



# MAX2045/MAX2046/MAX2047 Evaluation Kits

## General Description

The MAX2045/MAX2046/MAX2047 evaluation kits (EV kits) simplify evaluation of the MAX2045/MAX2046/MAX2047 vector multipliers. Each kit enables testing of the device's RF performance and requires no additional support circuitry. The EV kit input and output use SMA connectors and baluns (for single-ended-to-differential conversions) to facilitate the connection to RF test equipment.

Each EV kit is assembled with either the MAX2045, MAX2046, or MAX2047 and incorporates all matching components optimized for the corresponding band of frequency operation.

## Component Suppliers

SUPPLIER	PHONE	FAX
Murata	800-831-9172	814-238-0490
Toko	800-745-8656	—

**Note:** When contacting these suppliers, please indicate that you are using the MAX2045/MAX2046/MAX2047.

## Features

- ◆ Easy Evaluation of the MAX2045/MAX2046/MAX2047
- ◆ +4.75V to +5.25V Single-Supply Operation
- ◆ Include RF Input and Output Matching
  - 2040MHz to 2240MHz (MAX2045)
  - 1740MHz to 2060MHz (MAX2046)
  - 790MHz to 1005MHz (MAX2047)
- ◆ Configurable for Current-Control Mode and Single-Ended and Differential Voltage-Control Mode
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX2045EVKIT	-40°C to +85°C	32 QFN-EP*
MAX2046EVKIT	-40°C to +85°C	32 QFN-EP*
MAX2047EVKIT	-40°C to +85°C	32 QFN-EP*

\*EP = Exposed paddle.

## MAX2045 Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4–C16	14	22pF ±5%, 50V C0G ceramic capacitors (0402) Murata GRP1555C1H220J
C2, C3	2	220pF ±10%, 50V X7R ceramic capacitors (0402) Murata GRP155R71H221K
C17	1	0.01µF ±10%, 25V X7R ceramic capacitor (0402) Murata GRP155R71E103K
J1, J2	2	PC board edge-mount SMA RF connectors (flat-tab launch) EFJohnson 142-0741-856
J3	1	Header, 10 x 2, 0.100in spacing Molex 10-89-1201

DESIGNATION	QTY	DESCRIPTION
L1	1	1.5pF ±0.1pF, 50V C0G ceramic capacitor (0402) Murata GRP1555C1H1R5B
L2	1	8.2nH ±5% chip inductor (0402) Toko LL1005-FH8N2J
R1	1	280Ω ±1% resistor (0402) Any
R2, R4, R6	0	Not installed
R3, R5	2	0Ω resistors (0402) Any
T1	1	1:1 balun (50:50) Murata LDB15C500A1900
T2	1	4:1 balun (200:50) Murata LDB15C201A1900
U1	1	MAX2045ETJ-T (32-pin QFN)

Evaluate: MAX2045/MAX2046/MAX2047

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## MAX2046 Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	3.9pF $\pm$ 0.1pF, 50V C0G ceramic capacitor (0402) Murata GRP1555C1H3R9B
C2, C3	2	220pF $\pm$ 10%, 50V X7R ceramic capacitors (0402) Murata GRP155R71H221K
C4–C13, C15, C16	12	22pF $\pm$ 5%, 50V C0G ceramic capacitors (0402) Murata GRP1555C1H220J
C14	1	6.2pF $\pm$ 0.25pF, 50V C0G ceramic capacitor (0402) Murata GRP1555C1H6R2C
C17	1	0.01 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitor (0402) Murata GRP155R71E103K
J1, J2	2	PC board edge-mount SMA RF connectors (flat-tab launch) EFJohnson 142-0741-856
J3	1	Header 10 x 2, 0.100in spacing Molex 10-89-1201
L1	1	1.5pF $\pm$ 0.1pF, 50V C0G ceramic capacitor (0402) Murata GRP1555C1H1R5B
L2	1	12nH $\pm$ 5% chip inductor (0402) Toko LL1005-FH12NJ
R1	1	280 $\Omega$ $\pm$ 1% resistor (0402) Any
R2, R4, R6	0	Not installed
R3, R5	2	0 $\Omega$ resistors (0402) Any
T1	1	1:1 balun (50:50) Murata LDB15C500A1900
T2	1	4:1 balun (200:50) Murata LDB15C201A1900
U1	1	MAX2046ETJ-T (32-pin QFN)

## MAX2047 Component List

DESIGNATION	QTY	DESCRIPTION
C1–C16	16	47pF $\pm$ 5%, 50V C0G ceramic capacitors (0402) Murata GRP1555C1H470J
C17	1	0.01 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitor (0402) Murata GRP155R71E103K
J1, J2	2	PC board edge-mount SMA RF connectors (flat-tab launch) EFJohnson 142-0741-856
J3	1	Header 10 x 2, 0.100in spacing Molex 10-89-1201
L1	1	15nH $\pm$ 5% chip inductor (0402) Toko LL1005-FH15NJ
L2	1	39nH $\pm$ 5% chip inductor (0402) Toko LL1005-FH39NJ
R1	1	280 $\Omega$ $\pm$ 1% resistor (0402) Any
R2, R4, R6	0	Not installed
R3, R5	2	0 $\Omega$ resistors (0402) Any
T1	1	1:1 balun (50:50) Murata LDB20C500A900
T2	1	4:1 balun (200:50) Murata LDB20C201A900
U1	1	MAX2047ETJ-T (32-pin QFN)

### Quick Start

The MAX2045/MAX2046/MAX2047 EV kits are fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation. The EV kits come configured for single-ended, voltage-control operation. For differential voltage- or current-mode operation, see the *Detailed Description* section.

### Test Equipment Required

Table 1 lists the required test equipment to verify the MAX2045/MAX2046/MAX2047 operation. It is intended as a guide only, and some substitutions are possible.

### Connections and Setup

This section provides a step-by-step guide to operating the EV kits and testing the devices' functions. Do not turn on DC power or RF signal generators until all connections are made.

# MAX2045/MAX2046/MAX2047 Evaluation Kits

**Table 1. Required Test Equipment**

EQUIPMENT	QTY	DESCRIPTION
Power supply	1	Capable of delivering up to 250mA at 4.75V to 5.25V
Power supplies	2	Capable of swinging from 0 to +5.5V
Current sources (optional)	2	Capable of delivering 5mA of current
Low-noise RF signal generators	2	HP 8648B or equivalent
Network analyzer	1	HP 8753ES or equivalent
Ammeter/voltmeters	2	—
50Ω SMA cables	2	—

### Testing the Supply Current

- 1) If available, set the current limit of the power supply to 250mA. Do not turn on the supply. Connect the DC supply set to 5V, through an ammeter, to the VCC and GND terminals on the EV kit. Use a voltmeter to verify that the voltage is at  $V_{CC} = 5V$ .
- 2) Turn on the DC supply; the supply current should read approximately 160mA.

