



## ABSTRACT

This document outlines the basic hardware and software components for the BOOSTXL-TPS65033 Socketed Programming Board. The BoosterPack enables pre-assembly programming for both the TPS650320-Q1 and the TPS65033x-Q1 devices. The TPS65032001-Q1 and TPS65033000-Q1 are re-configurable PMICs for prototyping various device settings. The settings can then be provided to TI for a final production PMIC. Alternatively, the TPS65032001-Q1 and TPS65033000-Q1 devices can be programmed in production to match a wide range of application requirements. The non-safety versions of the TPS650320-Q1 and TPS65033x-Q1 will similarly allow programming of production units.

## Table of Contents

<b>1 BOOSTXL-TPS65033 Components and Environment</b> .....	2
<b>2 BOOSTXL-TPS65033 Board Information</b> .....	2
2.1 Critical Socketed Board Connections.....	3
2.2 Jumpers and Test Points.....	4
<b>3 Programming GUI Operation</b> .....	5
3.1 Initial Set-up.....	5
3.2 Connection Debugging.....	9
3.3 Basic Operation of the GUI.....	10
3.4 Scripting.....	16
<b>4 Recommended Operating Procedure</b> .....	19
<b>5 BOOSTXL-TPS65033 Schematic</b> .....	20
<b>6 BOOSTXL-TPS65033 Board Layers</b> .....	22
<b>7 BOOSTXL-TPS65033 Bill of Materials</b> .....	26
<b>8 Revision History</b> .....	28

## Trademarks

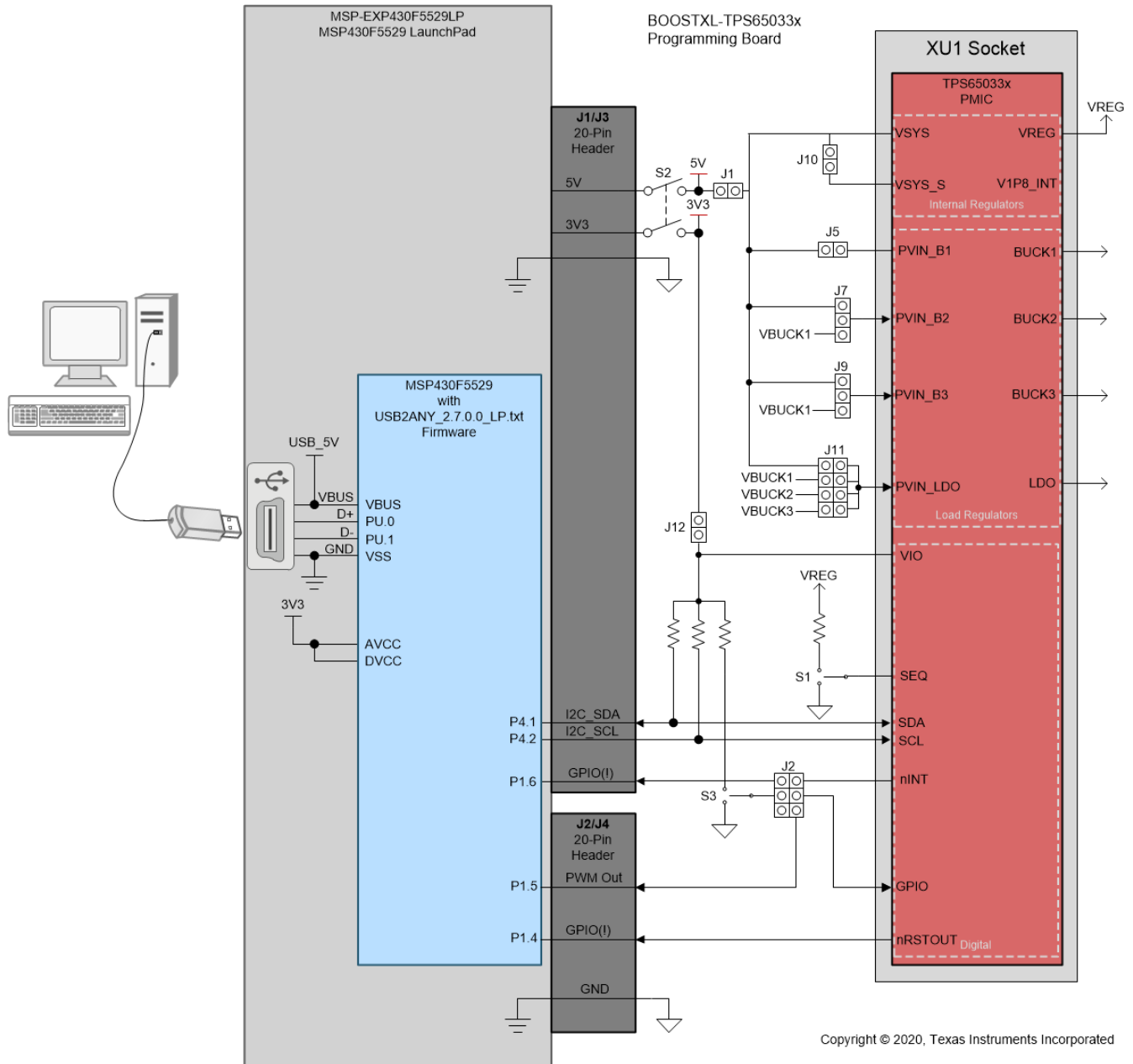
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## 1 BOOSTXL-TPS65033 Components and Environment

The TPS65032001-Q1 and TPS65033x-Q1 family of PMICs are configurable and programmable only through I2C instructions. The BOOSTXL-TPS65033 socketed board is designed to act as a BoosterPack to the low cost TI LaunchPads, enabling a LaunchPad to act as the USB-to-I2C interface for communication with a personal computer. This separation reduces the cost of prototyping and enables experimentation with various TI devices, including custom software development using existing LaunchPad tools. Many of these tools can be found online at [TI DevTools](#). The [programming GUI](#) is also available in the [TI DevTools Gallery](#). This GUI is compatible with both the [MSP430F5529LP](#) and the [MSP432E401Y](#) LaunchPads.

## 2 BOOSTXL-TPS65033 Board Information

The BOOSTXL-TPS65033 is designed to stack on top of a LaunchPad, connecting the relevant power and MCU pins to the PMIC through the headers J1/J3 and J2/J4. Power is delivered to the PMIC from the USB port of a PC through the the LaunchPad 5 V and 3.3 V rails. The following block diagram demonstrates how the LaunchPad interfaces with the PC and the PMIC.



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Figure 2-1. Programming Board and LaunchPad Connections

## 2.1 Critical Socketed Board Connections

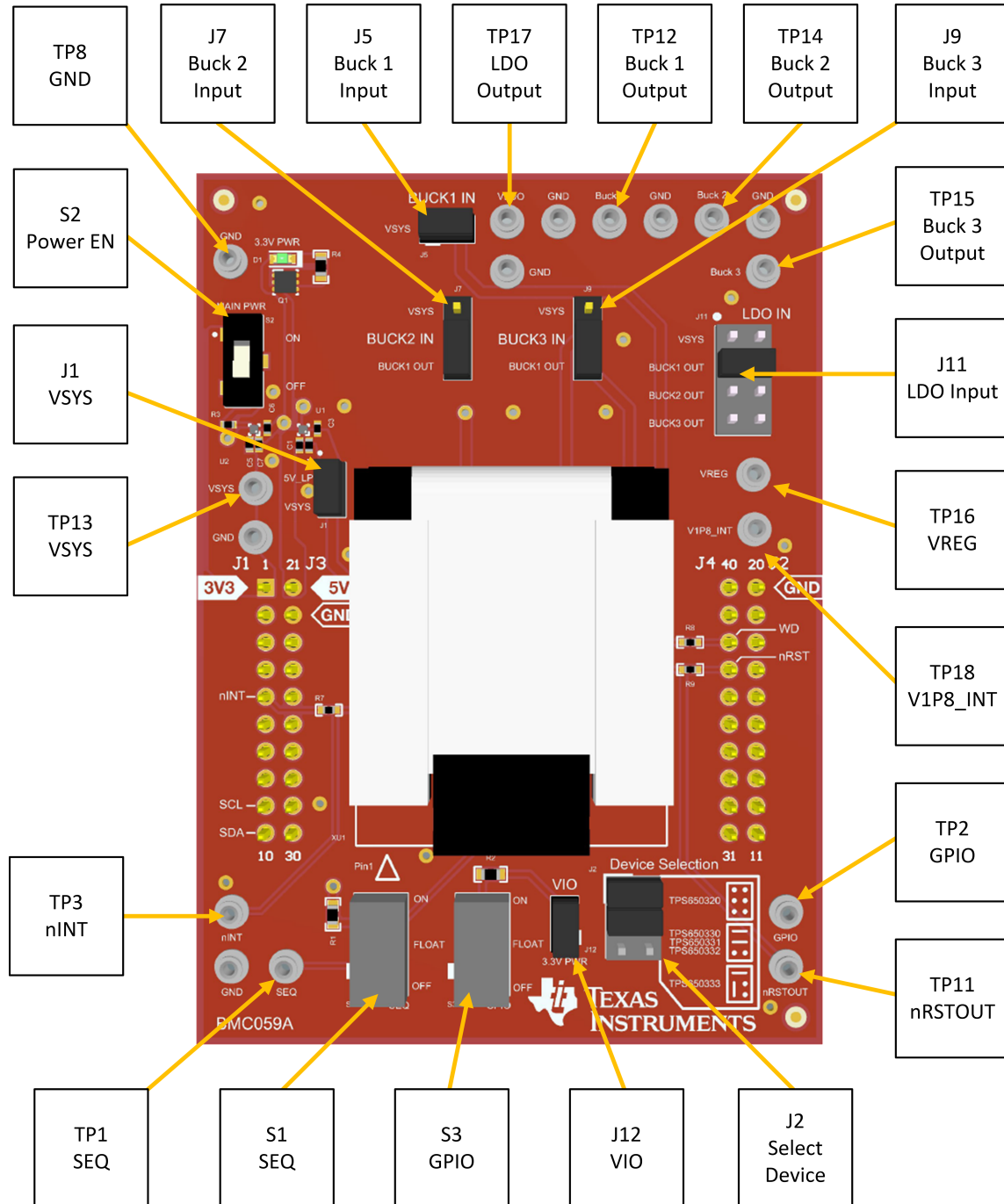
Critical connections for operating the socketed board are the 5 V rail, the 3.3 V rail, and the I2C pins. The remaining connections to the LaunchPad are left available for future experimentation. Note: I2C pull-ups must be pulled up to VIO. This can optionally be pulled up to 3.3 V (default) or an alternate rail through the J12.

By default, the 3.3 V rail must be present to power the VIO and GPIO pins to fully enable the PMIC. If evaluation without a PC is desired, both the 5 V and the VIO domains should be externally supplied. If VIO is supplied by a voltage other than 3.3 V, J12 should be left open to prevent potential current paths to the MCU 3.3 V. For most configurations, the PMIC can supply VIO when externally connected to an appropriate test point, for example the Buck 1 output if configured for 3.3 V, or the Buck 2 output if configured for 1.8 V.

### 2.1.1 Power Switches

Both the 5 V and 3.3 V rails connect to the PMIC through separate current limiting load switches. The load switches are simultaneously enabled with the S2 toggle switch on the top left area of the board. See [Section 5](#) for the complete BOOSTXL-TPS65033 schematic. It is recommended to keep S2 open when connecting the LaunchPad to the PC to reduce the initial current draw from the USB port.

### 2.2 Jumpers and Test Points



**Figure 2-2. Programming Board Test Points and Jumpers**

### 3 Programming GUI Operation

#### 3.1 Initial Set-up

##### 3.1.1 Finding the GUI

The Graphical User Interface (GUI) for the BOOSTXL-TPS65033 can be found in the [Gallery](#) at [TI DevTools](#). This GUI will connect to the BOOSTXL-TPS65033 provided a compatible I2C controller is connected ([MSP430F5529LP](#), [MSP432E401Y](#), or [USB2ANY](#)). This GUI is also compatible with the [TPS650320Q1EVM](#) and [TPS650330Q1EVM](#), which both have on-board MSP432E401Y MCUs.

