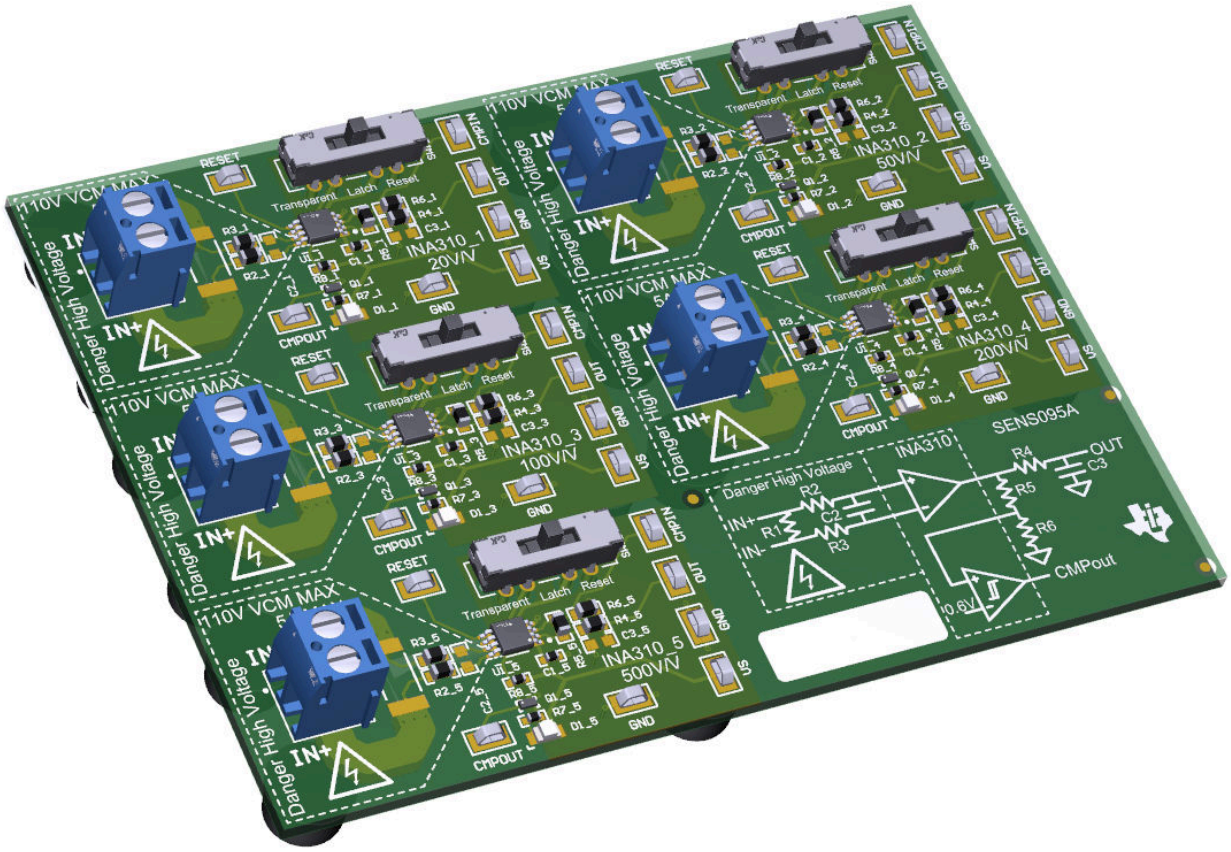
User's Guide

INA310EVM User's Guide

ABSTRACT

This user's guide describes the characteristics, operation, and use of the INA310EVM. This EVM is designed to evaluate the performance of the INA310x. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the INA310EVM. This document includes a schematic, reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).



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Trademarks

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General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center http://ti.com/customer support for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions may result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitable qualified, you should immediately stop from further use of the HV EVM.

1. Work Area Safety:
   a. Keep work area clean and orderly.
   b. Qualified observer(s) must be present anytime circuits are energized.
   c. Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
   e. Use stable and non-conductive work surface.
   f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. Electrical Safety:
   a. As a precautionary measure, it is always good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
   b. De-energize the TI HV EVM and all its inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   c. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   d. Once EVM readiness is complete, energize the EVM as intended.

