General Description

The MAX17016 evaluation kit (EV kit) demonstrates the standard 10A application circuit of the MAX17016. This DC-DC converter steps down high-voltage batteries to generate low-voltage core or chipset/RAM bias supplies in notebook computers.

The MAX17016 EV kit provides a dynamically adjustable 1.5V/1.05V output voltage from a 7V to 24V battery input range. It delivers up to 10A output current while achieving high efficiency. Programmed by a single resistor, the EV kit operates at 300kHz switching frequency and has superior line- and load-transient response.

The EV kit is a fully assembled and tested printed circuit board (PCB). It also allows the evaluation of other dynamically adjustable output voltages by varying the external reference input, which can be realized by changing resistors R1, R2, and R3.

Features

- 7V to 24V Input Range
- Dynamically Selectable 1.5V/1.05V Output Voltage
- Dynamically Adjustable Output Voltage (0 to 0.9V_{IN} Range)
- 10A Output Current (Continuous)
- 300kHz Switching Frequency
- Power-Good Output Indicator (PGOOD)
- Low-Profile, Surface-Mount Components
- Fully Assembled and Tested

Ordering Information

PART	TYPE
MAX17016EVKIT+	EV Kit

+Denotes lead-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	1µF ±10%, 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J105K Taiyo Yuden LMK105BJ105KV
C3	1	1000pF ±10%, 50V ceramic capacitor (0402) TDK C1005X7R1H102K Murata GRM155R71H102K
C4, C5	2	10µF ±20%, 25V X5R ceramic capacitors (1210) TDK C3225X7R1E106M Taiyo Yuden TMK325BJ106MM
C6	0	Not installed, 1000µF, 50V aluminum electrolytic capacitor (16mm x 25mm) SANYO 50ME1000AX
C7	1	0.1µF ±10%, 25V X7R ceramic capacitor (0603) TDK C1608X7R1E104K Murata GRM188R71E104K
C8, C9, C13	0	Not installed, capacitors (0603)
C10, C11	2	330µF, 2V, 6mΩ polymer capacitors (D case) Panasonic EEFSX0D331XR (6mΩ ESR, 1.9mm height) NEC TOKIN PSGD0E337M7 (7mΩ ESR, 2.8mm height)
C12, C15–C19	6	10µF ±20%, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J106M Murata GRM21BR61A106K
C14	1	1µF ±10%, 25V X5R ceramic capacitor (0603) Murata GRM188R61E105K Taiyo Yuden GDK107BJ105KA
D1	1	3A, 30V Schottky diode (SMA case) Nihon EC31QS03L Central Semiconductor CMSH3-40MA, lead free
D2	1	Surface-mount LED, green (0805)
EN, FBSENSE, GATE, PGOOD, REFIN, $\overline{SKIP}$	6	Test points Keystone 5000

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
JU1	1	3-pin header
JU2	1	4-pin header
JU3	1	2-pin header
L1	1	1.0µH, 3.25mΩ, 16A power inductor Würth 744 355 2100 Vishay/Dale IHLP4040DZER1R0M11
N1	1	n-channel, logic-level MOSFET (SOT23) Fairchild 2N7002 (Top Mark: 702) Central Semiconductor 2N7002
N2	0	Not installed, n-channel MOSFET (DPAK)
R1, R11	2	49.9kΩ ±1% resistors (0603)
R2	1	54.9kΩ ±1% resistor (0603)
R3	1	97.6kΩ ±1% resistor (0603)

DESIGNATION	QTY	DESCRIPTION
R4	1	1kΩ ±5% resistor (0603)
R5	1	200kΩ ±1% resistor (0603)
R6	1	4.7Ω ±5% resistor (0603)
R7, R9	0	Not installed, resistors (0603)
R8	1	0Ω ±5% resistor (0603)
R10	1	40.2kΩ ±1% resistor (0603)
R12	1	10kΩ ±1% NTC resistor (0603) Murata NCP18XH103F03RB
R13	1	100kΩ ±5%, resistor (0603)
R14	1	Not installed, 1W resistor (2512)
R15	1	51Ω ±5% resistor (0603)
U1	1	PWM controller (40 TQFN) Maxim MAX17016ETL+
—	3	Shunts
—	1	PCB: MAX17016 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	637-435-1110	www.centralsemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
NEC TOKIN America, Inc.	408-324-1790	www.nec-tokinamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
SANYO Electric Co., Ltd.	619-661-6835	www.sanyodevice.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com
Würth Electronik GmbH & Co. KG	201-785-8800	www.we-online.com

