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## 1 Overview

The INA700 is a digital power monitor with integrated 16-bit delta-sigma ADC specifically designed for space constrained current-sensing applications. The device includes an integrated copper shunt capable of up to 10 continuous amps with common-mode voltage support from  $-0.3\text{ V}$  to  $+40\text{ V}$ . The device can measure internal die temperature and power consumption for the monitored bus. The INA700 also has built-in diagnostic capabilities to indicate system health accessible through a digital output pin, ALERT. The device operates from a single supply of  $2.7\text{ V}$  to  $5.5\text{ V}$ , drawing less than  $1.1\text{ mA}$  of current during operation over temperature, and  $< 5\text{-}\mu\text{A}$  current during shutdown. Users can interface the output with a multitude of microcontrollers (MCUs) in a standard I<sup>2</sup>C interface.

**Table 1-1. Device Summary**

PRODUCT	DIGITAL PROTOCOL	ADC RESOLUTION	MAX GAIN ERROR	MAX OFFSET CURRENT
INA700	I <sup>2</sup> C	16-bit	$\pm 0.65\%$	$\pm 2\text{ mA}$

### 1.1 Kit Contents

Table 1-2 lists the contents of the EVM kit. Contact [Texas Instruments' customer support center](#) if any component is missing.

**Table 1-2. Kit Contents**

ITEM	QUANTITY
INA700EVM	1

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**Note**

This EVM requires the TI Sensor Control Board (SCB) that is sold separately.

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## 1.2 Related Documentation From Texas Instruments

This user's guide is available from the TI website under literature number [SBOU285](#). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. When ordering, identify the document by both title and literature number. [Table 1-3](#) lists documentation related to the EVM. Click the links in [Table 1-3](#) for further information. The device name links to the product web folder on [www.ti.com](http://www.ti.com). The literature number links to the document PDF.

**Table 1-3. Related Documentation**

DOCUMENT TITLE	DOCUMENT LITERATURE NUMBER
<a href="#">INA700 data sheet</a>	<a href="#">SBOSAB4</a>

## 2 Hardware

The INA700EVM is an easy-to-use platform that can evaluate the main features and performance of the INA700 device. The EVM supports current measurements up to 10 continuous amps through the PCB, and includes a graphical user interface (GUI) used to read and write device registers as well as view and save results data.

The EVM is intended to provide basic functional evaluation of the device. The layout is not laid out for electromagnetic compatibility (EMC) testing. The EVM consists of a single printed circuit board (PCB). The PCB may also be referred to as the EVM in this document, and has the INA700 installed. A separate PCB may be used in conjunction with the EVM, known as the SCB Controller, and is used to interface the EVM with the GUI.

### 2.1 Features

- GUI support to read and write device registers as well as view and save results data
- EVM detached from SCB for custom use cases
- Multiple EVM support with single SCB or GUI
- Conveniently powered from a common micro-USB connector through the SCB

## 3 Operation

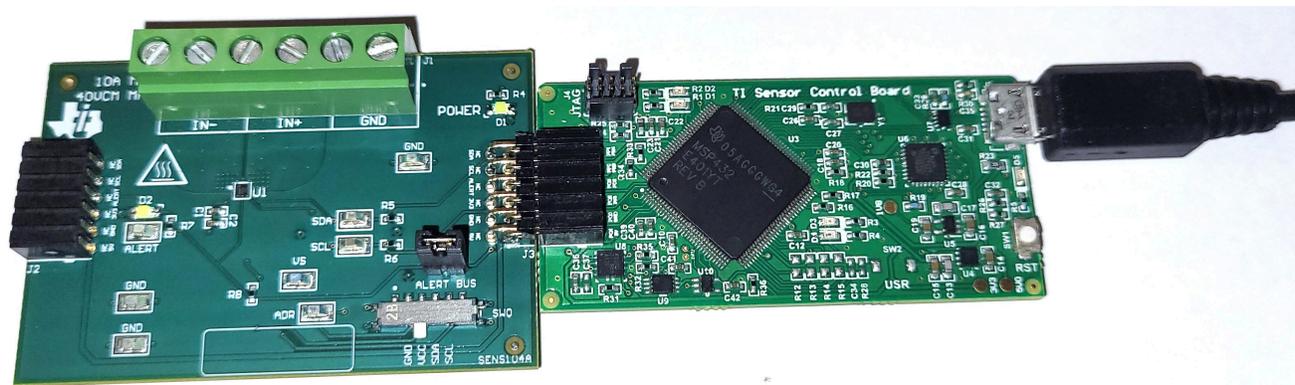
### 3.1 Quick Start Setup

The following instructions describe how to set up and use the EVM.