WARNING

While the EVM is energized, never touch the EVM or its electrical circuits, as they could be at high voltages capable of causing electrical shock hazard.

3. Personal Safety
   a. Wear personal protective equipment (for example: latex gloves or safety glasses with side shields) or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

1 Overview

The INA310x is an ultra-precise current sense amplifier that can measure voltage drops across shunt resistors over a wide common-mode range from –4 V to 110 V, independent of supply voltage with an integrated comparator. The high precision current measurement accuracy is achieved through a combination of low offset voltage (20 µV, maximum), small gain error (0.15%, maximum) and a high DC CMRR (160 dB, typical). The INA310x has a high signal bandwidth of 1.3 MHz designed for high voltage DC current measurements and high-speed applications like fast overcurrent protection.

The INA310x incorporates an open-drain comparator and internal reference that provides a 0.6-V threshold. An external resistive divider sets the current trip point. The comparator includes a latching capability that can be made transparent by grounding (or leaving open) the RESET pin.

The INA310x operates from a single 2.7-V to 20-V supply and draws 1.6 mA of supply current. The INA310x is available in five gain options: 20 V/V, 50 V/V, 100 V/V, 200 V/V, and 500 V/V. These gain options address a wide dynamic range of current-sensing applications.

The INA310x is specified over an operating temperature range of −40°C to +125°C and is offered in a space-saving 8-pin VSSOP package.

Table 1-1. Device Summary

EVM ORDERABLE	PRODUCT	GAIN	MAX GAIN ERROR	MAX OFFSET VOLTAGE
INA310AEVM	INA310A1	20 V/V	0.15%	±20 µV
	INA310A2	50 V/V		
	INA310A3	100 V/V		
	INA310A4	200 V/V		
	INA310A5	500 V/V		
INA310BEVM	INA310B1	20 V/V	0.5%	±150 µV
	INA310B2	50 V/V		
	INA310B3	100 V/V		
	INA310B4	200 V/V		
	INA310B5	500 V/V		

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
INA310AEVM or INA310BEVM test board	1

1.2 Related Documentation From Texas Instruments

This user's guide is available from the TI website under literature number SBOU284. 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. The literature number links to the document PDF.

Table 1-3. Related Documentation

DOCUMENT TITLE	DOCUMENT LITERATURE NUMBER
INA310 data sheet	SBOSA86

2 Hardware

The EVM is intended to provide basic functional evaluation of the INA310x. The layout is not intended to be a model for the target circuit, nor is the layout intended for electromagnetic compatibility (EMC) testing. The EVM consists of one printed circuit board (PCB) with optional PCB cutouts for each of the five gain options (1 to 5) listed in Table 1-1. Each PCB cutout has one INA310xn device (where x is version A or B, and n is 1, 2, 3, 4, or 5), test points and sockets for external hardware connections, and pads to solder down optional circuitry. The EVM supports current measurements up to 5 A through the PCB.

2.1 Features

- Evaluation of all gain options through provided device boards
- Ease of access to device pins with test points
- Pads and sockets for optional filtering at the input pins and output pin
- Multiple input signal options, including a method to solder a shunt resistor (2512) and safely measure current up to 5 A

3 Operation

3.1 Quick Start Setup

The following instructions describe how to set up and use the EVM. For these instructions, when referencing part designators, the part version (A or B) and the gain option (1, 2, 3, 4, or 5) will be ignored. For example R1_A3 will just be referred to as R1.

1. Choose the desired gain option panel variation
2. Connect an external DC supply voltage (between 2.7 V and 20 V) to a VS test point, then connect the ground reference of that supply to a GND test point on the same panel
3. Provide a differential input voltage signal to the IN+ and IN– nodes by connecting the signal leads to their respective pins on terminal J1 on the EVM as explained in *Measurements*

3.2 Measurements

The EVM can be used with either an onboard or external shunt resistor. To use the onboard shunt resistor, solder a 2512 surface-mount technology (SMT) shunt resistor across the pads of R1, and connect it in series with the external system and load current through J1. An external shunt can be connected directly across the terminals of J1.

