INA210-215EVM User's Guide

This user's guide describes the characteristics, operation, and use of the INA210-215EVM evaluation module (EVM). This EVM is designed to evaluate the performance of the INA210-215 voltage output current shunt monitors in a variety of configurations. The EVM layout and design are flexible enough to allow evaluation of a wide range of applications. This document also includes a schematic, reference printed circuit board (PCB) layouts, and a complete bill of materials.

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1 Introduction and Overview

1.1 INA210-215

The INA210-215 devices are voltage output, high-side measurement, bi-directional, zero-drift current shunt monitors. This family of devices has gains that range from 50 V/V to 1000 V/V. The voltage developed across the device inputs is amplified by the corresponding gain of the specific device and is presented at the output pin. These devices can sense voltage drops across shunts at common-mode voltages from –0.3 V to 26 V, independent of supply voltages. These devices operate with supply voltages between 2.7 V and 26 V and draw a maximum of 100 µA. The low offset of the zero-drift architecture enables current sensing with maximum drops across the shunt as low as 10-mV full-scale.

The INA210-215 devices are currently available in an SC70 surface-mount package. Table 1 summarizes the available device options.

Table 1. INA210-215 Device Summary

Product	Gain
INA210	200
INA211	500
INA212	1000
INA213	50
INA214	100
INA215	75

1.2 INA210-215EVM

The INA210-215EVM 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 INA210-215EVM printed circuit board (PCB) is designed to provide the following 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 device pins
- 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
- Multiple input signal options
- Evaluation of all gain options through provided device boards as well as a location to solder a test device directly onto the board

The INA210-215EVM allows the user to install a shunt resistor, and then connect both the common-mode voltage and load to develop the input voltage, or 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 an actual application.

Refer to the INA210-215 product data sheet (SBOS437) for comprehensive information about the INA210-215 family of devices.

1.3 Hardware Included

The initial release of this evaluation board and user's guide may precede the actual release of some members of the INA210-215 device family. As additional devices with the family are released, the INA210-215EVM evaluation board will be associated with them. A test fixture populated with an INA210 is provided in all INA210-215EVMs delivered, as Figure 1 shows.