1. Purchase a SCB if you do not already have one.
2. Download this driver and install it **as an administrator**: <https://www.ti.com/lit/zip/sbac253>.
  - a. Follow the download prompts. An account on my.TI™ on-line information services is required.
  - b. Take note that this driver is labeled as a PAMB driver and is also used for the SCB.
3. Attach the EVM to the SCB Controller as shown in [Figure 3-1](#).
  - a. Refer to [Figure 3-2](#) when connecting multiple EVMs of the same type together.
4. Connect the EVM to the PC using a USB cable.
  - a. Insert the micro-USB cable into the SCB Controller onboard USB receptacle J2.
  - b. Plug the other end of the USB cable into a PC.
5. Access the GUI from this link in either Chrome, Firefox, or Safari: [https://dev.ti.com/gallery/info/CurrentSensing/INA700EVM\\_GUI/](https://dev.ti.com/gallery/info/CurrentSensing/INA700EVM_GUI/).
6. Connect the GND reference of the external system to the GND node of the EVM (pin 1 of J1).
7. Ensure the load current is disabled, then place the INA700 IN+ and IN– nodes to the load line by connecting the signal leads to J1 pin 5 or 6 and J1 pin 3 or 4 on the EVM as explained in [Current Sensing Operation](#).

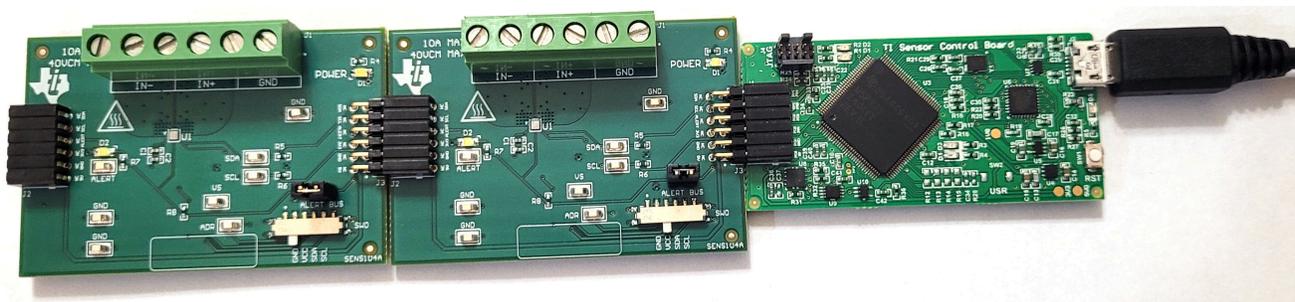
### 3.2 EVM Operation

To use the EVM with the SCB Controller (sold separately), connect the EVM as shown in [Figure 3-1](#).



**Figure 3-1. EVM (Left) Connected to SCB Controller (Right)**

If using multiple EVMs, connect them as shown in [Figure 3-2](#). Make sure to use a different address for each device. The GUI only supports one EVM/device type at a time and up to four EVMs total.



**Figure 3-2. Multiple EVMs Connected to SCB Controller**

### 3.2.1 Setup

#### 3.2.1.1 Driver Installation

Download and install this driver: <https://www.ti.com/lit/zip/sbac253>. This is a one-time step per computer and will require an account on my.TI™ on-line information services. Note that this driver is labeled as a PAMB driver and is also used for the SCB. Unzip the folder and **run the .exe file with administrator privileges**.

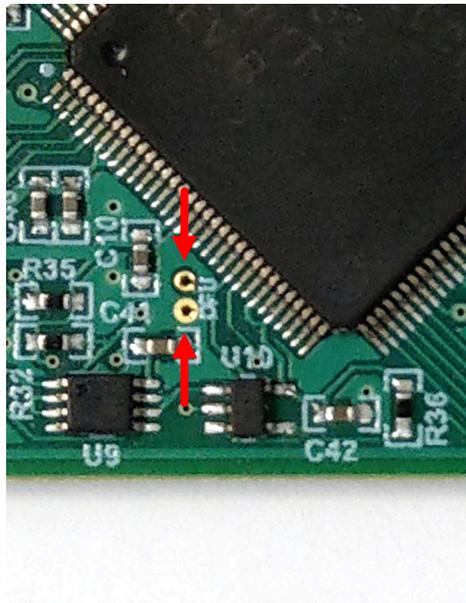
#### 3.2.1.2 Firmware

Firmware updates will be pushed through the GUI (requires previous driver to be installed). Downloaded offline GUIs will only update the SCB Controller with the latest firmware available at the time of download. To check for the latest GUI or Firmware updates, launch the latest GUI version from the web browser.

##### 3.2.1.2.1 Firmware Debug

If the firmware must be manually reinstalled for any reason, follow these steps to reinstall the firmware. Make sure the EVM is connected to the SCB.

1. Check to see if the GUI can program the firmware manually.
  - a. Plug the SCB controller into the PC
  - b. Launch the GUI
  - c. Check to see if the MCU entered Device Firmware Update (DFU) mode. If so, the GUI may notify you and try to update the firmware to the latest version.
  - d. If the GUI does not update automatically, go to *File* → *Program Device...*
2. If step 1 is unsuccessful (or if the *Program Device* button is grayed out), manually configure the MCU on the SCB Controller to DFU Mode through the software or hardware:
  - a. Through software:
    - Send the command 'bsl' on the SCB's USB Serial (COM) port.
  - b. Through hardware:
    - For safety, **turn off and disconnect all load sources and external voltages**
    - While shorting the two test points labeled *DFU* (shown in [Figure 3-3](#)) with a pair of tweezers (or wire), press and release the RESET button.



**Figure 3-3. Test Points Used to Enter DFU Mode Manually**

With the MCU in DFU mode, upload the firmware through the method outlined in [step 1](#).

