Texas Instruments

User's Guide
SBOU086–August 2011

INA216EVM

This user's guide describes the characteristics, operation, and use of the INA216EVM evaluation module (EVM). This EVM is designed to evaluate the performance of the INA216 family of voltage output current shunt monitors. This EVM has a flexible configuration, allowing for user evaluation suitable to a variety of applications. This document also includes a schematic and a complete bill of materials.

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1 Introduction and Overview

1.1 INA216

The INA216 devices are voltage output, high-side measurement, unidirectional, zero-drift current shunt monitors. This family of devices has gains that range from 25V/V to 200V/V. The voltage developed across the device inputs is amplified by the corresponding gain of the chosen device and is presented at the output pin. The INA216 devices can sense voltage drops across shunts at common-mode voltages between 1.8V to 5.5V. The low offset of the zero-drift architecture enables current sensing with maximum drops across the shunt as low as 10mV full-scale.

The INA216 is currently available in a wafer chip-scale package (WCSP). Table 1 summarizes the available device options.

Table 1. INA216 Device Summary

Product	Gain
INA216A1	25
INA216A2	50
INA216A3	100
INA216A4	200

1.2 INA216EVM

The INA216EVM is intended to provide basic functional evaluation of this device family. The fixture layout is not intended to be a model for the target circuit, nor is it laid out for electromagnetic compatibility (EMC) testing.

The layout of the INA216EVM printed circuit board (PCB) is designed to provide these features:

- Easy handling of the small package; a mechanical drawing of the recommended land pattern is found at the end of the product data sheet.
- Easy access to all pins of the device
- Space for optional input filtering capacitors and resistors as well as a prototype area for additional user-defined circuitry
- Space for shunt resistors of various footprints
- Evaluation of all gain options through provided device boards

The INA216EVM allows the user to install a shunt resistor, and then connect both the common-mode voltage and load to develop the input voltage, or to omit the shunt resistor and apply a differential voltage directly to the device input. This flexibility allows a user to test the device operation in a simulated manner as well as in an actual application.

Refer to the INA216 product data sheet for comprehensive information about the INA216 family of devices.

1.3 Hardware Included

The INA216 family of devices are available in a WCSP with each of the available gain versions provided in all INA216EVMs delivered, as Figure 1 shows.

