

# MAXIM

## MAX1960 Evaluation Kit

### General Description

The MAX1960 evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board that evaluates the MAX1960 family of PWM synchronous step-down controllers. There are two circuits on the board. The first has the MAX1960 installed but can also be used to evaluate the MAX1961. This circuit provides a 1.8V output at up to 15A, or the output can be adjusted from 0.8V to  $(0.9 \times V_{IN})$ . The second circuit evaluates the MAX1962. Components for the second circuit are not installed on the standard evaluation kit. Both circuits can operate with a 2.35V to 5.5V input voltage.

### Features

- ◆ 2.35V to 5.5V Input Supply Range
- ◆ 1.8V Output at Up to 15A
- ◆ Output Voltage Adjustable Down to 0.8V
- ◆ Fixed-Frequency PWM Operation
- ◆ Selectable 500kHz/1MHz or External Synchronization
- ◆  $\pm 4\%$  Voltage Margining

### Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX1960EVKIT	0°C to +70°C	20 QSOP

### Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	0.47 $\mu$ F $\pm 10\%$ , 10V X5R ceramic capacitor (0603) TDK C1608X5R1A474K or equivalent
C2, C3, C13	0	Not installed; 0.47 $\mu$ F $\pm 10\%$ , 10V X5R ceramic capacitors (0603) TDK C1608X5R1A474K or equivalent (tripler)
C4	1	1 $\mu$ F $\pm 20\%$ , 6.3V X5R ceramic capacitor (0402) Panasonic ECJ0EB0J105M or equivalent
C5	1	0.1 $\mu$ F $\pm 10\%$ , 10V X5R ceramic capacitor (0402) TDK C1005X5R1A104K or equivalent
C6	1	2.2 $\mu$ F $\pm 10\%$ , 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J225K or equivalent
C7, C8, C9	3	10 $\mu$ F $\pm 20\%$ , 6.3V X5R ceramic capacitors (0805) Panasonic ECJ2FB0J106M or equivalent
C10, C38	2	0.22 $\mu$ F $\pm 10\%$ , 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J224K or equivalent
C11	1	Not installed, 10pF ceramic capacitor (0402)
C12	1	0.01 $\mu$ F $\pm 10\%$ , 25V X7R ceramic capacitor (0402) Murata GRP155R71E103K or equivalent

DESIGNATION	QTY	DESCRIPTION
C14, C15	2	680 $\mu$ F, 2.5V, 8m $\Omega$ POSCAPs Sanyo 2R5TPD680M8
C16, C17	2	4700pF $\pm 10\%$ , 50V X7R ceramic capacitors (0603) TDK C1608X7R1H472K or equivalent
C37	1	470 $\mu$ F, 6.3V POSCAP Sanyo 6TPB470M
D1	1	Single Schottky diode (SOT-323) Central CMSSH-3
D2-D5	0	Not installed, Schottky diodes (SOD-123) Central CMHSH5-2L (tripler)
JU1, JU2, JU3	3	3-pin headers
JU4	1	4-pin 3-way header
L1	1	0.22 $\mu$ H inductor Sumida CDEP105(S)-0R2NC-50
N1	1	N-channel MOSFET (D-Pak) IRF IRLR7821
N2	1	N-channel MOSFET (D-Pak) IRF IRLR7833
R1	1	301k $\Omega$ $\pm 1\%$ resistor (0603)
R2	1	6.8k $\Omega$ $\pm 5\%$ resistor (0603)
R3	1	12.4k $\Omega$ $\pm 1\%$ resistor (0603)
R4	1	10k $\Omega$ $\pm 1\%$ resistor (0603)
R5	1	10 $\Omega$ $\pm 5\%$ resistor (0603)
R12, R13	2	1 $\Omega$ $\pm 5\%$ resistors (0603)
U1	1	Maxim MAX1960EEP (20-pin QSOP)
None	4	Shunts, two position
None	1	MAX1960EVKIT PC board

Evaluates: MAX1960/MAX1961/MAX1962

# MAX1960 Evaluation Kit

**Evaluates: MAX1960/MAX1961/MAX1962**

The following components are for the optional MAX1962 circuit and are not installed:

