

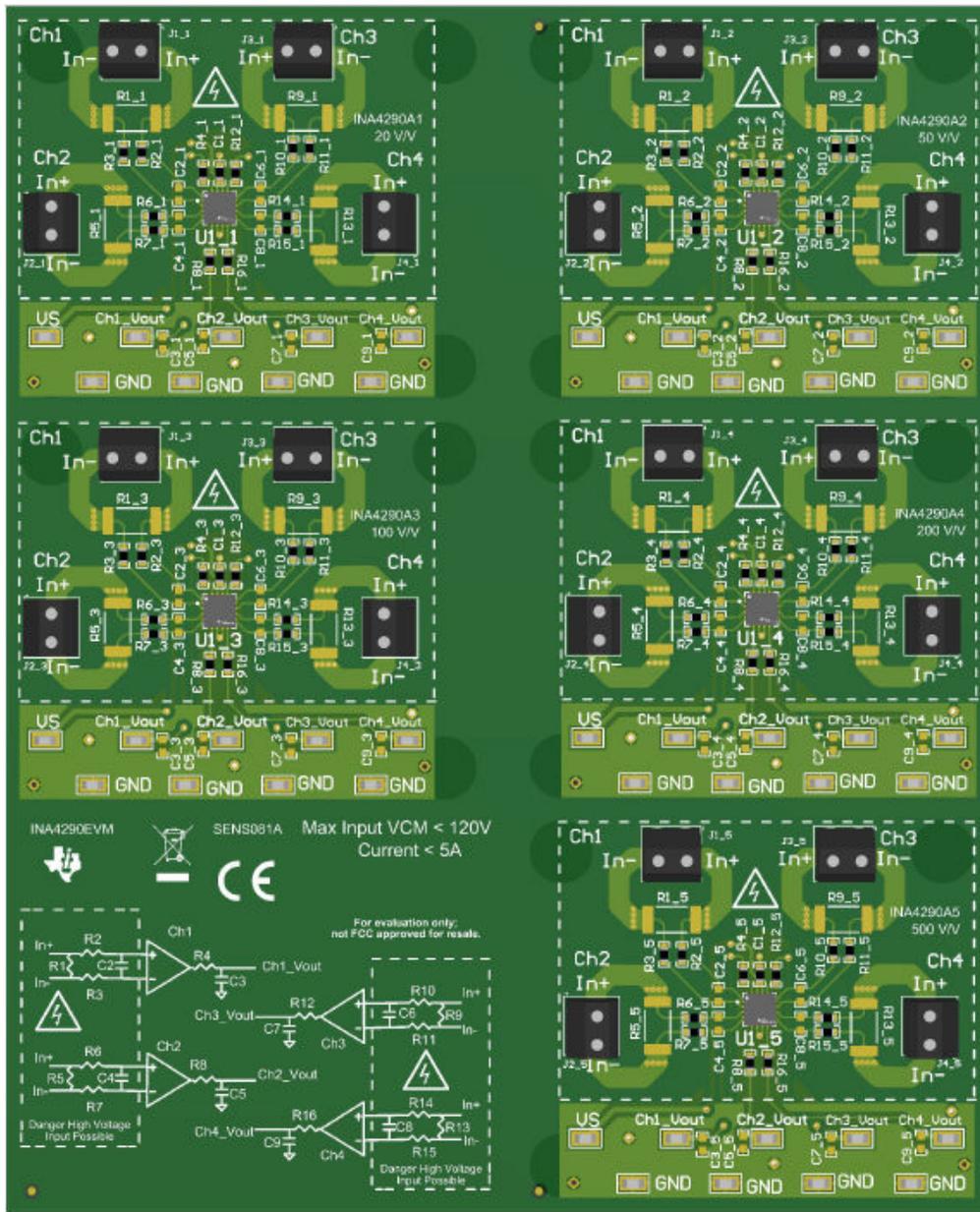
# User's Guide

## INA4290 Evaluation Module



### ABSTRACT

This user's guide describes the characteristics, operation, and use of the INA4290 evaluation module (EVM). This EVM is designed to evaluate the performance of the INA4290 voltage-output, current shunt monitor in a variety of configurations. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the INA4290EVM. This document also includes a schematic, reference printed-circuit board (PCB) layouts, and a complete bill of materials (BOM).



## Table of Contents

<b>1 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines</b> .....	3
<b>2 Overview</b> .....	4
2.1 EVM Kit Contents.....	4
2.2 Related Documentation From Texas Instruments.....	4
<b>3 Hardware</b> .....	5
3.1 Features.....	5
<b>4 Operation</b> .....	6
4.1 Quick Start Setup.....	6
4.2 Measurements.....	6
<b>5 EVM Components</b> .....	7
5.1 R2_n, R3_n, R4_n, R6_n, R7_n, R8_n, R10_n, R11_n, R14_n, R15_n, C2_n - C9_n.....	7
5.2 C1_An.....	7
5.3 R1_n, R5_n, R9_n, R13_n(Rshunt).....	7
5.4 U1_n (INA4290).....	7
<b>6 Schematic, PCB Layout, and Bill of Materials</b> .....	8
6.1 Schematics.....	8
6.2 PCB Layout.....	13
6.3 Bill of Materials.....	15

## List of Figures

Figure 6-1. INA4290EVM Schematic: Gain A1 Panel.....	8
Figure 6-2. INA4290EVM Schematic: Gain A2 Panel.....	9
Figure 6-3. INA4290EVM Schematic: Gain A3 Panel.....	10
Figure 6-4. INA4290EVM Schematic: Gain A4 Panel.....	11
Figure 6-5. INA4290EVM Schematic: Gain A5 Panel.....	12
Figure 6-6. INA4290EVM Top Overlay.....	13
Figure 6-7. INA4290EVM Bottom Overlay.....	13
Figure 6-8. INA4290EVM Top Layer.....	13
Figure 6-9. INA4290EVM Bottom Layer.....	13
Figure 6-10. INA4290EVM Top Solder.....	14
Figure 6-11. INA4290EVM Bottom Solder.....	14
Figure 6-12. INA4290EVM Drill Drawing.....	14

## List of Tables

Table 2-1. INA4290 Gain Option Summary.....	4
Table 2-2. INA4290EVM Kit Contents.....	4
Table 2-3. Related Documentation.....	4
Table 6-1. Bill of Materials.....	15

## Trademarks

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



Always follow TI's setup 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://support/ti.com> 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 nonconductive work surface.
- f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

## 2. Electrical Safety

As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

- a. 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.
- b. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- c. After 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 the EVM in an adequate lucent plastic box with interlocks to protect from accidental touch.