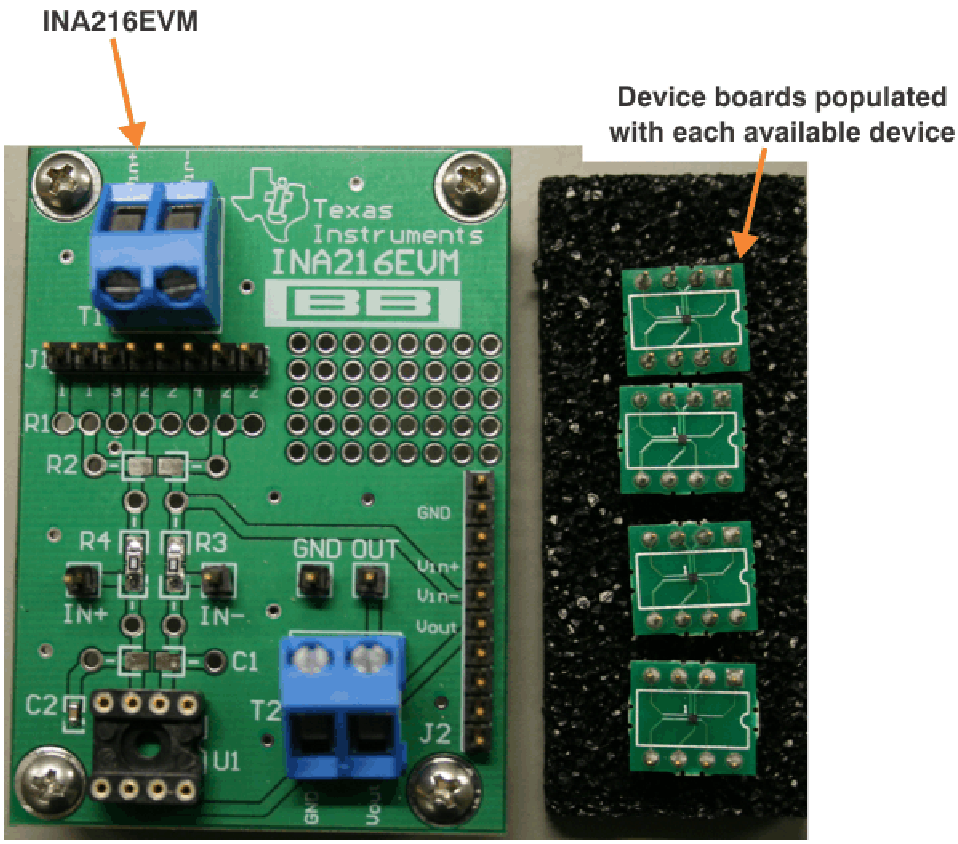

Figure 1. Hardware Included with the INA216EVM

The INA216EVM kit is shipped with the following items:

- INA216EVM PCB
- Four populated test boards (INA216A1, INA216A2, INA216A3, INA216A4)

If any of the items in the EVM kit shipment are missing or damaged, please contact the Texas Instruments Product Information Center nearest you to inquire about a replacement.

2 Quick Start Setup and Use

Follow these procedures to set up and use the INA216EVM.

Step 1. Insert the device board to be evaluated into the U1 location. The U1 location allows the user to interchange device boards to evaluate the impact of implementing various gains in the design.

Step 2. Connect the INA216 input pins to both the common-mode source as well as the load. The INA216 derives its supply voltage from the VIN+ input pin; as a result, the common-mode voltage is limited to a range of +1.8V to 5.5V. The INA216 is a unidirectional current shunt monitor, so the voltage drop created across the shunt resistor should be positive with respect to the VIN– input pin in order for the device to operate correctly.

2.1 Measurement With Shunt

This connection method allows the user to install a shunt resistor on the evaluation board and connect the common-mode voltage and load to incorporate the test device directly into a sample application, as Figure 2 illustrates. To configure a measurement evaluation with a shunt, follow these procedures.

1. Install shunt resistor into the R2 location. If not using a surface-mount or through-hole shunt, refer to Section 3.1 for a summary of the R1 component specifications.
2. Connect the common-mode voltage to the V_{IN+} terminal of T1.
3. Connect load to the V_{IN-} terminal of T1.

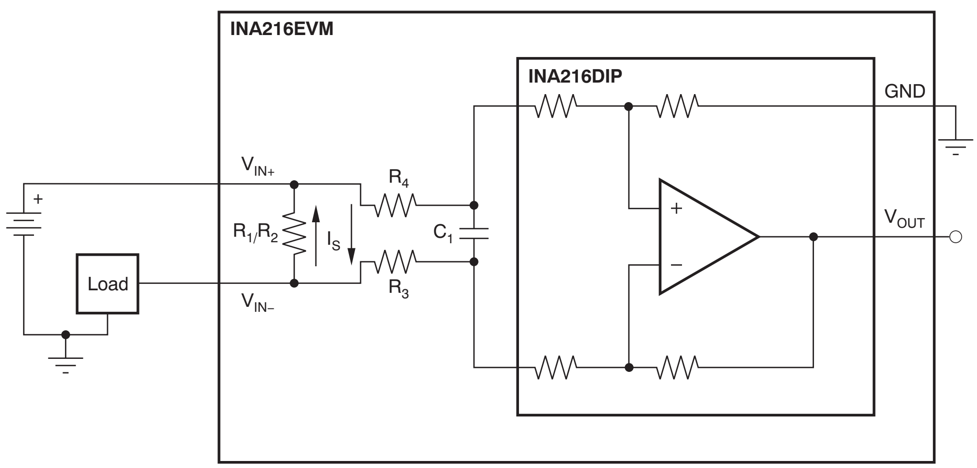

Figure 2. Measurement with Shunt

2.2 Measurement Without Shunt

This connection method allows the user to either simulate the voltage developed across a sense resistor based on a given set of system conditions, or to connect the INA216EVM remotely to an existing shunt already included in an example application. Figure 3 illustrates a measurement configuration without a shunt.

To configure a measurement evaluation without a shunt, follow these procedures.

1. Connect a differential voltage to the V_{IN+} and V_{IN-} terminals of T1. The INA216 can only accept positive differential signals, so the V_{IN+} terminal should always be larger than the V_{IN-} terminal or the output will be saturated into the lower rail.
2. Measure the output voltage at the V_{OUT} terminal of T2.

