# *EVM User's Guide: TPS2HCS10-Q1*
# ***Smart Fuse Evaluation Module***

## Description

The HSS-HCMOTHERBRDEVM and corresponding daughter cards (such as the HSS-2HCS08EVM) are used to showcase and evaluate all features of the Texas Instruments' smart fuse high-side switch portfolio. The motherboard is designed to be used with several different daughter cards enabling the use of a single host EVM for a variety of different high-side switches and controllers with varying on-resistances and functionality. A pre-flashed TM4C MCU is included with each HSS-HCMOTHERBRDEVM to act as a USB-to-SPI bridge and allow the user to seamlessly configure/manipulate the device. This MCU communicates with a Windows® host GUI application titled *Smart Fuse Configurator* to allow for full configuration and evaluation of the attached high-side switch.

## Get Started

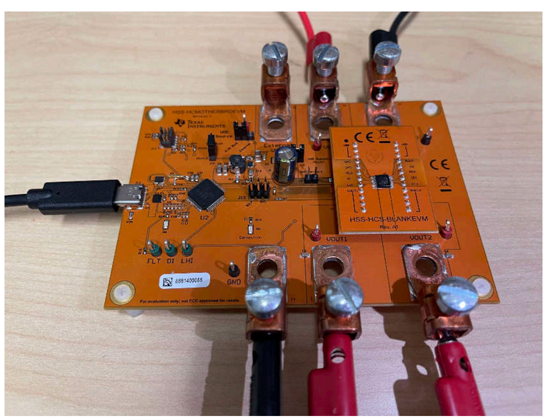
1. Order both the HSS-HCMOTHERBRDEVM and an accompanying daughter card (such as the HSS-2HCS08EVM) on ti.com.[1]
2. Plug the daughter card into the socket of the motherboard aligning the dots to signify pin 1.
3. Connect a power supply to the VBB line (*T6*) and connect the ground of the power supply to the ground line of the board.
4. Connect the relevant loads to the outputs of the board (*T2* and *T3*).
5. Download the Smart Fuse Configurator from the EVM product page.
6. Open the Smart Fuse Configurator host program and use as described in this document.

## Features

- Daughter card socket: modular daughter card design allowing to use any TI smart fuse high-side switch via the same motherboard EVM
- TM4C123GH6 32-bit Arm Cortex-M4F based MCU: used as a USB to SPI host from the host PC to the attach high-side switch daughter card
  – 9-pin Cortex-M JTAG port allows for users to program/debug own firmware to the TM4C123
- LMR43610-Q1 automotive 3V to 36V, 1A, low-EMI synchronous buck regulator: uses the supply voltage to derive 3.3V power rail to supply VDD of high-side switch
  – Can be disabled via jumper setting if external VDD source is desired
- Test points: fully accessible test-points/headers allowing complete access to SPI lines, fault signals, power rails

## Applications

- Automotive Zone ECU
- Power Distribution Modules
- Body control modules



[1] The daughter cards and mother boards have two separate orderable numbers.

# 1 Evaluation Module Overview

## 1.1 Introduction

The HSS-HCMOTHERBRDEVM and accompanying daughter card EVMs (such as the HSS-2HCS08EVM) are hardware evaluation boards used for evaluation and development of Texas Instruments' smart fuse high-side switch portfolio. A daughter card and motherboard approach is used in the hardware ecosystem to promote reuse of hardware and software, as well showcase the pin compatibility between different smart fuse devices.

As many of TI's smart fuse high-side switches have a digital SPI interface, this hardware ecosystem is designed to simplify evaluation and development as well as reduce the need for the user to invest any significant software resources on the host side. The HSS-HCMOTHERBRDEVM has an integrated TM4C123 Cortex-M4F USB microcontroller that serves as a USB-to-SPI bridge between a host PC and the attached daughter card EVM. A simple Windows GUI program titled *Smart Fuse Configurator* is provided that allows a multitude of features including:

- Reading/graphing load current, input/output voltage, and junction temperature via the high-side switch's integrated ADC
- Turn on/off channels and set operational settings such as PWM and current limit
- Providing an interface to tune the I2T curve and compare with a customer wire profile for fuse replacement
- Monitor device and channel fault status complete with aggregation statistics
- Setup/configure all register settings of the high-side switch directly from the GUI
- Direct register reads/writes through console view
- Export/import settings as well as export development artifacts such as C configuration arrays/structures
- Save high-side switch configuration data to MCU flash
- Multi-lingual support including Japanese and English

The host GUI does not require special drivers, and uses standard Windows USB-HID calls to communicate with the HSS-HCMOTHERBRDEVM. Only Windows is supported with this EVM ecosystem. The EVM comes with the TM4C firmware pre-programmed without the need for the user to perform any initial firmware flashing.

## 1.2 Kit Contents

The EVM kit for the HSS-HCMOTHERBRDEVM includes the following:

- One HSS-HCMOTHERBRDEVM with MCU pre-flashed at factory with latest firmware
- One USB-C cable

The kit for the daughter cards are specific to the high-side switch associated with the daughter card. An example kit contents for the HSS-2HCS08EVM daughter card can be seen below:

- One HSS-2HCS08EVM daughter card with a TPS2HCS08-Q1 high-side switch device

Note that in addition to daughter cards with silicon pre-soldered, TI offers a "blank" daughter card called HSS-HCS-BLANKEVM. This blank daughter card is useful when running destructive tests and can be used with any compatible HCS high-side switch.

## 1.3 Specification

The HSS-HCMOTHERBRDEVM and daughter card boards are meant to be used together to evaluate automotive applications where high-side switches are used to drive primarily off-board loads. This EVM contains a pre-flashed microcontroller with firmware that acts as a SPI<-> USB bridge between the high-side switch (SPI) and the host PC system running the GUI (USB). The EVM is designed for ease-of-use and all that is needed is to plug in USB and relevant loads, supply power, and evaluate through the GUI. A block diagram of the various blocks of the EVM can be seen below.

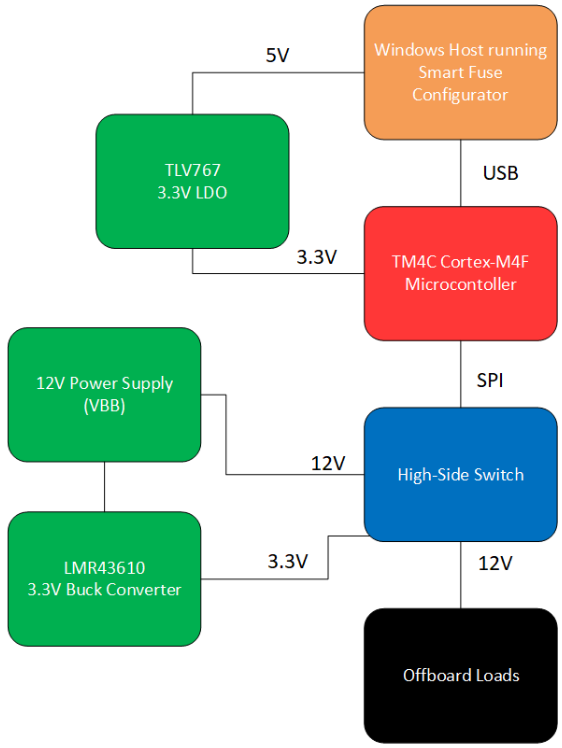



**Figure 1-1. Block Diagram for HSS-HCMOTHERBRDEVM**

As seen from the image above, the EVM has multiple power rails that are derived from input power sources. The 12 V supply voltage is fed into a LMR43610 buck converter to derive the 3.3V rail for the high-side switch. This buck converter is used for the low IQ functionality, so that the *low-power mode* of the high-side switch can be measured through the EVM. A TLV767 LDO is used to derive the 3.3V microcontroller supply from the 5 V USB connection through the PC.

Note that this board is intended to evaluate the standard functionality of the device. The board is not designed to withstand automotive transients events such as hard short-to-ground events, reverse battery events, and ISO 16750-2 load dumps. If short-to-ground is to be performed on the EVM, please refer to the Transient Testing section on how to run transient testing safely on the EVM.

## 1.4 Device Information

The HSS-HCMOTHERBRDEVM and daughter cards uses the following devices from Texas Instruments.

**Table 1-1. Devices Used**

| Device Name | Description | Purpose |
|---|---|---|
| TM4C123GH6PMI7R | 32-bit Arm Cortex-M4F based MCU with 80 -MHz, 256 -KB Flash, 32 -KB RAM, 2 CAN, RTC, USB, 64-Pin | Acts as USB<->SPI bridge between host PC and high-side switch. |
| LMR43610MSC3RPERQ1 | 36-V, 1-A/2-A Buck Converter with <2.5 µA IQ at 150°C TJMAX in 4-mm2 HotRod™ QFN | Derives the 3.3V VDD rail for the high-side switch from the input power supply |
| TLV76633QWDRBRQ1 | Fixed-output, 1-A, 16-V, positive-voltage low-dropout (LDO) linear regulator | Provides 3.3V supply for microcontroller from 5 V USB signal |
| **TPS2HCS08-Q1** | 8-mOhm, Automotive Dual-Channel, SPI controlled High-Side Switch with low Quiescent Current ON Mode and Integrated I2t Wire Protection | High-side switch being evaluated |

# 2 Hardware

## 2.1 Assembly Instructions

To get started with the HSS-HCMOTHERBRDEVM the following resources are required:

- 1x HSS-HCMOTHERBRDEVM
  - Firmware is pre-flashed for the EVM and no need for the user to program the EVM initially.
  - Standard USB cable included.
- 1x HSS-2HCS08EVM daughter card (or any compatible high-side switch daughter card EVM).
- Windows host with .NET framework run-time v4.7.2 (included in all Windows 10 versions and later).
  - Can be downloaded from https://dotnet.microsoft.com/en-us/download/dotnet-framework/net472 for all other versions.
- Texas Instruments Smart Fuse Configurator software tool (4MB).

No special drivers or large proprietary frameworks are needed to run the Smart Fuse Configurator.

To get started, plug the daughter card into the headers marked J1 and J2 on the HSS-HCMOTHERBRDEVM as seen in Figure 2-1. Note that the dots on the motherboard and daughter card signify the pin 1 connection for proper alignment.

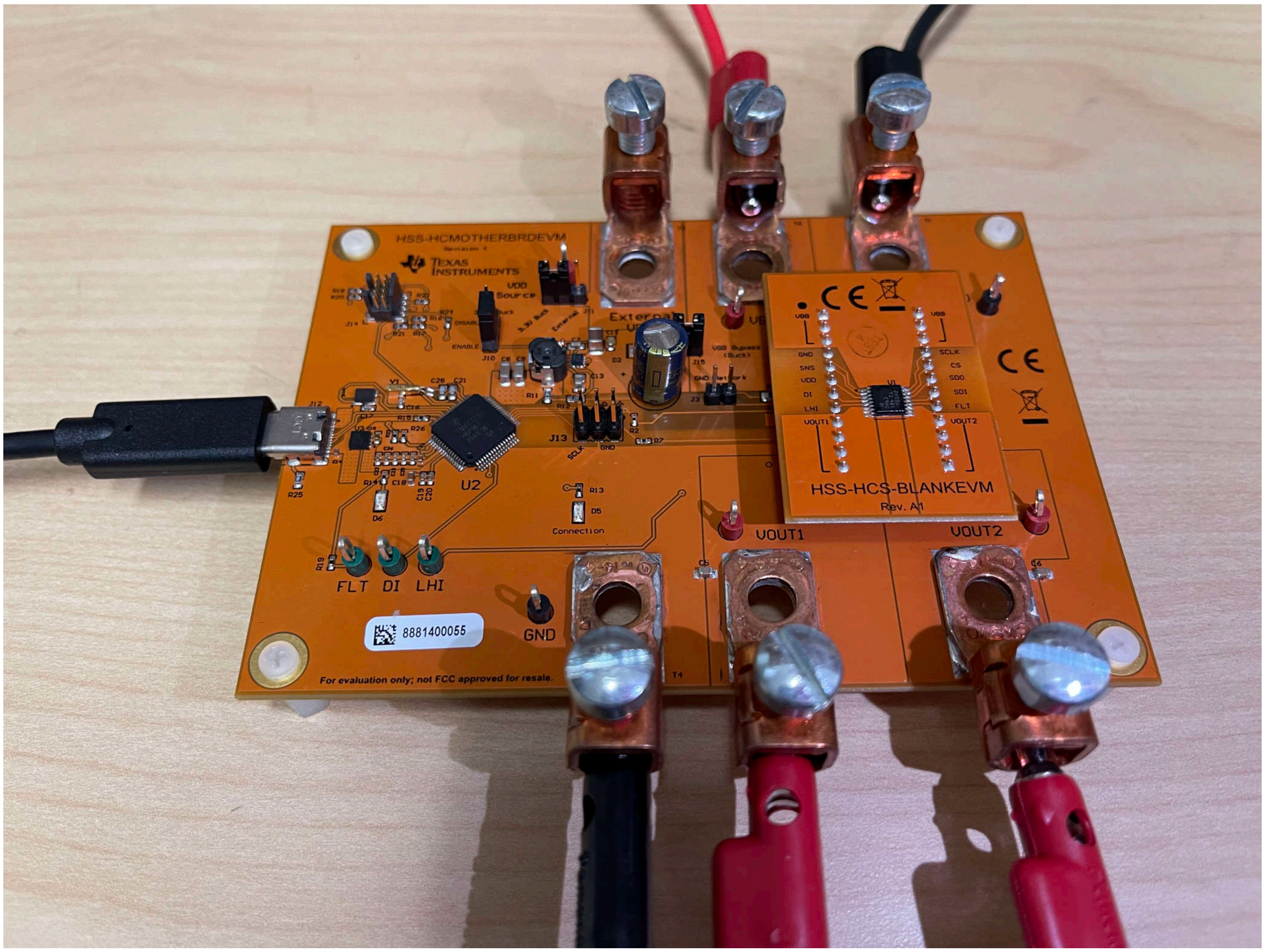



**Figure 2-1. Board Alignment**

Next, plug the USB-C cable into the HSS-HCMOTHERBRDEVM as seen in Figure 2-2.

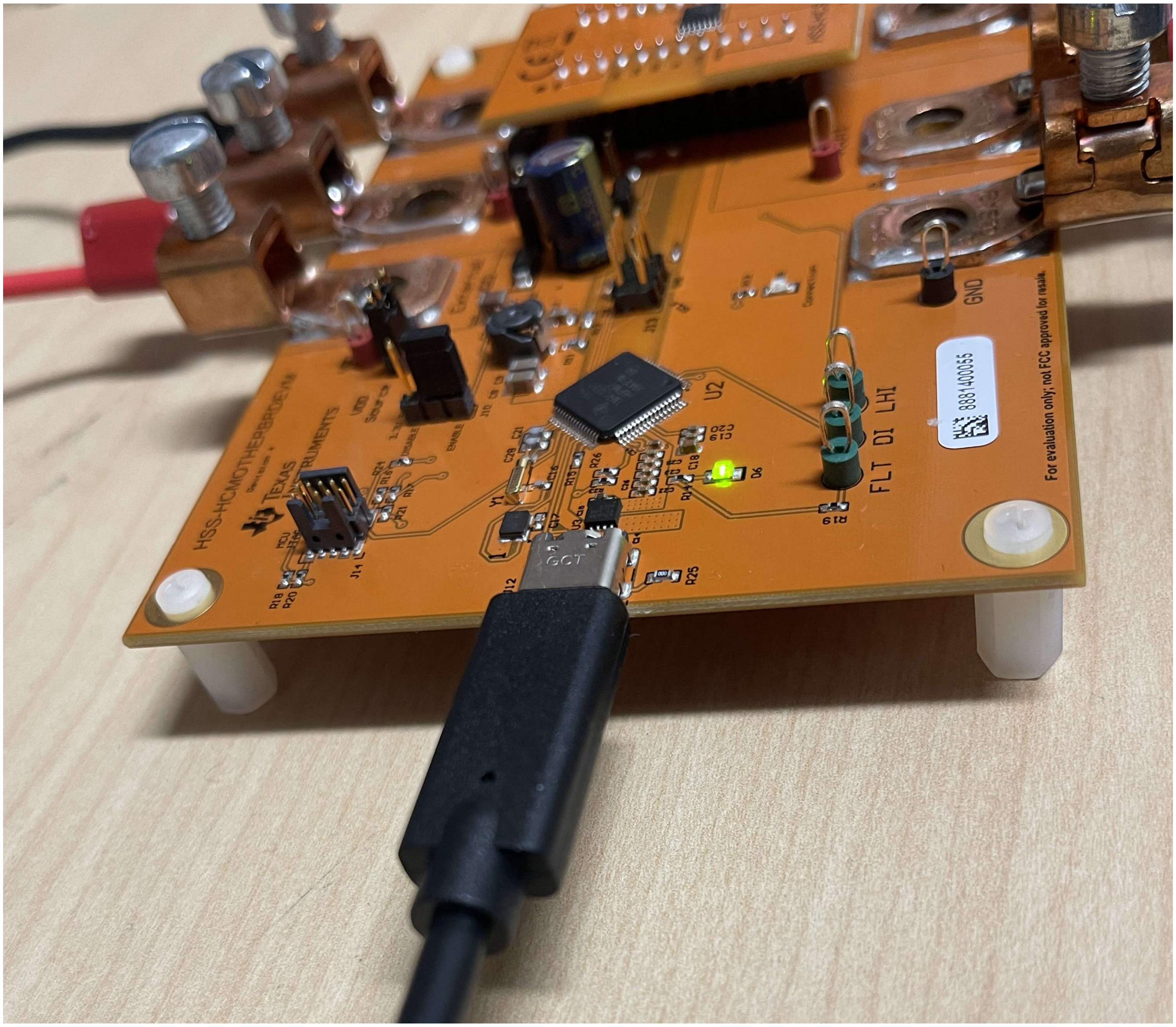



**Figure 2-2. USB Connection**

If successful, then the green LED on D6 illuminates and Windows automatically detects/installs the high-side switch EVM.

Next, connect the relevant power supply to the VBB banana jack (T6) and connect the ground connection of the power supply to the GND banana jack of the EVM (T1) as seen below. Do the same for the desired load connections VOUT1 (T2) and VOUT2 (T3). Make sure that the ground connections of the loads are connected back to a ground port of the EVM (such as T4).

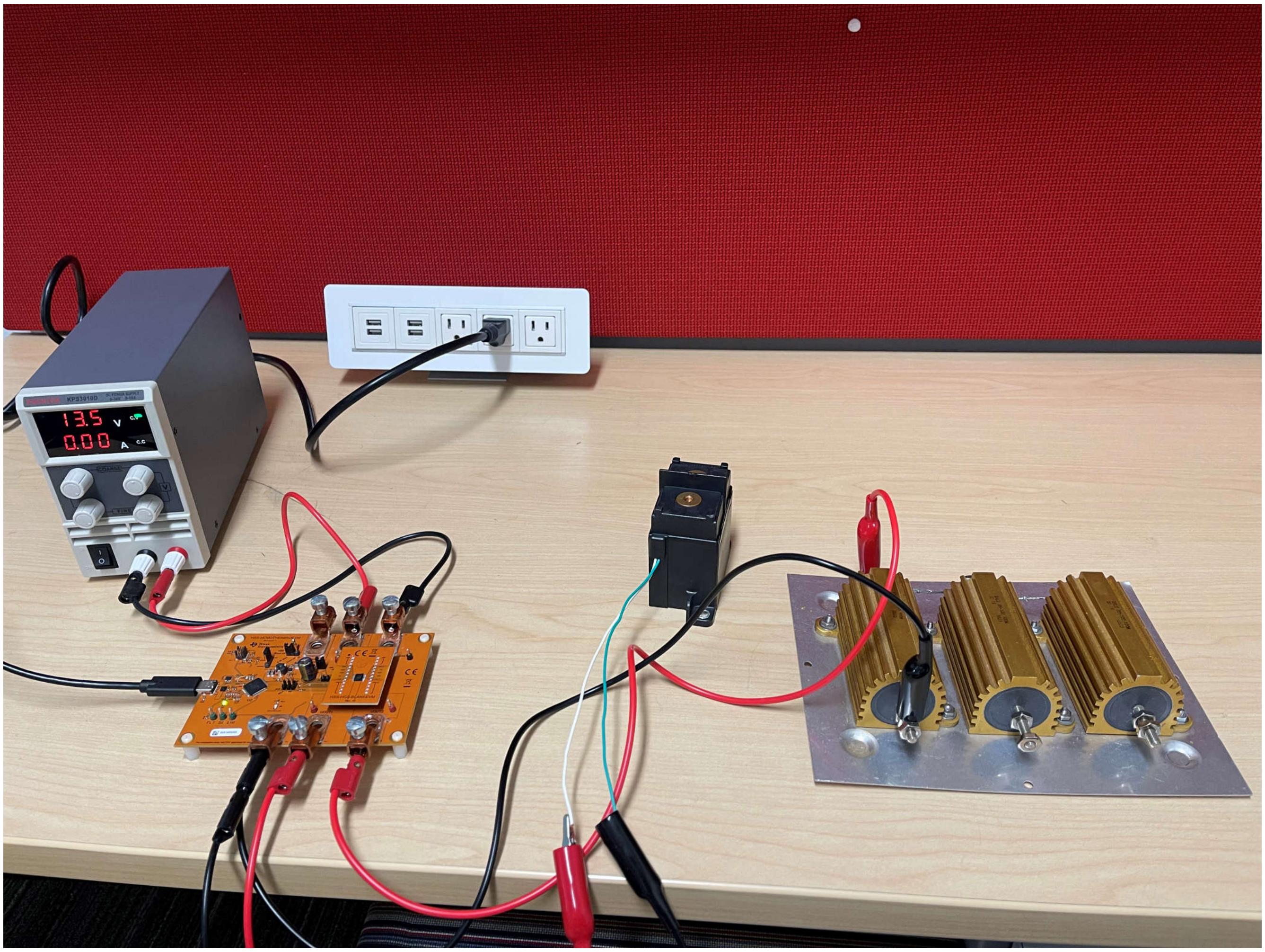


**Figure 2-3. Loads Connected**

With all of the supply, loads, and USB connected, turn on the power supply to the EVM. Note that the high-side switches used in this EVM are designed for 12V automotive systems, however refer to the device data sheet for exact details on the input/output conditions supported.

