19-2693; Rev 1; 1/04

MAX9982 Evaluation Kit

Evaluates: MAX9982

General Description

The MAX9982 evaluation kit (EV kit) simplifies the evaluation of the MAX9982 825MHz to 915MHz high-linearity active down-converter mixer. It is fully assembled and tested at the factory. Standard 50Ω SMA connectors are included on the EV kit for the inputs and outputs to allow quick and easy evaluation on the test bench.

This document provides a list of equipment required to evaluate the device, a straightforward test procedure to verify functionality, a description of the EV kit circuit, the circuit schematic, a bill of materials (BOM) for the kit, and artwork for each layer of the PC board.

Contact MaximDirect sales at 888-629-4642 to check on pricing and availability for these kits.

Features

- ♦ **Fully Assembled and Tested**
- ♦ **+26.8dBm Input IP3**
- ♦ **+13dBm Input 1dB Compression Point**
- ♦ **825MHz to 915MHz RF Frequency**
- ♦ **725MHz to 1085MHz LO Frequency**
- ♦ **70MHz to 170MHz IF Frequency**
- ♦ **2dB Conversion Gain**
- ♦ **12dB Noise Figure**
- ♦ **-5dBm to +5dBm LO Drive**
- ♦ **Built-In LO Switch with 43dB LO1-to-LO2 Isolation**

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Coilcraft	800-322-2645	www.coilcraft.com
Digi-Key	800-344-4539	www.digikey.com
Johnson	507-833-8822	www.johnsoncomponents.com
Mini-Circuits	718-934-4500	www.minicircuits.com
Murata	770-436-1300	www.murata.com

Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX9982EVKIT	-40°C to +85°C	Thin QFN 20-EP* (5mm × 5mm)

*EP = Exposed paddle.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C6, C7	4	33pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H330J
C3	1	0.033µF ±10%, 25V X7R ceramic capacitor (0603) Murata GRM188R71E333K
C4, C5	2	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K
C8, C11	2	220pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H221J
C9, C10	2	330pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H331J
L1, L2	2	560nH ±5% wire-wound inductors (1008) Coilcraft 1008CS-561XJBC

DESIGNATION	QTY	DESCRIPTION
R1	1	249Ω ±1% resistor (0603)
R3, R4	1	137Ω ±1% resistors (0603)
R5	1	47kΩ ±5% resistor (0603)
J1–J4	4	PC board edge-mount SMA RF connectors (flat tab launch) Johnson 142-0741-856
T1	1	4:1 transformer (200:50) Mini-Circuits TC4-1W-7A
TP1	1	Large test point for 0.062in PC board (red) Mouser 151-107
TP2	1	Large test point for 0.062in PC board (black) Mouser 151-103
TP3	1	Large test point for 0.062in PC board (white) Mouser 151-101
U1	1	MAX9982ETP-T*

The exposed paddle conductor on U1 must be solder attached to a grounded pad on the circuit board to ensure a proper electrical/thermal design.

Quick Start

The MAX9982 EV kit is fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation.

Test Equipment Required

Table 1 lists the equipment required to verify the operation of the MAX9982 EV kit. It is intended as a guide only, and some substitutions can be made.

Connections and Setup

This section provides a step-by-step guide for testing the basic functionality of the EV kit. As a general precaution to prevent damaging the outputs by driving high-VSWR loads, **do not turn on DC power or RF signals until all connections are made.**

This procedure is specific to operation with an RF input-frequency range of 825MHz to 915MHz, low-side injected LO for a 100MHz IF. Choose the test frequency based on the particular system's frequency plan, and adjust the following procedure accordingly. See Figure 1 for the mixer test setup diagram.

