MAX2511 Evaluation Kit

Evaluates: MAX2511

General Description

The MAX2511 Evaluation Kit (EV kit) simplifies testing of the MAX2511 low-power IF transceiver. The EV kit provides 50Ω SMA connectors for all RF inputs and outputs. A varactor-tuned tank circuit is provided for the MAX2511 VCO, and it can be tuned by applying a control voltage to the EV kit.

Features

- **+2.7 to +5.5V Single-Supply Operation**
- **SMA Connectors for Signal Ports Compatible with 50Ω Test Equipment**
- **Allows Individual and Cascade Evaluation of Circuit Blocks**
- **10.7MHz Receive Filter Included**
- **On-Board Jumpers Allow Testing of Advanced System Power Management (four modes)**
- **Includes VCO Tank Circuit (435.7MHz nominal)**
- **Fully Assembled and Tested**

Component Suppliers

SUPPLIER	PHONE/ FAX	INTERNET
Alpha Industries	(617) 935-5150/ (617) 933-0159	http://www.alphaind.com
AVX	(803) 946-0690/ (803) 626-3123	http://www.avxcorp.com
Coilcraft	(847) 639-6400/ (847) 639-1469	http://www.coilcraft.com
Murata	(814) 237-1431/ (814) 238-0490	http://www.murata.com

Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX2511EVKIT-SO	-40°C to +85°C	Surface Mount

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3	2	10nF ceramic capacitors
C2	1	100pF ceramic capacitor
C4, C8, C10, C11, C13, C14, C15, C20, C22, C25, C26	10	47nF ceramic capacitors (C11 not supplied)
C5	1	10pF ceramic capacitor
C6, C7	2	47pF ceramic capacitors
C9, C16, C17, C18, C19	5	470pF capacitors
C12	0	47nF ceramic capacitor (not installed)
C21, C23	2	100nF ceramic capacitors
C24	1	10µF tantalum capacitor AVX TAJC106K016
C27, C28	0	47pF ceramic capacitors (not installed)
D1	1	Dual varactor diode Alpha SMV1204-199

DESIGNATION	QTY	DESCRIPTION
IF, $\overline{IF}$, LIMIN, LIMOUT, $\overline{LIMOUT}$, MIXOUT, OSCOUT, TXIN, $\overline{TXIN}$	8	50Ω edge-mount SMA connectors ($\overline{TXIN}$ connector not installed)
L1	1	8.2nH inductor Coilcraft 0805CS-080XMBC
L2, L3	2	220nH inductors Coilcraft 0805CS–221XMBC
LOP, LON	0	50Ω top-mount SMA connectors (not installed)
R1, R10	2	270Ω resistors
R2, R4	2	1kΩ resistors
R3	1	10kΩ resistor
R5, R6	2	953Ω, 1% resistors
R7, R8, R11, R13	4	51Ω resistors
U1	1	MAX2511EEI (28 QSOP)
JU5	1	10.7MHz ceramic bandpass filter Murata SFE10.7MA5-A
None	2	Shunts
None	8	2-pin headers
None	2	3-pin headers

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For small orders, phone 408-737-7600 ext. 3468.

Quick Start

The following section provides instructions for operating the MAX2511 evaluation kit (EV kit) as an IF transceiver. The differential IF port (IF, $\overline{IF}$) is a bidirectional port configured for operation over a wide range of frequencies (200MHz to 440MHz). The high-side oscillator is configured for nominal 435.7MHz operation, with approximately 100MHz total span. The TXIN, $\overline{TXIN}$, LIMOUT, and $\overline{LIMOUT}$ ports are configured for 10.7MHz operation.

Test Equipment Required

This section lists the test equipment recommended for verifying operation of the MAX2511. It is intended only as a guide; some substitutions may be possible.