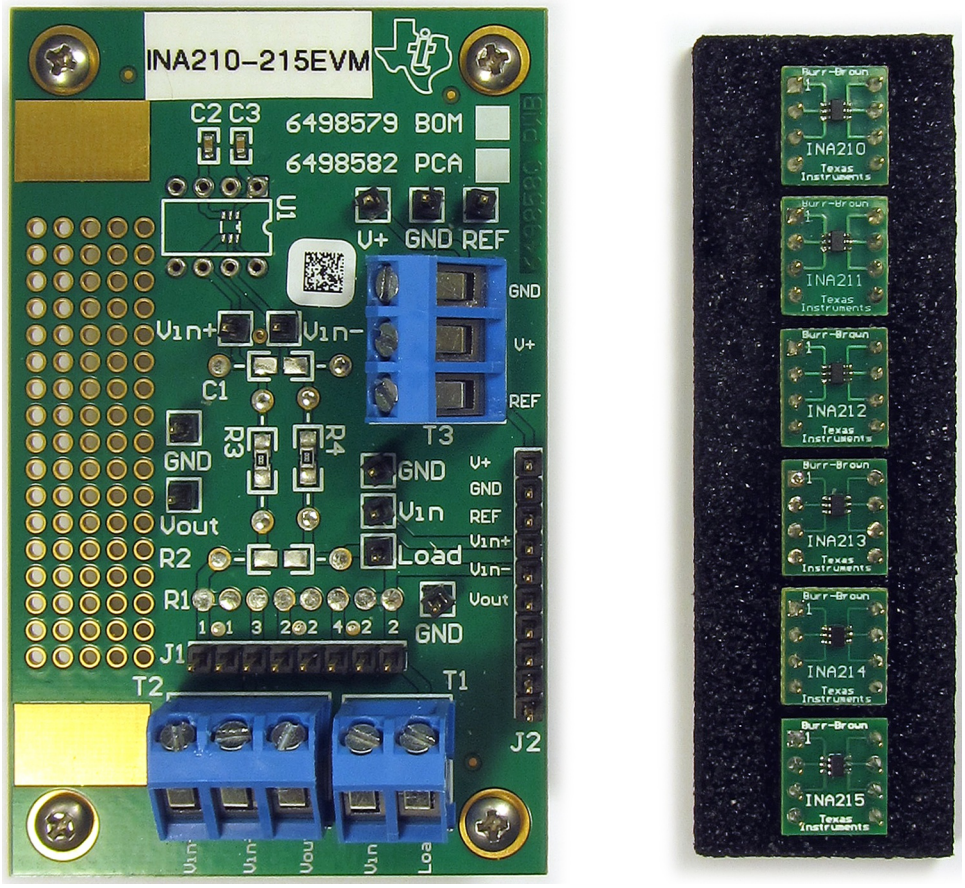

Figure 1. Hardware Included with the INA210-215EVM

The INA210-215EVM kit is shipped with the following items:

- INA210-215EVM PCB
- Six populated test boards (INA210, INA211, INA212, INA213, INA214, INA215)

If any of these items 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 INA210-215EVM.

Step 1. Insert the device board to be evaluated into the U1 location. The U1 location allows the user to either evaluate one of the provided device boards or install the test device directly on the surface-mount pads in the U1 footprint.

Step 2. Connect an external dc supply voltage between 2.7 V and 26 V to the V+ terminal referenced to the GND terminal of T3. The INA210-215 device output voltage is limited to 50 mV above ground to 200 mV below the supply level.

Step 3. Connect the REF terminal of T3 to ground. The voltage applied at the reference input can vary depending on how the device is to be used. Further details regarding the use of the reference voltage are discussed later in this document.

Step 4. Connect the input.

2.1 Measurement with Shunt

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

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

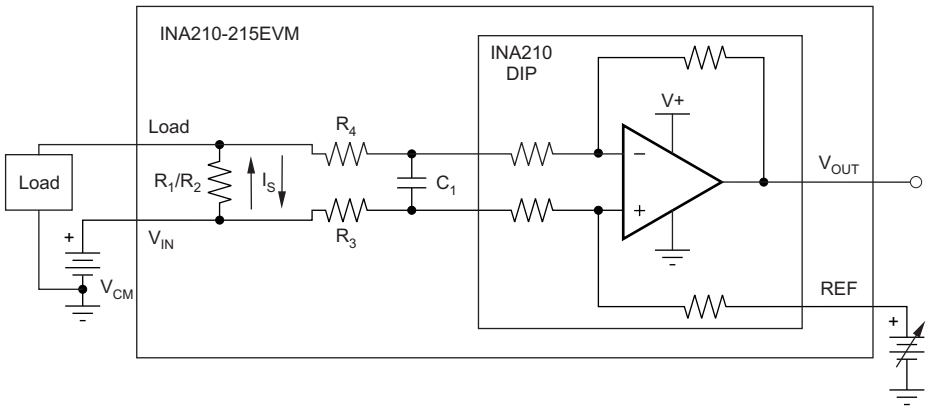

Figure 2. Measurement with Shunt

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 INA210-215EVM 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 T2. With the reference voltage set at ground, ensure that the V_{IN+} terminal is the more positive of the two inputs.
2. Measure the output voltage at the V_{OUT} terminal of T2.

