19-1256; Rev 2; 10/98

MAX2102 Evaluation Kit

Evaluates: MAX2102

General Description

The MAX2102 evaluation kit (EV kit) simplifies evaluation of the MAX2102 direct-conversion tuner IC for digital DBS applications.

The board includes RF and LO inputs and I/Q baseband-output connectors, for fast evaluation in a 50Ω environment. The RF and LO input frequency range is 950MHz to 2150MHz. A probe-tip jack is available to examine the prescaler output with a high-impedance probe.

Component Suppliers

SUPPLIER	PHONE	FAX
AVX	(803) 946-0690	(803) 626-3123
Panasonic	(201) 392-7522	(201) 392-4441

Features

- ♦ **Simple RF Test Board Offers 50Ω Test Ports for RF and LO Inputs and Baseband Outputs**
- ♦ **Direct-Conversion Signal Tuning from 950MHz to 2150MHz, to I/Q Baseband**
- ♦ **Input Levels: -69dBm to -19dBm per Carrier**
- ♦ **Allows Testing of 50dB Automatic Gain-Control Range**
- ♦ **Permits Observation of Dual-Modulus Prescaler Output**
- ♦ **Fully Assembled and Tested**

Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX2102EVKIT-SO	0°C to +70°C	Surface Mount

Component List

DESIGNATION	QTY	DESCRIPTION
B1–B5	5	Surface-mount bead cores Panasonic EXC-CL3216U
C1, C9	2	47µF, 10V, ±20% electrolytic capacitors Panasonic ECE-V1AA470P
C2, C3, C8, C11	4	0.1µF, 50V (min), 10% ceramic capacitors
C4–C7, C14, C15	6	22pF, 50V (min), 10% ceramic capacitors
C10, C12	2	10pF, 50V (min), 10% ceramic capacitors
C13, C16	2	10pF, 50V (min), 10% ceramic capacitors
C17, C19, C21, C22	4	1000pF, 50V (min), 10% ceramic capacitors
C20	1	10µF, 16V, ±20% tantalum capacitor AVX TAJC106M106
C26, C27	2	0.22µF, 50V (min), 10% ceramic capacitors
J1, J3	2	BNC connectors

DESIGNATION	QTY	DESCRIPTION
J2, J4, J5	3	Edge-mount SMA connectors
J6	1	Scope-probe connector
JU2, JU3	2	3-pin headers (0.1" centers)
		Shunts
R1, R7	2	47Ω, 5% resistors
R3, R13	2	Open
R4, R16	2	51Ω, 5% resistors
R6	1	2kΩ, 5% resistor
R8, R10	2	22Ω, 5% resistors
R11, R12	2	56Ω, 5% resistors
R15	1	100Ω, 5% resistor
R17	1	4.7Ω, 5% resistor
U1	1	Maxim MAX2102CWI (28-pin SO)
None	1	MAX2102 circuit board
None	1	MAX2102 data sheet

Test Equipment Required

- RF-signal generator to generate the RF-carrier signals, with 950MHz to 2150MHz frequency range and -69dBm to -19dBm power range.
- RF-signal generator to generate the LO signal, with 950MHz to 2150MHz frequency range at -10dBm.
- (Optional) RF balun, such as Anzac H-9, if testing the MAX2102 with a differential LO drive.
- Dual-channel digitizing oscilloscope with 50Ω terminated inputs and 100MHz minimum bandwidth for time-domain baseband measurements. In addition, a high-frequency, high-impedance probe is required if monitoring the prescaler.
- Network/spectrum analyzer capable of measuring 30kHz to 100MHz signals for frequency-domain baseband measurements.
- +5V power supply that can deliver a minimum of 300mA.
- Adjustable voltage source that can supply a 1V to 4V range and source and sink 500µA for automatic gain control (AGC).

Connections and Setup

Ensure that the RF signal generators are disabled, and that the power supplies are off until all connections are made.