### Testing the Gain (Single-Ended Voltage Mode)

- 1) Connect a DC supply set to +3.2V to the VI1 and VQ1 terminals (Figure 1).
- 2) Using a calibrated network analyzer, connect port 1 to the RF\_IN terminal (SMA J1) and port 2 to the RF\_OUT terminal (SMA J2).
- 3) Configure the network analyzer to measure S21. The analyzer should read approximately 7dB gain at  $f_{IN} = 2140MHz$  (MAX2045), 7.4dB gain at  $f_{IN} = 1900MHz$  (MAX2046), and 8.4dB gain at  $f_{IN} = 915MHz$  (MAX2047).
- 4) Changing the DC supply on the VI1 and VQ1 terminals changes the magnitude of the gain. To adjust the phase, use separate DC supplies on the VI1 and VQ1 terminals.

### Testing the Gain (Current Mode)

- 1) Configure the evaluation kits for current mode (see the *Detailed Description* section).
- 2) Connect a current source set to 4mA to the II1 and IQ1 terminals. Leave II2, IQ2, and all voltage-control pins open (Figure 1).
- 3) Using a calibrated network analyzer, connect port 1 to the RF\_IN terminal (SMA J1) and port 2 to the RF\_OUT terminal (SMA J2).

4) Configure the network analyzer to measure S21. The analyzer should read approximately 6.2dB gain at  $f_{IN} = 2140MHz$  (MAX2045), 6.6dB gain at  $f_{IN} = 1900MHz$  (MAX2046), and 8.1dB gain at  $f_{IN} = 915MHz$  (MAX2047).

5) Changing the current source value changes the magnitude of the gain. To adjust the phase, use separate current sources on the II1 and IQ1 terminals.

### Detailed Description

The EV kits come with all necessary components for easy testing. For each kit, make sure all ground pins on the 20-lead header are connected to ground. The REFOUT voltage can be monitored from pins 17 and 18 on the 20-lead header by installing a 0Ω resistor for R6.

To operate the device in differential voltage-control mode, remove R5 and R3, and install 0Ω resistors for R2 and R4. Figure 1 shows the connections on the 20-pin header corresponding to the voltage- and current-control inputs. Using this configuration, an external DC source can also be applied to VI2 and VQ2 for single-ended operation using an external regulated voltage.

For current-mode operation, leave the VI and VQ (header pins 1, 2, 5, and 6) open, and remove R3 and R5.

### Bias Resistor

The bias resistor value (280Ω) was optimized during characterization at the factory. This value should not be adjusted. If the 280Ω (±1%) resistor is not readily available, substitute a standard 280Ω (±5%) resistor.

### On-Chip Reference Voltage

An on-chip, 2.5V reference voltage is provided for single-ended control mode. REFOUT is connected, through R3 and R5, to VI2 and VQ2 to provide a stable reference voltage. The equivalent output resistance of the REFOUT pin is approximately 80Ω. REFOUT is capable of sourcing 1mA of current with <10mV drop in voltage.

### Capacitors

Ceramic capacitors C16 and C17 provide bypass on the supply. Place C16 as close to the part as possible for high-frequency bypassing. C4–C11 are bypass capacitors for the control inputs. C1 and C14 are DC-blocking capacitors for the on-board baluns. DC-blocking capacitors prevent DC current from flowing into the transformers and can be used as part of the matching circuit. Capacitors C13 and C15 are used to provide an RF ground for transformer T2. Capacitor C12 is used to bypass the 2.5V reference in case the reference is used. As the differential RF outputs are relatively high

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impedance, they are more susceptible to component parasitics. It is often good practice to relieve the ground plane directly underneath large components to reduce associated shunt-C parasitics.

## Layout

The EV kit's PC board can serve as a guide for laying out a board using the MAX2045/MAX2046/MAX2047.

Keep RF signal lines as short as possible to minimize losses and radiation. Always use controlled-impedance lines on all high-frequency inputs and outputs and use low-inductance connections to ground on all GND pins. At all differential ports, keep the differential lines together

and of the same length to ensure signal balance. The PC board layout should provide a large ground pad under the device for proper RF grounding and thermal performance. This pad should be connected to the ground plane of the board by using multiple vias. To minimize inductance, route the ground pins of the device to the large ground pad. Solder the exposed pad on the bottom of the device package to the PC board exposed pad (refer to the MAX2045/MAX2046/MAX2047 data sheet).

The MAX2045/MAX2046/MAX2047 EV kits can be used as a reference for board layout. Gerber files are available upon request at [www.maxim-ic.com](http://www.maxim-ic.com).

