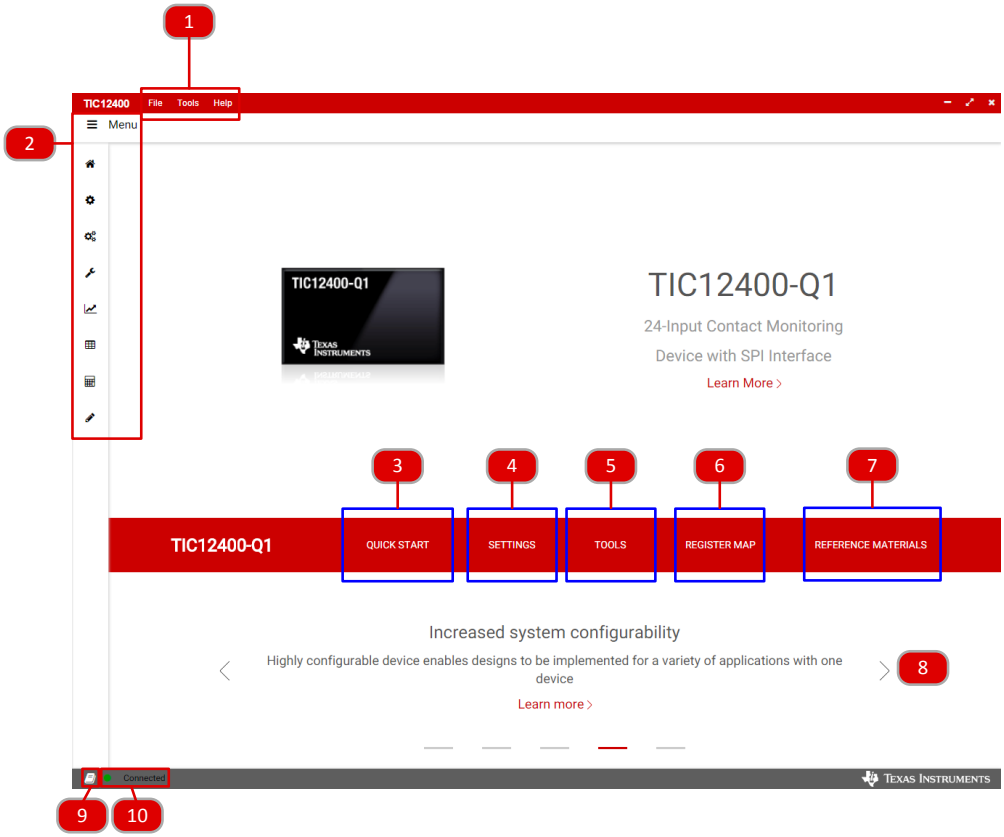
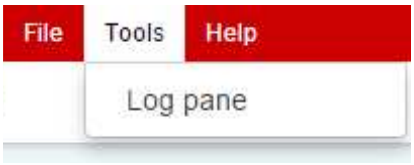
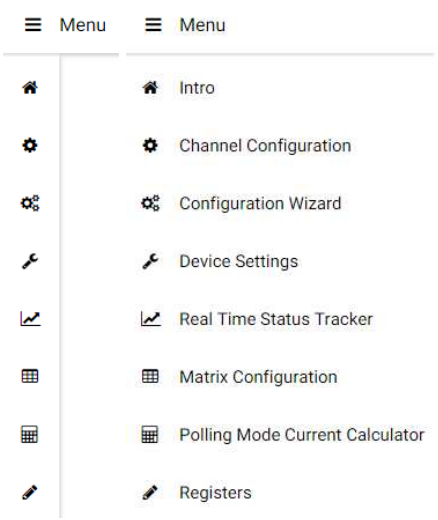


Figure 10. GUI Home Page

1.	The Menu bar has several sub menus that are within “File”, “Tools” and “Help” drop down menus. “File” drop down menu provides access to “Saving Registers”, “Save Registers As”, and “Load Registers”. This means switch profiles can be saved and loaded as needed.
	
	“Tools” drop down menu provides access to the Logging feature of the GUI. This records both SPI Reads and Writes.
	
	“Help” drop down menu provides access to information pertaining to GUI version and MSP430 firmware revision.
	
2.	The Menu bar can be clicked to show the minimized and maximized menu, default is minimized. The buttons on the bar are from top to bottom as follows:
	• Intro (Home): Brings the user back to the Intro screen • Channel Configuration: Page to configure the channels of the device in a graphical format • Configuration Wizard: Guided setup of MSDI based on system level requirements • Device Settings: Access device settings without manually adjusting the register settings • Real Time Status Tracker: Live visual monitoring of channel inputs • Matrix Configuration: Graphical configuration of the Matrix mode settings • Polling mode current calculator: Page to calculate the current consumption of the devicewhile in polling mode with multiple settings, and Register Map. These are also available buttons on the right of the “Intro” page. • Registers: Register access page 
3.	Quick Start. Opens up a sub menu with two options. 1. A configuration wizard that walks through the system level use case to setup the device 2. Load default configuration for the device
4.	The settings button will open a sub menu for Channel Configurations, Device Settings and Matrix configuration. These are the same pages accessed by the men bar on the left side of the GUI.

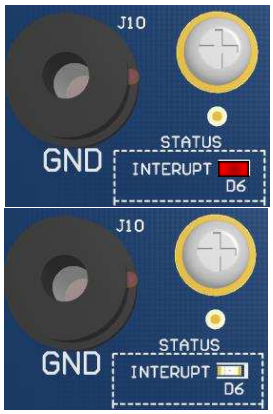
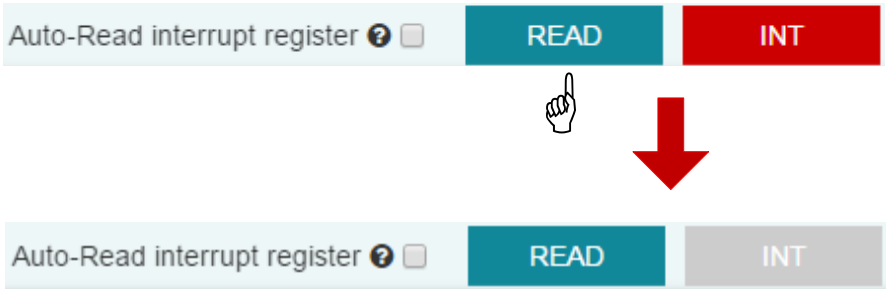
5.	The tools button will open a sub menu to access the Polling Mode current Calculator and Real-Time Status Tracker pages.
6.	Clicking on the register map button will direct the user to the Register map page via a sub menu.
7.	Reference materials button that pulls up links to the EVM User's Guide, Datasheet and a reference video.
8.	Benefits banner. Clicking on the links in this section will show greater details on the device benefits and how they differ from today's implementations.
9.	The button toggles ON/OFF the Log page, which is also seen in the Tools->Log pane.
	
10.	If the EVM is connected to the PC with the USB cable then the GUI will show that it is connected by showing a green dot. If there is no communication with either the on board micro controller (MSP430) or the device then the following image will be seen, indicated no communication.
	

5.3 Device Settings Page

The *Device Configuration* page controls many of the features for TIC12400 that control device general operation.

Figure 11. Device Configuration Page

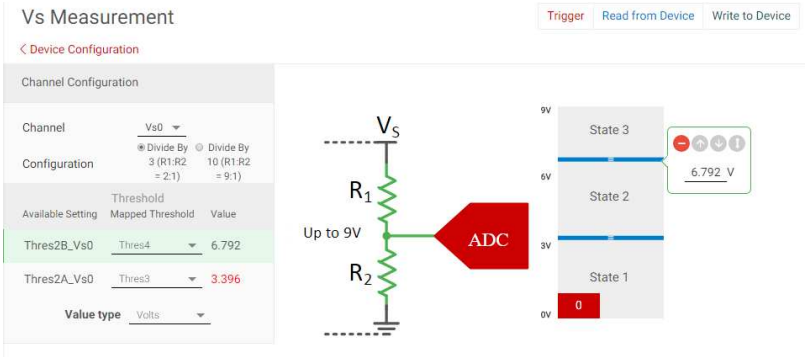
1.	The device has a variety of setting and features that are accessed and controlled by doing read and writes to the device. It is important to note that when selecting and changing setting within the GUI it must be written to the device prior to initiating the activation of the device by clicking on the “Trigger” button. Once the Trigger is turned ON all registers become read only (with the exception of the CRC_T, RESET, and TRIGGER bits). Trigger initiates the wetting currents and starts external switch monitoring. 
2.	The device has several features that help ensure robust communications to and from the device to the micro controller on the SPI bus. Interrupts can be generated in the $\overline{INT}$ pin of the device to communicate to the user that either “SPI_FAIL”, “PARITY_FAIL”, or “CRC_CALC_COMPLETE” fault has occurred. 
3.	The device has the ability to alert the user when Switch State Change (SSC) has occurred. The Channel Configuration sets the conditions that initiate a SSC. If this feature is not selected then the SSC is recorded but the $\overline{INT}$ pin is not asserted. This is also true for the VS0 and VS1 voltage state change. There are four different thresholds (VS0_THRES2A/B and VS1_THRES2A/B) that can be set for VS measurements to establish state changes. If the VS0/VS1 Threshold Crossing features are not selected then the $\overline{INT}$ pin is not asserted after a state change, but it will be stored in the device and the user must read the device to determine that the a state change occurred. 
4.	If the "Wetting Current Diag" is selected then an $\overline{INT}$ assertion occurs if any of the "Wetting Current Diag – IN0/1/2/3" fail. If the "ADC Diag" is selected then an $\overline{INT}$ is asserted if the ADC Diag fails 
5.	The device has the ability to assert the $\overline{INT}$ pin when System Faults occur such as “Over Voltage”, “Under Voltage”, “Temperature Warning”, and “Temperature Shutdown”. 
6.	This button sends a software reset to the device via SPI. This will reset all registers to their default setting! The user must write back all the registers before selecting “Trigger” and to start wetting current and start external switch monitoring. 

7.	The TIC12400 GUI monitors the $\overline{INT}$ pin approximately at every second. There is an INTERUPT led on the EVM lights up when the $\overline{INT}$ pin is asserted. This coincides with the INT icon. Once the $\overline{INT}$ is asserted then selecting the READ button reads the INT_STAT register which clears the $\overline{INT}$ assert   If the Auto-Read interrupt register features is selected then the GUI will automatically read the INT_STAT register every 5 seconds, which will clear the INT and record the INT_STATE register information into GUI, but it does clear the INT_STAT register within the device. 
8.	The Wetting Current Auto-Scaling feature allows the user to enable or disable the auto scaling feature in continuous mode. 
9.	The Temperature warning and wetting current reduction feature provides the ability to enable or disable the wetting current reduction feature when a Temperature warning event occurs. 
10.	The TIC12400 has the ability to do an ADC diagnostics and also has the ability to test wetting currents on IN0, IN1, IN2, and IN3 and diagnose if there are faults. 

11.

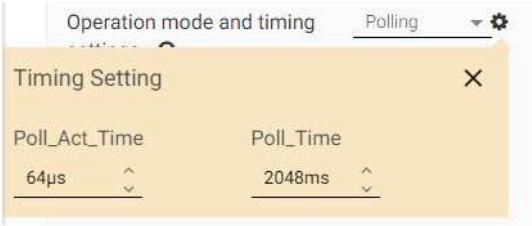
The TIC12400's advanced settings have several features that allow the user to optimize their switch state change monitoring system. VS measurement can be enabled or disabled here. Once enabled the advanced settings menu becomes accessible to the right of the checkbox.

Accessing the VS Measurement settings will allow the user to select the channel, resistor divider ratio and select the thresholds. The thresholds can be shown in volts or ADC thresholds or volts.

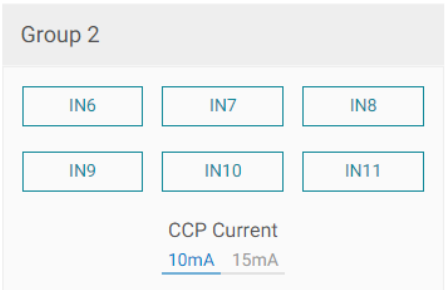


The Operation mode and timing settings can also be configured between polling and continuous mode.

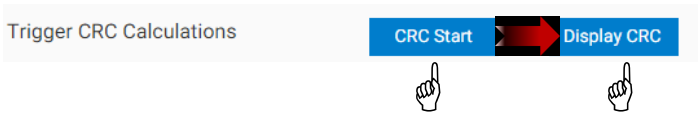
Clicking the Settings cog opens the timing settings menu to configure the polling mode.



The CCP or clean current polling settings can also be configured by clicking the configure CCP option. This will allow the user to enable CCP by channel and select the current to be either 10 mA or 15 mA by group.



Additional the detection filter can be adjusted and the Interrupt assertion scheme can be selected.

12.	CRC calculations can be initiated and results displayed within this window. Note, an $\overline{INT}$ can be setup to indicate when the CRC calculation is completed by the device, which at that time it can be read.  Displayed results will look as follows: 

5.4 Channel Configuration Page

The Channel Configuration page controls the Channel settings for how to indicate state change when monitoring the Channels.