1) Connect the +5V power supply to J7 (“VCC”). Connect ground to J8 (“GND”).
2) Ensure that there are no shunts installed at JU2 or JU3.
3) Connect the variable voltage source to the pad labeled “AGC.” Ensure that the voltage source’s ground is connected to J8.
4) Connect an SMA cable from the LO signal-generator source to SMA connector J4 (LO) on the board. A 6dB attenuator connected in-line between J4 and the cable is recommended to minimize reflections that could affect power-level control on some signal generators. See the section *Using a Differential Oscillator Source* for information on driving the LO port differentially.
5) Connect an SMA cable from the RF-carrier signal-generator source to SMA connector J2 (RFIN). A 6dB pad between J2 and the cable is recommended.
6) Connect two cables of equal length from the dual-channel oscilloscope inputs to BNC connectors J1 and J3 (“IOUT,” “QOUT”). Ensure that the oscilloscope inputs are 50Ω.
7) Set up the instruments:
   —Set the RF-carrier signal source to deliver 950MHz at -30dBm at RFIN. Be sure to account for attenuator and cable losses.
   —Set the LO signal source to deliver 950.125MHz at -10dBm at LO. Be sure to account for attenuator and cable losses.
   —Set up the oscilloscope to view a 125kHz sine wave at 0.5Vp-p full scale, triggered from either the “IOUT” or “QOUT” signal.
8) Turn on the power supplies and enable the signal generators.
9) Adjust the AGC control voltage until the IOUT and QOUT signals are approximately 0.25Vp-p.

Analysis

AGC

Vary the RF-carrier signal-generator power over the -19dBm to -69dBm range. Use the AGC voltage control (in a 1V to 4V range) to keep the IOUT and QOUT signals in the 0.25Vp-p range.

Note (from the EV kit schematic) that the board includes 47Ω resistors (R1, R7) in series with the baseband IOUT and QOUT outputs, which results in a 6dB attenuation with the cable terminated to 50Ω at the oscilloscope. The actual voltage swing per carrier is 0.5Vp-p at the MAX2102’s IOUT and QOUT pins.

Vary the LO and RFIN frequency over the 950MHz to 2150MHz range, maintaining 125kHz between RFIN and LO. Observe that over 50dB, AGC range is maintained across the frequency band.

Quadrature Accuracy

The difference in phase between the IOUT and QOUT baseband signals should be 90°, with Q lagging I if the LO frequency is greater than the RFIN frequency.

Using both the oscilloscope’s DELAY measurement function and averaging, determine the quadrature phase mismatch (deviation from 90°).

The baseband frequency is 125kHz. At higher baseband frequencies, the delay between IOUT and QOUT becomes more difficult to measure accurately. Additionally, phase error due to small differences in group delay in IOUT and QOUT measurement channels becomes more pronounced. Therefore, low baseband frequencies are suggested when making this measurement.

The quadrature amplitude mismatch is:

$$\text{Amplitude mismatch} = 20\log (A_I / A_Q)$$

where A_I = IOUT signal amplitude, and A_Q = QOUT signal amplitude.

Vary the LO and RFIN frequency over the 950MHz to 2150MHz range, maintaining 125kHz between RFIN and LO. Observe that the quadrature phase and gain mismatch remains within the specifications across the band.

Adjustments and Control

Prescaler

Jumper JU2 controls prescaler enabling and disabling. The prescaler on the MAX2102 EV kit is configured to be disabled as shipped. In this configuration, there is no short installed on JU2. To enable the prescaler, install a short in the “PSON” position. This connects pin 25 on the MAX2102 to GND.

JU3 controls the prescaler divider ratio (modulus). Install a short in the “DIV65” position for divide-by-65 mode, or in the “DIV64” position for divide-by-64 mode. For external control of the prescaler modulus (for example, from an external synthesizer), drive JU3’s center connector directly.

Using a Differential Oscillator Source

To use a differential LO source, do the following:

1) Remove R16.
2) Install J5 (SMA connector), if not already populated.
3) Connect the RF balun so that LO and $\overline{\text{LO}}$ are driven by complementary signals. Drive the balun input from the LO signal source. Ensure that any unused ports on the balun are terminated with 50Ω terminators.