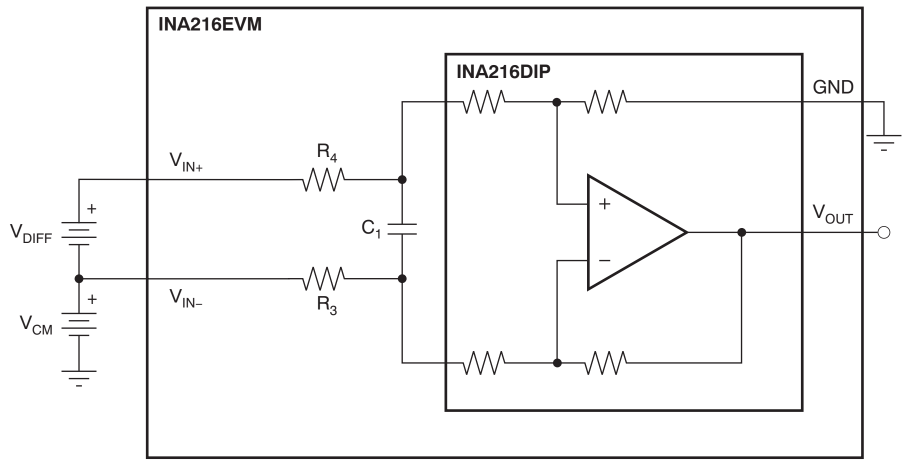

Figure 3. Measurement without Shunt

NOTE: The output voltage is equal to the gain of the device multiplied by the differential voltage measured directly at the device input pins.

3 INA216EVM Circuit

This section summarizes the INA216EVM components.

3.1 R1

R1 can be used for shunt resistors that have a package that is not easily adaptable to a standard, two-terminal, through-hole footprint or to a 0603 through 1206 surface-mount footprint. Specifically, this component location was added to allow for the use of TO-126, TO-220, TO-247, and four-terminal inline radial packages such as the CS3 series of shunts from Ohmite. The numbers located on the PCB between R1 and J1 correspond to each of the holes in the R1 footprint. Holes with the same number are connected together. The designation of *1* and *2* indicates that particular hole is connected directly to the V_{IN+} and V_{IN-} inputs, respectively. The designation of *3* and *4* indicates that particular hole is intended for the sense measurement of a four-wire shunt.

Care must be taken to ensure that the shunt is placed in the correct position in the R1 location. This placement consideration is evident when using a two-connection shunt with a spacing of 200 mils (.200in or 5,080mm). As shown in Figure 4 through Figure 7, the shunt must be placed in the second *1*-designated hole in order for the other leg to fit into the *2* position. If the shunt is placed in the first *1* position, the second leg is left floating; no differential voltage is then generated for the current monitor.

Additional packages can be tested by using the provided prototype area of the board.

