



# MAX9922 Evaluation Kit

## General Description

The MAX9922 evaluation kit (EV kit) is a fully assembled and tested PCB used to evaluate the MAX9922 and MAX9923 ultra-precision, high-side current-sense amplifiers. An ultra-low offset voltage ( $V_{OS}$ ) of  $10\mu V$  (max) allows accurate measurement of currents at both extremes of sense voltages ( $V_{SENSE}$ ), from 10mV to 100mV. The EV kit has a 1.9V to 28V input common-mode sense voltage range that is independent of the 2.85V to 5.5V  $V_{DD}$  supply.

The MAX9922 EV kit comes assembled with the MAX9922 IC with adjustable gain, but can also evaluate the MAX9923 ICs with fixed gains of 25V/V (MAX9923T), 100V/V (MAX9923H), and 250V/V (MAX9923F). The MAX9922/MAX9923 are capable of both unidirectional and bidirectional operation.

## Features

- ◆ Bidirectional or Unidirectional Current Sensing
- ◆ Shutdown Logic Input Control
- ◆ Multiple Gains Available  
Adjustable (MAX9922)  
25V/V (MAX9923T)  
100V/V (MAX9923H)  
250V/V (MAX9923F)
- ◆ 2.85V to 5.5V Supply Range ( $V_{DD}$ )
- ◆ 1.9V to 28V Input Common-Mode Range Independent of  $V_{DD}$
- ◆ Lead(Pb)-Free and RoHS Compliant
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX9922EVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

## Component List

COMPONENT	QTY	DESCRIPTION
C1	1	4.7 $\mu F$ $\pm 10\%$ , 6.3V X5R ceramic capacitor (0603) Murata GRM188R70J475K TDK C1608X5R0J475K
C2, C7	2	0.1 $\mu F$ $\pm 10\%$ , 25V X7R ceramic capacitors (0603) TDK C1608X7R1E104K Murata GRM188R71E104K
C3, C4, C5, C8	0	Not installed, capacitors (0603)
C6	1	1000pF $\pm 10\%$ , 50V X7R ceramic capacitor (0603) Murata GRM1885C1H102J TDK C1608X7R1H102K
JU1, JU2	2	2-pin headers
JU3	1	3-pin header
R1	1	0.1 $\Omega$ $\pm 1\%$ current-sense resistor (1206) IRC LRC-LR1206LF-01-R100-F

COMPONENT	QTY	DESCRIPTION
R2	1	249k $\Omega$ $\pm 0.1\%$ resistor (0603)
R3	1	1k $\Omega$ $\pm 0.1\%$ resistor (0603)
R4	1	100k $\Omega$ $\pm 5\%$ resistor (0603)
R5, R6	2	1k $\Omega$ $\pm 5\%$ resistors (0603)
R7, R8, R9	0	Not installed, resistors—short PC trace (0603)
SHDN	1	Test point Keystone 5000
U1	1	High-side current-sense amplifier (10 $\mu$ MAX <sup>®</sup> ) Maxim MAX9922EUB+
—	3	Shunts
—	1	PCB: MAX9922/3 Evaluation Kit+

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## Component Suppliers

SUPPLIER	PHONE	WEBSITE
IRC, Inc.	361-992-7900	www.irctt.com
Keystone Electronics Corp.	209-796-2032	www.keyelco.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
TDK Corp.	847-803-6100	www.component.tdk.com

**Note:** Indicate that you are using the MAX9922 when contacting these component suppliers.

### Quick Start

#### Recommended Equipment

- 12V, 100mA power supply (VSOURCE)
- 3.3V power supply (VDD)
- Electronic load capable of sinking 100mA
- Digital voltmeter (DVM)

#### Procedure

The MAX9922 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution: Do not turn on power supplies until all connections are completed.**

