



# MAX5060 Evaluation Kit

Evaluates: MAX5060

## General Description

The MAX5060 evaluation kit (EV kit) provides a +3.3V adjustable output voltage from a +12V input source. It delivers up to 20A of output current with a switching frequency of 270kHz and achieves efficiencies up to 93%.

The MAX5060 single-phase, PWM controller provides high-output-current capability in a compact package with a minimum number of external components. The MAX5060 utilizes average current-mode control that offers accurate current limit and current sharing, and avoids oversizing the MOSFETs and inductor.

Differential sensing enables accurate control of the output voltage, while adaptive voltage positioning provides optimum transient response. An internal regulator enables operation with +4.75V to +5.5V, or +7V to +28V input-voltage ranges. The high switching frequency, up to 1.5MHz, allows the use of low inductor and input capacitor values. This accommodates the use of PCB-embedded planar magnetics, achieving superior reliability, current sharing, thermal management, compact size, and low system cost.

The MAX5060 also features a clock input (CLKIN) for synchronization to an external clock, and a clock output (CLKOUT) with 180° phase delay to control a second out-of-phase converter for lower-input-capacitor ripple current. The MAX5060 also limits the reverse current if the bus voltage becomes higher than the regulated output voltage. This device is specifically designed to limit current sinking when multiple power-supply modules are paralleled. The MAX5060 offers an adjustable +0.6V to +5.5V ( $V_{IN} > 7V$ ) output voltage.

## Features

- ◆ +10V to +14V Input-Voltage Range
- ◆ 3.3V Output Voltage
- ◆ 20A Output Current
- ◆ 270kHz Switching Frequency
- ◆ Up to 93% Efficiency
- ◆ Synchronization Up to 1.5MHz
- ◆ Limits Reverse-Current Sinking
- ◆ Voltage Signal Proportional to the Output Current
- ◆ Clock Output for Ripple-Phase Operation
- ◆ Overvoltage Protection
- ◆ Enable (ON/OFF) Input
- ◆ Power-Good Output
- ◆ Size: 1.65in x 1.05in
- ◆ Requires 400LFM Airflow and Larger Heatsink for 0°C to +70°C Temperature Range

## Ordering Information

PART	TYPE
MAX5060EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3	2	470pF ±10%, 50V X7R ceramic capacitors (0402) KEMET C0402C471K5RAC Murata GRP155R71H471K
C2	1	0.022μF ±10%, 16V X7R ceramic capacitor (0402) Murata GRP155R71C223K
C4	1	0.01μF ±10%, 25V X7R ceramic capacitor (0402) KEMET C0402C103K3RAC Murata GRP155R71E103K
C5	1	0.22μF ±10%, 6.3V X5R ceramic capacitor (0402) Murata GRM155R60J224K

DESIGNATION	QTY	DESCRIPTION
C6, C12	2	0.47μF ±10%, 10V X5R ceramic capacitors (0603) KEMET C0603C474K8PAC Murata GRM188R61A474K
C7	1	1μF ±10%, 10V X5R ceramic capacitor (0603) KEMET C0603C105K8PAC Murata GRM188R61A105K
C8, C9	2	0.1μF ±10%, 25V X7R ceramic capacitors (0603) KEMET C0603C104K3RAC Murata GRM188R71E104K

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C10, C11	2	22 $\mu$ F $\pm$ 20%, 16V X5R ceramic capacitors (1812) Murata GRM43ER61C226M
C13	1	220 $\mu$ F $\pm$ 20%, 4V, 5m $\Omega$ E-size, SP-cap Panasonic EEFSE0G221R
C14	1	Not installed (0603)
C15	1	100 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitor (1210) AVX 12106D107MAT Murata GRM32ER60J107M
C16	1	47 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitor (1206) Murata GRM31CR60J476M
D1	1	20V, 0.5A Schottky diode (SOD123) Diodes Inc. B0520LW Fairchild Semiconductor MBR0520L Central Semiconductor CMHSH5-2L
D2	1	35V, 8A Schottky diode POWERMITE 3 Microsemi UPS835LE3/TR13
D3	1	30V, 0.1A Schottky diode (SOD523) Central Semiconductor CMOSH-3
J1	1	8-pin header, single-row, straight, 0.05in center
L1	1	0.6 $\mu$ H, 20A inductor Pulse PG0702.601NL
N1, N2	2	20V, 25A, 4m $\Omega$ n-channel MOSFETs (8 SO PowerPak) Vishay Siliconix Si7866DP
Q1	1	nnp transistor (SOT523) Central Semiconductor CMUT2222A