With the device powered, open the auto_hss_configurator.exe executable that ships with the Smart Fuse Configurator software package. Note that the software package from TI.com is a portable zip file and does not need any specific installer to operate. Once opened, the software program automatically detects the attached high-side switch and updates the connection status to Connected as seen in Figure 2-4.

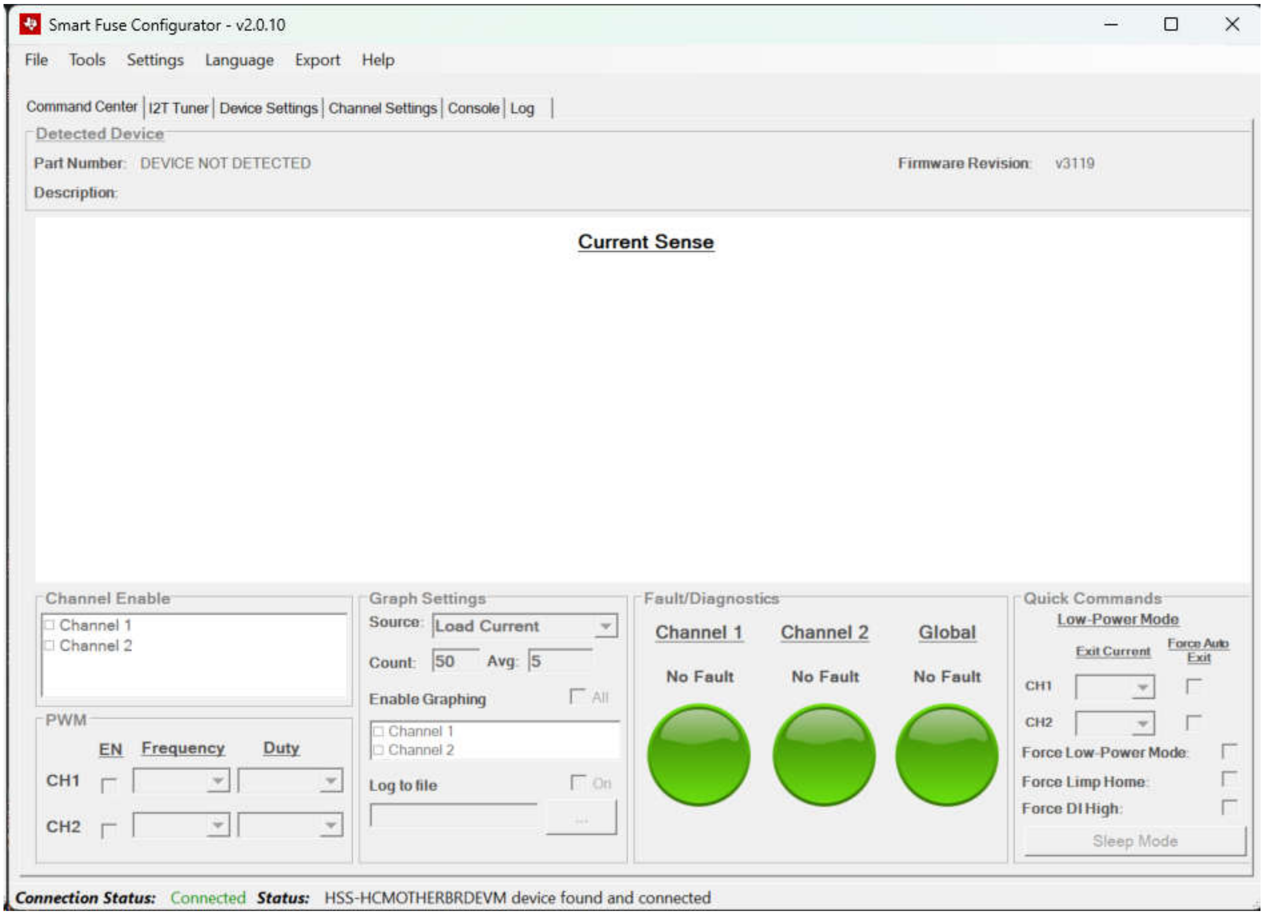



**Figure 2-4. USB Interface Detected**

If the EVM is not connected, then the Connection Status shows up as *Disconnected*. In this state, the main elements of the GUI are disabled until the device is connected.

Note that even though the USB connection to the EVM is detected, the software interface does not enable until an active daughter card is detected on the board. A background thread on the GUI automatically polls and checks for a valid daughter card through a read to device register 0x00 (device ID register). If a valid ID is read, the GUI automatically enables and populates the relevant device information, shown in Figure 2-5.

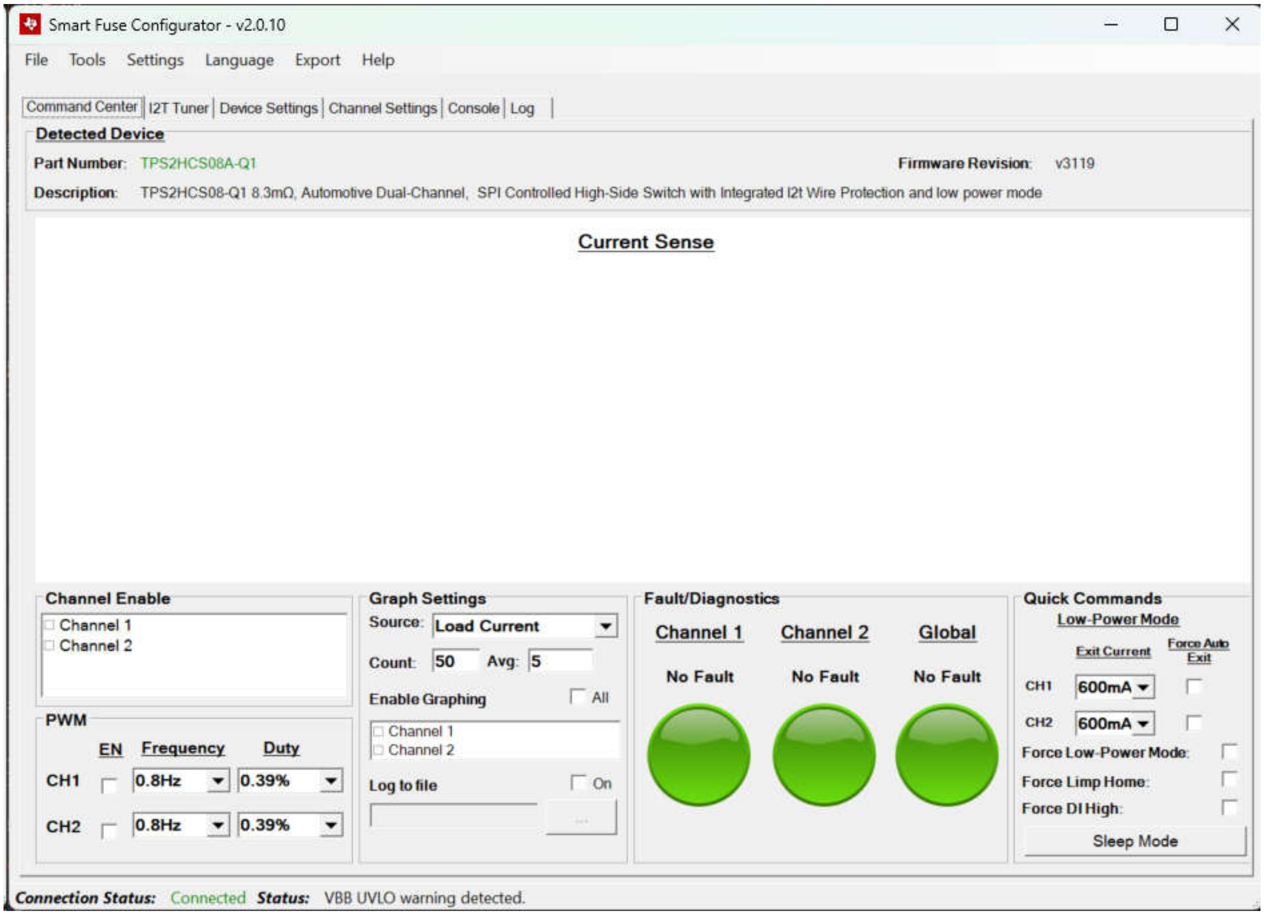



**Figure 2-5. Device Detected**

On the main interface, the status bar displays the latest command/status event that happened on the GUI. In this case, the status bar message shows that the high-side switch device was connected from the *High-side switch device found and connected* message. Whenever a setting is changed on the device or a significant setting is change on the GUI a message is displayed in the status bar. A timestamped list of all previous events can be seen in the Log tab as seen in Figure 2-6.

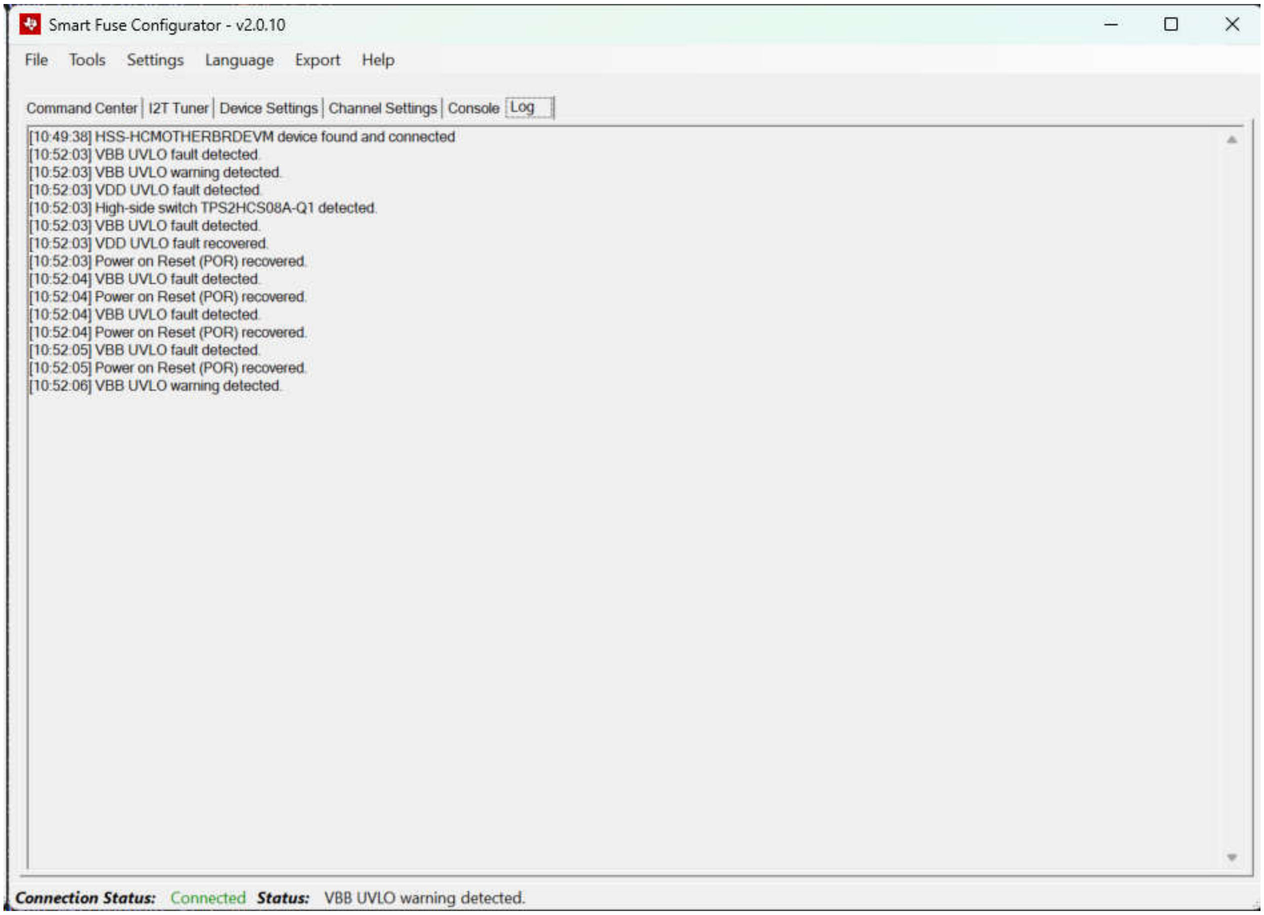



**Figure 2-6. Log View**

Once connected, the GUI communicates with the EVM and read out both the device ID string as well as the firmware revision from the EVM. This information is displayed under the *Detected Device* section in the Command Center tab.

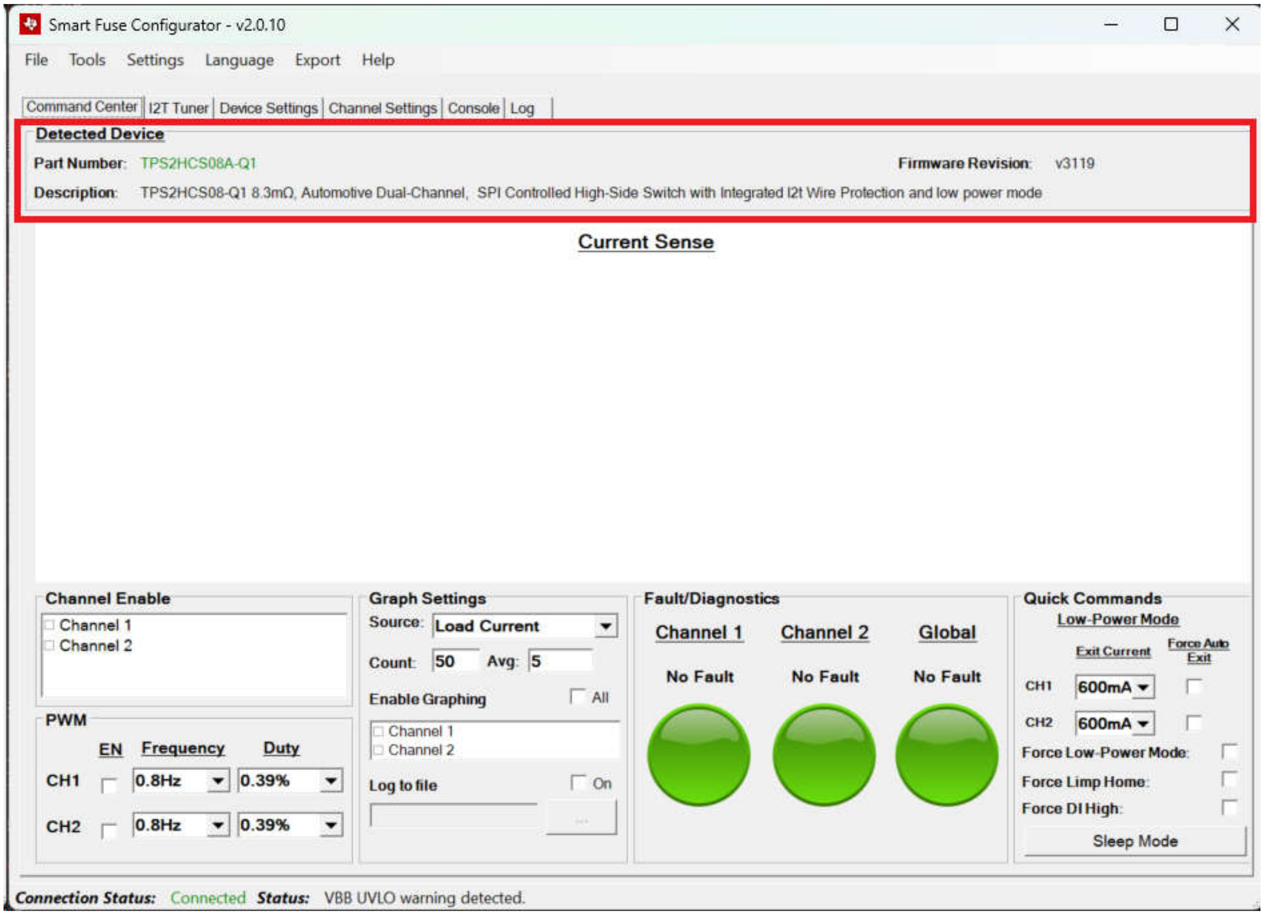



**Figure 2-7. Device Information**

The detailed usage guide for each of the tabs in the software can be found in the following sections.

## 2.2 Revision Differences

The HSS-HCMOTHERBRDEVM has several different hardware revisions that are detailed below in Table 2-1. Note that all of the revisions of the EVM have compatible firmware with each other and no revision-specific software is required.

**Table 2-1. Differences Between EVM Revisions**

| Revision | PCB Color | Notes |
|---|---|---|
| 1 | White | • Initial release of the EVM |
| 2 | Blue | • Diode added to buck converter to prevent reverse current and damage to buck converter |
| 3 | Purple | • Unused LEDs removed<br>• SPI lines isolated from power planes and debug header moved to allow for high frame rates<br>• Electrolytic capacitor added to input of the buck converter to help with transient testing<br>• Digipot removed due to accuracy issues<br>• Each VDD pin has a banana jack connector and the ability to isolate buck converter from VBB for transient testing |
| 4 | Orange | • Connectors changed to accommodate higher load currents and future variants<br>• D5 LED will now signify if daughter card is connected and host is connected via USB. |

## 2.3 Jumper Information

The HSS-HCMOTHERBRDEVM has several different jumper configurations that can configure the device in various functional modes. The summary of these jumper configurations can be found below.

**Table 2-2. Jumper Configurations**

| Jumper Number | Purpose |
|---|---|
| J3 | Connecting this jumper shorts out the ground network while leaving the jumper populated connects the diode/resistor network on ground. |
| J10 | Enables/disables the onboard 3.3V buck converter used for powering VDD. |
| J11 | Controls if VDD is sourced from the VDD banana jack on J8 or if VDD is sourced from the 3.3V buck converter. |
| J15 | Isolates the external VDD supplied from banana jack J8 from the input of the buck converter. If the user is performing transient testing where large voltage spikes occur on VBB, then depopulate J15 and source VDD externally. |

## 2.4 Interfaces

The HSS-HCMOTHERBRDEVM has several different power, programming, and diagnostic interfaces available.

The power interfaces are summarized below.

**Table 2-3. Power Interfaces**

| Identifier | Name | Description |
|---|---|---|
| T5 | External VDD | Used for supplying external VDD to the high-side switch. See Transient Testing for more information. |
| T6 | VBB | Main power source of the device. This is generally modeled from a 12 V automotive supply. |
| T2, T3 | VOUT1 and VOUT2 | Channel outputs that go to the desired loading conditions. |
| T1, T4 | GND | Ground connections. |

The motherboard EVM also has the following digital interfaces.

**Table 2-4. Digital Interfaces**

| Identifier | Description |
|---|---|
| J12 | USB connection to host that is used to communicate with the Smart Fuse Configurator software. Note that the 3.3V power supply for the MCU is derived from USB via a 3.3V LDO. |
| J13 | Used if an external SPI primary device wants to be used. In this scenario, connect the SPI primary device to the signals on this header and keep the USB port unplugged. |
| J14 | JTAG used for programming the TM4C microcontroller. A source code package is provided, or the user can write their own MCU code from scratch. |

## 2.5 Test Points

The HSS-HCMOTHERBRDEVM has the following test points available:

**Table 2-5. Test Points**

| Identifier | Description |
|---|---|
| VBB | Power source of the device |
| VOUT1 and VOUT2 | Outputs to the desired loads |
| GND | Ground connection |
| VDD | Connection to the digital supply for the high-side switch. This can also be used to supply an external VDD supply if configured with the ***J11*** header and having the ***J15*** header disconnected |
| FLT, DI, LHI | Probe points for the digital signals of the high-side switch. FLT is an open drain output with a pull-up resistor connected to the MCU's 3.3V rail. |

## 2.6 Transient Testing

By default, the smart fuse evaluation module is used to optimize out-of-box user experience and ease-of-use. Support has been added to support transient testing such as short-to-ground without damaging any onboard component. TI recommends that if any voltage spike is to occur on the supply/VBB line (such as the one that occurs in a short-to-ground scenario), then the EVM is configured to bypass the onboard buck converter and instead source VDD externally. This can be done by disconnecting the *J15* jumper and setting *J11* to the *external*. This jumper configuration can be seen below.