- 1) Verify that all jumpers (JU1, JU2, and JU3) are in their default positions, as shown in Tables 1, 2, and 3.
- 2) Set the input power supply to 12V. Connect the ground of the power supply to the PGND pad, and connect the positive terminal to the VSOURCE pad.
- 3) Set the VDD power supply to 3.3V. Connect the ground of the VDD supply to the GND pad and connect the positive terminal to the VDD pad.
- 4) Set the electronic load to sink 100mA.
- 5) Connect the load's ground to the GND pad. Connect the electronic load's positive terminal to the LOAD pad.
- 6) Connect the DVM across the VOUT pad and the GND pad.
- 7) Turn on the 3.3V power supply.
- 8) Turn on the 12V power supply.
- 9) Adjust the electronic load current ( $I_{SENSE}$ ) between 0A and 100mA and verify that  $V_{OUT}$  is proportional to  $V_{SENSE}$  according to the following equation:

$$V_{OUT} = R_{SENSE} \times \left(1 + \frac{R_2}{R_3}\right) \times I_{SENSE} + V_{REF}$$

where  $R_{SENSE} = R_1$  and  $V_{REF} = V_{DD}/2$ .

### Detailed Description of Hardware

The MAX9922 EV kit is a current-sense amplifier that measures the load current and provides an analog voltage output. The EV kit comes assembled with the MAX9922 IC, which allows adjustable gain with a pair of external resistors ( $R_2$  and  $R_3$ ) between OUT, FB, and REF. The EV kit is configured for bidirectional current sensing. The output voltage ( $V_{OUT}$ ) is given by the following equation:

$$V_{OUT} = R_{SENSE} \times \left(1 + \frac{R_2}{R_3}\right) \times I_{SENSE} + V_{REF}$$

where  $R_{SENSE} = 0.1\Omega$ ,  $I_{SENSE}$  = load current, and  $V_{REF} = V_{DD}/2$ . For unidirectional operation, the output voltage ( $V_{OUT}$ ) is given by the following equation:

$$V_{OUT} = R_{SENSE} \times \left(1 + \frac{R_2}{R_3}\right) \times I_{SENSE}$$

#### Shutdown Input Control

The MAX9922 EV kit features 2-pin jumper JU1 to control the logic shutdown input. For normal operation, remove the shunt from jumper JU1 to drive  $\overline{SHDN}$  high. To place the device in shutdown mode, drive  $\overline{SHDN}$  low by placing a shunt across the JU1 pins. Table 1 summarizes jumper JU1's function.

**Table 1. Jumper JU1 Function ( $\overline{SHDN}$ )**

SHUNT POSITION	$\overline{SHDN}$ PIN	MODE
Installed	Connected to GND	Shutdown mode
Not installed*	Connected to VDD through pullup resistor R4	Normal operation

\*Default position.

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**Table 2. Jumper JU2 Function (REF)**

SHUNT POSITION	REF PIN	OPERATION
Installed	Connected to GND	Unidirectional
Not installed*	Set to $V_{DD}/2$	Bidirectional

\*Default position.

**Table 3. Jumper JU3 Function (RSB)**

SHUNT POSITION	RSB PIN	HIGH SIDE
1-2*	Connected to VSOURCE	VSOURCE
2-3	Connected to LOAD	LOAD

\*Default position.

### External Reference

The MAX9922 EV kit features 2-pin jumper JU2 to support both unidirectional and bidirectional operation. For unidirectional current-sense applications, connect the REF input to GND by placing a shunt across JU2. For bidirectional operation, connect REF to a reference voltage. By default, the EV kit provides a  $V_{DD}/2$  voltage-divider when the shunt on JU2 is not installed. In this mode,  $V_{OUT}$  equals  $V_{REF}$  when  $V_{SENSE}$  equals 0mV. Table 2 summarizes jumper JU2's function.

### Current-Sense Amplifier Supply Input

The MAX9922 EV kit features 3-pin jumper JU3 to select the current-sense amplifier voltage supply ( $V_{RSB}$ ) input. The  $V_{RSB}$  pad can be connected to either side of the current-sense resistor by changing the shunt position of JU3. Place a shunt across pins 1-2 if the VSOURCE pad is being used to power  $V_{RSB}$ . Place a shunt across pins 2-3 if the LOAD pad is being used to power  $V_{RSB}$ . Table 3 summarizes jumper JU3's function.