- One (optionally two) RF signal generator capable of delivering at least 0dBm of output power in the 10MHz to 500MHz frequency range (HP8656B, HP8648A, or equivalent). One generator is required to test the Rx and Tx signal paths; the other is used optionally as an external LO source if the on-chip oscillator is overdriven.
- An RF spectrum analyzer that can cover the transmitter's output frequency range, as well as a few harmonics (HP8560E, for example)
- A voltmeter for measuring the RSSI output voltage
- An oscilloscope for observing the limiter output signals
- A power supply that can provide at least 100mA at +2.7V to +5.5V
- Two voltage sources for providing the gain-control (GC) pin voltage and the oscillator frequency-adjust voltage (FADJ)
- Two 50Ω SMA terminators
- **Optional:** An RF 180° hybrid combiner or balun (Anzac H-9 or equivalent). This is used for differential coupling into the IF and $\overline{IF}$ connectors on the transceiver. If a hybrid is not available, these inputs and outputs can be evaluated in a single-ended configuration at a slight performance cost.

Connections and Setup

This section provides step-by-step instructions for getting the EV kit up and running in both Tx and Rx modes.

Tx Mode

Perform the following steps to evaluate the MAX2511 in Tx mode:

1) Make the DC connections: set the power supply to 3V with a 100mA current limit, and connect it to the VCC and GND terminals on the EV kit. Set one voltage source to 2V, and connect it to the gain-control terminal (labeled GC). Connect the other voltage source to the FADJ pin and set it to 1.75V.
2) Enable Tx mode by putting 3-pin jumper TXEN in the "1-2" position and jumper RXEN in the "2-3" position. This sets TXEN to V_{CC} and RXEN to GND. The supply current should be about 40mA. (See Table 1.)
3) Connect the spectrum analyzer to OSCOUT. Set the analyzer to 435.7MHz center frequency with a 100MHz total span. Adjust the FADJ voltage source to center the LO frequency at or near 435.7MHz. The OSCOUT output power should be around -9dBm.
4) Remove the SMA cable from the OSCOUT port. Connect the spectrum analyzer to IF. Terminate the other output ($\overline{IF}$(J9)) with a 50Ω SMA terminator. Optionally, IF and $\overline{IF}$ can be combined using a 180° balun. With no TXIN signal applied, the LO leakage is the only transmitter signal observable.
5) Connect an RF generator to the TXIN input and set it to 10.7MHz at -16dBm of output power. The spectrum analyzer should show an image-rejected output spectrum with the desired signal at 425MHz, the suppressed LO at 435.7MHz, and the image at 446.4MHz. You may need to fine tune the FADJ voltage to keep the LO at the correct frequency. Because the Tx output is loaded by the Rx input (approximately 200Ω differential), the single-ended Tx output power will be near -8.5dBm into the 50Ω spectrum analyzer. If the Tx output were loaded with 100Ω differential, this would correspond to -2dBm.
6) Test the GC function by slowly lowering the voltage on the GC pin from 2V to 0V. You will see at least a 40dB change in fundamental output power over this voltage range. Note the decreasing supply current draw with reduced output power due to the MAX2511's unique biasing scheme.
7) When the transmitter is set up properly, you may wish to test other features, such as shutdown mode (both TXEN and RXEN jumpers set to "2-3") (see Table 1). The image rejection of the MAX2511 over frequency can be checked by varying the TXIN and LO frequencies.

Rx Mode

This section describes how to connect and use the MAX2511's receiver section.

1) Verify that DC connections have been made, per step 1 in the *Tx Mode* section.

Table 1. Operating Modes

MODE	JUMPER SETTING	
	RXEN	TXEN
Shutdown	2–3	2–3
Transmit	2–3	1–2
Receive	1–2	2–3
Standby	1–2	1–2

2) Switch the part into Rx mode by moving the RXEN jumper to the "1" position and the TXEN jumper to the "3" position (Table 1). Verify that the GC voltage is 2V.

3) Connect the spectrum analyzer to the OSCOUT pin, and verify that LO is still at the correct frequency (435.7MHz). Adjust the FADJ pin voltage, if necessary. Set the RF generator to 425MHz at -30dBm. Connect the generator to the IF connector. Terminate the $\overline{IF}$ with a 50Ω SMA terminator. Optionally, the RF generator's signal can be split using a 180° balun connected to IF and $\overline{IF}$. This connection is the same as the optional balun connection for Tx mode, but the balun is used in the reverse direction.

4) Connect an oscilloscope to the limiter output LIMOUT, and set its input impedance to 50Ω. The signal level observed on the oscilloscope should be around 28mVp-p, which corresponds to 550mVp-p at the device pin. Note that R5 and the 50Ω oscilloscope load impedance form a 20:1 voltage divider. The limiter's output voltage range can be adjusted by varying the GC voltage.

