



MAX16838 Evaluation Kit

General Description

The MAX16838 evaluation kit (EV kit) demonstrates the MAX16838 high-brightness LED (HB LED) driver, integrating a step-up DC-DC preregulator followed by two channels of linear current sinks. The step-up preregulator switches at 500kHz and operates as a current-mode-controlled regulator capable of providing up to 300mA for the linear circuits. Each channel is capable of operating up to 33V and provides up to 150mA. The channels are configurable for 100mA or 150mA HB LED output current. The MAX16838 IC is available in a 20-pin TQFN package with an exposed pad for enhanced thermal power dissipation.

The MAX16838 EV kit operates from a DC supply voltage of 7V up to the HB LED string-forward voltage. The EV kit can withstand a 40V load-dump condition. The EV kit also demonstrates the MAX16838 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.

Features

- ◆ **Input Voltage from 7V Up to HB LED Forward Voltage**
- ◆ **Demonstrates Overvoltage Protection (35.6V)**
- ◆ **HB LED String Output Currents Configurable for 100mA or 150mA**
- ◆ **Demonstrates UVLO (6.4V)**
- ◆ **Demonstrates Cycle-by-Cycle Current Limit and Thermal Shutdown Features**
- ◆ **Demonstrates Adaptive Output-Voltage Optimization**
- ◆ **Configurable LED Current Foldback (VIN < 6.5V)**
- ◆ **Proven PCB and Thermal Design**
- ◆ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX16838EVKIT+	EV Kit

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	10 μ F, 50V electrolytic capacitor (6.3mm x 6.0mm case) SANYO 50CE10KX
C2	1	47 μ F, 50V electrolytic capacitor (6.3mm x 7.7mm case) SANYO 50CE47KX
C3, C6	2	0.1 μ F \pm 10%, 50V X7R ceramic capacitors (0805) Murata GRM21BR71H104K
C4, C5, C9	3	1 μ F \pm 10%, 50V X7R ceramic capacitors (0805) Murata GRM21BR71H105K
C7	1	47 μ F, 50V electrolytic capacitor (6.3mm x 7.7mm case) Panasonic EEE-FK1H470XP
C8	1	33 μ F, 50V electrolytic capacitor (6.3mm x 7.7mm case) SANYO 50CE33KX
C10	1	1000pF \pm 10%, 25V X7R ceramic capacitor (0805) Murata GRM216R71E102K

DESIGNATION	QTY	DESCRIPTION
C11	1	0.22 μ F \pm 10%, 50V X7R ceramic capacitor (0805) Murata GRM21BR71H224K
C12, C13	0	Not installed, ceramic capacitors (0603)
C14	1	4700pF \pm 5%, 50V C0G ceramic capacitor (0805) Murata GRM2165C2A472JA
C15, C16	2	2200pF \pm 5%, 50V C0G ceramic capacitors (0805) Murata GRM2165C2A222JA
D1	1	40V, 3A Schottky diode (SMA) Diodes Inc. B340LA
D2	1	75V, 250mA high-speed diode (SOT23) Central Semi CMPD914E (Top Mark: C5DE)
JU1	1	3-pin header
JU2, JU3	2	2-pin headers
L1	1	10 μ H \pm 20%, 3.5A inductor Coilcraft MSS734-103ML



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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
L2	1	33 μ H \pm 20%, 2.9A inductor Coilcraft MSS1246-333ML
R1	1	169k Ω \pm 1% resistor (0805) Use lead-free only
R2, R4	2	40.2k Ω \pm 1% resistors (0805) Use lead-free only
R3	1	172k Ω \pm 1% resistor (0805) Use lead-free only
R5, R6	2	2.2k Ω \pm 5% resistors (0805) Use lead-free only
R7	1	0.12k Ω \pm 1%, 1W sense resistor (2010) IRC LRC-LR2010LF-01-R120-F
R8	1	22.1k Ω \pm 1% resistor (0805)
R9	1	619k Ω \pm 1% resistor (0805)