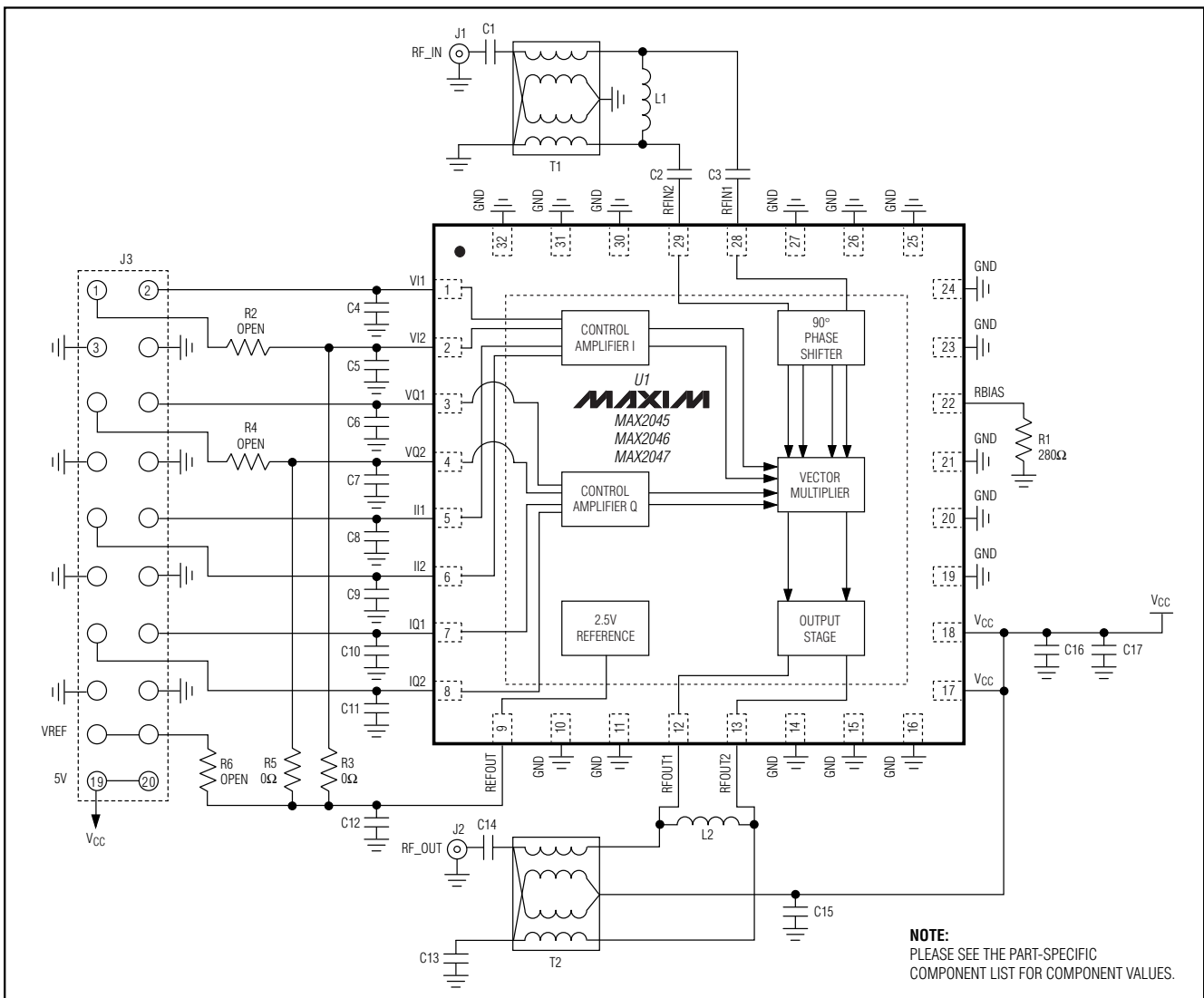


Figure 1. MAX2045/MAX2046/MAX2047 EV Kit Schematic

# MAX2045/MAX2046/MAX2047 Evaluation Kits

Evaluate: MAX2045/MAX2046/MAX2047

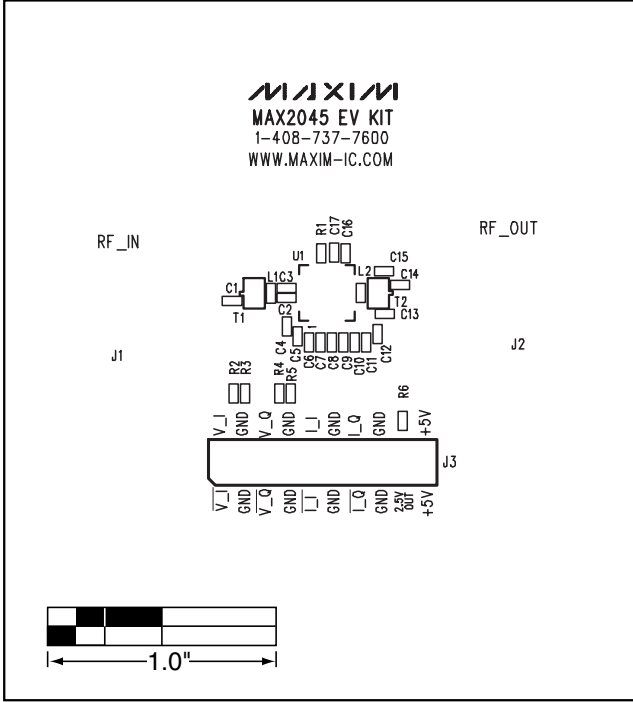


Figure 2. MAX2045 EV Kit Component Placement Guide—Top Silkscreen

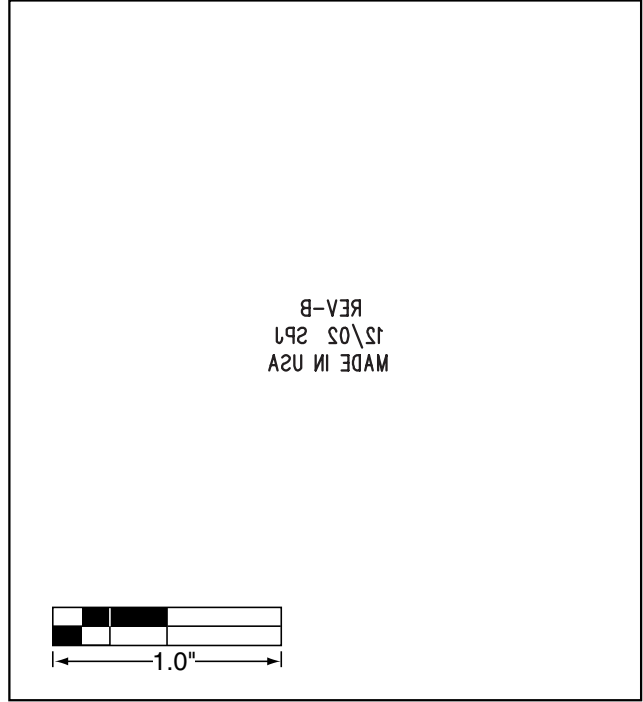


Figure 3. MAX2045 EV Kit Component Placement Guide—Bottom Silkscreen