3.2.1 Detailed Setup

To configure a measurement evaluation, follow these steps:

1. Connect a shunt resistor by doing either of the following:
   a. Solder a 2512 resistor across the pads of R1 that connects the IN+ and IN– inputs.
   b. Connect an external shunt across the IN+ and IN– terminals of J1.
2. Connect the IN+ and IN– terminals in series with the load while powered off.
   a. When measuring more than 5 A, make sure the high current path does not go through the EVM (including the terminal block J1).
   b. When using 5 A or less with either an onboard or external shunt, the current path can be passed through the EVM.

> **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 5 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.

3. Power on the system and measure the output voltage at the OUT test point
   a. Vout is equal to the gain of the device multiplied by the differential voltage measured directly at the device input pins

3.3 Comparator

The INA310 incorporates an open-drain active high comparator and internal reference providing a 0.6-V threshold. An external resistor divider sets the current trip point, and the comparator output will assert high when a voltage greater than 0.6 V is preset at the CMPin pin. Switch SW1 can be used to put the comparator in either latch or transparent mode. When in latch mode, SW1 can be moved to the reset position to clear the alert. The switch will then automatically return to the latch position. When the comparator threshold is reached, LED D1 will turn on.

4 Circuitry

This section summarizes the EVM subsystems and their components. For these descriptions, when referencing part designators, the part version (A or B) and the gain option (1, 2, 3, 4, or 5) will be ignored. For example R1_A3 will just be referred to as R1.

4.1 Current Sensing IC

This section describes the main INA device and supporting components.

U1 is the INA310x current-sensing device (any gain or variant). C1 is a bypass capacitor that is placed near the sensor to help mitigate power-supply noise and provide current quickly to the device when needed.

The non-input device pins can be monitored directly through the test points TP1 – TP7. Note that there is one extra test point on GND for convenience. The input pins can be monitored either through the terminal J1, or by probing the pads of C2.

4.2 Input Signal Path

This section describes the circuitry of the input signal path.

J1 is used to connect IN+ and IN–.

R1 can be used for an optional onboard shunt resistor with a 2512 footprint. Alternatively, a shunt can be placed across the IN+ and IN– terminals of J1. If desired, a differential voltage can be applied directly for measurement tests.

C2, R2, and R3 combine to make an optional input filter. R2 and R3 are populated with 0-Ω resistors by default. When using input filtering, take the input bias current of the device into account. See the data sheet for more information on input filtering.

4.3 Device Output and Comparator

This section describes the circuitry around the output and comparator of the device.

R4 and C3 are used for an optional output filter. C3 is left unpopulated and R4 is populated with a 0-Ω resistor by default.

R5 and R6 are used as a voltage divider to set the threshold at CMPin. By default, these resistors are set with R5 = 10.2 kΩ and R6 = 3.4 kΩ so that the voltage at CMPin is 1/4th the voltage of OUT, causing the comparator to trip when the output voltage is at 2.4 V.

R8 is the pullup resistor for the active high comparator alert pin CMPout. LED D1 and current-limiting resistor R7 are used with the N-Channel MOSFET Q1 to indicate when the ALERT pin is triggered.

Switch SW1 is used to put the comparator in either latch or transparent mode. When in latch mode, SW1 can be moved to the reset position to clear the alert. The switch will then automatically return to the latch position.