#### Limitation for safe use:

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

## 2 Overview

The INA4290 device is a voltage-output, high-side quad-channel current sense amplifier in a QFN (16) package. As shown in [INA4290 Gain Option Summary](#), the INA4290 has gains that range from 20 V/V to 500 V/V, depending on the gain option that is selected. The voltage developed across the device inputs is amplified by the corresponding gain of the specific device, and is presented at the output pin. The device can accurately sense voltage drops across shunts at 2.7-V to +120-V common-mode voltages, dependent of supply voltages. The device survives common-mode voltages from –20 V to +122 V. The device operates with supply voltages between 2.7 V and 20 V, and draws a typical of 320  $\mu$ A per channel at room temperature.

**Table 2-1. INA4290 Gain Option Summary**

Product	Gain (V/V)
INA4290A1	20
INA4290A2	50
INA4290A3	100
INA4290A4	200
INA4290A5	500

### 2.1 EVM Kit Contents

[INA4290EVM Kit Contents](#) summarizes the contents of the INA4290EVM kit. Contact the nearest [Texas Instruments Product Information Center](#) if any component is missing. TI also recommends to check the [INA4290 device product folder](#) at [www.ti.com](http://www.ti.com) for any further information regarding this product.

**Table 2-2. INA4290EVM Kit Contents**

Item	Item Part Number	Quantity
INA4290EVM test board	<a href="#">INA4290EVM</a>	1

### 2.2 Related Documentation From Texas Instruments

This document provides information regarding Texas Instruments' integrated circuits used in the assembly of the INA4290EVM.

**Table 2-3. Related Documentation**

Document	Literature Number
<a href="#">INAx290</a> product data sheet	<a href="#">SBOS961</a>

### 3 Hardware

The INA4290EVM provides a basic functional evaluation of the INA4290. 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 INA4290EVM is one PCB with five optional PCB cutouts the engineer can use to test each of the five gain options (1 to 5) listed in [INA4290 Gain Option Summary](#). Each PCB cutout has one INA4290An device (where  $n$  is 1, 2, 3, 4, or 5), test points and sockets for external hardware connections, and pads to solder down optional circuitry.

#### 3.1 Features

The INA4290EVM PCB provides the following 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.

See the [INAx290 2.7-V to 120-V, 1.1-MHz, Ultra-Precise Current Sense Amplifier Data Sheet](#) for comprehensive information about the INA4290 and the available gain options.

## 4 Operation

### 4.1 Quick Start Setup

Follow these procedures to set up and use one of the INA4290EVM panels. For these instructions, n is gain option 1, 2, 3, 4, or 5 and x is the channel option 1, 2, 3, or 4.

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. 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 the Jx\_n pin 1 and Jx\_n pin 2 for channel x on the EVM, as explained in [Measurements](#). The INA4290 is a unidirectional current-sensing device because there is no reference pin. The device can only measure current in one direction.

### 4.2 Measurements

The user can either emulate the voltage developed across a sense resistor based on a given set of system conditions with the INA4290EVM, or connect the device inputs to an external shunt. The user can also solder a surface-mount technology (SMT) shunt resistor across the In+ and In– pads, and these inputs can be connected in series with the external system and load. In+ and In- will refer the input of either channel being measured. Jx\_n for channel x and Jx\_n for channel x. Also shunt resistor is R1\_n for channel 1, R5\_n for channel 2, R9\_n for channel 3, and R13\_n for channel 4 will be referred to as Rshunt.

To configure a measurement evaluation without a shunt resistor, follow this procedure:

1. Connect a positive differential voltage across the In+ and In– tab. Given the internal GND reference of the device, make sure that the In+ pin is the more positive of the two inputs. Note the In+ and In- are not in the same location on each connector. Use marking on the board to see which pin is In+ and In-.
2. Connect a 2.7-V to 120-V common-mode voltage to the inputs if the differential voltage supply is a floating supply. Connect the positive lead of the external voltage source to the In– tab and source ground to a GND test point. The minimum common-mode voltage should be >VS. This action effectively raises the absolute common-mode voltage of the input pins, while still retaining a positive input differential signal.
3. Measure the output voltage at the Vout test point with respect to GND.

To configure a measurement evaluation with a shunt resistor, follow this procedure:

1. Solder a 2512 resistor at the Rshunt pads that connects the In+ and In– inputs.
2. Connect the In+ and In– tabs in series with the load and bus voltage sources while powered off.

#### WARNING

Make sure that the equipment (shunt resistor, wires, connectors, and so on) can support the amperage and power dissipation first before you measure the current. Also make sure that the current flowing through Jx does not exceed 5 A. Failure to do so can result in hot surfaces (> 55 °C), damage to the EVM, or personal injury.

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

## 5 EVM Components

This section summarizes the INA4290EVM components. For these instructions, n is gain option 1, 2, 3, 4, or 5.

### 5.1 R2\_n, R3\_n, R4\_n, R6\_n, R7\_n, R8\_n, R10\_n, R11\_n, R14\_n, R15\_n, C2\_n - C9\_n

R2\_n, R3\_n, R4\_n, R6\_n, R7\_n, R8\_n are factory-installed 0-Ω 0603 resistors.

C2\_n - C9\_n are not populated.

Collectively, these pads allow user-defined filters for the input pins (IN+ and IN–) and the output pin (OUT) of the INA4290. If a filter is desired, remove these resistors and replace them with > 0-Ω SMT resistors and populate the capacitor pads with capacitors. Consider the input bias current of the device when using input filtering.