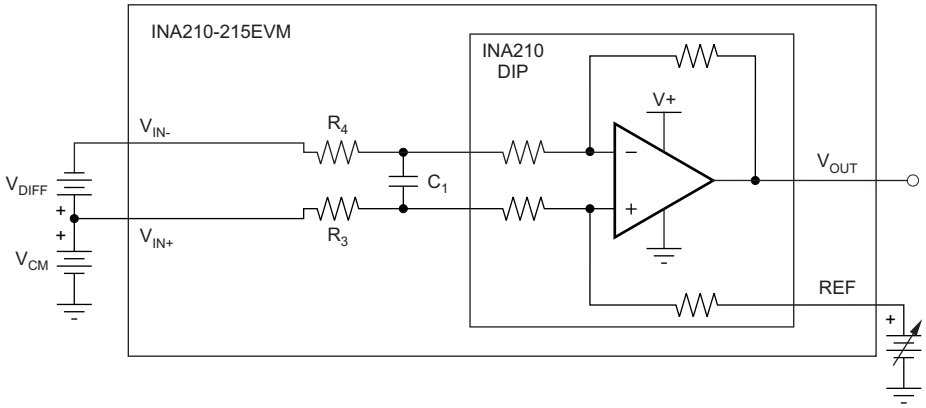

Figure 3. Measurement without Shunt

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 INA210-215EVM Circuit

This section summarizes the INA210-215EVM components.

3.1 R1

R1 can be used for shunt resistors that have a package that may not be 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 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 printed circuit board (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 a particular hole is connected directly to the V_{IN+} and V_{IN-} inputs, respectively. The designation of *3* and *4* indicates that a 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 (.200 in or 5,080 mm). As shown in Figure 4 and 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 will be generated for the current monitor.