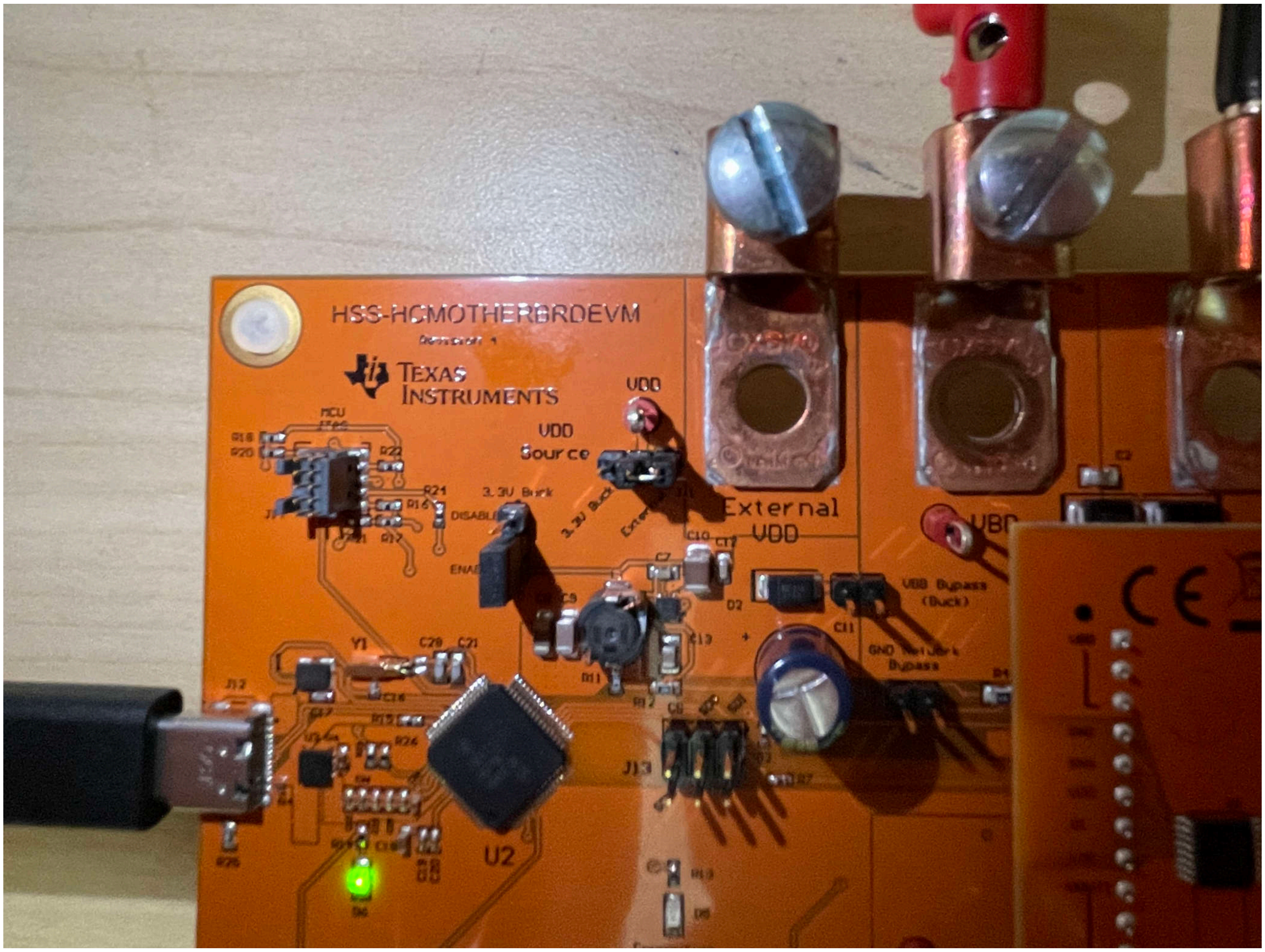



**Figure 2-8. Configured for External VDD**

Once configured to use an external VDD source, connect a compatible (generally 5V or 3.3V) power supply to *External VDD* as seen below.

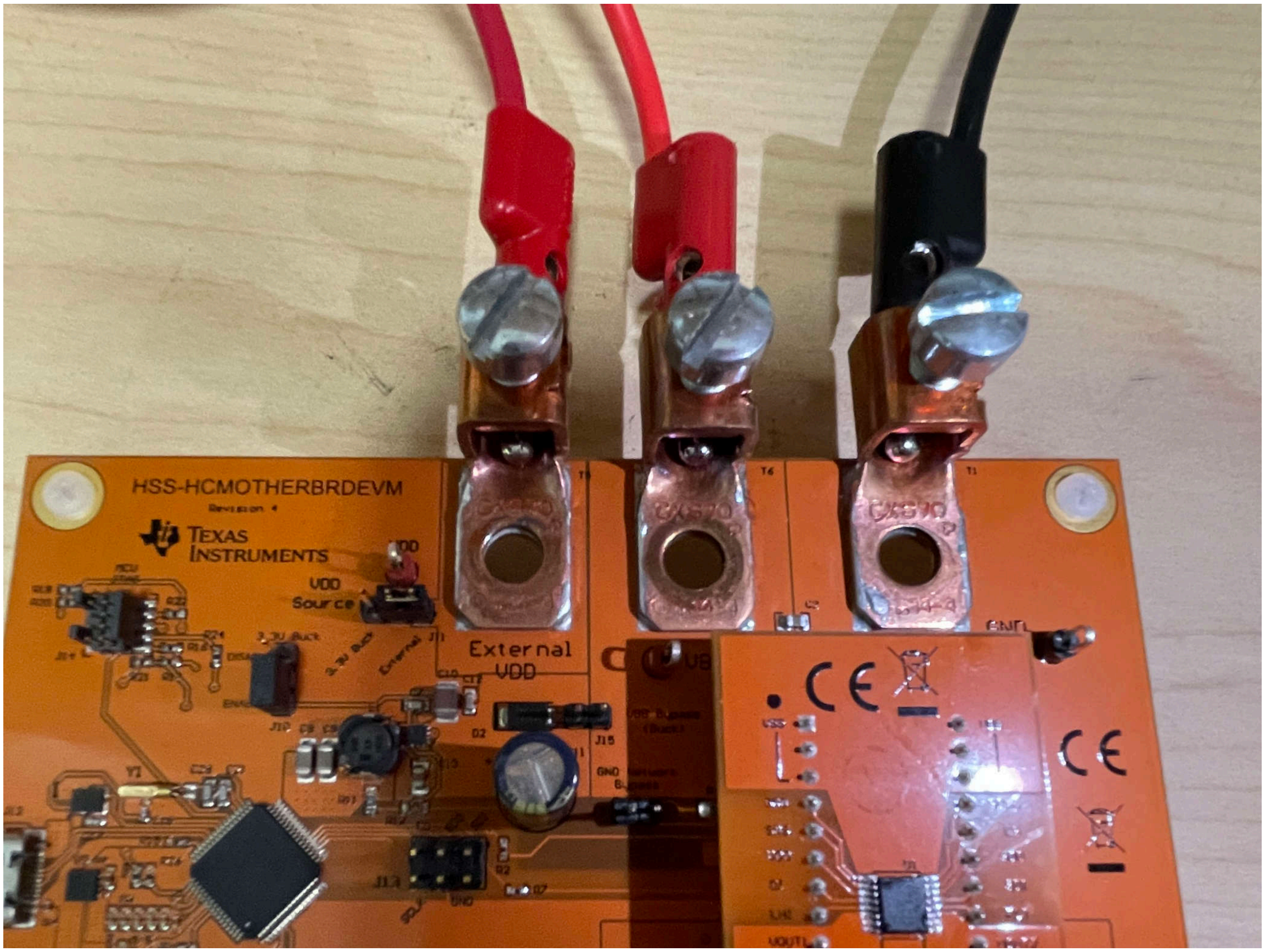



**Figure 2-9. Connected External VDD**

With an external power supply sourcing VDD, a short-to-ground or other transient condition can be safely applied to the EVM. An example of a short-to-ground condition can be seen below in Figure 2-10.

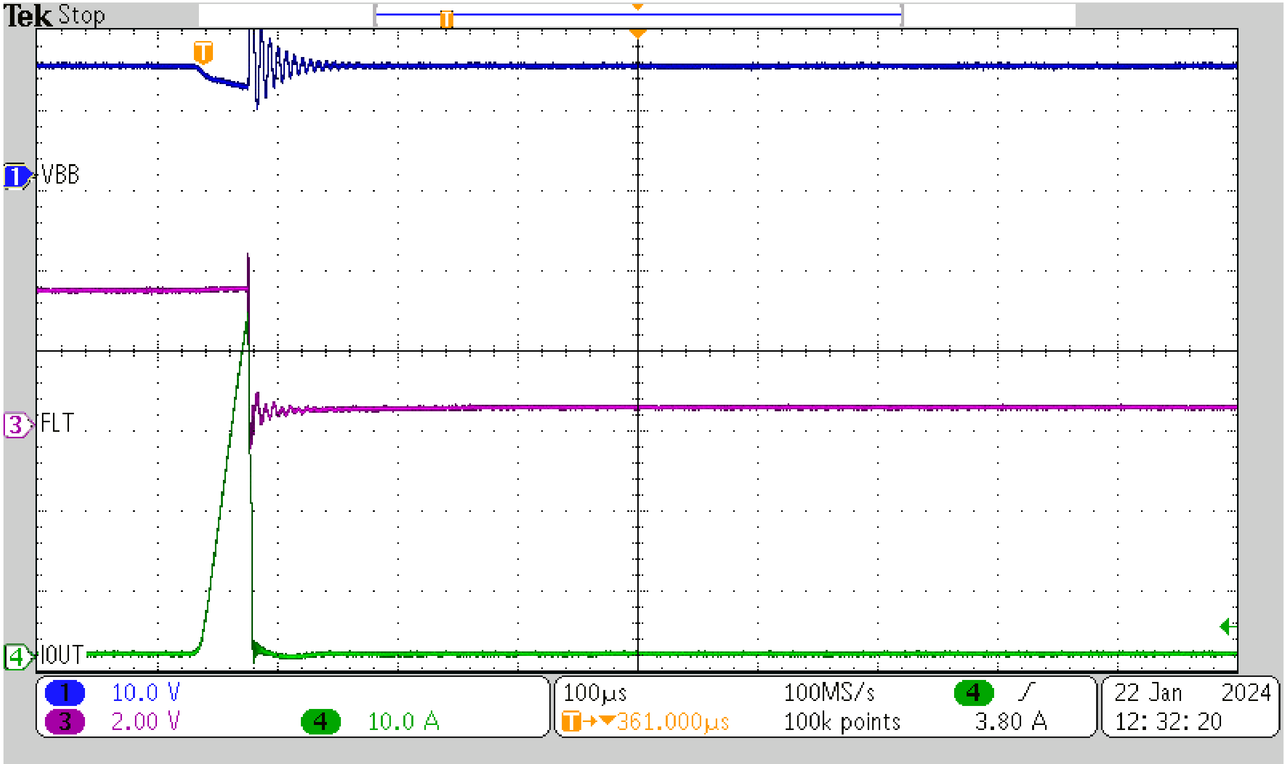



**Figure 2-10. Short-to-Ground Event**

# 3 Software

## 3.1 Software Usage

The Smart Fuse Configurator software is a companion software used to accompany the HSS-HCMOTHERBRDEVM and corresponding daughter cards. This software can be downloaded from the product page of the HSS-HCMOTHERBRDEVM and comes in the format of a packaged zip file. Simply unzip the downloaded package and open the software on a Windows host machine. As the EVM uses USB-HID, there are no drivers that are required to be installed and Windows automatically detects/installs the EVM without the need to download proprietary software packages. The sections below describe the functionality of the Smart Fuse Configurator in detail.

### *3.1.1 Command Center View*

The Command Center View is meant to provide quick access to some of the common configuration and run-time settings of the attached high-side switch. The user has the ability to turn on/off individual channels, plot/graph ADC readings such as current sense, configure PWM settings, and put the device into several diagnostic states. Note that by default, the device is set to auto-persist changes made in the GUI. This means that when the user changes a setting on the interface, the command is sent through USB and translated as a SPI command to persist to the high-side switch.

To enable/disable individual channels, simply click the desired channel in the *Channel Enable* box. This causes the corresponding channel to turn on and conduct current if there is a load on the output. Likewise, to enable current sense/graphing for a particular channel, click the desired channel on the *Graph Settings* box. This causes the GUI to start a polling thread that periodically reads the high-side switch of the current sense register. When a channel is enabled for graphing, the microcontroller automatically enables the relevant ADC bits in the register settings.

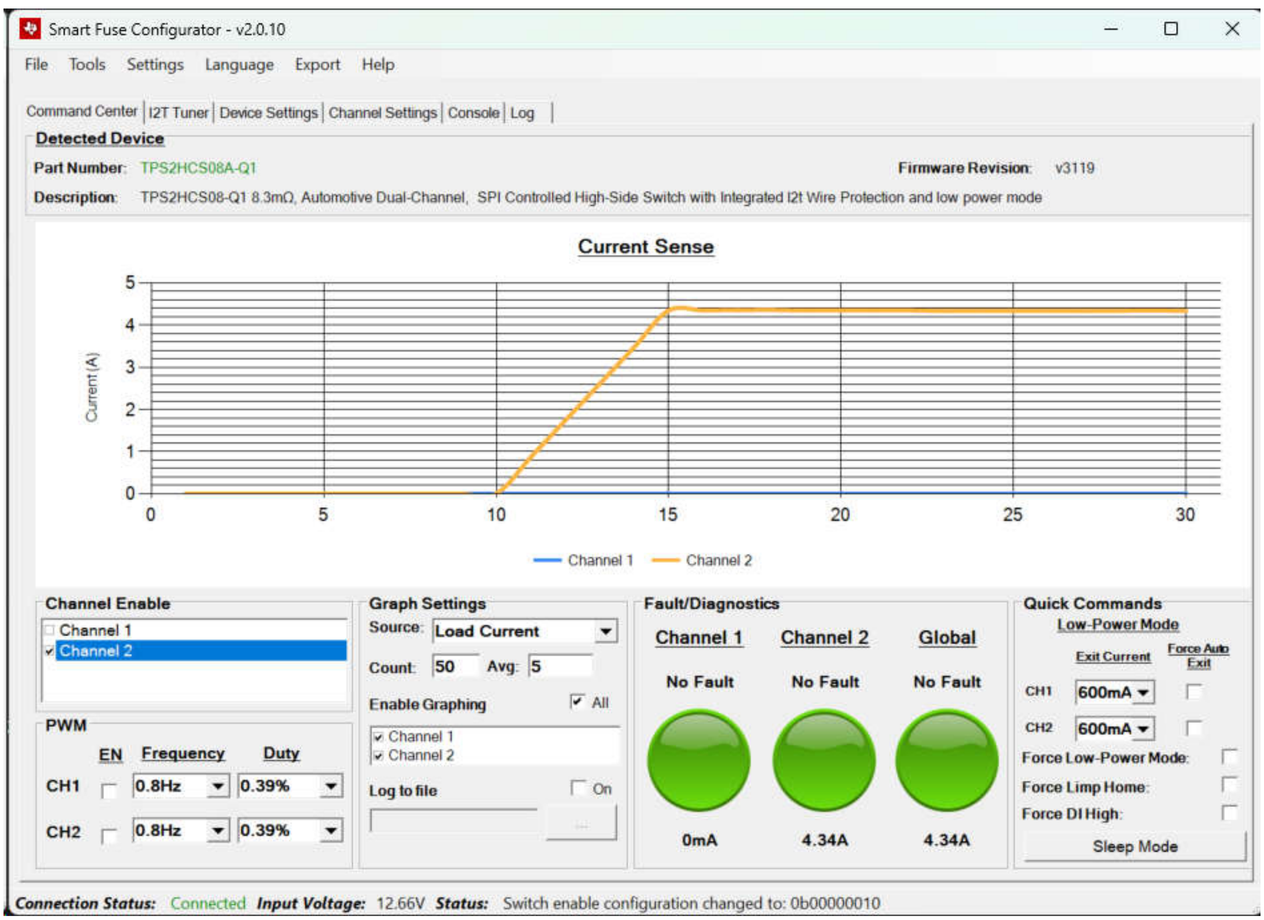



**Figure 3-1. Current Sense Graph**

Note that by default the device is set to collect and average a specified number of values before plotting them on the graph. The maximum number of samples to collect can be changed through the *Count* setting and the averaged number of samples can be changed with the *Avg* setting. In addition to load current, the device can also be configured to graph/report FET temperature and output voltage. This setting is changed through the *Source* box.

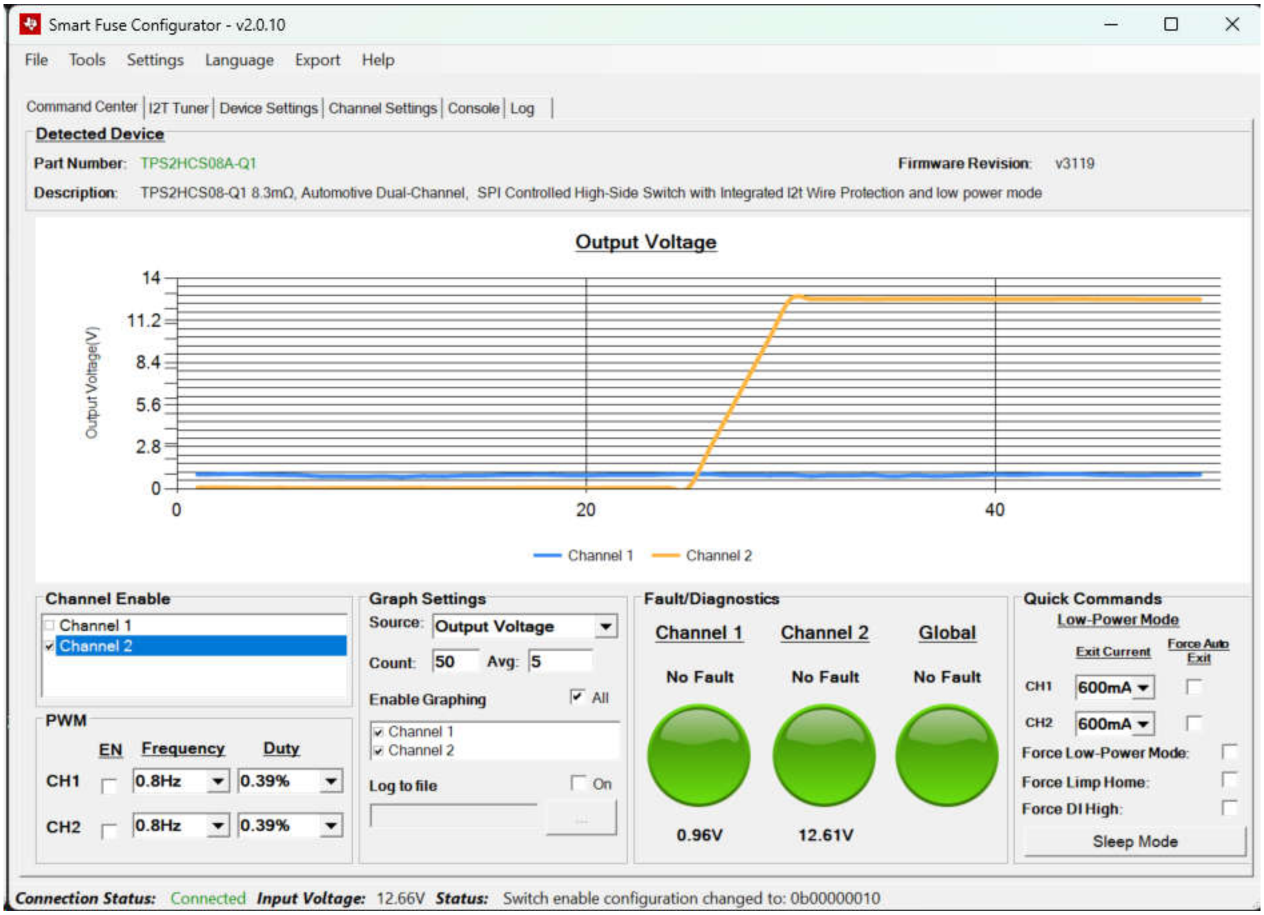



**Figure 3-2. Voltage Graph**

The *Log to File* button gives the user the ability to dump any sense readings to a specified comma separated value (CSV) file. When this box is selected, the program prompts for a location to save and start recording files if that location is valid. The log file is closed/saved if the *Log to File* button is turned off or if the program is closed.

The *Quick Commands* box provides various settings/diagnostic commands. The LPM exit current can quickly be configured per-channel and the device can be forced into low-power mode through the *Low-Power Mode* box. Once in low-power mode, if the load current on a corresponding channel exceeds what is configured in the settings the device exits the low-power mode (or if the low-power mode box is unchecked). Refer to the device data sheet (SLVSGY2) for exact operation behavior for low-power mode.

The *Force Limp Home* box forces the device to enter a limp home mode state. Generally, external circuitry is designed to trigger the LHI pin of the high-side switch when a system-wide fault occurs, however for evaluation purposes the *Force Limp Home* box causes the MCU to force trigger the *LHI* pin of the high-side switch. This causes the device to default to the state configured in the device configuration registers of the high-side switch (see the data sheet for details).