The GUI can be operated through Google Chrome™ or Mozilla Firefox™ web browsers. To run the GUI in the browser, click the thumbnail and follow the prompted instructions for first time installation. The GUI requires both a browser plugin and the TI Cloud Agent software for access to the local USB ports. The GUI can also be downloaded for offline operation by hovering over the downward arrow in the GUI thumbnail and selecting the desired platform – Windows®, macOS®, or Linux®.

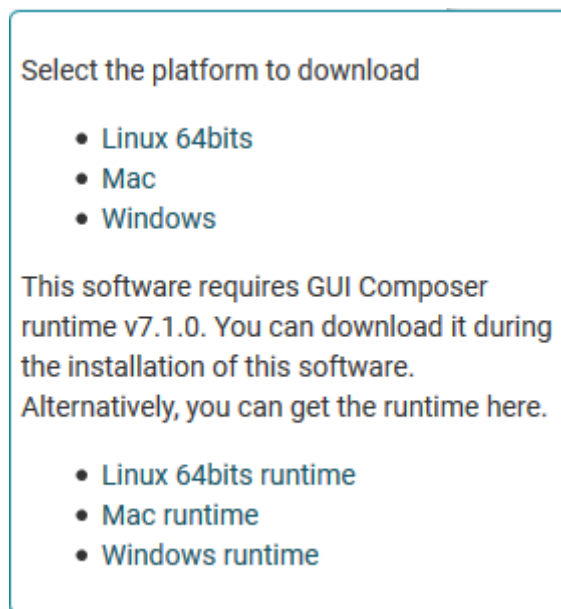
##### 3.1.2 Offline Installation

To download the offline installer, click the downward arrow on the below the thumbnail and select the relevant operating system for the destination PC.



**Figure 3-1. Standalone Installer Download Icon**

The platform downloads will include the GUI Composer runtime installer if internet access is available during installation. If the PC has no internet access at time of installation, the runtime installer may need to be downloaded in advance using the additional links below the platform installation URLs.

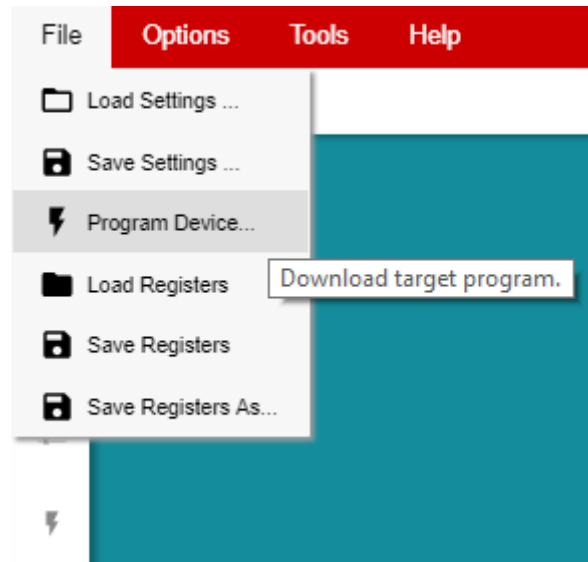


**Figure 3-2. Standalone Installer Operating System Options**

### 3.1.3 Flashing the MSP430F5529 LaunchPad

Initial operation with the MSP430F5529 LaunchPad requires downloading pre-configured firmware into the MSP430 in order to be recognized by the GUI.

The GUI incorporates a tool to flash the MSP430F5529 LaunchPad, located under the File tab in the top menu. This tool is pre-configured to flash the MSP430F5529LP only, and cannot be used with other LaunchPads.



**Figure 3-3. LaunchPad Firmware Flashing Tool**

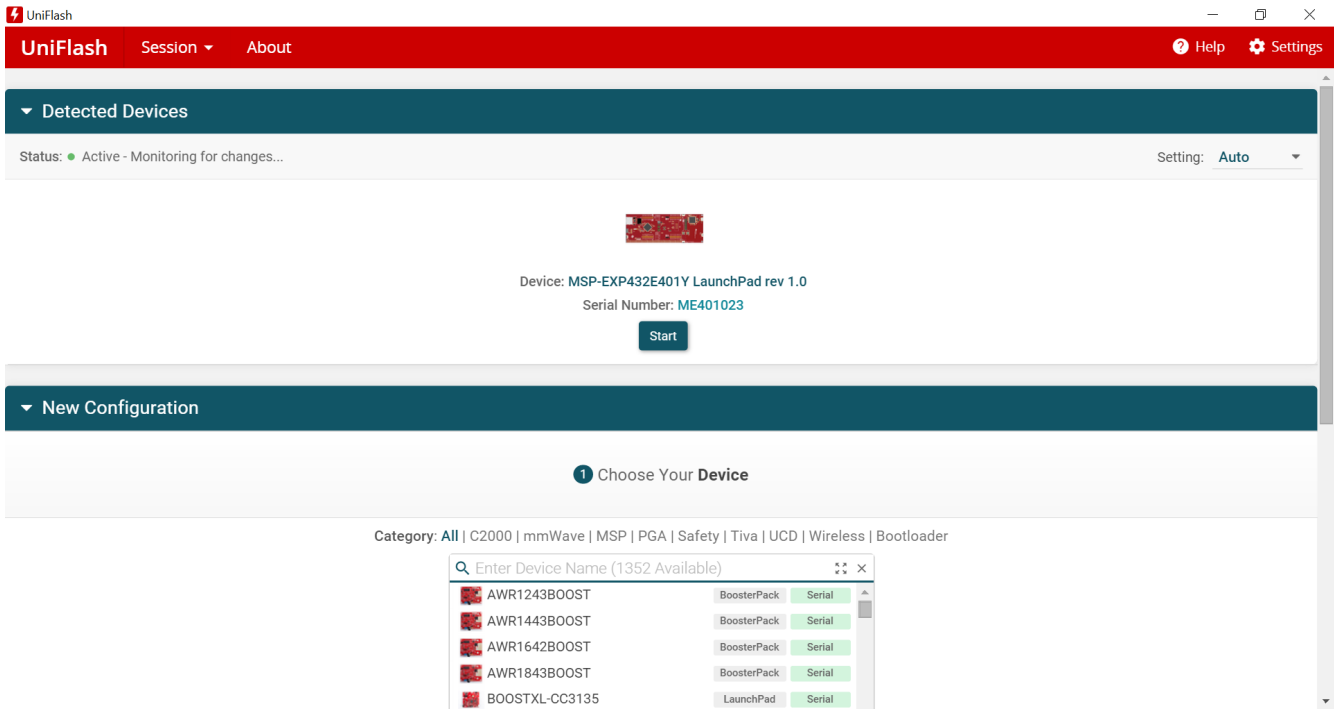
To flash the LaunchPad, first connect the MSP430F5529LP to the PC using a micro-USB cable, then select File > Program Device. The GUI will automatically download the firmware, recognize the LaunchPad, and flash the board.

Afterwards the LaunchPad will be recognized as the specific USB-to-I2C interface for operating with the TPS65032001-Q1 and TPS65033x-Q1 PMICs.

### 3.1.4 Flashing the MSP432E401Y Launch Pad

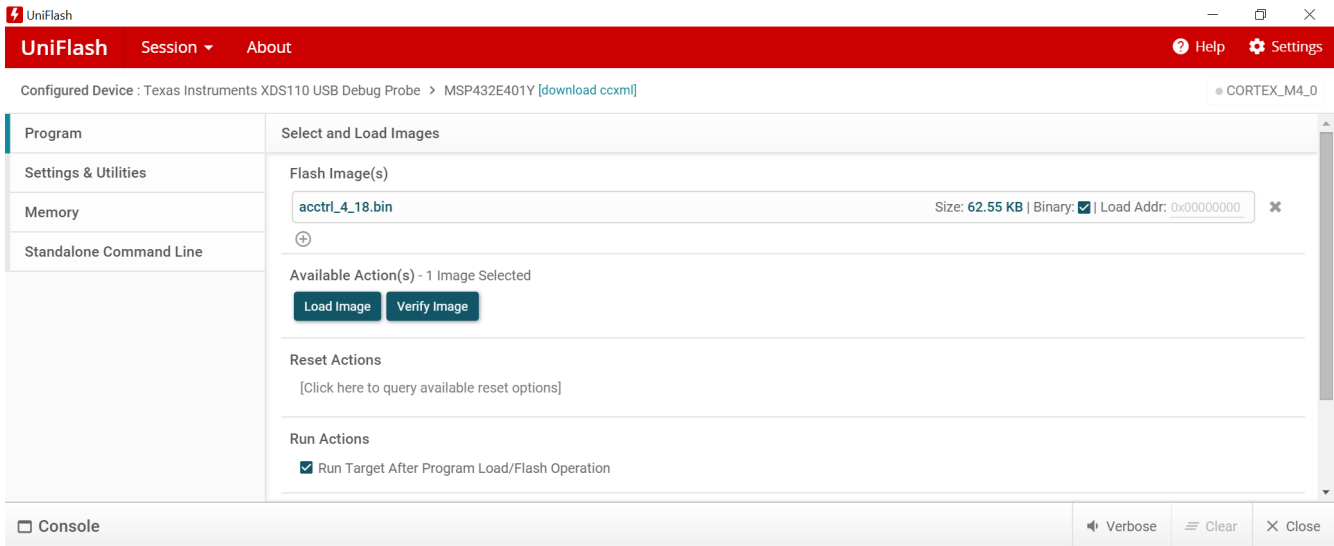
Initial operation with the MSP432E401Y LaunchPad requires downloading pre-configured firmware into the MSP432 in order to be recognized by the GUI. See [Section 3.1.2](#) about how this firmware must be accessed by installing the GUI for offline operation.

1. Once downloaded, the MSP432 firmware file, `acctrl_4_18.bin`, can be found at: `{Installation Directory}\install_image_TPS6503xx-Q1_GUI.zip\TPS6503xx-Q1_GUI\app\firmware`
2. Install [UniFlash](#), a free firmware flashing tool from TI.
3. Connect the LaunchPad to the PC. Use the USB port on the MSP432E401Y LaunchPad that is opposite the Ethernet port.
4. Run UniFlash. The program should automatically detect the connected MSP432E401Y LaunchPad. Once detected, click *Start*.



**Figure 3-4. UniFlash Initial Setup**

5. On the next page, browse to the binary file downloaded in Step 1 and click *Load Image*.



**Figure 3-5. UniFlash Load Firmware Image**

6. If prompted, update the XDS110 Debugger firmware. After accepting the update, UniFlash will update the firmware automatically and continue to load the binary image. The console will indicate a successful program.

```

    □ Console
    [10/5/2020, 1:12:36 PM] [WARNING] CS_DAP_0: Warning: A firmware update is required for the XDS110 probe. The current firmware is version 2.3.0.9. The probe must be upgraded to firmware version 3.0.0.12 to be compatible with this software. Click the "Update" button to update the firmware. DO NOT UNPLUG THE DEBUG PROBE DURING THE UPDATE. (Emulation package 9.1.1.00002)
    [10/5/2020, 1:12:58 PM] [INFO] CORTEX_M4_0: GEL Output: Memory Map Initialization Complete
    [10/5/2020, 1:13:01 PM] [SUCCESS] Program Load completed successfully.
    
```

**Figure 3-6. UniFlash Successful Program**

7. Unplug the micro USB cable from the MSP432E401Y LaunchPad.
8. Now plug the USB cable in to the micro USB port adjacent to the Ethernet port.
9. Install jumper on pins 3-4 (USB-OTG) of JP1 to supply the target 5 V supply through USB.