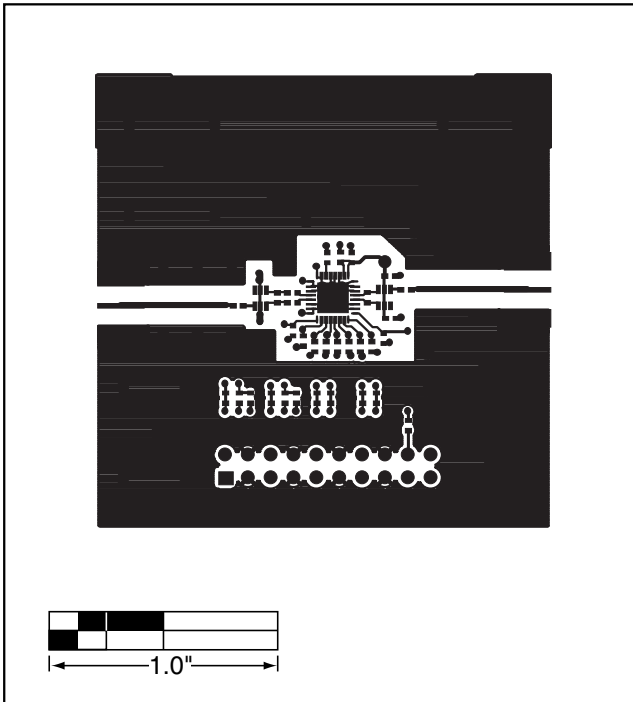


Figure 4. MAX2045 EV Kit PC Board Layout—Primary Component Side

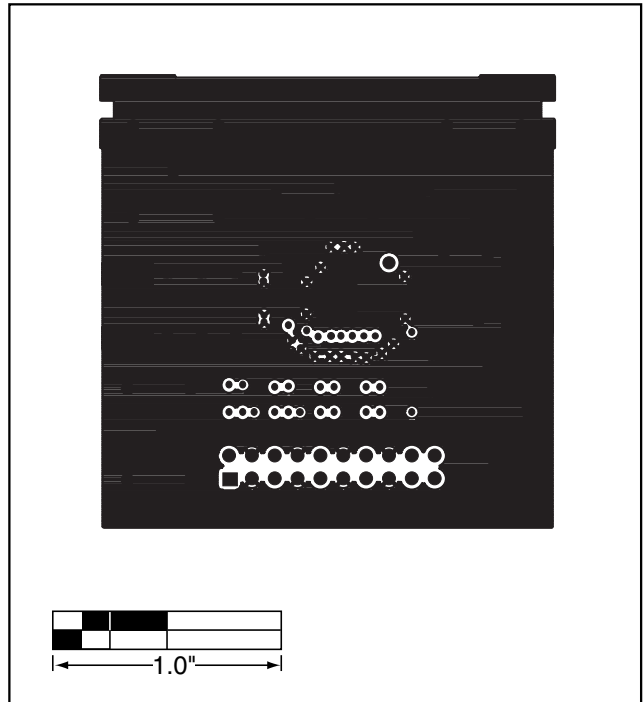


Figure 5. MAX2045 EV Kit PC Board Layout—Ground Layer (Layer 2)

# MAX2045/MAX2046/MAX2047 Evaluation Kits

Evaluate: MAX2045/MAX2046/MAX2047

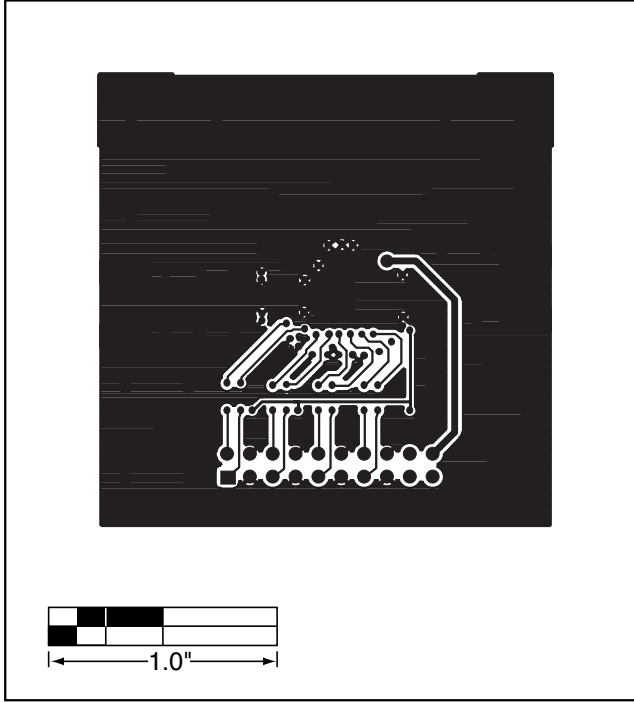


Figure 6. MAX2045 EV Kit PC Board Layout—Route Layer (Layer 3)