DESIGNATION	QTY	DESCRIPTION
R10	1	10k Ω \pm 5% resistor (0805)
R11	1	11k Ω \pm 5% resistor (0805)
R12	1	1.6k Ω \pm 5% resistor (0805)
R13	1	15k Ω \pm 1% resistor (0805)
R14	1	21k Ω \pm 1% resistor (0805)
R15	1	30.1k Ω \pm 1% resistor (0805)
SGND	1	Black miniature PC test point
U1	1	Dual-channel LED driver (20 TQFN-EP*) Maxim MAX16838ATP+
VCC	1	Red miniature PC test point
—	3	Shunts (JU1, JU2, JU3)
—	1	PCB: MAX16838 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 Incorporated	805-446-4800	www.diodes.com
IRC, Inc.	361-992-7900	www.irctt.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
SANYO Electric Co., Ltd.	619-661-6835	www.sanyodevice.com

Note: Indicate that you are using the MAX16838 when contacting these component suppliers.

Quick Start

Required Equipment

- MAX16838 EV kit
- 7V to 40V, 2A DC power supply
- Digital voltmeter
- Two series-connected HB LED strings rated no less than 150mA
- Current probe to measure the HB LED current

Procedure

The MAX16838 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 pins 2-3 of jumper JU1 (enabled).
- 2) Verify that a shunt is installed on jumper JU2 (LED current = 150mA).
- 3) Verify that a shunt is not installed on jumper JU3 (independent channel operation).
- 4) Connect the power supply to the VIN PCB 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 an HB LED string anode to the CH1 PCB pad and the cathode to the OUT1 PCB pad.
- 7) Connect an HB LED string anode to the CH2 PCB pad and the cathode to the OUT2 PCB pad.

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- 8) Clip the current probe across the channel 1 or channel 2 HB LED+ wire to measure the HB LED current.
- 9) Turn on the power supply and set it to 10V.
- 10) Measure the voltage from the OUT1 and OUT2 PCB pads to PGND and verify that the lowest voltage is approximately 1V.
- 11) Measure the HB LED current using the current probe and verify both channels' operation.

Detailed Description of Hardware

The MAX16838 EV kit demonstrates the MAX16838 HB LED driver with an integrated power MOSFET and step-up DC-DC preregulator followed by two channels of linear current sinks. The preregulator switches at 500kHz and operates as a current-mode-controlled regulator, providing up to 300mA for the linear circuit while providing OVP. Cycle-by-cycle peak current limit is set to 2.5A by resistor R7. Resistors R8 and R9 set the OVP voltage to 35.6V. The preregulator power section consists of inductor L2, switching diode D1, and current-sense resistor R7.

The MAX16838 EV kit circuit operates from a DC supply voltage of 7V up to the HB LED string-forward voltage, providing at least 2A. The circuit handles load-dump conditions up to 40V. Optional bulk capacitor C1 and inductor L1 provide EMI filtering on the VIN power line. The VIN power UVLO is set to 6.4V by resistors R1 and R2. The LED current foldback threshold is set by resistors R3 and R4 and linearly drops the LED string current when VIN drops below 6.5V. The MAX16838 IC, in a 20-pin TQFN package with an exposed pad, provides enhanced thermal power dissipation on a proven 1oz copper PCB design.

Output channels OUT1 and OUT2 are capable of operating up to 33V and sink up to 150mA per channel. The output channels' linear current sinks are configurable for 150mA or 100mA. The EV kit is capable of driving higher rated LEDs by shorting OUT1 and OUT2 (using jumper JU3), thus providing up to 300mA to the connected LED string. Resistors R13 and R15 and jumper JU2 configure the linear current setting for the MAX16838 ISET pin, which sets the HB LED string current.

The MAX16838 EV kit features PCB pads to facilitate connecting HB LED strings for evaluation. The CH1 and CH2 PCB pads provide connections for connecting each HB LED string's anode to the DC-DC preregulator output. The OUT1 and OUT2 PCB pads provide connections

for connecting each HB LED string's cathode to the respective linear channel's current sink.