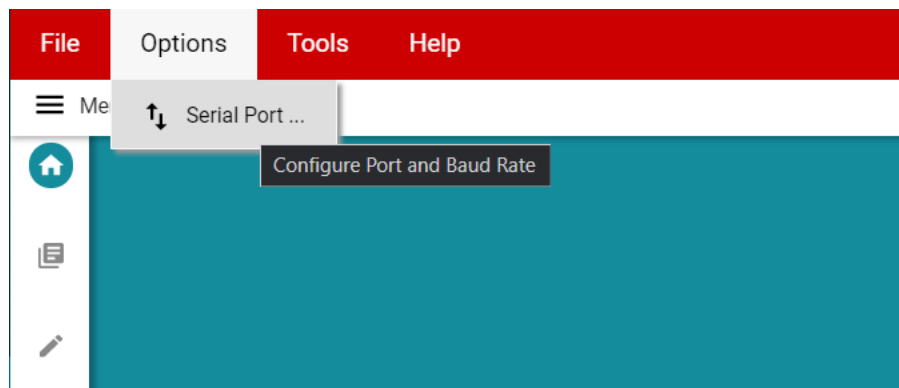
After completing this process, the GUI will recognize the LaunchPad as a USB-to-I2C interface. Next, stack the BOOSTXL-TPS65033 on top of the MSP432E401Y LaunchPad. The headers should align according to [Table 3-1](#).

**Table 3-1. BoosterPack to MSP432E401Y LaunchPad Connections**

BOOSTXL-TPS65033 Pin Header	MSP432E401Y LaunchPad Pin Header
J1	J5
J2	J6
J3	J7
J4	J8

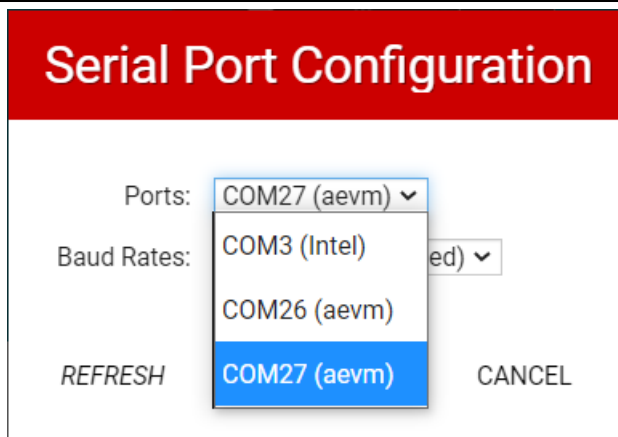
Note there may be two separate interfaces (or COM ports) recognized by the GUI. If one is failing to connect, use the GUI to switch to an alternate port.

1. Click the Options menu at the top of the GUI, select *Serial Port*.


**Figure 3-7. Serial Port Options**

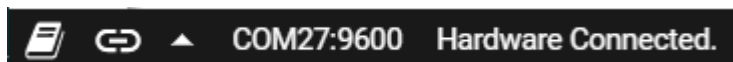
2. Use the Ports dropdown to select the alternative interface.





**Figure 3-8. GUI Serial Port Selection**

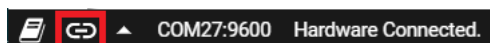
3. The GUI will indicate a successful connection through the black connection toolbar.



**Figure 3-9. Hardware Connected Indicator**

### 3.2 Connection Debugging

The connection link in the black toolbar at the bottom of the GUI can be toggled to refresh the connection to the LaunchPad. The flow chart in [Figure 3-11](#) can aid in debugging potential connection issues with the BOOSTXL-TPS65033.



**Figure 3-10. Refreshing the GUI-to-MCU Connection**

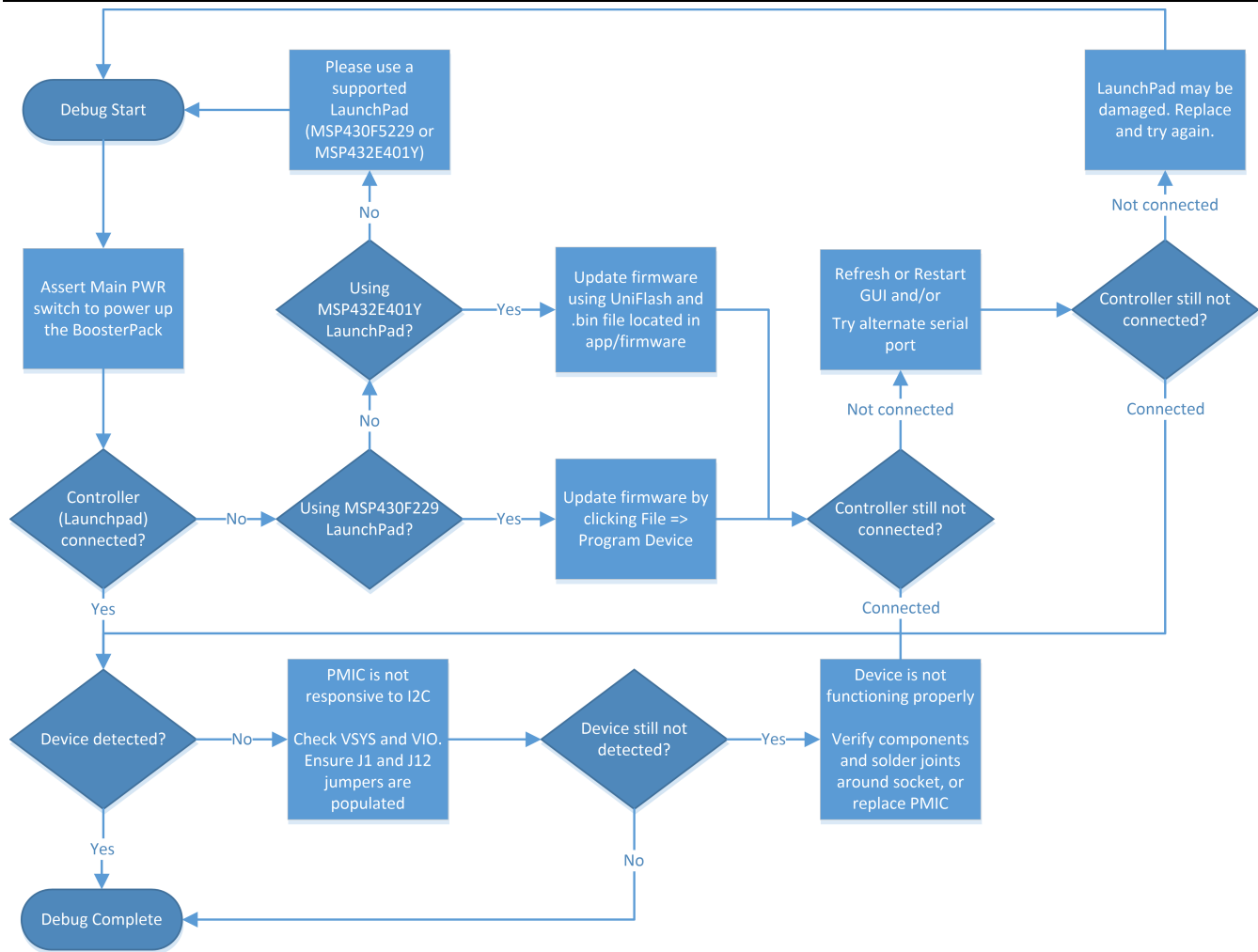


Figure 3-11. BOOSTXL-TPS65033 Connection Debug Flow Chart

### 3.3 Basic Operation of the GUI

The GUI displays a README.md prompt each time the GUI is launched. The prompt can be disabled for subsequent sessions by selecting the I checkbox at the bottom of the window. The README.md information is always available in the Help tab at the top of the GUI.

The GUI automatically attempts to connect to the flashed LaunchPad, with the connection status displayed in the bottom left hand corner of the GUI window. Once connected to the LaunchPad, the GUI attempts to read the register information of the PMIC populated in the socket. If the PMIC appears unresponsive, verify the serial port connection and confirm that all relevant shunts are populated according to Figure 2-2. If all shunts are populated properly, pressing the RST button on the LaunchPad (S3) below the socketed board can often recover USB communication.

#### 3.3.1 Home

The Home section is the landing page of the GUI. Here the GUI presents an overview of the EVM and [Programming BoosterPack \(BOOSTXL-TPS65033\)](#), and emphasize navigation to the remaining four sections through the tiles on the bottom of the page.

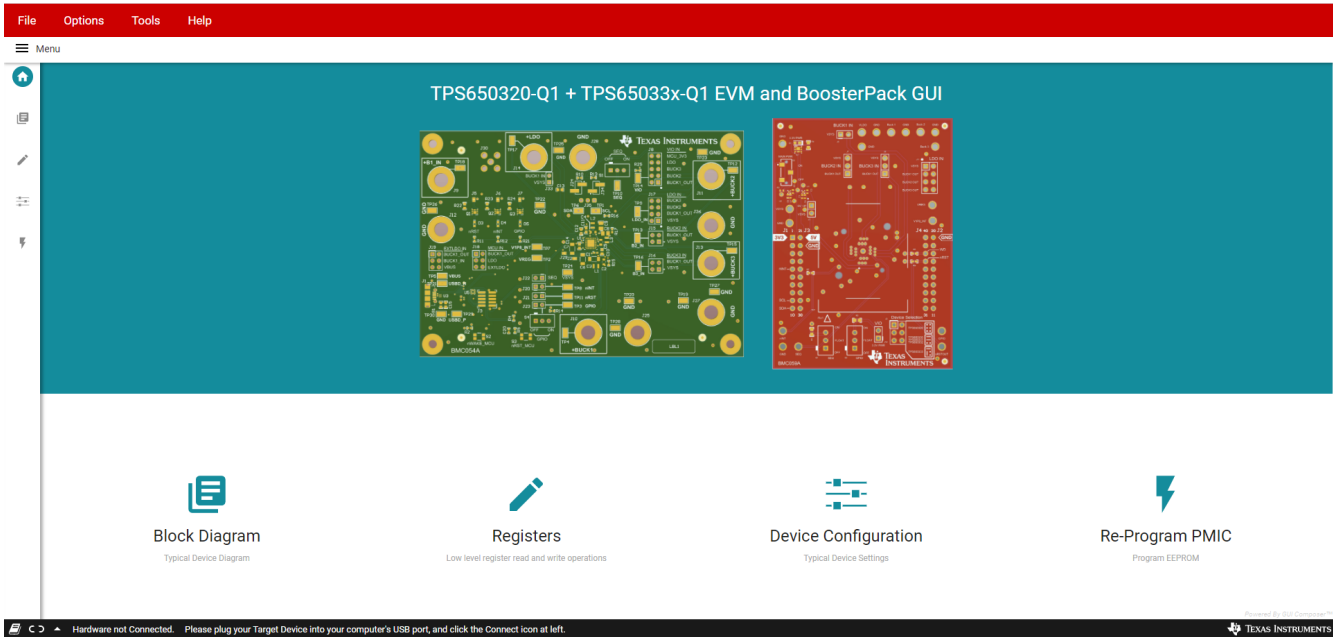


Figure 3-12. TPS6503xx-Q1 GUI Home Screen

### 3.3.2 Block Diagram

The Block Diagram section displays the typical components and functional blocks of the PMIC. A block diagram for the [Programming BoosterPack](#) is also shown.