DESIGNATION	QTY	DESCRIPTION
C18, C19	2	680 $\mu$ F, 2.5V, 8m $\Omega$ POSCAPs Sanyo 2R5TPD680M8 or equivalent
C20, C21	2	4700pF $\pm$ 10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H472K or equivalent
C22, C32, C33	0	Not installed; 1 $\mu$ F $\pm$ 10%, 16V X5R ceramic capacitors (0603) Panasonic ECJ1VB1C105K or equivalent (tripler)
C23	1	6800pF $\pm$ 10%, 25V X7R ceramic capacitor (0402) Murata GRP155R71E682K or equivalent
C24	1	Not installed, 10pF ceramic capacitor (0402)
C25, C39	2	0.22 $\mu$ F $\pm$ 10%, 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J224K or equivalent
C26, C27, C28	3	10 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitors (0805) Panasonic ECJ2FB0J106M or equivalent
C29	1	4.7 $\mu$ F $\pm$ 10%, 6.3V X5R ceramic capacitor (0603) Panasonic ECJ1VB0J475K or equivalent
C30	1	0.1 $\mu$ F $\pm$ 10%, 10V X5R ceramic capacitor (0402) TDK C1005X5R1A104K or equivalent
C31	1	1 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitor (0402) Panasonic ECJ0EB0J105M or equivalent
C34	1	1 $\mu$ F $\pm$ 10%, 16V X5R ceramic capacitor (0603) Panasonic ECJ1VB1C105K or equivalent
C35	1	470 $\mu$ F, 6.3V POSCAP Sanyo 6TPB470M

DESIGNATION	QTY	DESCRIPTION
C36	1	Not installed (0805)
D6	1	Single Schottky diode (SOT-323) Central CMSSH-3
D7-D10	4	Not installed, Schottky diodes (SOD-123) Central CMHSH5-2L (tripler)
JU5	1	4-pin 3-way header
JU6, JU7	2	3-pin headers
JU8	1	2-pin header
L2	1	0.45 $\mu$ H inductor Sumida CDEP105(S)-0R4MC-50
N3	1	N-channel MOSFET (D-Pak) IRF IRLR7821
N4	1	N-channel MOSFET (D-Pak) IRF IRLR7833
R6	1	10k $\Omega$ $\pm$ 1% resistor (0603)
R7	1	12.4k $\Omega$ $\pm$ 1% resistor (0603)
R8	1	20k $\Omega$ $\pm$ 5% resistor (0603)
R9	1	1.5m $\Omega$ $\pm$ 5%, 1W resistor (2512) Panasonic ERJM1WTJ1M5U
R10	1	10 $\Omega$ $\pm$ 5% resistor (0603)
R11	1	Not installed (0603)
R14, R15	2	1 $\Omega$ $\pm$ 5% resistors (0603)
U2	1	MAX1962EEP (20-pin QSOP)
None	3	Shunts

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centalsemi.com
International Rectifier	310-322-3331	www.irf.com
Kamaya	260-489-1533	www.kamaya.com
Murata	814-237-1431	www.murata.com
Panasonic	714-373-7939	www.panasonic.com
Sanyo	619-661-6835	www.sanyo.com
Sumida	847-545-6700	www.sumida.com
TDK	847-803-6100	www.component.tdk.com

**Note:** Please specify that you are using the MAX1960/MAX1961/MAX1962 when contacting these suppliers.

# MAX1960 Evaluation Kit

Evaluates: MAX1960/MAX1961/MAX1962

## Quick Start

The MAX1960 EV kit is fully assembled and tested. Follow these steps to verify board operation. **Do not turn on the power supply until all connections are completed:**

- 1) Verify jumpers JU1, JU2, and JU3 are shorted between pins 2 and 3.
- 2) Preset input power supply to between 2.7V and 5.5V. Turn power supply off.
- 3) Connect the positive power-supply lead to the IN1 pad on the EV kit. Connect the supply ground to the PGND1 pad on the EV kit.
- 4) Connect a voltmeter and load from OUT1 to PGND1 on the EV kit.
- 5) Turn on the power supply.
- 6) Verify that the voltage at OUT1 is  $+1.8V \pm 1.5\%$ .