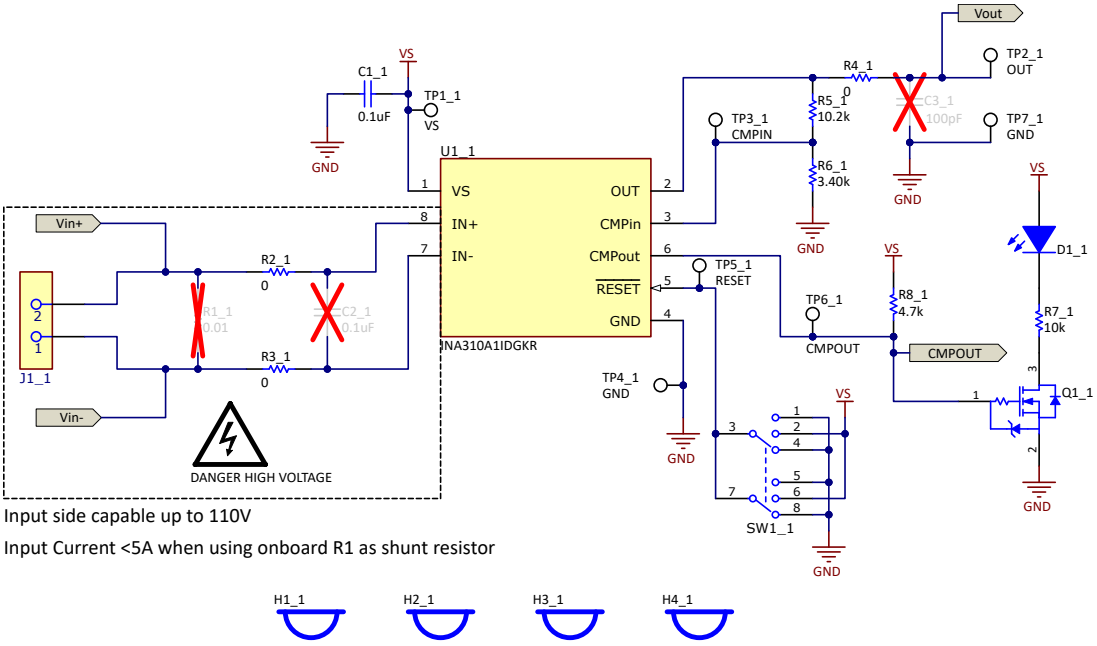
5 Schematics, PCB Layout, and Bill of Materials

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

Figure 5-1 and Figure 5-2 show the schematic of the EVM. Figure 5-1 shows the circuitry for the A1 sub board on the INA310AEM. Only the schematic for the A1 version is shown as all variants use the same schematic. The only differences between schematics for different variants and gain versions is that U1 changes to match the device, and the "_1" appended to each component below will change to match the gain number of the device. Figure 5-2 shows the hardware section of the schematic that is not repeated per sub board.



LBL2_1

PCB Label

THT-14-423-10

Size: 0.65" x 0.20 "

LBL2 Variant/Label Table					
Variant	LBL2_1 Label Text	LBL2_2 Label Text	LBL2_3 Label Text	LBL2_4 Label Text	LBL2_5 Label Text
001	INA310A1	INA310A2	INA310A3	INA310A4	INA310A5
002	INA310B1	INA310B2	INA310B3	INA310B4	INA310B5

Figure 5-1. INA310 Schematic

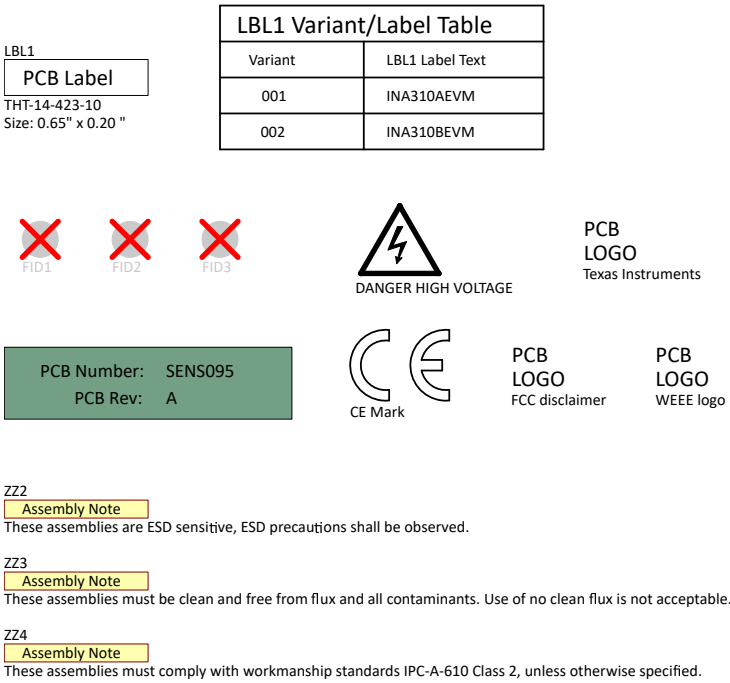


Figure 5-2. INA310 Hardware Schematic

5.2 PCB Layout

Figure 5-3 through Figure 5-6 show the PCB layers of the EVM.