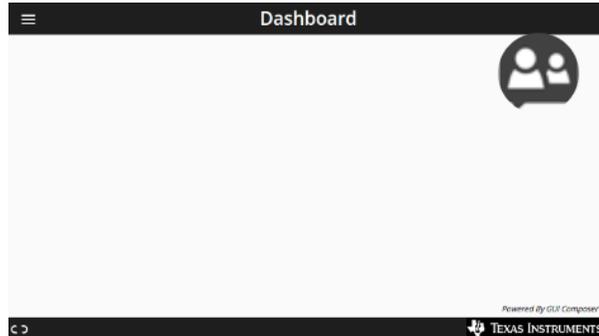
#### 3.2.1.3 GUI Setup and Connection

The GUI can be accessed from this link in either Chrome, Firefox, or Safari: [https://dev.ti.com/gallery/info/CurrentSensing/INA700EVM\\_GUI/](https://dev.ti.com/gallery/info/CurrentSensing/INA700EVM_GUI/).

### 3.2.1.3.1 Initial Setup

To set up the GUI the first time:

1. Make sure that the previously mentioned driver was installed successfully to ensure that everything works properly and that the GUI can update the EVM firmware, if necessary.
2. Check to make sure the EVM or SCB Controller unit is plugged into the PC, then go to the previously-provided GUI link.
  - Ensure that the EVM is connected to the SCB before plugging the SCB into a USB port.
3. Click the *GUI Composer* application (see [Figure 3-4](#)) to launch the GUI from the web browser.



## INA700EVM\_GUI

Version 1.0.0

by [CurrentSensing](#) (Group)

GUI for the INA700EVM



8 Views

**Figure 3-4. GUI Composer Application**

- a. The GUI link will bring up all versions of the GUI. TI recommends to launch the newest version available.
- b. For first-time GUI Composer setup, follow the prompts to download the *TI Cloud Agent* and browser extension shown in [Figure 3-5](#). Close the README.md dialog box to see these prompts.

## TI Cloud Agent Installation

Hardware interaction requires additional one time set up. Please perform the actions listed below and try your operation again. (What's this?)

- Step 1: **INSTALL** browser extension
- Step 2: **DOWNLOAD** and install the TI Cloud Agent Application
- Help. I already did this

**FINISH**

**Figure 3-5. TI Cloud Agent**

4. Optionally, click the  icon in the *GUI Composer* application (Figure 3-4) and follow the prompts to download the GUI for offline use.

### 3.2.1.3.2 GUI to EVM Connection

To connect the GUI to the EVM, follow these steps:

1. Set up and launch the GUI as described in [Initial Setup](#)
  - a. Make sure to connect the EVM to the SCB before powering on
2. Close the README.md file page to initiate a connection between the EVM and the GUI. If successful, the *Hardware Connected* message should be visible near the bottom-left corner of the GUI



**Figure 3-6. Hardware Connected**

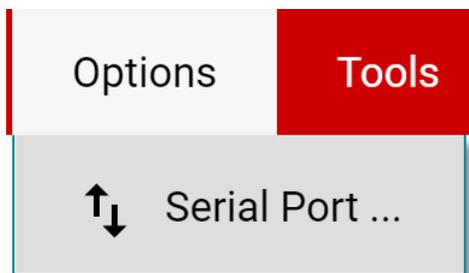
- a. A green indicator with the device type and the text *DEVICE CONNECTED* should also be visible near the top-left corner of the GUI

DEVICE CONNECTED



**Figure 3-7. Device Connected**

- b. If *Hardware Connected* and *DEVICE CONNECTED* do not show in the GUI, long-press the RESET button on the EVM to try again.
  - i. If the long-press reset does not work, check different hardware COM ports under *Options* → *Serial Port*, as shown in Figure 3-8.



**Figure 3-8. Change Serial Port**

- c. If the hardware still does not connect, make sure you are using the correct GUI and EVM combination.

- i. If you are using the correct GUI and EVM combination, you may need to reprogram the firmware of the SCB described in [Firmware Debug](#).
- ii. Many connectivity issues can be addressed by doing one of the following:
  1. Long-press the RESET button on the EVM with the EVM and SCB connected to each other.
    - Refreshing the GUI may also help
  2. Connect the EVM to a different USB port
    - Avoid using long cables and USB hubs
    - If using a desktop PC, try a USB port on the back

### 3.2.2 GUI Operation

Set up, launch, and connect the GUI to the EVM per [GUI Setup and Connection](#). Refer to the sections below for a description on how to use each page of the GUI.

#### 3.2.2.1 Home Tab

The GUI starts out on the Home tab. To get back to this page from anywhere, click the  (Home) icon on the menu on the left.

From the homepage, you can easily confirm successful GUI to EVM connection (see [GUI to EVM Connection](#)), as well as access helpful resources through the buttons on the bottom.