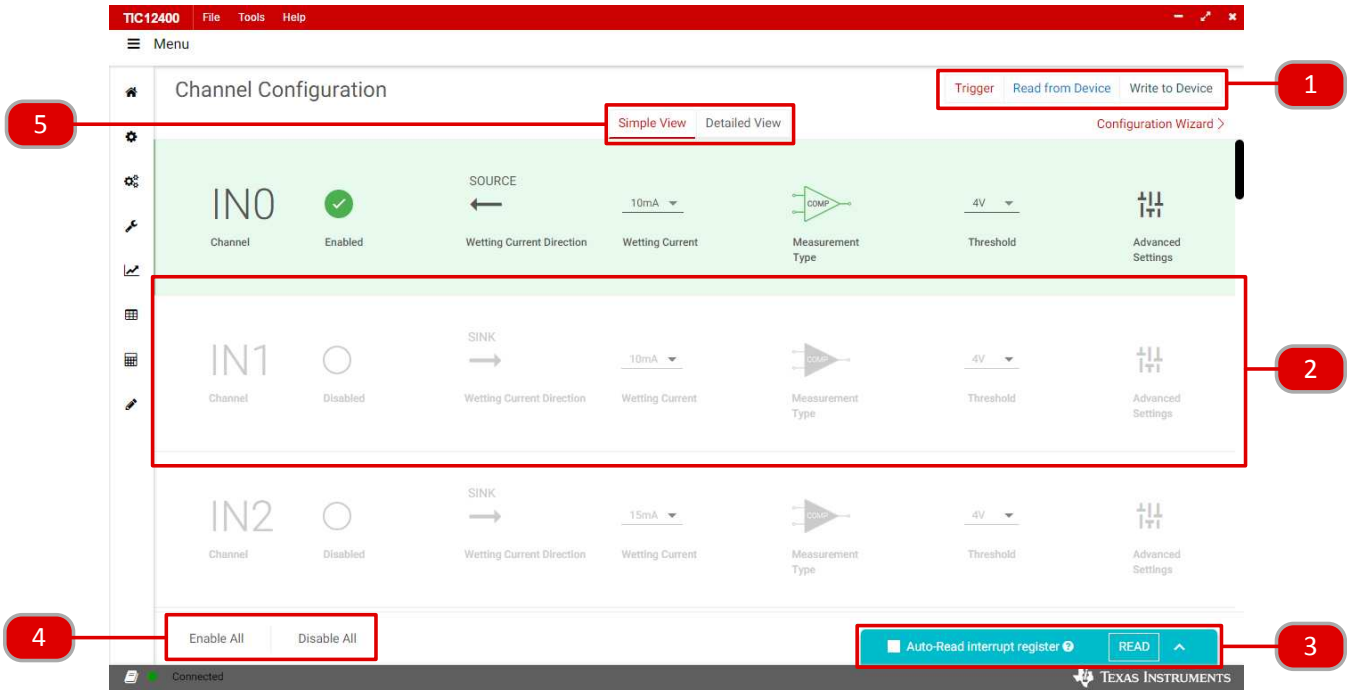
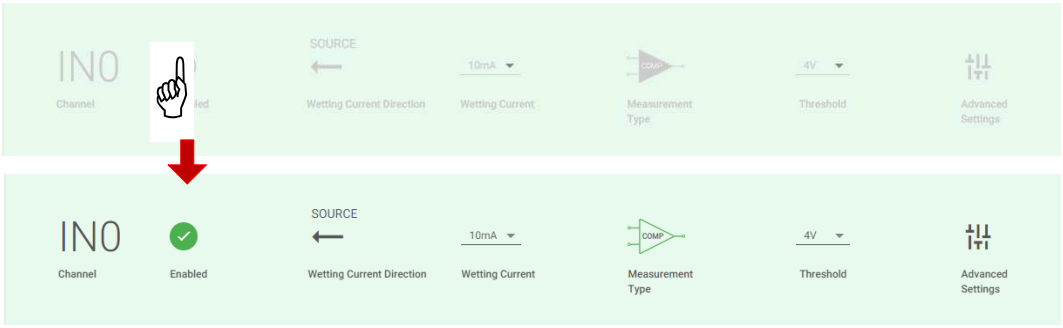


Figure 12. Channel Configuration Page

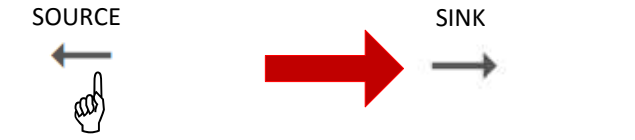
1.	The TIC12400 has a variety of setting and features that are accessed and controlled by doing read and writes to the device. It is important to note that when selecting and changing setting within the GUI it must be written to the device prior to initiating the activation of the device by clicking on the “Trigger” button. Once the Trigger is turned ON all registers become read only (with the exception of the CRC_T, RESET, and TRIGGER bits). Trigger initiates the wetting currents and starts external switch monitoring. 

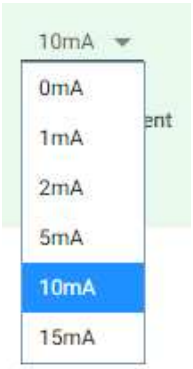
The TIC12400 has 24 channels that can be configured a variety of ways to detect all types of switches. Within the “Simple View” the GUI breaks down each channel into manageable easy to visualize channel settings. In order to change the setting the Channel must be Enabled, which is done by clicking on the Enable/Disable button. The channel will no longer be greyed out and channel information will be able to be changed.



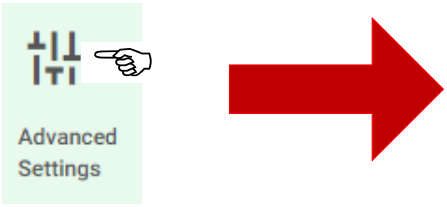
Each Column describes the feature that can be changed and a simple single click will toggle between settings or allow to select from a drop down menu.

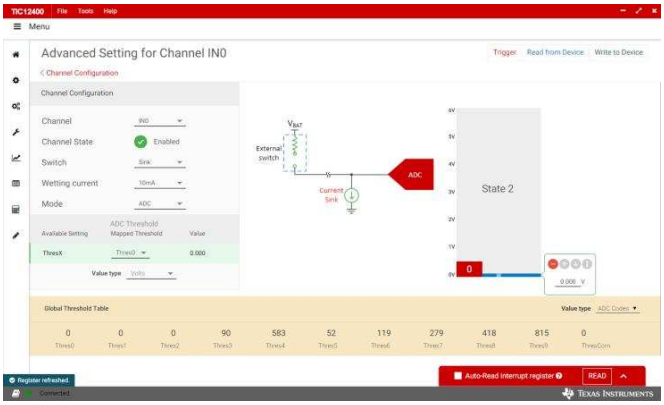
2.

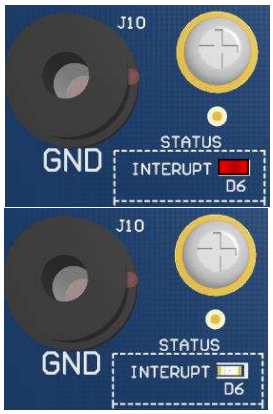
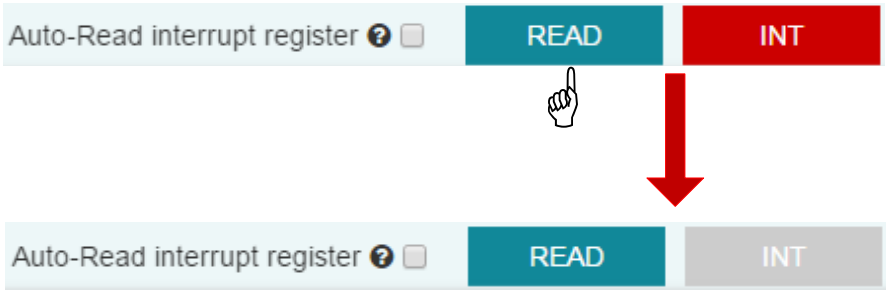




More advanced setting for each Channel can be accessed clicking on the settings icon.

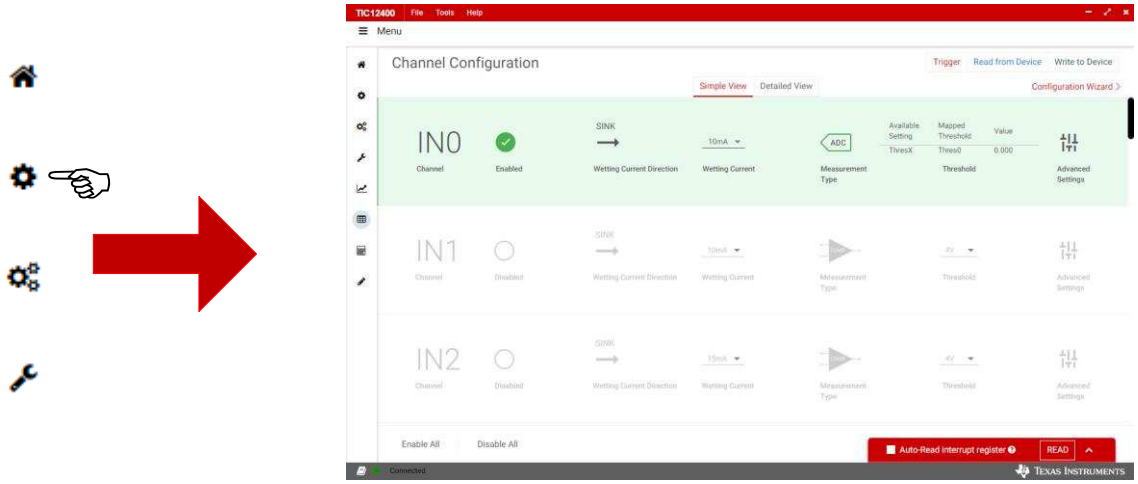




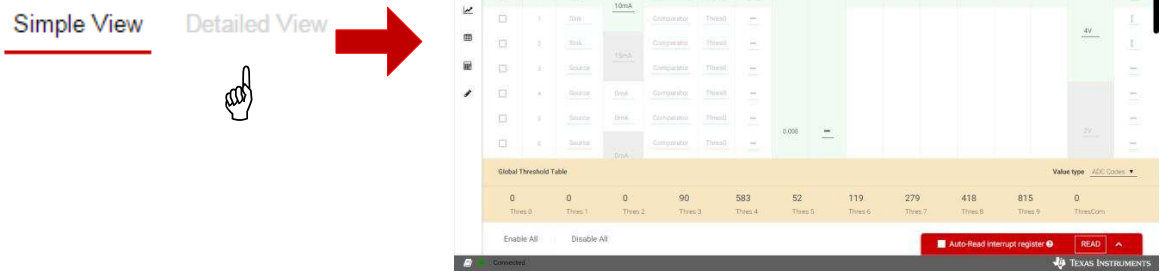
3.	The GUI monitors the $\overline{INT}$ pin approximately at every second. There is an INTERUPT led on the EVM lights up when the $\overline{INT}$ pin is asserted. This coincides with the INT icon. Once the $\overline{INT}$ is asserted then selecting the READ button reads the INT_STAT register which clears the $\overline{INT}$ assert   If the Auto-Read interrupt register features is selected then the GUI will automatically read the INT_STAT register every 5 seconds, which will clear the INT and record the INT_STATE register information into GUI, but it does clear the INT_STAT register within the device. 
4.	All the Channels can be Enabled or Disabled all at once by clicking on these buttons. 

5.

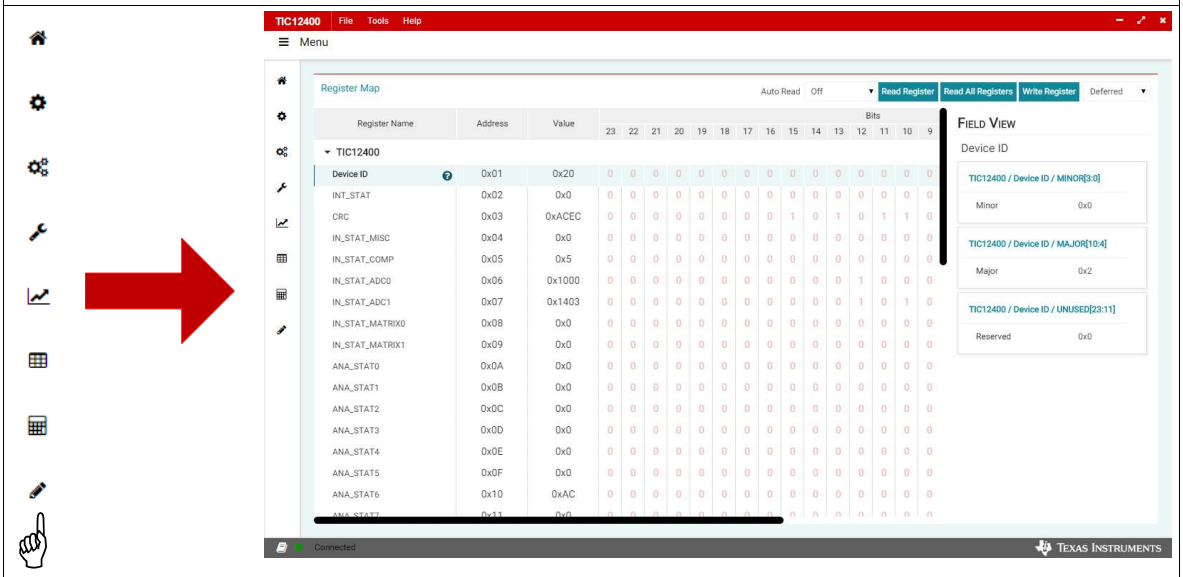
The TIC12400 Channel Configurations can be controlled by one of three ways.
1) "Simple View" is the default mode of accessing the Channel Configurations if