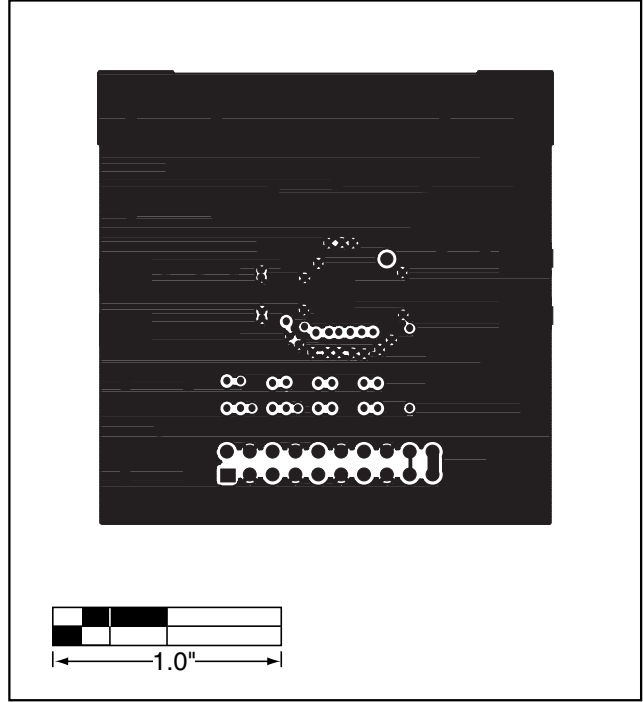


Figure 7. MAX2045 EV Kit PC Board Layout—Secondary Side

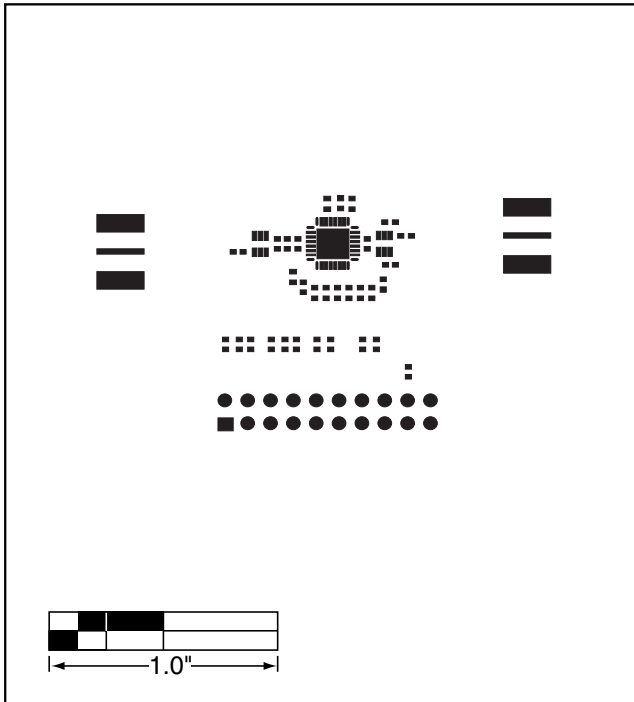


Figure 8. MAX2045 EV Kit PC Board Layout—Top Solder Mask

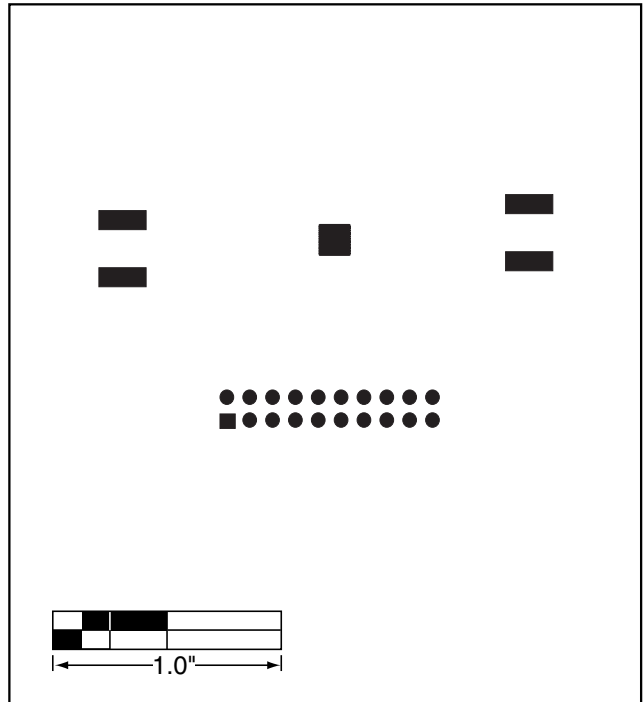


Figure 9. MAX2045 EV Kit PC Board Layout—Bottom Solder Mask

# MAX2045/MAX2046/MAX2047 Evaluation Kits

Evaluate: MAX2045/MAX2046/MAX2047

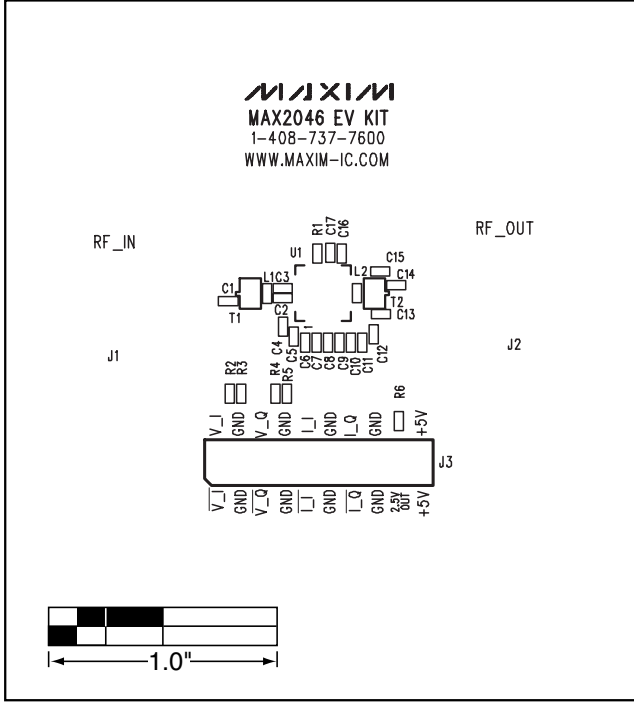


Figure 10. MAX2046 EV Kit Component Placement Guide—Top Silkscreen