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

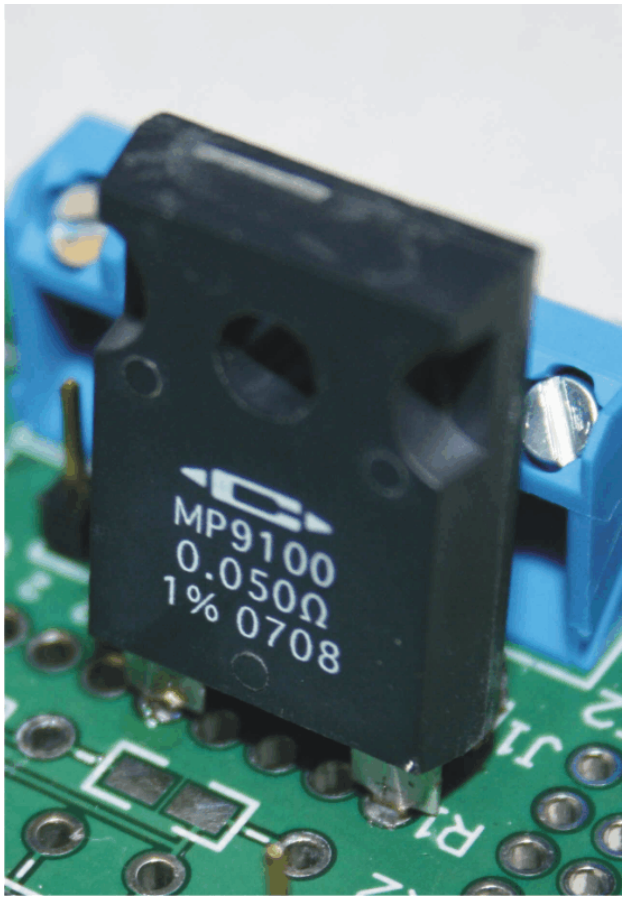

Figure 4. TO-247 Package In R1

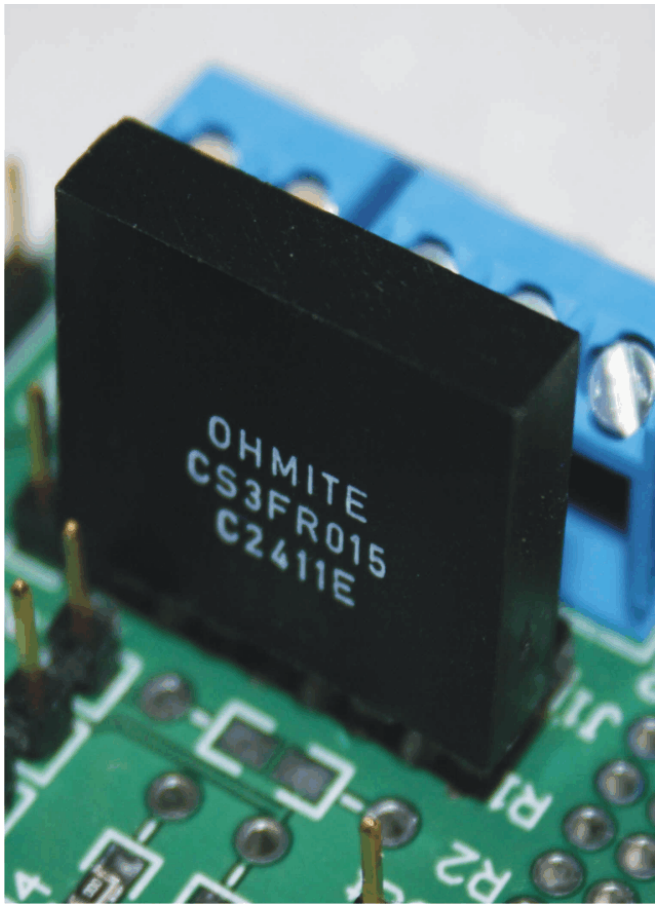

Figure 5. CS3 Package in R1

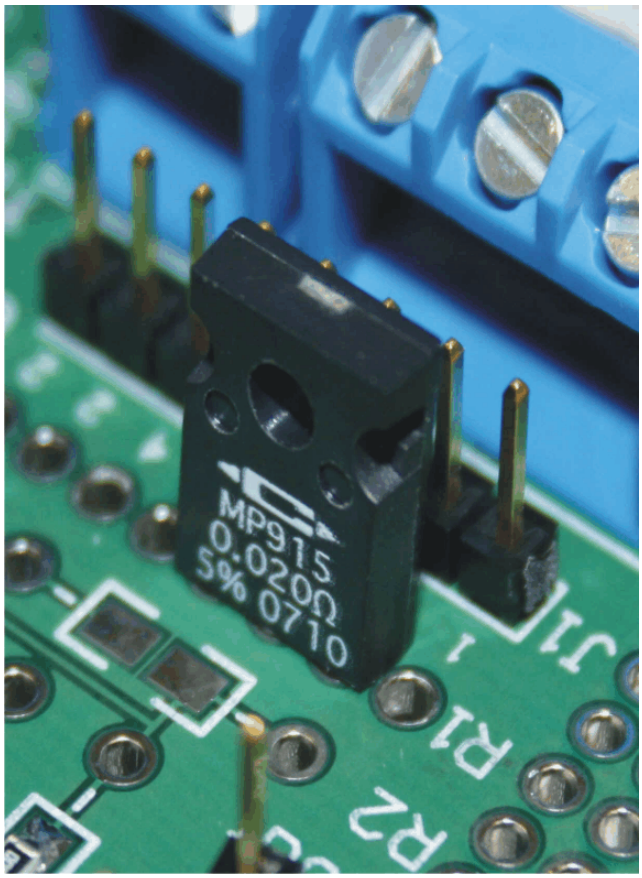

Figure 6. TO-126 Package in R1

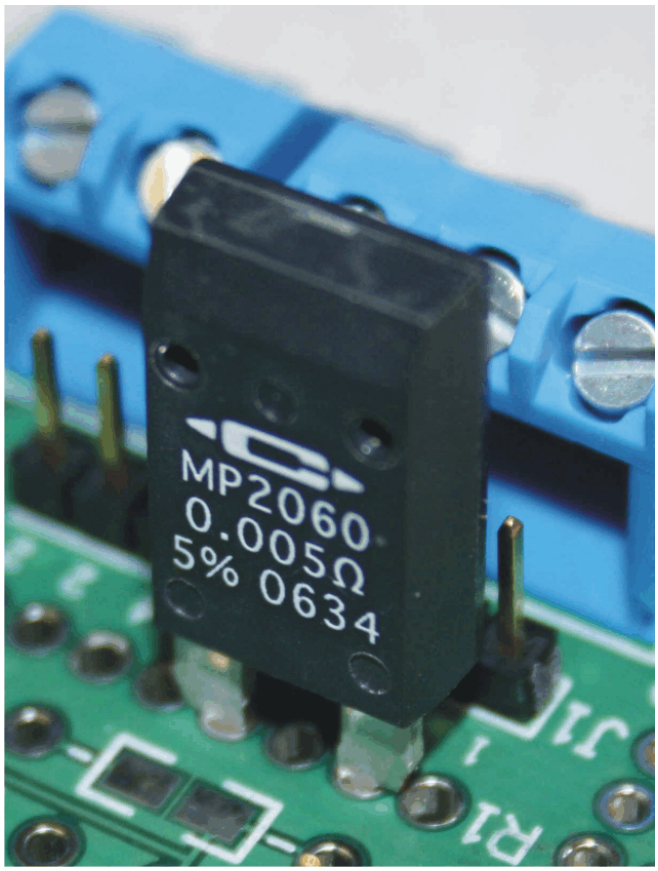

Figure 7. TO-220 Package in R1

3.2 R2

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

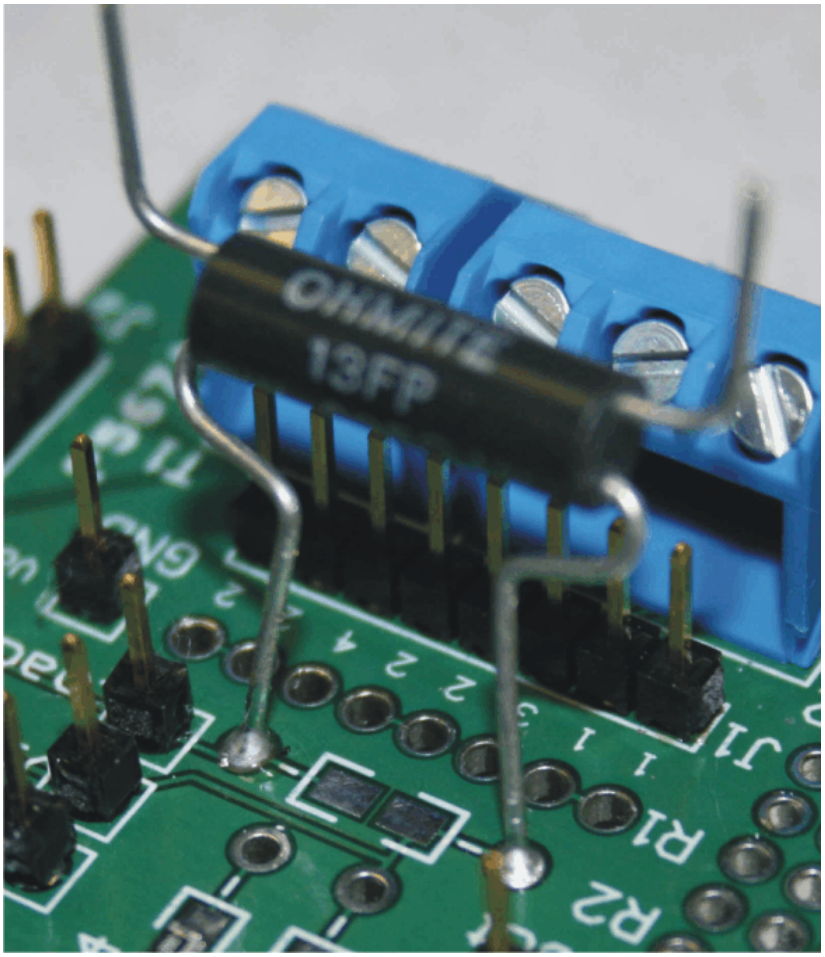

Figure 8. Radial Package in R2

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 both 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 INA210-215 product data sheet (SBOS437).

3.4 Bypass Capacitors and Jumpers

C2 and C3 are 0.1-µF supply bypass capacitors.

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. Five device boards are supplied with the INA210-215EVM board. Each board is populated with one of the available device gains. This interchangeable option allows users to test the devices and determine the gain setting that is best suited for a given application.

Here is a list of the factors involved in selecting the appropriate device.

- The INA210-215 devices are identical with the exception of different gain settings.
- The differential input voltage is either applied across the inputs or developed based on the load current that flows through the shunt resistor.
- The limiting factor that requires attention to be given to device selection is the output voltage.
- 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. The output voltage must remain with the range of 50 mV above ground to 200 mV below the supply voltage.
- 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 lower gain.