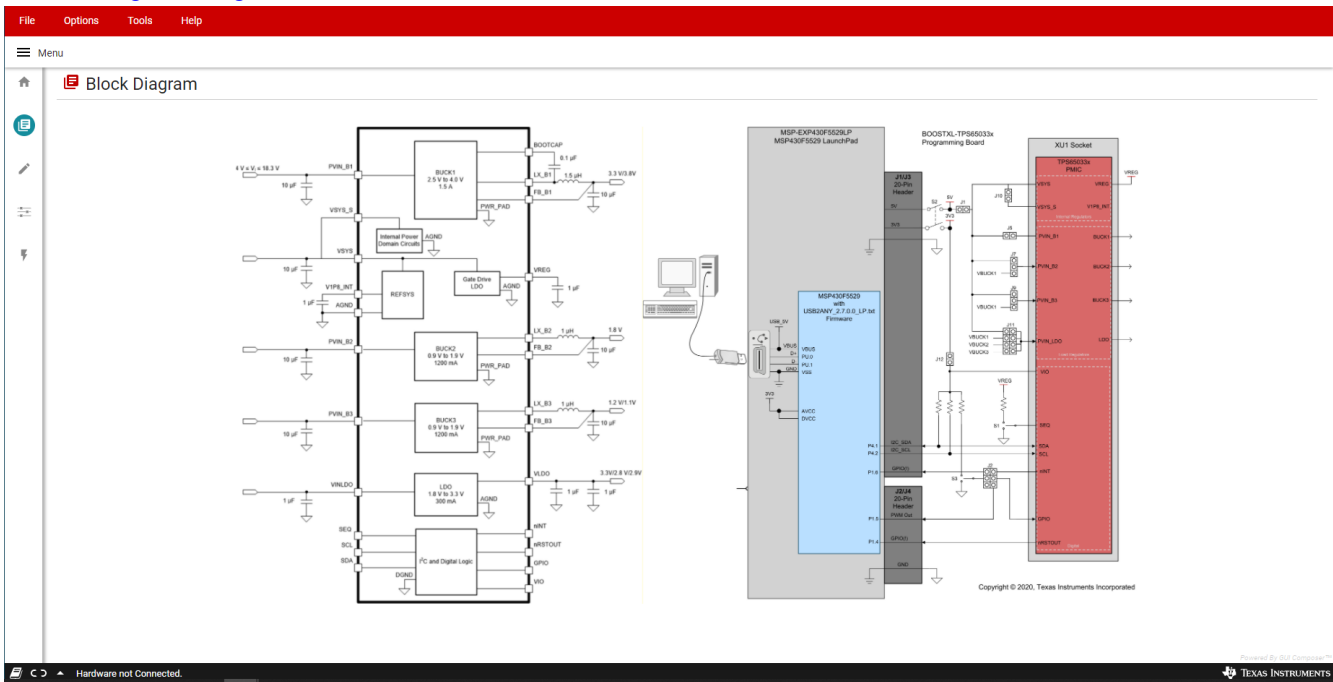


Figure 3-13. TPS6503xx-Q1 GUI Block Diagram Page

### 3.3.3 Registers

The Registers section provides an overview of the internal register map, and includes basic interfaces for each PMIC register. [Figure 3-14](#) illustrates the register page and the primary interactive regions.

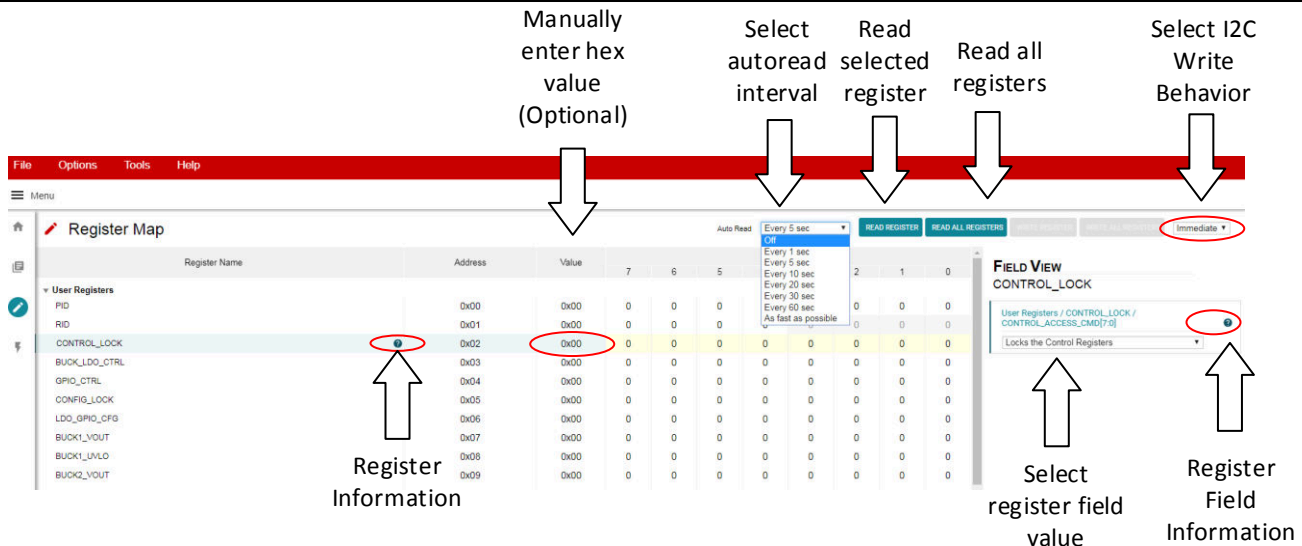


Figure 3-14. Register Page Interfaces

The register table displays each register name, address, last known value from the PMIC, and corresponding bit values. Selecting a title or bit fields in the table will update the Field View column on the right side of the GUI. The Field View displays the individual fields contained within the associated register address. Within the register page, clicking a blue icon containing a question mark (?) will expand additional descriptions if available. The expanded description views can then be closed by clicking the red (x) icon.

This register page can poll the device periodically using the *Auto Read* feature in the top right corner, or allow manual read instructions using the *Read Register* and *Read All Registers* buttons.

A drop-down menu selection at the top right of the register map indicates how the registers are written as the user interacts with the register page. With *Immediate* selected, any update to the register page is automatically sent to the PMIC, whereas *Deferred* will wait for the *Write Register* or *Write All Registers* instructions before communicating with the device. After each write, the register page will automatically read the affected register address to confirm the latest value in the device.

### 3.3.4 Device Configuration

The Device Configuration section is organized into selectable tabs at the top of the page, where only the contents of the blue tab is actively displayed. Each tab contains categorized visual instruments relating to individual bit fields within the register map. Each instrument is linked to the latest bit values in the register map table, and can be used to alter settings within the PMIC through the dropdown menus or check box features. If the *Auto Read* function in the register map is inactive, the *Read All Registers* button in the top right area of the Device Configuration page can be used to manually refresh the register page, which will then update the instruments with the latest device values.

The PMIC incorporates *Control Lock* and *Configuration Lock* features that can prevent I<sup>2</sup>C writes to various registers within the device. The status of these locks will always be displayed in the top right hand corner of the Device Configurations page, and can be toggled by clicking their associated checkbox. When the GUI is properly connected to the EVM and write instructions appear to be ignored by the PMIC, confirm the status of these indicators to verify the device is able to accept new write instructions.

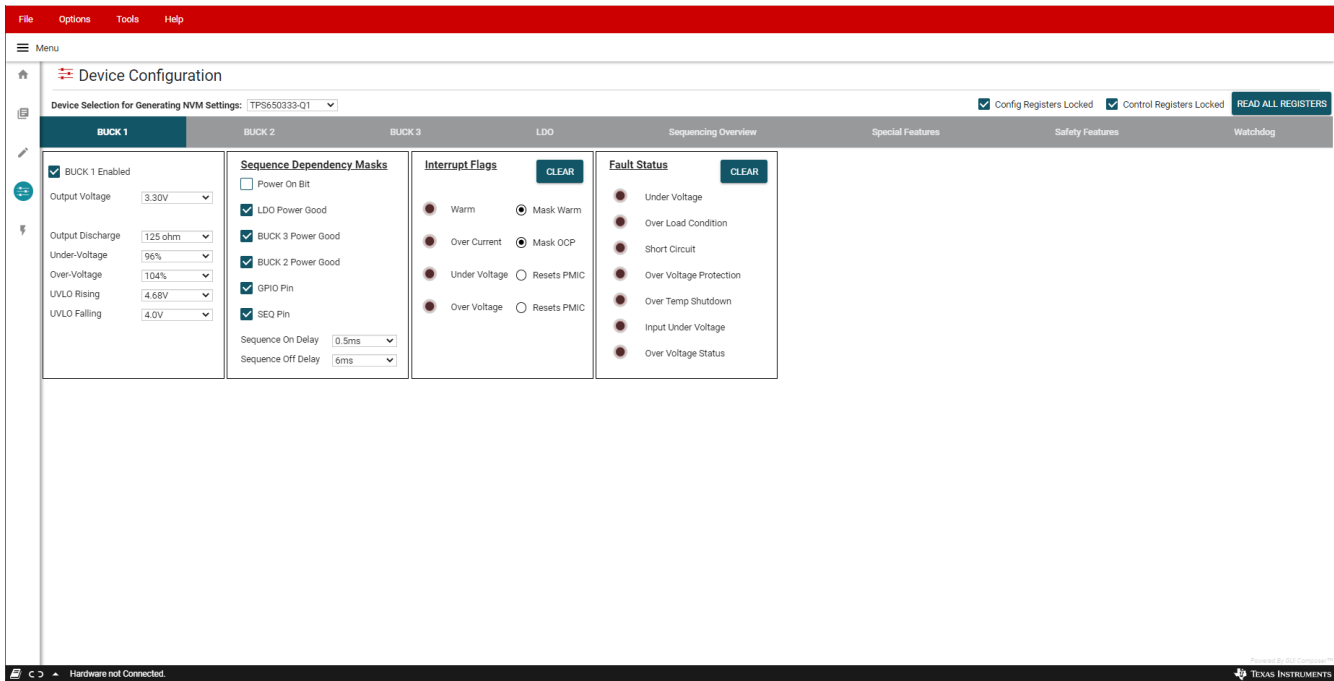


Figure 3-15. TPS6503xx-Q1 GUI Device Configuration Page

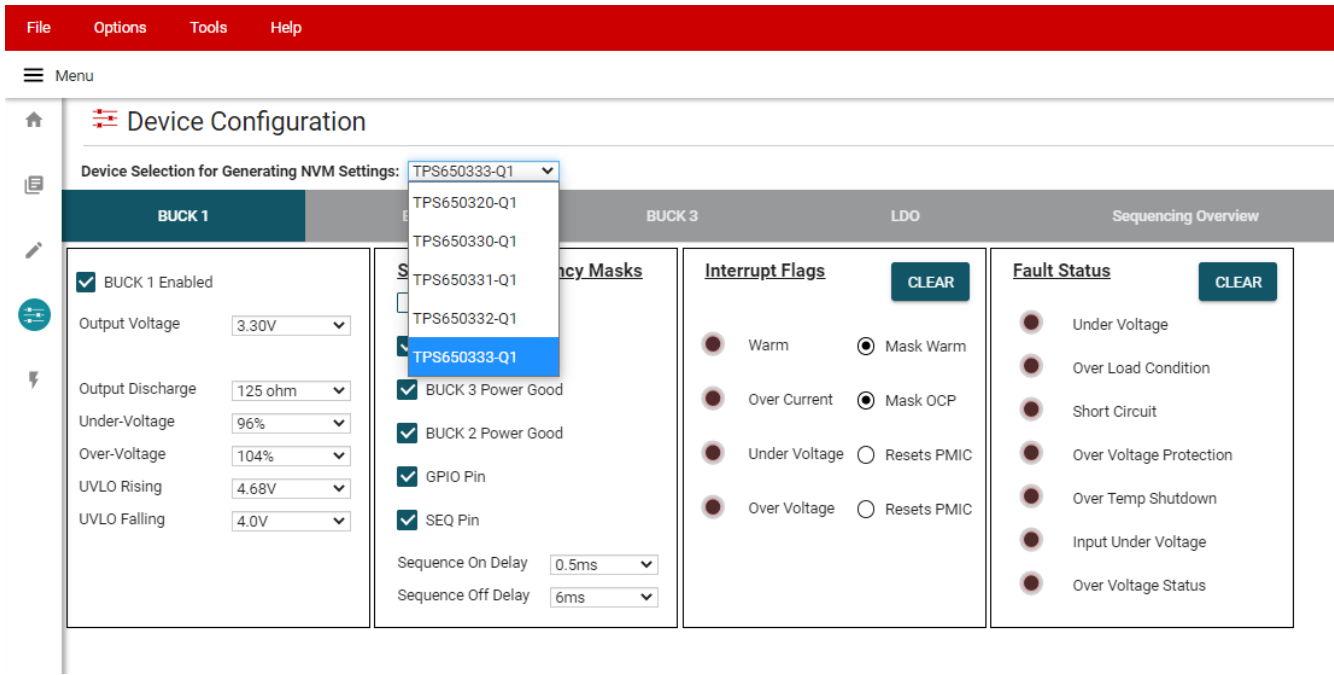
### 3.3.4.1 Using Device Configuration to Define Spin Settings

In some circumstances, TI may provide customized, pre-programmed devices for the camera application. Contact a local TI sales representative for more information.