DESIGNATION	QTY	DESCRIPTION
R1	1	2.0k $\Omega$ $\pm$ 1% resistor (0402)
R2	1	100k $\Omega$ $\pm$ 1% resistor (0402)
R3	1	51.1k $\Omega$ $\pm$ 1% resistor (0402)
R4, R17	2	4.99k $\Omega$ $\pm$ 1% resistors (0402)
R5	1	100k $\Omega$ $\pm$ 5% resistor (0402)
R6	1	226k $\Omega$ $\pm$ 1% resistor (0402)
R7, R14	0	Not installed, resistors (0402)
R8	1	10k $\Omega$ $\pm$ 1% resistor (0402)
R9	1	0 $\Omega$ resistor (0603)
R10	1	5.6k $\Omega$ $\pm$ 5% resistor (0402)
R11	1	1 $\Omega$ $\pm$ 5% resistor (0402)
R12	1	2.2 $\Omega$ $\pm$ 5% resistor (0402)
R13	1	0.001 $\Omega$ $\pm$ 1%, 0.5W current-sense resistor (2010) Vishay Dale WSL2010-18 0.001
R15, R18	2	22 $\Omega$ $\pm$ 5% resistors (0402)
R16	1	22.1k $\Omega$ $\pm$ 1% resistor (0402)
R19	1	10k $\Omega$ $\pm$ 5% resistor (0402)
R20	1	100k $\Omega$ $\pm$ 5% resistor (0402)
R21	1	20.5k $\Omega$ $\pm$ 1% resistor (0402)
U1	1	Current-mode DC-DC controller (28 TQFN) Maxim MAX5060ETI+
—	1	Aluminum heatsink Width = 0.40in, height = 0.40in Length = 1.65in Color = unfinished
—	1	Double-sided thermal tape, 0.40in x 1.65in Bond-ply 100 Thickness = 0.008in The Bergquest Company BP100-0.008
—	1	PCB: MAX5060 Evaluation Kit+

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## Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corporation	843-946-0238	www.avxcorp.com
Central Semiconductor Corp.	631-435-1110	www.centalsemi.com
Diodes Inc.	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
KEMET Corp.	864-963-6300	www.kemet.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Pulse Engineering	858-674-8100	www.pulseeng.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

**Note:** Indicate that you are using the MAX5060 when contacting these component suppliers.

## Quick Start

### Recommended Equipment

Before beginning, the following equipment is needed:

- MAX5060 EV kit
- One DC power source capable of supplying 10A at 12V
- One voltmeter
- One load capable of sinking 30A

### Procedure

The MAX5060 EV kit is a fully assembled and tested surface-mount board. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are completed.**

- 1) Connect +VIN and COM to the DC power.
- 2) Connect +VOUT and COM to the load.
- 3) Set the load to 5A.
- 4) Turn on the power supply and increase the voltage to 12V.
- 5) Verify the voltage at +VOUT is +3.3V.

## Detailed Description of Hardware

The MAX5060 EV kit provides a +3.3V adjustable output voltage from a +12V input source. It delivers up to 20A of output current with 400LFM of airflow.

### Remote Voltage Sensing

For high currents, there can be significant voltage drop across the wires connecting the MAX5060 converter to the load. To compensate for this voltage drop, the MAX5060 EV kit includes remote sense pins that allow the voltage to be sensed at the load. To use this feature, connect wires from VOUT\_SENSE and SENSE- (pins 7 and 8 of J1 on the MAX5060 EV kit) to the load.

### Enable

The EN (pin 11 on the MAX5060) is internally pulled up to VCC with 15 $\mu$ A of current. This allows the MAX5060 to power on when the +12V input source powers on. To control enable with an external signal generator, connect the external signal generator to enable (pin 4 of J1 on the MAX5060 EV kit). A logic-low shuts down the power drivers.