1) Calibrate the power meter for 870MHz. For safety margin, use a power sensor rated to at least +20dBm, or use padding to protect the power head as necessary.
2) Connect 3dB pads to DUT ends of each of the three RF signal generators' SMA cables. This padding improves VSWR and reduces the errors because of mismatch.
3) Use the power meter to set the RF signal generators according to the following:
   - RF signal source: -5dBm into DUT at 870MHz (approximately -2dBm before the 3dB pad)
   - LO1 signal source: 0dBm into DUT at 770MHz (approximately +3dBm before the 3dB pad)
   - LO2 signal source: 0dBm into DUT at 771MHz (approximately +3dBm before the 3dB pad)
4) Disable the signal generator outputs.
5) Connect the RF source (with pad) to RF IN.
6) Connect the LO1 and LO2 signal sources to the EV kit LO inputs.
7) Measure loss in the 3dB pad and the cable that is connected to IF OUT. Losses are frequency dependent, so test this at 100MHz (the IF frequency). Use this loss as an offset in all output power/gain calculations.

Table 1. Test Equipment

EQUIPMENT	QTY	DESCRIPTION
HP E3631A	1	DC power supply
Fluke 75 series II	1	Digital multimeter (ammeter)
HP/Agilent 8648B	3	RF signal generators
HP 437B	1	RF power meter
HP 8561	1	Spectrum analyzer
HP 8482A	1	High-power sensor (power head)
3dB pad	4	3dB attenuators

8) Connect this 3dB pad to the EV kit's IF OUT connector, and connect a cable from the pad to the spectrum analyzer.
9) Set the DC supply to +5.0V, and set a current limit of approximately 250mA if possible. Disable the output voltage and connect supply to the EV kit through a low internal resistance ammeter. Enable the supply. Re-adjust the supply to get +5.0V at the EV kit because there will be a voltage drop across the ammeter when the mixer is drawing current.
10) Select LO1 by leaving LO_SEL (TP3) unconnected or connecting it to +5V. If left floating, LO_SEL pulls high by an on-board pullup resistor.
11) Enable the LO and the RF sources.

Testing the Mixer

Adjust the center and span of the spectrum analyzer to observe the IF output tone at 100MHz. The level should be at approximately -5.4dBm (2.6dB conversion gain, 3dB pad loss). The spectrum analyzer's absolute magnitude accuracy is typically no better than ±1dB; therefore, use the power meter to get an accurate output power measurement. There will also be a tone at 99MHz, which is due to the LO signal applied to LO2. The amount of suppression between the 100MHz and 99MHz signals is the switch isolation.

Connect LO_SEL to GND to select LO2. Observe that the IF output level at 99MHz increases while the 100MHz level decreases.

Detailed Description

The MAX9982 is a highly integrated downconverter. RF and LO baluns are integrated on-chip, as well as an LO buffer and a SPDT LO input select switch. The EV kit circuit consists mostly of supply decoupling capacitors and DC-blocking capacitors, allowing for a simple design-in.

Supply Decoupling Capacitors

Ceramic capacitors C4 and C5 are 0.1µF used for filtering lower frequency noise on the supply. C8 is a 220pF bypass capacitor for IF frequencies. C11 is used to provide an IF ground for the center tap of T1. Although called out, replacing C11 with a short circuit causes little to no change in performance.

DC-Blocking Capacitors

The MAX9982 has internal baluns on the RF, LO1, and LO2 inputs. These inputs have almost 0Ω resistance at DC; therefore, 33pF DC-blocking capacitors C1, C6, and C7 are used to prevent any external bias from being shunted directly to ground. C9 and C10 are used to block DC current from flowing into the transformer along with providing the flexibility for matching.

RFBIAS

Bias current for the mixer is set with resistor R1 (249Ω, ±1%). This value was carefully chosen for best linearity and lowest supply current through testing at the factory. Changing this value, or using lower tolerance resistors, degrades performance.