   A 6dB attenuator connected in-line between the LO and $\overline{\text{LO}}$ ports and the balun is recommended to minimize reflections, which may affect balun and signal-generator performance.
4) Drive the balun with sufficient power to drive LO and $\overline{\text{LO}}$ with -10dBm each. Be sure to account for losses in the balun, cables, and attenuators.

Interface to MAX1002/MAX1003 A/D Converters

The MAX2102 EV kit can easily be interfaced to the MAX1002/MAX1003 EV kit, allowing evaluation of the MAX2102 in the digital domain. The MAX1002/MAX1003 are low-cost, dual, 60Msps/90Msps analog-to-digital converters for DBS applications.

For most applications, an anti-aliasing lowpass filter is inserted in the signal path between IOUT (MAX2102 EV kit) and IIN+ (MAX1002/MAX1003 EV kit), and another equivalent filter is inserted between QOUT and QIN+. Refer to the MAX2102/MAX2105 data sheet for details on this filter.

Using 50Ω filters with BNC connectors is a simple way to implement the necessary filtering.

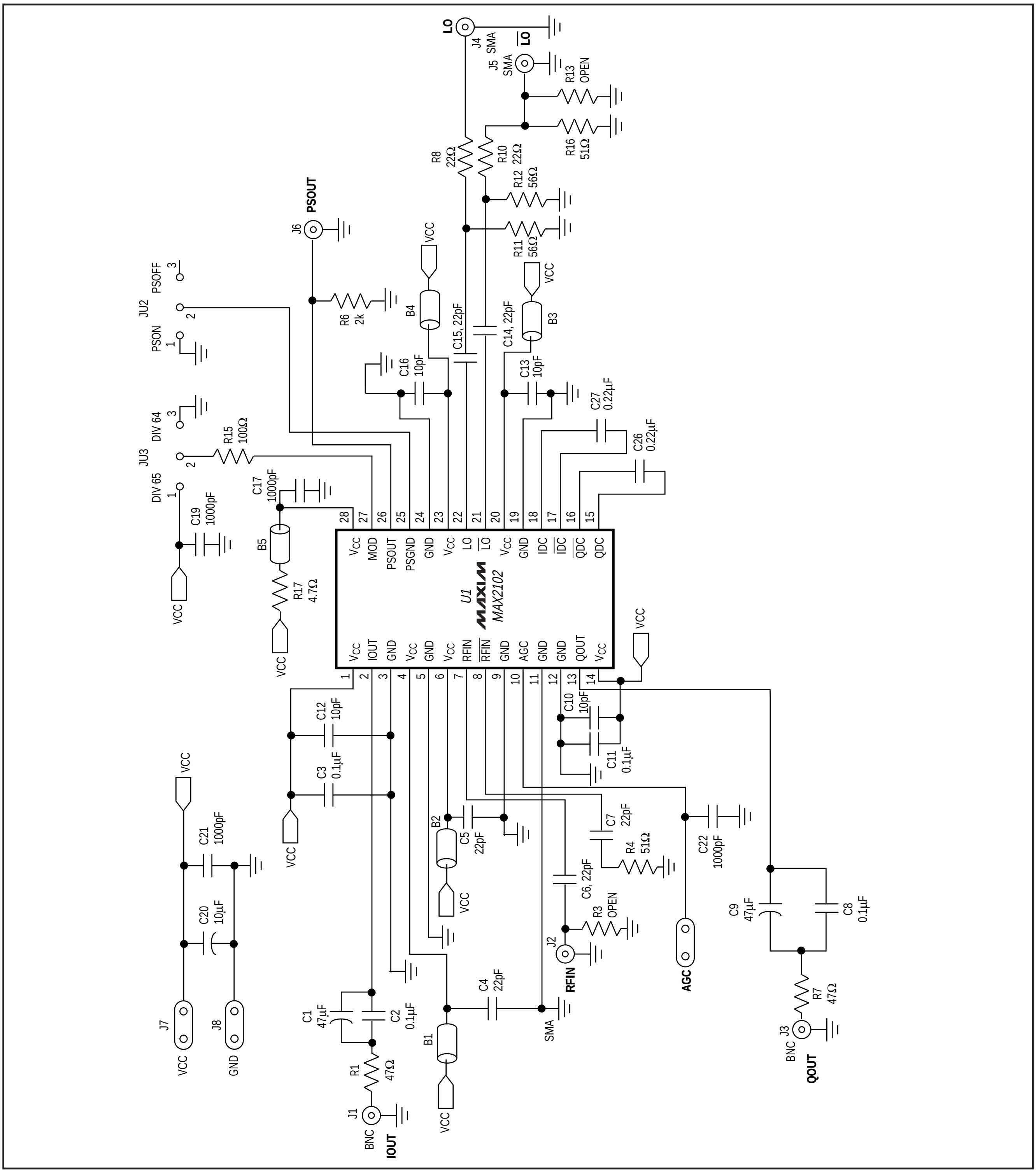

Figure 1. MAX2102 EV Kit Schematic

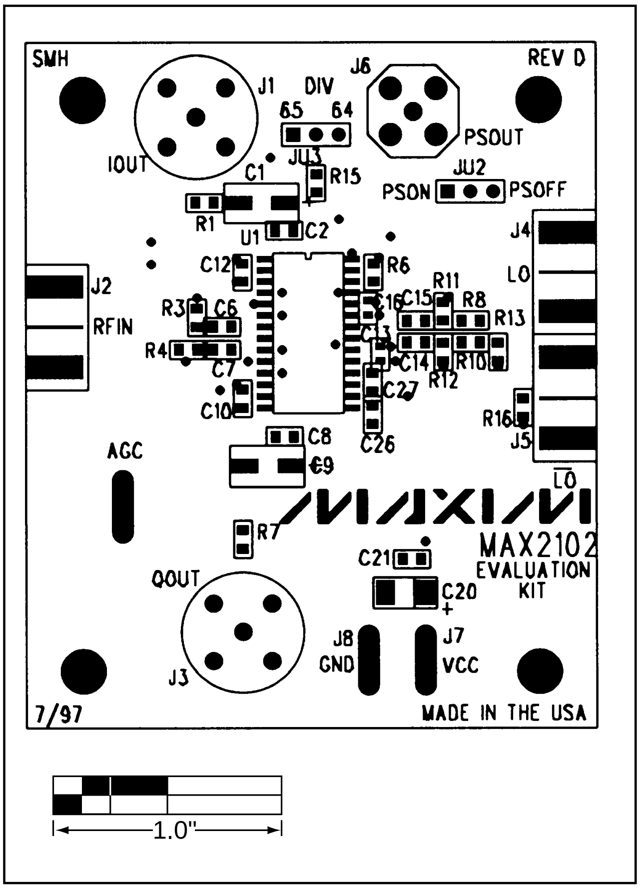

Figure 2. MAX2102 EV Kit Component Placement Guide—Component Side

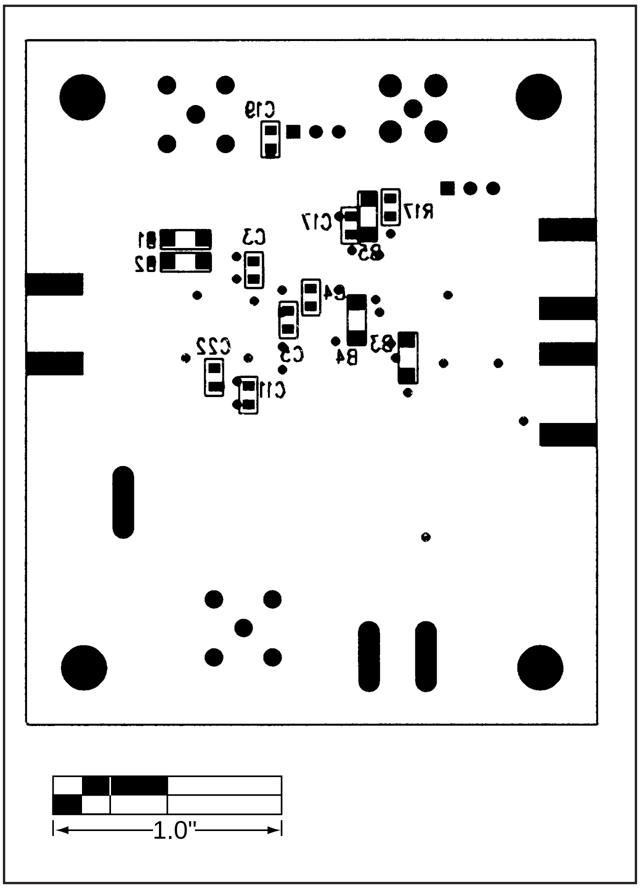

Figure 3. MAX2102 EV Kit Component Placement Guide—Solder Side