Note: *Indicate that you are using the MAX17016 when contacting these component suppliers.*

Quick Start

Recommended Equipment

- 7V to 24V power supply, battery, or notebook AC adapter
- DC bias power supply, 5V at 100mA
- Dummy load capable of sinking 10A
- Digital multimeter (DMM)
- 100MHz dual-trace oscilloscope

Procedure

The MAX17016 EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are completed.**

1) Ensure that the circuit is connected correctly to the power supplies and dummy load prior to applying any power.

2) Verify that the shunts are placed as follows:

JUMPER	SHUNT POSITION	FUNCTION
JU1	1-2	EN high
JU2	1-2	Forced PWM
JU3	Not installed	+1.5V output

3) Turn on battery power prior to +5V bias power; otherwise, the output undervoltage (UVP) FAULT latch sets, disabling the regulator until +5V power is cycled below the VCC POR (0.5V) or EN is toggled.

4) Observe the 1.5V output with the DMM and/or oscilloscope. Look at the LX switching node and MOSFET gate-drive signals while varying the load current.

Detailed Description

Jumper Settings

Several jumper settings in the following tables illustrate some features of the MAX17016 EV kit.

Shutdown Control Input

The MAX17016 EV kit features a 3-pin jumper (JU1) that selects the shutdown control input. Table 1 lists the selectable jumper options.

Pulse-Skipping Control Input

The MAX17016 EV kit features a 4-pin jumper (JU2) for pulse-skipping control input. This four-level input determines the mode of operation under normal steady-state conditions and dynamic output-voltage transitions. The default configuration has a shunt installed at pins 1-2 for low-noise, forced-PWM mode. Table 2 lists the other selectable jumper options. Refer to the *Modes of Operation* section of the IC data sheet for a more detailed description.

Table 1. Jumper JU1 Functions

SHUNT POSITION	EN PIN	MAX17016 OUTPUT
1-2*	Connected to VDD	Enabled (V_{OUT} = 1.5V/1.05V)
2-3	Connected to GND	Shutdown mode (V_{OUT} = 0V)
Not installed	EN must be driven by an external signal connected to the EN test point	Operation depends on the external EN signal levels

**Default position.*

Table 2. Jumper JU2 Functions

SHUNT POSITION	$\overline{SKIP}$ PIN	OPERATIONAL MODE
1-2*	Connected to VDD	Low-noise mode, forced-PWM operation
1-3	Connected to REF	Pulse-skipping mode with forced-PWM during transitions
1-4	Connected to GND	Pulse-skipping mode without forced-PWM during transitions
Not installed	Open	Ultrasonic mode without forced-PWM during transitions

**Default position.*

External Gate

The MAX17016 EV kit features a 2-pin jumper (JU3) that controls the gate of the external MOSFET (N1). The external MOSFET can be controlled through the gate test point, to dynamically adjust the REFIN voltage by forcing N1's drain to a low- or a high-impedance state. The default configuration has a shunt installed on only one pin of JU3 to provide a 1.5V output. Table 3 lists the selectable jumper options.

Table 3. Jumper JU3 Functions

SHUNT POSITION	EXTERNAL GATE	MAX17016 OUTPUT
Installed	Connected to VDD	A logic-high on gate turns on the external MOSFET, effectively shorting R3 (V_{OUT} = 1.05V through resistor-dividers R1 and R2)
Not installed*	Pulled to GND by R13	A logic-low on gate turns off the external MOSFET (V_{OUT} = 1.5V through resistor-dividers R1 and R2 + R3)