IF±

The MAX9982 employs a differential IF output to offer increased IP2 system performance. The IF outputs look like an open collector with 1.8pF of differential capacitance. Inductors L1 and L2 are used to resonate out the on-chip and evaluation board capacitance at the IF frequency of interest along with providing a low resistance path for biasing of the IF amplifier. R3 and R4 provide a real impedance used to establish the 200Ω differential impedance. C9 and C10 provide DC blocking along with adding in the flexibility for tuning. The 4:1 balun (T1) transforms the 200Ω differential impedance to 50Ω single ended for ease of measurement. The EV kit IF is matched for operation over the 70MHz to 100MHz frequency range.

Resistors R3 and R4 affect the gain of the mixer. For a typical 2.0dB gain, 137Ω resistors are used for R3 and R4. Higher mixer gain can be realized by increasing R3 and R4 and returning L1, L2, C9, and C10 for IF impedance matching. For example, R3 = R4 = 250Ω, L1 = L2 = 330nH, C9 = C10 = 56pF yields a mixer gain of 4.5dB at 70MHz IF with an IF return loss of 12dB.

As the differential IF outputs are relatively high impedance (200Ω), they are more susceptible to component parasitics. Relieve the ground plane directly underneath large components to reduce associated shunt-C parasitics.

LO_SEL

The EV kit includes a 47kΩ pullup resistor for easy selection of the LO port. Providing a ground at TP3 selects LO2, and leaving TP3 open selects LO1. To drive TP3 from an external source, follow the limits called out in the MAX9982 data sheet. Logic voltages should not be applied to TP3 without the +5V applied. Doing so can cause the on-chip ESD diodes to conduct and could damage the part.

Modifying the EV Kit

The RF and LO inputs are broadband matched, so there is no need to modify the circuit for use anywhere in the 825MHz to 915MHz RF range (725MHz to 1085MHz LO range).

Retuning for a different IF is as simple as scaling the values of the IF pullup inductors up or down with frequency. The IF outputs look like an open collector with 3.6pF to ground (1.8pF differential) from the chip. This capacitance, along with approximately 5.6pF from the evaluation board can be resonated out at the frequency of interest by proper selection of the bias inductor (L1, L2). To determine the inductor value use the following equation:

$$f_{IF} = \frac{1}{2\pi\sqrt{L \times C}}$$

The IF output network is tuned for operation at approximately 70MHz, so a 560nH inductor is used. For lower IF frequencies (i.e., larger component values), maintain the component's Q value at the cost of a larger case size unless it is unavoidable.

Layout Considerations

The MAX9982 evaluation board can be a guide for your board layout. Pay close attention to thermal design and close placement of parts to the IC. The MAX9982 package exposed paddle (EP), conducts heat from the part and provides a low-impedance electrical connection. The EP must be attached to the PC board ground plane with a low thermal and electrical impedance contact. Ideally, this can be achieved by soldering the backside package contact directly to a top metal ground plane on the PC board. Alternatively, the EP can be connected to a ground plane using an array of plated vias directly below the EP. The MAX9982 EV kit uses nine equally spaced, 0.016in-diameter, plated through holes to connect the EP to the lower ground planes.

Depending on the ground plane spacing, large surface-mount pads in the IF path may need to have the ground plane relieved under them to reduce shunt capacitance.