   Note: Ensure that the LO frequency is maintained at 435.7MHz to keep the IF output centered within the Rx 10.7MHz filter's passband.

5) Connect a voltmeter to the RSSI test pad in the upper-left corner of the EV kit to monitor the RSSI output voltage. For -30 dBm of RXIN power, the RSSI voltage should be approximately 750mV. Lower the input power in 10dBm steps, observing the decrease in RSSI output voltage of about 100mV per 10dB change in input power. Increase RXIN power above -30dBm to verify compression performance. Return the power to -30dBm.

6) Observe that the signal at LIMOUT remains constant over the RXIN power range.

System Power-Management Features

Besides the Tx/Rx modes previously mentioned, the MAX2511 supports two other operating modes: shutdown and standby. Bring both TXEN and RXEN jumpers to the "2-3" position (TXEN = RXEN = GND), putting the part in shutdown mode and reducing supply current to around 0.1µA.

To enter standby mode, bring both TXEN and RXEN jumpers to the "1-2" position, so that TXEN = RXEN = V_{CC}. This reduces the supply current to about 9.5mA while leaving the oscillator and other circuitry active (for fast switching into either Rx or Tx mode).

Detailed Description

The following section covers the EV kit's circuit blocks in detail (see the MAX2511 data sheet for additional information).

Tx Inputs

The TXIN and $\overline{TXIN}$ pins are differential inputs to the MAX2511's image-reject transmitter. The EV kit is shipped configured for single-ended operation at the TXIN connector. To convert to differential operation, populate C12 with a 47nF capacitor, and install an SMA connector. The input impedance of these pins is set by pull-up resistors R7 and R8. This input is typically a 10.7MHz signal at 100mVp-p.

Tx Outputs

The MAX2511's Tx output pins (TXOUT and $\overline{TXOUT}$) are high-impedance open collectors; therefore, external inductors are used for proper biasing. DC-blocking capacitors are used to connect to these outputs. TXOUT and $\overline{TXOUT}$ are connected to the SMA connectors IF and $\overline{IF}$. Consult the schematic diagram for more information. C18, C19, L2, and L3 act only to provide biasing and DC blocking; they do not set the output impedance. Refer to the MAX2511 data sheet for more information on designing a matching network for this port.

Rx Input

The Rx input pins (RXIN and $\overline{RXIN}$) do not require external DC biasing. Capacitors C16 and C17 provide DC blocking. On the EV kit, they are connected in a shared configuration with the Tx outputs, at the IF and $\overline{IF}$ SMA connectors (see Figure 2 for more information).

Rx Output and Limiter Input

The receive downconverter mixer's output appears at the MIXOUT pin—a current source that can drive a 165Ω load to 2Vp-p. The MIXOUT pin is terminated with 330Ω (R10 + R11) for proper match to the bandpass filter (Z_O = 330Ω). Therefore, the net load at MIXOUT is 330Ω || 330Ω = 165Ω.

The EV kit design allows separate testing of the Rx mixer and limiter sections of the MAX2511. Coupling capacitor C20 is used to connect the node between R10 and R11 to an external SMA connector. This

network has some attenuation, but presents the correct impedance to the MIXOUT pin and provides a nearly 50Ω output impedance for measurement. The voltage attenuation is 21.4dB.

The limiter input pin (LIMIN) requires a DC bias level set by the VREF pin. To present this bias level, resistors R10 + R11 and R1 + R13 and are connected to VREF and not to ground. To minimize noise, this voltage is bypassed with capacitor C21 to ground.

Oscillator Tank

The oscillator tank shipped with the EV kit is configured for operation at a 425MHz IF frequency, with a 10.7MHz second IF. This places the desired oscillator frequency at 435.7MHz. The oscillation frequency can be controlled over approximately a 100MHz range by adjusting the FADJ voltage from 0V to 3V. Do not apply voltages higher than 10V to the FADJ connector.

If this frequency range does not cover your target IF frequency, it is fairly simple to retune the oscillator by adjusting capacitor C5 and inductor L1 (see the MAX2511 data sheet for more information on oscillator tank design).