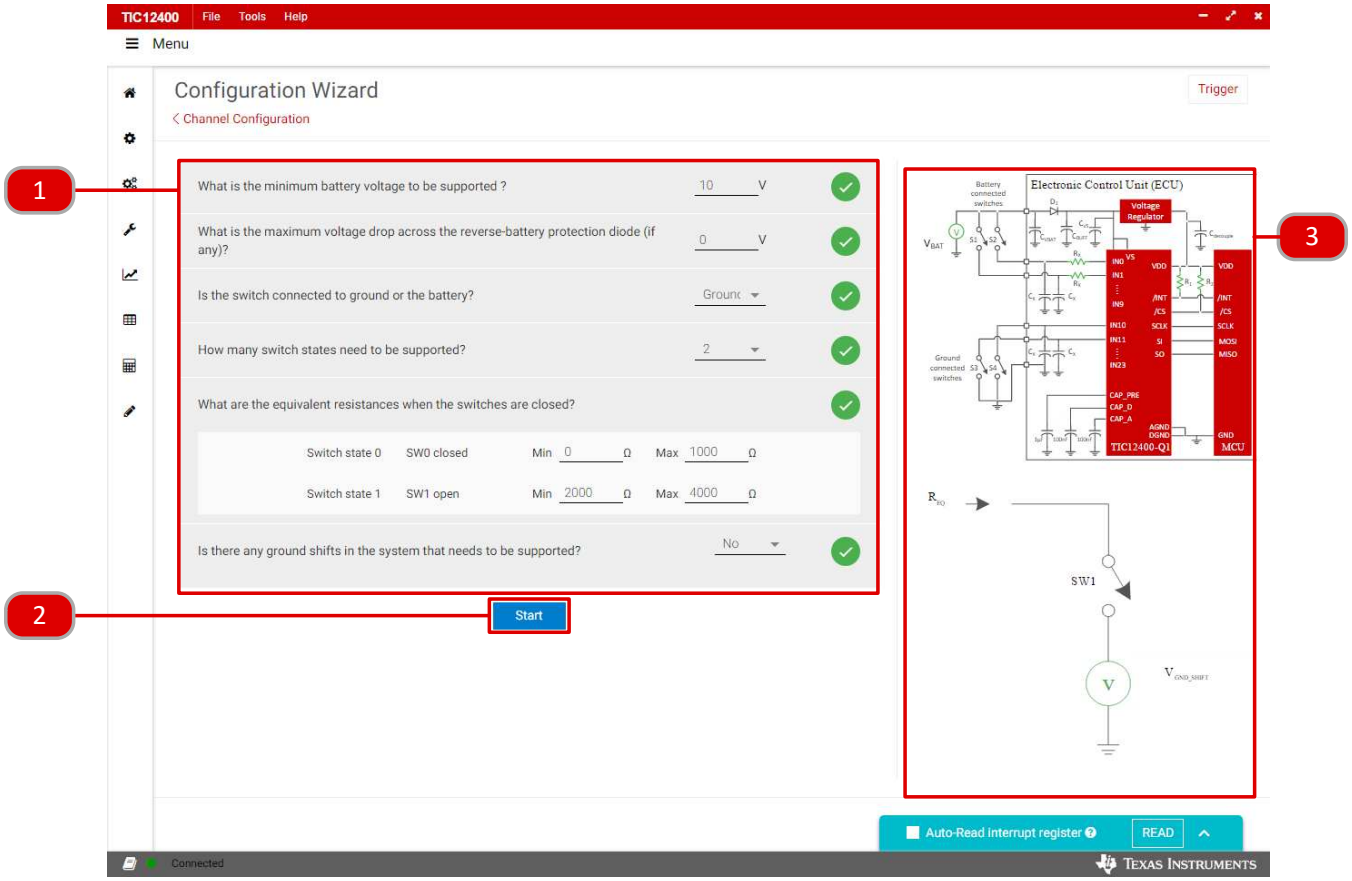
2) "Detailed View" allows the user to see all the Channel Configurations at once and also to design to show all the dependent variables.



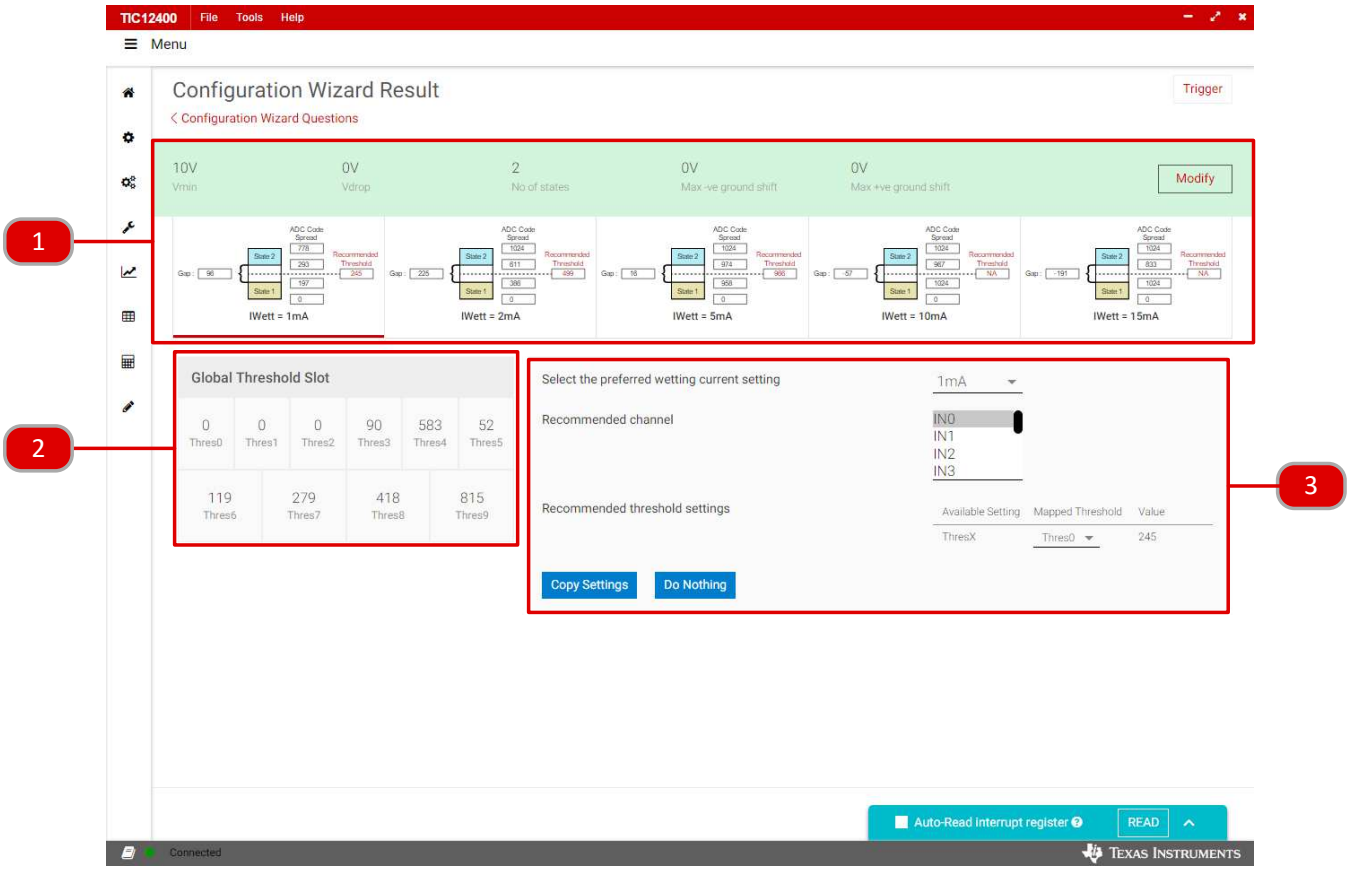
3) Register Map view allows the user to do individual bit control for configuration registers.

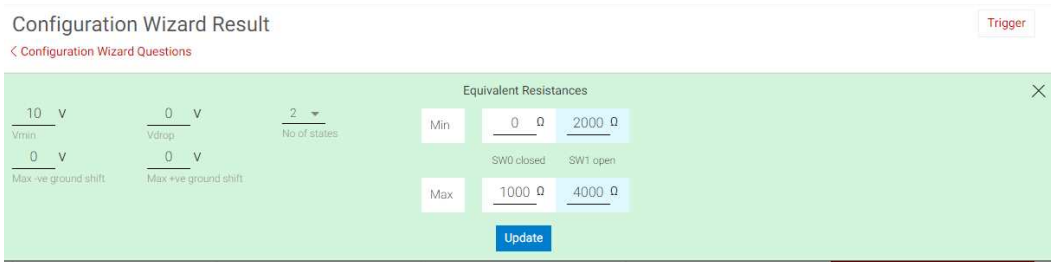
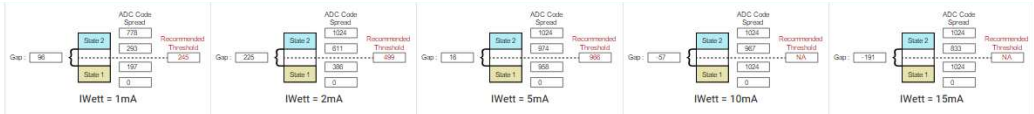


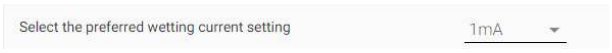
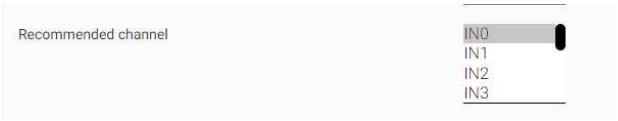
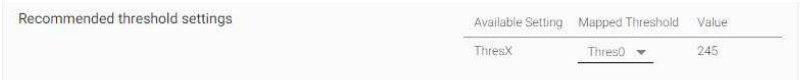
5.5 Channel Configuration Wizard

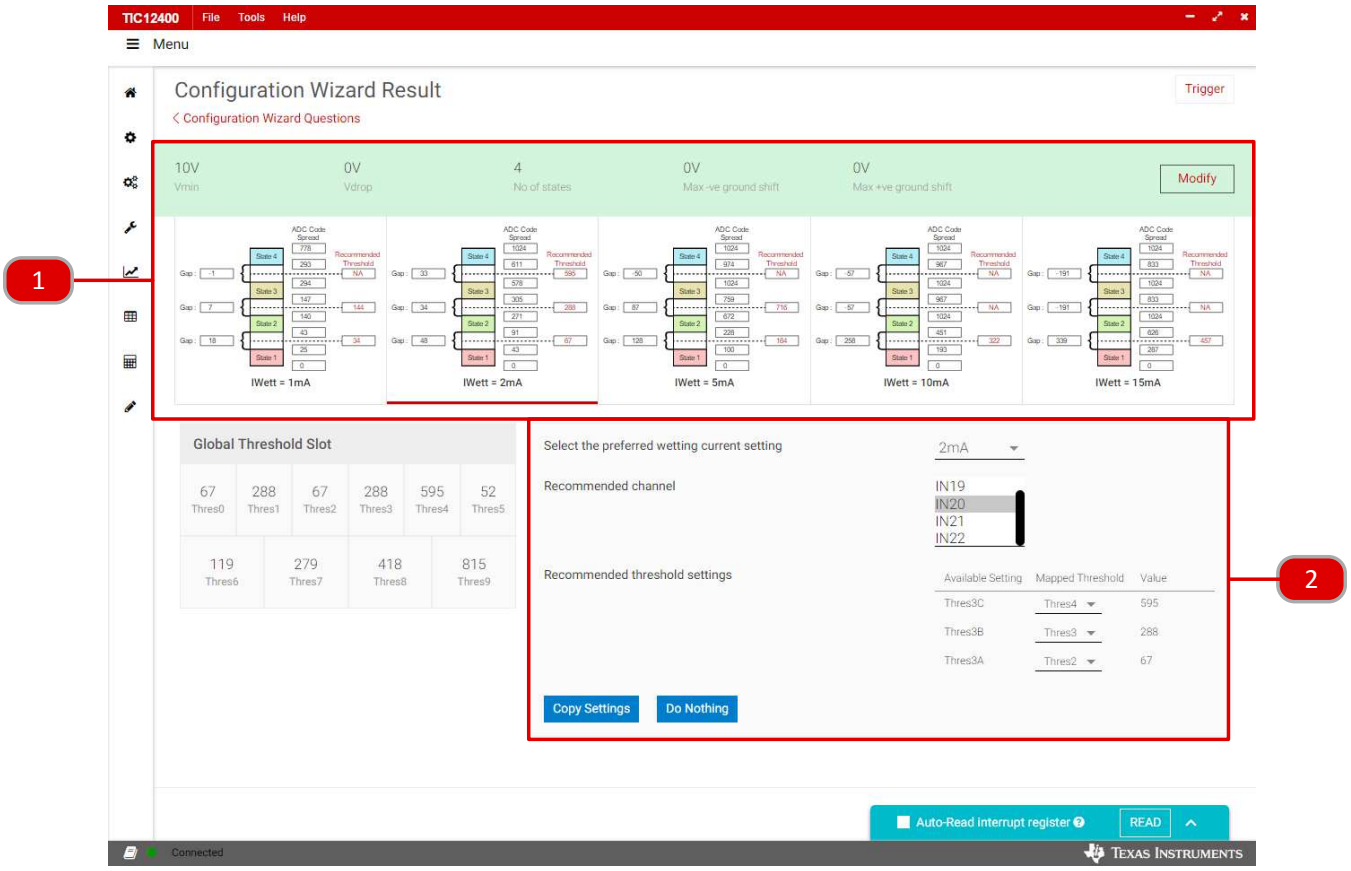


1.	The TIC12400 GUI will walk through the system configuration with a series of question prompts on the system configuration. Once a prompt is completed the GUI will move on the to the next step. You can edit any prompt at any time regardless of your current step in the wizard.
2.	After completing the question prompts. The start button will move to the next area to be configured.
3.	The red outline will show the current part of the system being addressed by the prompt. As more questions are answered this area will show how the external system is being interpreted by the GUI.