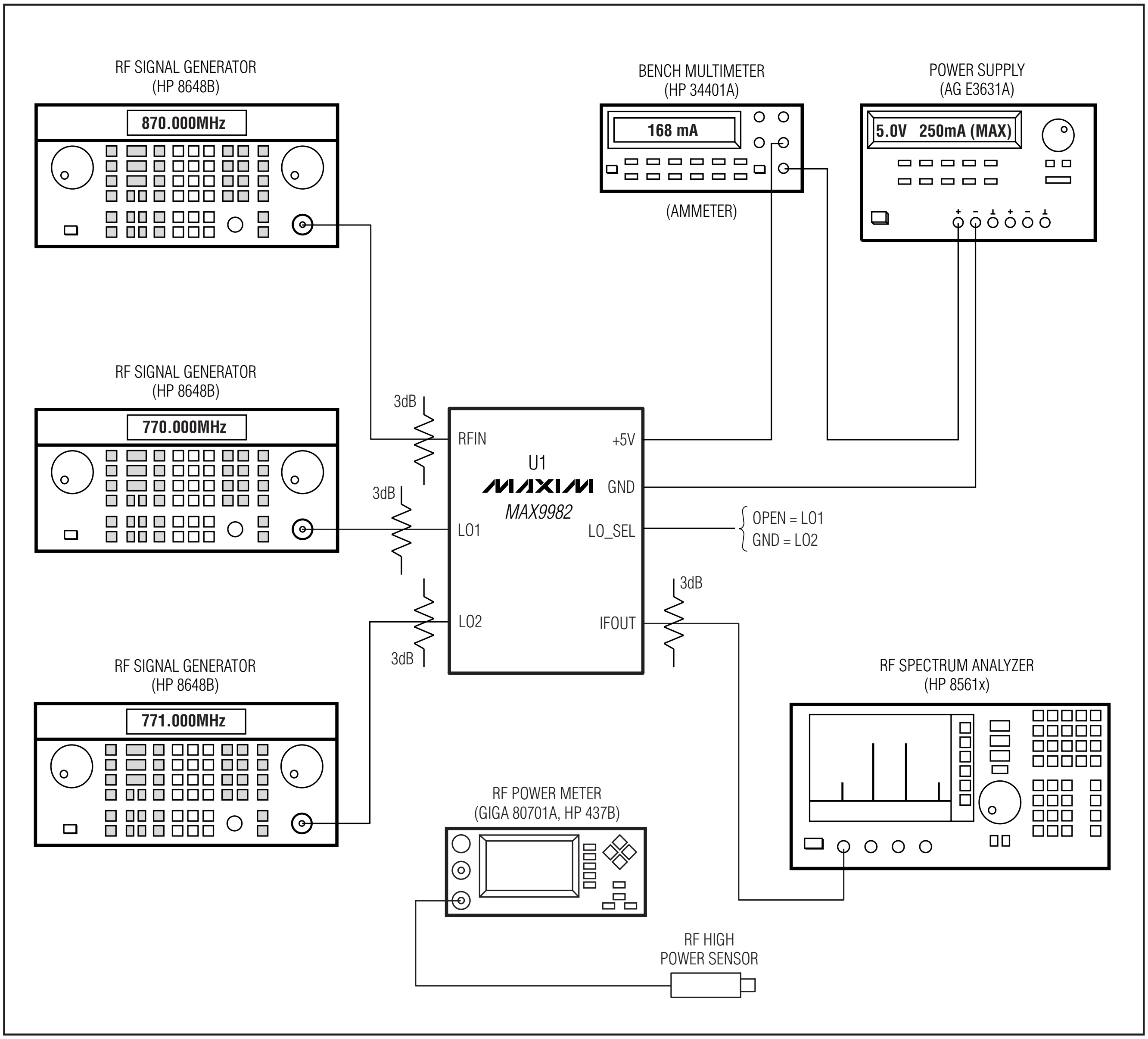

Figure 1. Test Setup Diagram

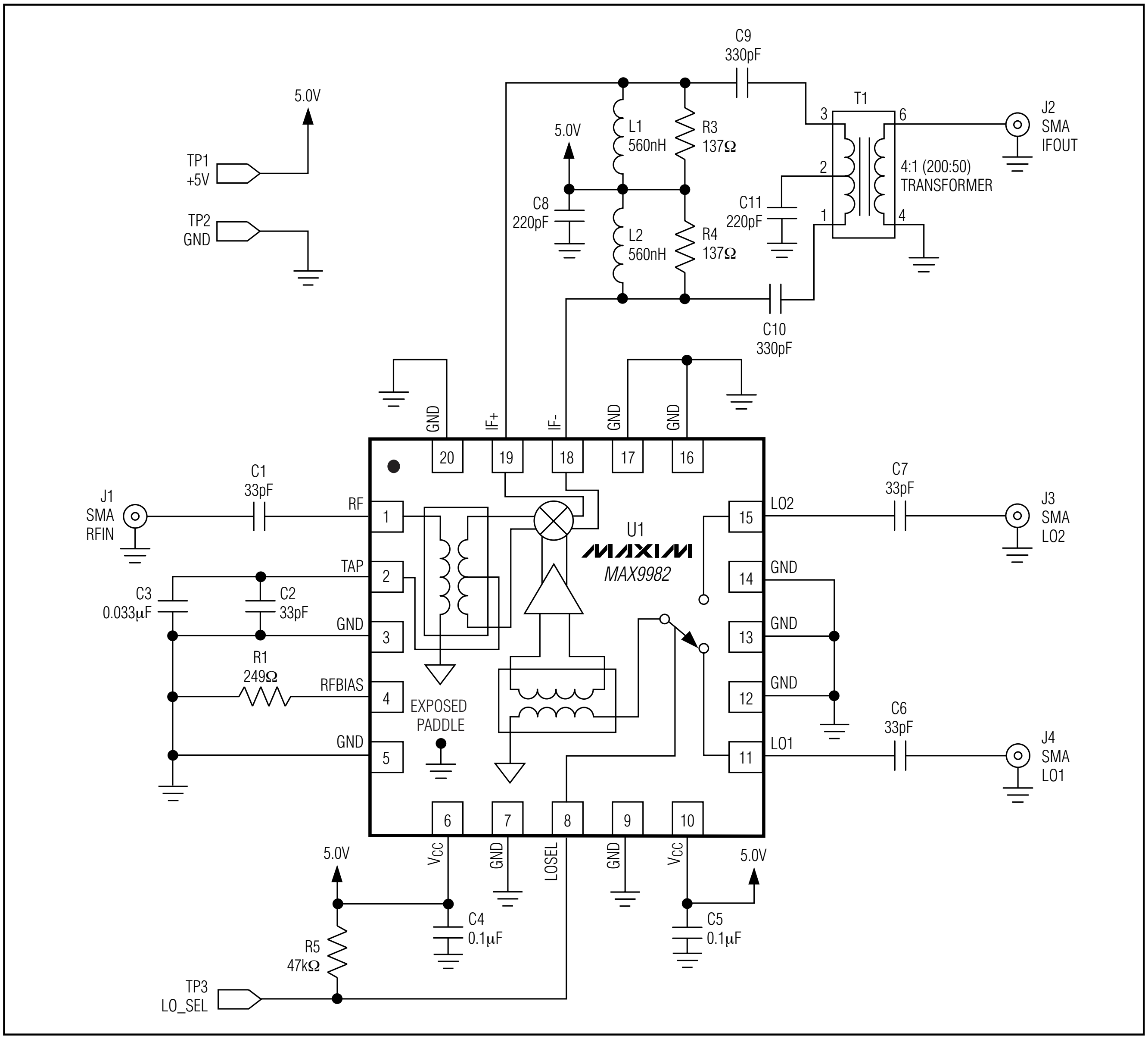

Figure 2. MAX9982 EV Kit Schematic