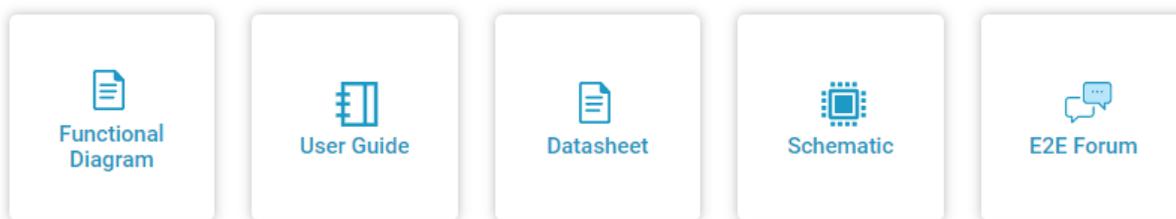


Figure 3-9. Home Tab Links

#### 3.2.2.2 Registers Tab

To view and edit the device registers, click the  (Registers) icon on the menu on the left. The Registers tab will look similar to the one shown in [Figure 3-10](#).

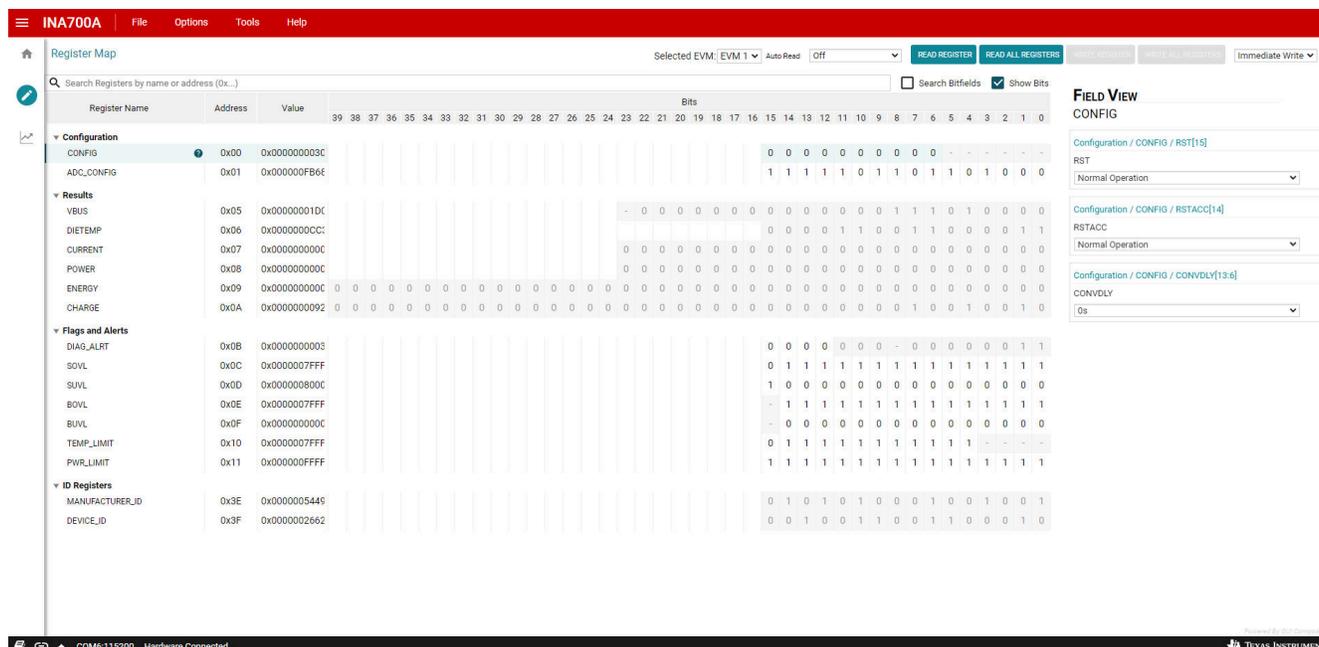
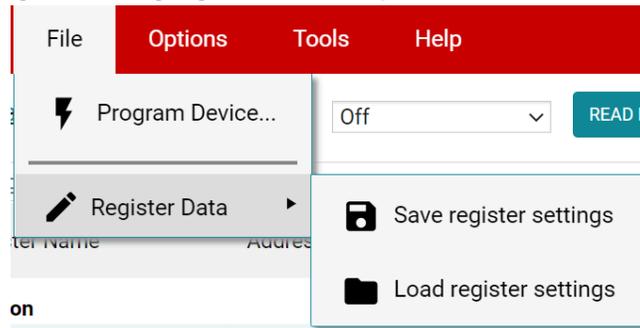


Figure 3-10. GUI Registers Tab

From this page, you can read and write device registers on the EVM. Here are some important notes:

- Use the *Selected EVM* drop-box to choose which device to work with on the Registers page
  - Note, changing this here also changes the same setting for the Configuration tab
  - Functionally, this button sets the default read and write address in the MCU and then reads all register values back to update the Registers page. Note that if data is collected at high frequency, this may cause a minor delay in the data collection. For optimal performance, set the device settings before you start collecting data.
- By default, all changes are automatically written to the device. If desired, you can change the *Immediate Write* setting to *Deferred Write* to only allow writing when you are ready.
  - You can modify writable register values from any of these methods:
    - Through the widget settings in the *Field View* section on the right
    - Changing the *Value* field directly with either hex or decimal values
    - Double-clicking any individual bit
- Remember that turning on *Auto Read* will only update registers in the Registers page and not the plots in the *Results Data* section
  - Leaving *Auto Read* on while collecting data for plots can interfere with data collection timing
- For questions about a register or register bit field, click the  icon
  - For even more questions about registers, check the data sheet
- For convenience, register settings can be saved and loaded back to any device with the same Registers page. To save or reload register settings, go to *File* → *Register Data*