### 5.2 C1\_An

C1\_An is a 0.1-μF, power-supply bypass capacitor.

### 5.3 R1\_n, R5\_n, R9\_n, R13\_n(Rshunt)

Rshunt is unpopulated, but allows the user to solder down a surface-mount shunt resistor between the In+ and In– pads sensed by IN+ and IN– input pins. If used, make sure Rshunt has proper power dissipation for the selected current load and below 5 A. The chosen resistor must have a 2512 footprint.

### 5.4 U1\_n (INA4290)

U1\_An is the location for the INA4290An test device.

Consider these factors when selecting the appropriate device gain:

- The differential input voltage is either applied across the inputs or developed based on the load current that flows through the shunt resistor.
- Make sure that the output voltage does not exceed the supply voltage. This limiting factor requires attention to device selection.
- 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 within the device-specified swing limitations for response in the linear range.
- An output below the minimum allowable output requires a device with a higher gain. Likewise, an output above the maximum allowable output requires a device with a lower gain.

## 6 Schematic, 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. They are not intended to be used for INA4290EVM PCB manufacturing.

### 6.1 Schematics

Figure 6-1 through Figure 6-5 show the schematics for the A pinout of the INA4290EVM PCB for all gain options.

Input side capable up to 120V; Input Current <5A when using onboard Rx1 as shunt resistor

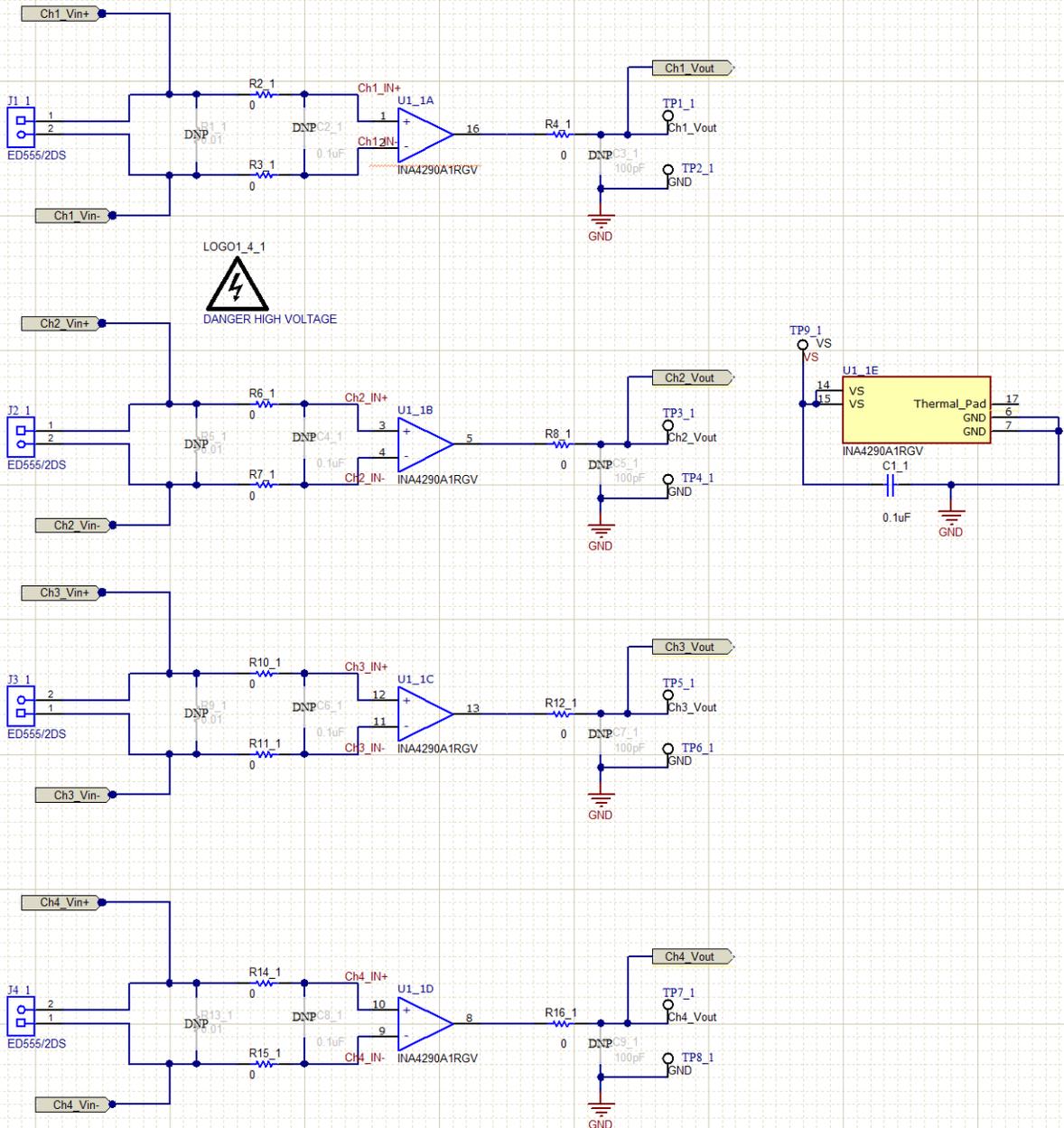


Figure 6-1. INA4290EVM Schematic: Gain A1 Panel

Input side capable up to 120V; Input Current <5A when using onboard Rx1 as shunt resistor