LO Overdrive

The MAX2511 EV kit can be operated from an external LO source with a few modifications (Figure 1). The following components must be removed entirely: R2, R4, C5, and D1. Add capacitors C27 and C28 (both 47pF SMT capacitors). Add J2 and J3 (top-mount SMA connectors). Replace C6 and C7 with 0Ω shorts and L1 with a 100Ω resistor. These modifications allow a differential LO source to be AC coupled into the TANK and $\overline{TANK}$ pins. The circuit can then be driven from a differential LO source at LO and $\overline{LO}$ with a power level of -3dBm per side (0dBm total). The external signal source used can be split into LO and $\overline{LO}$ with an additional 180° balun of the same type as mentioned in the *Test Equipment Required* section. For optimum LO suppression and image rejection, a differential LO source is recommended if overdriving LO.

Layout Issues

A good PC board is an essential part of an RF circuit design. The EV kit PC board can serve as a guide for laying out a board using the MAX2511.

Remove the ground plane directly under LO tank components, IF port coupling components, and limiter outputs (Figure 5).

Rx Inputs and Tx Outputs

The RXIN and $\overline{RXIN}$ input coupling network should be symmetrical to provide the best input balance if used as a differential input. The TXOUT and $\overline{TXOUT}$ biasing networks should also be symmetrical to present an equivalent load on each pin.