The *Sleep Mode* button prompts a dialog to put the device in sleep mode. In sleep mode, the device enters an inactive state with minimal power consumption. In this mode, all device configurations are reset to the reset values. The Smart Fuse Configurator software, however, has logic that restores the configured values after sleep mode is exited. By clicking the sleep mode button, a prompt occurs to warn the user about the state change,

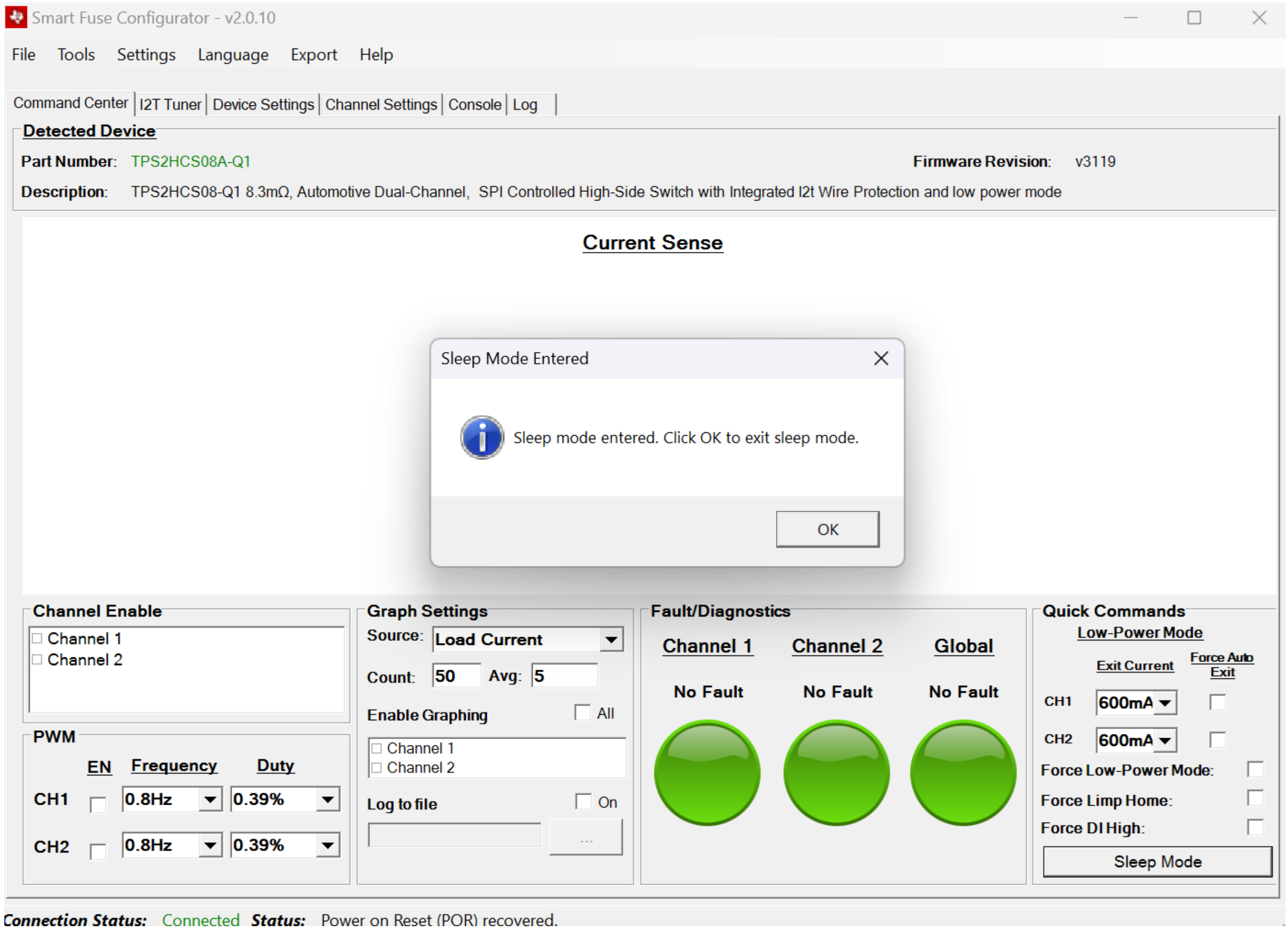



**Figure 3-3. Entering Sleep Mode**

Once *Yes* is clicked, the device goes into sleep mode by a SPI write to the corresponding SLEEP register. The device stays in sleep mode until the user clicks *OK* on the GUI.

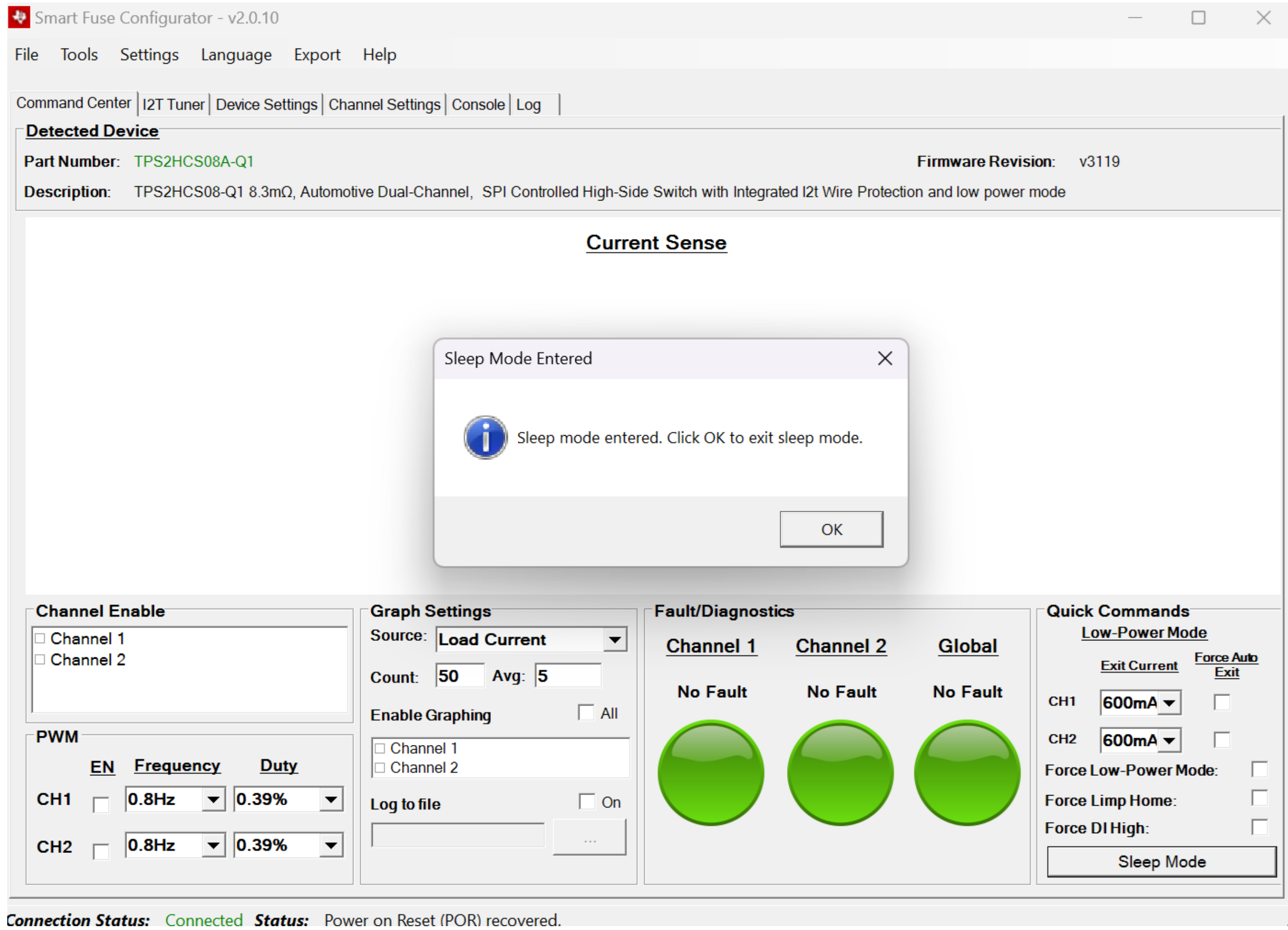



**Figure 3-4. Device in Sleep Mode**

Once *OK* is clicked, a dummy write occurs that takes the device out of sleep mode. Once out of sleep mode, the GUI takes the current configuration settings from the GUI and writes them back to the device.

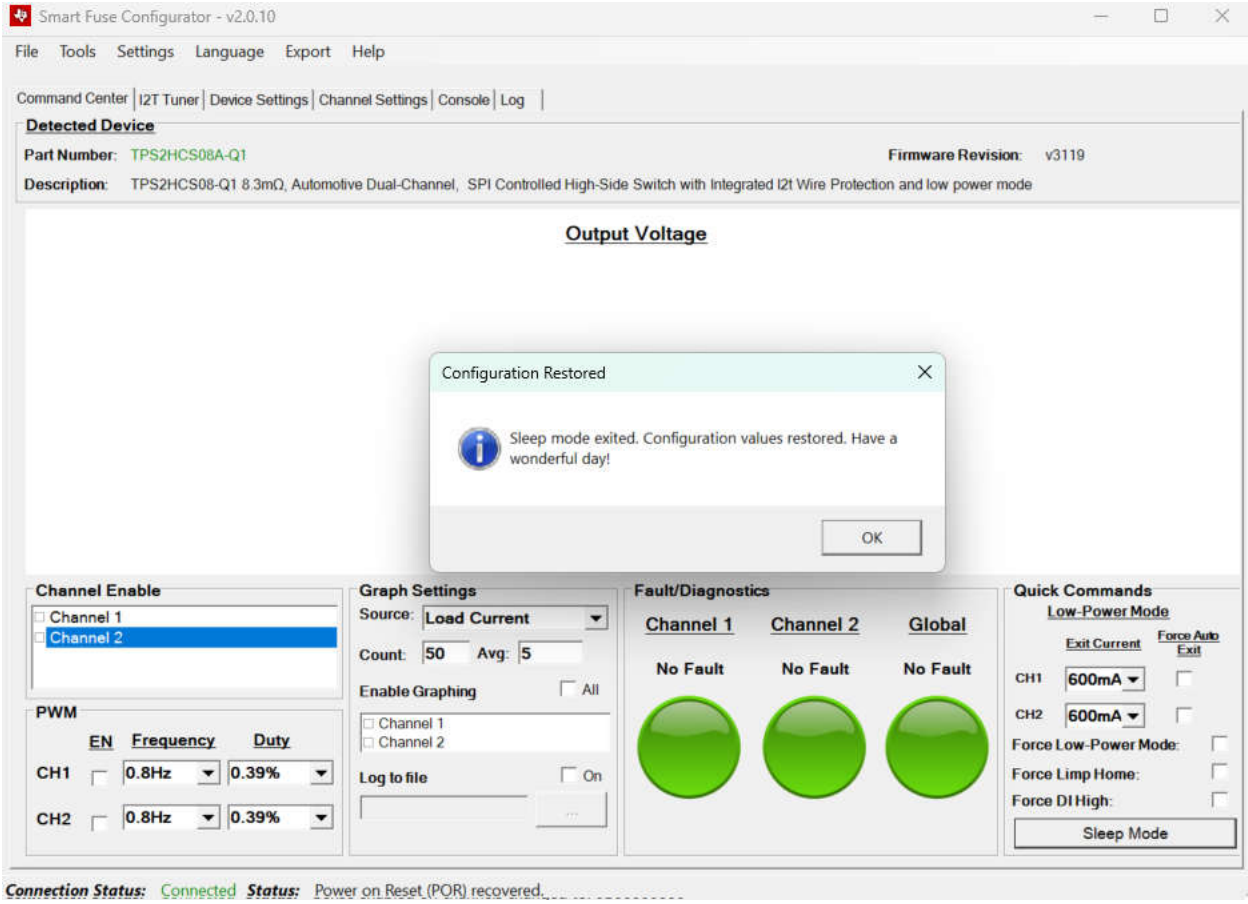



**Figure 3-5. Exiting Sleep Mode**

### 3.1.2 I2T Tuner

The *I2T Tuner* tab allows the user to configure/tune the I2T settings of the high-side switch and visualize the resulting curve versus a custom wire profile. On the *I2T Curve* sub-tab, the I2T curve of the device can be configured in real-time with a custom provided wire model.

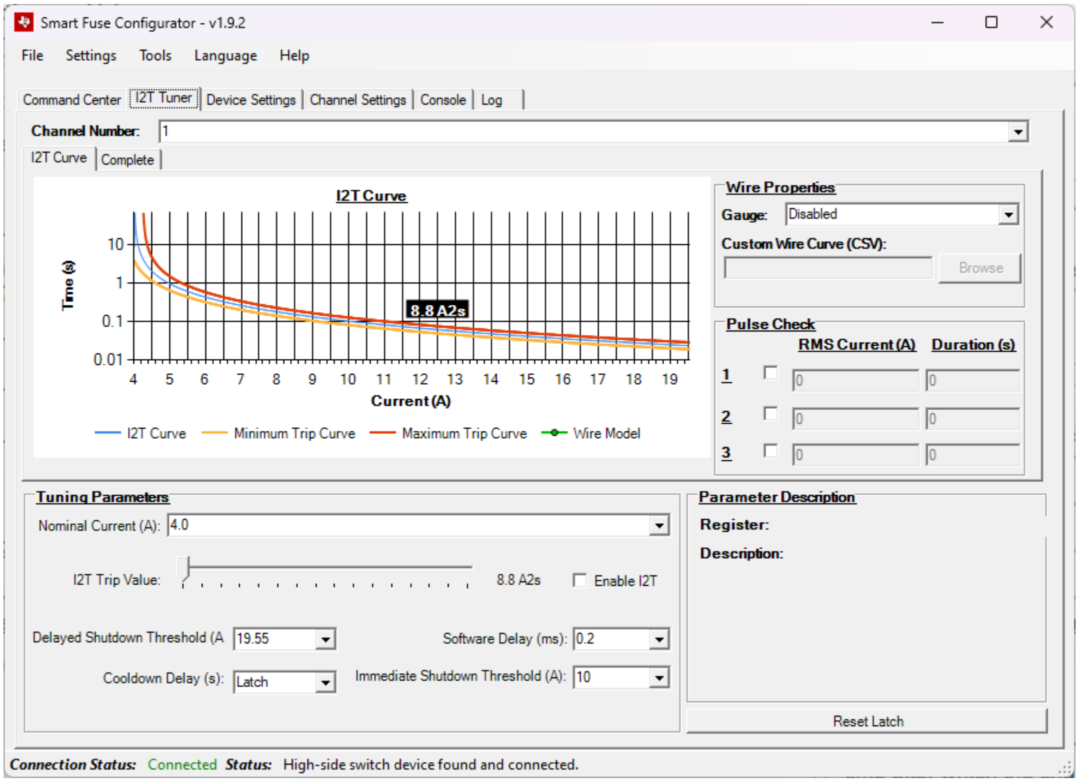



**Figure 3-6. I2T Curve Tuner**

By adjusting the *I2T Trip Value* slider, the I2T curve adjusts in real-time on the graph. Note that when the slider is changed, the GUI persists the new value to the device (if auto-persist is enabled, which is by default).

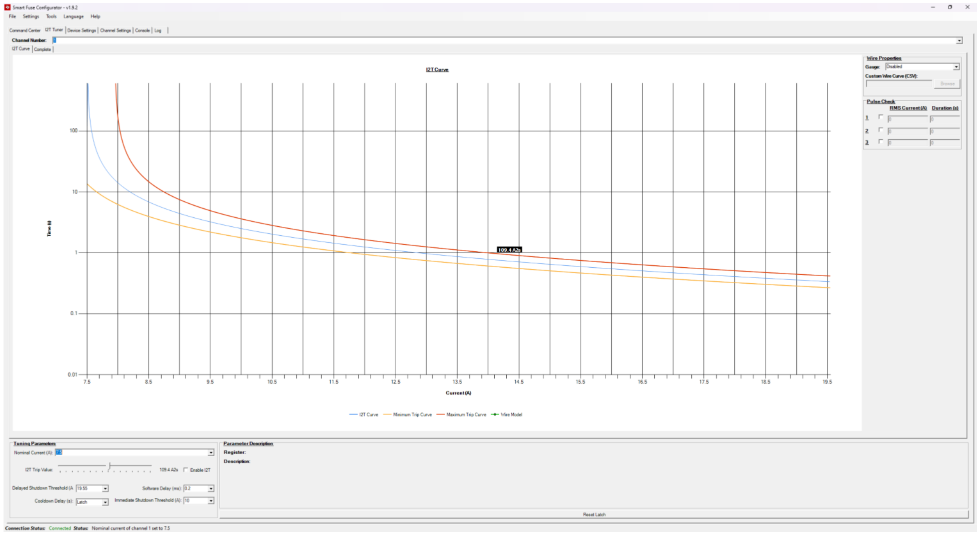


**Figure 3-7. Adjusting I2T Trip Value**

In the *Wire Properties* box, the user has the ability to plot a wire model against the current I2T graph. A couple of different example/dummy models are provided, however the user has the ability to provide a wire model in CSV format. This format is a simple CSV format that contains current and time values. For example, the following CSV file:

```
Current,Time
5,100
8,80
10,50
13,40
15,30
17,20
18,10
19,5
```

This results in the following curve being plotted on the I2T graph.

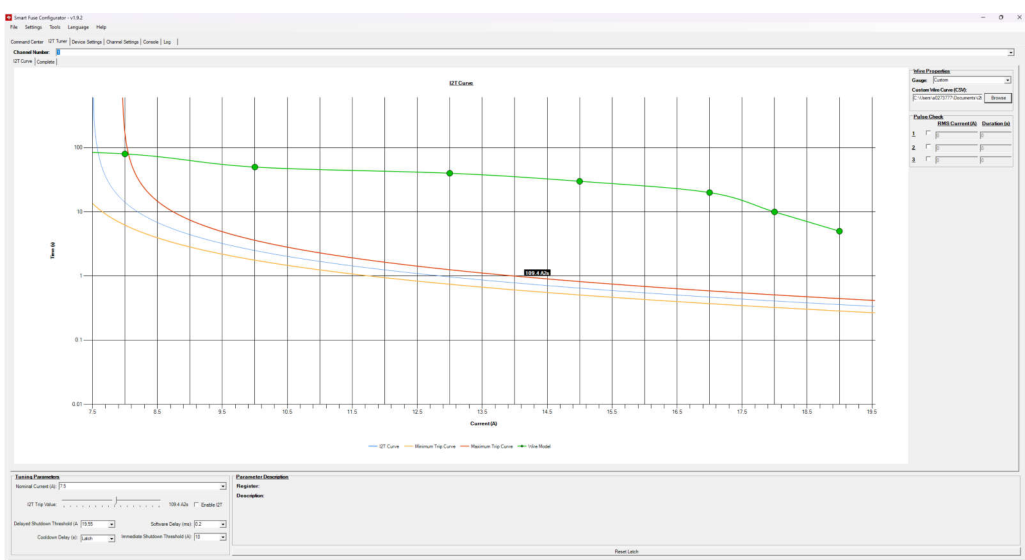


**Figure 3-8. Custom Wire Model**

The user also has the ability to plot a static DC pulse (RMS current + time) on the graph to determine if a particular I2T setting trips on a transient such as a capacitive inrush event. In the *Pulse Check* box, enable a pulse and input a current/duration. An example of plotting a static current point can be seen below:

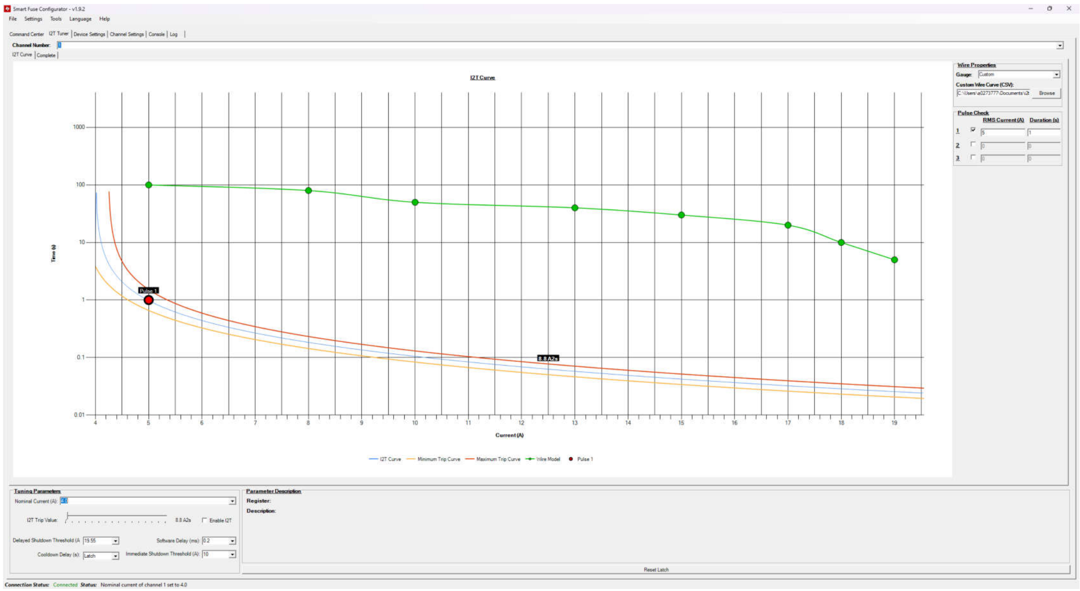


**Figure 3-9. Custom Pulse**

In the example above, the inputted pulse is below the I2T trip curve signifying that the device does not erroneously trip on the provided transient event.

In the *Complete* sub-tab, the user can examine the full fuse current profile as described in the data sheet.

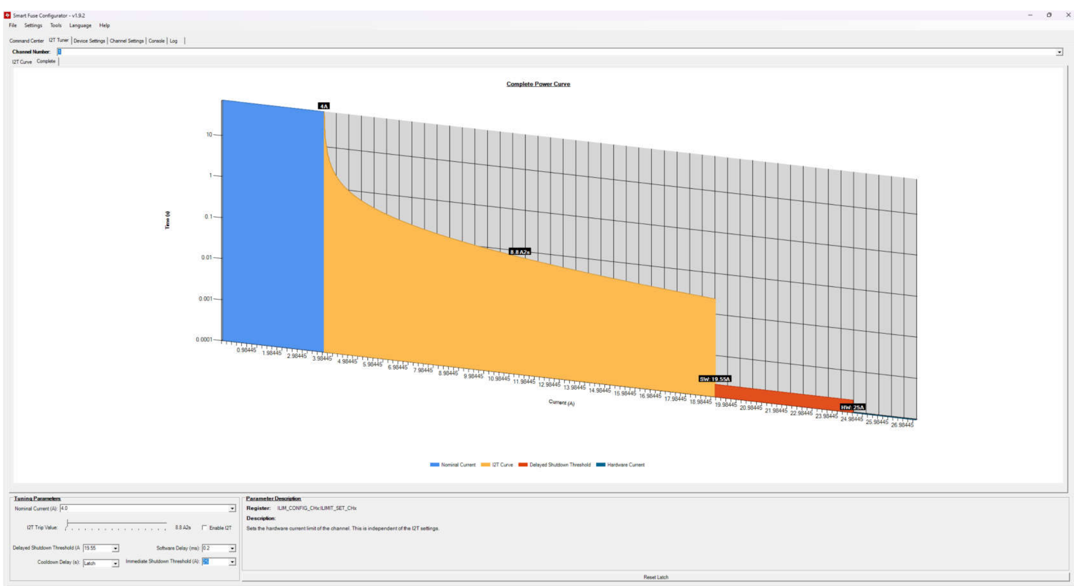


**Figure 3-10. Full Current Profile**

When any of the controls under the *Tuning Parameters* box are changed, the graph is updated real-time to show the updated parameters.

