19-4947; Rev 1; 5/10

MAX16814 Evaluation Kit

General Description

The MAX16814 evaluation kit (EV kit) demonstrates the MAX16814 high-brightness LED (HB LED) driver, integrating a step-up DC-DC preregulator followed by 4 channels of linear current sinks. The step-up preregulator switches at 350kHz and operates as a current-mode-controlled regulator capable of providing up to 600mA for the linear circuits. Each of the 4 linear channels can operate up to 40V and provide up to 150mA per channel. The 4 channels are configurable for 100mA or 150mA HB LED output current. The IC is a 20-pin TSSOP package with an exposed pad for enhanced thermal power dissipation.

The EV kit operates from a DC supply voltage of 6.5V up to the HB LED string forward voltage. The EV kit can withstand a 40V load-dump condition. The EV kit also demonstrates the IC features such as adaptive voltage optimization, undervoltage lockout (UVLO), overvoltage protection (OVP), cycle-by-cycle current limit, thermal shutdown, and digital PWM dimming operation using a digital PWM input signal to control the brightness of the HB LEDs. The EV kit also demonstrates a reference IC design for automotive applications.

Features

- **Input Voltage from 6.5V Up to HB LED Forward Voltage**
- **Demonstrates OVP (33V)**
- **HB LED String Output Currents Configurable for 100mA or 150mA**
- **Demonstrates UVLO (5V)**
- **Demonstrates Open and Short LED Fault Protection and Detection**
- **Demonstrates Cycle-by-Cycle Current Limit and Thermal-Shutdown Features**
- **Demonstrates Adaptive Voltage Optimization**
- **Proven PCB and Thermal Design**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX16814EVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	10µF, 50V electrolytic capacitor (6.3mm x 6mm case) SANYO 50CE10KX
C2	1	47µF, 50V electrolytic capacitor (6.3mm x 7.7mm case) SANYO 50CE47KX
C3, C4, C7, C12	4	1µF ±10%, 50V X7R ceramic capacitors (0805) Murata GRM21BR71H105K
C5	1	33µF, 50V electrolytic capacitor (6.3mm x 7.7mm case) SANYO 50CE33KX
C6	0	Not installed, electrolytic capacitor (6.3mm x 7.7mm case)
C8, C13–C16	0	Not installed, ceramic capacitors (0603)
C9	1	1000pF ±5%, 25V C0G ceramic capacitor (0603) Murata GRM1885C1E102J
C10	1	0.022µF ±5%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H223K
C11	1	0.1µF ±10%, 50V X7R ceramic capacitor (0805) Murata GRM21BR71H104K
C17	1	47pF ±5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H470J
C18–C21	4	2200pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H222J
D1	1	60V, 1A Schottky diode (SMB) Diodes, Inc. B160B-13-F
D2	1	75V, 250mA high-speed diode (SOT23) Central Semi CMPD914E (Top Mark: C5DE)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
JU1, JU3–JU11	10	2-pin headers
JU2	1	3-pin header
L1	1	10µH ±20%, 3A inductor Coilcraft MSS1048-103ML
L2	1	22µH ±20%, 5A inductor Coilcraft MSS1260-223Ml
N1	1	40V, 9A n-channel MOSFET (8 SO) International Rectifier IRF7469
R1	1	33.2kΩ ±1% resistor (0805)
R2, R7	2	10kΩ ±1% resistors (0805)
R3	1	22Ω ±5% resistor (0805)
R4	1	0.100Ω ±1%, 0.5W resistor (2010) IRC LRC-LRF2010LF-01-R100-F
R5	1	2.4kΩ ±1% resistor (0805)
R6	1	261kΩ ±1% resistor (0805)
R8, R9	2	10kΩ ±5% resistors (0805)
R10, R16	2	30.1kΩ ±1% resistors (0805)
R11	1	20kΩ ±1% resistor (0805)
R12	1	200Ω ±1% resistor (0603)
R13	1	21kΩ ±1% resistor (0603)
R14	1	4.7Ω ±5% resistor (0805)
R15	1	15kΩ ±1% resistor (0805)
R17	0	Not installed, resistor (0603)
SGND	1	PC miniature test point, black
U1	1	4-channel HB LED driver controller (20 TSSOP-EP*) Maxim MAX16814AUP+
VCC	1	PC miniature test point, red
—	7	Shunts (JU1–JU7)
—	1	PCB: MAX16814 EVALUATION KIT+

EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	631-435-1110	www.centralsemi.com
Coilcraft, Inc.	847-639-6400	www.coilcraft.com
Diodes, Inc.	805-446-4800	www.diodes.com
International Rectifier	310-322-3331	www.irf.com
IRC, Inc.	361-992-7900	www.irctt.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
SANYO Electric Co., Ltd.	619-661-6835	www.sanyodevice.com

Note: *Indicate that you are using the MAX16814 EV kit when contacting these component suppliers.*

Quick Start

Required Equipment

- MAX16814 EV kit
- 6.5V to 40V, 4A DC power supply
- One digital voltmeter
- Four series-connected HB LED strings rated no less than 150mA
- A current probe to measure the HB LED current

Output Testing

The 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) Verify that a shunt is installed on jumper JU1 and on pins 1-2 of jumper JU2 (enabled).
2) Verify that a shunt is installed on jumper JU3 (150mA).
3) Verify that shunts are not installed on jumpers JU4–JU7 (all channels powered).
4) Connect the power supply to the VIN pad and the power supply's ground to the PGND PCB pad.
5) Connect the digital voltmeter across the OUT1 and PGND PCB pads.
6) Connect each HB LED string as follows:

   Channel 1: Connect an HB LED string anode to the VOUT PCB pad and the cathode to the OUT1 PCB pad.

   Channel 2: Connect an HB LED string anode to the VOUT PCB pad and the cathode to the OUT2 PCB pad.

   Channel 3: Connect an HB LED string anode to the VOUT PCB pad and the cathode to the OUT3 PCB pad.

   Channel 4: Connect an HB LED string anode to the VOUT PCB pad and the cathode to the OUT4 PCB pad.
7) Clip the current probe across the channel 1 HB LED wire to measure the HB LED current.
8) Turn on the power supply and set it to 10V.
9) Measure the voltage from the OUT1–OUT4 PCB pads to PGND and verify that the lowest voltage is approximately 1V.
10) Measure the HB LED current using the current probe and verify all channels.

Detailed Description of Hardware

The MAX16814 EV kit demonstrates the MAX16814 HB LED driver with an integrated step-up DC-DC preregulator followed by 4 channels of linear current sinks. The preregulator switches at 350kHz and operates as a current-mode-controlled regulator providing up to 600mA for the linear circuit while providing OVP. Cycle-by-cycle current limit is set by resistor R4 and resistors R6 and R7 set the OVP voltage to 33V. The preregulator power section consists of inductor L2, MOSFET N1, power-sense resistor R4, and switching diode D1.

The EV kit circuit operates from a DC supply voltage of 6.5V up to the HB LED forward string voltage. The circuit handles load-dump conditions up to 40V. Bulk capacitors C1, C2 and inductor L1 provide EMI filtering on the VIN power line. The IN power UVLO is set to 5.5V by resistors R1 and R2. The IC, in a 20-pin TSSOP package with an exposed pad, provides enhanced thermal power dissipation on a proven 1oz copper PCB design.

Each of the 4 linear channels (OUT1–OUT4) can operate up to 40V and sink up to 150mA per channel. Each of the 4 channel's linear current sinks are configurable for 150mA or 100mA, or can be disabled independently. Jumpers JU4–JU7 provide the disable feature when the HB LED string is not connected. See the *Channel 1–Channel 4 Current-Sink Disabling* section. Resistors R15, R16 and jumper JU3 configure the linear current setting for the IC SETI pin, which sets the HB LED string current.

The EV kit features PCB pads to facilitate connecting HB LED strings for evaluation. The VOUT PCB pads provide connections for connecting each HB LED string's anode to the DC-DC preregulator output. The OUT1–OUT4 PCB pads provide connections for connecting each HB LED string's cathode to the respective linear channel's current sink. Additionally, 2-pin headers JU8–JU11 provide convenient access to the VOUT and respective OUT_ connections when using a twisted-pair wiring-connection scheme. On each header, pin 1 provides access to the respective OUT_ connection and pin 2 provides access to the VOUT connection. Capacitors C18–C21 are included on the design to prevent oscillations and provide stability when using long, untwisted HB LED connecting cables during lab evaluation. These capacitors are not required on a typical HB LED design.

A DIM PCB pad is provided for using a digital PWM signal to control the brightness of the HB LEDs. The EV kit can also demonstrate the IC's synchronizing feature using the SYNC PCB pad and an external AC clock signal. Test points are provided for easy access to IC's VCC and SGND.