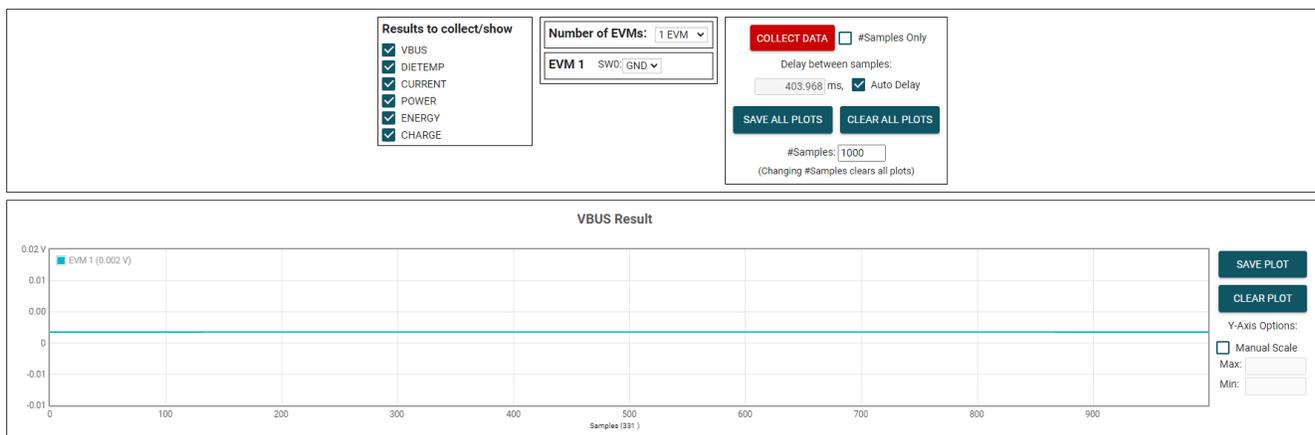


**Figure 3-11. Save and Load Register Settings**

- Press the *Read All Registers* button after loading the data to update the Registers page with the actual device values in case the loaded registers were not compatible with the connected device

### 3.2.2.3 Results Data Tab

To view and collect results data over time, click the  (Results Data) icon to open the Results Data page. [Figure 3-12](#) shows part of the Results Data page for reference.



**Figure 3-12. Results Page and Settings**

Below is a description of how to use the buttons and settings at the top of the Results Data page and next to each plot:

- Results to collect/show
  - Use this section to select which register values to collect data for. If a results register is unselected, then the plot below will not show the data and the EVM will not try to read this value during the collect cycle.
  - If you disable one of these settings while the EVM is collecting data, the plot will not show. The data will still be collected, however, and the plot will update in the background. Simply reselect to show data.
- Number of EVMs
  - Set the *Number of EVMs* drop-down menu to the number of EVMs currently in use
    - See [Figure 3-2](#) for how to attach multiple EVMs together
    - Changing this field also changes the same setting in the Configuration tab
  - The GUI only supports one EVM or device type at a time, up to four EVMs total
  - Switch settings
    - Use the onboard switch to select a different address for each EVM
    - Set the switch settings in the GUI to match the setting for each connected EVM
      - *EVM 1* will automatically populate with the lowest addressed device unless a setting has already been selected
      - Changing this here also changes the same setting in the Configuration tab
    - If more than one device is attached, an asterisk symbol (\*) will appear next to the selected EVM on the Registers and Configuration tabs
      - Changing the switch settings of any EVM sets that EVM as the selected EVM
- Collect/Plots settings
  - Collect Data
    - Press the *COLLECT DATA* button to start data collection
    - In this mode, the MCU reads and sends the selected result values for each device over a USB BULK channel. All results from one device are read before moving on to the next device.
      - All result values from all EVMs together are considered one "sample set"
    - Although you can read and write to other registers through the Registers page while collecting data, it is possible that this adds a delay to the data collection
    - Press the *STOP COLLECT* button to stop collecting data
  - #Samples Only
    - If this checkbox is selected, then the GUI will automatically stop collecting data after the number of samples specified in the #Samples box have been collected
    - If not selected, the GUI will continue collecting data and only store the most recent #Samples
  - Delay between samples
    - Sets the delay between the start of each sample set
    - Desired delay time may not be obtainable if it is set faster than the read loop, which depends on the number of results being collected, the number of EVMs, and your CPU
    - Although you can read and write to other registers through the Registers page while collecting data, it is possible that this adds a delay to the data being collected
  - Auto Delay
    - Sets delay based on conversion times, averaging, and number of channels being converted
    - If multiple EVMs are used, the time put in the delay box will be from the EVM with the shortest calculated delay value
  - Save All Plots
    - Press the *SAVE ALL PLOTS* button to save the data for each currently selected result from the *Results to collect/show* section in a spreadsheet
    - Press the *SAVE PLOT* button next to each plot to save just the data from that plot in a spreadsheet
  - Clear All Plots
    - Press the *CLEAR ALL PLOTS* button to clear the data from all plots together
    - Press the *CLEAR PLOT* button next to each plot to clear the data from just that plot
  - #Samples
    - Change the number in this box to change the number of samples shown in each plot
      - Changing this number clears out the plot buffers, so the plots will be cleared on the next read