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Table 1. MAX5060 EV Kit Pinout

CONNECTOR	PIN	NAME	DESCRIPTION
J1	1	SYNC/ON	Drive with an external signal to synchronize the switching frequency. Connecting to COM turns off the MAX5060.
	2	V_IOUT	The voltage on this pin is proportional to the output load current. On the MAX5060 EV kit, $V_{IOUT} = 0.135 \times I_{LOAD}$ .
	3	SGND	Signal Ground.
	4	EN	Enable.
	5	PGOOD	Power-Good Output. Open-drain, active-low output goes low when the output voltage falls out of regulation.
	6	CLK_OUT	Oscillator Output.
	7	SENSE-	Low-Side Remote Voltage Sense Input.
	8	VOUT_SENSE	High-Side Remote Voltage Sense Input.

### Output Voltage

The MAX5060 EV kit provides a +3.3V output voltage. Change the output voltage to a value between 0.6V and 5.5V by changing the resistor-divider R16/R17.

Use the equation shown below to set the output voltage.

$$R17 = \frac{R16}{\left( \frac{V_{OUT(NL)}}{0.6 \times \left( 1 + \frac{R4}{R2} \right)} \right) - 1}$$

Use resistors between 1k $\Omega$  and 10k $\Omega$ .

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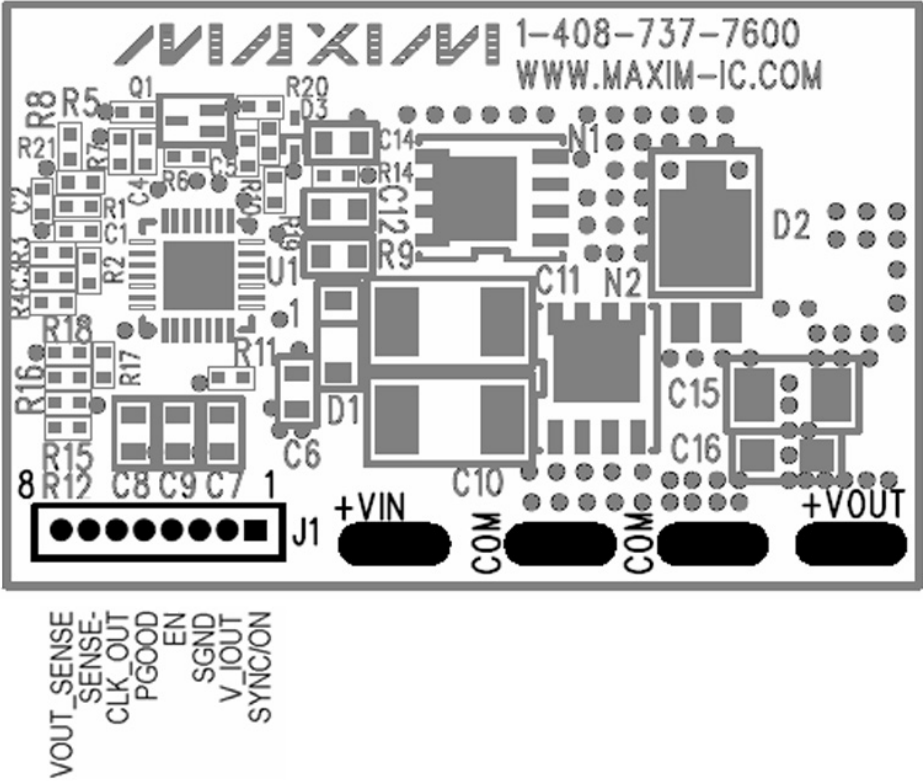