The Device Configuration tabs in the GUI can be used to define custom settings for TI to pre-program into the device Non-Volatile Memory (NVM). Before beginning the spin definition, see the [Camera PMIC Spin Selection Guide](#) to determine if there is an existing spin that is already compatible with the target application and the image sensor or both.

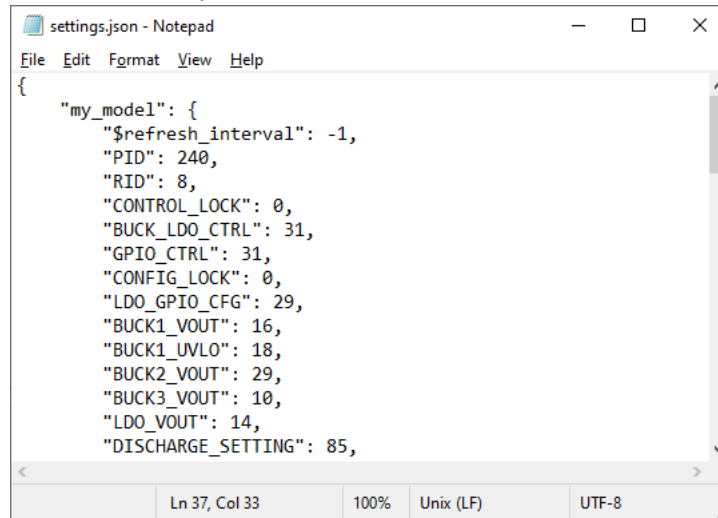
Since the visual instruments in the Device Configuration page link directly to the corresponding bits and registers in the Register Map page, the Device Configuration page can be used to quickly define desired OTP register settings.

1. Select the desired camera PMIC from the drop-down menu above the tab indicators to start. The GUI will automatically show, hide, or disable features corresponding to the selected PMIC. This drop down box will not be adjustable if a device is connected to the GUI.



**Figure 3-16. Device Selection for Generating NVM Settings**

2. Select the desired regulator, sequencing, and additional feature settings in each of the tabs. These changes will be reflected in the Register Map page. For determining the power sequence settings, see [Section 3.3.4.2](#).
3. Click File > Save Settings in the top left corner of the GUI. This exports the register settings in a JSON file that is provided to generate the NVM spin.



**Figure 3-17. Example Settings Output**

### 3.3.4.2 Configuring the Power Sequence

The *Sequencing Overview* tab includes instruments to customize the power sequence of the PMIC. Note that the check boxes are power sequence *masks*. If a particular logic signal needs to be included as part of the regulator or logic power up sequence, leave the box next to the logic signal unchecked. TI recommends to set *Power On Bit* unmasked for each rail that is required in the application.

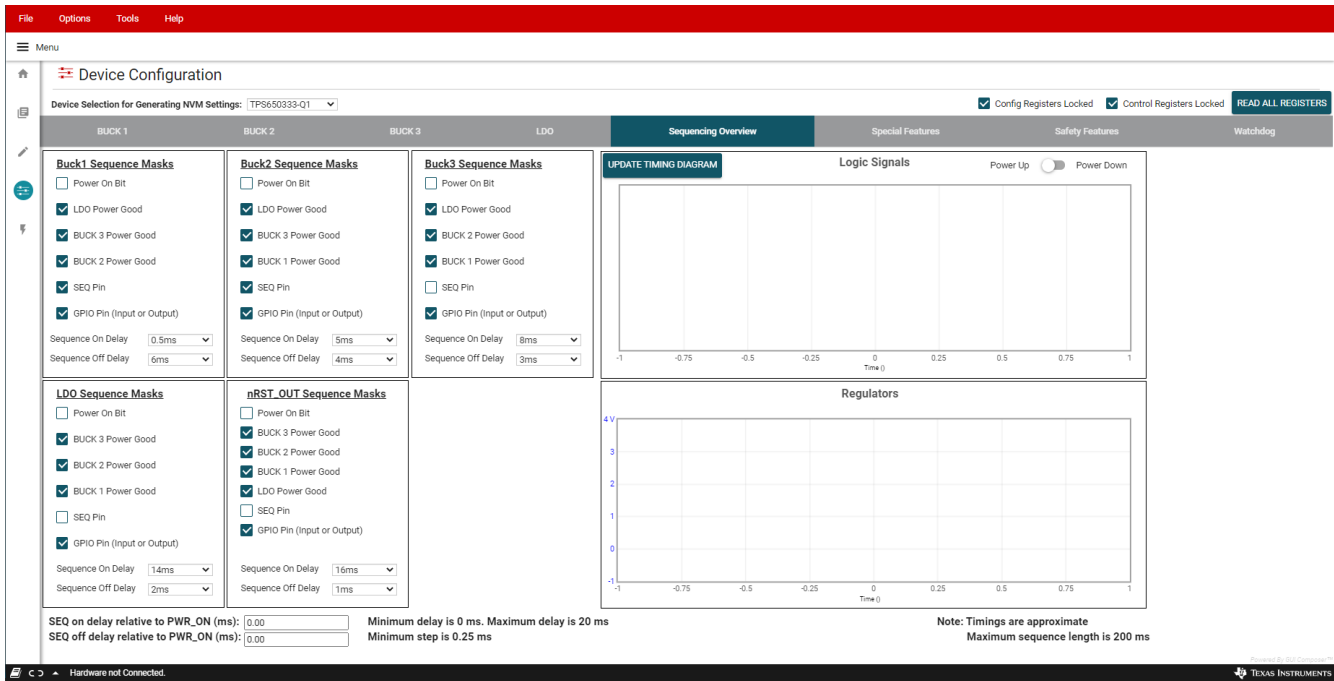


Figure 3-18. Sequencing Overview Tab

When using a TPS65033x-Q1 device, the GPIO pin can also be used for power sequencing of an external regulator or other device. In the *Special Features* tab, configure GPIO as an output to include its sequencing in the *Sequencing Overview* tab. Note that when using GPIO for sequencing, the GPIO Function must be *Enabled*.

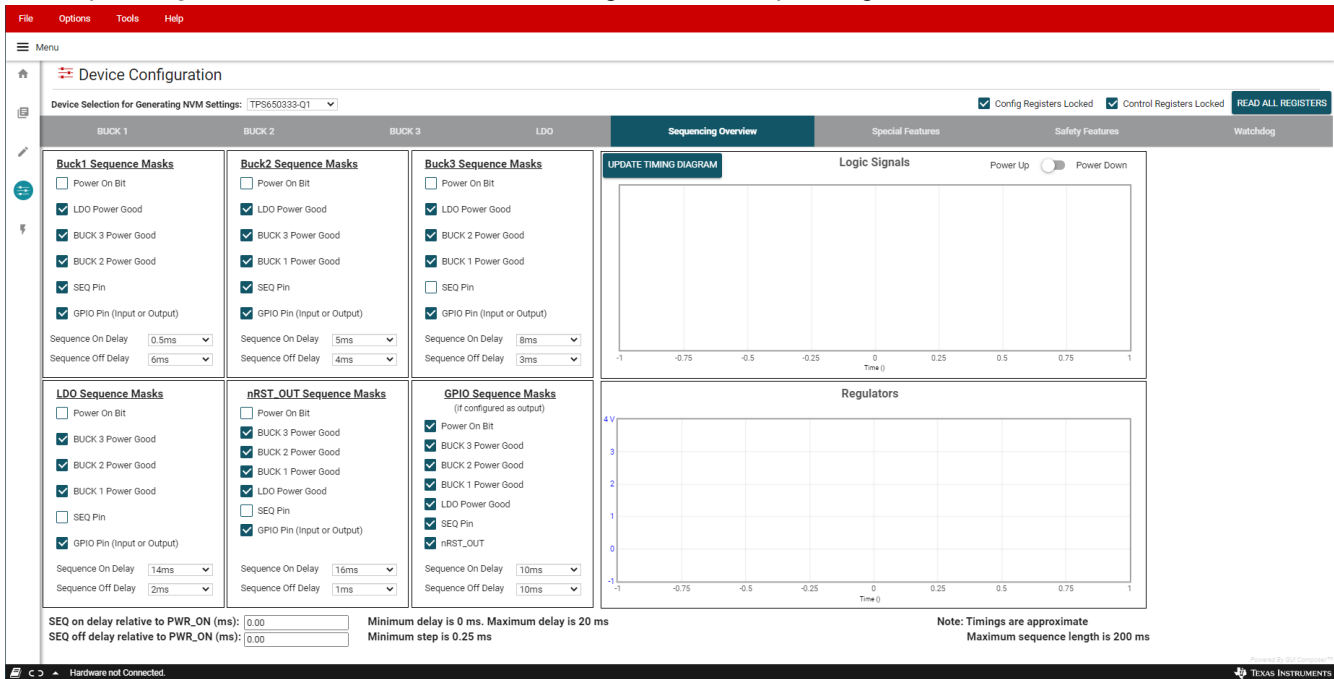


Figure 3-19. Sequencing Overview Including GPIO

For reference, the GUI can generate example power-up and power-down timing diagrams based on the sequence settings present when the *UPDATE TIMING DIAGRAM* button is clicked. As noted, rise and fall times are approximate, and the maximum sequence length is 200 ms. Changes to regulator enable and output discharge settings are reflected in the timing diagram. If the sequence settings are not valid, the GUI will provide a notifying message and the timing diagram will not be updated. For example, if a regulator is enabled but fails to power-up within 200 ms, the sequence settings are not valid.

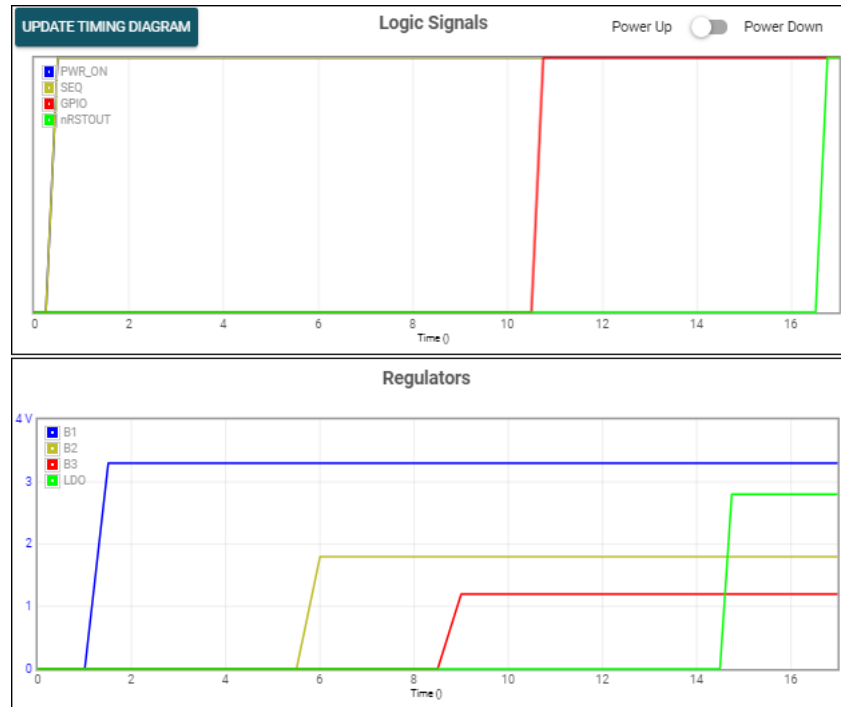


Figure 3-20. GUI Generated Timing Diagram

### 3.4 Scripting

The GUI includes a scripting feature in the tools menu at the top of the window. Scripting enables automated writes and reads to the PMIC, allowing sequential instructions to be sent to the PMIC. Scripts can be saved as a .js or .txt file, and imported using the *Upload* arrow at the top of the scripting window. Scripting allows the re-configuration of multiple PMICs before sending to assembly or populating on a PCB.