Enable and UVLO

The EV kit features two jumpers to enable/disable U1 and configure the UVLO. Jumper JU1 enables the EV kit when a shunt is installed and a shunt is also installed on pins 1-2 of jumper JU2. Removing jumper JU1 disables the EV kit. Configuring jumper JU2 to pins 2-3 allows an external controller to enable the circuit and also disables UVLO resistors R1 and R2. Connect the external controller to the ENABLE and SGND PCB pads. Refer to the *Enable* section in the MAX16814 IC data sheet for additional information. See Table 1 for jumper JU1 and JU2 settings.

HB LED Current

The EV kit features a jumper to reconfigure the IC current sinks on all 4 channels. When inserted, jumper JU3 configures the current-sink limits to 150mA, and removing the jumper configures the current-sink limits to 100mA. See Table 2 for jumper JU3 settings.

Table 1. Enable and UVLO (JU1, JU2)

SHUNT POSITION		EN PIN	EV KIT OPERATION
JU1	JU2		
Installed	1-2	Connected to UVLO R1 and R2 divider	Enabled (UVLO operating)
Not installed	1-2	Connected to UVLO R1 and R2 divider	Disabled
Not installed	2-3	Connected to ENABLE PCB pad	External controller enabled (no on-board UVLO)

Table 2. HB LED Current (JU3)

SHUNT POSITION	SETI PIN	HB LED CURRENT-SINK LIMITS (mA)
Not installed	Connected to R15	100
Installed	Connected to R15 and R16	150

To reconfigure the circuit for another current-sink threshold, replace resistor R15 and use the following equation to calculate a new value for the desired current:

$$R15 = \frac{1500}{I_{LED}}$$

where I_{LED} is the desired HB LED current in amps and R15 is the new resistor value for obtaining the desired HB LED current. Remove jumper JU3 when configuring for another current-sink level.

Channel 1–Channel 4 Current-Sink Disabling

The EV kit features jumpers to disable each channel's OUT_ current sink. When disabling a channel, install a jumper in the channel's respective OUT_ jumper. Remove the shunt to use a channel's OUT_ sink capability. See Table 3 for jumper JU4–JU7 settings.

Table 3. Disabling Channel 1–Channel 4 (JU4–JU7)

OUT_	JUMPER	SHUNT POSITION	CHANNEL OPERATION
OUT1	JU4	Not installed	Channel 1 operational, connect an HB LED string* to VOUT and OUT1
		Installed	Channel 1 OUT1 not used
OUT2	JU5	Not installed	Channel 2 operational, connect an HB LED string* to VOUT and OUT2
		Installed	Channel 2 OUT2 not used
OUT3	JU6	Not installed	Channel 3 operational, connect an HB LED string* to VOUT and OUT3
		Installed	Channel 3 OUT3 not used
OUT4	JU7	Not installed	Channel 4 operational, connect an HB LED string* to VOUT and OUT4
		Installed	Channel 4 OUT4 not used

**The series-connected HB LED string must be rated no less than 150mA.*

Additional Configurations and Features

The EV kit includes several other features to facilitate evaluation of the IC. HB LED digital dimming control, fault management through a $\overline{FLT}$ signal, synchronizing to an external clock using the RT signal, and reconfiguring the OVP for other voltages are detailed in the following sections.

HB LED Digital-Dimming Control

The EV kit features a DIM PCB input pad for connecting an external digital PWM signal. The DIM PCB pad is pulled up to VCC by resistor R8. Apply a digital PWM signal with a 0.8V logic-low (or less) and a 2.1V logic-high (or greater) level, and frequencies from 100Hz to 20kHz. To adjust the HB LED brightness, vary the signal duty cycle from 0 to 100% and maintain a minimum pulse width of 1µs. Apply the digital PWM signal to the DIM and SGND PCB pads. Refer to the *LED Dimming Control* section in the MAX16814 IC data sheet for additional information on the MAX16814 dimming feature.

$\overline{FLT}$ and RT (External Clock Synchronizing) Signals

The EV kit features the IC's $\overline{FLT}$ and AC-coupled RT signals. The $\overline{FLT}$ signal is pulled up to VCC by resistor R9. The $\overline{FLT}$ signal is pulled low when there are open or shorted HB LED(s) on an OUT_ channel or a thermal shutdown condition has occurred. Refer to the *Fault Protections* section in the MAX16814 IC data sheet for further information on the $\overline{FLT}$ signal.