Figure 1. MAX5060 EV Kit Pinout

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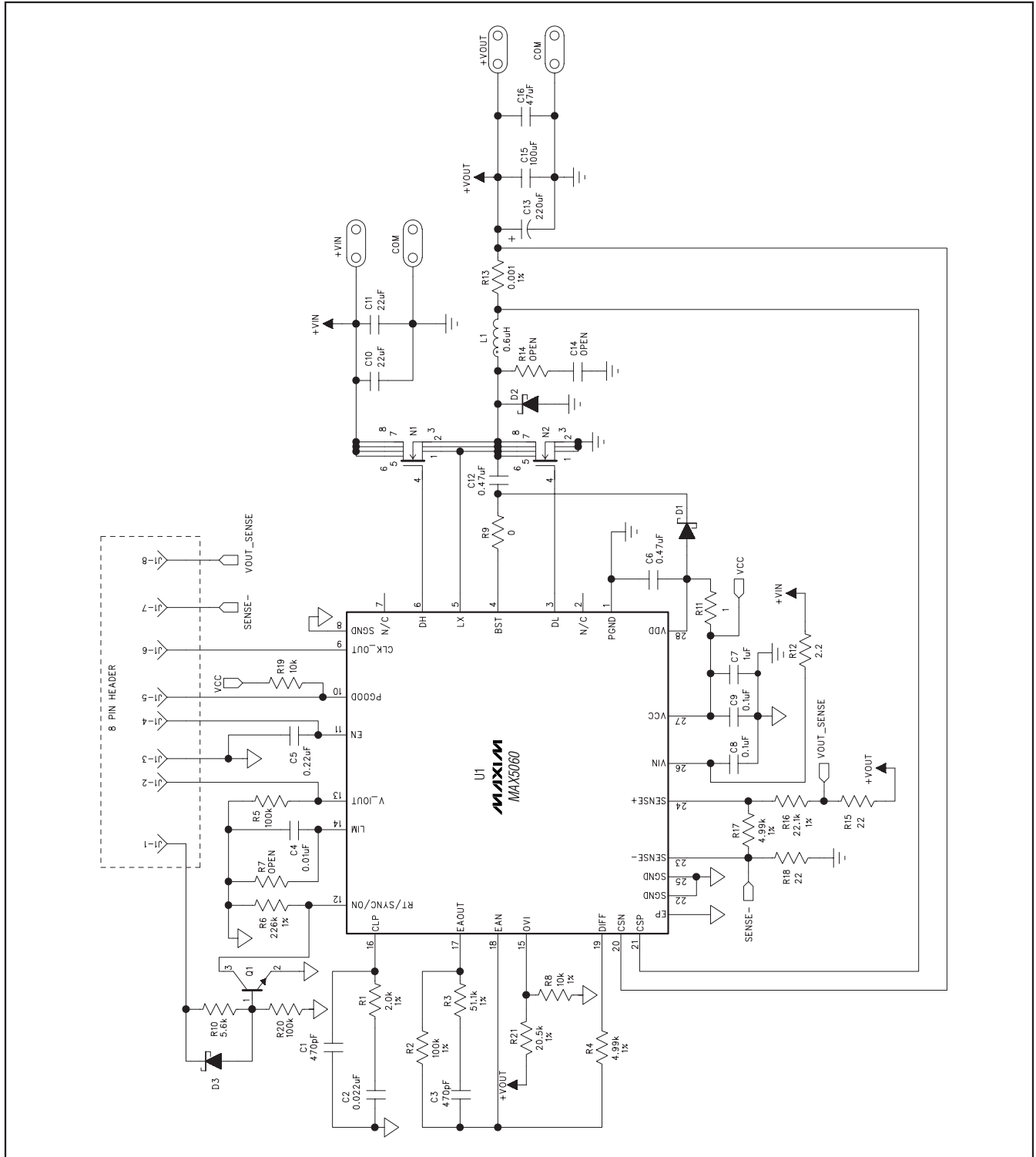


Figure 2. MAX5060 EV Kit Schematic

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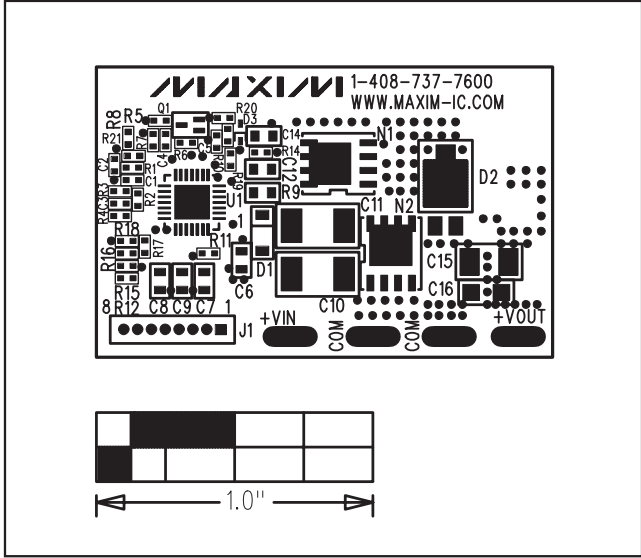