### 3.1.3 Device Settings

The *Device Settings* tab allows the user to change device level settings that are not specific to one channel of the device. Additionally in the *Device Settings* tab, all fault diagnostics are shown as well as statistics and descriptions of each individual faults (both device-wise and channel-wise). A non-faulted example of this view can be seen below.

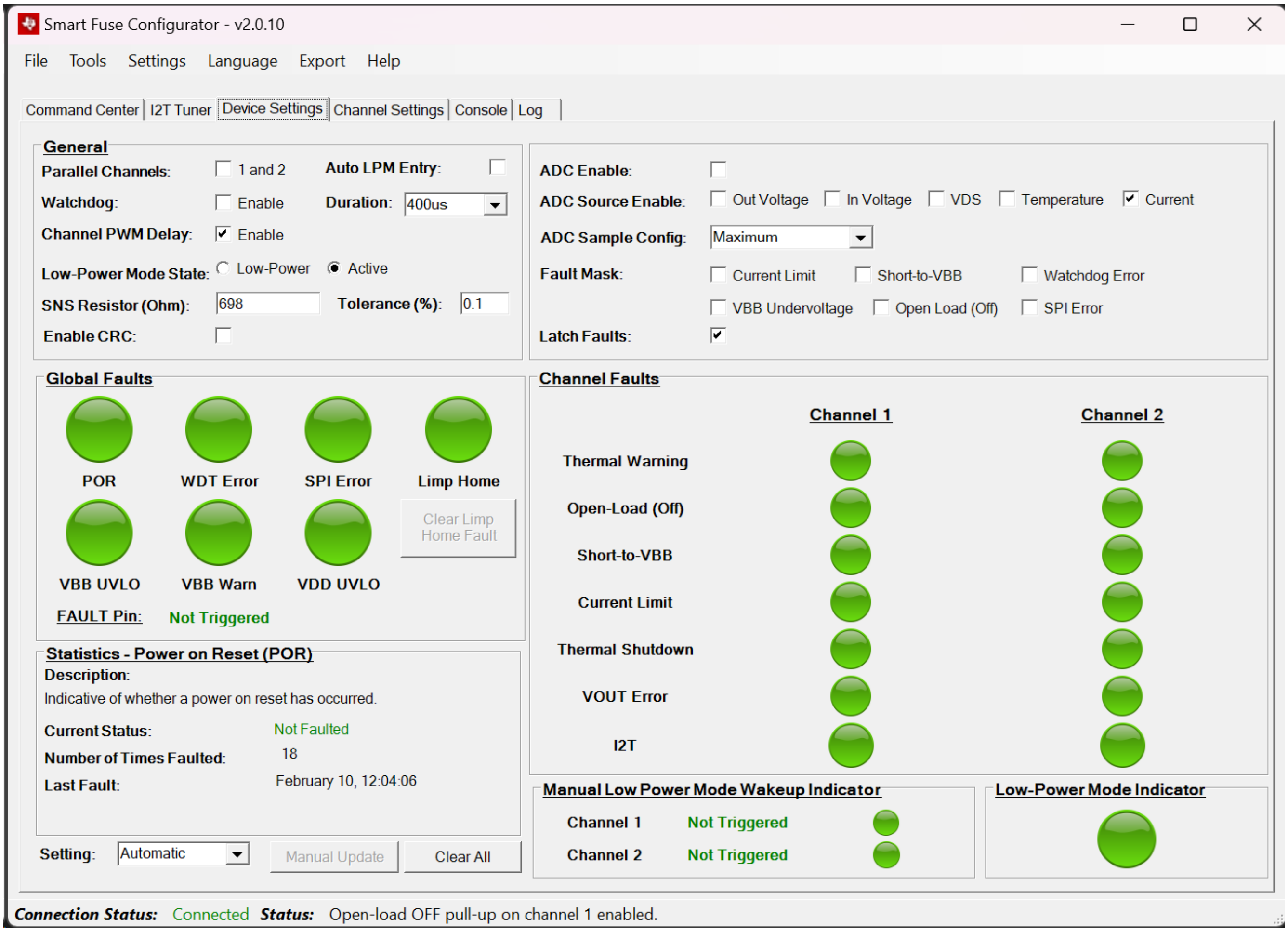



**Figure 3-11. Device View**

From here, the user can click and change any setting in the *General* box and the corresponding device setting is changed. Additionally, this tab shows the fault diagnostics of the device in real-time. If the *Setting* box is set to *Automatic*, then a thread runs in the background that periodically polls the fault status of the device. When faulted, the corresponding fault circle changes red. The user can click any of the circles to populate the *Statistics* box with a description of the fault and when the last fault occurred and the total number of times that the specific fault triggered.

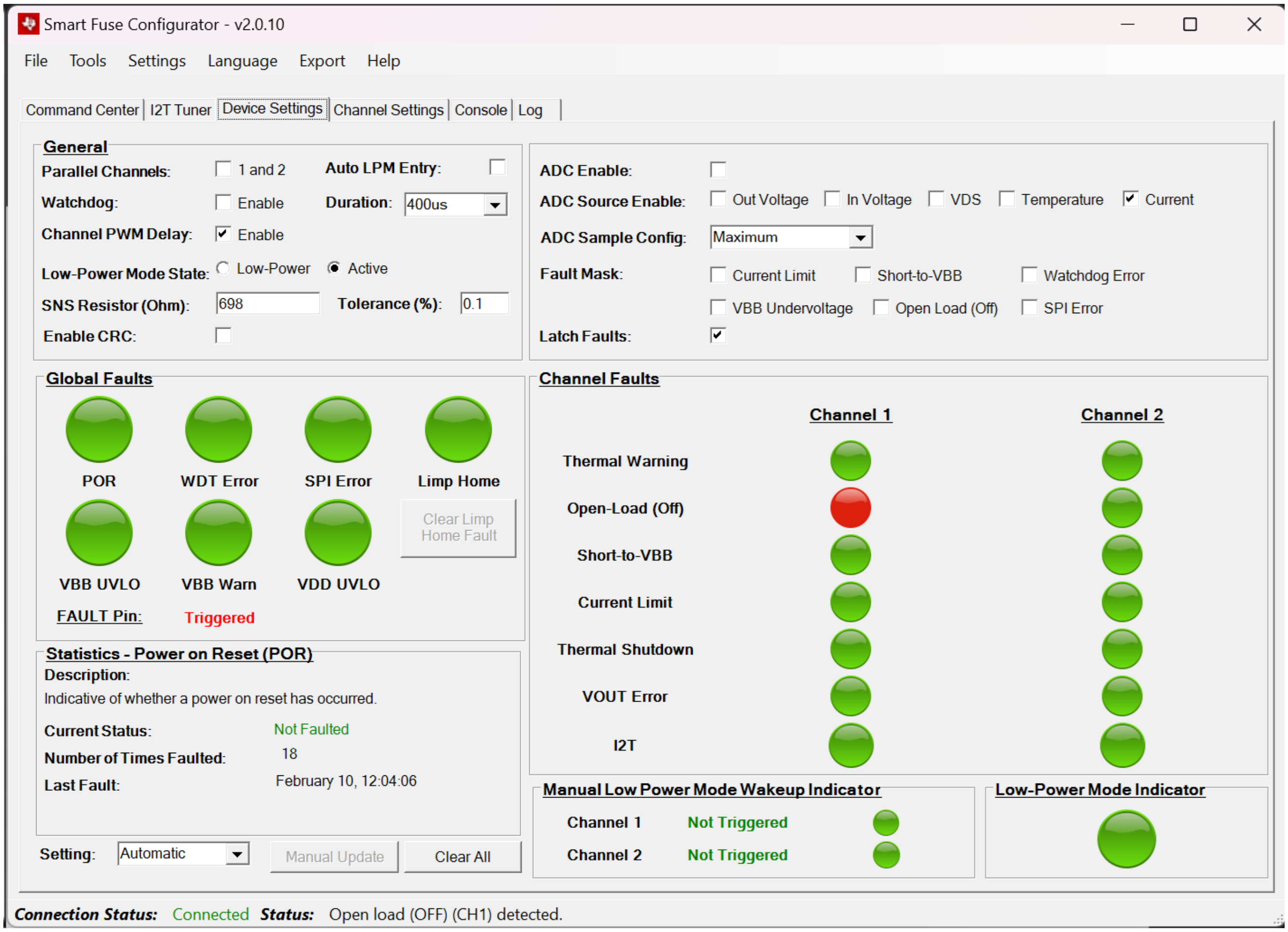



**Figure 3-12. Faulted Device View**

In the example above, an open-load fault on channel one is reported. Note that when certain faults occur, the *FAULT* pin is also reported to be triggered. This pin is the open-drain fault pin that goes from the high-side switch to the microcontroller.

Note that some of the device faults (such as POR) are cleared on read. This makes the device faults not desirable for the GUI to auto-poll the fault status as an important fault event can potentially be missed. To remedy this, the device can be set into *Manual* update mode. In this mode, the user must click the *Manual Update* button to read the fault status and update the indications on the GUI.

### 3.1.4 Channel Settings

The *Channel Settings* tab shows a list of settings that are specific to channels and not to the device as a whole. As many of the supported high-side switches are multi-channel devices, the *Channel Number* drop-down box is used to change between settings for different channels. Many of these settings are duplicated from the command center view, however changing them in one tab also updates the setting in the other tab. Likewise, the *I2T Parameters* box contains parameters that are the same as those configured in the I2T Tuner tab. Refer to the device data sheet for the meaning/configuration values of each parameter.

The *Capacitive Charging* box controls the capacitive charging mode that the device is set to:

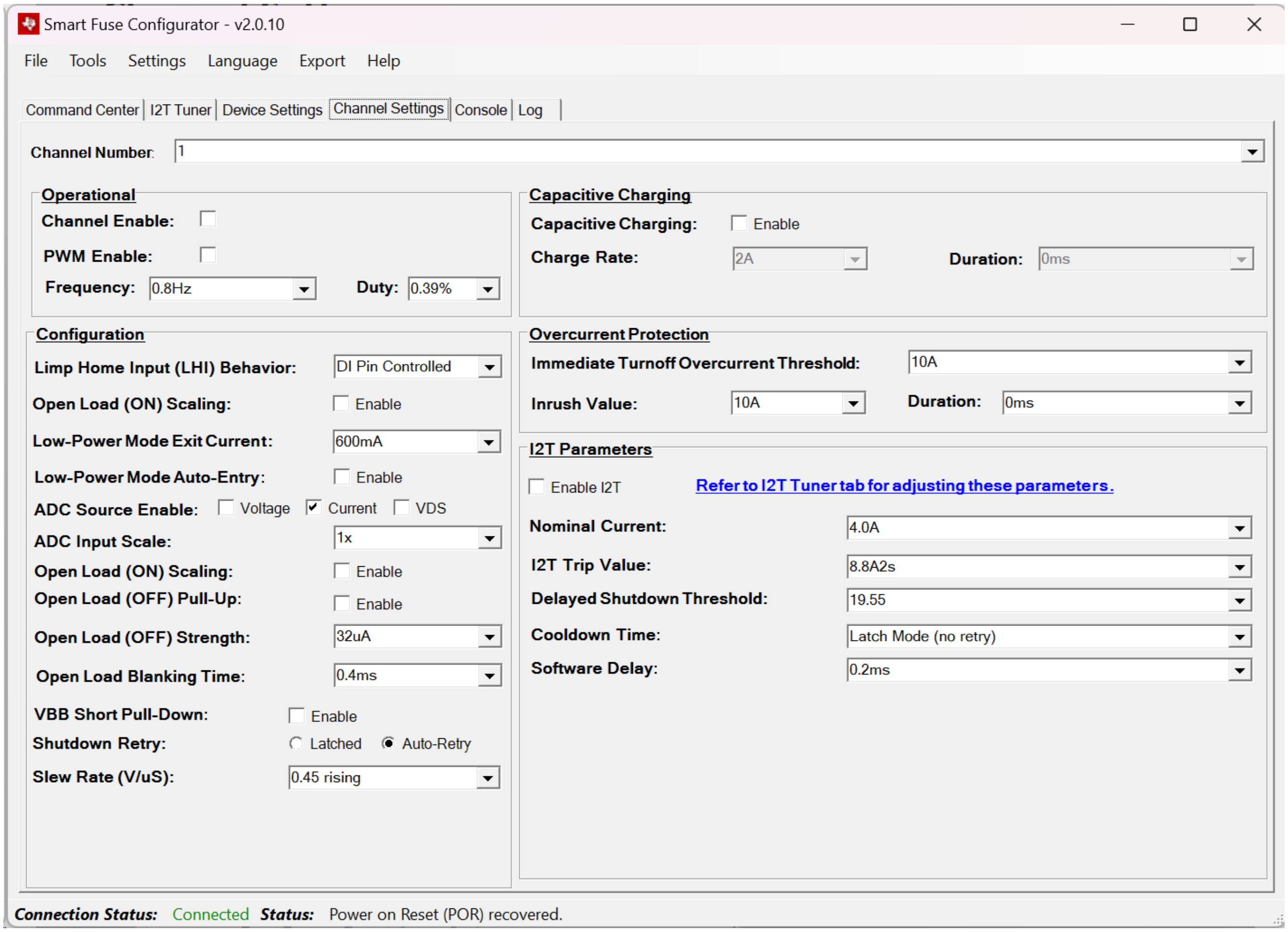



**Figure 3-13. Channel Settings**

### 3.1.5 Console View

The *Console View* tab gives the user the ability to perform raw SPI reads/writes to the attached high-side switch. This mode is intended to be an advanced super-user mode and does not place any protections on data validation or verify that invalid configuration settings are not being sent. The console supports two commands: raw reads and raw writes. For a read command, simply enter "READ XX", where XX is replaced with the register in hex that is desired to be read. Similarly, for write commands, simply enter "WRITE X1 X2" where X1 is the register to write and X2 is the value to write, both in hex. Note that letter case, number of digits, and the presence of '0x' do not matter here as the GUI parses in the relevant format.

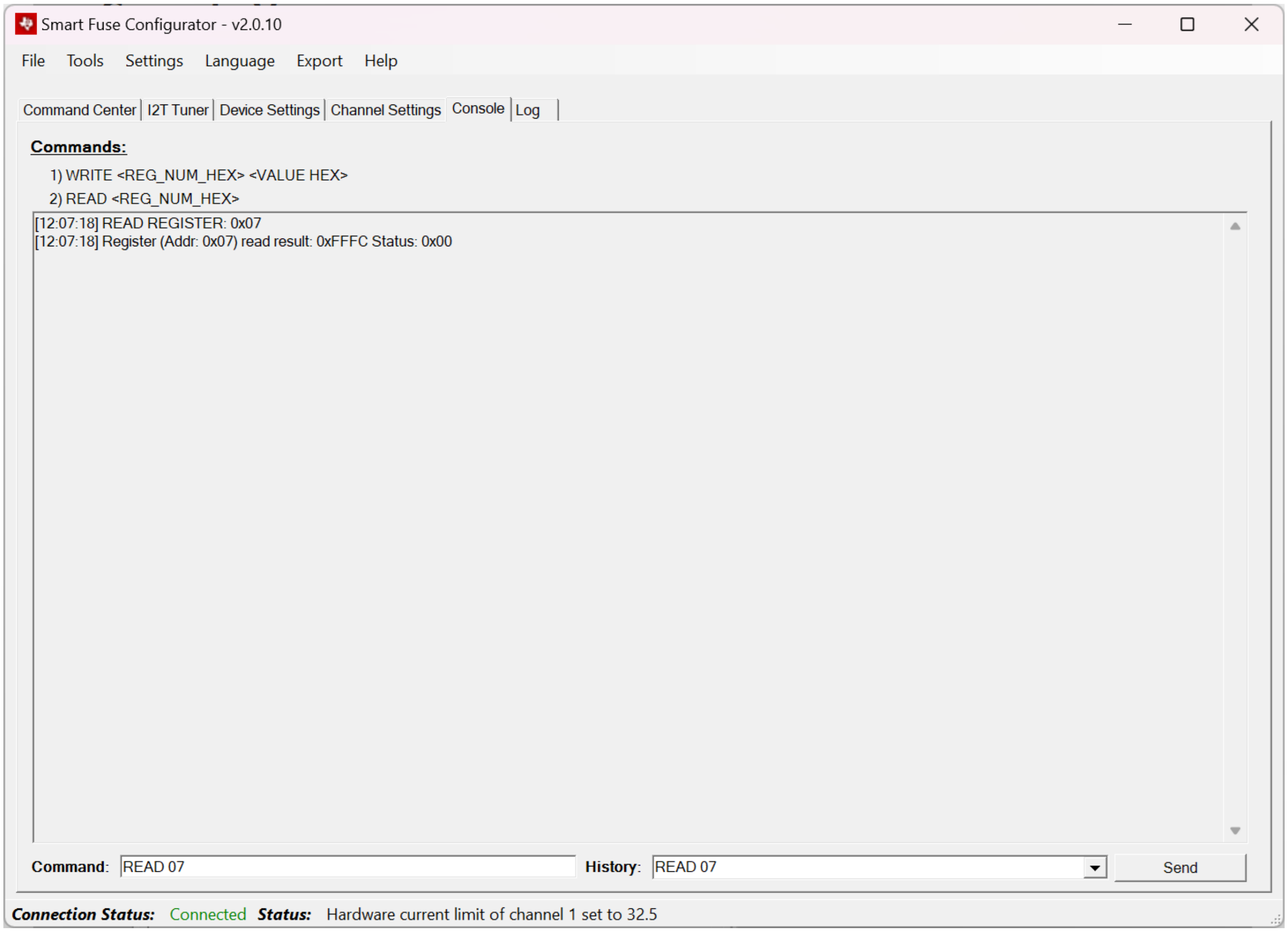



**Figure 3-14. Console View**

The status byte that is returned on a read/write corresponds to the global fault register. See the SPI read/write format section in the data sheet (SLVSGY2) for more information.

### 3.1.6 Log View

The log view shows a log of all events and interactions that happened in the system as well as any fault and diagnostic events.

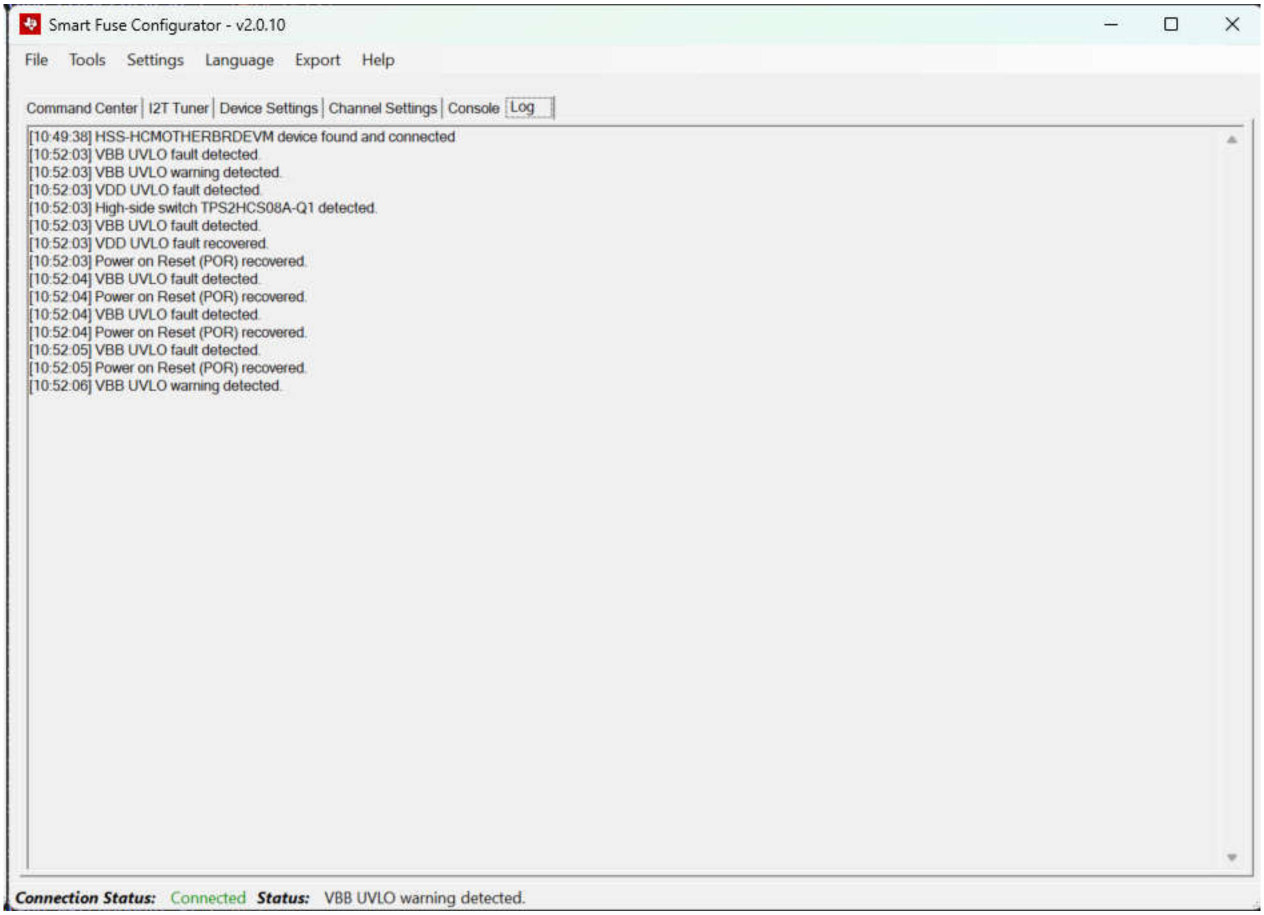



**Figure 3-15. Log View**

### 3.1.7 Importing/Exporting

The Smart Fuse Configurator tool has the ability to import/export settings into the GUI so that the user can quickly load a previous configuration upon loading the program. This is simply done through the ***Save Settings*** and ***Load Settings*** prompts from the ***File*** menu. Note that the settings can only be saved/loaded when the high-side switch EVM is connected. When saved, the settings are in a simple ASCII format such as follows:

```
TPSHCSCONFIGURATOR
/* TPS2HCS08_LPM */
3,65408
/* TPS2HCS08_FAULT_MASK */
5,65408
/* TPS2HCS08_SW_STATE */
7,65532
/* TPS2HCS08_DEV_CONFIG */
9,256
/* TPS2HCS08_ADC_CONFIG */
10,65338
/* TPS2HCS08_PWM_CH1 */
14,61440
/* TPS2HCS08_ILIM_CONFIG_CH1 */
15,7
/* TPS2HCS08_CH1_CONFIG */
16,49166
/* TPS2HCS08_I2T_CONFIG_CH1 */
21,32832
```

```
/* TPS2HCS08_PWM_CH2 */
23,61440
/* TPS2HCS08_ILIM_CONFIG_CH2 */
24,0
/* TPS2HCS08_CH2_CONFIG */
25,49154
/* TPS2HCS08_I2T_CONFIG_CH2 */
30,0
```

### *3.1.8 Firmware Updates*

The HSS-HCMOTHERBRDEVM has the ability to update the firmware on the TM4C microcontroller over USB. To enable this, the microcontroller leverages the *DFU ecosystem* developed by TI. To put the device into firmware update mode, click *Tools->Enter DFU Mode*.