In addition to being able to accommodate the device boards, a surface-mount footprint is also included so the user can install one of these devices directly onto the board, if desired. Figure 9 illustrates the U1 footprint on the EVM. Figure 10 shows the U1 slot populated with a DIP board device.

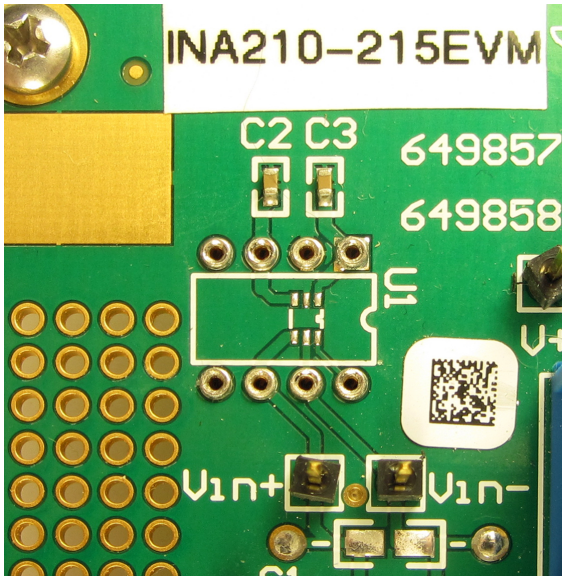

Figure 9. U1 Footprint

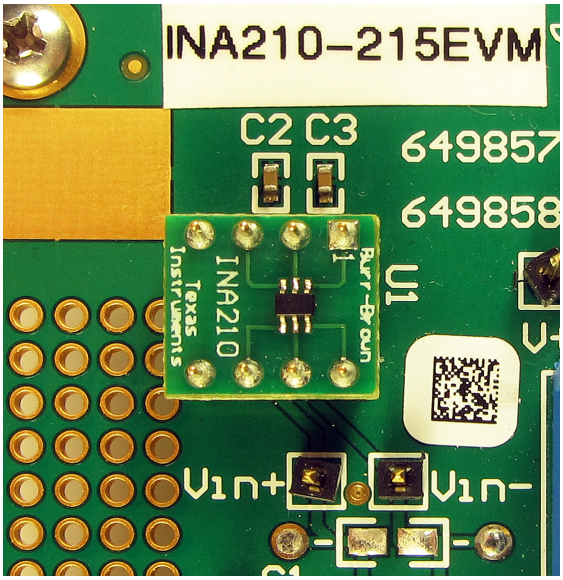

Figure 10. U1 Populated with DIP Board

3.6 Voltage Inputs

The V_{IN+} and V_{IN-} terminals of T2 are intended to be used if the designer is configuring the EVM for measurement without an onboard shunt resistor (see Figure 3). These inputs 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. The acceptable differential input voltage range and polarity are determined by the supply voltage, reference voltage, and gain of the selected device.

V_{IN} and Load terminals of T1 are intended to be used if the user configures the EVM for measurement with a shunt resistor (see Figure 2). The common-mode voltage should be connected to the V_{IN} terminal and the load should be connected to the Load terminal. The shunt can be installed in R1, R2, or the prototype area, and wired to the R2 footprint. As in the setup for the measurement without a shunt resistor, the input voltage range and polarity are determined by the supply voltage, reference voltage, and the gain of the selected device.

3.7 Miscellaneous

The REF terminal of T3 allows the user to configure the INA210-215EVM for either unidirectional or bi-directional operation

Two easily accessible oscilloscope ground pads are located on the board to facilitate easier probing.

4 Reference Voltage Setup

The INA210-215 devices allow for the use of an external reference. This reference determines how the output responds to certain input conditions. The reference also allows these devices to be used in both unidirectional and bi-directional applications.

4.1 Unidirectional Mode

Unidirectional refers to a load current that flows in only one direction. For unidirectional applications, the reference voltage can be set to ground or to +5V. If the reference is set to ground, the output is set at near ground with no input voltage, and responds to input voltages that are positive with respect to V_{IN-}/Load. If the reference is set to +5V, the output is set near +5V with no input voltage, and responds to input voltages that are negative with respect to V_{IN-}/Load.