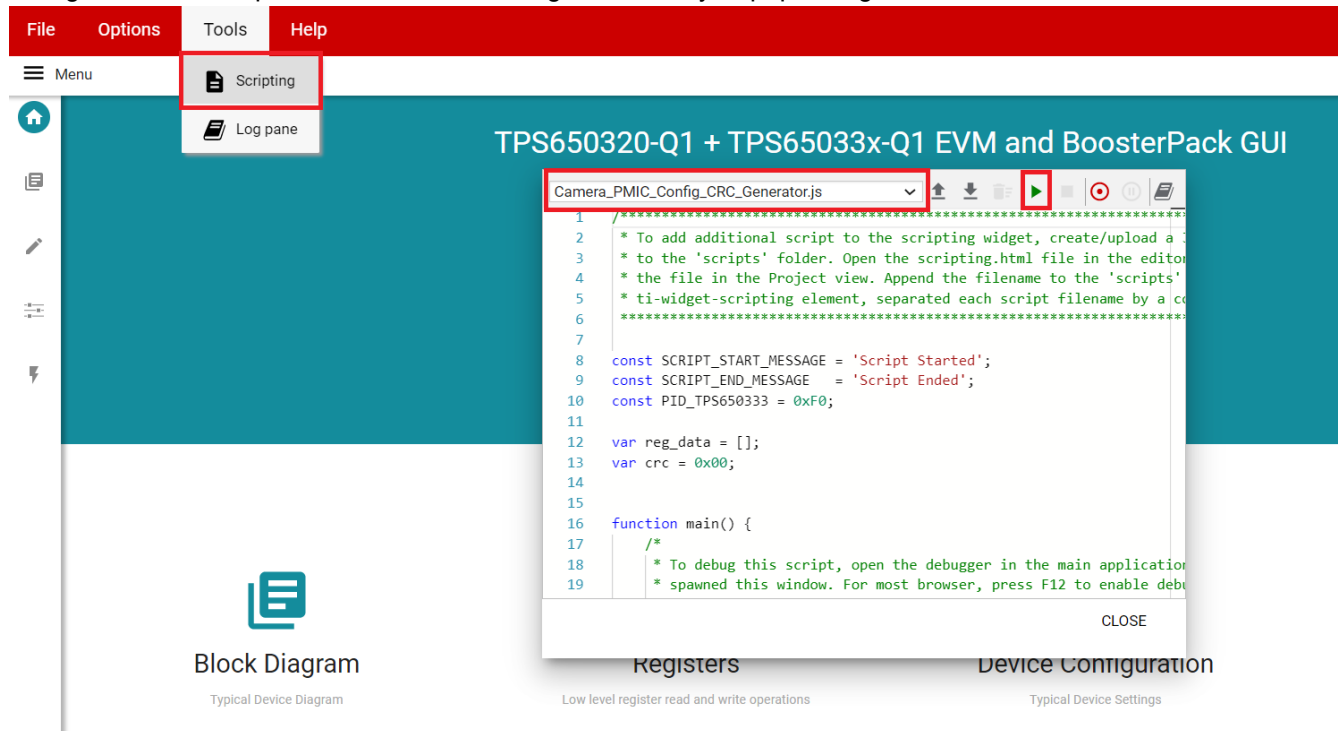


Figure 3-21. TPS6503xx-Q1 GUI Scripting Window



An example script for re-programming a device can be seen below, where output voltages and sequencing settings are reconfigured from the default settings.

```

/* Entry point for the script, which will be executed when the user presses the PLAY button in the
Scripting Dialog. */
function main() {
write('CONTROL_LOCK', 0xDD); // Unlock control registers
write('CONFIG_LOCK', 0xAA); // Unlock configuration registers
write('GPIO_CTRL', 2); // Disable configuration CRC
write('BUCK_LDO_CTRL', 0x00); // Turn off all regulators to prevent faults
write('BUCK3_VOUT', 6); // Change Buck 3 output voltage
write('LDO_VOUT', 8); // Change LDO output voltage
write('SEQ_TRIG_BUCK2', 10); // Update Buck 2 sequence dependencies
write('SEQ_TRIG_BUCK3', 2); // Update Buck 3 sequence dependencies
write('SEQ_TRIG_LDO', 26); // Update LDO sequence dependencies
write('SEQ_TRIG_nRSTOUT', 2); // Update nRSTOUT sequence dependencies
write('BUCK1_SEQ_DLY', 145); // Update Buck 1 sequence delay
write('BUCK2_SEQ_DLY', 86); // Update Buck 2 sequence delay
write('BUCK3_SEQ_DLY', 54); // Update Buck 3 sequence delay
write('LDO_SEQ_DLY', 118); // Update LDO sequence delay
write('nRSTOUT_SEQ_DLY', 6); // Update nRSTOUT sequence delay
write('BUCK_LDO_CTRL', 31); // Re-enable all regulators
write('EEPROM_PFG_CMD', 45); // Burn settings into EEPROM
}

```

Figure 3-22 details the typical device programming flow. Most blocks can be executed with one or more register write commands in the script file. Only the J2 configuration and GPIO trigger application cannot be done via scripting.

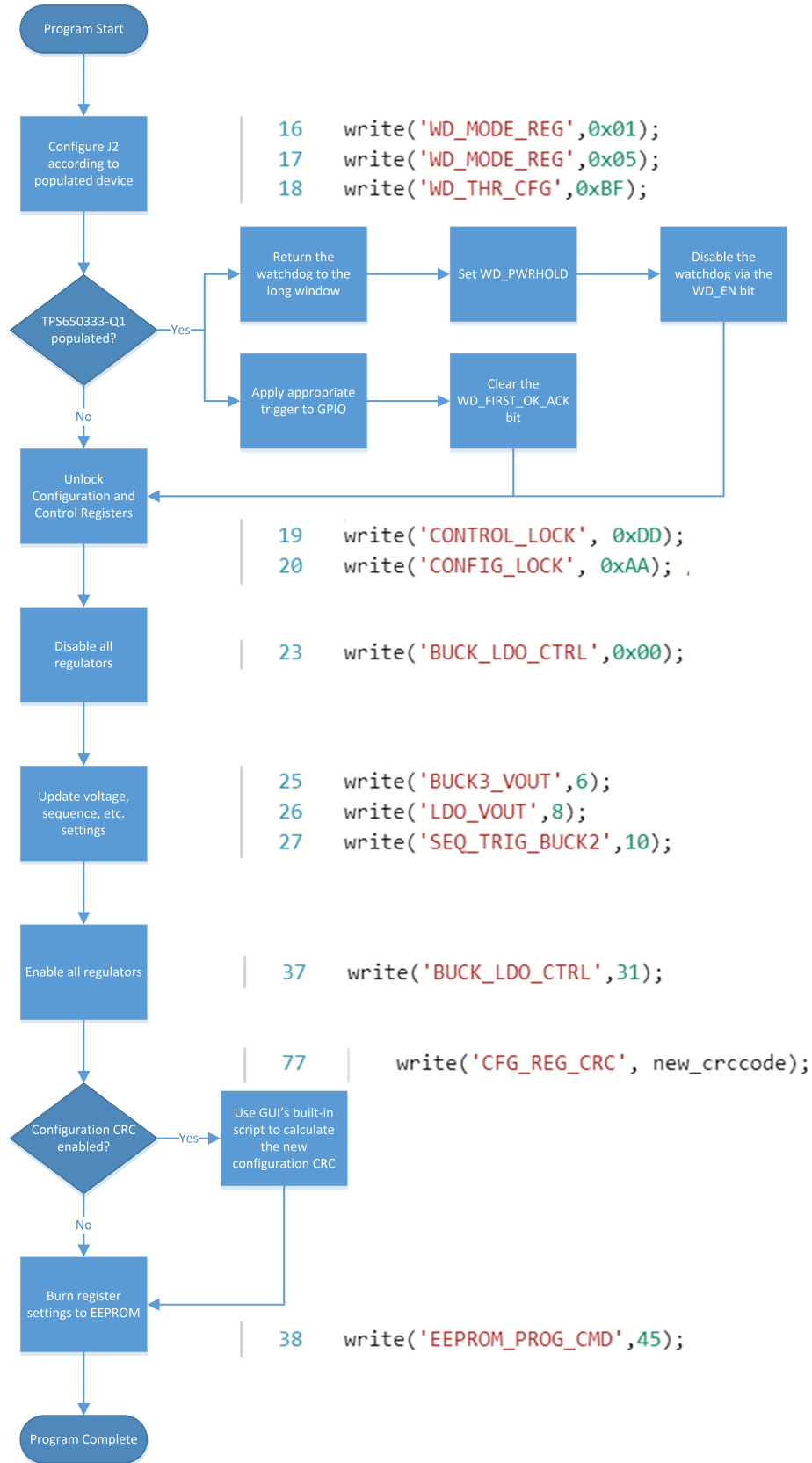


Figure 3-22. Example Script Program Flow

## 4 Recommended Operating Procedure

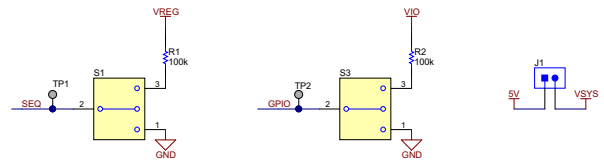
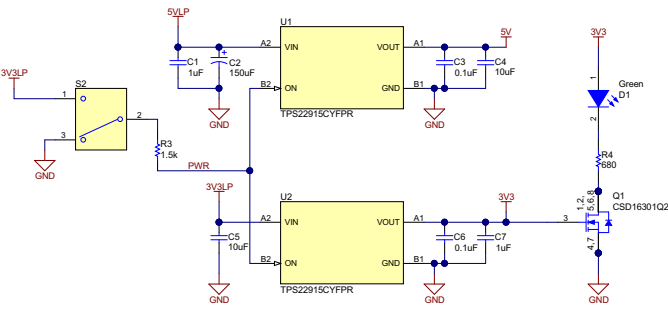
- Due to the parasitic elements introduced by the BOOSTXL-TPS65033 socket, it is recommended to use the BOOSTXL-TPS65033 board primarily for digital evaluation. This includes features like NVM programming, state machine behavior, diagnostics, and fault handling.
- For analog performance evaluation of the PMIC, please refer to the [TPS650320-Q1 EVM](#) and the [TPS650330-Q1 EVM](#).