Figure 3. MAX5060 EV Kit Component Placement Guide—Top Layer

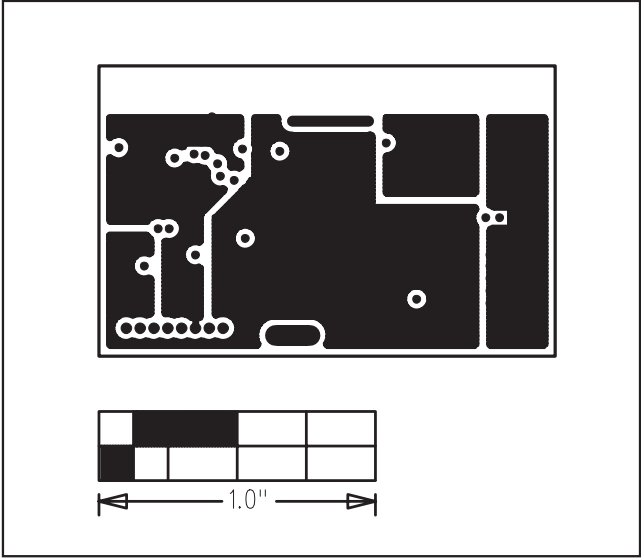


Figure 5. MAX5060 EV Kit PCB Layout—GND (Layer 2)

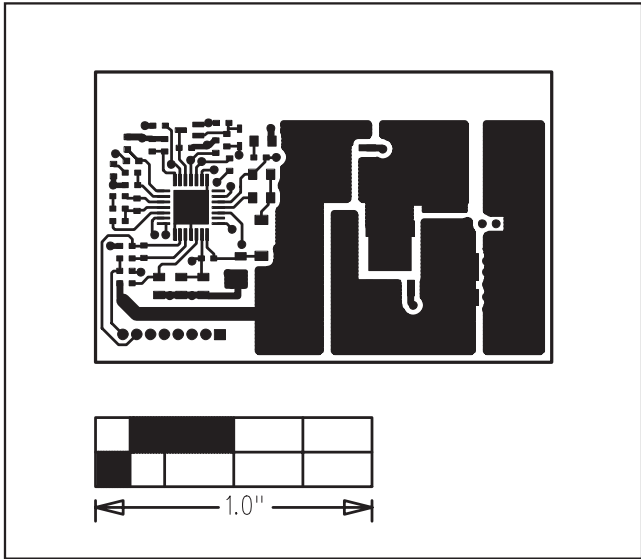


Figure 4. MAX5060 EV Kit PCB Layout—Top Layer

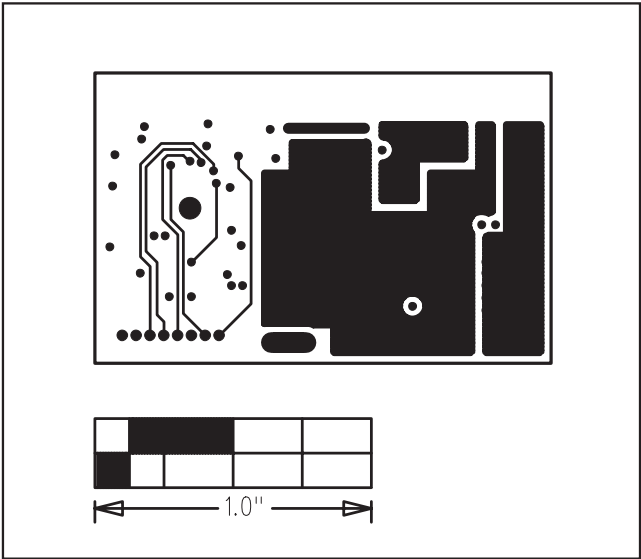


Figure 6. MAX5060 EV Kit PCB Layout—Signal and GND (Layer 3)

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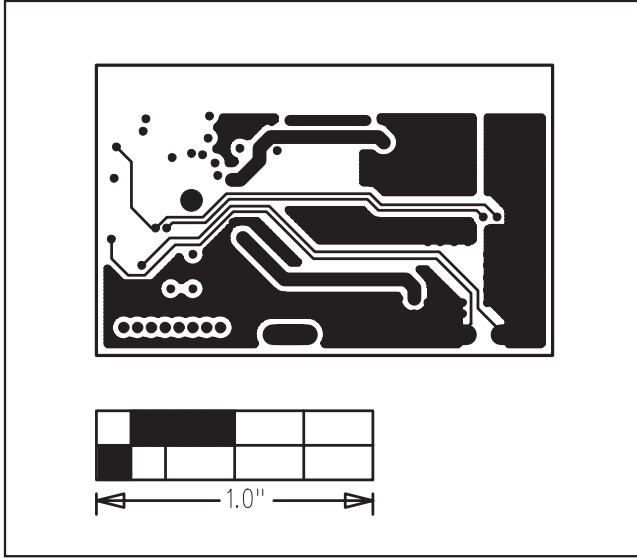