**Default position.*

Evaluating Other Dynamic Output Voltages

The EV kit output is preset to 1.05V/1.5V. However, the output voltage can also be adjusted between 0 and 2V (FB = OUT) by selecting R1, R2, and R3 values. The MAX17016 regulates FB to the voltage set at REFIN. By changing the voltage at REFIN, the MAX17016 can be used in applications that require dynamic output voltage changes between multiple set points. Using the external gate signal, a resistor can be switched in and out of the REFIN resistor-divider, changing the voltage at REFIN. A logic-high on gate turns on the external n-channel MOSFET, forcing N1's drain to a low-impedance state. A logic-low on gate disables the n-channel MOSFET, so N1's drain is high impedance. The two output voltages (FB = OUT) are determined by the following equations:

$$V_{OUT(LOW)} = \left(\frac{R2}{R1+R2}\right) V_{REF}$$

$$V_{OUT(HIGH)} = \left(\frac{R2+R3}{R1+R2+R3}\right) V_{REF}$$

where V_{REF} = 2.0V.

Setting V_{OUT} with a Resistive Voltage-Divider at FB

Connecting FB to a resistive voltage-divider allows for output voltages above the reference voltage ($0.9V_{IN}$ range). To get an output above 2V, install resistor R9 with a 10kΩ ±1% resistor and replace R8 with following equation:

$$V_{OUT} = V_{FB}\left(1+\frac{R8}{R9}\right)$$

where $V_{FB} = V_{REFIN}$.

The switching frequency setting input should then be adjusted by replacing external resistor R5 (R_{TON}) according to the following equations:

$$T_{SW} = C_{TON}(R_{TON} + 6.5k\Omega)\left(\frac{V_{FB}}{V_{OUT}}\right)$$

$$T_{SW} = \frac{1}{f_{SW}}$$

where C_{TON} = 16.26pF, f_{SW} = 300kHz, and V_{FB} = V_{REFIN} under normal operating conditions.

Refer to the MAX17016 data sheet for selection of output capacitor and inductor values for output voltages greater than 2V.

Transient Load Tester

The MAX17016 EV kit features an optional transient load tester consisting of a power MOSFET (N2), R14, and a termination resistor (R15). Refer to Application Note 752: *Creating a Fast Load Transient*, located at **www.maximintegrated.com/AN752**, for a more detailed discussion.