A DIM PCB pad is provided for using a digital PWM signal to control the brightness of the HB LEDs. Test points are also provided for easy access to MAX16838 IC's VCC and SGND.

Enable and UVLO

The MAX16838 EV kit features jumper JU1, which enables/disables U1 and configures the UVLO. Install a shunt across pins 1-2 to allow an external controller to enable the circuit. Connect the external controller to EN and SGND PCB pads. Install a shunt across pins 2-3 to enable the UVLO function. Refer to the *Enable (EN)* and *Undervoltage Lockout* sections in the MAX16838 IC data sheet for additional information. See Table 1 for jumper JU1 settings.

HB LED Current

The MAX16838 EV kit features a jumper to reconfigure the MAX16838 current sinks on both channels. When inserted, jumper JU2 configures the current sink to 150mA; removing the jumper configures the current sink to 100mA. See Table 2 for jumper JU2 settings.

To reconfigure the circuit for another current-sink threshold, replace resistor R13 and use the following equation to calculate a new value for the desired current:

$$R13 = \frac{1512}{I_{LED}} (\Omega)$$

Table 1. Enable and UVLO (JU1)

SHUNT POSITION	EN PIN	EV KIT OPERATION
1-2	Connected to EN PCB pad	External controller enabled (no on-board UVLO)
2-3	Connected to UVLO R1 and R2 divider	Enabled (UVLO operating)

Table 2. HB LED Current (JU2)

SHUNT POSITION	ISET PIN	HB LED CURRENT SINK (mA)
Not installed	Connected to R13	100
Installed	Connected to R13 and R15	150

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where ILED is the desired HB LED current in amps and R13 is the new resistor value for obtaining the desired HB LED current. Remove jumper JU2 when configuring for another current-sink threshold.

Evaluating Higher Rated LEDs

The MAX16838 EV kit is capable of driving higher rated LEDs by shorting OUT1 and OUT2 together (using jumper JU3), thus providing 200mA to 300mA to the connected LED string. To operate the EV kit using higher rated LEDs:

- Connect the anode of the LED string to the CH1 or CH2 PCB pad and the cathode of the LED string to the OUT1 or OUT2 PCB pad
- Install a shunt at jumper JU3 to double the configured current sink

Remove the shunt at jumper JU3 to operate the channel's OUT1 and OUT2 sink capability independently. See Table 3 for jumper JU3 settings.

Additional Configurations and Features

The MAX16838 EV kit includes several other features to facilitate evaluation of the MAX16838 IC. HB LED digital dimming control, fault management through a $\overline{\text{FLT}}$ signal, and reconfiguring the OVP are detailed in the following sections.

HB LED Digital Dimming Control

The MAX16838 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 R10. 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 200Hz to 20kHz. To adjust the HB LED brightness, vary the signal duty cycle from 0 to 100% and maintain a minimum pulse width of 1 μ s. Apply the digital PWM signal to the DIM and SGND PCB pads. Refer to the *LED Dimming Control* section in the MAX16838 IC data sheet for additional information on the MAX16838 dimming feature.

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

The MAX16838 EV kit features a $\overline{\text{FLT}}$ signal that is pulled up to VCC by resistor R11. The $\overline{\text{FLT}}$ signal is pulled low when there are open or shorted HB LED(s) on an OUT_ channel or a MAX16838 IC thermal shutdown condition has occurred. Refer to the *Fault Protections* section in the MAX16838 IC data sheet for further information on the $\overline{\text{FLT}}$ signal.

Table 3. Configuration for Higher Rated LEDs Current (JU3)

SHUNT POSITION	CHANNEL OPERATION
Not installed	LED maximum current = 150mA/channel
Installed	LED string maximum current = 300mA

Note: The series-connected HB LED string must be rated no less than 200mA.

The RT PCB pad is used for connecting an external clock for synchronizing the MAX16838 switching frequency through its RT pin. Refer to the *Oscillator Frequency/External Synchronization* section in the MAX16838 IC data sheet for additional information on the MAX16838 synchronizing feature.