1. Connect the socketed board to the MSP430F5529 LaunchPad by aligning placing the socketed board on top of the LaunchPad, aligning the J1/J3 and J2/J4 headers, and pressing the two boards together. For the MSP432E401Y, align with the J5/J7 and J6/J8 headers.
2. Ensure S1, S2, and S3 of the socketed board are not asserted (down position), and connect the LaunchPad to the PC using a micro-USB cable. A TPS65032001-Q1 or TPS65033x-Q1 device may be inserted into the socket at any time that S2 is open and proper ESD considerations are observed. Ensure the unit's Pin 1 indicator is aligned with the Pin 1 silkscreen indicator on the lower left corner of the socketed board.
3. Ensure the *Device Selection* jumper (J2) matches the generic part number of the device populated in the socket.
4. If this is the first time using the LaunchPad with the [TPS6503xx-Q1 GUI](#), flash the LaunchPad using the steps outlined in [Section 3.1.3](#) or [Section 3.1.4](#). This will permanently configure the LaunchPad to act as a USB-to-I2C adapter and will not be necessary for subsequent sessions.
5. Set S2 to the active position. The D1 LED will indicate when power is supplied to the socket.
6. Verify the connection status of the adapter in the bottom left corner of the GUI window. If *Hardware not Connected* is displayed, toggle the connection icon once to refresh the adapter connection. With the D1 LED active and the adapter recognized by the GUI, I2C communication should be available to the PMIC. The adapter will disconnect if I2C communication fails. Verify that the I2C pull-up voltage is available (J12 and VIO test point) if the GUI consistently disconnects after read or write attempts.
7. Navigate to the Register Map or Device Configuration page, and select the *Read All Registers* button in the top right corner of the GUI window.
8. The Register Map will populate with the returned values as the PMIC replies to the I2C read requests. The Register Map can directly interact with the PMIC through drop down menus for each register field or by directly writing into the value column for the individual registers. For a graphical representation of common device settings, select the slider icon below the pencil icon in the left toolbar to navigate to the *Device Configuration* view. These visual indicators are linked directly to the respective bits or bitfields in the register map.
9. Selecting the tabs at the top of the Device Configuration view will navigate through the categorized register fields.
10. By default, the Control and Configuration registers of the PMIC are always locked after a re-start event, preventing accidental I2C writes to the device. The check-boxes in the top right corner of the *Device Configuration* view can verify if critical registers are accepting write instructions from the I2C master. These check boxes can also be used to lock and unlock the associated registers.
11. By default, certain regulators are dependent on either the status of SEQ (S1), or the status of SEQ and GPIO (S3). All sequencing dependencies are visible in the regulator's respective tab, or by using the *Sequencing Overview* tab within the *Device Configuration* view.
12. When registers are unlocked, any changes to the device registers will take effect immediately.
13. The PMIC will always return to default settings if a fault occurs that forces a transition to the RESET state.
14. Register changes will not be stored in EEPROM unless the programming instruction has been sent to the PMIC through the I2C.
15. The EEPROM is programmed when a hex value of 0x2D is written to register 0x4A. In the GUI, this can be done directly through the register map or by clicking the *Flash EEPROM* button in the *Re-Program PMIC* view of the GUI.

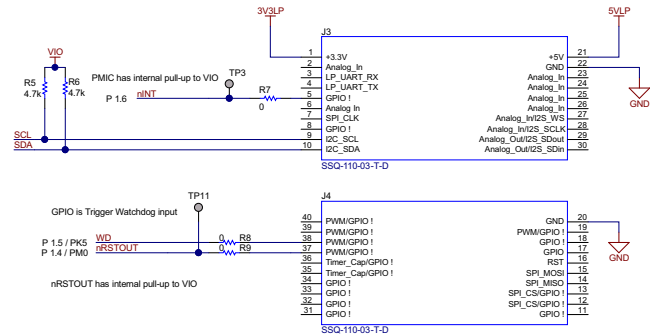
## 5 BOOSTXL-TPS65033 Schematic

### Board Power (Switches and I-Limiting)

### SEQ, GPIO, and VSYS Selection



### Launchpad Connectors



### TPS65033x Socket

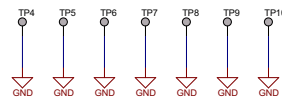
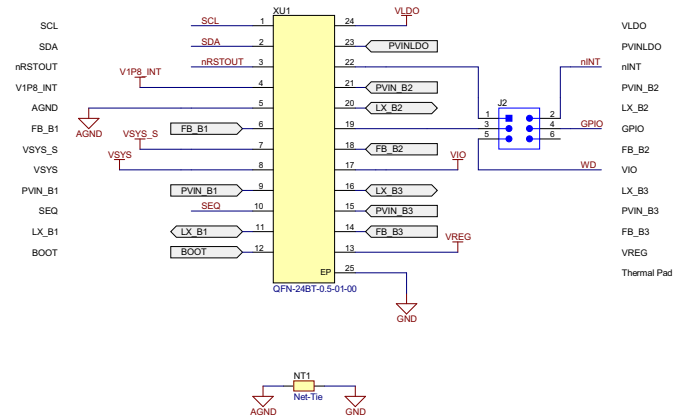
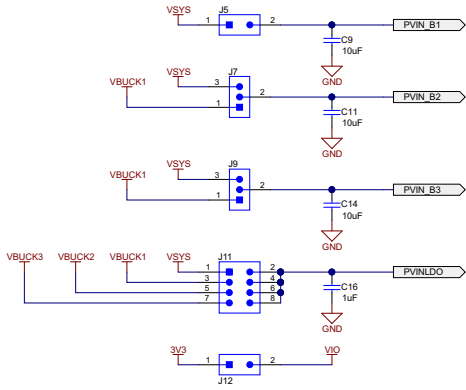
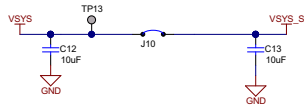


Figure 5-1. BOOSTXL-TPS65033 LaunchPad and Socket Connections

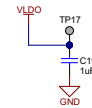
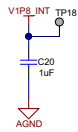
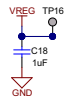
## Regulator Input Supply Selection



## VSYS\_S Selection



## Internal Supply Capacitors



## Regulator Output Filters

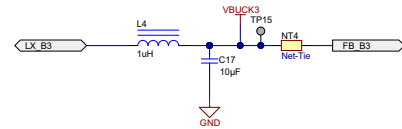
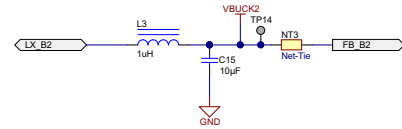
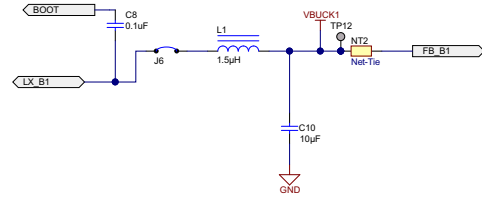


Figure 5-2. BOOSTXL-TPS65033 Power Supplies



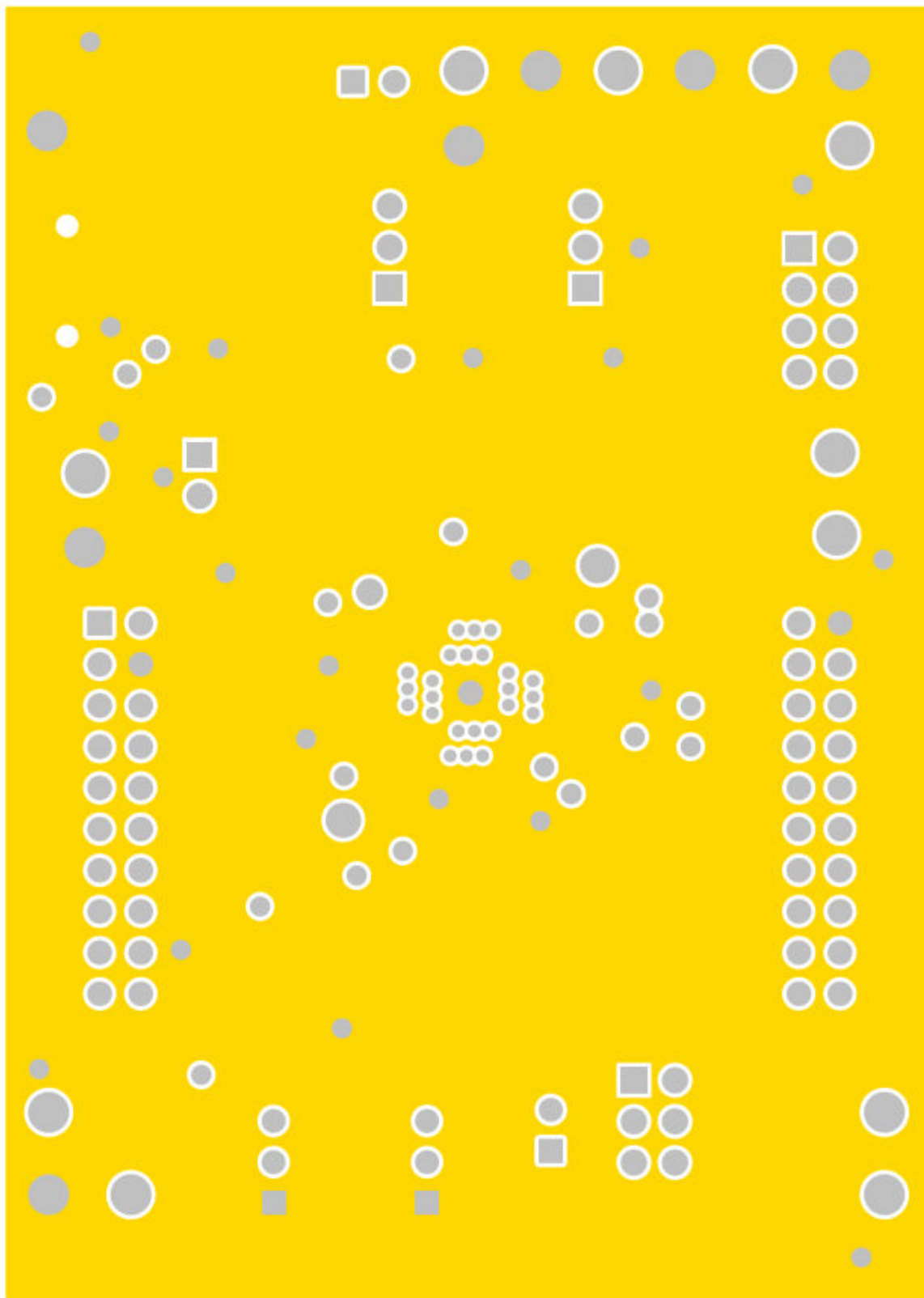
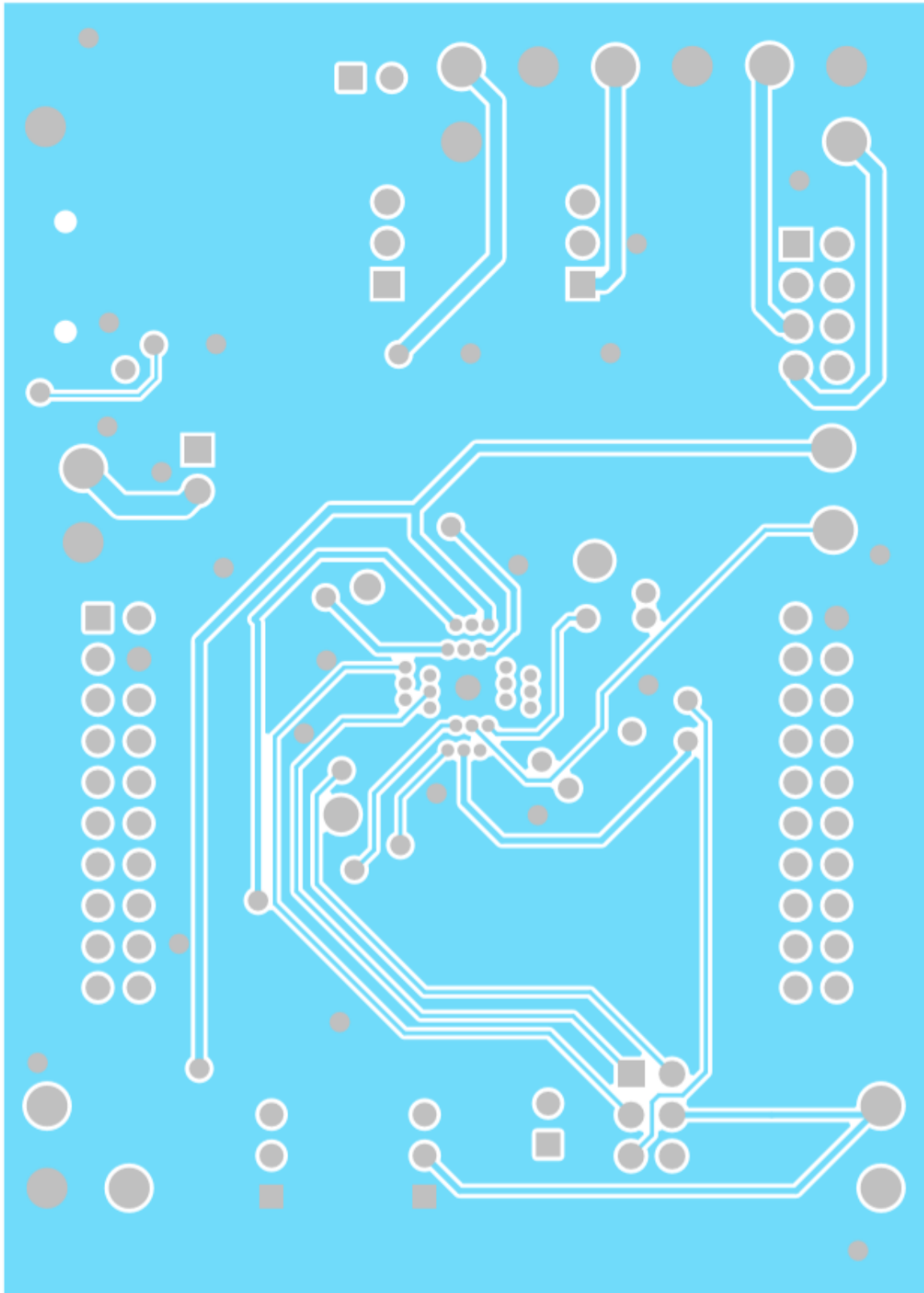