1.	The system configuration from the previous page is shown at the top of the section. Clicking the Modify button will bring up a prompt to change these settings.
	
	Here is it possible to change of the settings again as necessary for either adding a new switch to the configuration or adjusting the overall system details. After the desired system configuration is set, press the Update button to change the setting and click the X to return to the wizard.
	
	Each IWett setting will give a recommended threshold. If the Recommended threshold in N/A that setting is not recommended.
	
2.	This displays the current global thresholds for the ADC.

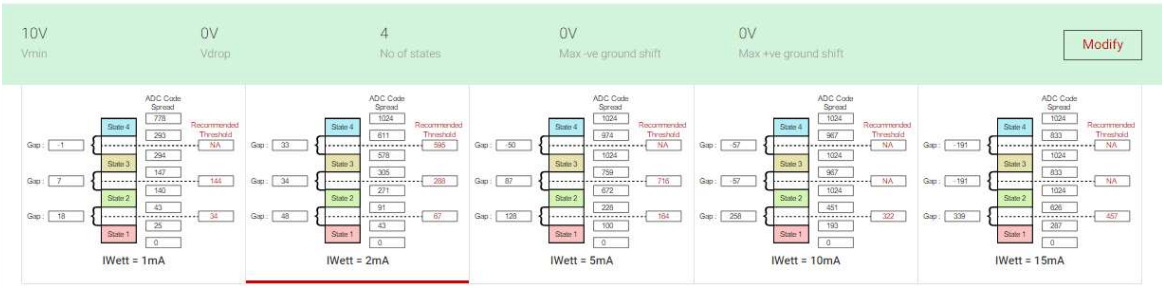
3.	The wetting current setting can be selected either by using the drop down menu in this section or clicking the setting in section 1.
	
	Based on the number of switch states the GUI will recommend the appropriate channel that can handle the switch type.
	
	The Recommended thresholds section will show which thresholds are available to use. It is important to keep track of the global thresholds that are currently being used by other channels as the TIC12400 is configured.
	
	After the desired settings are correct, clicking the copy settings will configure the TIC12400 device. Clicking Do Nothing will exit the wizard. The wizard can be used multiple times to update TIC12400 per each switch in the system.
	



1.

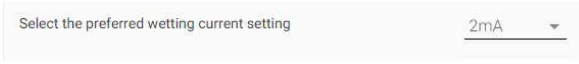
The current setting and threshold calculations will be different for different switch states. For 4 switch states 3 thresholds must be used. If any of the threshold boxes for a given wetting current setting are populated with NA, that current setting cannot be used. If all of the current settings cannot be used the resistance ranges for the switch are not supported. For more information on the supported resistance values for multiple switch states see the datasheet.

In this example the only supported wetting current is 2 mA as all of the thresholds have values.

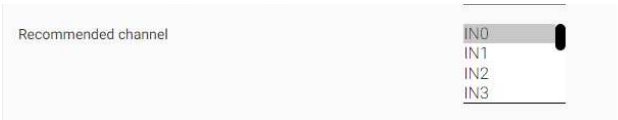


2.

In this example the only supported wetting current is 2 mA as all of the thresholds have non NA values.

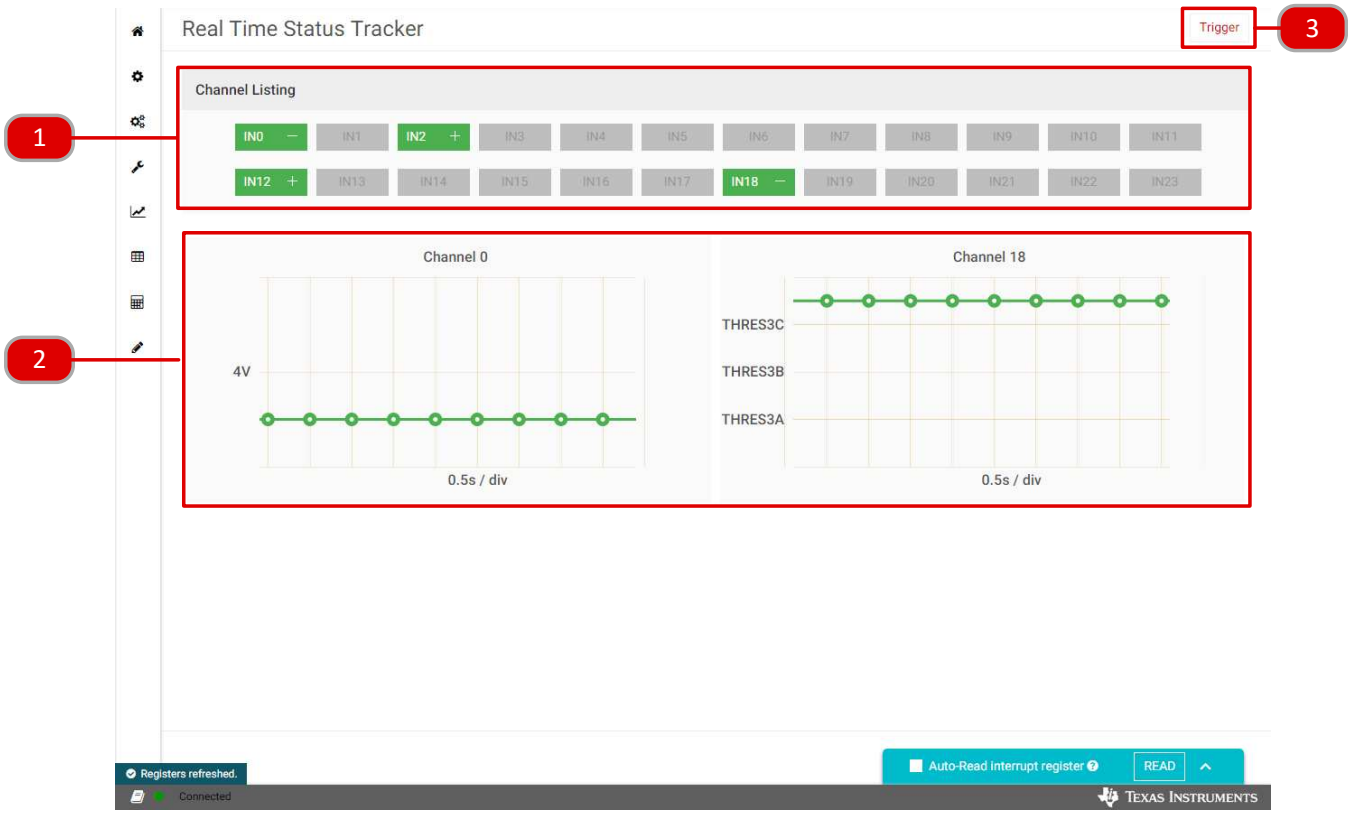


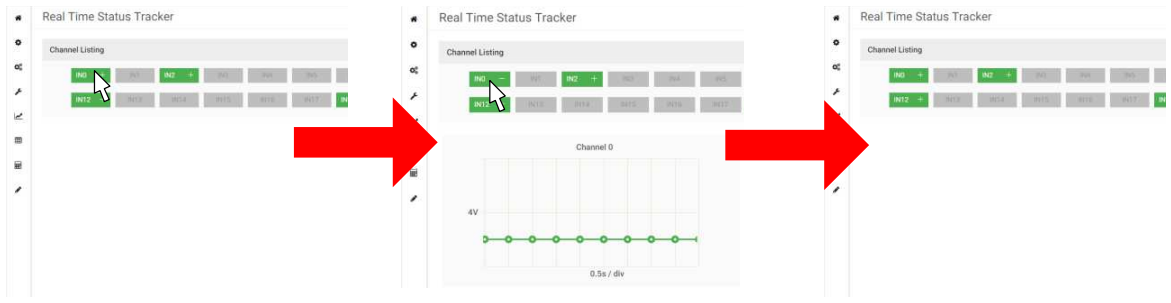
The recommended channels that are available all support the 4 switch configuration and the channels that do not support 4 switch states are not recommended.



Additionally the available threshold settings are Thres3A/B/C. These thresholds can be mapped to any unmapped thresholds but must follow the rules that ThresC > ThresB > ThresA.

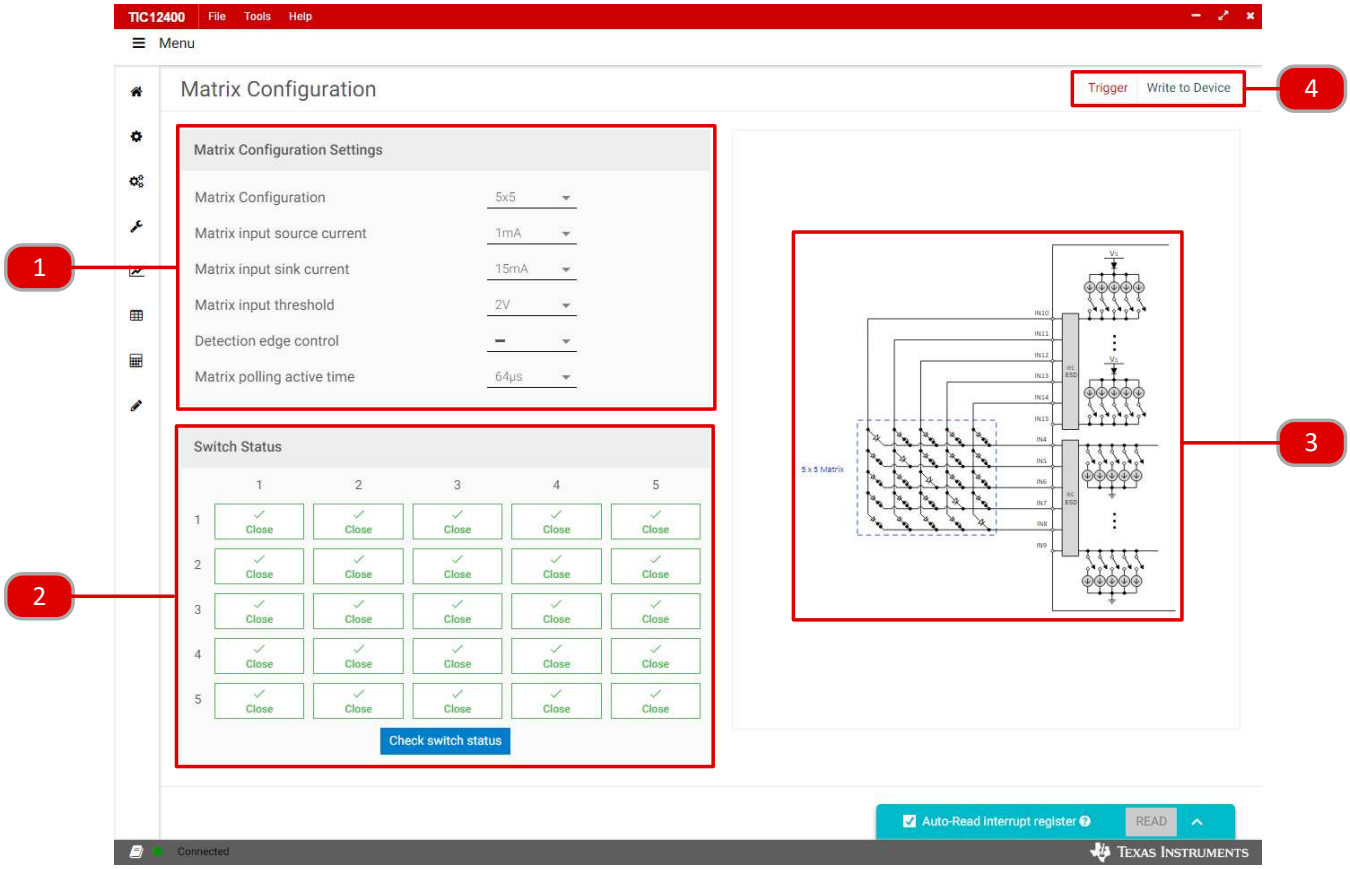
5.6 Real Time Status Tracker



1.	The channel list includes all the available channels for the device. Enabled channels display green and disabled channels display gray. Clicking green channels will turn on the GUI tracker for that channel. Clicking the same button again will disable the GUI tracker. Note this does not enable/disable the channel in the device, it changes if the GUI displays any real time changes.
	

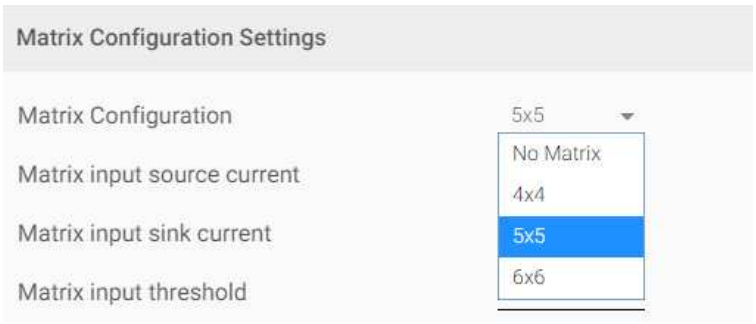
	This will show each channel that the GUI tracker is enabled for. Each channel will show the threshold on the left side of the graph. For multiple switch state channels all the thresholds are shown. As the switch state changes the graph will update accordingly as shown below if the Trigger has been enabled in section 3.
2.	
	Clicking the trigger button will enable the device to monitor the inputs and update the real time status tracker.
3.	