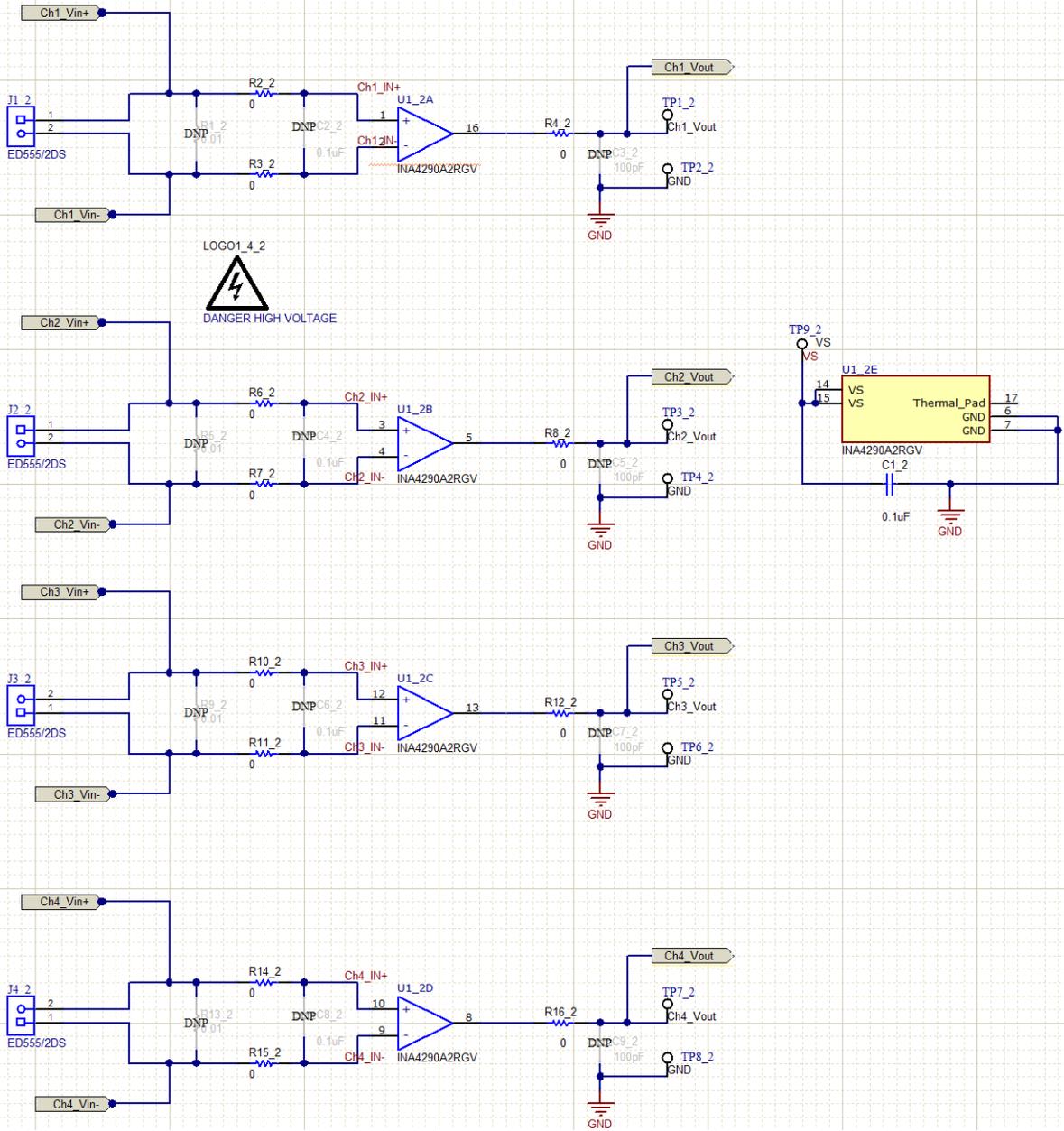


Figure 6-2. INA4290EVM Schematic: Gain A2 Panel

Input side capable up to 120V; Input Current <5A when using onboard Rx1 as shunt resistor