Figure 6-2. Mid-Layer 1



**Figure 6-3. Mid-Layer 2**



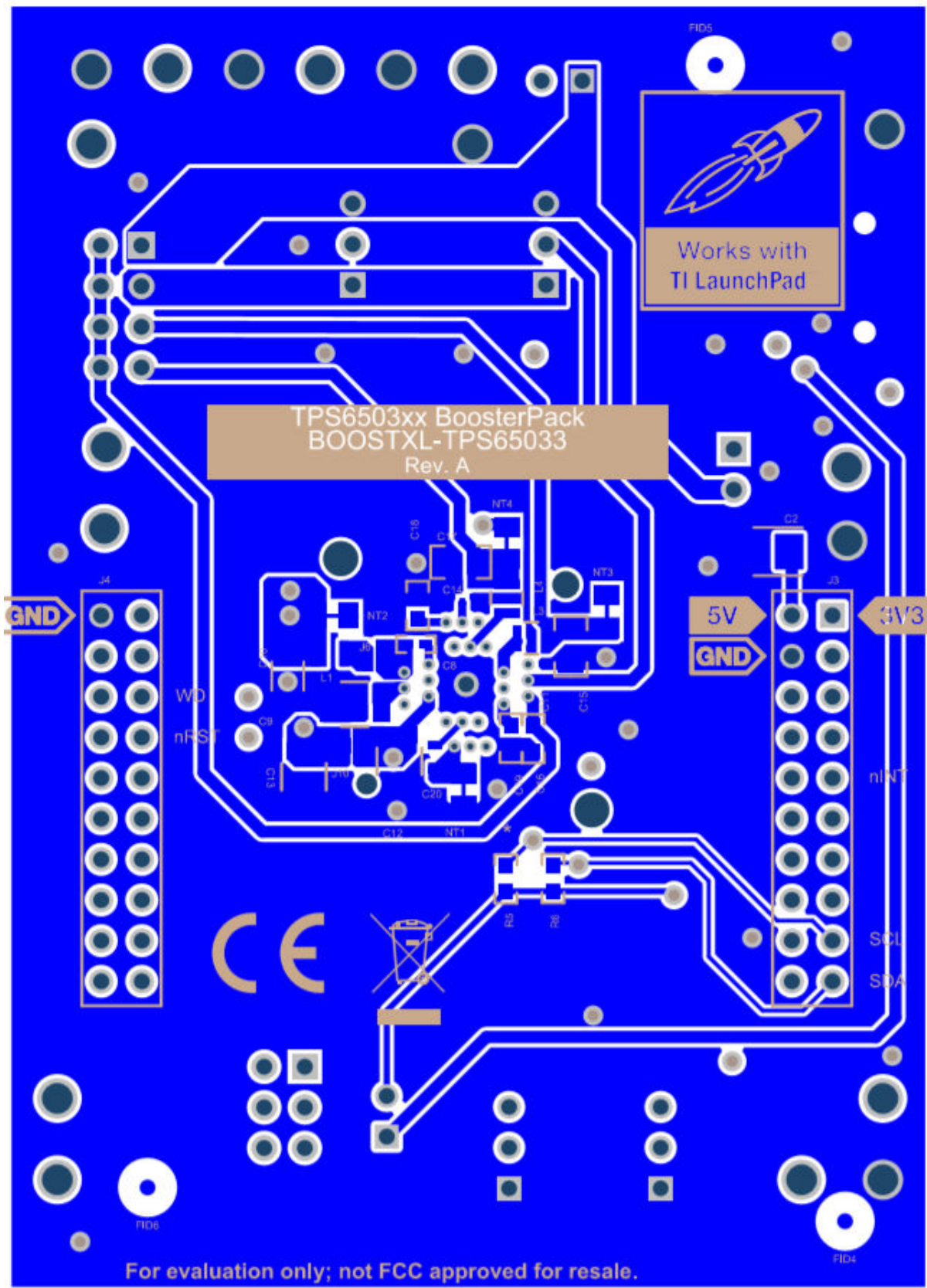


Figure 6-4. Bottom Layer (Mirrored)

## 7 BOOSTXL-TPS65033 Bill of Materials

**Table 7-1. BOOSTXL-TPS65033 Bill of Materials (BOM)**

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		BMC059	Any
C1, C7	2	1 $\mu$ F	CAP, CERM, 1 $\mu$ F, 35 V, $\pm$ 20%, X5R, 0402	0402	GRM155R6YA105ME1 1D	MuRata
C2	1	150 $\mu$ F	CAP, TA, 150 $\mu$ F, 6.3 V, $\pm$ 20%, 0.025 $\Omega$ , SMD	3528-21	T520B157M006ATE025	Kemet
C3, C6	2	0.1 $\mu$ F	CAP, CERM, 0.1 $\mu$ F, 10 V, $\pm$ 20%, X5R, 0402	0402	885012105010	Würth Elektronik
C4, C5, C11, C14	4	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 10 V, $\pm$ 20%, X5R, 0402	0402	CL05A106MP5NUNC	Samsung Electro-Mechanics
C8	1	0.1 $\mu$ F	CAP, CERM, 0.1 $\mu$ F, 50 V, $\pm$ 20%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104M0 50BB	TDK
C9, C12, C13	3	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 25 V, $\pm$ 20%, X7R, AEC-Q200 Grade 1, 1210	1210	CGA6P1X7R1E106M2 50AC	TDK
C10	1	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 10 V, $\pm$ 20%, X7R, AEC-Q200 Grade 1, 1206	1206	LMK316AB7106MLHT	Taiyo Yuden
C15, C17	2	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 0805	0805	JMJ212CB7106KGHT	Taiyo Yuden
C16, C18, C19, C20	4	1 $\mu$ F	CAP, CERM, 1 $\mu$ F, 10 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 0603	0603	LMK107B7105KAHT	Taiyo Yuden
D1	1	Green	LED, Green, SMD	0.8x1.6 mm	HSMG-C190	Avago
H1	1		IC to place in Socket XU1		TPS650330QRGEQ1	Texas Instruments
J1	1		Header, 100 mil, 2x1, Tin, TH	Header 2x1	90120-0122	Molex
J2	1		Header, 100 mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions
J3, J4	2		Receptacle, 2.54 mm, 10x2, Tin, TH	10x2 Receptacle	SSQ-110-03-T-D	Samtec
J5, J12	2		Header, 100 mil, 2x1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions
J7, J9	2		Header, 100 mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J11	1		Header, 100 mil, 4x2, Tin, TH	Header, 4x2, 100 mil, Tin	PEC04DAAN	Sullins Connector Solutions
L1	1	1.5 $\mu$ H	Inductor, Shielded, Metal Composite, 1.5 $\mu$ H, 2.3 A, 0.11 $\Omega$ , AEC-Q200 Grade 0, SMD	0806	TFM201610ALMA1R5 MTA	TDK
L3, L4	2	1 $\mu$ H	Inductor, 1 $\mu$ H, 3.1 A, 0.06 $\Omega$ , SMD	2.0x1.6x1.0 mm	TFM201610GHM-1R0 MTA	TDK
Q1	1	25 V	MOSFET, N-CH, 25 V, 5 A, DQK0006C (WSON-6)	DQK0006C	CSD16301Q2	Texas Instruments
R1, R2	2	100 k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KJNEA	Vishay-Dale
R3	1	1.5 k	RES, 1.5 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K50JNED	Vishay-Dale
R4	1	680	RES, 680, 5%, 0.1 W, 0603	0603	RC0603JR-07680RL	Yageo
R5, R6	2	4.7k	RES, 4.7 k, 5%, 0.1 W, 0603	0603	RC0603JR-074K7L	Yageo

**Table 7-1. BOOSTXL-TPS65033 Bill of Materials (BOM) (continued)**

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R7, R8, R9	3	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
S1, S3	2		Switch, Slide, SPDT, On-Off-On, 3 Pos, 0.05 A, 48 V, TH	9.5x5 mm	AS1E-2M-10-Z	Copal Electronics
S2	1		Switch, Slide, SPDT, 0.2 A, J Lead, SMD	SMD, 3-Leads, Body 8.5x3.5 mm, Pitch 2.5 mm	CL-SB-12A-01T	Copal Electronics
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	8	1x2	Shunt, 100 mil, Flash Gold, Black	Closed Top 100 mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18	18		PCB Pin, Swage Mount, TH	PCB Pin(2505-2)	2505-2-00-44-00-00-07-0	mill-Max
U1, U2	2		5.5 V, 2 A, 38 mΩ Load Switch With Quick Output Discharge, YFP0004AAAA (DSBGA-4)	YFP0004AAAA	TPS22915CYFPR	Texas Instruments
XU1	1		Socket, QFN-24, 0.5 mm Pitch	Socket, QFN-24, 0.5 mm Pitch	QFN-24BT-0.5-01-00	Enplas Tech Solutions

## 8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Revision * (April 2019) to Revision A (October 2020)</b>	<b>Page</b>
• Changed the title from <i>TPS65033x Programming Board Users Guide</i> to <i>BOOSTXL-TPS65033 EVM User's Guide</i> .....	1
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Updated the <i>Abstract</i> section.....	1
• Changed the part numbers from <i>TPS650320</i> and <i>TPS65033x</i> to <i>TPS65032001-Q1</i> and <i>TPS65033x-Q1</i> throughout the user's guide.....	1
• Updated links in the <i>BOOSTXL-TPS65033 Components and Environment</i> section.....	2
• Updated the <i>Critical Socketed Board Connections</i> section.....	3
• Updated the <i>Power Switches</i> section.....	4
• Updated the <i>Finding the GUI</i> section.....	5
• Updated the <i>Offline Installation</i> section.....	5
• Added the <i>Flashing the MSP432E401Y Launch Pad</i> section.....	6
• Updated the <i>Basic Operation of the GUI</i> section.....	10
• Added the <i>Home</i> section.....	10
• Added the <i>Block Diagram</i> section.....	11
• Added the <i>Registers</i> section.....	11
• Added the <i>Device Configuration</i> section.....	12
• Added the <i>Using Device Configuration to Define Spin Settings</i> section.....	12
• Added the <i>Configuring the Power Sequence</i> section.....	12
• Updated the <i>Scripting</i> section.....	16
• Updated the <i>Recommended Operation Procedure</i> section.....	19
• Added the <i>BOOSTXL-TPS65033 Schematic</i> section.....	20
• Added the <i>BOOSTXL-TPS65033 Board Layers</i> section.....	22
• Added the <i>BOOSTXL-TPS65033 Bill of Materials</i> section.....	26

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  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 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.

### **WARNING**

**Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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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電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。[http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

#### 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.
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