4.2 Bi-directional Mode

Bi-directional refers to a load current that flows in both directions. Figure 2 shows I_S flowing in both directions. For bi-directional applications, the reference voltage can be set anywhere within the 0-V to 5-V range specified for the reference input. The voltage applied to the reference pin establishes the output voltage of the device with no input voltage. The output voltage is limited by the supply voltage, so there is a greater available range for positive input voltages than negative voltages because the reference voltage is limited to the range of 0 V to 5 V.

The maximum range for the output of this device to accommodate a bi-directional application involves applying 5 V to the reference pin and a supply voltage of 18 V. This configuration allows for a maximum output voltage range of –4.95 V/+20.8 V about the 5-V reference.

5 INA210-215EVM Schematic and PCB Layout

NOTE: Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing INA210-215EVM PCBs.

5.1 Schematic

Figure 11 shows the schematic for the INA210-215EVM PCB.

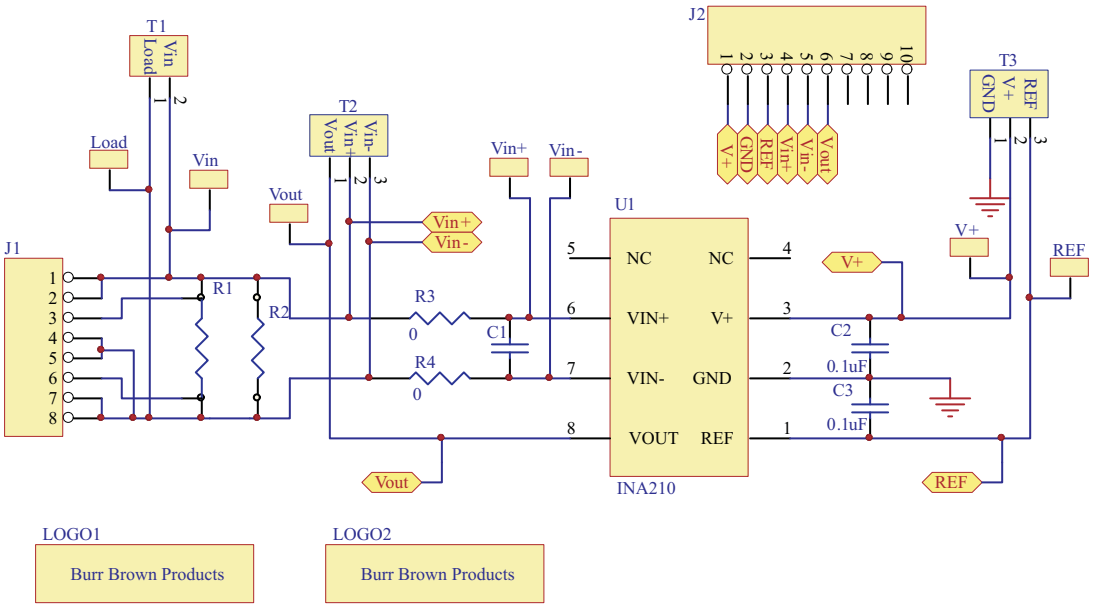

Figure 11. INA210-215EVM Schematic

5.2 PCB Layout

Figure 12 illustrates the PCB layout for the INA210-215EVM.