- Y-Axis Options
  - Manual Scale
    - Check this box to set all EVM results in this plot to the same scale value specified by the minimum and maximum fields
    - When this is not selected, each EVM will have a separate y-axis scale based on the minimum and maximum values of those EVM result values
    - For the DIETEMP Result, the units can also be toggled between °C and °F
      - This processes the existing data in the plots and converts new data coming in. If receiving new data while changing units, it is possible that a datapoint gets missed or duplicated.
  - Max
    - The maximum y-axis value to use for all EVMs in this plot
    - If this field is empty when Manual Scale is selected, then it will auto-populate with the maximum value currently in the plot
  - Min
    - The minimum y-axis value to use for all EVMs in this plot
    - If this field is empty when Manual Scale is selected, then it will auto-populate with the minimum value currently in the plot

### 3.2.3 Current Sensing Operation

The INA700 comes equipped with an internal shunt resistor and is out-of-the-box ready to measure up to 10 A of continuous current. There are two terminals each for IN- (J1 pins 5 and 6) and IN+ (J1 pins 3 and 4) for convenience.

#### 3.2.3.1 Detailed Setup

To configure a measurement evaluation, follow these steps:

1. Connect a current-carrying line by connecting a line input to the IN+ terminal and the resulting output line to the IN- terminal in series with the load while powered off.

#### WARNING

When measuring current, first make sure that the equipment (shunt resistor, wires, connectors, and so on) can support the amperage and power dissipation. Secondly, make sure that the current flowing through J1 does not exceed 10 A. Failure to do so can result in damage to the EVM, or personal injury.

Do not touch high voltage terminals.

The EVM may get hot.

2. Connect the system ground to the GND terminal (J1 pin 1).
3. Power on the system, then observe the device states and outputs through the GUI.

### 3.2.4 Direct EVM USB Communication

If desired, you can communicate to the EVM directly (that is, without the use of the GUI) through the USB port. You can send the desired command string over the serial COM port and receive the results either through the COM port or the USB BULK channel based on the mode. This is useful for interfacing the EVM with custom setups, scripts, or GUIs.

#### 3.2.4.1 Standard USB Read and Write Operations

Use the serial COM port to read and write registers through USB commands using the following format:

- Set device address format: setdevice DEVID
  - Where setdevice is always lower case, and DEVID is defined as:
    - The four least significant bytes (LSBs) of the address in decimal format. Ex, for an address of 0x4A, use 10
  - Note when the SCB is reset while one or more EVMs are connected, the address will default to the lowest address found

- The SCB checks for I<sup>2</sup>C or SPI at start-up, and if no device is attached, the SCB will default to SPI.  
Reset the SCB with an I<sup>2</sup>C EVM connected to use I<sup>2</sup>C
- For example, to set an I<sup>2</sup>C device with a register address of 0x4A, you could send the command:  
setdevice 10
- For this example, the EVM would return the acknowledgment and state (idle or collecting) in JSON format:

```

{"acknowledge":"setdevice 10"}
{"evm_state":"idle"}

```
- Read register format: rreg ADR
  - Where ADR is the address in hex, and rreg is always lower case.
  - Register addresses can be in upper or lower case, and do not need to be led by '0x'. 0 padding register addresses is also optional. For example, to read register address 0xB, some valid commands include:
    - rreg b
    - rreg 0B
    - rreg 0x0B
      - When '0x' is used, the 'x' must be lower case.
  - For this example, the EVM would return the results and state (idle or collecting) in JSON format:

```

{"acknowledge":"rreg 0x0B"}
{"register":{"address":11,"value":3}}
{"evm_state":"idle"}

```
- Write register format: wreg ADR VAL
  - Where ADR and VAL are in hex, and wreg is always lower case
  - Register addresses and values can be in upper or lower case, and do not need to be led by '0x'. 0 padding register addresses and values is also optional. For example, to write register address 0x1 with the value 0xfb69, some valid commands include:
    - wreg 1 fb69
    - wreg 01 0xfb69
    - wreg 0x01 0xFB69
      - When '0x' is used, the 'x' must be lower case.
  - For this example, the EVM would return the results and state (idle or collecting) in JSON format:

```

{"acknowledge":"wreg 0x01 0xfb69"}
{"console":"Writing 0xfb69 to ADC_CONFIG register"}
{"evm_state":"idle"}

```

### 3.2.4.2 Collect Data Through the USB BULK Channel

The Collect Data function reads the desired result registers and sends the data based on the specified settings. This function works best with continuous conversion mode and does not configure the EVM or associated register settings for you. Collect mode is started and stopped through the serial COM port, however the results will be sent over the USB BULK channel. To use this mode, use the following format:

- Start collecting data format: collect timerPeriod collectFlags channelAddressIDs numDevices
  - Where collect is always lower case, and each parameter is the decimal representation of the value in the following format:
    - timerPeriod
      - The timer delay used in the MCU to allow data collection sample sets (in  $\mu$ s, unsigned 32-bit value)
    - collectFlags
      - a byte of data that has a 1 to collect and a 0 to not collect each register value type, according to the following definitions:
        - VBUS = 0b0100000
        - DIETEMP = 0b0010000
        - CURRENT = 0b0001000
        - POWER = 0b0000100
        - ENERGY = 0b0000010
        - CHARGE = 0b0000001
    - channelAddressIDs
      - I<sup>2</sup>C
        - This is the four LSBs of each address chained together, starting with the least significant byte first
          - For example, if EVM 1 is on channel 0x44 and EVM 2 is on 0x46, the value here would be 0b01100100
    - NumDevices
      - The number of EVMs chained together (1-4)
  - For example, to start data collection for VBUS, and DIETEMP every 3.156 ms, for two INA700s with EVM 1 address = 0x44 and EVM 2 address = 0x46, you would send: collect 3156 48 100 2
    - For this example, the EVM would return the acknowledgment and state in JSON format:
 

```

              {"acknowledge":"collect 3156 48 100 2"}
              {"evm_state":"collecting"}
              
```
  - The USB BULK channel receives data in the format: frameID deviceNumID address registerSize data
    - Where each parameter is the decimal representation of the value in the following format:
      - frameID (1 byte)
        - Always reads 0. Used to ensure data is aligned
      - deviceNumID (1 byte)
        - An ID number corresponding to the EVM number
          - From the above example, this will be 1 if reading from EVM 1 which had address set to 0x44, and 2 if reading from EVM 2 which had an address set to 0x46
      - address (1 byte)
        - The register address that was read from the device
      - registerSize (1 byte)
        - The number of bytes that the following data will have
      - data (1 byte at a time)
        - The register data value, given in bytes with the most significant byte (MSB) first
- Stop collecting data format: stop
  - Where stop is always lower case
  - The EVM will return the acknowledgment and state in JSON format:
 

```

          {"acknowledge":"stop"}
          {"evm_state":"idle"}
          
```

## 4 Circuitry

This section summarizes the EVM subsystems and their components.

### 4.1 Current Sensing IC

This section describes the main device and supporting components.

U1 is the main current-sensing device, the INA700. C1 and C2 are bypass capacitors that are placed near the sensor to help mitigate power-supply noise and provide current quickly to the device when needed. LED D1 with current limiting resistor R4 are used to indicate when the EVM is powered on.

### 4.2 Input Signal Path

This section describes the circuitry of the input signal path.

J1 is the main connection terminal. Pins 1 and 2 of J1 are used to tie the system ground to the EVM ground. Pins 3 and 4 are tied to IN+, and Pins 5 and 6 are tied to IN-. There are two pins each for IN- and IN+ for convenience, as well as current capabilities. For currents greater than 5 A, ensure that all pins of the terminal blocks are populated.

### 4.3 Digital Circuitry

This section describes the digital circuitry around the device.

#### 4.3.1 I<sup>2</sup>C

J2 and J3 are the main header pins that connect the digital and power pins to the SCB Controller or other EVMs. J3 connects to the EVM or SCB on the right, while J2 connects to more EVMs on the left. R5 and R6 are used as pullup resistors for the main digital I/O pins.

SW0 sets the I<sup>2</sup>C address of the device. This can be useful when using the EVM with a custom controller (other than the SCB Controller), or when connecting multiple EVMs together. Currently the SCB Controller and GUI are set up to use up to four EVMs at a time.

R8 is used as a pullup resistor for the ALERT pin, which is routed to both J2 and J3. LED D2 and current limiting resistor R7 are used to indicate when the ALERT pin is triggered. Header J4 and jumper H5 are used to disconnect the ALERT pin from the EVM ALERT bus by disconnecting from J3. This is primarily used when working with multiple EVMs, so that the individual ALERT LEDs can be seen on each EVM when the ALERT bus is not needed.

## 5 Schematics, PCB Layout, and Bill of Materials

### Note

Board layouts are not to scale. These figures are intended to show how the board is laid out. The figures are not intended to be used for manufacturing EVM PCBs.

### 5.1 Schematics

This section shows the schematics for the SENS104, also known as the INA700EVM.

#### 5.1.1 SENS113 (INA700EVM)

Figure 5-1 and Figure 5-2 show the schematic of the EVM. Figure 5-1 shows the circuitry for the EVM. Figure 5-2 shows the mechanical components included with the EVM.