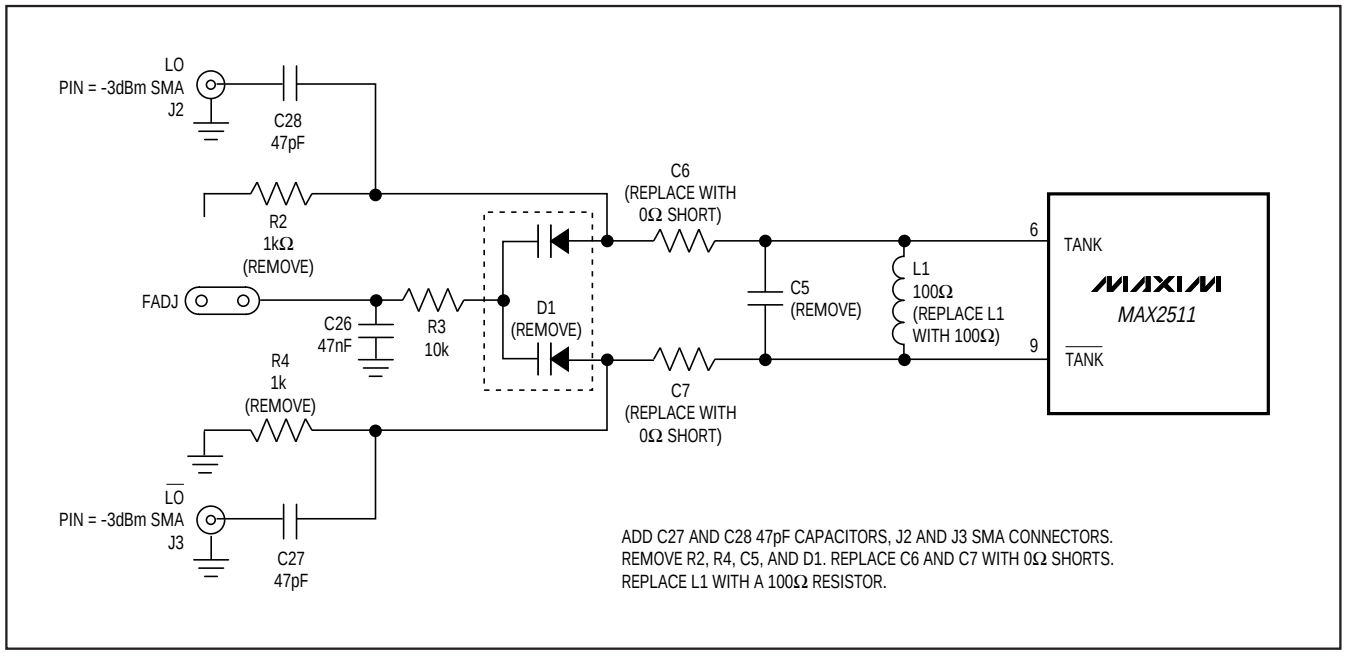


Figure 1. LO Overdrive Circuit

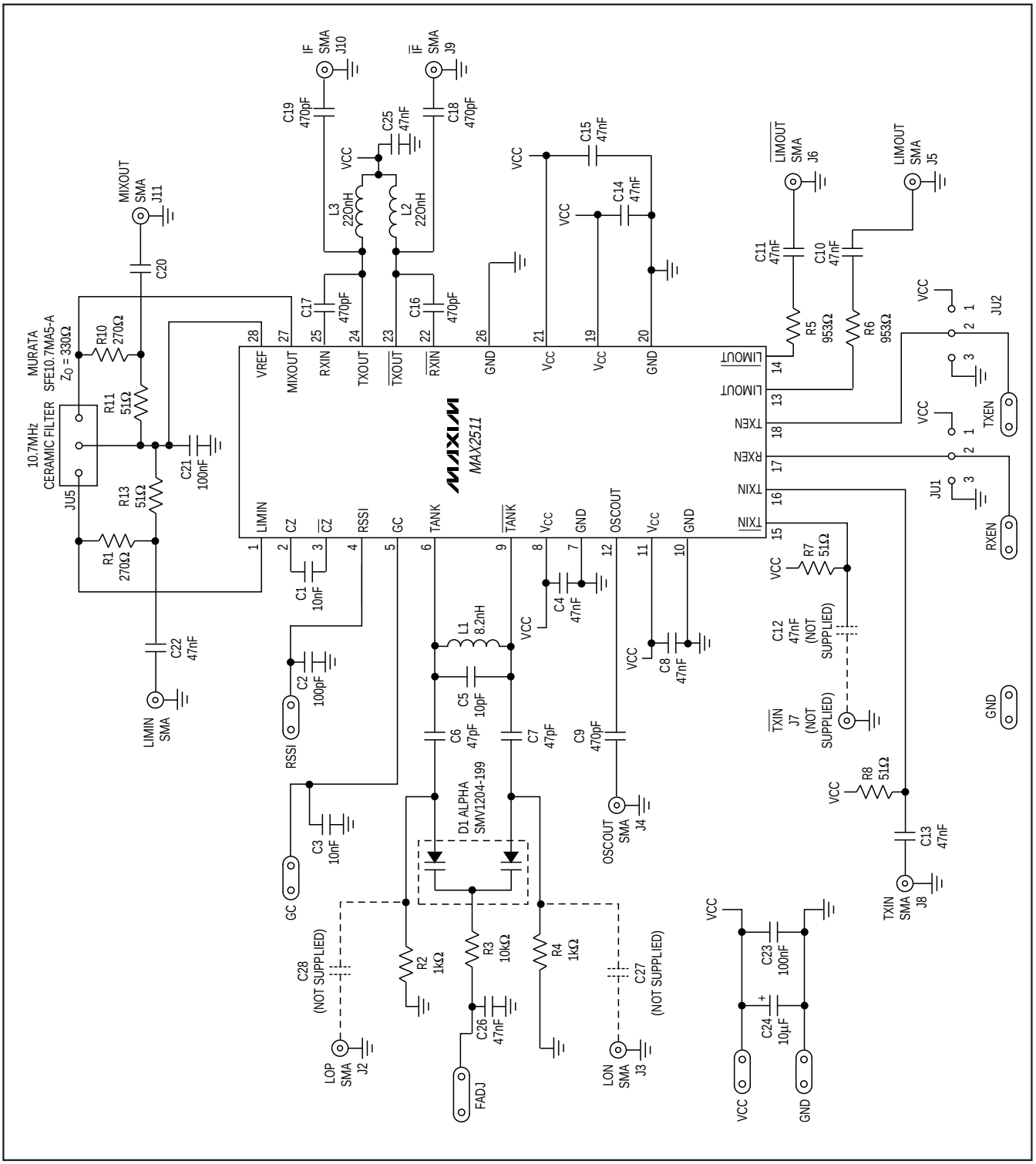


Figure 2. MAX2511 EV Kit Schematic

Power-Supply Decoupling

Each V_{CC} node on a PC board should have its own 47nF decoupling capacitor. This minimizes supply coupling from one section of the MAX2511 to another. A star topology for the supply layout, in which each V_{CC} node on the MAX2511 circuit has a separate connection to a central V_{CC} node, can further minimize coupling between sections of the MAX2511.