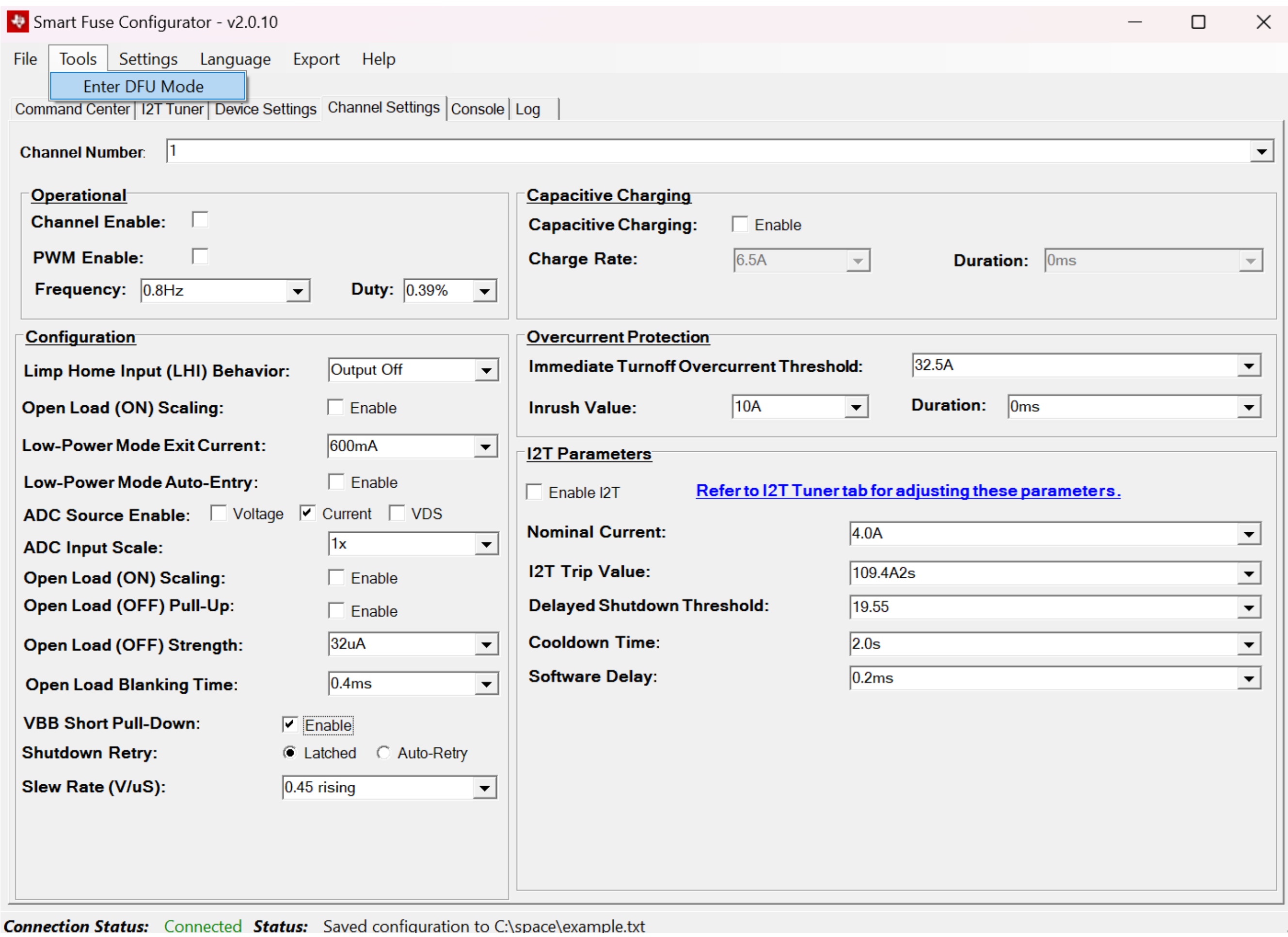



**Figure 3-16. Enter Firmware Update Mode**

Once in DFU mode, the high-side switch disconnects and the device enumerates as a DFU compatible USB device. Note that DFU drivers must be installed to support this mode of operation. These drivers are included with the standard TivaWare installation. The firmware update tool dfutool.exe is also included within the TivaWare installation. This tool can be used to download a binary to the onboard microcontroller of the device.

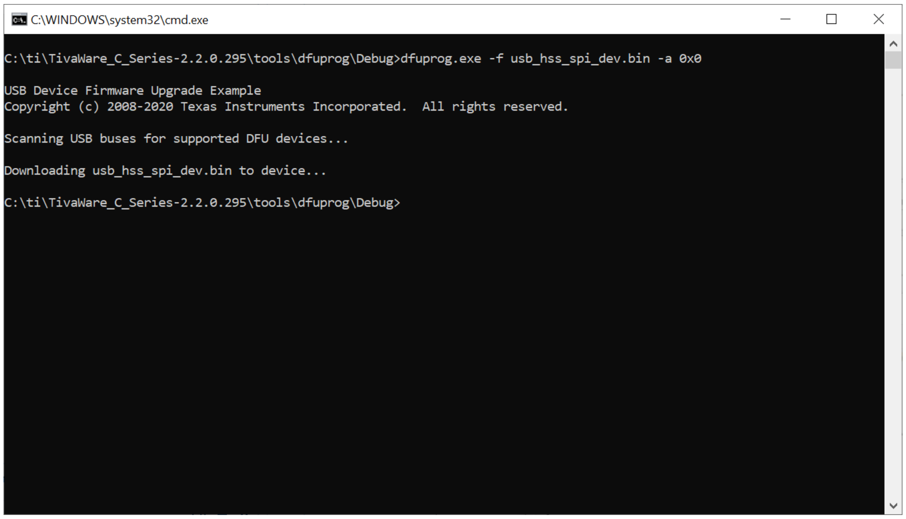



**Figure 3-17. dfuprog Invocation**

### 3.1.9 Persist Settings

By default, the Smart Fuse Configurator is set to automatically persist when a change is made on the GUI interface. Likewise, when a fault occurs in the system or a tab page is changed, the GUI automatically pings the high-side switch for the latest configuration data and update accordingly. This behavior can be changed to a manual mode by checking or unchecking the *Settings->Auto-Persist/Auto-Refresh* settings. Note that "persist" refers to a write operation to the high-side switch's register configuration and "refresh" refers to a reach from the high-side switch's register map.

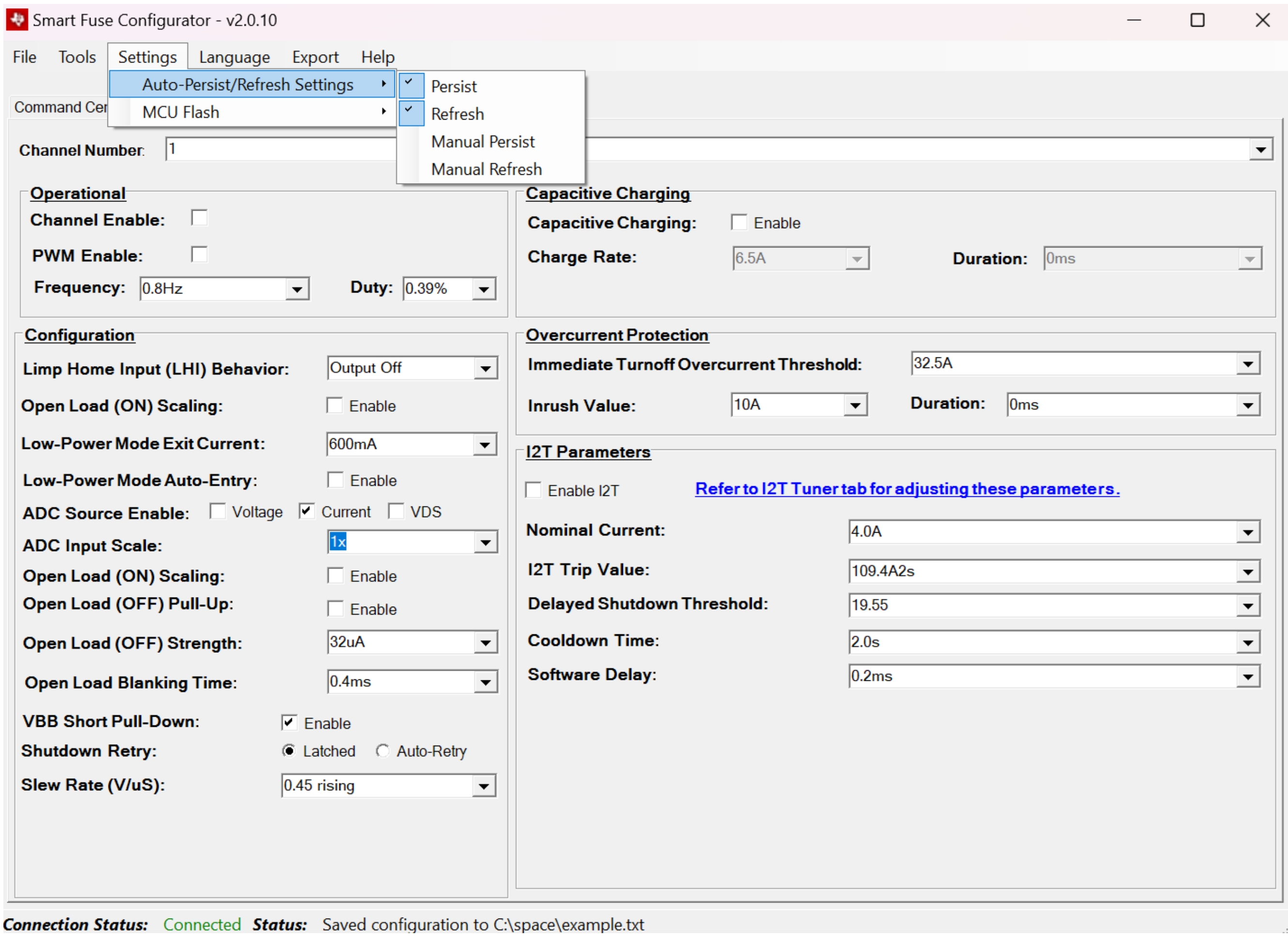



**Figure 3-18. Persist Settings**

Once unchecked, the device goes into manual persist and refresh mode. This enables the corresponding button in the *Settings* menu. Once clicked, these buttons initiate a manual refresh of the GUI (pinging the high-side switch for the latest data) or a manual persist of the settings. Note in manual refresh mode, the fault diagnostics are automatically set to manual refresh mode in the device settings tab.

### *3.1.10 Language Settings*

The Smart Fuse Configurator has the ability to switch between the language used for parameters and labels. To switch between languages, simply choose the desired language from the Language menu option.

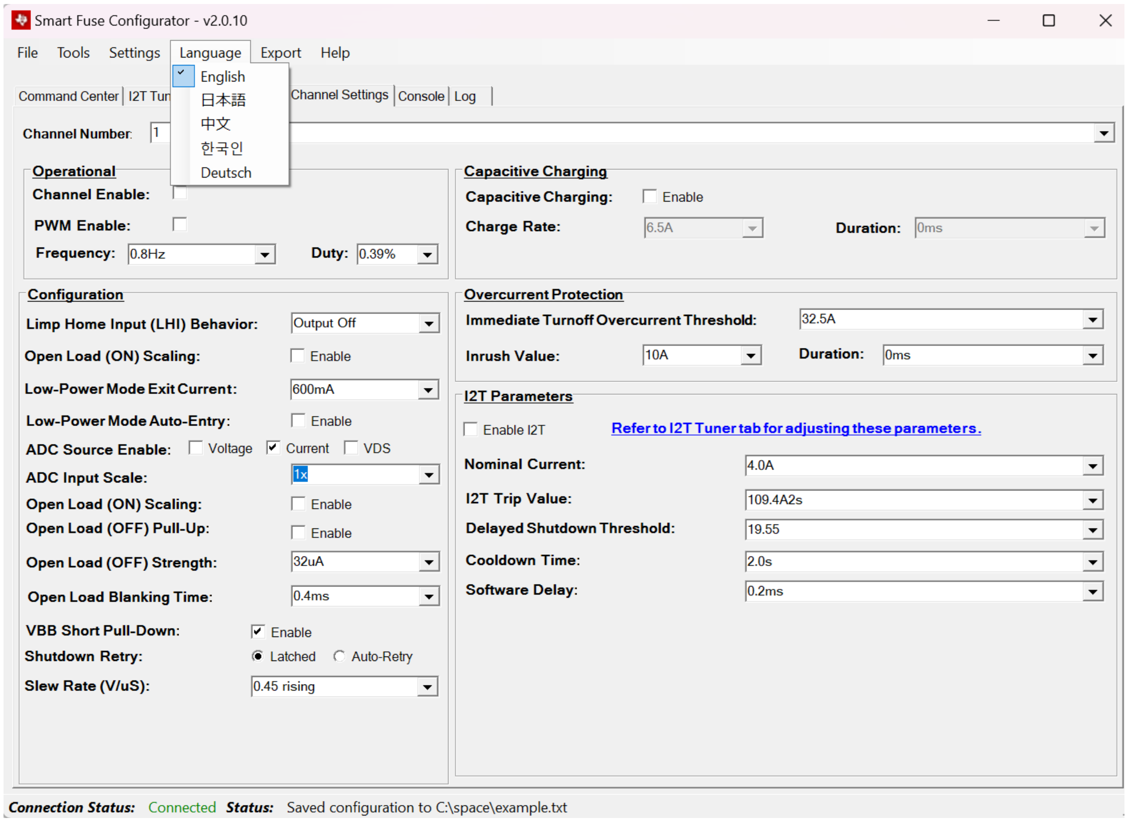



**Figure 3-19. Language Settings**

Currently English, Japanese, Korean, German, and simplified Chinese are supported.

## 3.2 Software Development

The Smart Fuse Configurator comes with a C header file that was generated from the register map of each supported high-side switch. Initially, this includes the TPS2HCS10-Q1 device. The header files are available on the product page and includes functionality such as:

- C structure for each bitfield/enumeration of each register
- Mask definitions of each bitfield
- Offset definitions of each bitfield
- Enumerations of each bitfield

This header file is meant to be used to enable software development on an embedded C platform. An excerpt of the SW_STATE register can be seen below.

```
/* --------- TPS2HCSXX_SW_STATE (0x07) ----------*/

#define TPS2HCSXX_SW_STATE_REG 0x07

typedef union
{
uint16_t word;
struct
{
/* This bit determines the output state of channel 1 for TPS2HCS08A/N-Q1
* versions.  */
uint16_t CH1_ON : 1;
/* This bit determines the output state of channel 2 for TPS2HCS08A/N-Q1
* versions.  */
uint16_t CH2_ON : 1;
/* Reserved */
uint16_t RESERVED_23 : 14;
} bits;
} TPS2HCSXX_SW_STATE;

typedef struct TPS2HCSXX_SW_STATE_OBJ
{
uint8_t reg;
TPS2HCSXX_SW_STATE value;
} TPS2HCSXX_SW_STATE_OBJ;

#define TPS2HCSXX_SW_STATE_CH1_ON_MASK 0x01
#define TPS2HCSXX_SW_STATE_CH1_ON_OFS 0

typedef enum {
ch1_on_en_0x0_field = 0x0,
ch1_on_en_0x1_field = 0x1,
} tps2hcsxx_ch1_on_field_t;

typedef enum {
ch1_on_en_0x0_mask = 0x0,
ch1_on_en_0x1_mask = 0x1,
} tps2hcsxx_ch1_on_mask_t;
```

An example of using the bit-wise operation to set CH1 to enabled can be seen below.

```
int main()
{
    TPS2HCSXX_SW_STATE enableReg;

    enableReg.bits.CH1_ON = 1;

    printf("\nChannel Enable: 0x%x\n", enableReg.byte);

    return 0;
}
```

A byte-wise example can be seen below.

```
#include "tps2hcs10.h"
#include <stdio.h>

int main()
{
    TPS2HC10S_SW_STATE enableReg;

    enableReg.byte = 0x01;

    printf("\nChannel Enable: 0x%x\n", enableReg.byte);

    return 0;
}
```