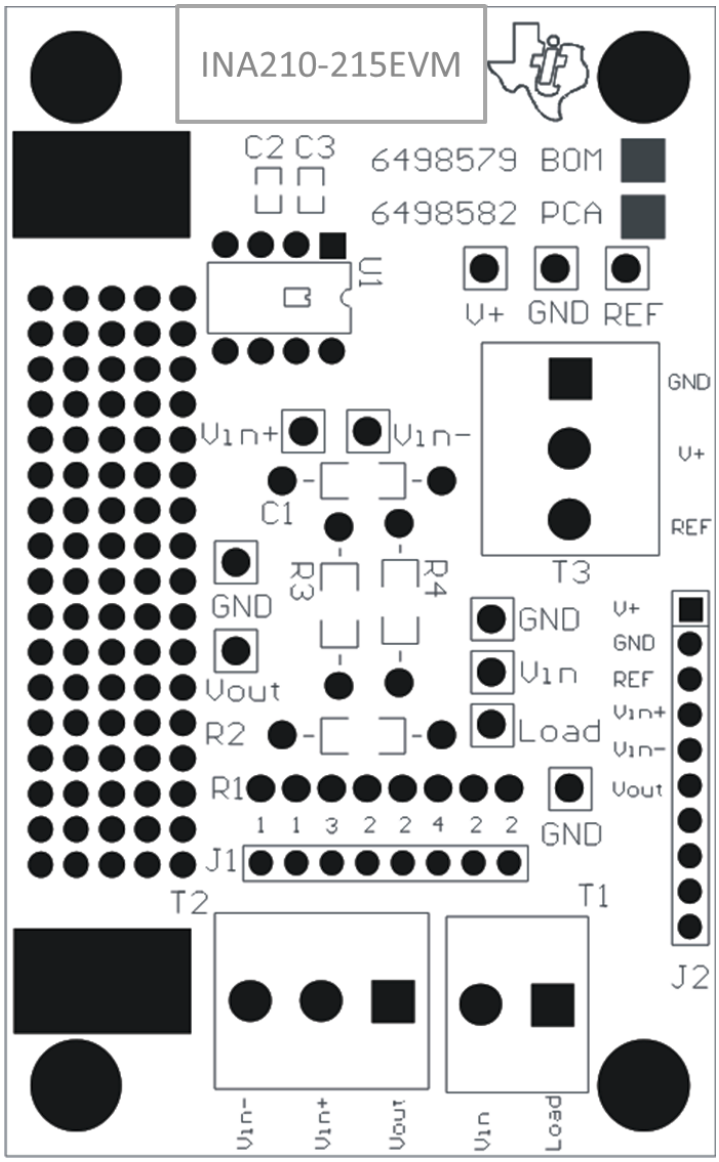

Figure 12. INA210-215EVM PCB

6 Bill of Materials

Table 2 provides the parts list for the INA210-215EVM.

Table 2. Bill of Materials

Count	RefDes	Value	Description	Part Number	MFR
Optional/Not Installed	R1	N/A	TO-126, TO-220, TO-247, C53		
Optional/Not Installed	R2	N/A	Resistor, 0603-1206/Through-hole		
2	R3, R4	0Ω	Resistor, 0Ω, 1/8W 5%, 0603-1206/Through-hole	ERJ-6GEY0R00V	Panasonic - ECG
Optional/Not Installed	C1	N/A	Capacitor, 0603-1206/Through-hole		
2	C2, C3	0.1uF	Capacitor, 0.1µF 50V X7R, 0603	CC0603KRX7R9BB104	Yagueo
2	J1, J2	Strip cut to size	Conn Header 32-POS .100" SGL GOLD (4 per Strip)	TSW-132-07-G-S	Samtec
11	All test points	TP cut to size	Conn Header 32-POS .100" SGL GOLD	TSW-132-07-G-S	Samtec
8	None	N/A	Pin Socket Rcpt .014-.026 30AU (U1)	5050863-5	AMP
4	None	N/A	Screw, Machine, Phillips, Panhead 4-40 x 1/4 SS	PMSSS 440 0025 PH	Building Fasteners
4	None	N/A	Standoffs, Hex , 4-40 Threaded, 0.500" length, 0.250" OD	2203	Keystone Electronics
6	INA210DIP - INA215DIP	N/A	Populated DIP-Adapter Board		Texas Instruments
2	T2, T3	N/A	3-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	ED300/3	On Shore Technology
1	T1	N/A	2-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	ED300/2	On Shore Technology

Revision History

Changes from Original (August 2008) to A Revision **Page**

- Added support throughout document for INA215. 1

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General Statement for EVMs including a radio

User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

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 could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

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 its own expense.

FCC Interference Statement for Class B EVM devices

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.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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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Important Notice for Users of EVMs Considered "Radio Frequency Products" in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

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