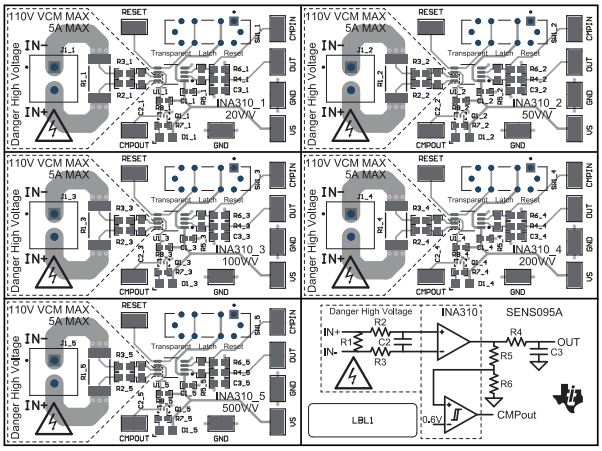


Figure 5-3. SENS095 Top View

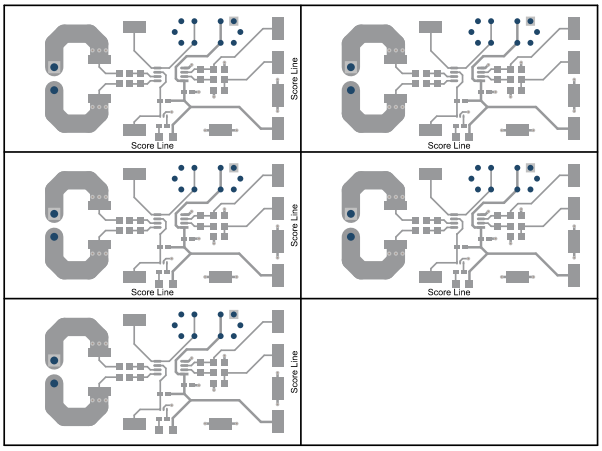


Figure 5-4. SENS095 Top Layer

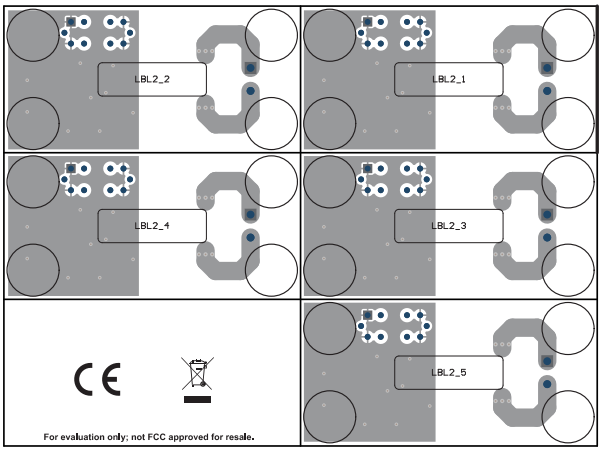


Figure 5-5. SENS095 Bottom View

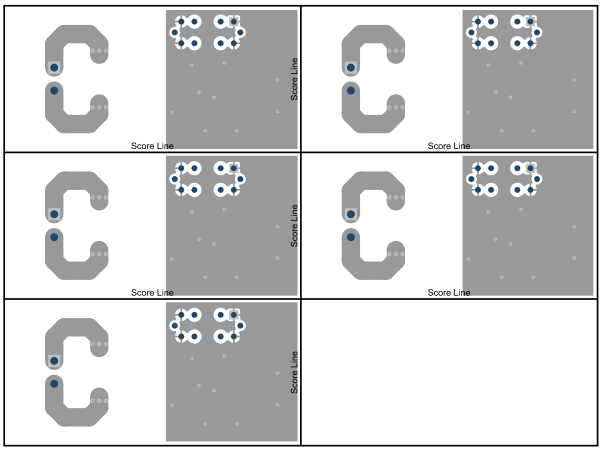


Figure 5-6. SENS095 Bottom Layer

5.3 Bill of Materials

This section shows the bill of materials for the SENS095.

Table 5-1 provides the parts list for the EVM.