### Input Differential Signal Range

The MAX9922/MAX9923 feature a proprietary input structure optimized for small differential signals as low as 10mV full scale for high efficiency or 100mV full scale for high dynamic range. For best linearity and accuracy, do not exceed  $V_{SENSE}$  of  $\pm 150$ mV. With a  $0.1\Omega$  sense resistor installed, the EV kit is optimized for a 100mA full-scale load current and a 10mV full-scale sense voltage. For other load-current applications, choose the appropriate sense resistor according to the following equation:

$$R_{SENSE} = \frac{V_{SENSE\_FULL\_SCALE}}{I_{LOAD\_FULL\_SCALE}}$$

In applications monitoring a high current, ensure that  $R_{SENSE}$  is able to dissipate its own  $I^2R$  loss. If the resistor's power dissipation is exceeded, its value may drift, or fail altogether.

### Evaluating the MAX9923T/MAX9923H/MAX9923F

The MAX9922 EV kit can also be used to evaluate the MAX9923T/MAX9923H/MAX9923F ultra-precision, fixed-gain, high-side current-sense amplifiers. Leave the FB pin unconnected by uninstalling feedback resistors R2 and R3. Replace U1 with the MAX9923T, MAX9923H, or the MAX9923F. For bidirectional mode, the output voltage ( $V_{OUT}$ ) is given by the following equation:

$$V_{OUT} = A_V \times R_{SENSE} \times I_{SENSE} + V_{REF}$$

where  $R_{SENSE} = 0.1\Omega$ ,  $I_{SENSE}$  = load current,  $V_{REF} = V_{DD}/2$ , and  $A_V$  is the gain of the device. For unidirectional operation, the output voltage ( $V_{OUT}$ ) is given by the following equation:

$$V_{OUT} = A_V \times R_{SENSE} \times I_{SENSE}$$

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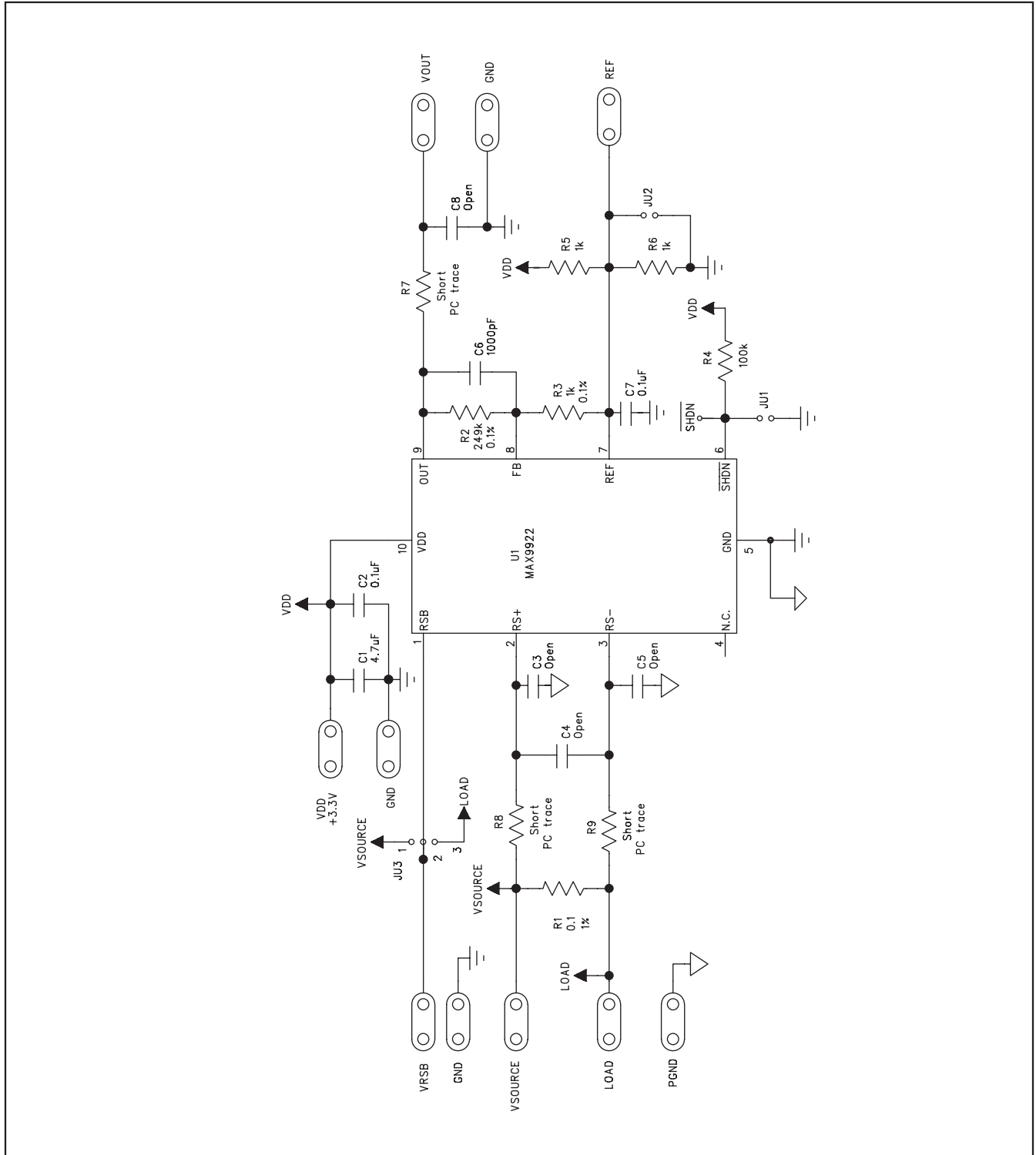


Figure 1. MAX9922 EV Kit Schematic

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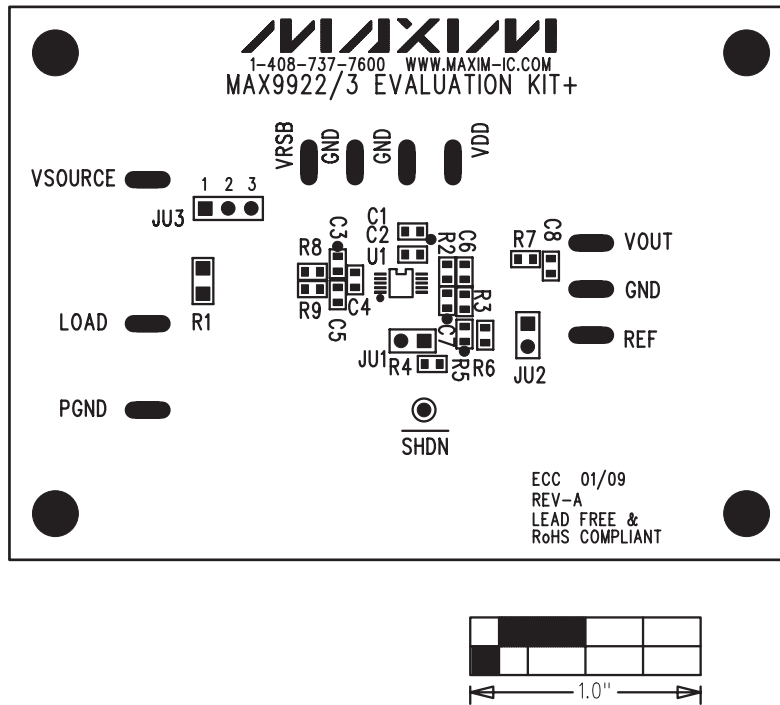