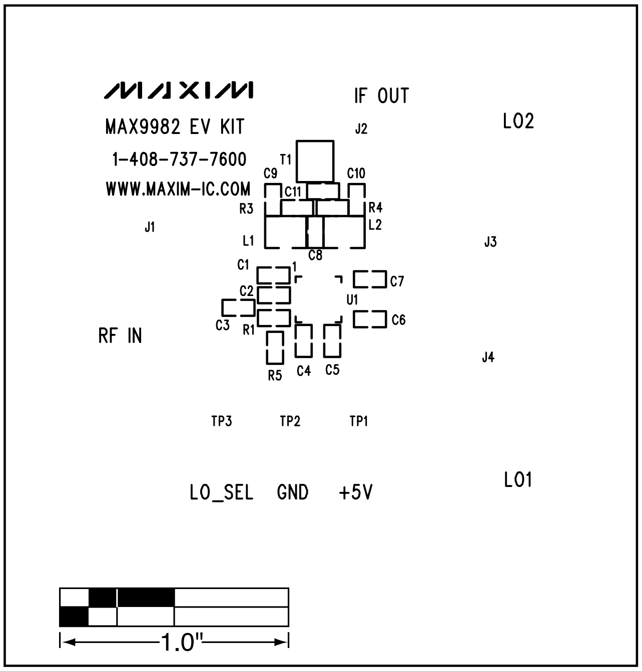

Figure 3. MAX9982 EV Kit PC Board Layout—Top Silkscreen

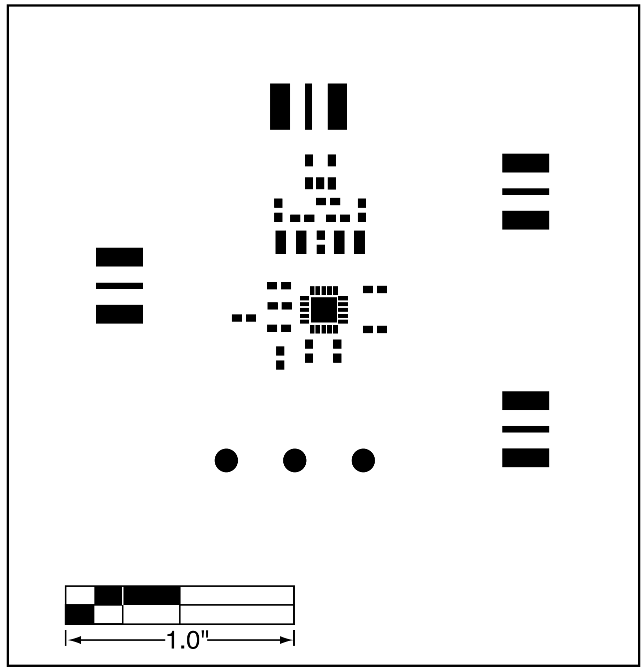

Figure 4. MAX9982 EV Kit PC Board Layout—Top Soldermask