Table 5-1. SENS095 Bill of Materials

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
!PCB	1		Printed Circuit Board		SENS095	Any
C1_1, C1_2, C1_3, C1_4, C1_5	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, 0402	0402	GRM155R71H104ME14D	MuRata
D1_1, D1_2, D1_3, D1_4, D1_5	5	White	LED, White, SMD	0805	VAOL-S8WR4	Visual Communications Company, LLC
H1_1, H1_2, H1_3, H1_4, H1_5, H2_1, H2_2, H2_3, H2_4, H2_5, H3_1, H3_2, H3_3, H3_4, H3_5, H4_1, H4_2, H4_3, H4_4, H4_5	20		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M
J1_1, J1_2, J1_3, J1_4, J1_5	5		2 Position Wire to Board Terminal Block Horizontal with Board 0.138" (3.50mm) Through Hole	CONN_TERM_POS2	691103110002	Wurth
LBL1, LBL2_1, LBL2_2, LBL2_3, LBL2_4, LBL2_5	6		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1_1, Q1_2, Q1_3, Q1_4, Q1_5	5	30V	MOSFET, N-CH, 30 V, 5.9 A, YJK0003A (PICOSTAR-3)	YJK0003A	CSD17585F5T	Texas Instruments
R2_1, R2_2, R2_3, R2_4, R2_5, R3_1, R3_2, R3_3, R3_4, R3_5, R4_1, R4_2, R4_3, R4_4, R4_5	15	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic
R5_1, R5_2, R5_3, R5_4, R5_5	5	10.2k	RES, 10.2 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710K2L	Yageo
R6_1, R6_2, R6_3, R6_4, R6_5	5	3.40k	RES, 3.40 k, 1%, 0.1 W, 0603	0603	RC0603FR-073K4L	Yageo
R7_1, R7_2, R7_3, R7_4, R7_5	5	10k	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R8_1, R8_2, R8_3, R8_4, R8_5	5	4.7k	RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K70JNED	Vishay-Dale
SW1_1, SW1_2, SW1_3, SW1_4, SW1_5	5		Switch Slide ON ON Mom DP3T Top Slide 0.3A 6VDC PC Pins Thru-Hole Bulk	SW_13MM00_3MM60	JS207011CQNR	C&K

Table 5-1. SENS095 Bill of Materials (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
TP1_1, TP1_2, TP1_3, TP1_4, TP1_5, TP2_1, TP2_2, TP2_3, TP2_4, TP2_5, TP3_1, TP3_2, TP3_3, TP3_4, TP3_5, TP4_1, TP4_2, TP4_3, TP4_4, TP4_5, TP5_1, TP5_2, TP5_3, TP5_4, TP5_5, TP6_1, TP6_2, TP6_3, TP6_4, TP6_5, TP7_1, TP7_2, TP7_3, TP7_4, TP7_5	35		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
U1_1	1		-4V to 110V, 1.3-MHz, Ultra-Precise Current Sense Amplifier With Open Drain Comparator and Reference	SSOP8	INA310A1IDGKR	Texas Instruments
U1_2	1		-4V to 110V, 1.3-MHz, Ultra-Precise Current Sense Amplifier With Open Drain Comparator and Reference	VSSOP8	INA310A2IDGKR	Texas Instruments
U1_3	1		-4-V to 110-V, 1.3-MHz, Ultra-Precise Current Sense Amplifier With Open Drain Comparator and Reference	VSSOP8	INA310A3IDGKR	Texas Instruments
U1_4	1		-4-V to 110-V, 1.3-MHz, Ultra-Precise Current Sense Amplifier With Open Drain Comparator and Reference	VSSOP8	INA310A4IDGKR	Texas Instruments
U1_5	1		-4-V to 110-V, 1.3-MHz, Ultra-Precise Current Sense Amplifier With Open Drain Comparator and Reference	VSSOP8	INA310A5IDGKR	Texas Instruments
C2_1, C2_2, C2_3, C2_4, C2_5	0	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0603	0603	GRM188R72A104KA35D	MuRata
C3_1, C3_2, C3_3, C3_4, C3_5	0	100pF	CAP, CERM, 100 pF, 50 V,+/- 10%, X7R, 0603	0603	CL10B101KB8NNNC	Samsung Electro-Mechanics
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R1_1, R1_2, R1_3, R1_4, R1_5	0	0.01	RES, 0.01, 1%, 3 W, 2512	2512	CRA2512-FZ-R010ELF	Bourns

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.

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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 2 4 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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