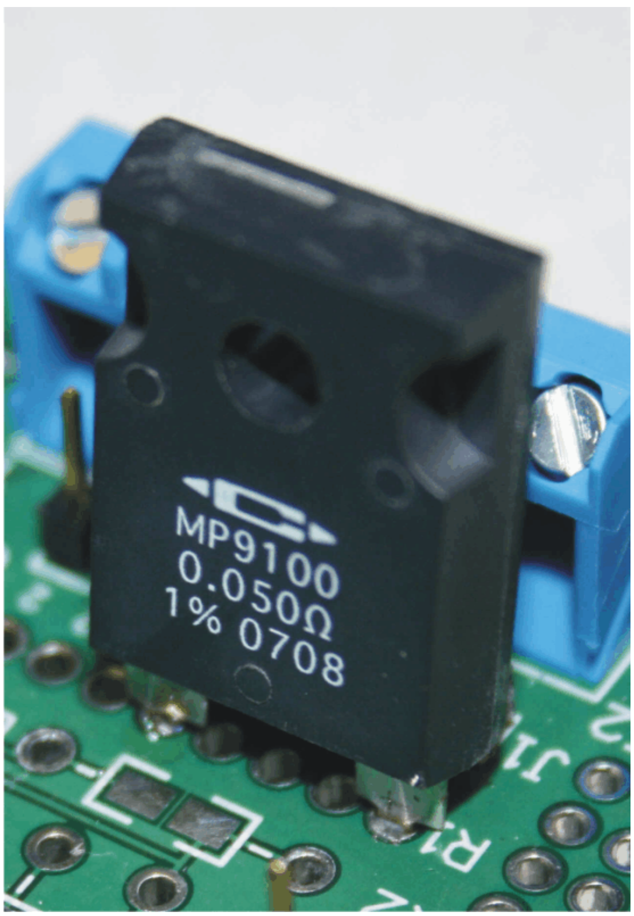

Figure 4. TO-247 Package in R1

Figure 5. CS3 Package in R1

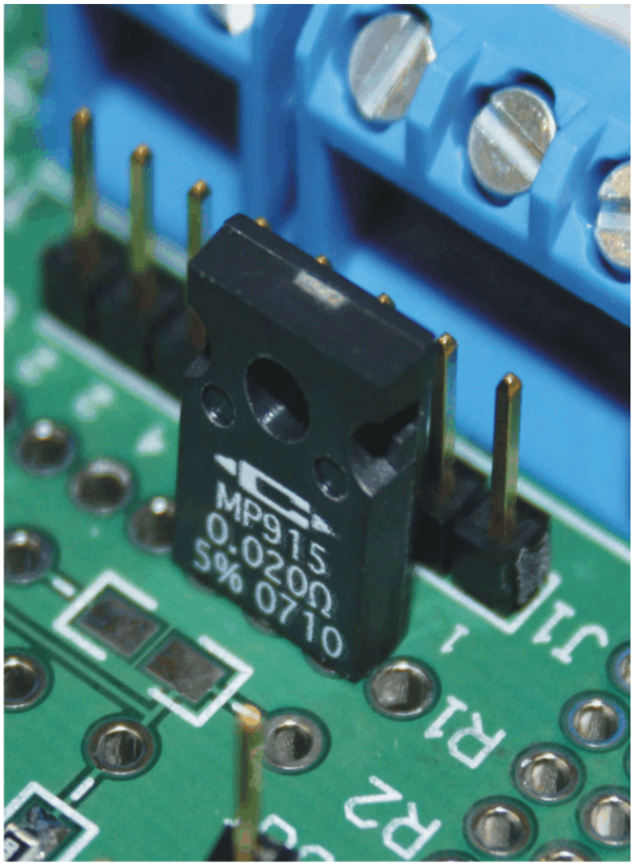

Figure 6. TO-126 Package in R1

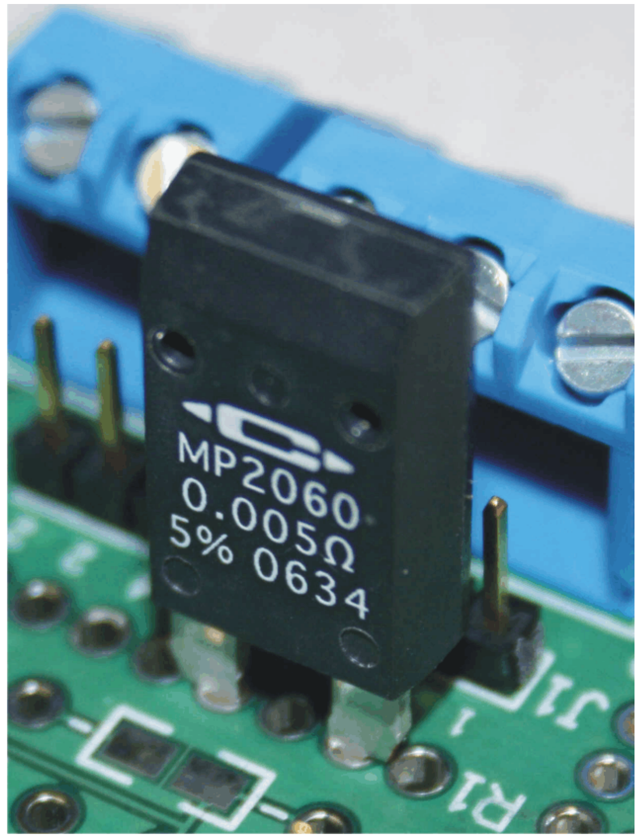

Figure 7. TO-220 Package in R1

3.2 R2

R2 is intended to handle two- and four-terminal radial packages (as Figure 8 illustrates) as well as surface-mount packages that range in size from 0603 to 1206.