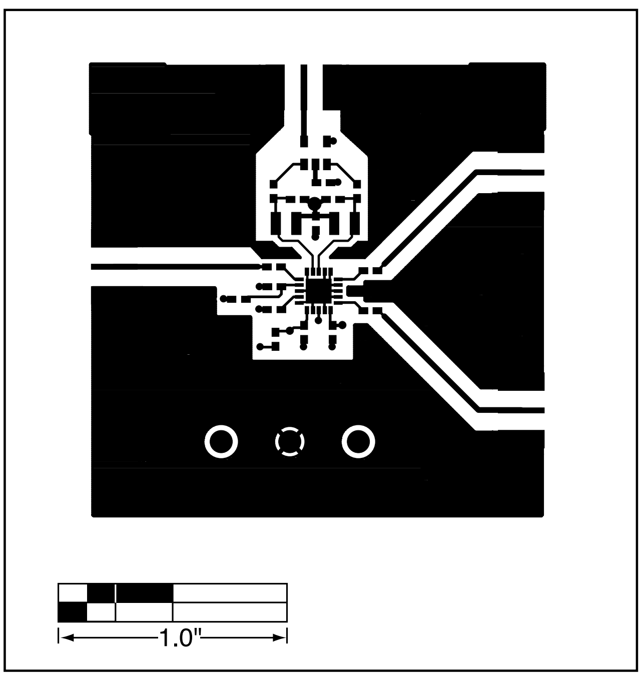

Figure 5. MAX9982 EV Kit PC Board Layout—Top Layer Metal

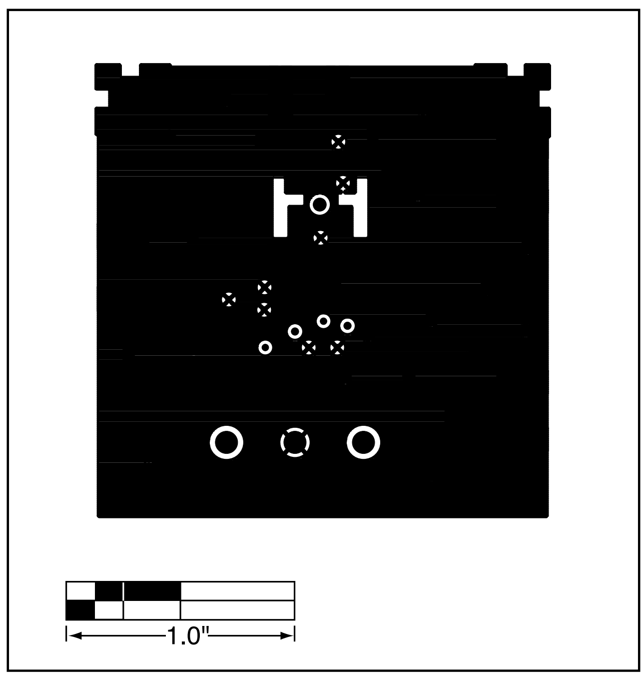