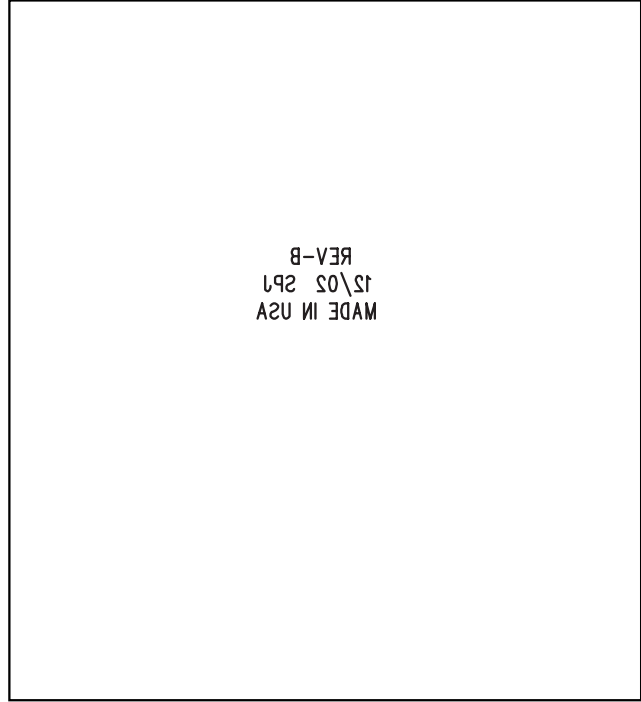


Figure 11. MAX2046 EV Kit Component Placement Guide—Bottom Silkscreen

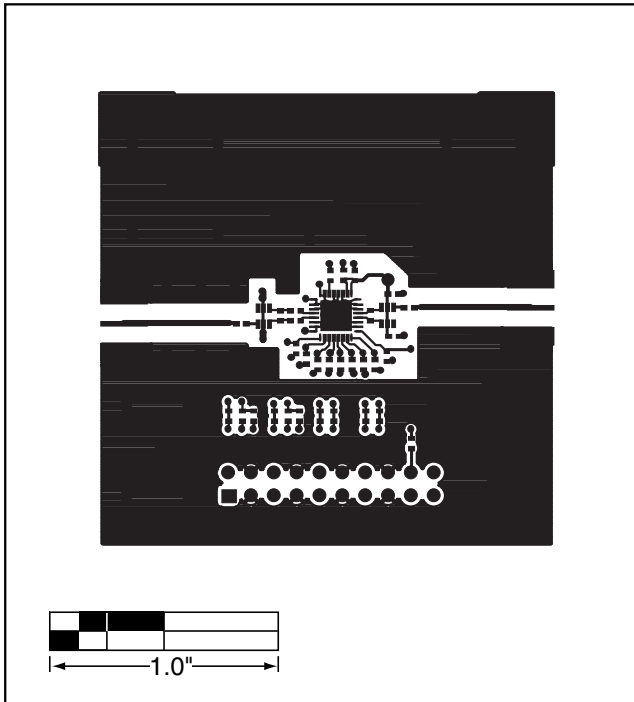


Figure 12. MAX2046 EV Kit PC Board Layout—Primary Component Side

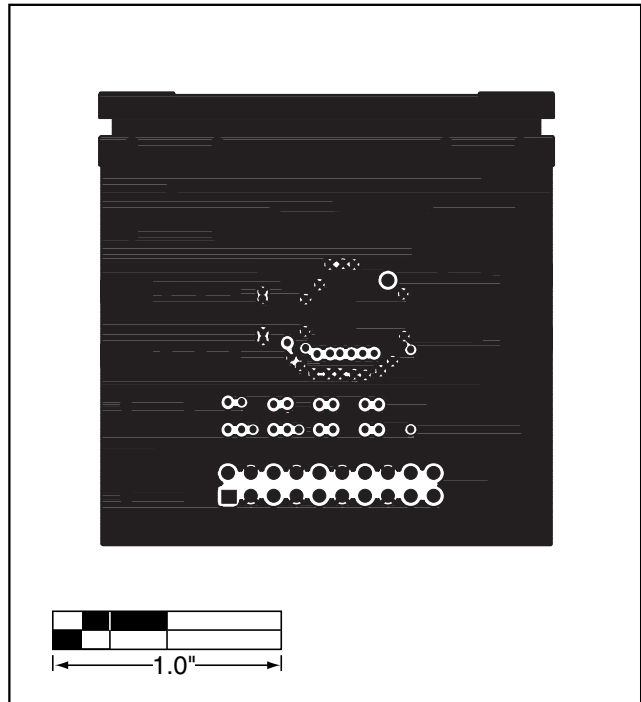


Figure 13. MAX2046 EV Kit PC Board Layout—Ground Layer (Layer 2)

# MAX2045/MAX2046/MAX2047 Evaluation Kits

Evaluate: MAX2045/MAX2046/MAX2047

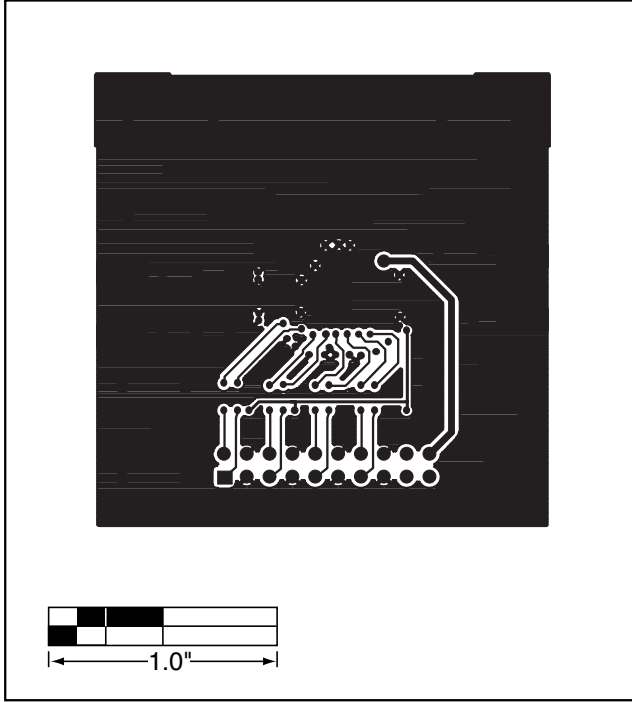


Figure 14. MAX2046 EV Kit PC Board Layout—Route Layer (Layer 3)