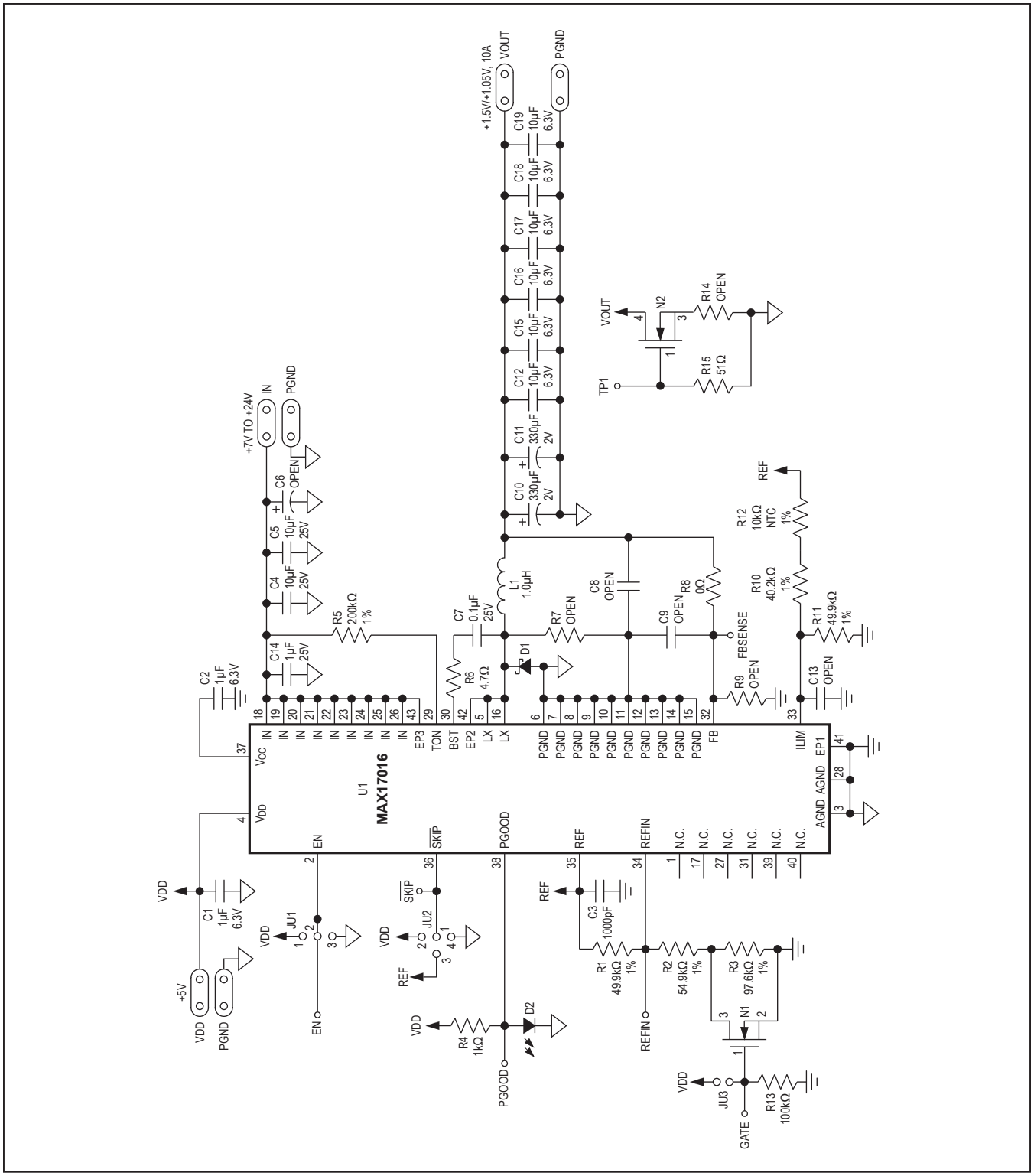

Figure 1. MAX17016 EV Kit Schematic

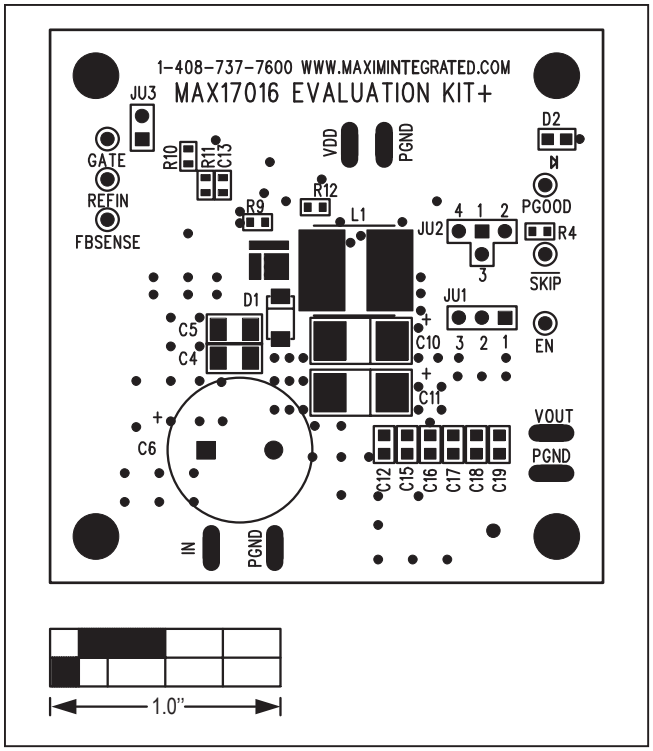

Figure 2. MAX17016 EV Kit Component Placement Guide—Component Side

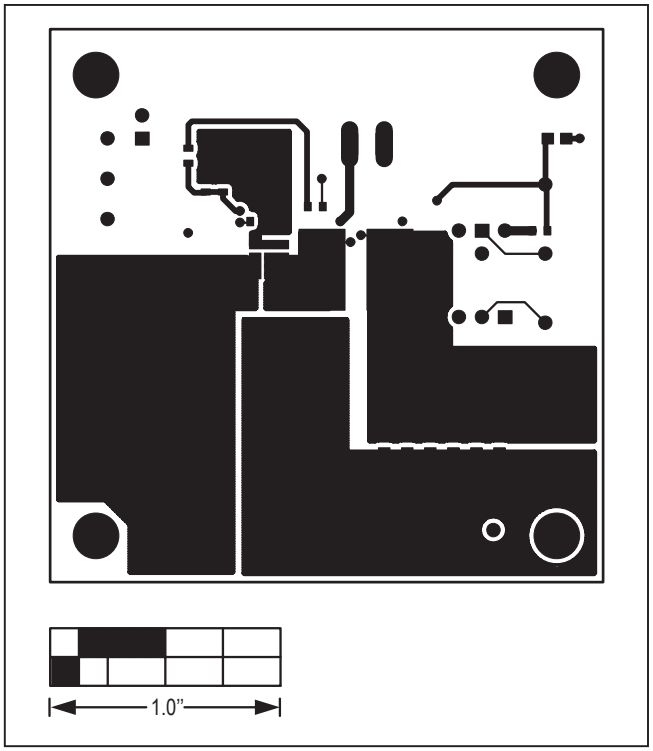

Figure 3. MAX17016 EV Kit PCB Layout—Component Side