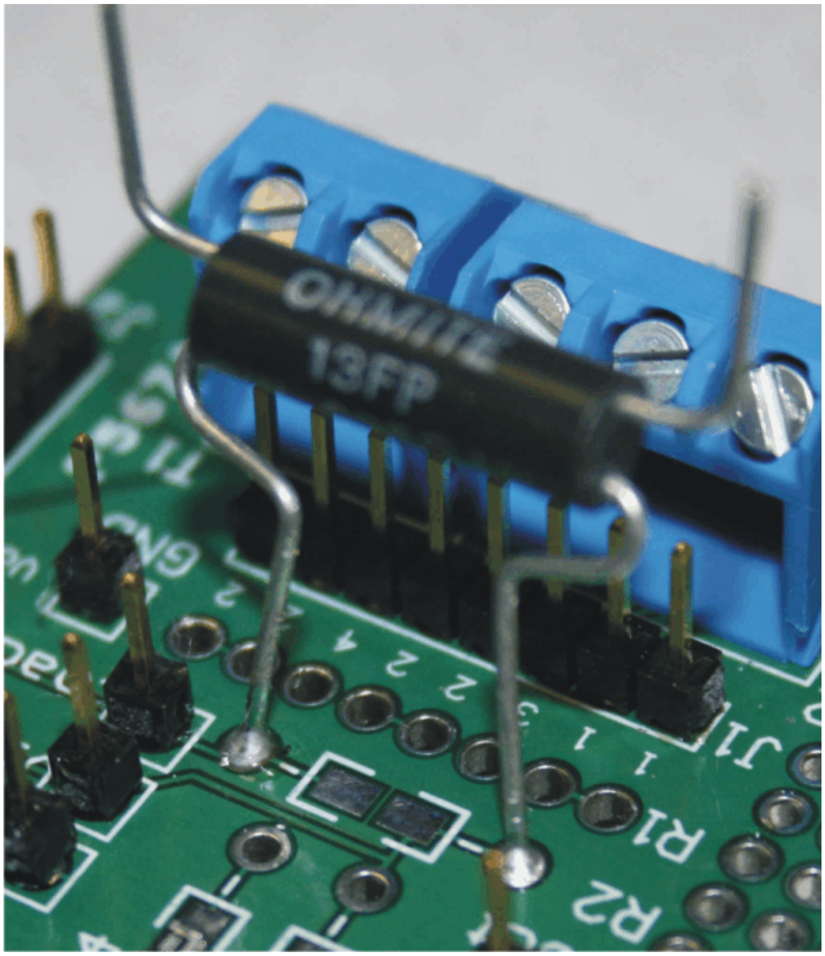

Figure 8. Radial Package in R2

3.3 R3, R4, C1

R3 and R4 are factory-installed 0Ω resistors. These resistors, in combination with C1, form an input filter. These locations allow for through-hole and surface-mount packages that range in size from 0603 to 1206. Additional information regarding the use of input filtering is provided in the INA216 product data sheet.

3.4 Bypass Capacitors and Jumpers

C2 is a 0.1μF supply bypass capacitor.

J1 is intended to be used as measurements points of R1, if necessary.

J2 is used as a test port at the factory but can be used for the corresponding input and output pins, if desired.

3.5 U1

U1 is the location for the test device, as shown in Figure 9. Four device boards are supplied with the INA216EVM board; each device board is populated with one of the available device gains. This interchangeable option allow users to test the devices and determine the gain setting that is best suited for a given application.

Figure 10 shows the U1 slot populated with a DIP board device as an example.