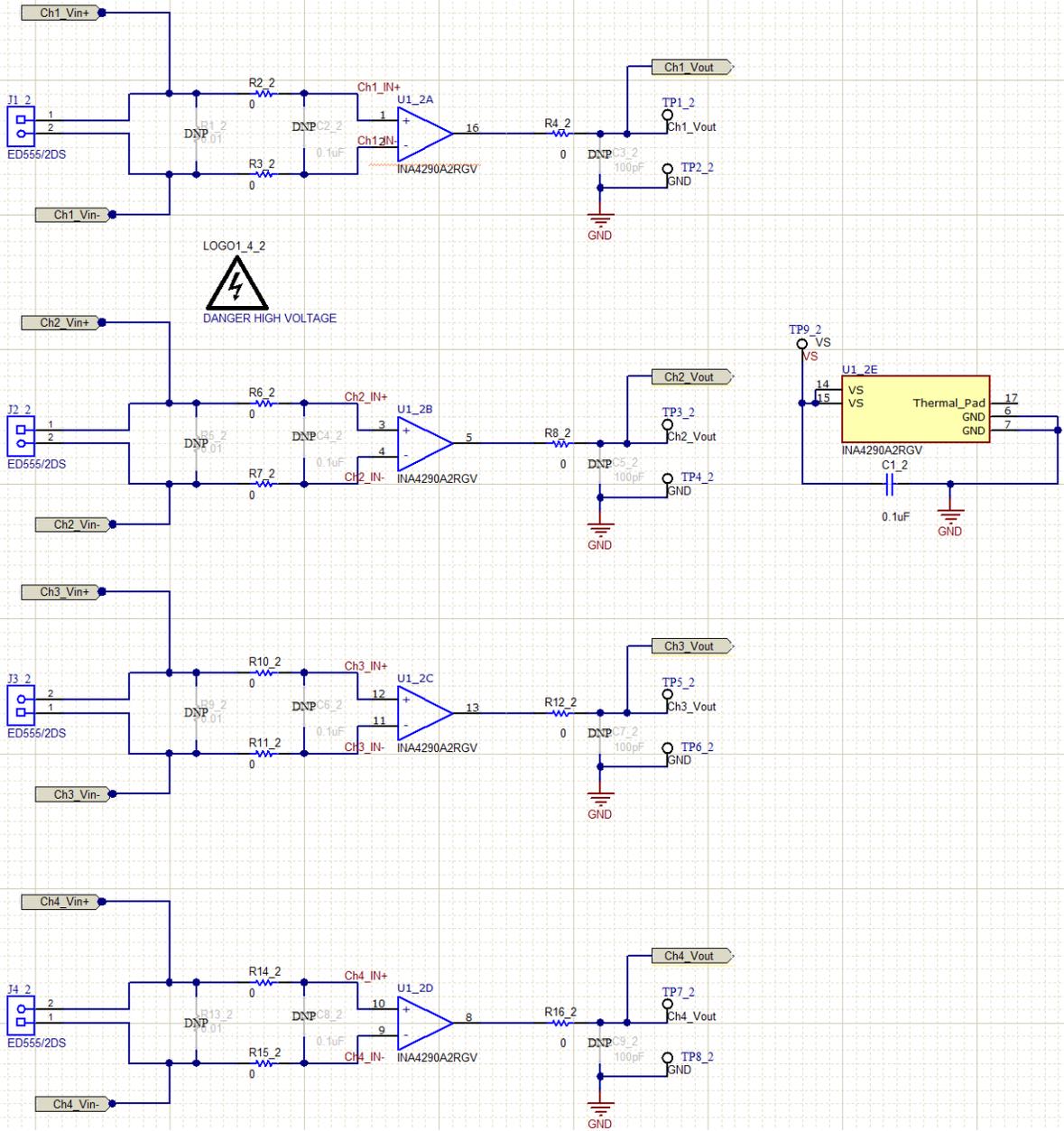


Figure 6-3. INA4290EVM Schematic: Gain A3 Panel

Input side capable up to 120V; Input Current <5A when using onboard Rx1 as shunt resistor

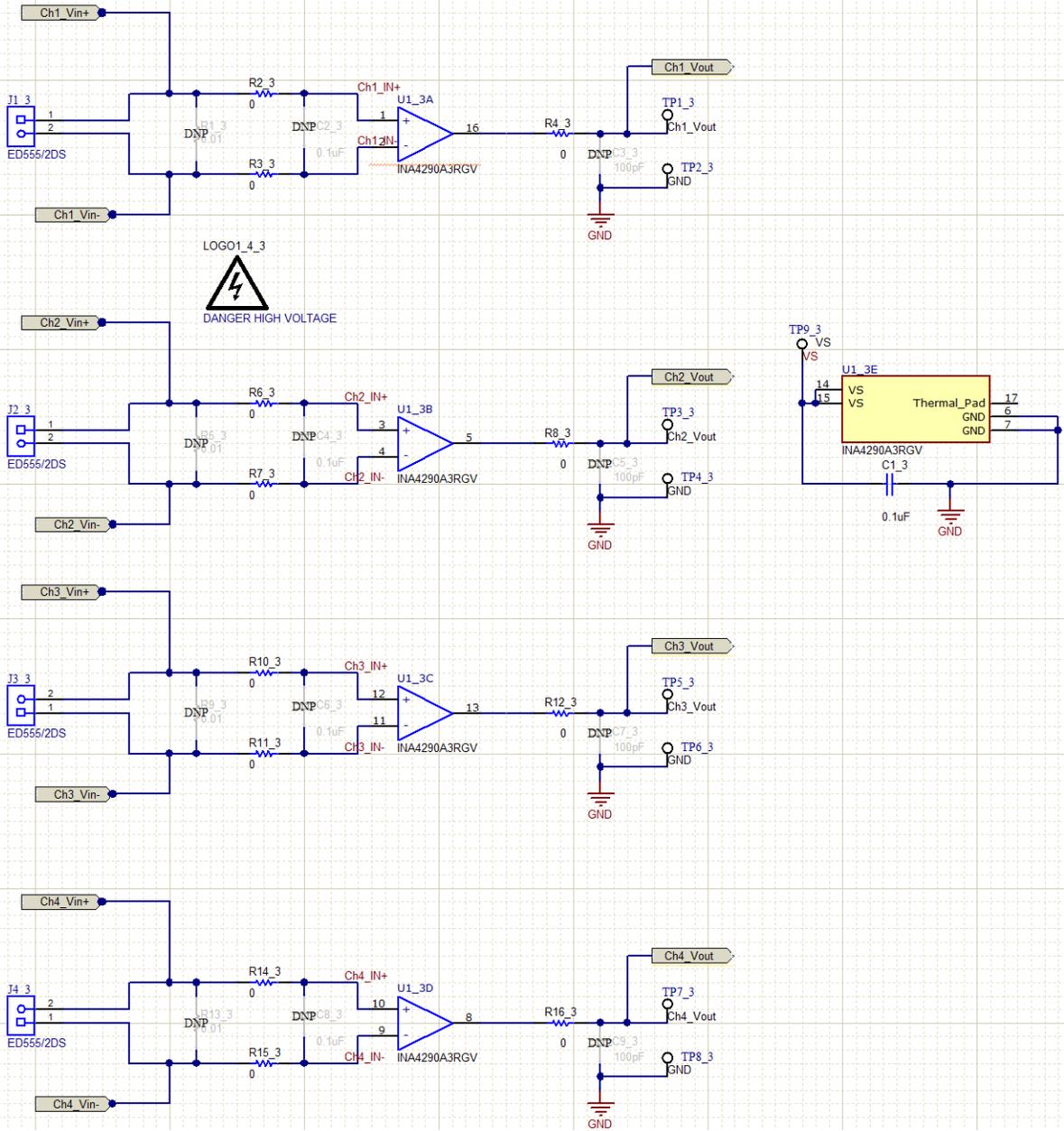


Figure 6-4. INA4290EVM Schematic: Gain A4 Panel

Input side capable up to 120V; Input Current <5A when using onboard Rx1 as shunt resistor