# 4 Hardware Design Files

## 4.1 Schematics

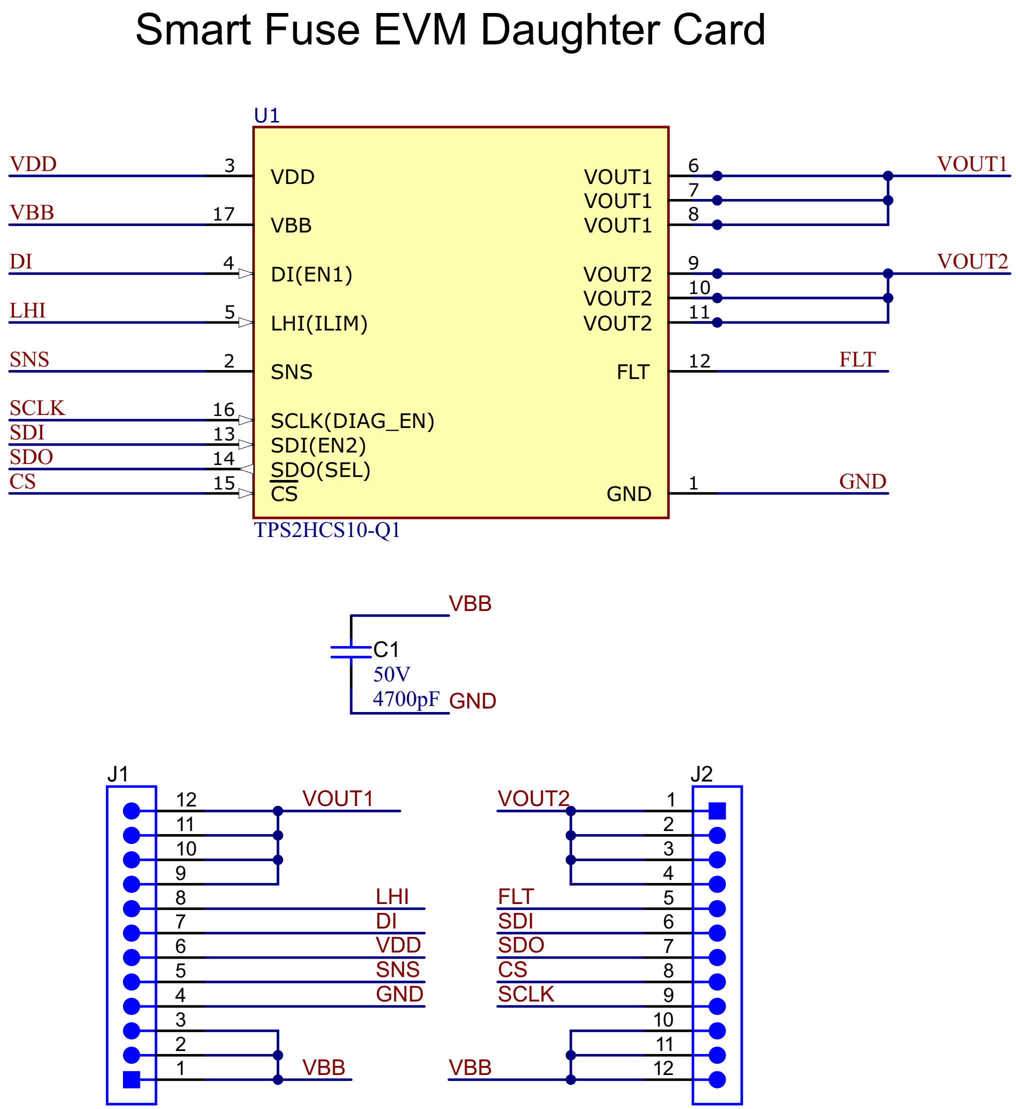



**Figure 4-1. Daughter Card Schematic**

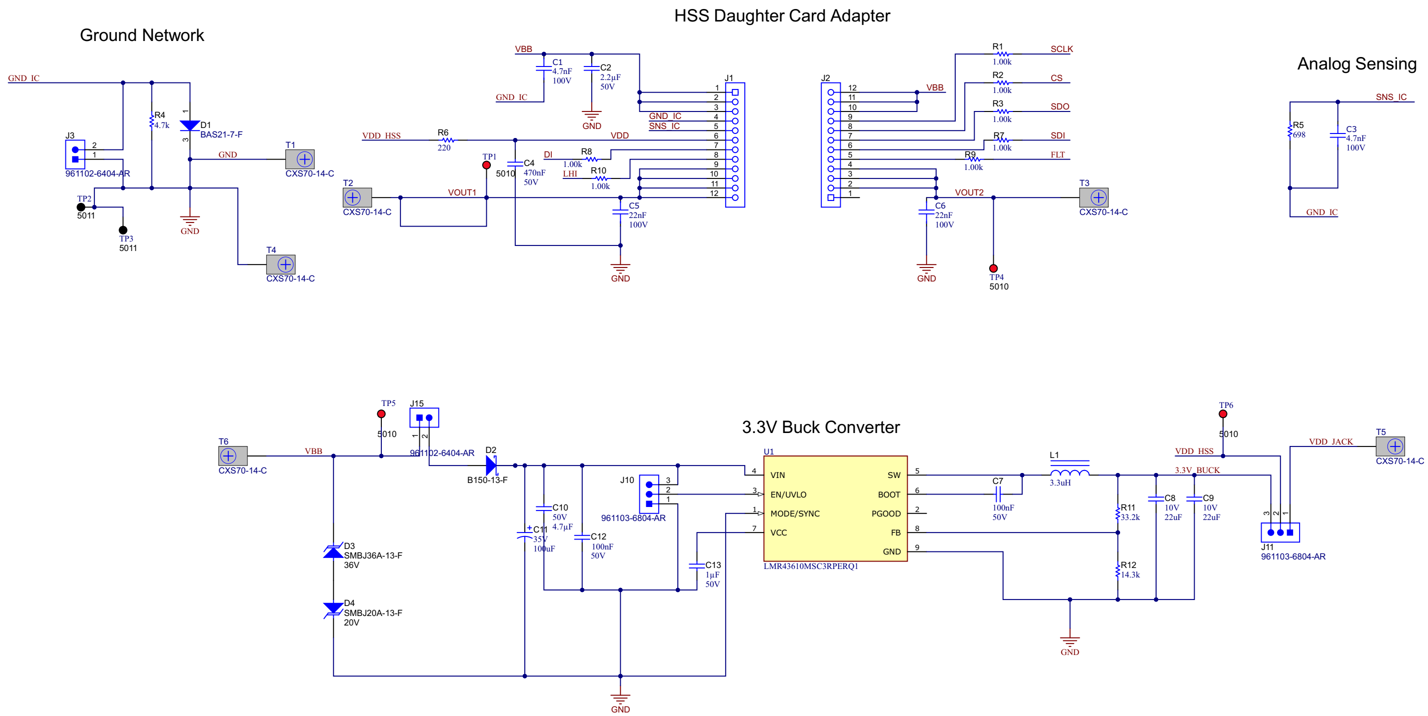



**Figure 4-2. Motherboard Schematic - High-Side Switch**

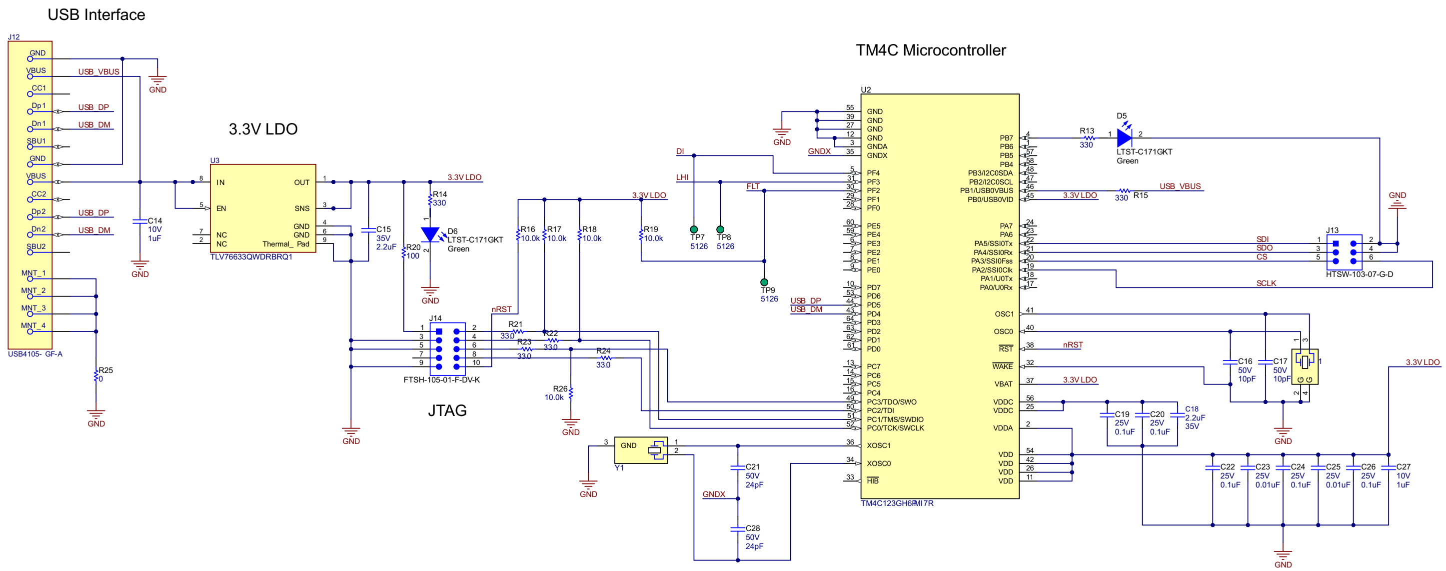
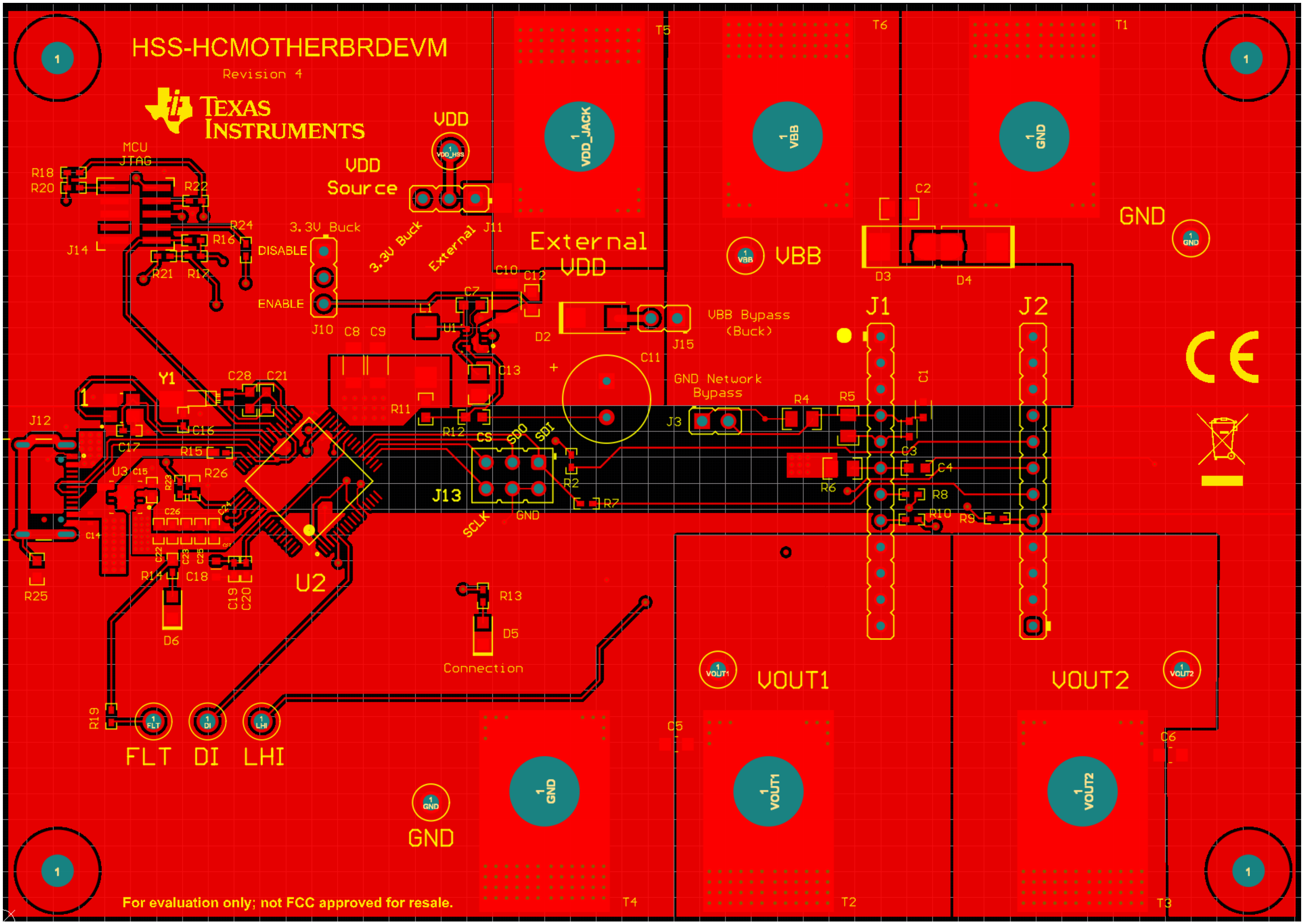


**Figure 4-3. Motherboard Schematic - MCU**

## 4.2 PCB Layouts



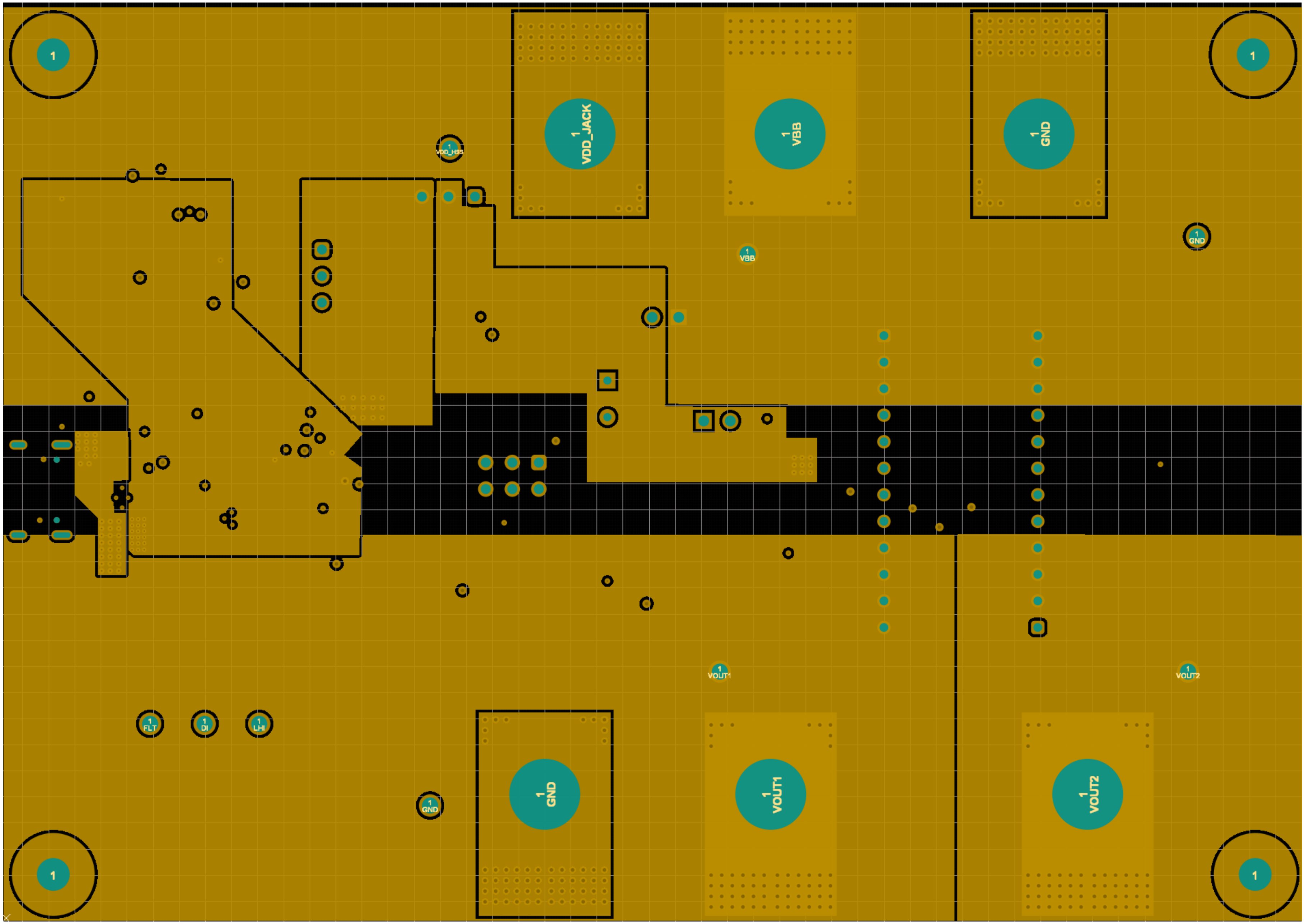



Figure 4-4. HSS-HCMOTHERBRDEVM Power Layer

Figure 4-4. HSS-HCMOTHERBRDEVM Top Layer

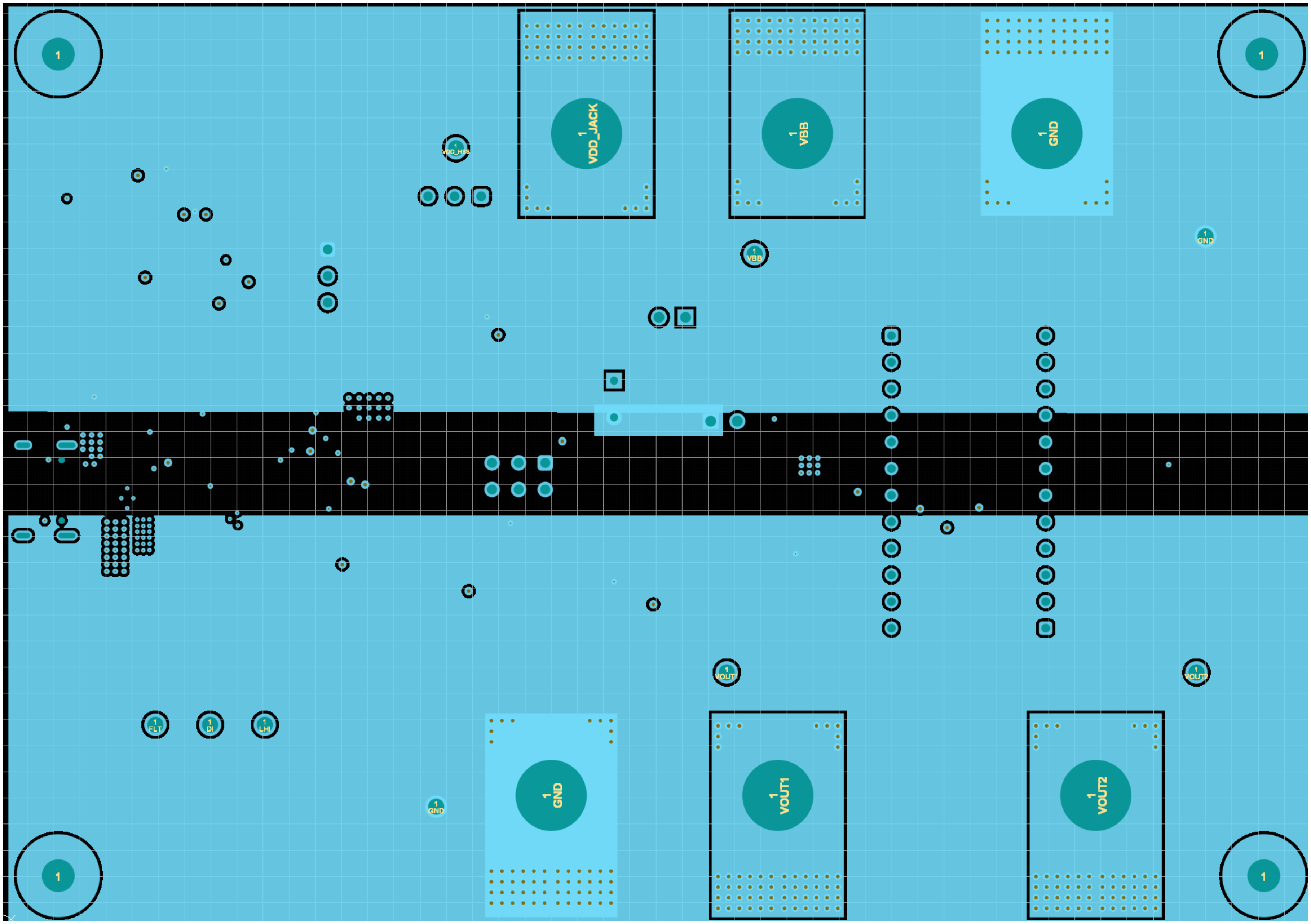



**Figure 4-6. HSS-HCMOTHERBRDEVM Ground Layer**

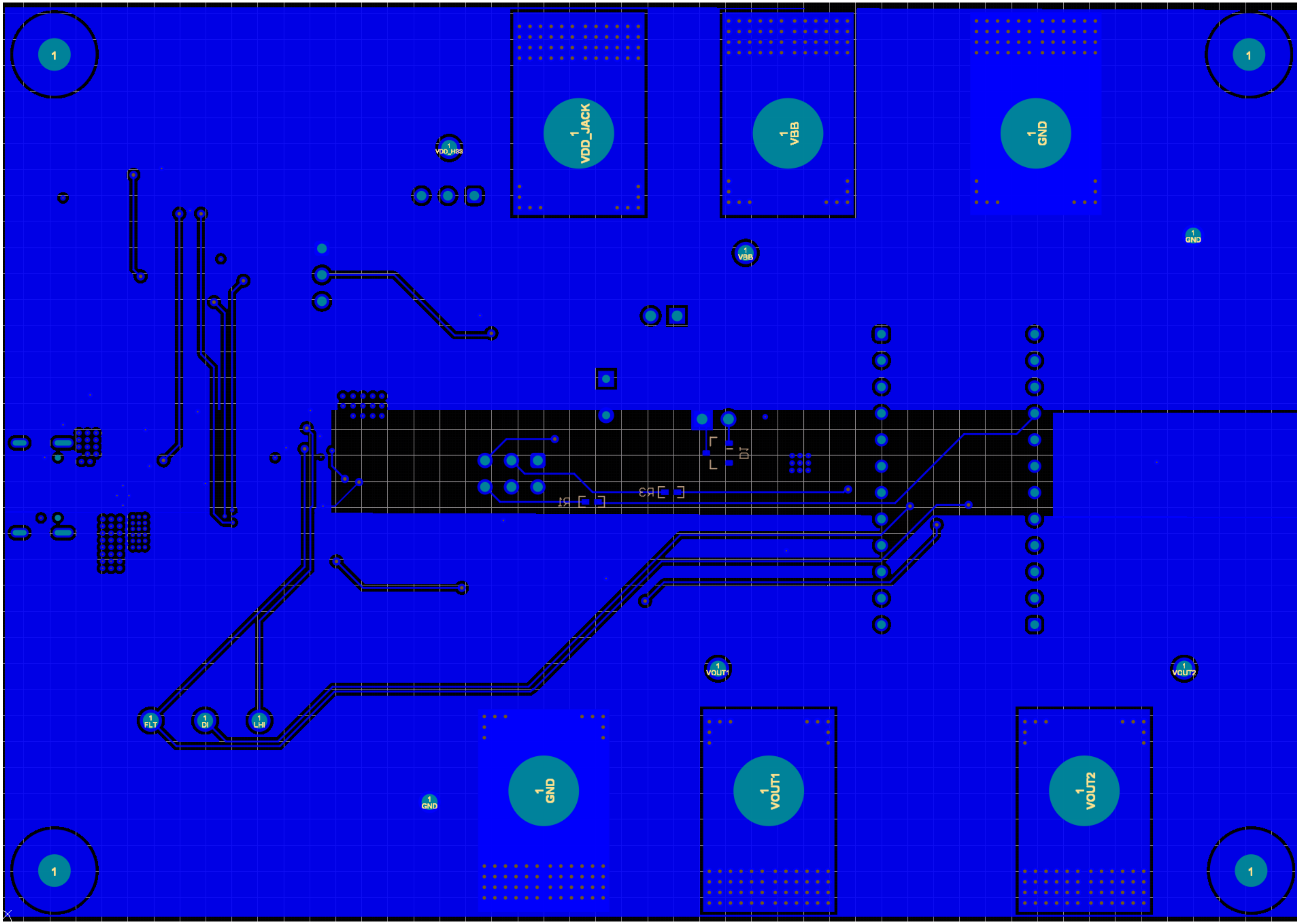
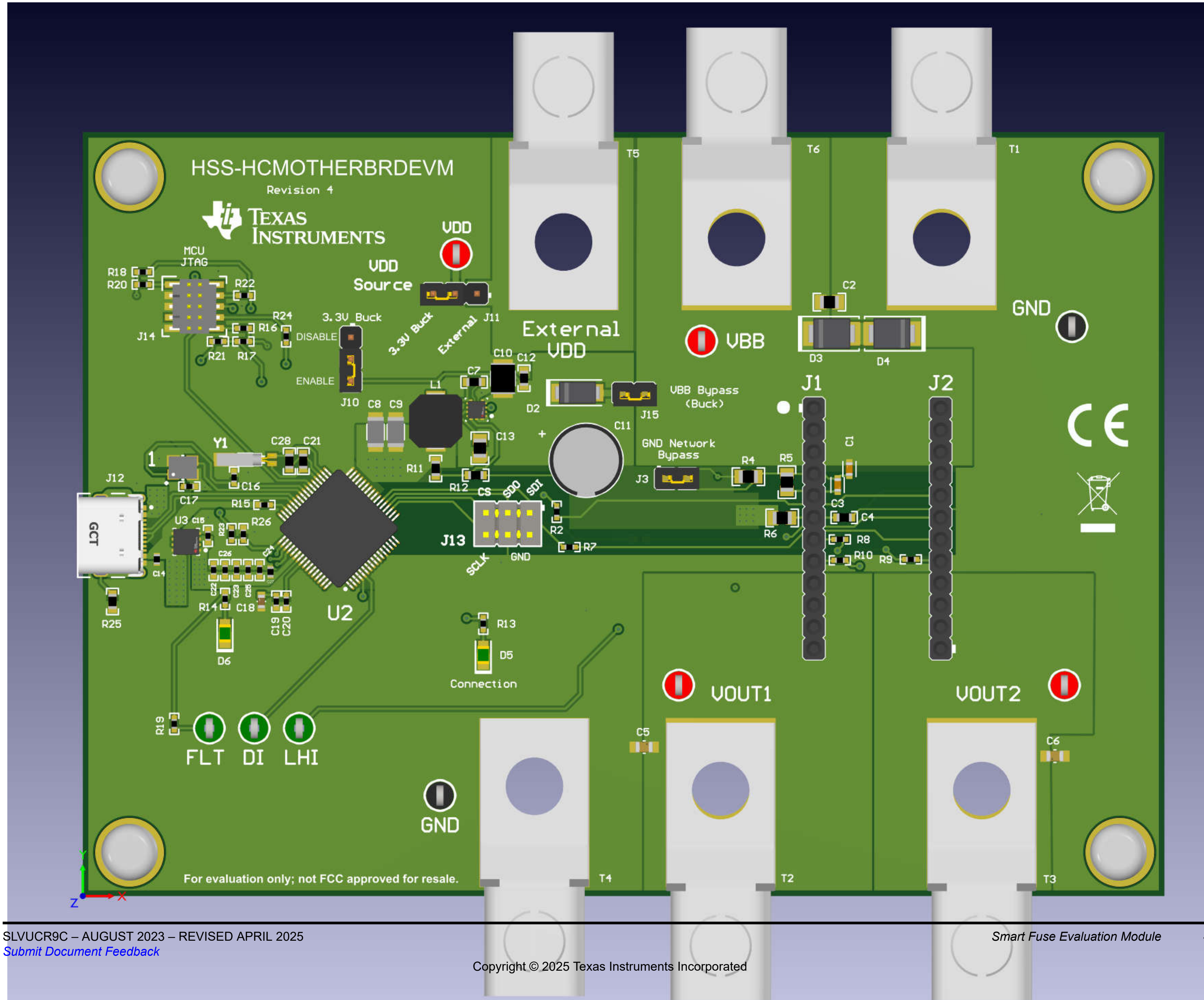



**Figure 4-7. HSS-HCMOTHERBRDEVM Bottom Layer**


HSS-HCMOTHERBRDEVM
Revision 4
TEXAS INSTRUMENTS
MCU JTAG
VDD
VDD Source
3.3V Buck
External
DISABLE
ENABLE
External VDD
VBB
VBB Bypass (Buck)
GND Network Bypass
GND
J1
J2
Y1
J12
J13
J14
J10
J11
J15
J3
U2
U3
L1
CS
SDO
SDI
SCLK
GCT
D2
D3
D4
D5
D6
Connection
FLT
DI
LHI
VOUT1
VOUT2
T1
T2
T3
T4
T5
T6
For evaluation only; not FCC approved for resale.