Figure 7. MAX5060 EV Kit PCB Layout—Signal (Layer 4)

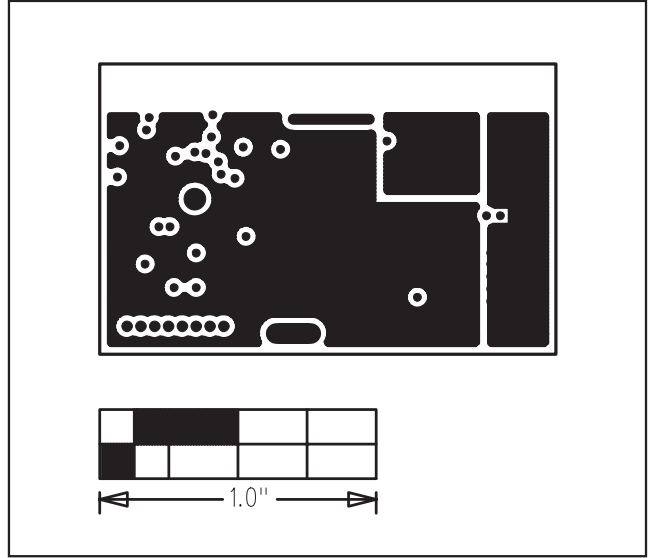


Figure 8. MAX5060 EV Kit PCB Layout—GND (Layer 5)

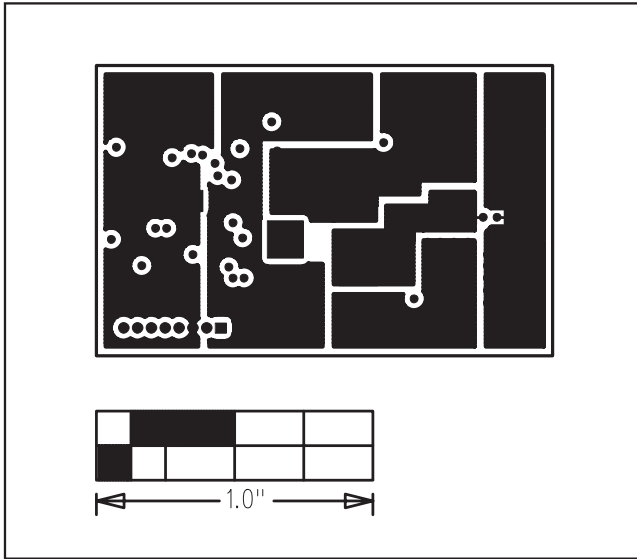


Figure 9. MAX5060 EV Kit PCB Layout—Bottom Layer

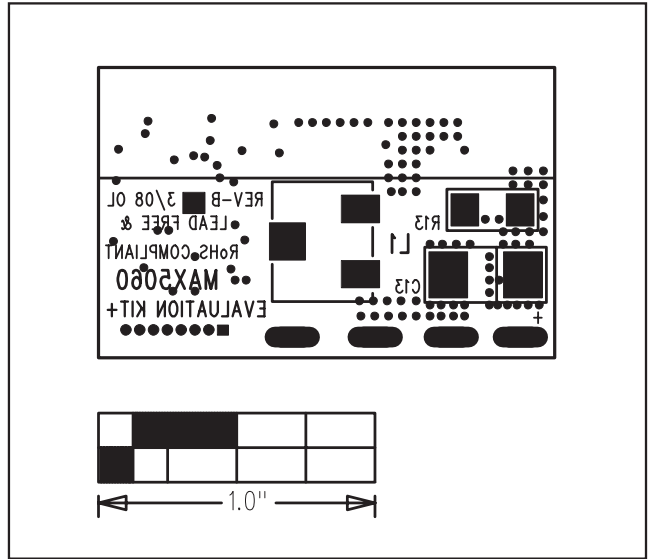


Figure 10. MAX5060 EV Kit Component Placement Guide—Bottom Layer



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## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	6/05	Initial release	—
1	4/08	Replaced obsolete inductor L1 and changed PCB to lead-free and RoHS-compliant.	1, 2, 5-8

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