## Jumper Selection

**Table 1. JU1 and JU2 Functions (MAX1960/MAX1961)**

JU1 POSITION	JU2 POSITION	OUT1 FUNCTION
1-2	1-2	Shutdown
1-2	2-3	-4% margining
2-3	1-2	+4% margining
2-3	2-3	Enable (normal operation)

**Table 2. JU3 and JU6 Functions**

JUMPER POSITION	OPERATING FREQUENCY
1-2	500kHz
2-3	1MHz
Not connected	Clock applied to SYNC_ input

**Table 3. JU4 and JU5 Functions (MAX1961/MAX1962)**

JUMPER POSITION	OUTPUT VOLTAGE
1-2	+1.5V
1-3	+1.8V
1-4	+3.3V
Not connected	+2.5V

**Table 4. JU7 Functions (MAX1962)**

JUMPER POSITION	OUT2 FUNCTION
1-2	Shutdown
2-3	Enable

**Table 5. JU8 Functions**

JUMPER POSITION	OUT2 VOLTAGE
1-2	Selected with JU5
Not connected	Adjustable—set with resistors R6 and R7

**Table 6. JU9 and JU11 Functions**

JUMPER PADS	CHARGE PUMP
Open	2x (normal)
Short	3x (tripler)

**Table 7. JU10 Functions (MAX1960/MAX1961)**

JUMPER PADS	FUNCTION
Open	JU1 and JU2 function as shown in Table 1
Short	CTL1 and CTL2 connected—use only one jumper on JU1 or JU2 for shutdown/enable

**Table 8. JU12 Functions (MAX1962)**

JUMPER PADS	FUNCTION
Open	Uses inductor resistance for current sensing
Short	Uses current-sense resistor

## Detailed Description

### Evaluating the MAX1961 or MAX1962

The MAX1960 EV kit comes with the MAX1960 installed, but can also be used to evaluate the MAX1961 and the MAX1962. Free samples of these parts can be obtained from Maxim.

To evaluate the MAX1961, first carefully remove U1 from the PC board and replace it with the MAX1961. Next, remove feedback resistors R3 and R4. Finally, short the pads of R3. The evaluation kit is now configured for the MAX1961.

To evaluate the MAX1962, a second circuit is provided on the PC board. Components for this circuit do not come installed on the standard evaluation kit board. To configure the board for the MAX1962, install the components recommended in the *Component List* section.

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## Setting the Output Voltage (MAX1960/MAX1962)

The MAX1960 uses a pair of feedback resistors to set the output voltage, which is fixed at +1.8V from the factory. The output voltage of the MAX1962 can also be set with feedback resistors, or can use its preset output voltages like the MAX1961 (see the *Selecting a Preset Output Voltage* section).

To change the output voltage on the MAX1960 circuit, first verify that a 10kΩ resistor is installed in R4. Then calculate a resistor value for R3:

$$R3 = R4 \times \left( \frac{V_{OUT}}{0.8} - 1 \right)$$

To set the output voltage on the MAX1962 circuit, first remove jumper JU8. Then, install a 10kΩ resistor in R6. Finally, calculate a resistor value for R7:

$$R7 = R6 \times \left( \frac{V_{OUT}}{0.8} - 1 \right)$$

When changing the output-voltage setting, refer to the MAX1960/MAX1961/MAX1962 data sheet for selecting compensation components, output inductor, and output capacitor for best performance.

## Selecting a Preset Output Voltage (MAX1961/MAX1962)

First, follow the procedure given under the *Evaluating the MAX1961 or MAX1962* section to set up the EV kit for using the MAX1961 or MAX1962. To select a preset output voltage with the MAX1962, short the pins of jumper JU8, remove resistors R6 and R7, and use JU5 to select the output voltage (Table 3). For the MAX1961, use JU4 to select the output voltage (Table 3).

When selecting different output voltages, refer to the MAX1960/MAX1961/MAX1962 data sheet for selecting compensation components, output inductor, and output capacitor for best performance.

## Evaluating at Low Input Voltages (Tripler Configuration)

In the default configuration, the EV kit works at input voltages from +2.7V to +5.5V. To work with input voltages below +2.7V, configure the charge pump as a tripler. When using the tripler, the input voltage range is +2.35V to +3.6V.

To configure the charge pump as a tripler, use the following procedure:

For the MAX1960/MAX1961 circuit:

- 1) Remove C1.
- 2) Add C2, C3, and C13 (see the *Component List*).
- 3) Add D2–D5 (see the *Component List*).
- 4) Short the pads of JU9.

For the MAX1962 circuit:

- 1) Remove C34.
- 2) Add C22, C32, and C33 (see the *Component List*).
- 3) Add D7–D10 (see the *Component List*).
- 4) Short the pads of JU11.

## Changing the Switching Frequency

JU3 and JU6 select between 500kHz and 1MHz operation. To optimize performance, it is also necessary to change the value of some of the components. The components for 1MHz operation come installed on the PC board (MAX1960/MAX1961 circuit), and are listed in the *Component List* table. For 500kHz operation, change the components listed in Table 9, and refer to the MAX1960/MAX1961/MAX1962 data sheet for selecting compensation components. The MAX1962 circuit component list is configured for 500kHz operation.