The SYNC PCB pad is used for connecting an external clock for synchronizing the IC switching frequency through its RT pin. The signal must also have a $4V_{P-P}$ amplitude and frequencies from 390kHz to 410kHz. Apply the external clock signal to the SYNC and SGND PCB pads. Refer to the *Oscillator Frequency/External Synchronization* section in the MAX16814 IC data sheet for additional information on the MAX16814 synchronizing feature.

OVP Configuration

The IC OVP resistors (R6 and R7) are configured for an OVP of 33V. This sets the maximum channel (VOUT) voltage at 33V. Capacitor C9 provides noise filtering to the OVP signal. To reconfigure the circuit for a different OVP voltage, replace resistor R6 with a different value using the following equation:

$$R6 = \left(\frac{OVP}{1001.235} - 1\right) \times R7$$

where R7 is 10kΩ, OVP is the overvoltage protection voltage desired, and R6 is the new resistor value for obtaining the desired overvoltage protection. Refer to the *Open-LED Management and Overvoltage Protection* section in the MAX16814 IC data sheet for additional information on the OVP feature.

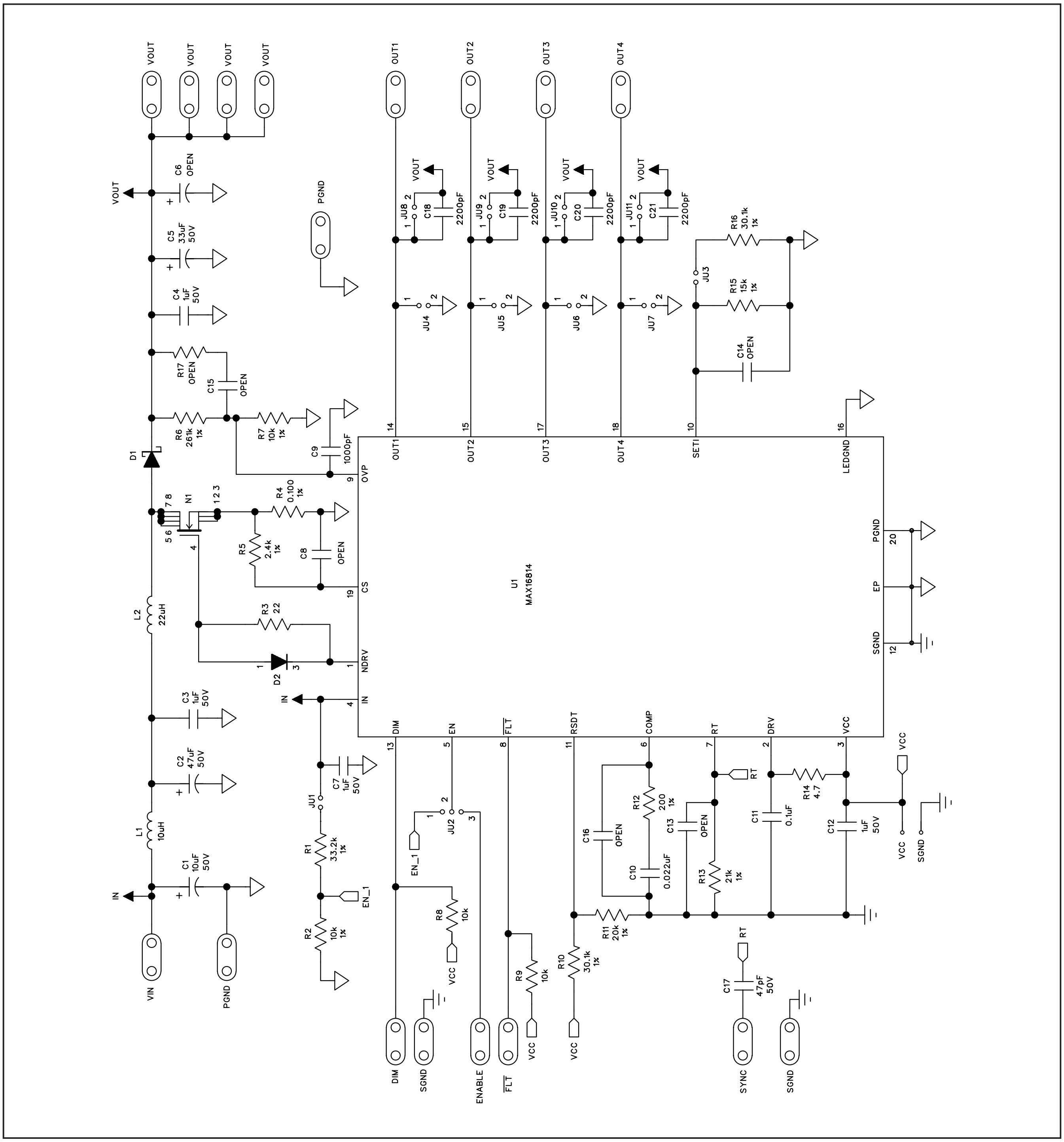

Figure 1. MAX16814 EV Kit Schematic

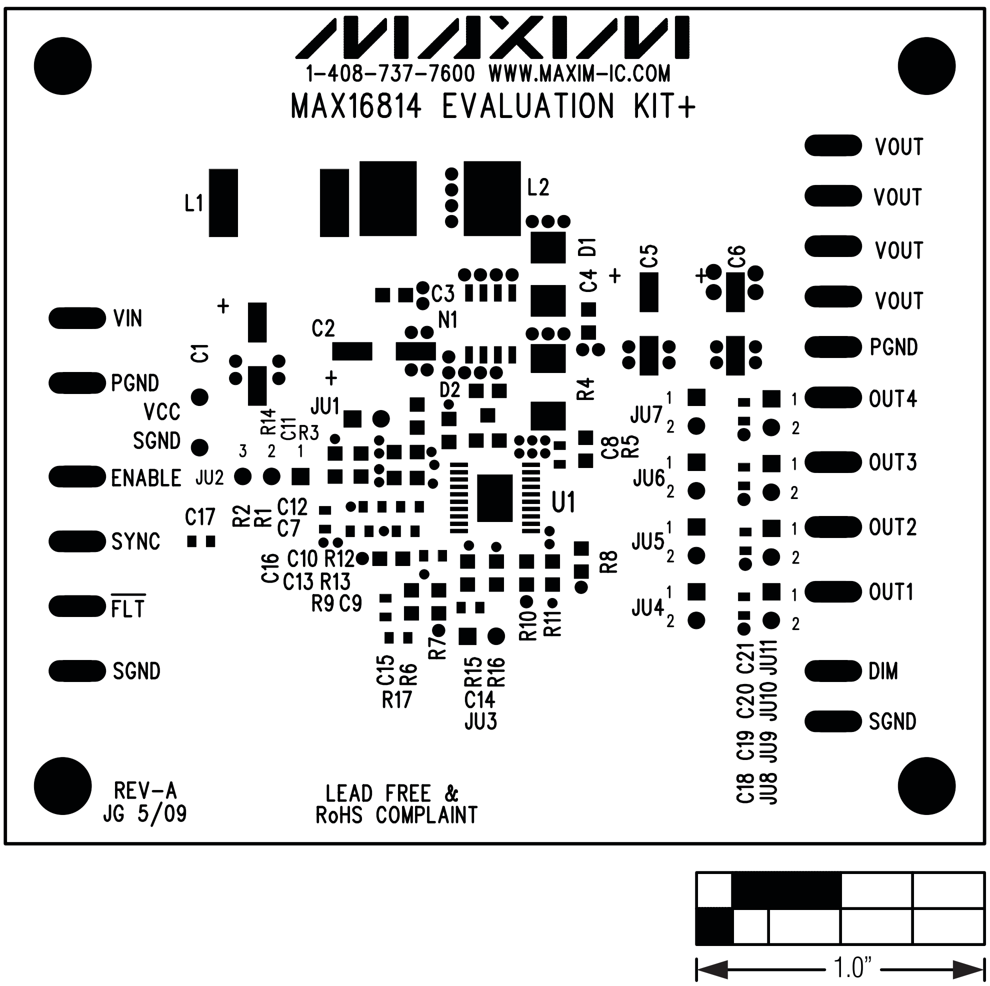

Figure 2. MAX16814 EV Kit Component Placement Guide—Component Side

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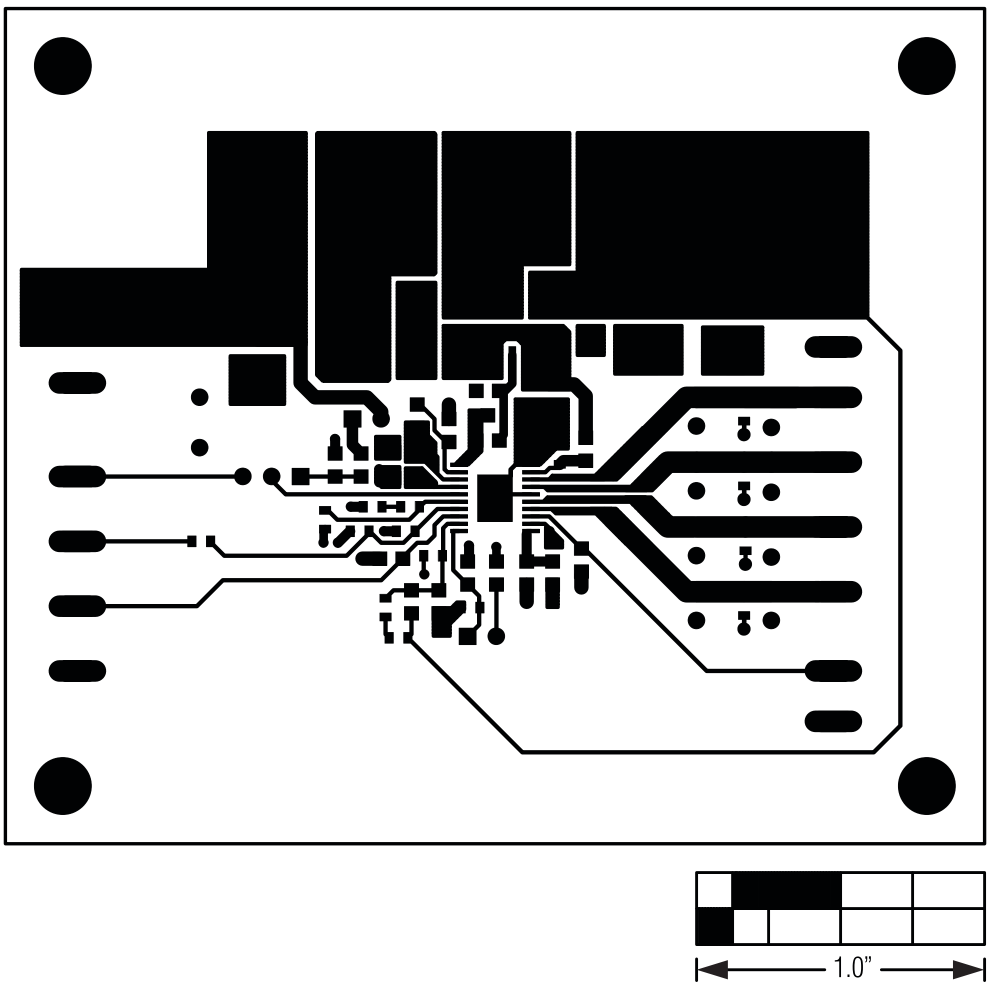