5.7 Matrix Configuration

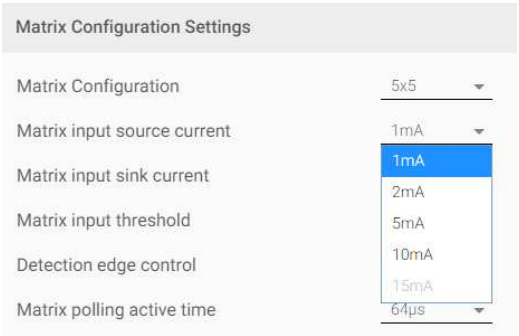


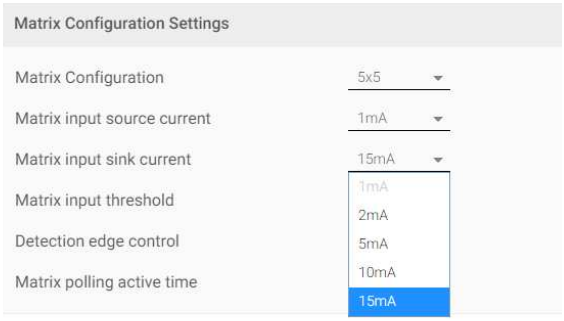
1.

The Matrix configuration settings area changes the setup for Matrix mode according to the system requirements Clicking the Matrix configuration will allow you to select between the supported configurations.

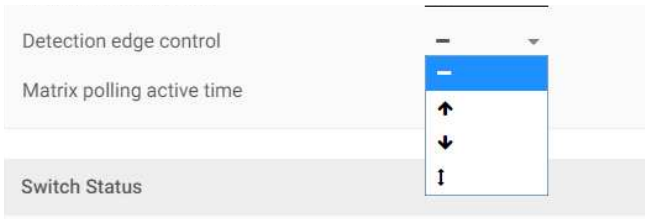


The input source and sink currents are also selectable via a drop down menu. The sink current must always be larger than the source current and the GUI will make unusable source and sink combinations un-selectable.

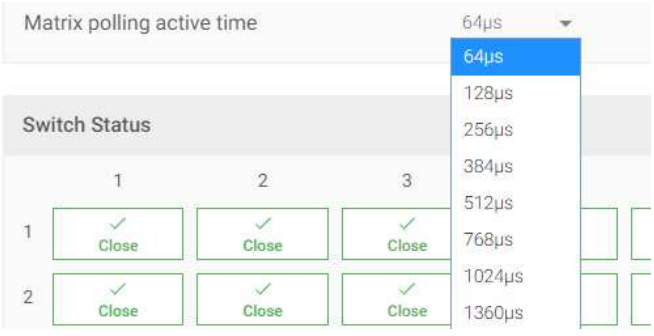


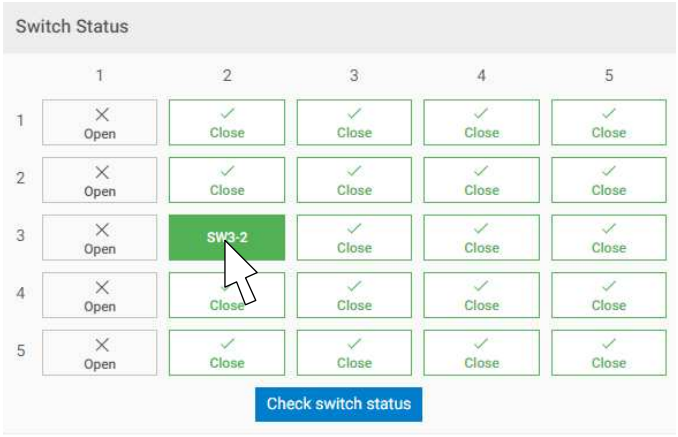
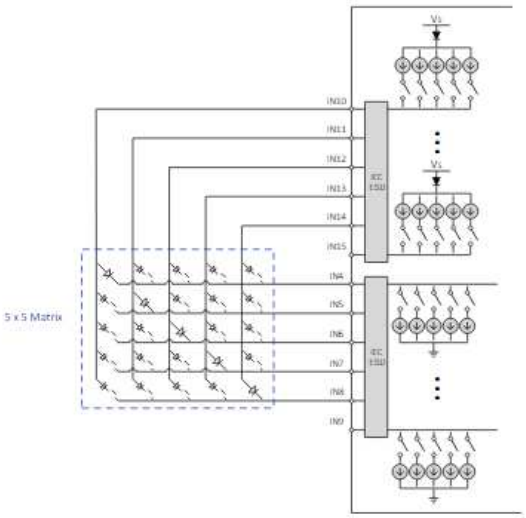


The detection edge control option lets you select between no detection, rising, falling, and rising or falling edge detection schemes.

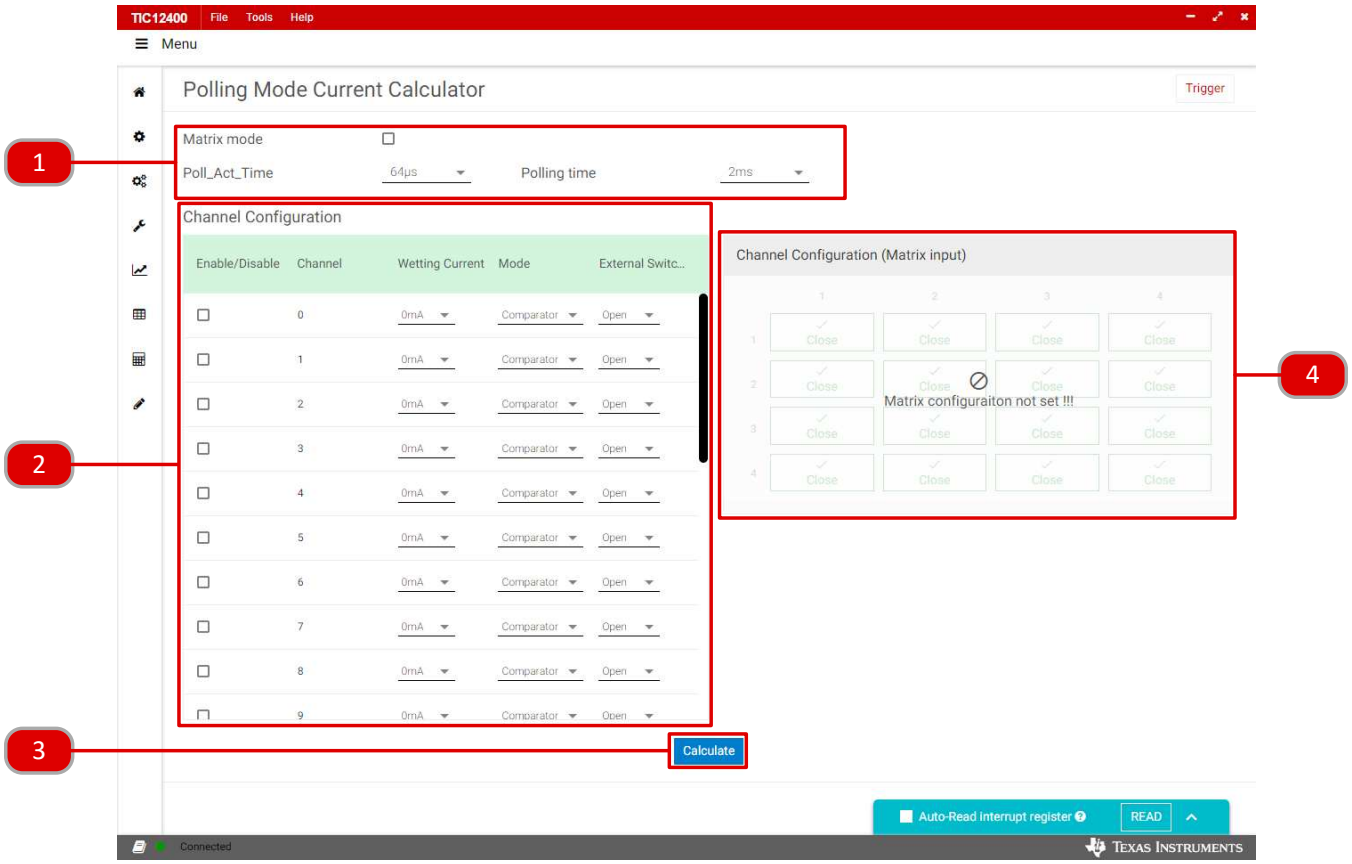


The Matrix polling active time controls how long the inputs are polled as described in the datasheet.



2.	The Switch Status area shows the current status of the matrix of switches. The status can be checked by clicking the Check switch status button. Mousing over a box will show which switch that is.
	
3.	This is a visual depiction of the matrix mode operation. Selecting the different matrix settings (4x4, 5x5, 6x6) will change the image to show which channels are being used.
	
4.	After setting the desired matrix configuration click the Write to Device button to set the register settings in the TIC12400 device. Use the Trigger button to monitor the TIC12400 enable monitoring of the inputs.

5.8 Polling Mode Current Calculator

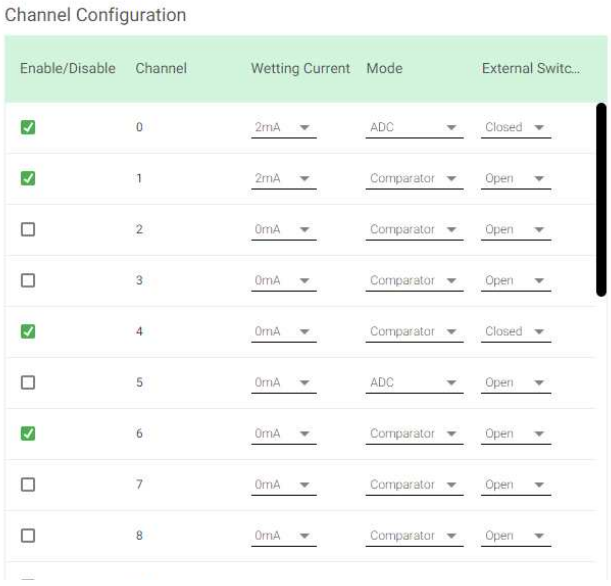


1.

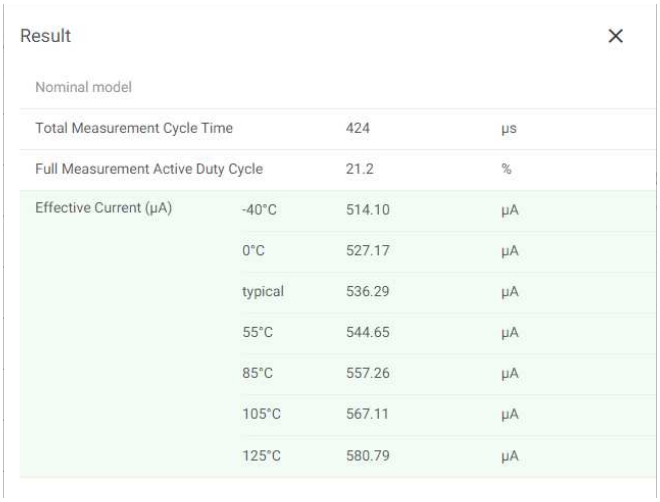
Matrix mode calculations can be enabled by clicking the checkbox. This will open up a menu to select the matrix configuration options.

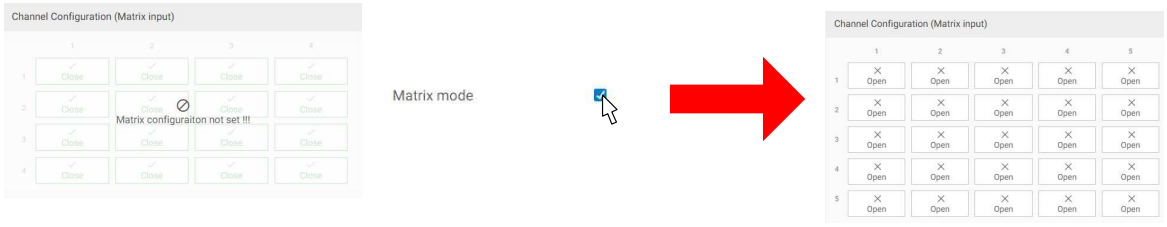
The Polling_Act_Time and Polling time can be selected as well.