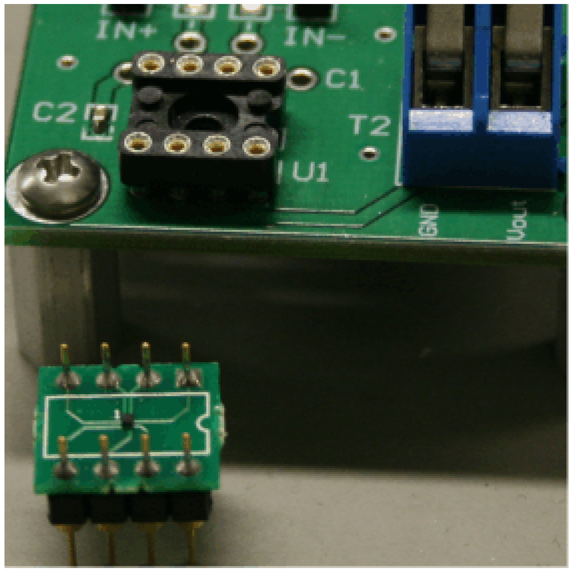

Figure 9. U1 Footprint

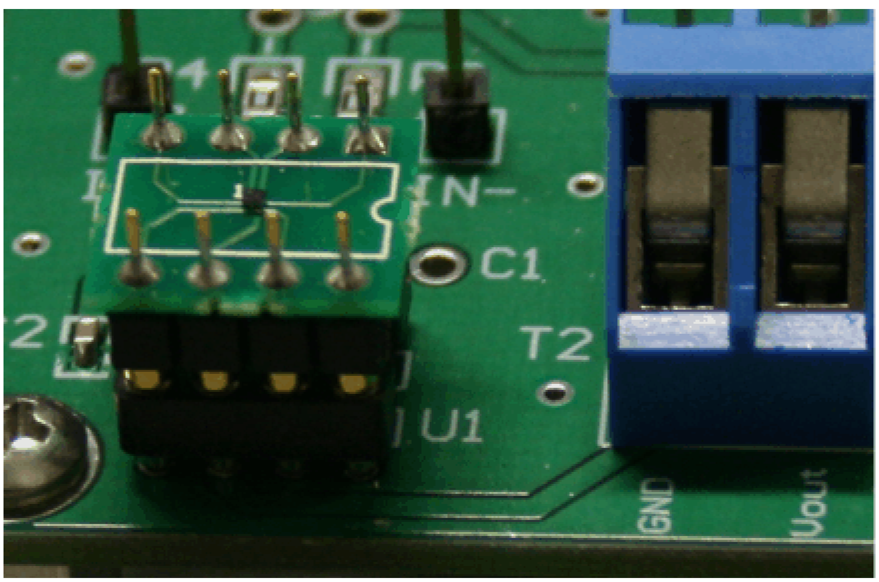

Figure 10. U1 Populated With DIP Board

There are several factors to consider when selecting the appropriate device:

- The INA216 devices are identical with the exception of different gain settings.
- The limiting factor that requires attention to be given to device selection is the output voltage.
- The output voltage has a restriction: it must remain within the range of 2mV above ground to 300mV below the supply voltage.
- The differential input voltage is either applied across the inputs, or developed based on the load current flowing through the shunt resistor.
- The selected device must allow the output voltage to remain within the acceptable range after the developed input voltage is amplified by the respective device gain.
- An output below the minimum allowable output requires the selection of a device with a higher gain. Likewise, an output above the maximum allowable output requires the selection of a device with a smaller gain.

3.6 Voltage Inputs

The V_{IN+} and $V_{IN–}$ terminals of T1 can accept a differential voltage that is amplified by the selected device gain and is presented at the V_{OUT} terminal of T2. These inputs could also be used to connect the differential voltage developed across an external shunt in an existing circuit, a differential voltage applied directly to the V_{IN+} and $V_{IN–}$ inputs, or by developing a differential voltage across an on-board shunt with the common-mode voltage and load connected. The common-mode voltage should be connected to the V_{IN+} terminal and the load should be connected to the $V_{IN–}$ terminal. The shunt can be installed in R1 or R2, or the prototype area and wired to the R2 footprint.

4 INA216EVM Schematic and PCB Layout

4.1 Schematic

Figure 11 illustrates the INA216EVM schematic.