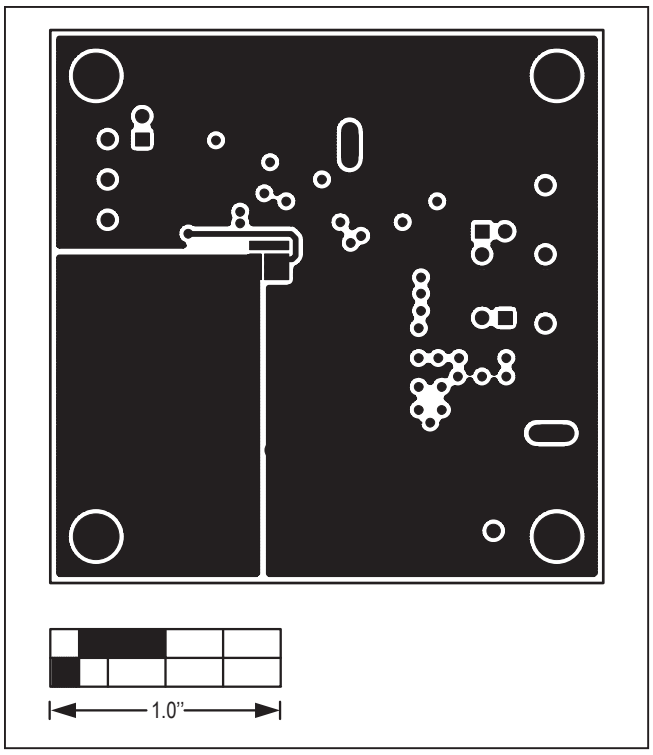

Figure 4. MAX17016 EV Kit PCB Layout—GND Layer 2

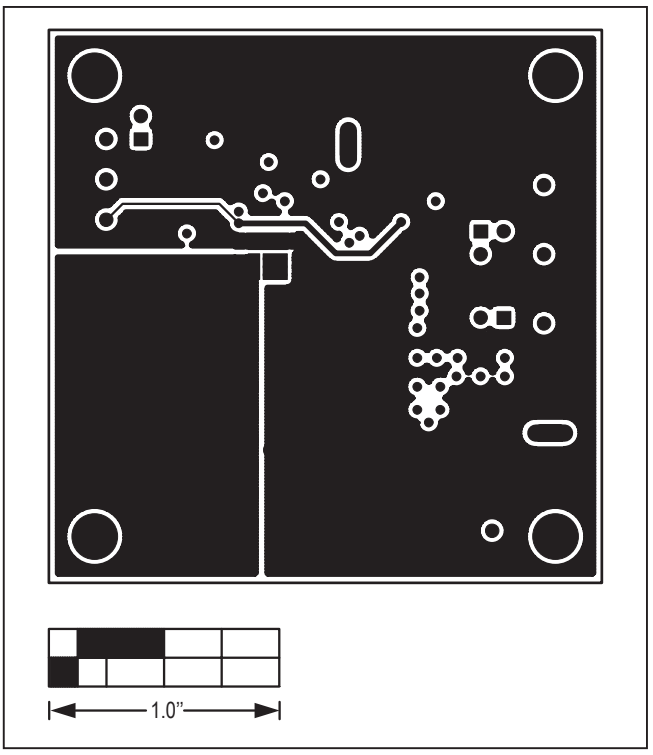

Figure 5. MAX17016 EV Kit PCB Layout—GND Layer 3

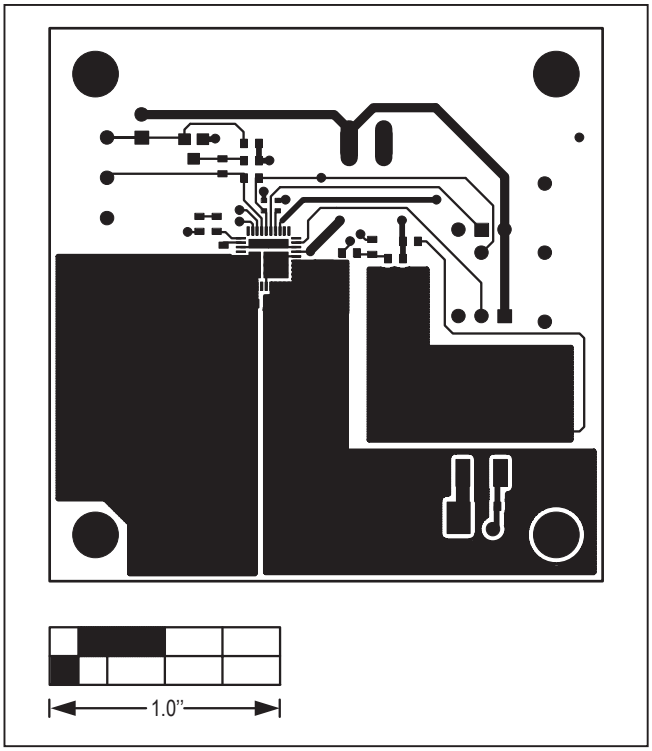

Figure 6. MAX17016 EV Kit PCB Layout—Solder Side