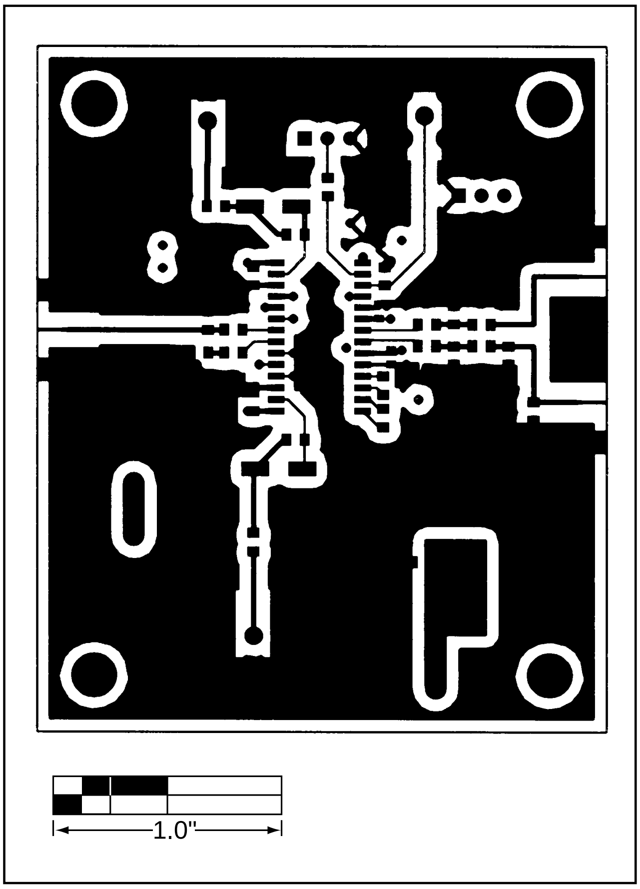

Figure 4. MAX2102 EV Kit PC Board Layout—Component Side

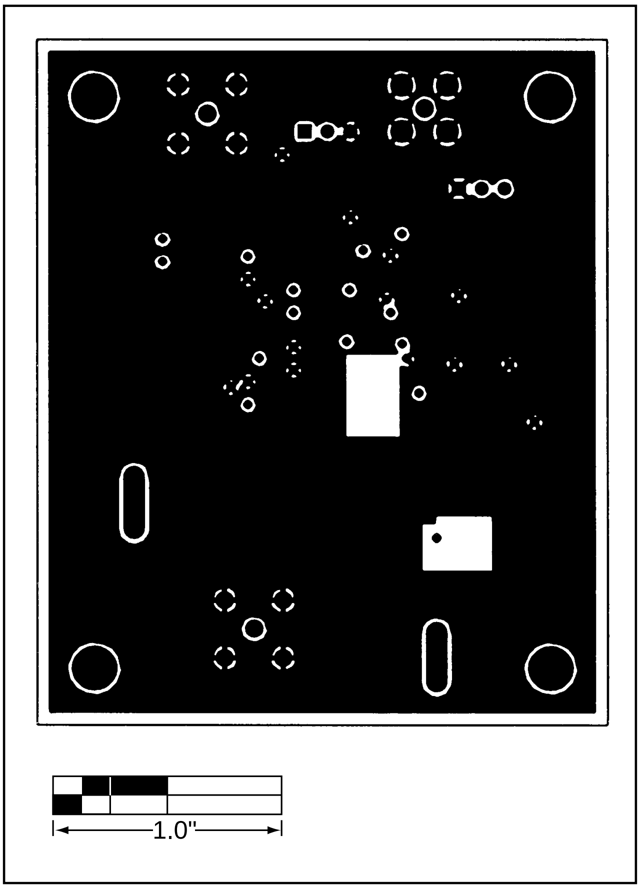

Figure 5. MAX2102 EV Kit PC Board Layout—Ground Plane

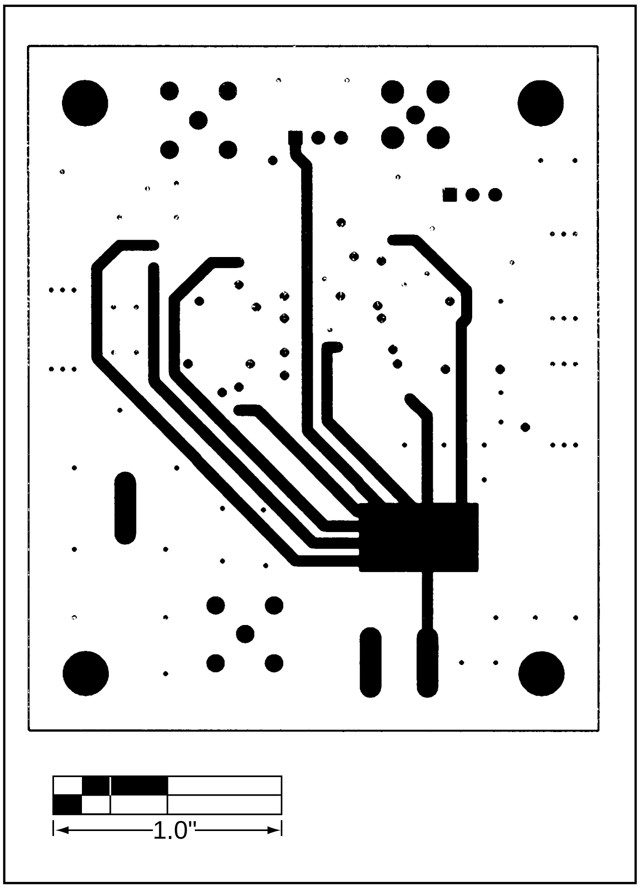

Figure 6. MAX2102 EV Kit PC Board Layout—Power Layer

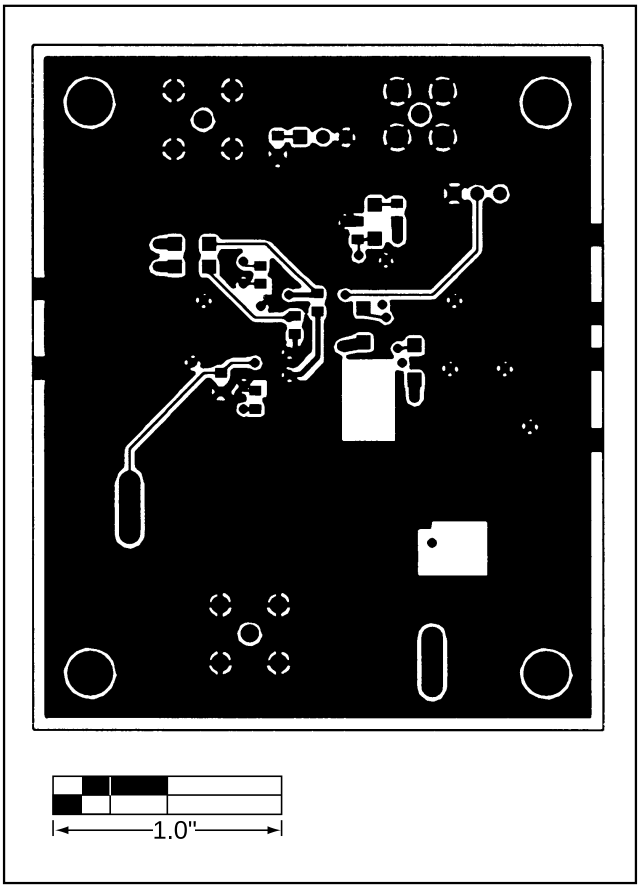

Figure 7. MAX2102 EV Kit PC Board Layout—Solder Side

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