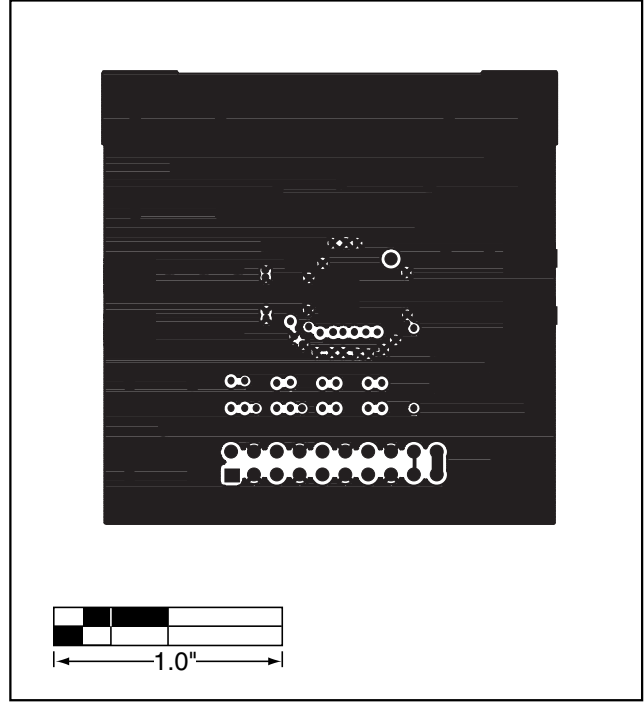


Figure 15. MAX2046 EV Kit PC Board Layout—Secondary Side

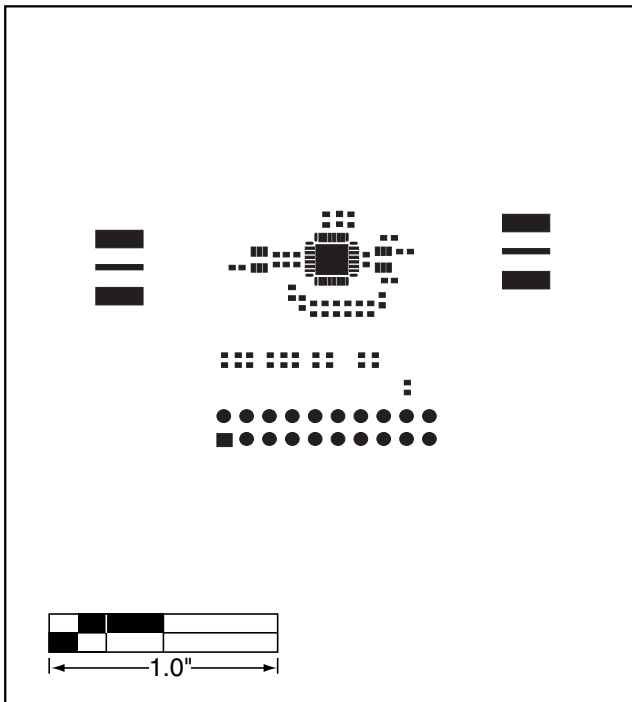


Figure 16. MAX2046 EV Kit PC Board Layout—Top Solder Mask

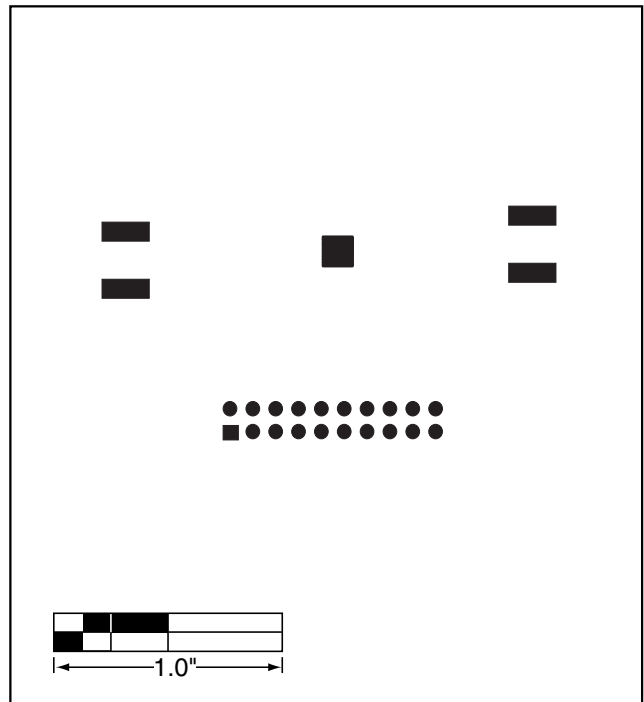


Figure 17. MAX2046 EV Kit PC Board Layout—Bottom Solder Mask



# MAX2045/MAX2046/MAX2047 Evaluation Kits

Evaluate: MAX2045/MAX2046/MAX2047

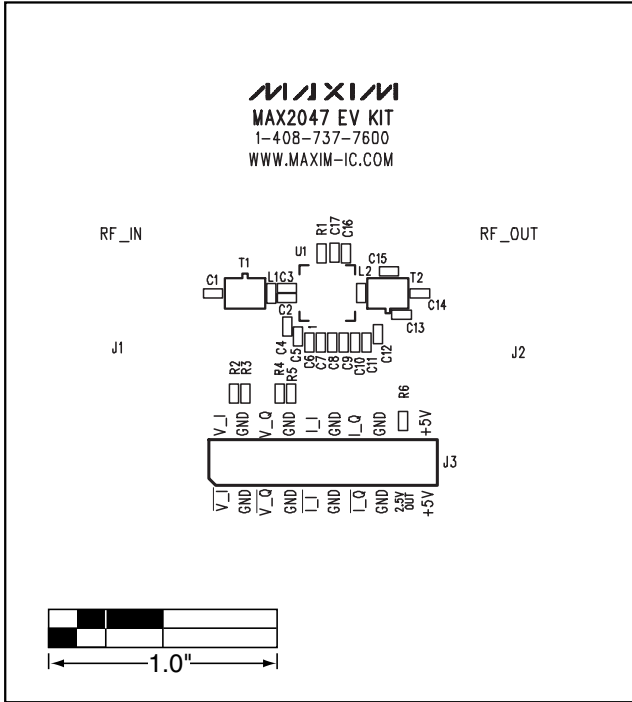


Figure 18. MAX2047 EV Kit Component Placement Guide—Top Silkscreen

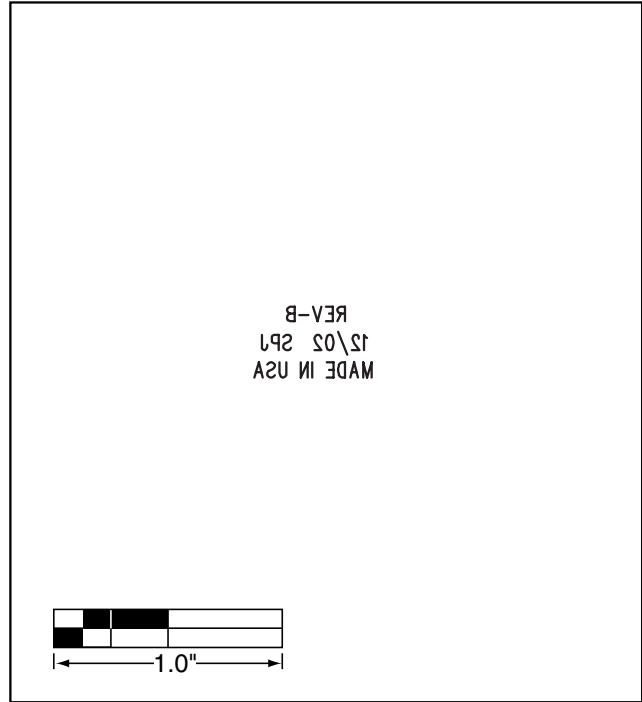


Figure 19. MAX2047 EV Kit Component Placement Guide—Bottom Silkscreen

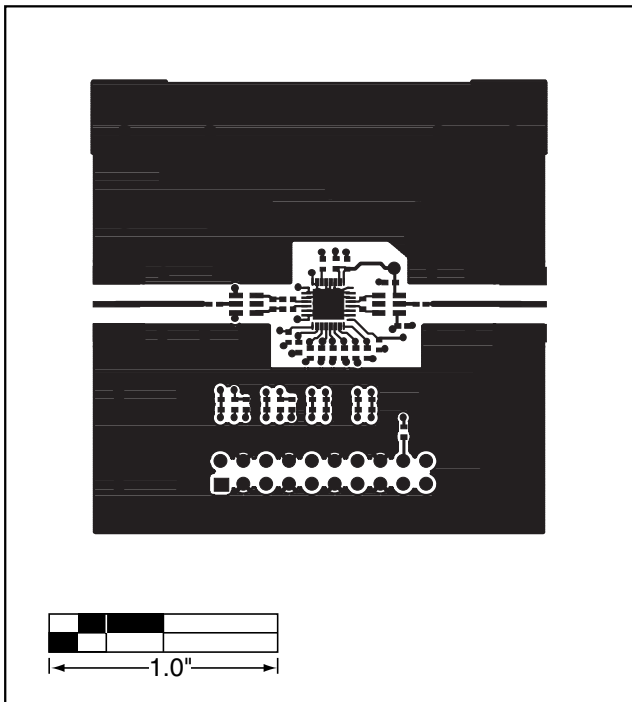


Figure 20. MAX2047 EV Kit PC Board Layout—Primary Component Side

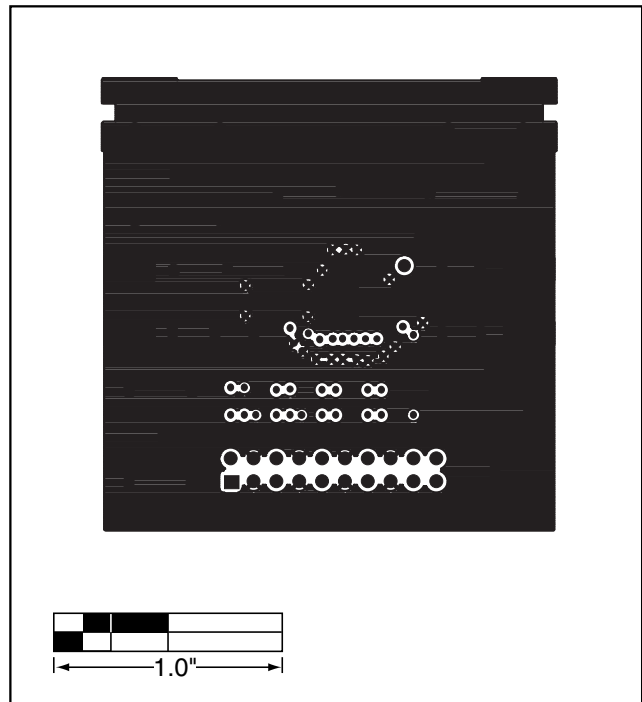


Figure 21. MAX2047 EV Kit PC Board Layout—Ground Layer (Layer 2)