**Table 9. Component Changes for 500kHz Operation**

DESIGNATION (MAX1960/MAX1961)	QTY	DESCRIPTION	NOTES
C1	1	1μF ±10%, 16V X5R ceramic capacitor (0603), Panasonic ECJ1VB1C105K	Without tripler
C2, C3, C13	3	1μF ±10%, 16V X5R ceramic capacitors (0603), Panasonic ECJ1VB1C105K	With tripler
C6	1	4.7μF ±10%, 6.3V X5R ceramic capacitor (0603), Panasonic ECJ1VB0J475K	—
L1	1	0.45μH inductor, Sumida CDEP105(S)-0R4MC-50	—

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## **Using SYNC and CLKOUT**

To synchronize the converter to an external clock, connect the clock signal (450kHz to 1.1MHz) to SYNC\_.

A clock output (CLKOUT\_) is provided on the EV kit. CLKOUT\_ functions both when the converter is switching at its preset frequency and when a SYNC signal is applied. The CLKOUT\_ waveform is 180° out-of-phase with the converter's clock, allowing a second converter to operate out-of-phase with the first by connecting CLKOUT\_ of the first converter to SYNC\_ of the second converter.

## **Evaluating Voltage Margining (MAX1960/MAX1961)**

A voltage-margining feature is provided on the MAX1960 and MAX1961. This allows the output to be shifted up or down by 4%. Voltage margining is controlled by JU1 and JU2 (Table 1).

## **Evaluating Shutdown**

Shutdown mode turns off the IC, reducing the input current to below 10μA. For the MAX1960/MAX1961, JU1 and JU2 control the shutdown feature (Table 1). On the MAX1962, JU7 controls shutdown (Table 4).

If voltage margining is not used on the MAX1960/MAX1961, then the pads of JU10 can be connected together to allow shutdown/enable using a single jumper. If this is done, either JU1 or JU2 must be completely removed and the other used to control shutdown/enable. Connecting both jumpers can cause an input supply to ground short, which could damage the EV kit.

**Evaluates: MAX1960/MAX1961/MAX1962**

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Evaluates: MAX1960/MAX1961/MAX1962