2. Each channel can be selected in this menu as well as the wetting current, input mode, and the external switch state.

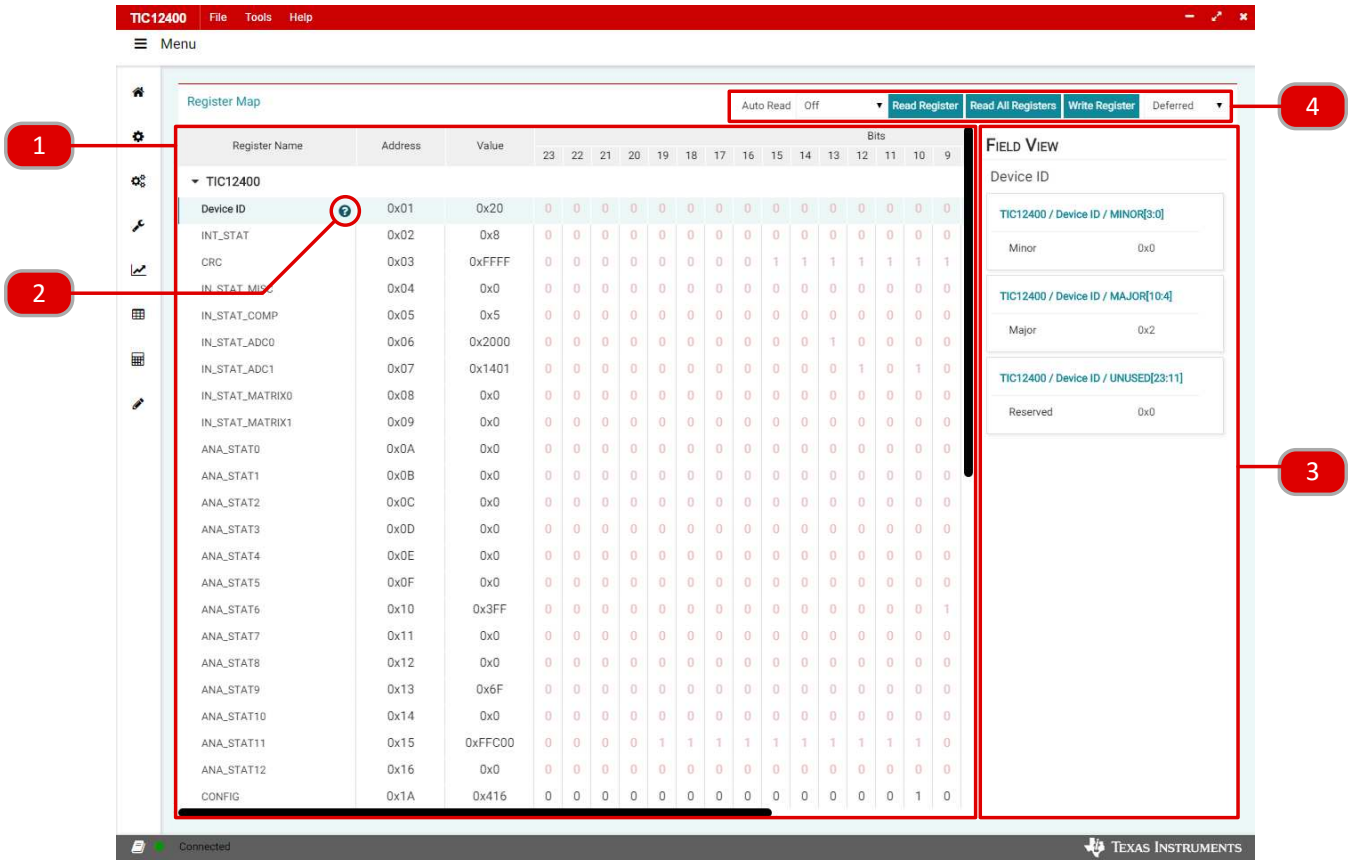


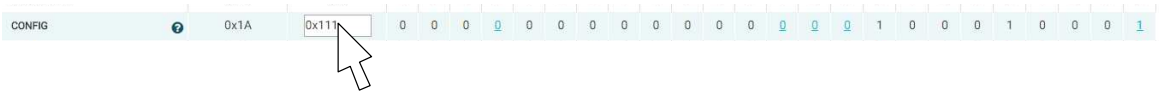
3. Clicking calculate will prompt the results page which will deliver the measurement cycle time, active duty cycle and the effective current for different temperatures.



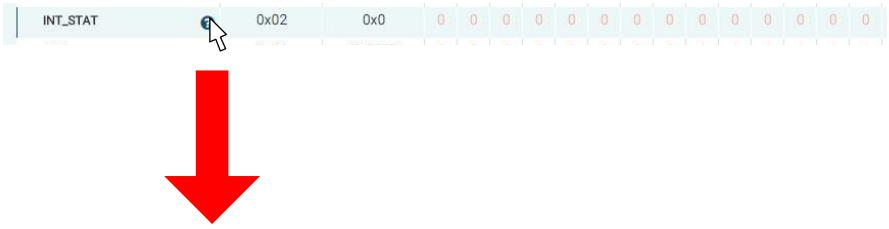
4.	The matrix channel configuration will not be interactive unless matrix mode is checked from section 1.
	
	After matrix mode is checked the boxes become interactive. Clicking different switches will close or open them and the current calculator will update accordingly.
	

5.9 Register Map



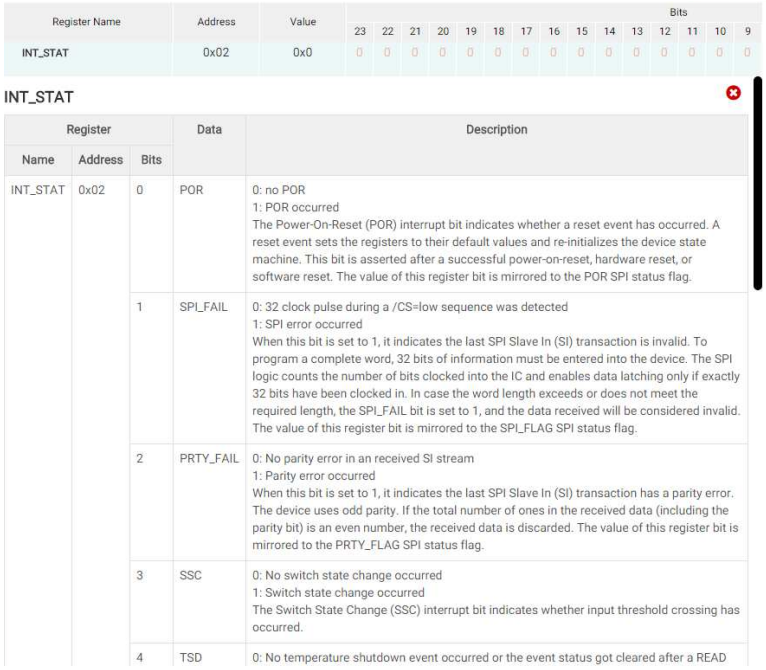
1.	The Register name is shown as it matches the datasheet. The address of the register and the value of the register is shown in hexadecimal. The bit representation of the Value is also shown. Registers that are read only will be shown as transparent red. Read and write registers are shown as black. One way to edit a register is to click the value field of that register. Registers of the device will not change until the Write Register button is clicked. If Auto Read is enable, any register changes that have not been sent to the device will be overwritten to the current value of the TIC12400. The bit field representation will also update as the value field of the register is adjusted.
	

For the selected register in the register field, a question mark help button will appear. Clicking this will show the full description for that register field.



Clicking the red x will exit the help menu for that register and take the user back to the register fields.

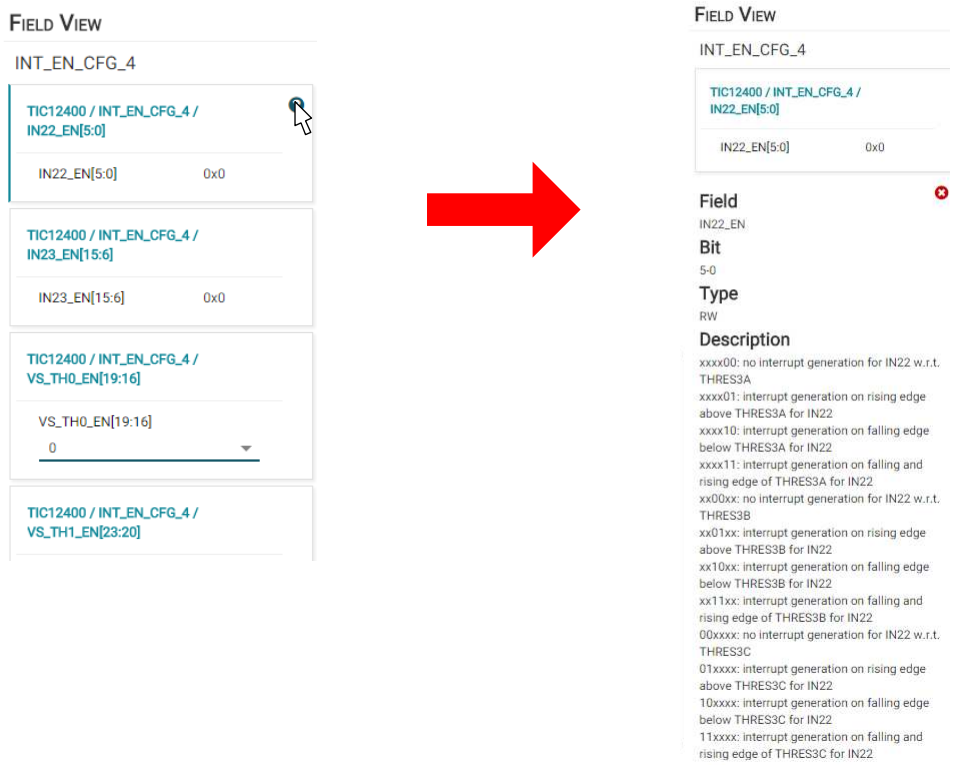
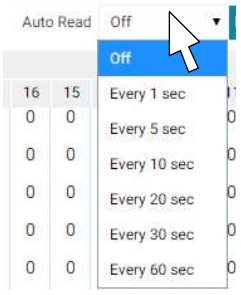
2.



Register Name	Address	Value	Bits													
			23	22	21	20	19	18	17	16	15	14	13	12	11	10	9
INT_STAT	0x02	0x0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

INT_STAT

Register			Data	Description
Name	Address	Bits		
INT_STAT	0x02	0	POR	0: no POR 1: POR occurred The Power-On-Reset (POR) interrupt bit indicates whether a reset event has occurred. A reset event sets the registers to their default values and re-initializes the device state machine. This bit is asserted after a successful power-on-reset, hardware reset, or software reset. The value of this register bit is mirrored to the POR SPI status flag.
		1	SPI_FAIL	0: 32 clock pulse during a /CS=low sequence was detected 1: SPI error occurred When this bit is set to 1, it indicates the last SPI Slave In (SI) transaction is invalid. To program a complete word, 32 bits of information must be entered into the device. The SPI logic counts the number of bits clocked into the IC and enables data latching only if exactly 32 bits have been clocked in. In case the word length exceeds or does not meet the required length, the SPI_FAIL bit is set to 1, and the data received will be considered invalid. The value of this register bit is mirrored to the SPI_FLAG SPI status flag.
		2	PRTY_FAIL	0: No parity error in an received SI stream 1: Parity error occurred When this bit is set to 1, it indicates the last SPI Slave In (SI) transaction has a parity error. The device uses odd parity. If the total number of ones in the received data (including the parity bit) is an even number, the received data is discarded. The value of this register bit is mirrored to the PRTY_FLAG SPI status flag.
		3	SSC	0: No switch state change occurred 1: Switch state change occurred The Switch State Change (SSC) interrupt bit indicates whether input threshold crossing has occurred.
		4	TSD	0: No temperature shutdown event occurred or the event status got cleared after a READ

	The field view area shows a bit by bit name and description for each setting available in that register. Clicking the ? Button will bring up that field's bit number(s) in the register, whether it is read or write and the description. Clicking the red x will exit the help description prompt.
3.	
4.	Auto read can be enabled on a polling timer that is adjustable in the GUI.
	
	The Immediate and deferred menu will adjust when the register are written after they are changed in the GUI. Immediate will send the new register settings to the device immediately after they are changed. The deferred setting will wait for the user to click the Write Register button before sending the new register settings to the device.
	

6 Board Files

This section contains the main board and SWITCH board schematics and BOMs.

6.1 Main Board Schematic

Figure 13 through Figure 17 illustrate the main board schematics.