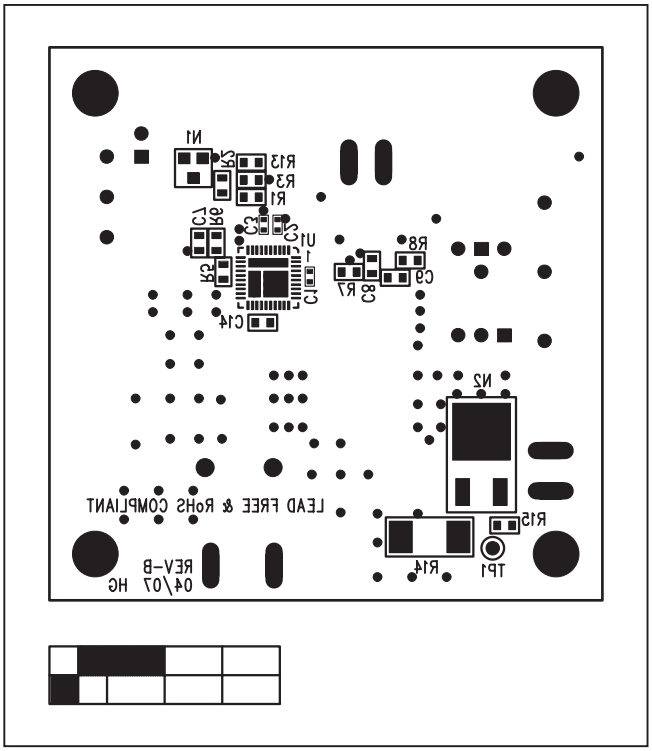

Figure 7. MAX17016 EV Kit Component Placement Guide—Solder Side

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated’s website at www.maximintegrated.com.

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