Figure 2. MAX9922 EV Kit Component Placement Guide—Component Side

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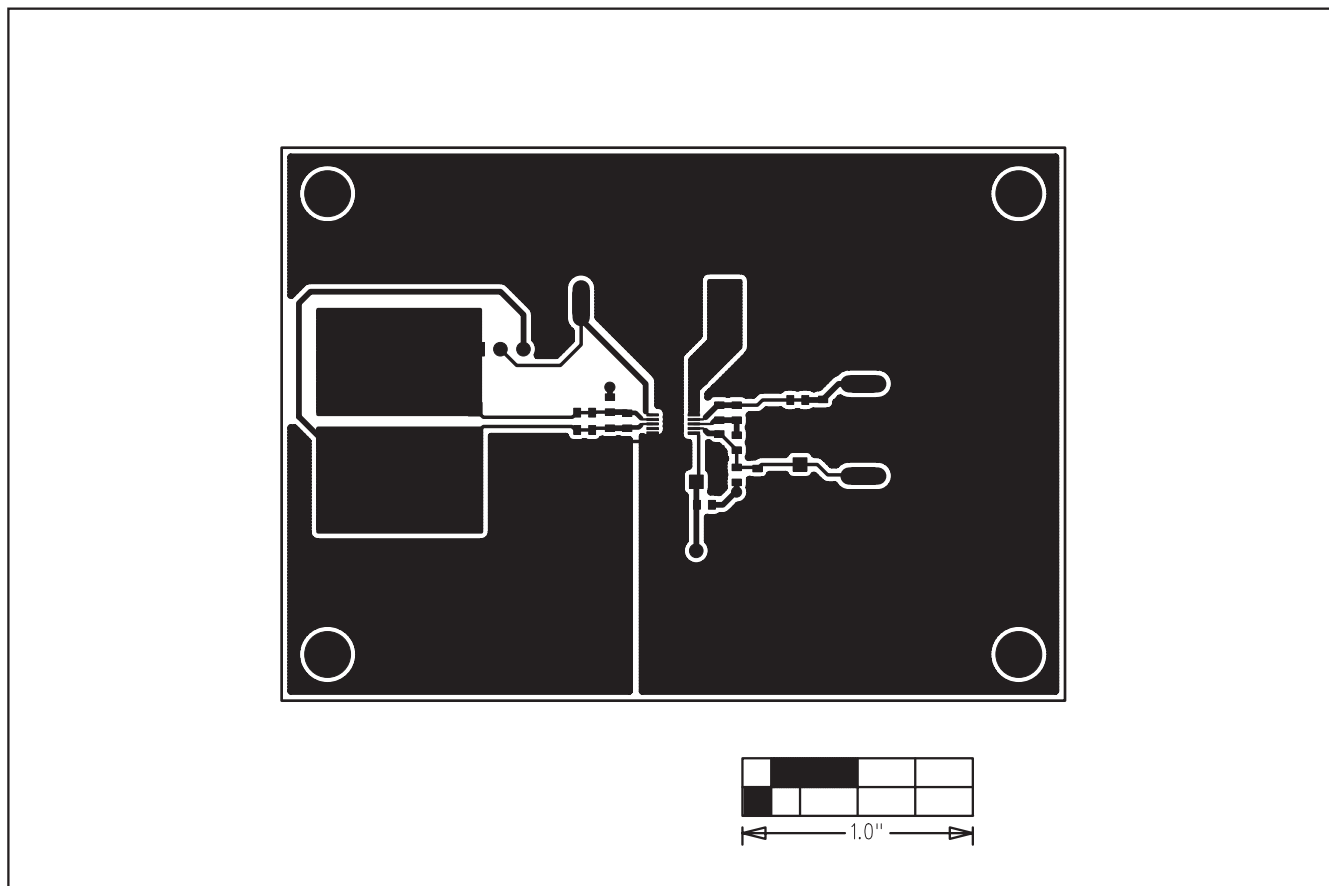