Figure 6. MAX9982 EV Kit PC Board Layout—Inner Layer 2 (GND)

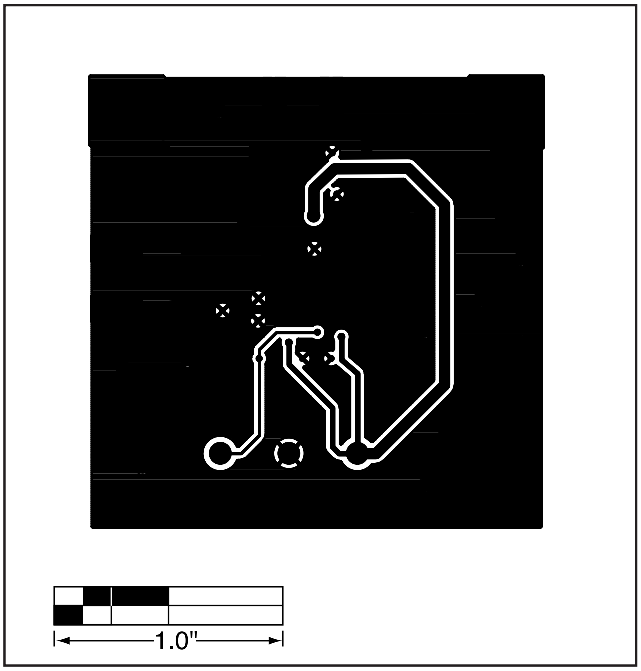

Figure 7. MAX9982 EV Kit PC Board Layout—Inner Layer 3 (Routes)