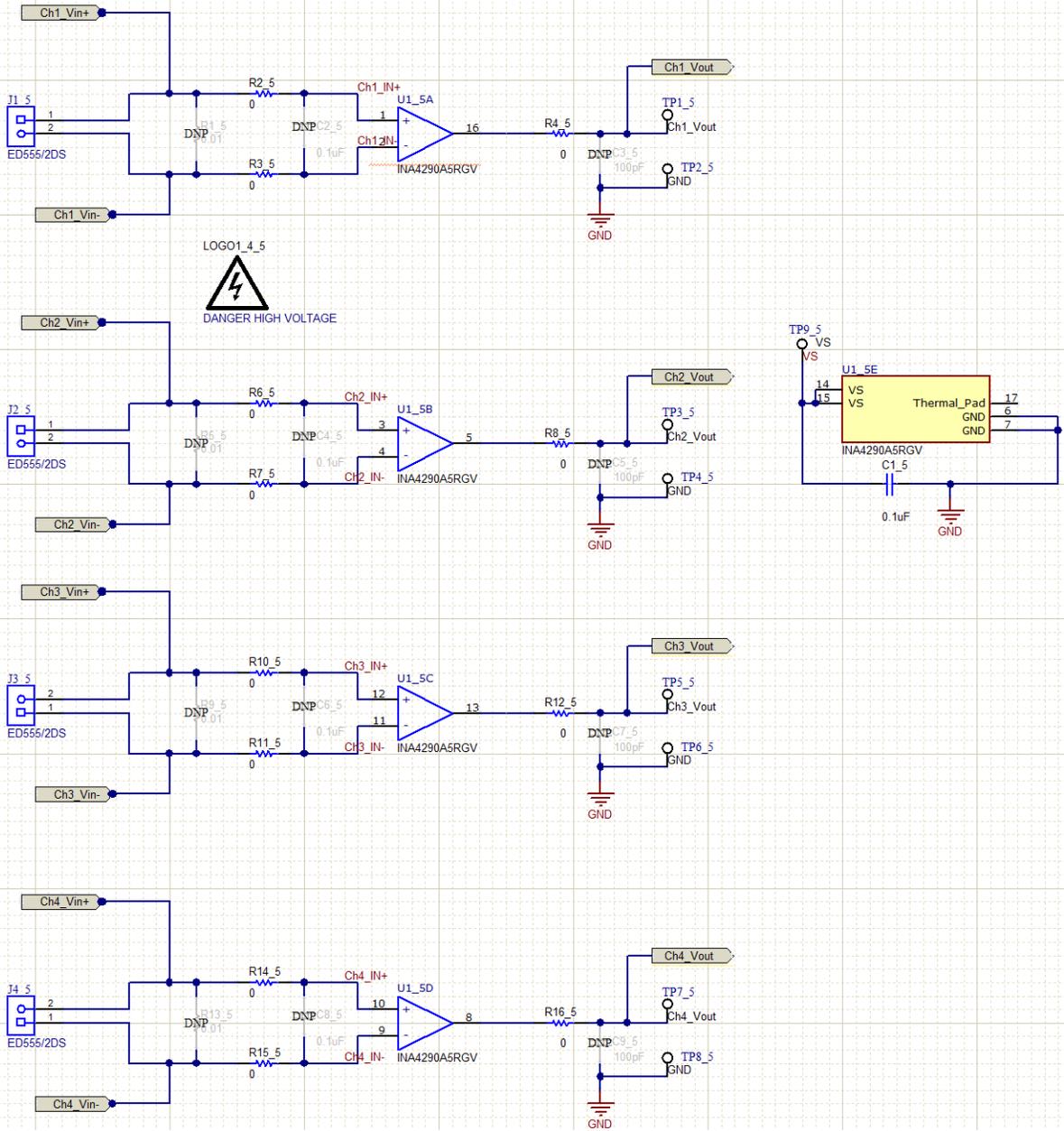


Figure 6-5. INA4290EVM Schematic: Gain A5 Panel

## 6.2 PCB Layout

Figure 6-6 through Figure 6-12 show the PCB layout for the INA4290EVM.