Figure 3. MAX9922 EV Kit Component PCB Layout—Component Side

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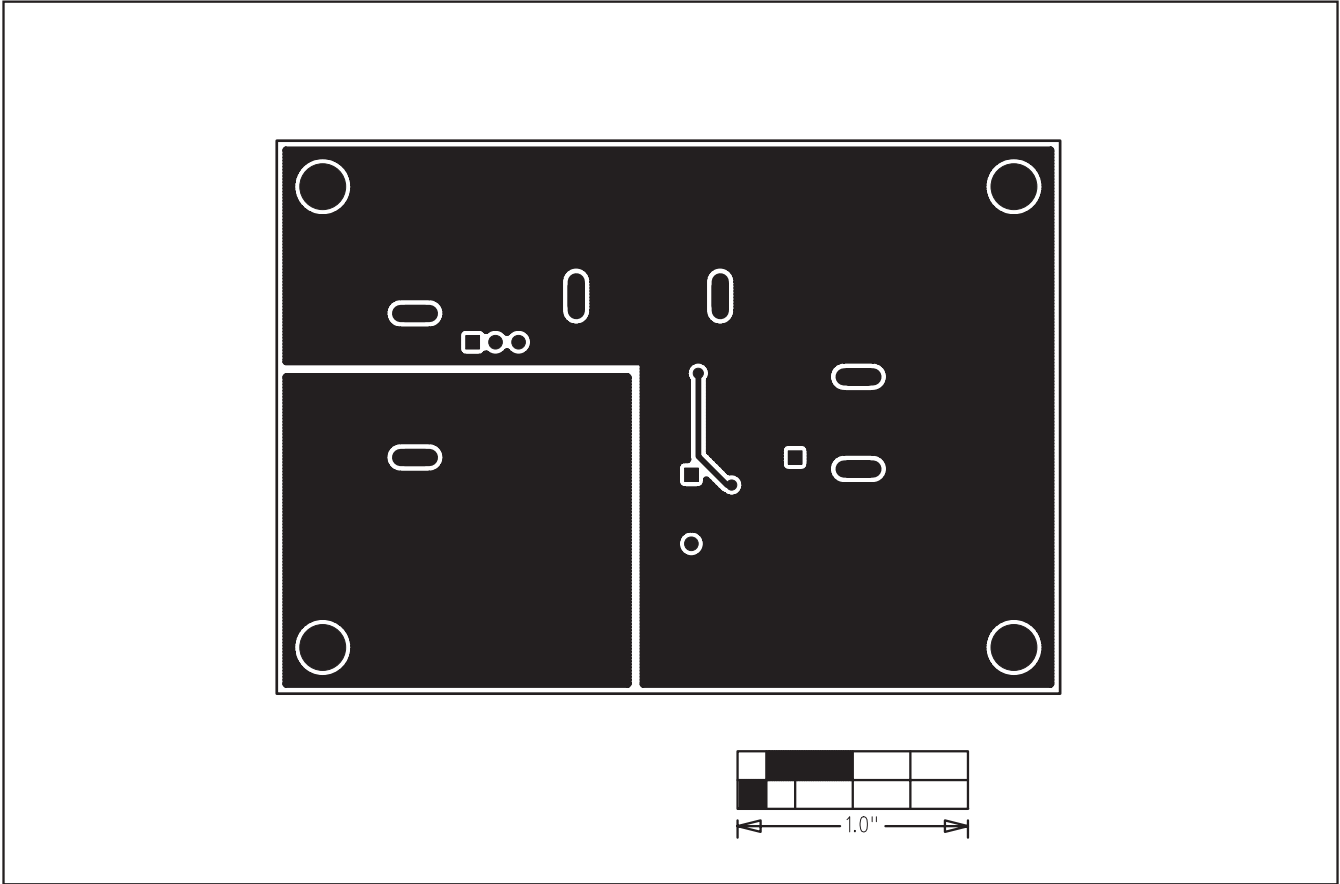


Figure 4. MAX9922 EV Kit PCB Layout—Solder Side

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**Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600** \_\_\_\_\_ **7**