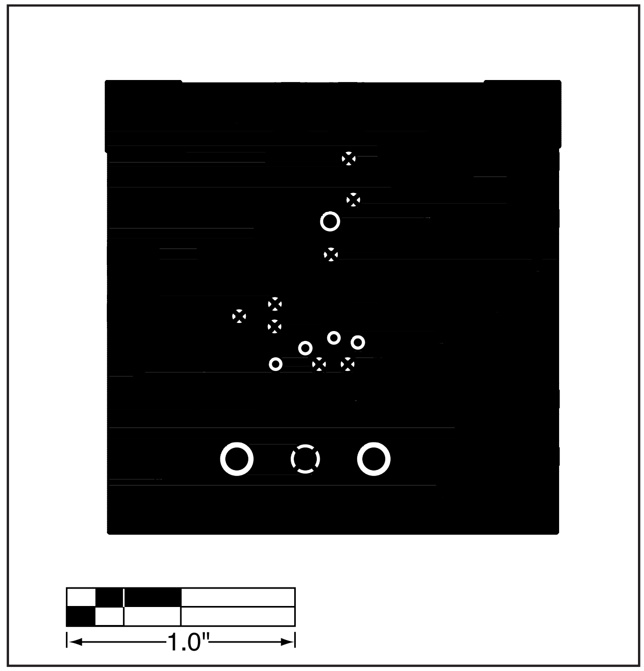

Figure 8. MAX9982 EV Kit PC Board Layout—Bottom Layer Metal

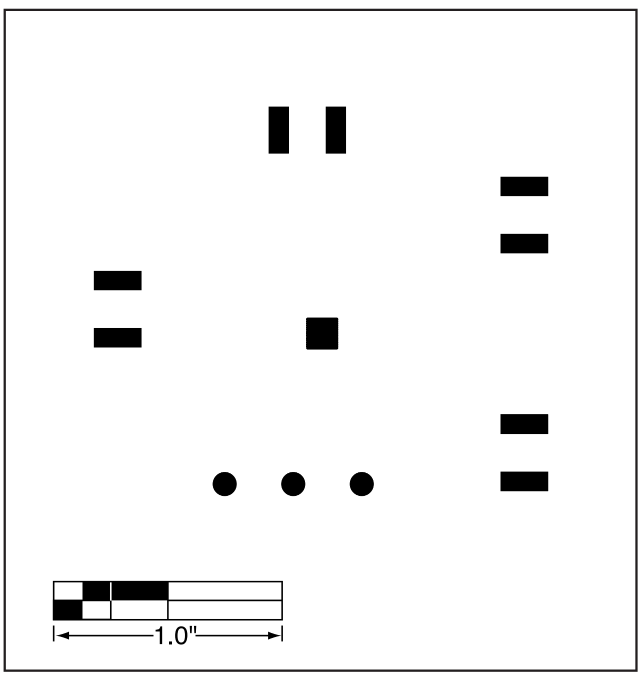

Figure 9. MAX9982 EV Kit PC Board Layout—Bottom Soldermask

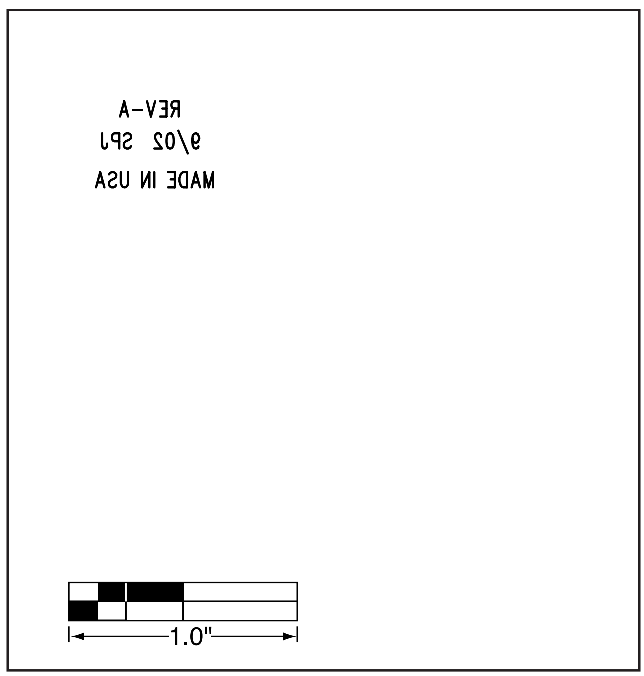

Figure 10. MAX9982 EV Kit PC Board Layout—Bottom Silkscreen