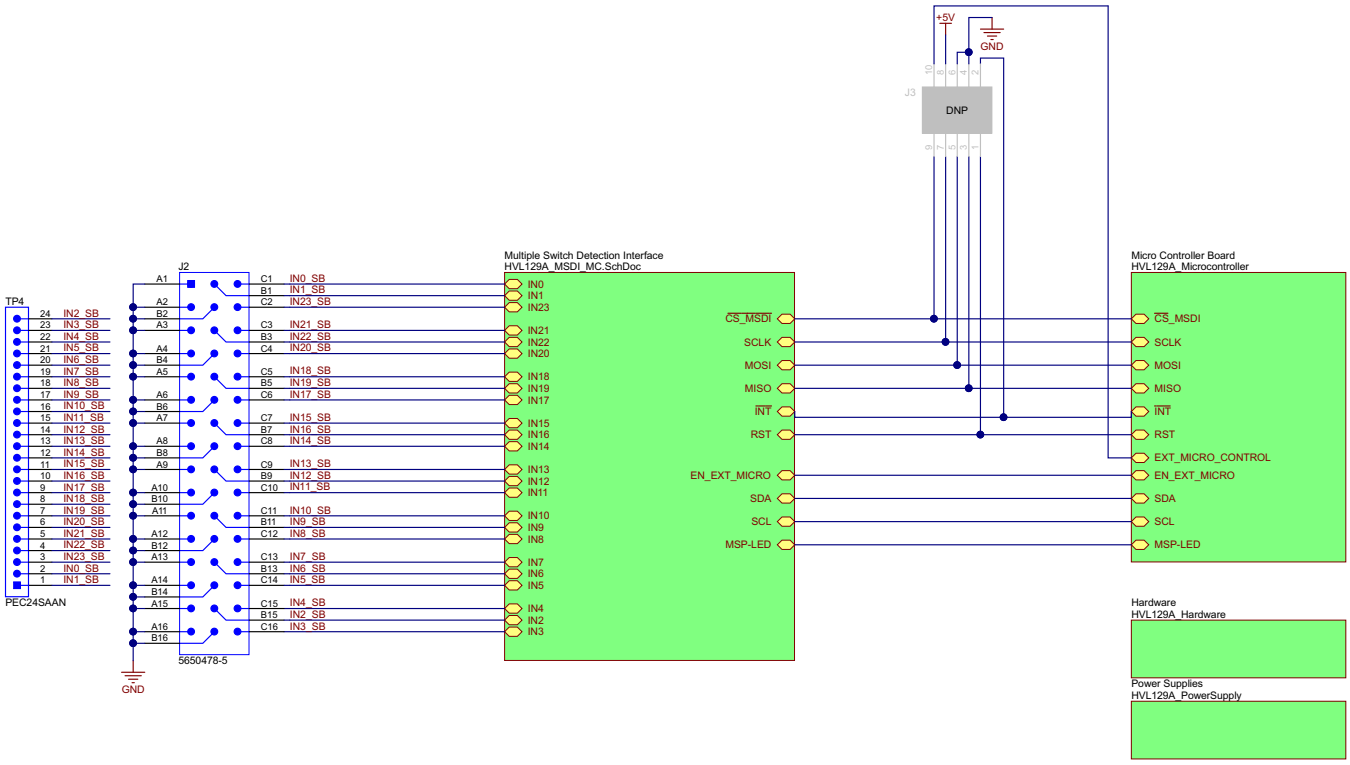


Figure 13. Page Connections

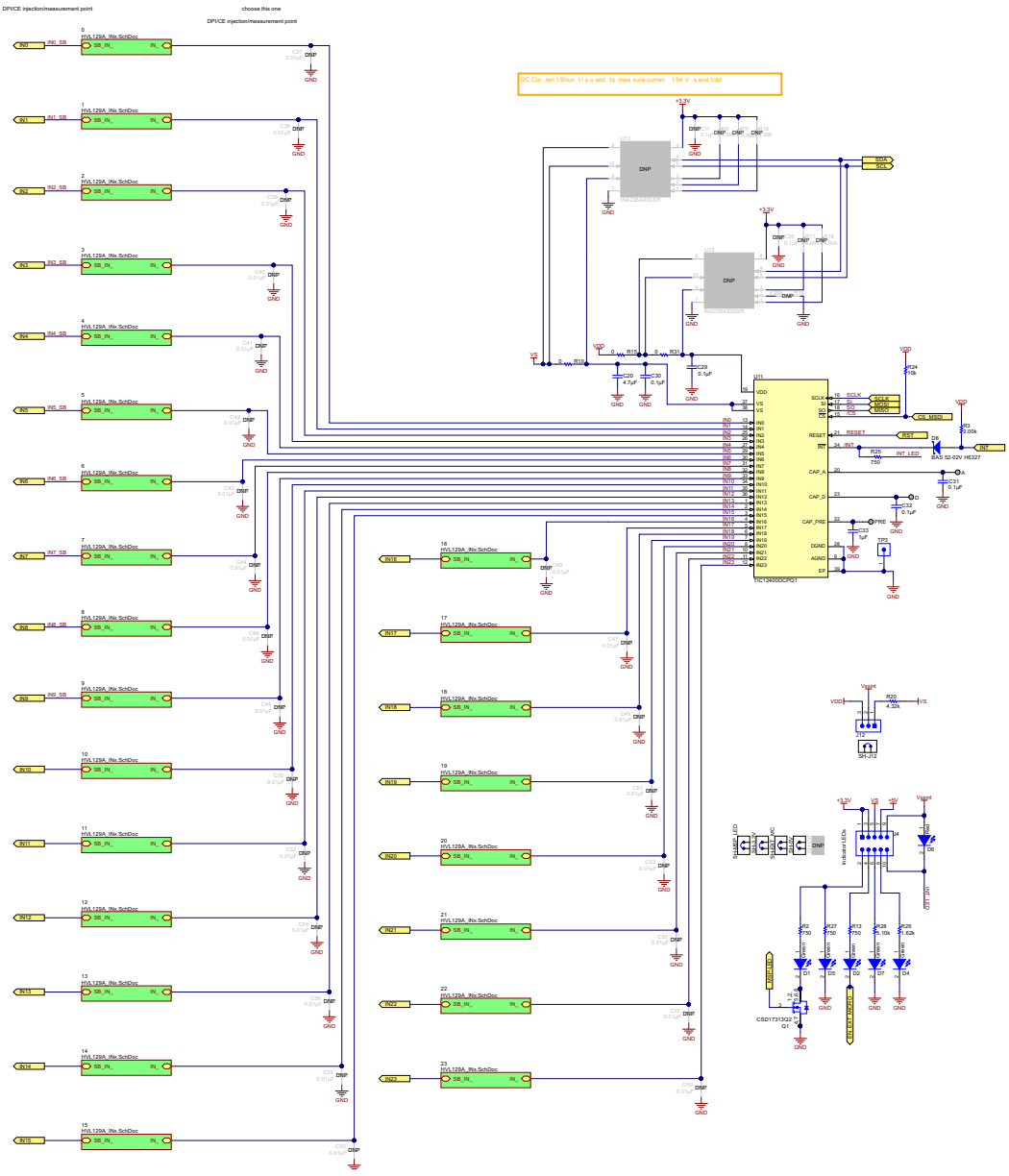


Figure 14. Main Device

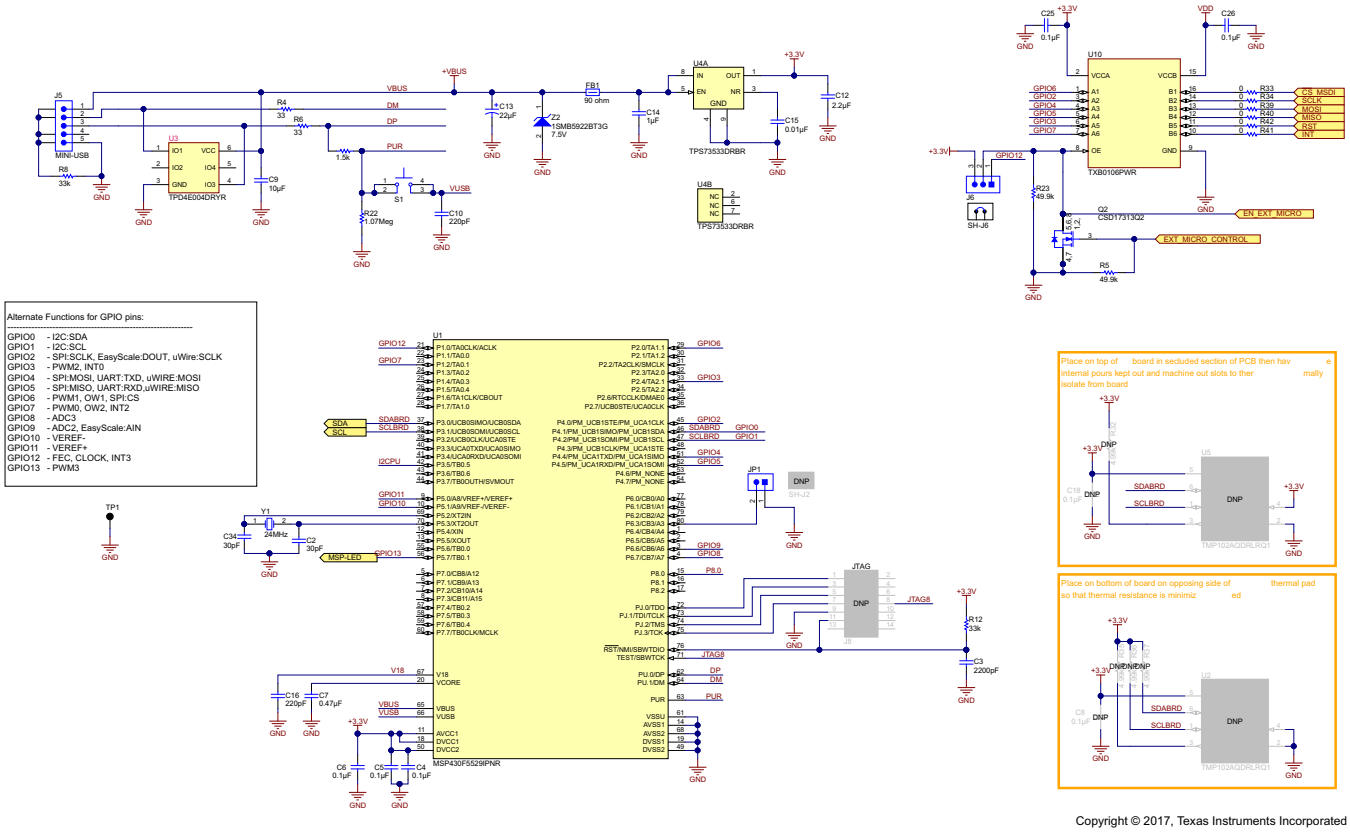


Figure 15. USB interface

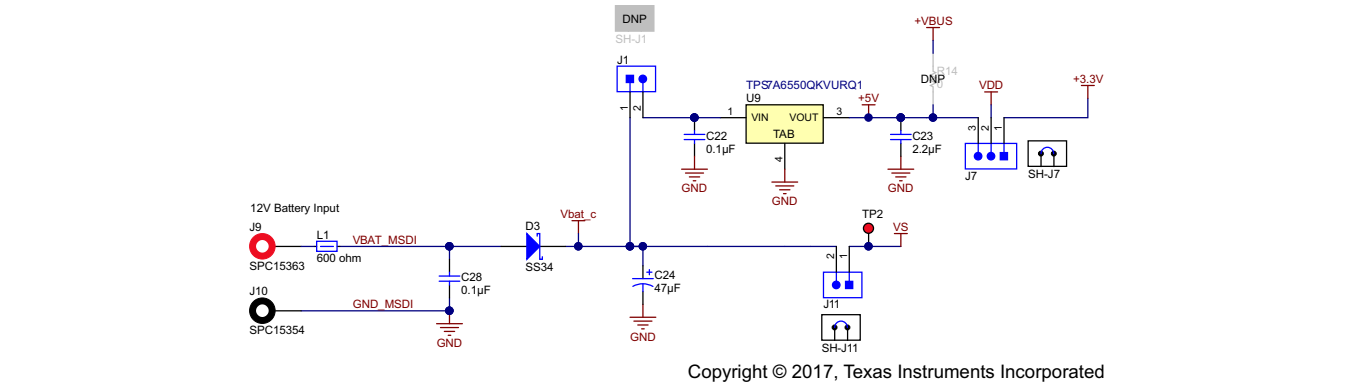


Figure 16. <Caption>

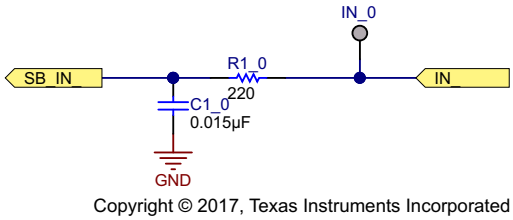


Figure 17. Input filters – IN10-IN23 use 10 Ω instead of 220 Ω

6.2 Switch Board Schematic

Figure 18 shows the SWITCH board schematic.

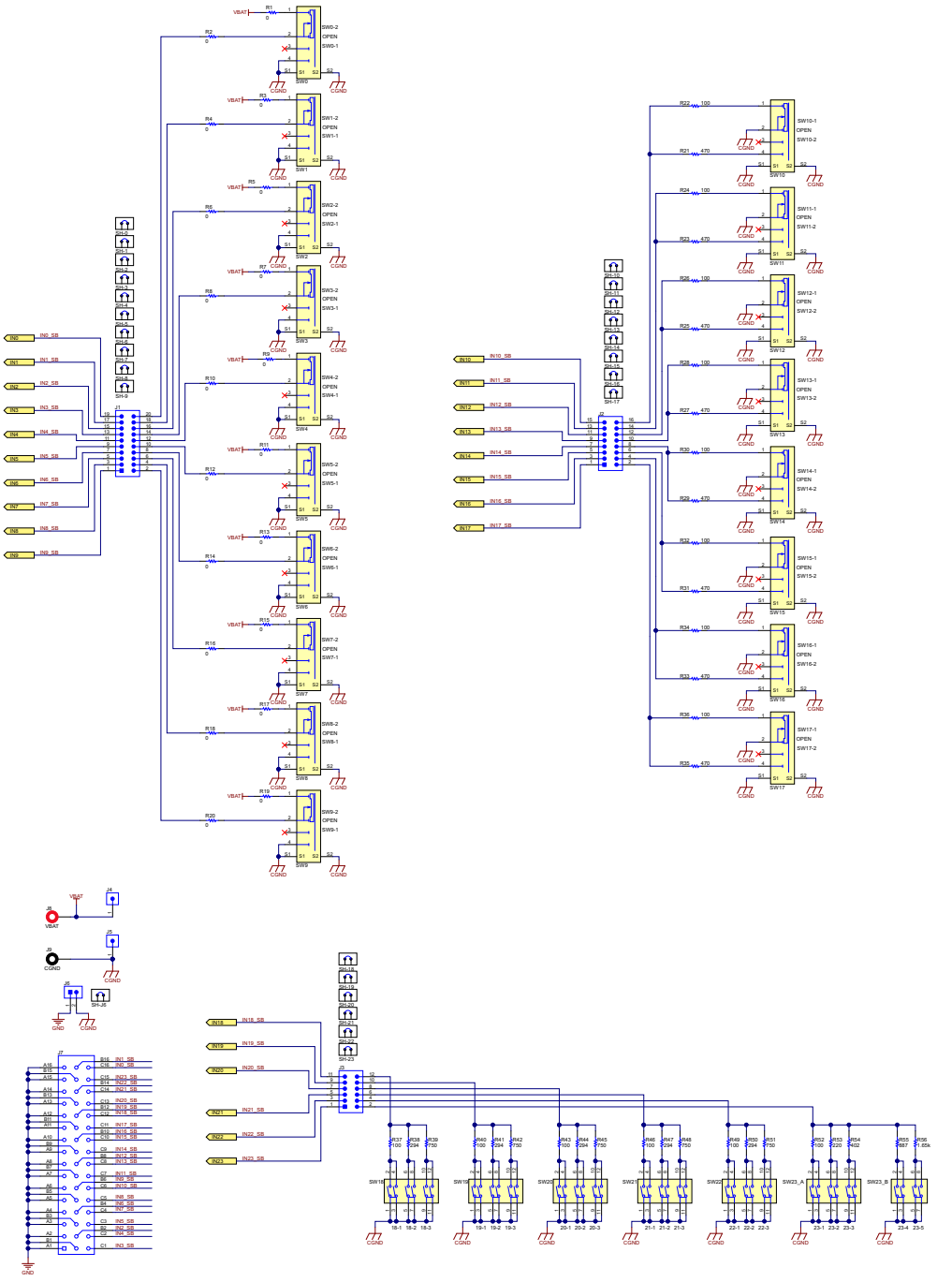


Figure 18. SWITCH Board Schematic

6.3 Main Board Bill of Materials

Table 1 lists the main board bill of materials (BOM).