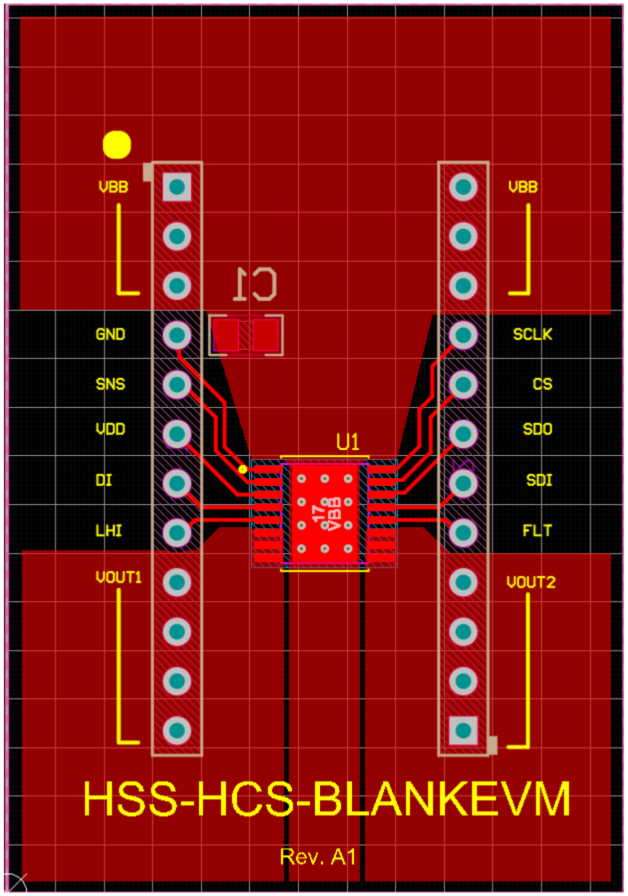



**Figure 4-9. Daughter Card Top Layer**

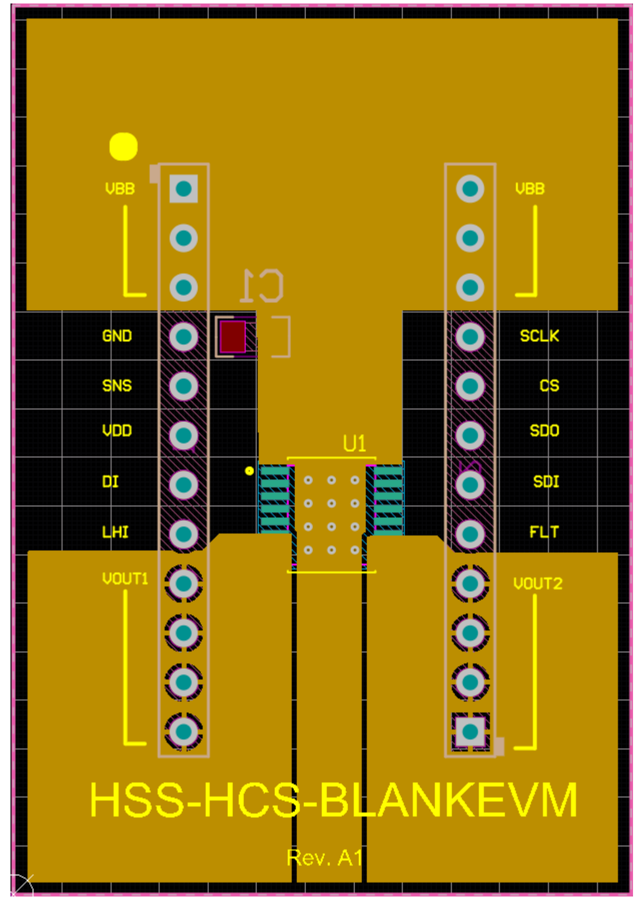



**Figure 4-10. Daughter Card Power Layer**

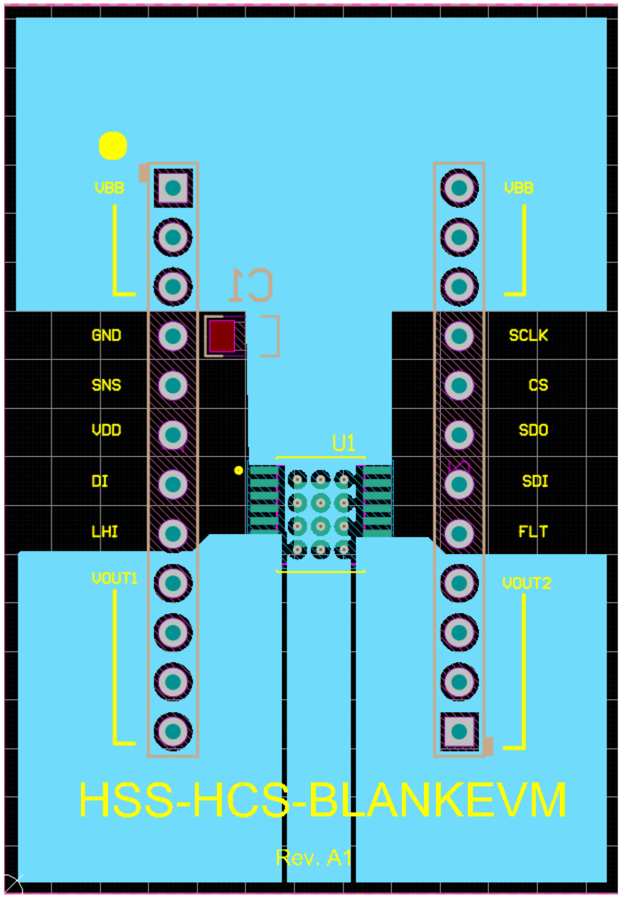



**Figure 4-11. Daughter Card GND Layer**

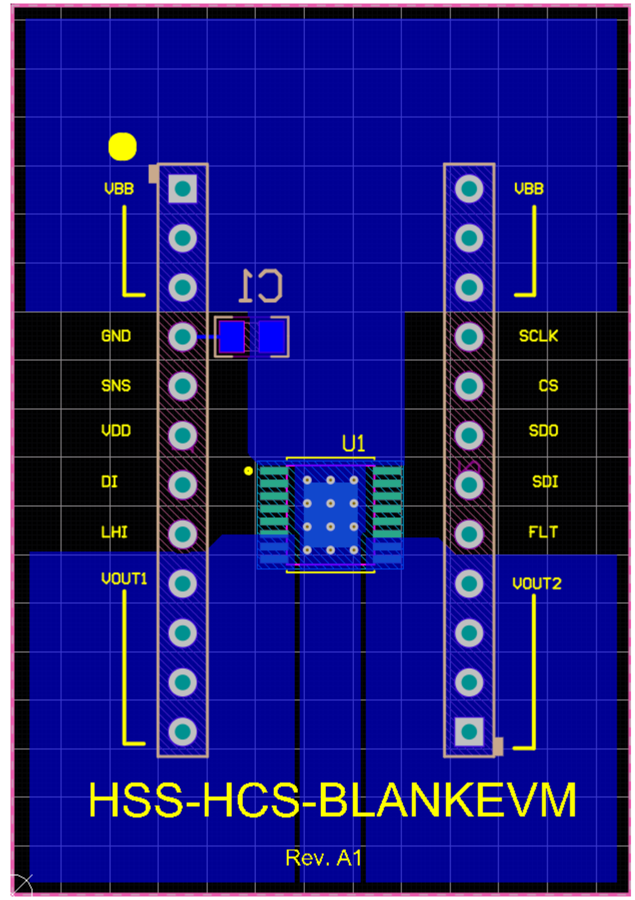



**Figure 4-12. Daughter Card Bottom Layer**

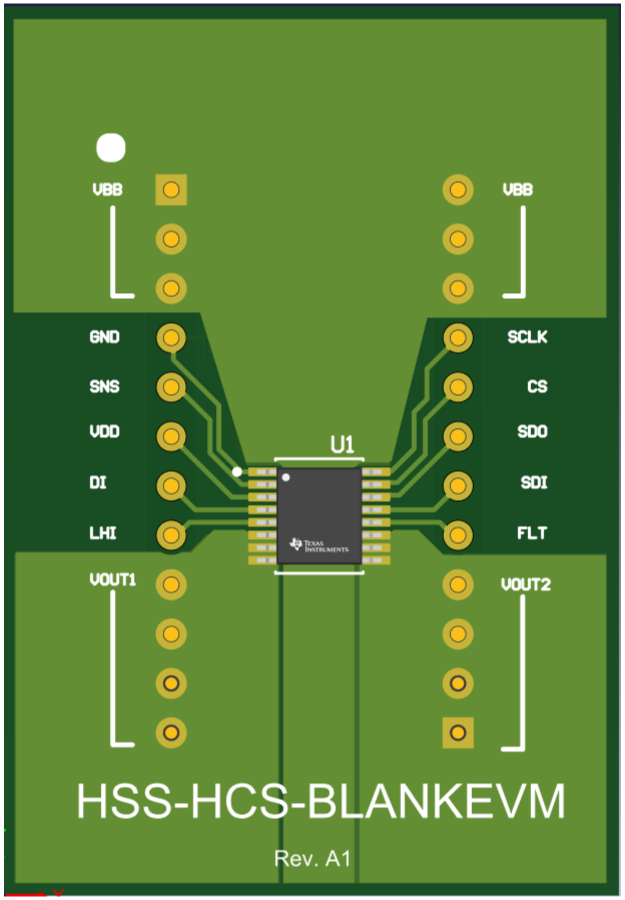



**Figure 4-13. Daughter Card 3D Plot**

### 4.3 Bill of Materials (BOM)

The table below is the bill of materials for the HSS-2HCS08EVM daughter card:

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| C1 | 1 | 4700 pF | CAP, CERM, 4700 pF, 50 V,+/- 5%, C0G/NP0, AEC-Q200 Grade 0, 0805 | 0805 | CGA4C2NP01H472J060AA | TDK |
| J1, J2 | 2 | | Header, 100mil, 12x1, TH | Header, 12x1, 100mil, TH | 800-10-012-10-001000 | Mill-Max |
| U1 | 1 | | 8.9mΩ, Automotive Dual-Channel, SPI Controlled High-Side Switch with Integrated I2 t Wire Protection and low power mode | HTSSOP16 | TPS2HCS08-Q1 | Texas Instruments |

The table below shows the bill of materials for the HSS-HCMOTHERBRDEVM board:

| Designator | Quantity | Value | Description | PartNumber | Manufacturer |
|---|---|---|---|---|---|
| 1 | 1 | | Crystal, 16 MHz, 8pF, SMD | NX3225GA-16.000M-STD-CRG-1 | NDK |
| C1, C3 | 2 | | 4700pF ±10% 100V Ceramic Capacitor X7R 0603 (1608 Metric) | ESD31C472K4T2A-18 | AVX Corporation |
| C2 | 1 | 2.2uF | CAP, CERM, 2.2 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805 | CGA4J3X7R1H225K125AE | TDK |
| C4 | 1 | 0.47uF | CAP, CERM, 0.47 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603 | CGA3E3X7R1H474K080AE | TDK |
| C5, C6 | 2 | | 0.022µF ±10% 100V Ceramic Capacitor X7R 0805 (2012 Metric) | VJ0805Y223KXBBC31 | Vishay |
| C7, C12 | 2 | 0.1uF | CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603 | C1608X7R1H104K080AA | TDK |
| C8, C9 | 2 | 22uF | CAP, CERM, 22 uF, 10 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206 | GCM31CR71A226KE02 | MuRata |
| C10 | 1 | 4.7uF | CAP, CERM, 4.7 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 1210 | C1210C475K5RACAUTO | Kemet |

| | | | | | |
|---|---|---|---|---|---|
| C11 | 1 | 100uF | CAP, AL, 100 uF, 35 V, +/-20%, 0.117 ohm, AEC-Q200 Grade 2, TH | EEU-FC1V101 | Panasonic |
| C13 | 1 | 1uF | CAP, CERM, 1 uF, 50 V, +/-10%, X7R, 0805 | 8.85012E+11 | Wurth Elektronik |
| C14, C27 | 2 | 1uF | CAP, CERM, 1 uF, 10 V, +/-10%, X7S, AEC-Q200 Grade 1, 0402 | GCM155C71A105KE38D | MuRata |
| C15 | 1 | 2.2uF | CAP, CERM, 2.2 uF, 35 V, +/-10%, X5R, 0402 | C1005X5R1V225K050BC | TDK |
| C16, C17 | 2 | 10pF | CAP, CERM, 10 pF, 50 V,+/-1%, C0G/NP0, 0402 | GRM1555C1H100FA01D | MuRata |
| C18 | 1 | 2.2µF | 2.2µF ±10% 35V Ceramic Capacitor X6S 0603 (1608 Metric) | GRT188C8YA225KE13D | Murata |
| C19, C20, C22, C24, C26 | 5 | 0.1uF | CAP, CERM, 0.1 uF, 25 V, +/-10%, X5R, 0402 | GRM155R61E104KA87D | MuRata |
| C21, C28 | 2 | 24pF | CAP, CERM, 24 pF, 50 V, +/-5%, C0G/NP0, 0603 | GRM1885C1H240JA01D | MuRata |
| C23, C25 | 2 | 0.01uF | CAP, CERM, 0.01 uF, 25 V, +/-10%, X7R, 0402 | GCM155R71E103KA37D | MuRata |
| D1 | 1 | 200V | Diode, Switching, 200 V, 0.2 A, SOT-23 | BAS21-7-F | Diodes Inc. |
| D2 | 1 | 50V | Diode, Schottky, 50 V, 1 A, SMA | B150-13-F | Diodes Inc. |
| D3 | 1 | 36V | Diode, TVS, Uni, 36 V, 58.1 Vc, SMB | SMBJ36A-13-F | Diodes Inc. |
| D4 | 1 | 20V | Diode, TVS, Uni, 20 V, 32.4 Vc, SMB | SMBJ20A-13-F | Diodes Inc. |
| D5, D6 | 2 | Green | LED, Green, SMD | LTST-C171GKT | Lite-On |
| H1, H2, H3, H4 | 4 | | Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead | NY PMS 440 0025 PH | B&F Fastener Supply |
| H5, H6, H7, H8 | 4 | | Standoff, Hex, 0.5"L #4-40 Nylon | 1902C | Keystone |

| | | | | | |
|---|---|---|---|---|---|
| J1, J2 | 2 | | Receptacle, 2.54mm, 12x1, Gold, TH | 801-47-012-10-012000 | Mill-Max |
| J3, J15 | 2 | | Header, 2.54mm, 2x1, TH | 961102-6404-AR | 3M |
| J10, J11 | 2 | | Header, 2.54mm, 3x1, Gold, TH | 961103-6804-AR | 3M |
| J12 | 1 | | USB - C (Type - C) USB 2.0 Receptacle Connector 24 Position Surface Mount, Right Angle; Through Hole | USB4105-GF-A | GCT |
| J13 | 1 | | Header, 2.54mm, 3x2, Gold, TH | HTSW-103-07-G-D | Samtec |
| J14 | 1 | | Header (Shrouded), 1.27mm, 5x2, Gold, SMT | FTSH-105-01-F-DV-K | Samtec |
| L1 | 1 | 3.3uH | Inductor, Shielded, Ferrite, 3.3 µH, 3.5 A, 0.025 ohm, AEC-Q200 Grade 0, SMD | CLF6045NIT-3R3N-D | TDK |
| R1, R2, R3, R7, R8, R9, R10 | 7 | 1.00k | RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402 | CRCW04021K00FKED | Vishay-Dale |
| R4 | 1 | 4.7k | RES, 4.7 k, 5%, 0.125 W, 0805 | CRCW08054K70JNEA | Vishay-Dale |
| R5 | 1 | 698 | RES, 698, 0.1%, 0.125 W, 0805 | RT0805BRD07698RL | Yageo America |
| R6 | 1 | 220 | RES, 220, 5%, 0.125 W, AEC-Q200 Grade 0, 0805 | CRCW0805220RJNEA | Vishay-Dale |
| R11 | 1 | 33.2k | RES, 33.2 k, 1%, 0.1 W, 0603 | RC0603FR-0733K2L | Yageo |
| R12 | 1 | 14.3k | RES, 14.3 k, 1%, 0.1 W, 0603 | RC0603FR-0714K3L | Yageo |
| R13, R14, R15 | 3 | 330 | RES, 330, 1%, 0.063 W, AEC-Q200 Grade 0, 0402 | CRCW0402330RFKED | Vishay-Dale |
| R16, R17, R18, R19, R26 | 5 | 10.0k | RES, 10.0 k, 1%, 0.063 W, 0402 | RC0402FR-0710KL | Yageo America |
| R20 | 1 | 100 | RES, 100, 1%, 0.1 W, 0402 | ERJ-2RKF1000X | Panasonic |
| R21, R22, R23, R24 | 4 | 33 | RES, 33.0, 1%, 0.063 W, AEC-Q200 Grade 0, 0402 | RMCF0402FT33R0 | Stackpole Electronics Inc |
| R25 | 1 | 0 | RES, 0, 5%, 0.1 W, 0603 | ERJ-3GEY0R00V | Panasonic |

| | | | | | |
|---|---|---|---|---|---|
| SH-J1, SH-J2, SH-J3, SH-J4 | 4 | 1x2 | Shunt, 100mil, Gold plated, Black | SNT-100-BK-G | Samtec |
| T1, T2, T3, T4, T5, T6 | 6 | | Terminal 70A Lug | CXS70-14-C | Panduit |
| TP1, TP4, TP5, TP6 | 4 | | Test Point, Multipurpose, Red, TH | 5010 | Keystone |
| TP2, TP3 | 2 | | Test Point, Multipurpose, Black, TH | 5011 | Keystone |
| TP7, TP8, TP9 | 3 | | Test Point, Multipurpose, Green, TH | 5126 | Keystone |
| U1 | 1 | | 36-V, 2-A Buck Converter with 1.5 µA IQ in 2-mm x 2-mm HotRod QFN | LMR43610MSC3RPERQ1 | Texas Instruments |
| U2 | 1 | | High performance 32-bit ARM(R) Cortex(R)-M4F based MCU, PM0064A (LQFP-64) | TM4C123GH6PMI7R | Texas Instruments |
| U3 | 1 | | 500-mA, 17-V linear voltage regulator | TLV76633QWDRBRQ1 | Texas Instruments |
| Y1 | 1 | | Crystal, 32.768 kHz, 12.5pF, SMD | MS3V-T1R 32.768KHZ +/-20PPM 12.5PF | Micro Crystal AG |

# 5 Additional Information

## 5.1 Trademarks

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# 6 Revision History

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

## 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

    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 DEGREDATION 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/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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

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

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。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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# IMPORTANT NOTICE AND DISCLAIMER



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