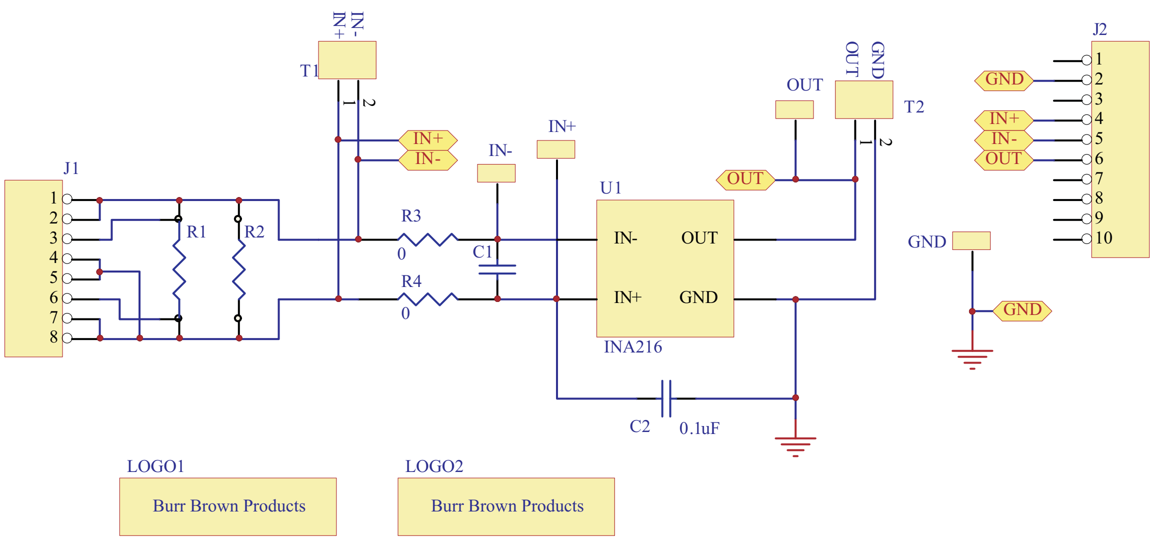

Figure 11. INA216EVM Schematic

4.2 PCB Layout

Figure 12 shows the INA216EVM PCB silkscreen image.

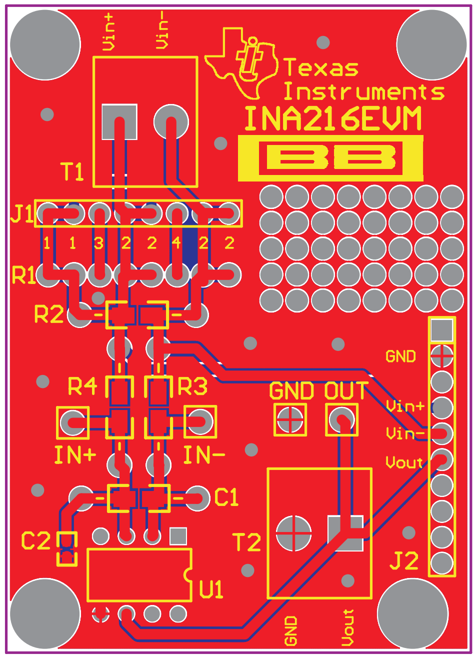

Figure 12. INA216EVM Silkscreen Image (Top)

5 Bill of Materials

Table 2 provides the parts list for the INA216EVM.

Table 2. INA216EVM Bill of Materials

Count	RefDes	Value	Description	Manufacturer	Part Number
Optional/ Not Installed	R1	N/A	TO-126, TO-220, TO-247, CS3 Packages		
Optional/ Not Installed	R2	N/A	Resistor, 0603-1206/Through-Hole		
2	R3, R4	0Ω	Resistor, 0Ω, 1/8W 5%, 0603-1206/Through-Hole	Panasonic - ECG	ERJ-6GEY0R00V
Optional/ Not Installed	C1	N/A	Capacitor, 0603-1206/Through-Hole		
1	C2	0.1µF	Capacitor, 0.1µF 50V X7R, 0603-1206/Through-Hole	Panasonic - ECG	ECJ-1VB1H104K
1	J1	N/A	Conn Header 32-Pos .100" Sgl Gold	Samtec	TSW-108-07-G-S
1	J2	N/A	Conn Header 32-Pos .100" Sgl	Samtec	TSW-110-07-G-S
4	All Test Points	N/A	Conn Header 32-Pos .100" Sgl Gold	Samtec	TSW-101-07-G-S
1	DIP Socket (U1)	N/A	IC Socket 8-Pin .300 Solder Tail	Mill-Max Manufacturing Corp.	210-43-308-41-001000
4	None	N/A	Screw, Machine, Phillips, Panhead 4-40X1/4 SS	Building Fasteners	PMSSS 440 0025 PH
4	None	N/A	Standoffs, Hex , 4-40 Threaded, 0.500" length, 0.250" OD	Keystone Electronics	2203
1	ESD Box	N/A	ESD Box for INA216A1DIP—INA216A4DIP	Protective PAK	37001
4	INA216A1DIP—INA216A4DIP	N/A	Populated DIP-Adapter Board	Texas Instruments	
2	T1, T2	N/A	2-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	On Shore Technology	ED300/2

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 1.8V to 5.5V and the output voltage range of 0V to 5V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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