Figure 3. MAX16814 EV Kit PCB Layout—Component Side

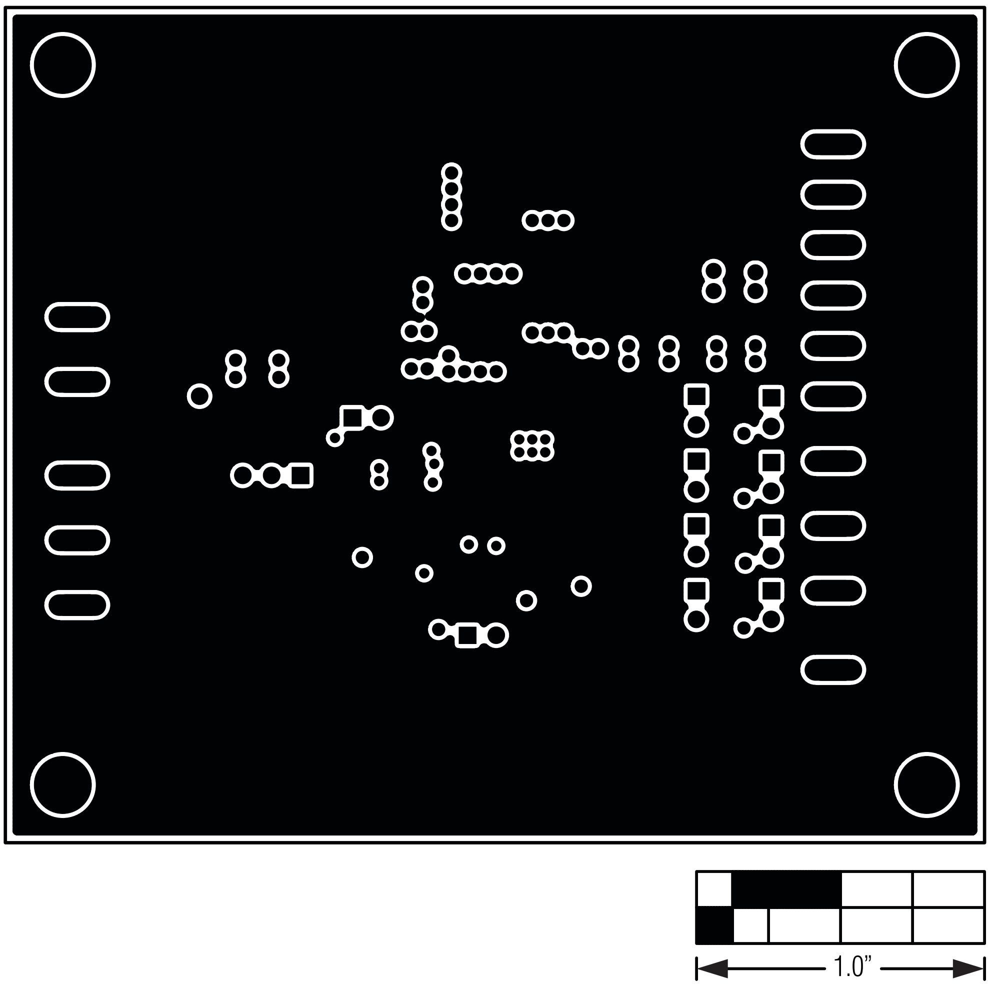

Figure 4. MAX16814 EV Kit PCB Layout—SGND Layer 2

MAX16814 Evaluation Kit

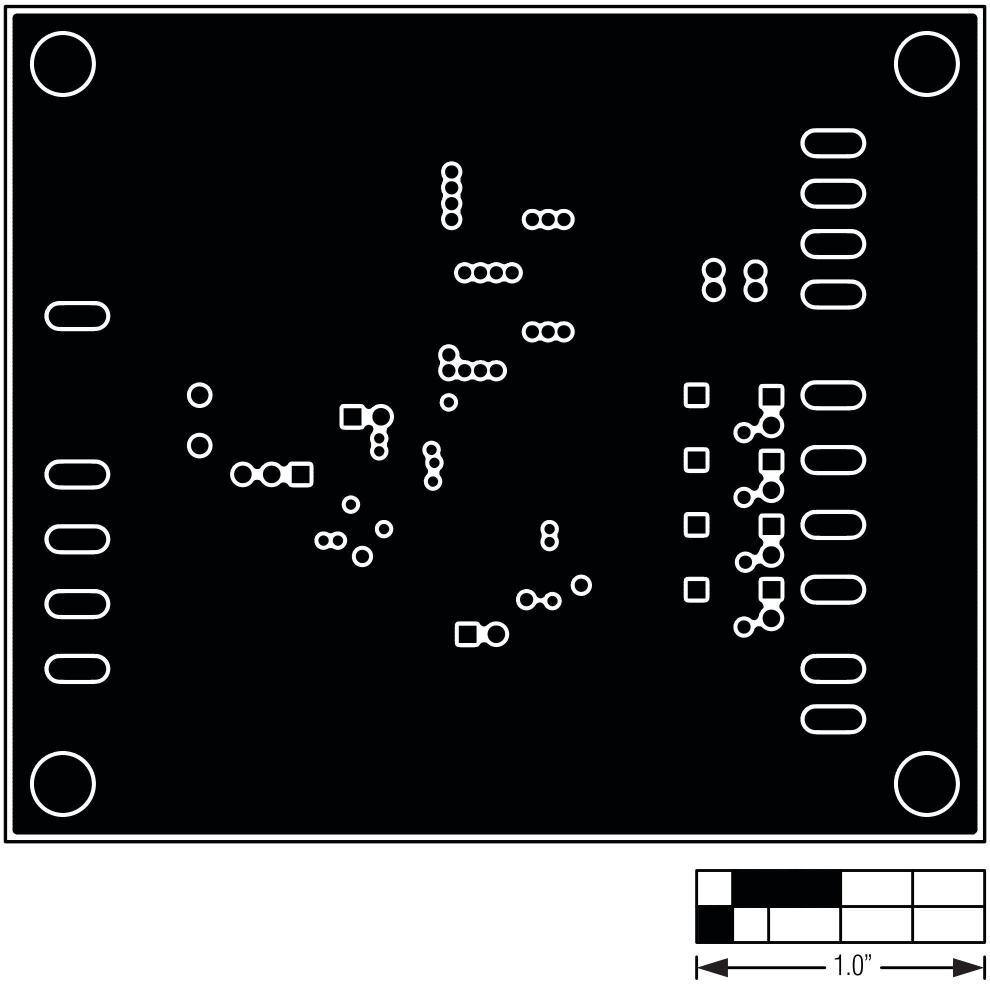

Figure 5. MAX16814 EV Kit PCB Layout—PGND Layer 3

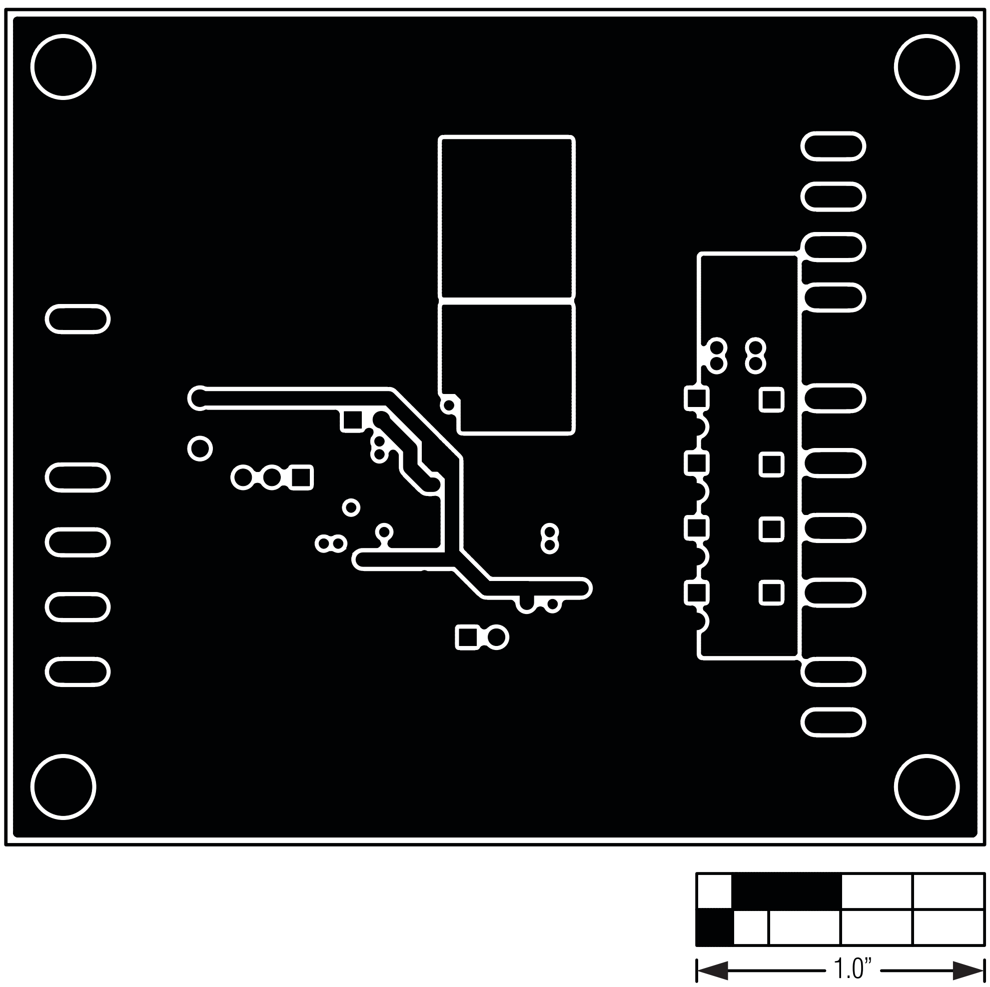

Figure 6. MAX16814 EV Kit PCB Layout—VCC and PGND Solder Side

MAX16814 Evaluation Kit

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/09	Initial release	—
1	5/10	Updated R12 in *Component List* and Figure 1	2, 6

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Электрон
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