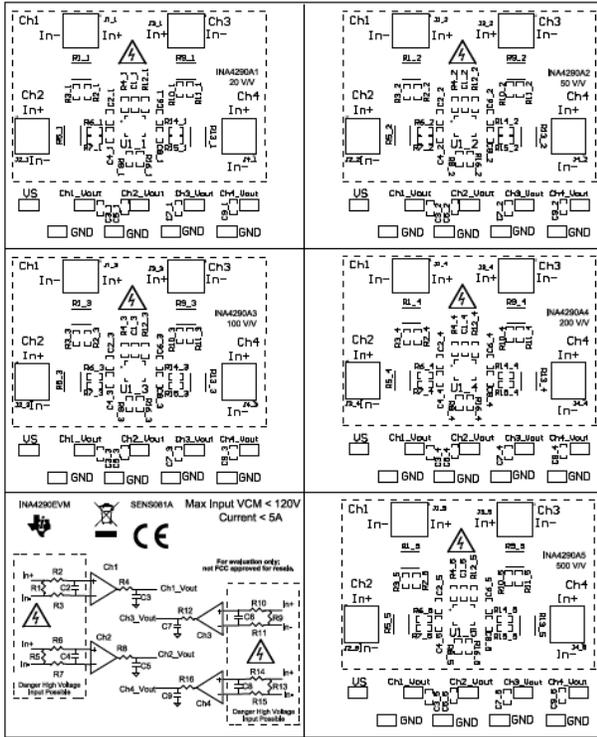


Figure 6-6. INA4290EVM Top Overlay

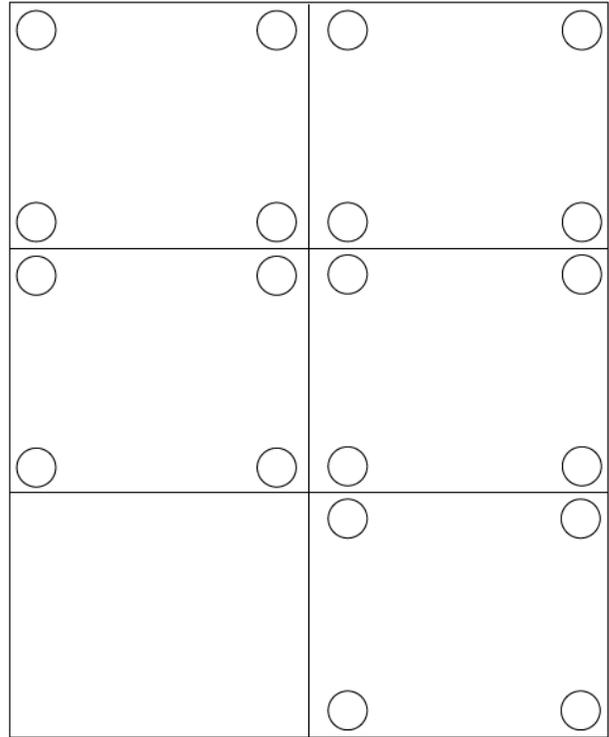


Figure 6-7. INA4290EVM Bottom Overlay

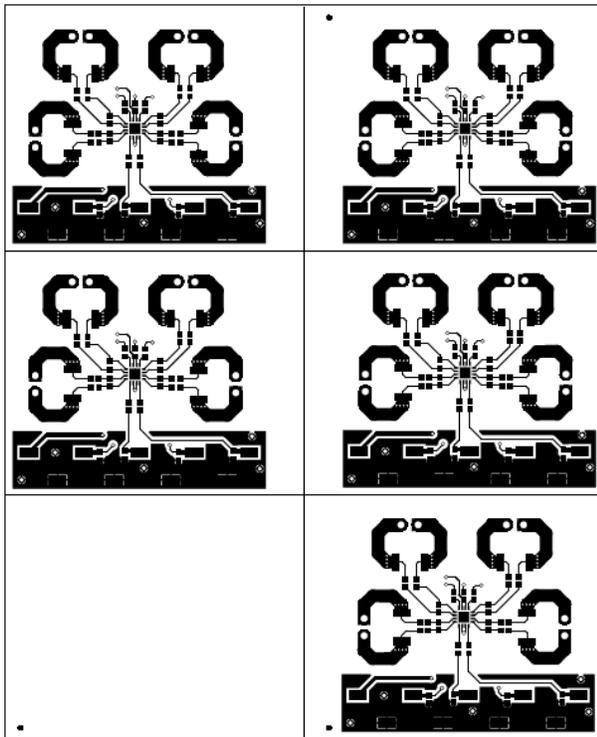


Figure 6-8. INA4290EVM Top Layer

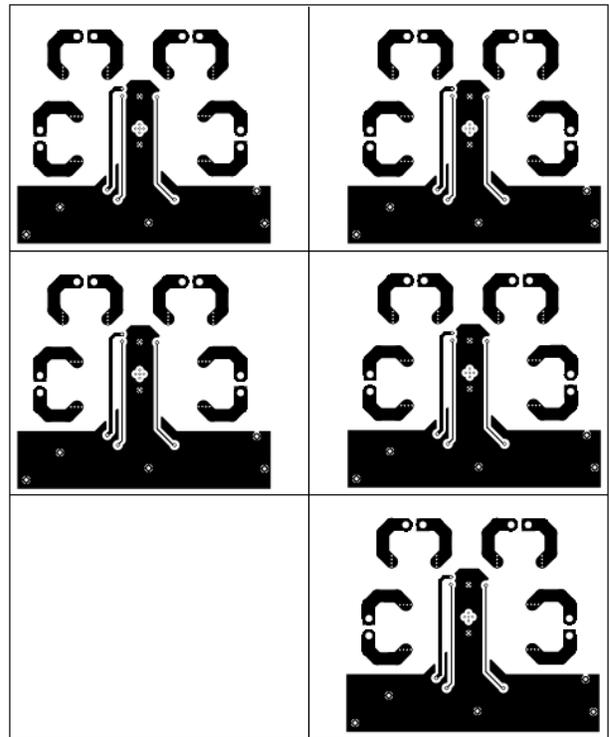


Figure 6-9. INA4290EVM Bottom Layer

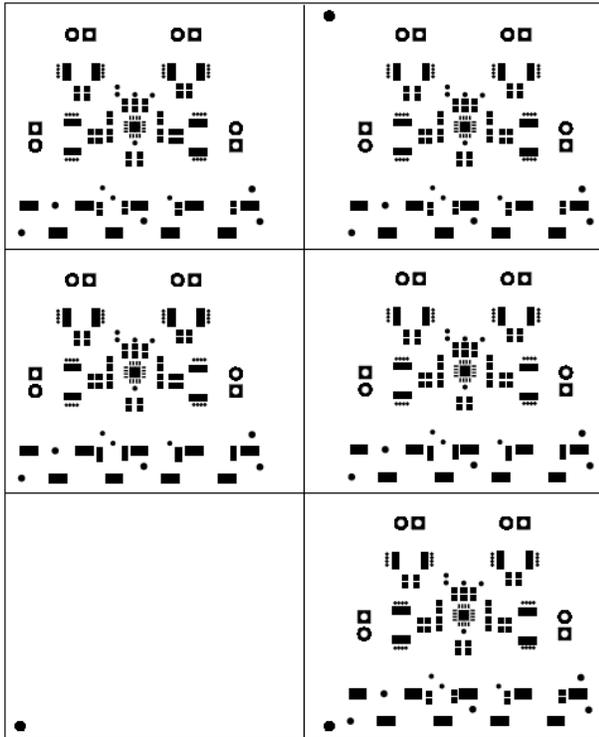


Figure 6-10. INA4290EVM Top Solder

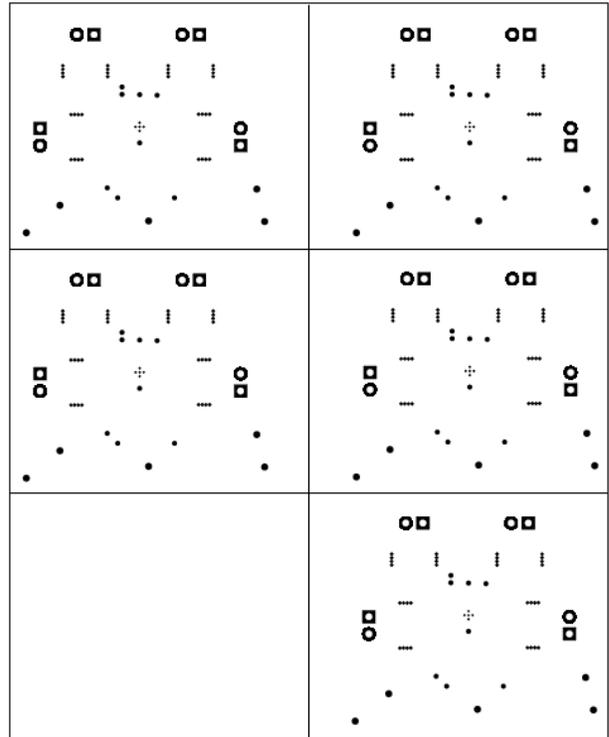


Figure 6-11. INA4290EVM Bottom Solder

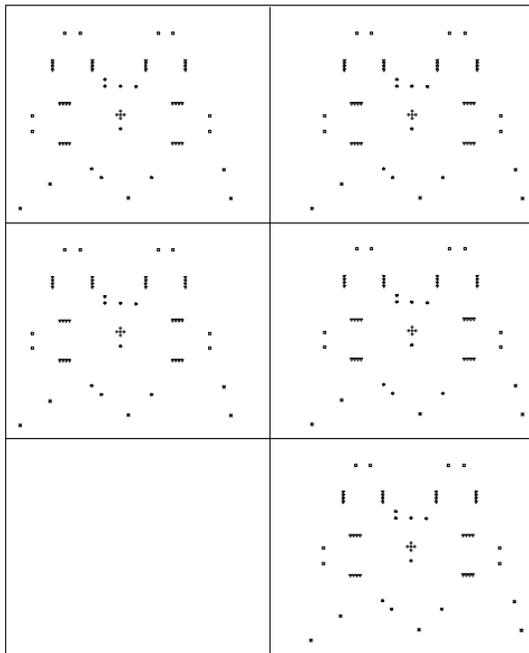


Figure 6-12. INA4290EVM Drill Drawing

Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
○	26	7.25mil (0.209mm)	PTH	Round	Top Layer - Bottom Layer	
▽	160	14.0mil (0.354mm)	PTH	Round	Top Layer - Bottom Layer	
○	48	14.0mil (0.354mm)	PTH	Round	Top Layer - Bottom Layer	
⊕	25	26.25mil (0.711mm)	PTH	Round	Top Layer - Bottom Layer	
□	48	68.00mil (1.728mm)	PTH	Round	Top Layer - Bottom Layer	
200 Total						

### 6.3 Bill of Materials

Table 6-1 provides the parts list for the INA4290EVM.

**Table 6-1. Bill of Materials**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C1_1, C1_2, C1_3, C1_4, C1_5	5	0.1uF	CAP. CERM, 0.1 uF, 25 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1E104K080AA	TDK
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, J2_1, J2_2, J2_3, J2_4, J2_5, J3_1, J3_2, J3_3, J3_4, J3_5, J4_1, J4_2, J4_3, J4_4, J4_5	20		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
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, R6_1, R6_2, R6_3, R6_4, R6_5, R7_1, R7_2, R7_3, R7_4, R7_5, R8_1, R8_2, R8_3, R8_4, R8_5, R10_1, R10_2, R10_3, R10_4, R10_5, R11_1, R11_2, R11_3, R11_4, R11_5, R12_1, R12_2, R12_3, R12_4, R12_5, R14_1, R14_2, R14_3, R14_4, R14_5, R15_1, R15_2, R15_3, R15_4, R15_5, R16_1, R16_2, R16_3, R16_4, R16_5	60	0	RES, 0, 5%, 0.125 W, 0603	0603	MCT06030Z0000ZP500	Vishay/Beyschlag