Table 1. Main Board Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number
!PCB1	1		Printed Circuit Board		HVL129
!PCB2	1		Daughter card load board. Set in separate ESD bag. Kiting item.	N/A	HVL149
C1_0, C1_1, C1_2, C1_3, C1_4, C1_5, C1_6, C1_7, C1_8, C1_9, C1_10, C1_11, C1_12, C1_13, C1_14, C1_15, C1_16, C1_17, C1_18, C1_19, C1_20, C1_21, C1_22, C1_23	24	0.015uF	CAP, CERM, 0.015 µF, 100 V, +/- 10%, X7R, 0603	0603	C0603C153K1RACTU
C2, C34	2	30pF	CAP, CERM, 30pF, 100V, +/-5%, C0G/NP0, 0603	0603	GRM1885C2A300JA01D
C3	1	2200pF	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603	0603	C0603X222K5RACTU
C4, C5, C6	3	0.1uF	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	0603	0603YC104JAT2A
C7	1	0.47uF	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603	0603	C0603C474K8RACTU
C9	1	10uF	CAP, CERM, 10uF, 16V, +/-20%, X5R, 0805	0805	0805YD106MAT2A
C10, C16	2	220pF	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603	0603	06035A221FAT2A
C12	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/-10%, X5R, 0805	0805	0805YD225KAT2A
C13	1	22uF	CAP ALUM 22UF 10V 20% SMD	E55	EEE-1AA220WR
C14	1	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0805	0805	C0805C105K3RACTU
C15	1	0.01uF	CAP, CERM, 0.01uF, 50V, +/-10%, X7R, 0603	0603	C1608X7R1H103K
C20	1	4.7uF	CAP, CERM, 4.7 µF, 50 V, +/- 20%, X7R, 1206_190	1206_190	C3216X7R1H475M160AC
C22, C31, C32	3	0.1uF	CAP, CERM, 0.1 µF, 25 V, +/- 5%, X7R, 0603	0603	C0603C104J3RAC
C23	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, +/- 10%, X7R, 0805	0805	GRM21BR71A225KA01L
C24	1	47uF	CAP, AL, 47 µF, 63 V, +/- 20%, ohm, SMD	SMT Radial G	EEETG1J470P
C25, C26	2	0.1uF	CAP, CERM, 0.1 µF, 25 V, +/- 5%, X7R, 0603	0603	C0603C104J3RACTU
C28	1	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0805	0805	C0805C104K5RACTU
C29, C30	2	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A
C33	1	1uF	CAP, CERM, 1 µF, 50 V, +/- 10%, X7R, 0603	0603	UMK107AB7105KA-T
D1, D2, D4, D5, D7	5	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190KGKT
D3	1	40V	Diode, Schottky, 40 V, 3 A, SMC	SMC	SS34
D6	1	Red	LED, Red, SMD	LED_0603	LTST-C191KRKT
D8	1	45V	Diode, Schottky, 45 V, 0.75 A, SOD-523	SOD-523	BAS 52-02V H6327
FB1	1	90 ohm	Ferrite Bead, 90 ohm @ 100 MHz, 1.5 A, 1206	1206	MI1206K900R-10
H2, H5, H8, H11	4		Standoff, Hex, 1"L #4-40 Nylon	Standoff	1902E
H3, H6, H9, H12	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH

Table 1. Main Board Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number
IN_0, IN_1, IN_2, IN_3, IN_4, IN_5, IN_6, IN_7, IN_8, IN_9, IN_10, IN_11, IN_12, IN_13, IN_14, IN_15, IN_16, IN_17, IN_18, IN_19, IN_20, IN_21, IN_22, IN_23	24		Test Lead clips and hooks, SMT	Test Point, Body 3.25x1.65mm	S1751-46
J1, J11, JP1	3		Header, 100mil, 2x1, Gold with Tin Tail, SMT	2x1 Header	TSM-102-01-L-SV
J2	1		Header, 2.54mml, 16x3, Gold, TH	Header, 2.54mml, 16x3, TH	5650478-5
J4	1		Header, 2.54mm, 5x2, Gold, SMT	Header, 2.54mm, 5x2, SMT	TSM-105-01-L-DV-P
J5	1		Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	USB Mini Type B	1734035-2
J6, J7, J12	3		Header, 100mil, 3x1, Gold, SMT	Samtec_TSM-103-01-X-SV	TSM-103-01-L-SV
J9	1		BANANA JACK, SOLDER LUG, RED, TH	Red Insulated Banana Jack	SPC15363
J10	1		BANANA JACK, SOLDER LUG, BLACK, TH	Black Insulated Banana Jack	SPC15354
L1	1	600 ohm	Ferrite Bead, 600 ohm @ 100 MHz, 2 A, 0805	0805	MPZ2012S601A
Q1, Q2	2	30V	MOSFET, N-CH, 30 V, 5 A, SON 2x2mm	SON 2x2mm	CSD17313Q2
R1_0, R1_1, R1_2, R1_3, R1_4, R1_5, R1_6, R1_7, R1_8, R1_9	10	220	RES, 220, 1%, 0.5 W, AEC-Q200 Grade 0, 0805	0805	ERJ-P6WF2200V
R1_10, R1_11, R1_12, R1_13, R1_14, R1_15, R1_16, R1_17, R1_18, R1_19, R1_20, R1_21, R1_22, R1_23	14	10.0	RES, 10.0, 1%, 0.5 W, AEC-Q200 Grade 0, 0805	0805	ERJ-P6WF10R0V
R2, R13, R25, R27	4	750	RES, 750, 5%, 0.1 W, 0603	0603	CRCW0603750RJNEA
R3	1	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA
R4, R6	2	33	RES, 33 ohm, 5%, 0.063W, 0402	0402	CRCW040233R0JNED
R5, R23	2	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	0603	CRCW060349K9FKEA
R7	1	1.5k	RES, 1.5k ohm, 5%, 0.063W, 0402	0402	CRCW04021K50JNED
R8, R12	2	33k	RES, 33k ohm, 5%, 0.063W, 0402	0402	CRCW040233K0JNED
R10, R15, R31, R33, R34, R39, R40, R41, R42	9	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA
R20	1	4.32k	RES, 4.32 k, 1%, 0.1 W, 0603	0603	RC0603FR-074K32L
R22	1	1.07Meg	RES, 1.07Meg ohm, 1%, 0.1W, 0603	0603	CRCW06031M07FKEA
R24	1	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	CRCW060310K0JNEA
R26	1	1.62k	RES, 1.62 k, 1%, 0.1 W, 0603	0603	CRCW06031K62FKEA
R28	1	5.10k	RES, 5.10 k, 1%, 0.1 W, 0603	0603	RC0603FR-075K1L
S1	1		Switch, Tactile, SPST-NO, SMT	Switch, 6.1x1.8x4.6 mm	EVQ-PSD02K

Table 1. Main Board Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number
SH-3.3V, SH-5V, SH-EXT_MC, SH-J6, SH-J7, SH-J11, SH-J12, SH-MSP_LED	8	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G
TP1	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011
TP2	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010
TP3	1		Header, 100mil, 1pos, Gold, TH	Testpoint	TSW-101-07-G-S
TP4	1		Header, 2.54mm, 24x1, Gold, TH	Header, 2.54mm, 24x1, TH	PEC24SAAN
U1	1		25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPNR
U3	1	TPD4E004DRYR	IC, 4-Chan ESD-Protection Array	SON-6	TPD4E004DRYR
U4	1		Single Output High PSRR LDO, 500 mA, Fixed 3.3 V Output, 2.7 to 6.5 V Input, with Low IQ, 8-pin SON (DRB), -40 to 125 degC, Green (RoHS & no Sb/Br)	DRB0008A	TPS73533DRBR
U9	1		Single Output Automotive LDO, 300 mA, Fixed 5 V Output, 4 to 40 V Input, 3-pin PFM (KVU), -40 to 125 degC, Green (RoHS & no Sb/Br)	KVU0003A	TPS7A6550QKVURQ1
U10	1		6-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR WITH AUTO-DIRECTION SENSING AND ±15-kV ESD PROTECTION, PW0016A	PW0016A	TXB0106PWR
U11	1		Multiple Switch Detection Interface (MSDI) device, DCP0038A	DCP0038A	TIC12400DCPQ1
Y1	1		Crystal, 24.000MHz, 20pF, SMD	Crystal, 11.4x4.3x3.8mm	ECS-240-20-5PX-TR
Z2	1	7.5V	Diode, Zener, 7.5V, 550mW, SMB	SMB	1SMB5922BT3G
C8, C18	0	0.1uF	CAP, CERM, 0.1 µF, 25 V, +/- 5%, X7R, 0603	0603	C0603C104J3RACTU
C11, C36	0	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	06035C104KAT2A
C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60	0	0.01uF	CAP, CERM, 0.01 µF, 50 V, +/- 5%, X7R, 0603	0603	C0603C103J5RACTU
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J3	0		Header(Shrouded), 2.54mm, 5x2, Gold, TH	Header, 2.54mm, 5x2, TH	AWHW-10G-0202-T
J8	0		Header, 100mil, 7x2, SMT	Header, 100 mil, 7x2, SMT	0015912140
R9, R11, R16, R17, R18, R19, R32, R35, R36, R37	0	4.99k	RES, 4.99 k, 1%, 0.1 W, 0603	0603	CR0603-FX-4991ELF
R14	0	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA
SH-INT, SH-J1, SH-J2	0	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G
U2, U5	0		Low-Power Digital Temperature Sensor With SMBus and Two-Wire Serial Interface in SOT563, DRL0006A	DRL0006A	TMP102AQDRLRQ1
U12, U13	0		High-or Low-Side Measurement, Bi-Directional CURRENT/POWER MONITOR with I2C(TM) Interface, DGS0010A	DGS0010A	INA226AIDGSR

6.4 SWITCH Board Bill of Materials

Table 2 lists the SWITCH board BOM.

Table 2. SWITCH Board Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number
!PCB1	1		Printed Circuit Board		HVL149
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH
H5, H6, H7, H8	4		Standoff, Hex, 1"L #4-40 Nylon	Standoff	1902E
J1	1		Header, 2.54mm, 10x2, Gold, SMT	1000x180x290mil	TSM-110-01-L-DV-P
J2	1		Header, 2.54mm, 8x2, Gold, SMT	Header, 2.54mm, 8x2, SMT	TSM-108-01-L-DV
J3	1		Header, 2.54mm, 6x2, Gold, SMT	Header, 2.54mm, 6x2, SMT	TSM-106-01-L-DV
J4, J5	2		Header, 100mil, 1pos, Gold, TH	Testpoint	TSW-101-07-G-S
J6	1		Header, 2.54 mm, 2x1, Gold, R/A, SMT	Header, 2.54 mm, 2x1, R/A, SMT	0878980204
J7	1		Receptacle, 2.54mm, 16x3, Gold, R/A, TH	Receptacle, 2.54mm, 16x3, R/A, TH	5650868-4
J8	1		BANANA JACK, SOLDER LUG, RED, TH	Red Insulated Banana Jack	SPC15363
J9	1		BANANA JACK, SOLDER LUG, BLACK, TH	Black Insulated Banana Jack	SPC15354
R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20	20	0	RES, 0, 5%, 0.25 W, 1206	1206	ERJ-8GEY0R00V
R21, R23, R25, R27, R29, R31, R33, R35	8	470	RES, 470, 1%, 0.25 W, 1206		RC1206FR-07470RL
R22, R24, R26, R28, R30, R32, R34, R36	8	100	RES, 100, 1%, 0.25 W, 1206		ERJ-8ENF1000V
R37, R40, R43, R46, R49, R52	6	100	RES, 100, 1%, 0.25 W, 1206	1206	ERJ-8ENF1000V
R38, R41, R44, R47, R50	5	294	RES, 294, 1%, 0.25 W, 1206	1206	RC1206FR-07294RL
R39, R42, R45, R48, R51	5	750	RES, 750, 1%, 0.25 W, 1206	1206	CRCW1206750RFKEA
R53	1	220	RES, 220, 1%, 0.25 W, 1206	1206	RC1206FR-07220RL
R54	1	402	RES, 402, 1%, 0.25 W, 1206	1206	ERJ-8ENF4020V
R55	1	887	RES, 887, 1%, 0.25 W, 1206	1206	ERJ-8ENF8870V
R56	1	1.65k	RES, 1.65 k, 1%, 0.25 W, 1206	1206	ERJ-8ENF1651V

Table 2. SWITCH Board Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number
SH-0, SH-1, SH-2, SH-3, SH-4, SH-5, SH-6, SH-7, SH-8, SH-9, SH-10, SH-11, SH-12, SH-13, SH-14, SH-15, SH-16, SH-17, SH-18, SH-19, SH-20, SH-21, SH-22, SH-23, SH-J6	25	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G
SW0, SW1, SW2, SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW10, SW11, SW12, SW13, SW14, SW15, SW16, SW17	18		Switch, Slide, SP3T, On-On-On, 3 Pos, 0.3A, 30 VDC, TH	12.6x4.3mm	SS-13D16-VG 4 PA
SW18, SW19, SW20, SW21, SW22, SW23_A	6		Switch, DPST, 3 Pos, 0.1 A, 50 VDC, SMD	17.67x9.78mm	204-213ST
SW23_B	1		Switch, DPST, 2 Pos, 0.1 A, 50 VDC, SMD	12.34x9.78mm	204-212ST
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

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   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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