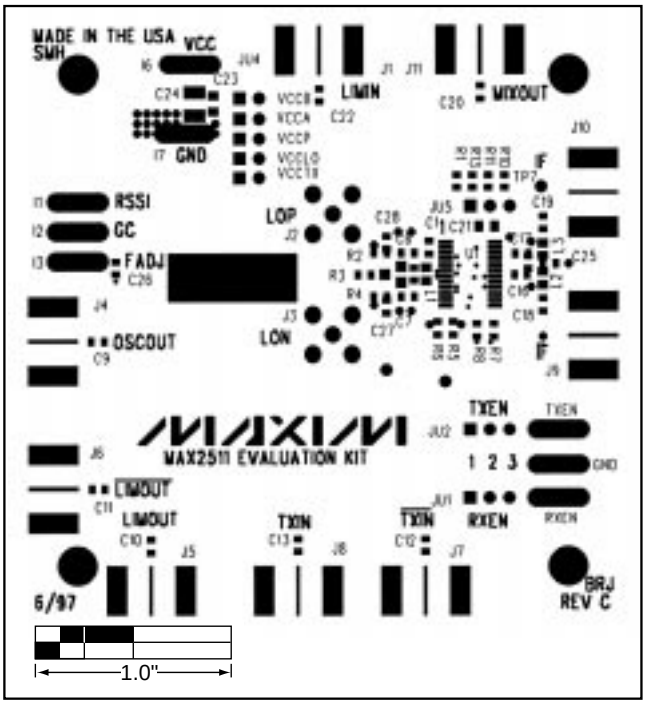


Figure 3. MAX2511 EV Kit PC Board Layout—Top Silkscreen and Pad Placement

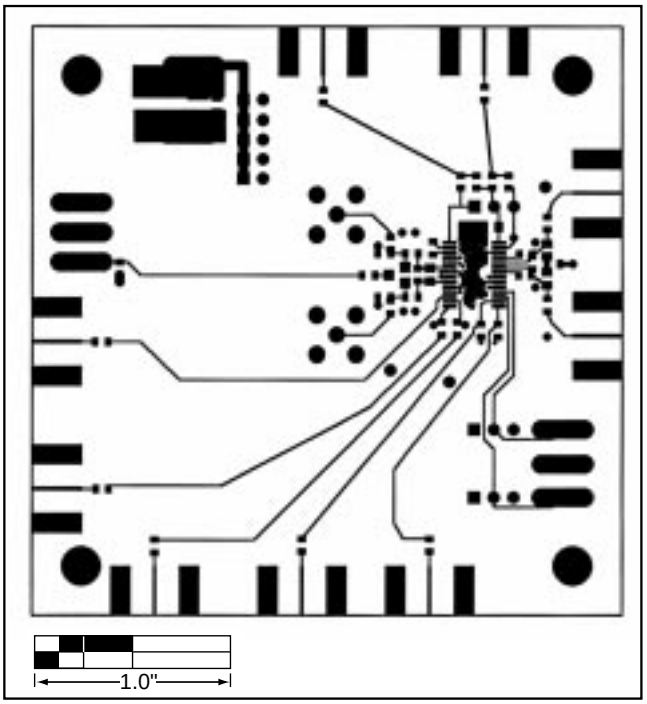


Figure 4. MAX2511EV Kit PC Board Layout—Component Side (layer 1)