# MAX2045/MAX2046/MAX2047 Evaluation Kits

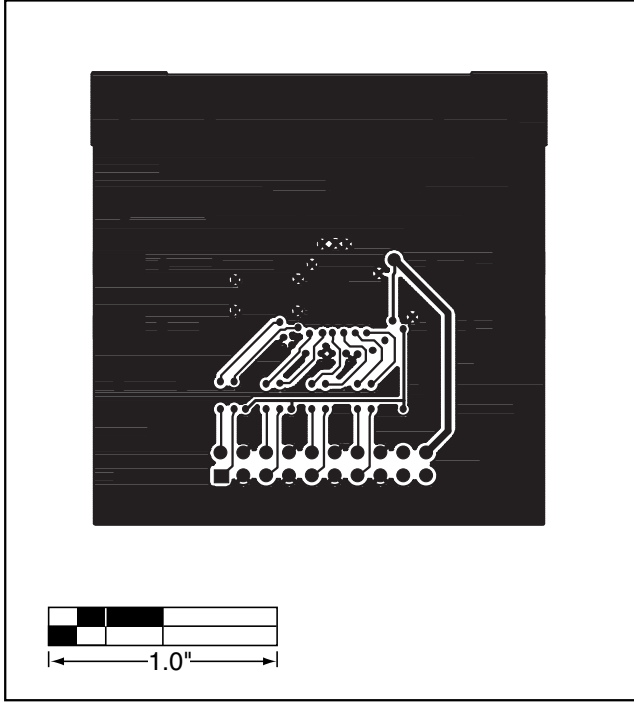


Figure 22. MAX2047 EV Kit PC Board Layout—Route Layer (Layer 3)

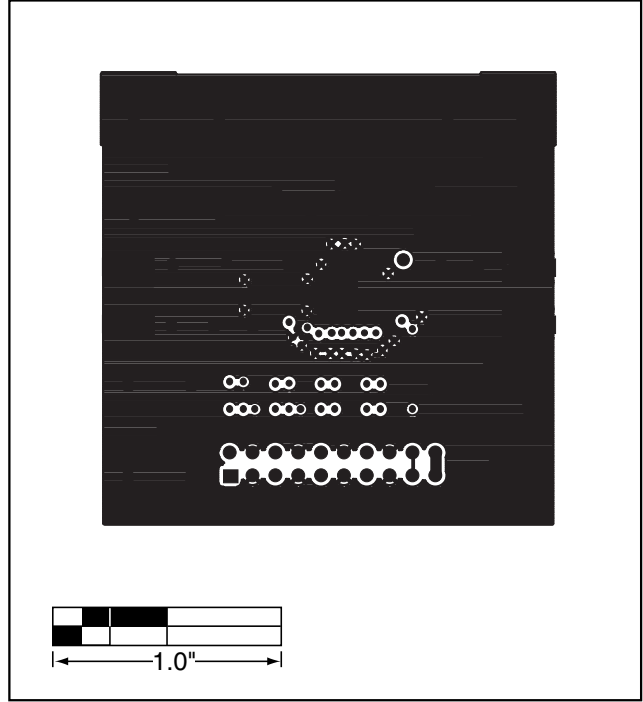


Figure 23. MAX2047 EV Kit PC Board Layout—Secondary Side

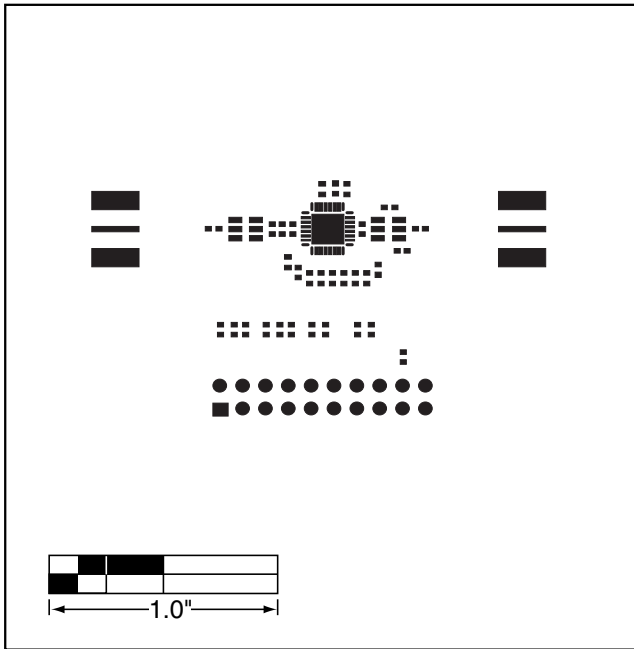


Figure 24. MAX2047 EV Kit PC Board Layout—Top Solder Mask

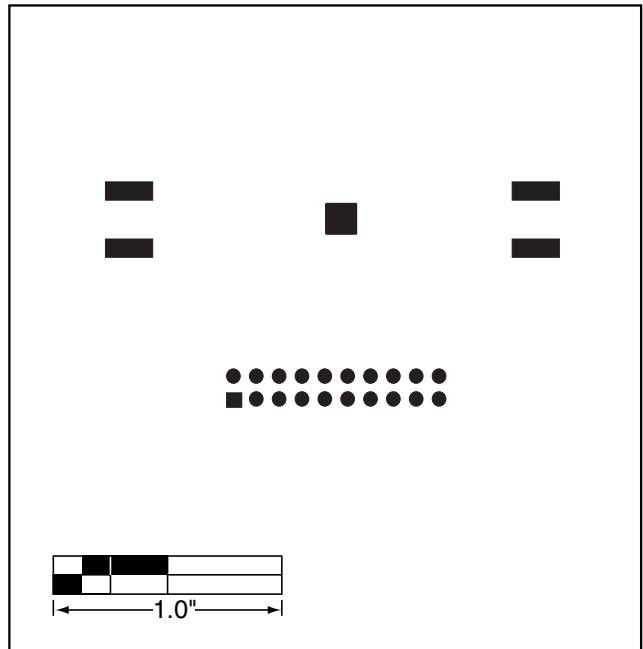


Figure 25. MAX2047 EV Kit PC Board Layout—Bottom Solder Mask

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