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, TP8_1, TP8_2, TP8_3, TP8_4, TP8_5, TP9_1, TP9_2, TP9_3, TP9_4, TP9_5	45		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
U1_1	1		2.7-V to 120-V, 1100-kHz, 20-V/V, Ultra-Precise Current-Sense Amplifier, VQFN16	VQFN16	INA4290A1RGV	Texas Instruments
U1_2	1		2.7-V to 120-V, 1100-kHz, 50-V/V, Ultra-Precise Current-Sense Amplifier, VQFN16	VQFN16	INA4290A2RGV	Texas Instruments
U1_3	1		2.7-V to 120-V, 900-kHz, 100-V/V, Ultra-Precise Current-Sense Amplifier, VQFN16	VQFN16	INA4290A3RGV	Texas Instruments

**Table 6-1. Bill of Materials (continued)**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
U1_4	1		2.7-V to 120-V, 850-kHz, 200-V/V, Ultra-Precise Current-Sense Amplifier, VQFN16	VQFN16	INA4290A4RGV	Texas Instruments
U1_5	1		2.7-V to 120-V, 800-kHz, 500-V/V, Ultra-Precise Current-Sense Amplifier, VQFN16	VQFN16	INA4290A5RGV	Texas Instruments
C2_1, C2_2, C2_3, C2_4, C2_5, C4_1, C4_2, C4_3, C4_4, C4_5, C6_1, C6_2, C6_3, C6_4, C6_5, C8_1, C8_2, C8_3, C8_4, C8_5	0	0.1uF	CAP, CERM, 0.1 uF, 25 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1E104K080AA	TDK
C3_1, C3_2, C3_3, C3_4, C3_5, C5_1, C5_2, C5_3, C5_4, C5_5, C7_1, C7_2, C7_3, C7_4, C7_5, C9_1, C9_2, C9_3, C9_4, C9_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, R5_1, R5_2, R5_3, R5_4, R5_5, R9_1, R9_2, R9_3, R9_4, R9_5, R13_1, R13_2, R13_3, R13_4, R13_5	0	0.01	RES, 0.01, 1%, 3 W, 2512	2512	CRA2512-FZ-R010ELF	Bourns

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