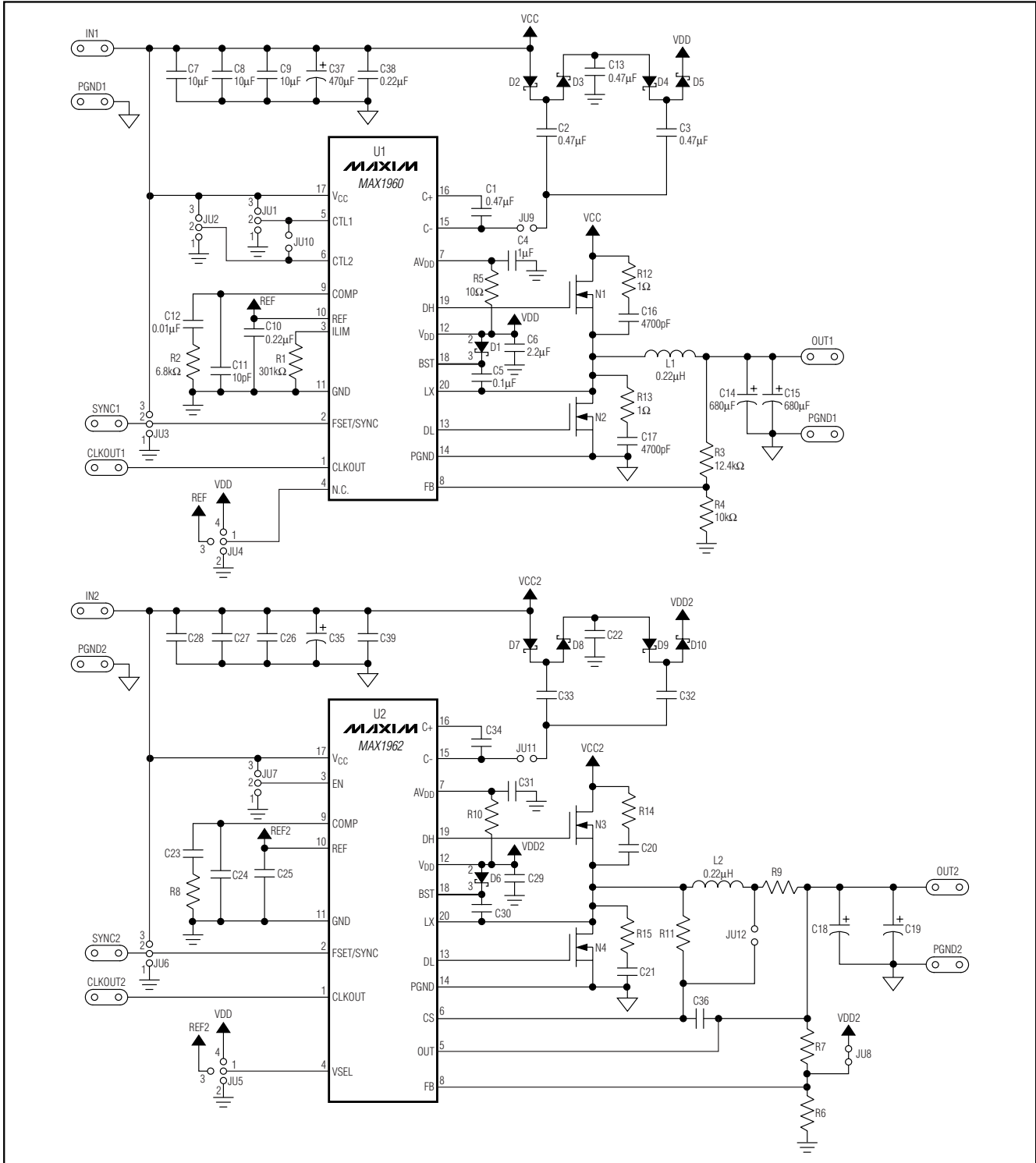


Figure 1. MAX1960 EV Kit Schematic

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Evaluates: MAX1960/MAX1961/MAX1962