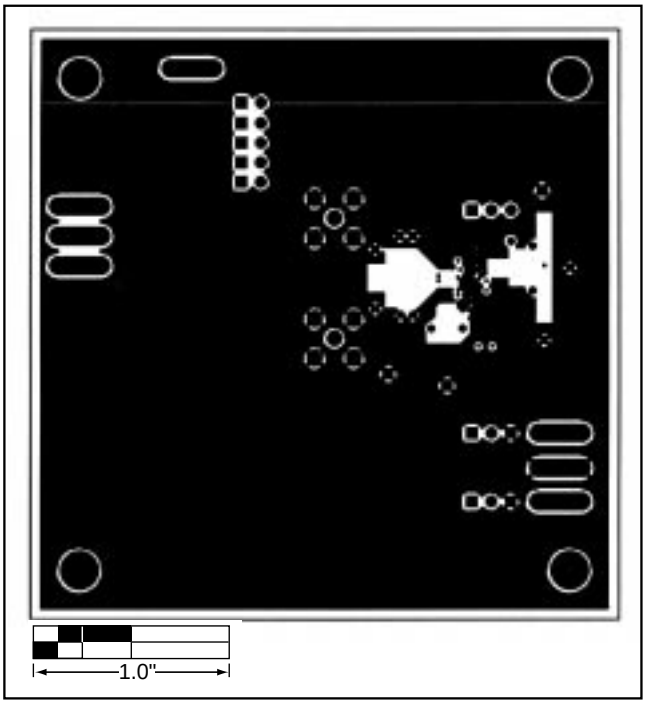


Figure 5. MAX2511 EV Kit PC Board Layout—Ground Plane (layer 2)

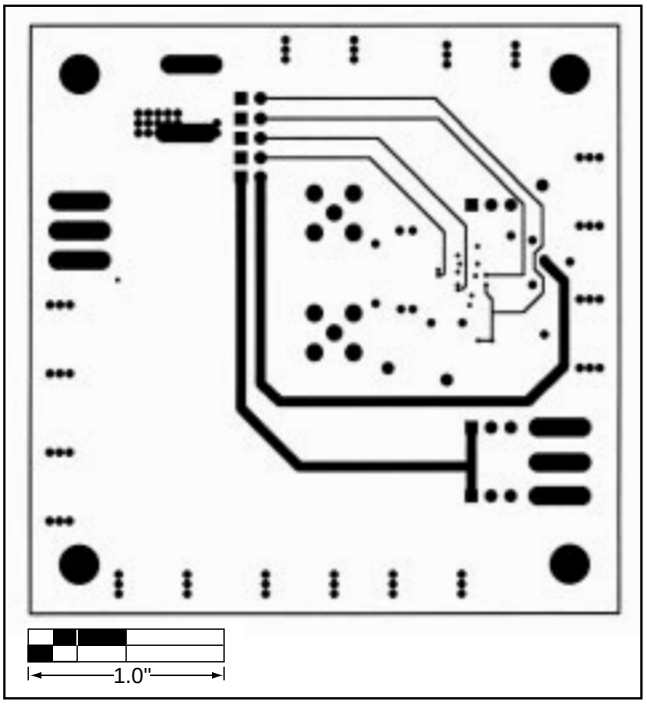


Figure 6. MAX2511 EV Kit PC Board Layout—Power-Supply Routing (layer 3)

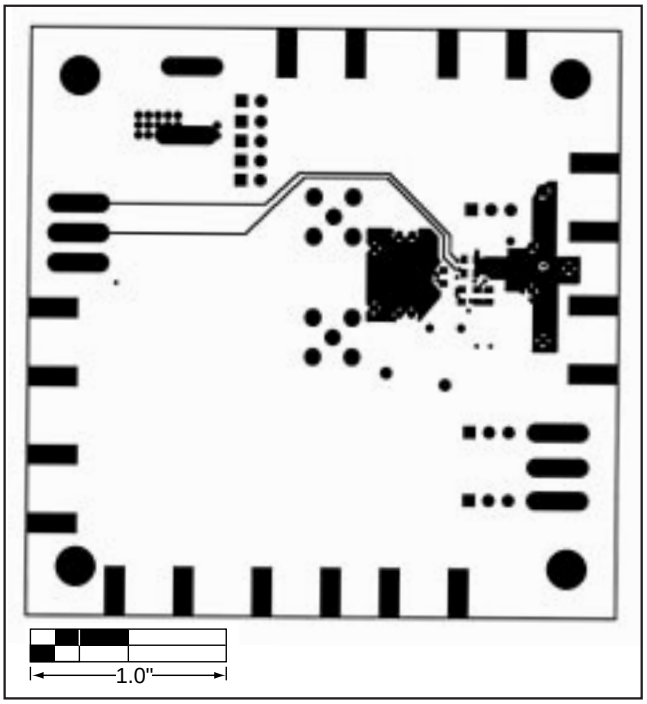


Figure 7. MAX2511 EV Kit PC Board Layout—Bottom (Solder Side) (layer 4)

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