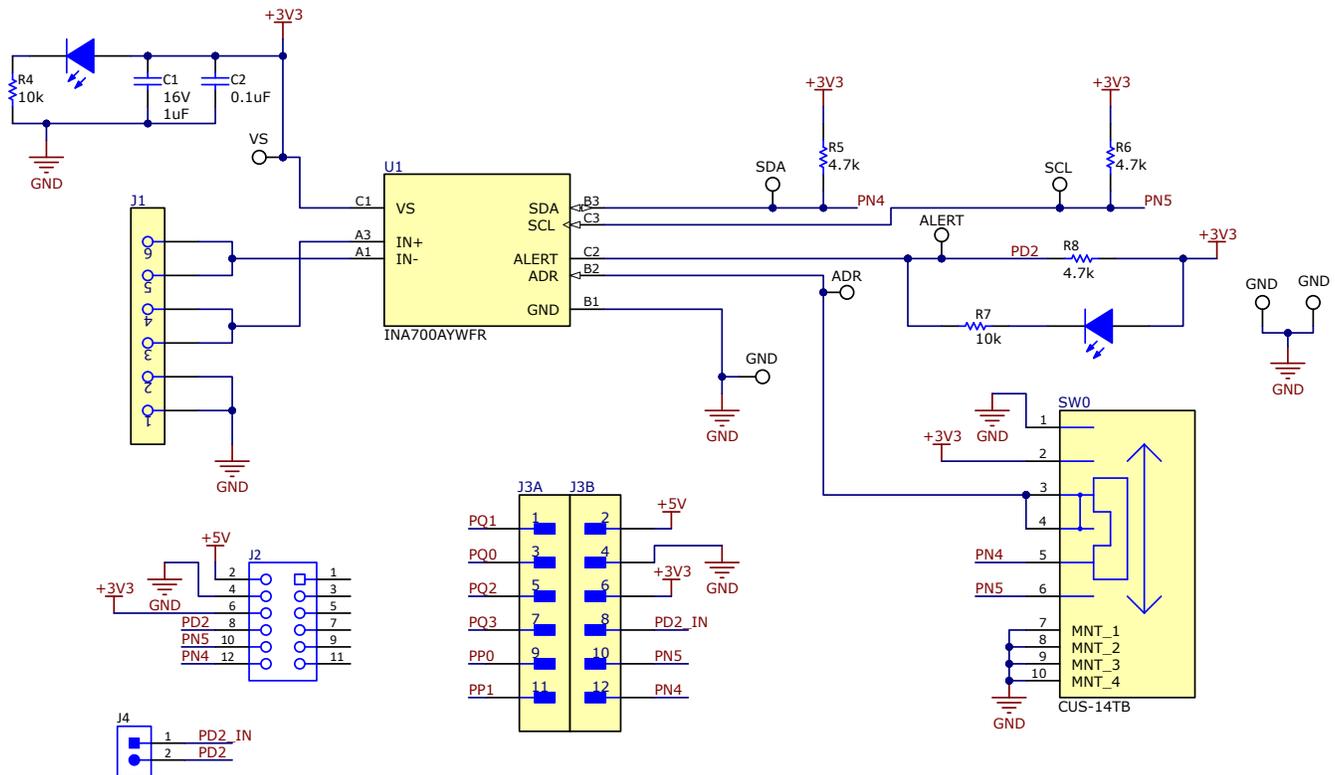


Figure 5-1. SENS113 Schematic



H5  
MECH  
60900213421



PCB Number: SENS104  
PCB Rev: A

PCB  
LOGO  
Texas Instruments



PCB  
LOGO  
FCC disclaimer

PCB  
LOGO  
WEEE logo



ZZ1  
Label Assembly Note  
This Assembly Note is for PCB labels only

ZZ2  
Assembly Note  
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3  
Assembly Note  
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4  
Assembly Note  
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

**Figure 5-2. SENS113 Hardware Schematic**



## 5.3 Bill of Materials

This section shows the bill of materials for the SENS104 PCB.

### 5.3.1 SENS113 (INA700EVM) BOM

Table 5-1 shows the bill of materials present on the SENS104 printed circuit board.

**Table 5-1. SENS113 Variants Bill of Materials**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C1	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X6S, 0402	0402	C1005X6S1C 105K050BC	TDK
C2	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, 0402	0402	GRM155R71 H104ME14D	MuRata
D1, D2	2	White	LED, White, SMD	0805	VAOL- S8WR4	Visual Communications Company, LLC
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.25 X 0.075, Clear	75x250 mil	SJ5382	3M
H5	1		JUMPER W/TEST PNT 1X2PINS 2.54MM		60900213421	Würth Elektronik
J1	1		TERM BLK 6POS SIDE ENTRY 5MM PCB	HDR6	69113771000 6	Würth Elektronik
J2	1		Receptacle, 2mm, 6x2, Gold, R/A, TH	Receptacle, 2mm, 6x2, R/A, TH	NPPN062FJF N-RC	Sullins Connector Solutions
J3	1		CONN HEADER R/A 12POS 2MM	HDR12	NRPN062PA RN-RC	Sullins Connector Solutions
J4	1		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Würth Elektronik
R4, R7	2	10k	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021 0K0JNED	Vishay-Dale
R5, R6, R8	3	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024 K70JNED	Vishay-Dale
SW0	1		Slide Switch SP4T Surface Mount, Right Angle	SMT_SW_11MM3_4MM1	CUS-14TB	Nidec Copal Electronics
TP1, TP2, TP3, TP5, TP7, TP8, TP10, TP11	8		Test Point, Miniature, SMT	Testpoint_Keystone_Miniatu re	5015	Keystone
U1	1		40-V, 16-Bit, Precision Digital Power/Energy/ Charge Monitor With Integrated Sense Element	PowerWCSP8	INA700AYWF R	Texas Instruments

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**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.**

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#### 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.

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

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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
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- 
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