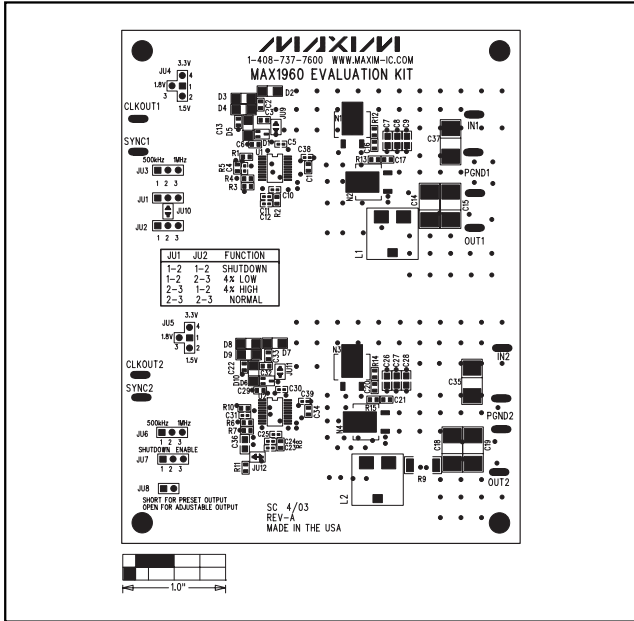


Figure 2. MAX1960 EV Kit Component Placement Guide—Component Side

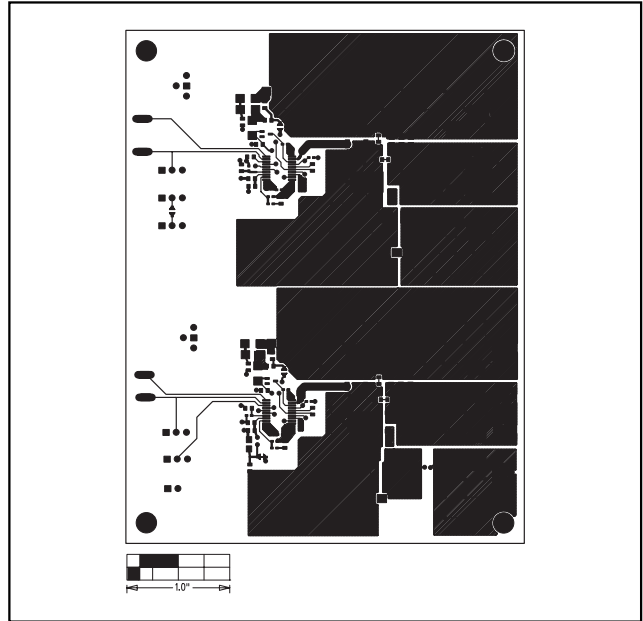


Figure 3. MAX1960 EV Kit PC Board Layout—Component Side

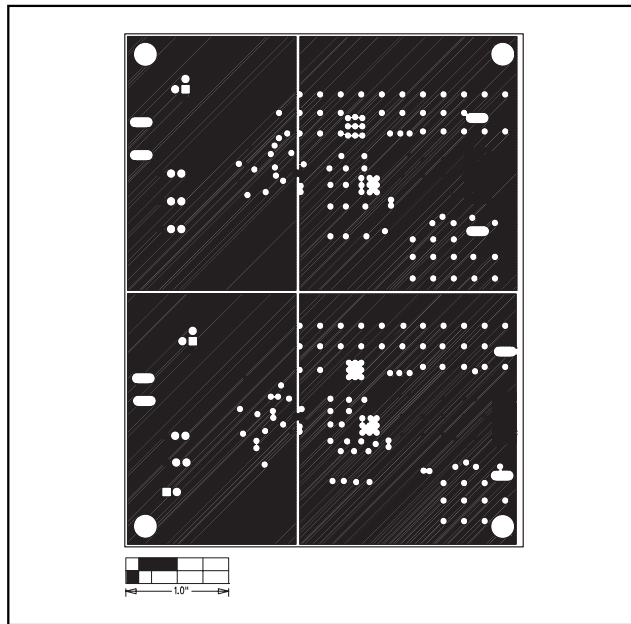


Figure 4. MAX1960 EV Kit PC Board Layout—Layer 2 (Ground)

# MAX1960 Evaluation Kit

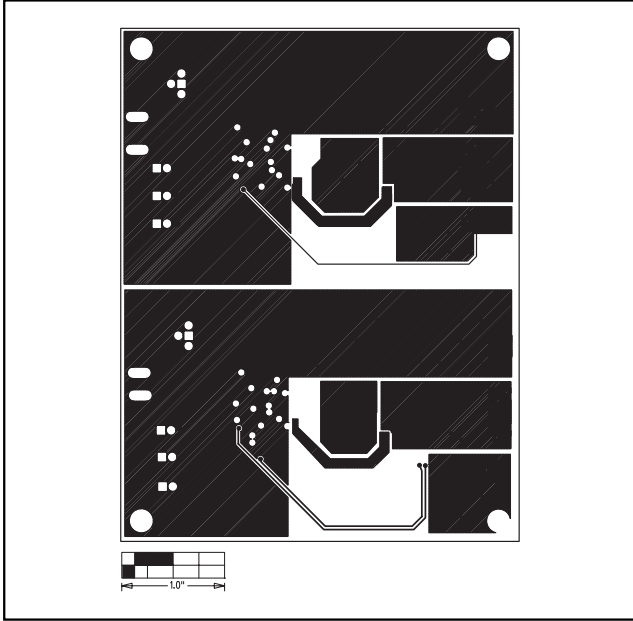


Figure 5. MAX1960 EV Kit PC Board Layout—Layer 3

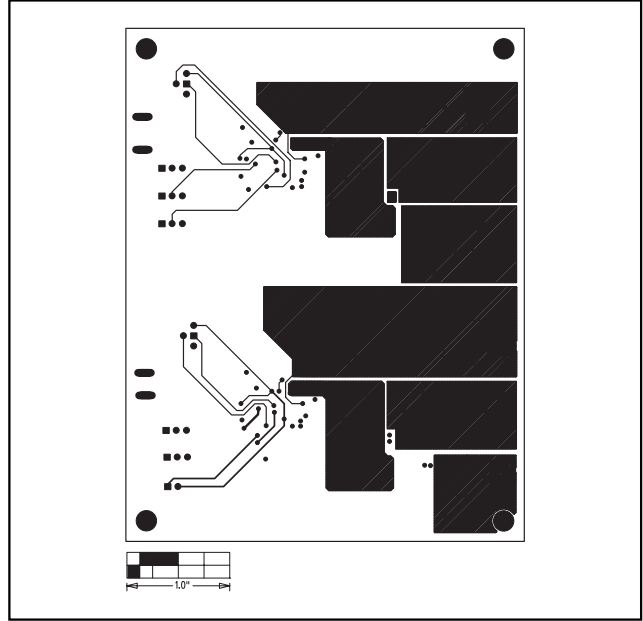


Figure 6. MAX1960 EV Kit PC Board Layout—Solder Side

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