Overvoltage Protection (OVP) Configuration

The MAX16838 OVP resistors (R8 and R9) are configured for an OVP of 35.6V. This sets the maximum channel voltage at 35.6V. To reconfigure the circuit for a different OVP voltage, replace resistor R9 with a different value using the following equation:

$$R9 = \left(\frac{\text{OVP}}{1.23\text{V}} - 1 \right) \times R8$$

where R8 is 22.1k Ω , OVP is the desired overvoltage protection voltage and R9 is the new resistor value for obtaining the desired overvoltage protection. Refer to the *Open-LED Management and Overvoltage Protection* section in the MAX16838 IC data sheet for additional information on the overvoltage feature.

LED Current-Foldback Threshold

Resistors R3 and R4 set the MAX16838 IC LED current foldback when VIN falls below 6.5V (the MAX16838 CFB pin falls below its 1.23V threshold). As VIN falls below 6.5V, the LED current decreases proportionally to the voltage at the MAX16838 CFB pin. Refer to the *Current Foldback* section in the MAX16838 IC data sheet for additional information.

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Evaluates: MAX16838

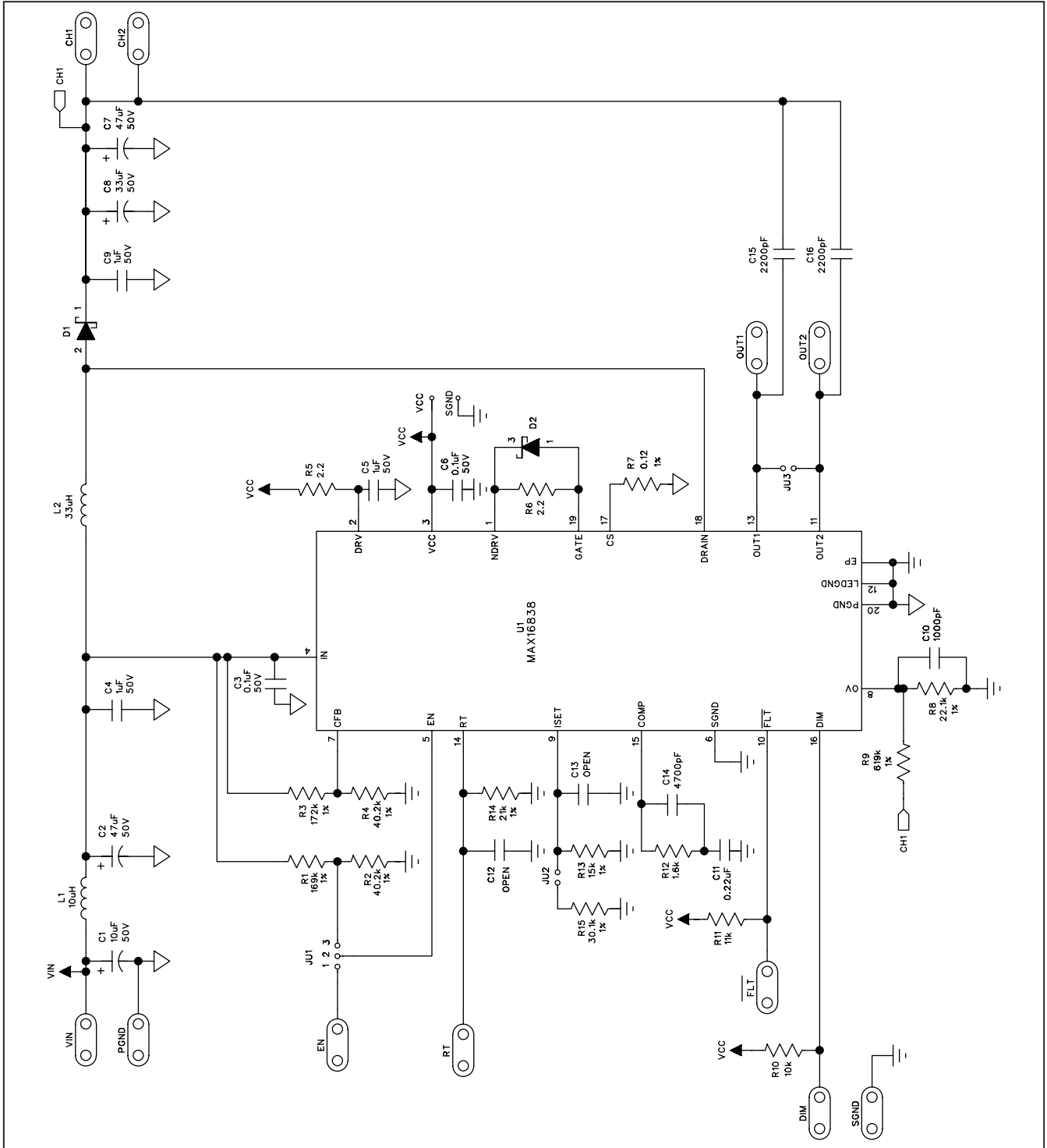


Figure 1. MAX16838 EV Kit Schematic

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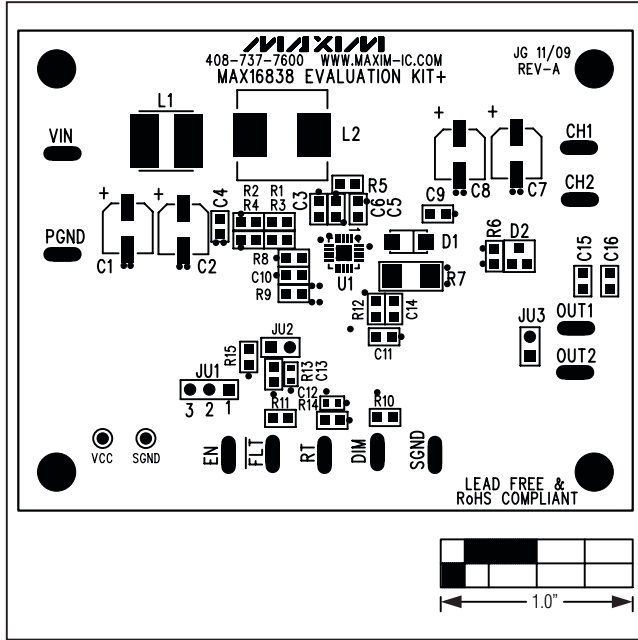


Figure 2. MAX16838 EV Kit Component Placement Guide—Component Side

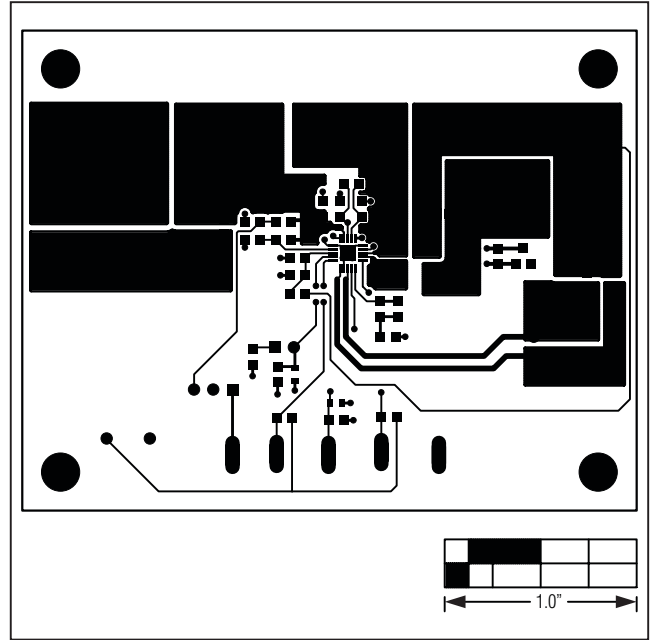


Figure 3. MAX16838 EV Kit PCB Layout—Component Side

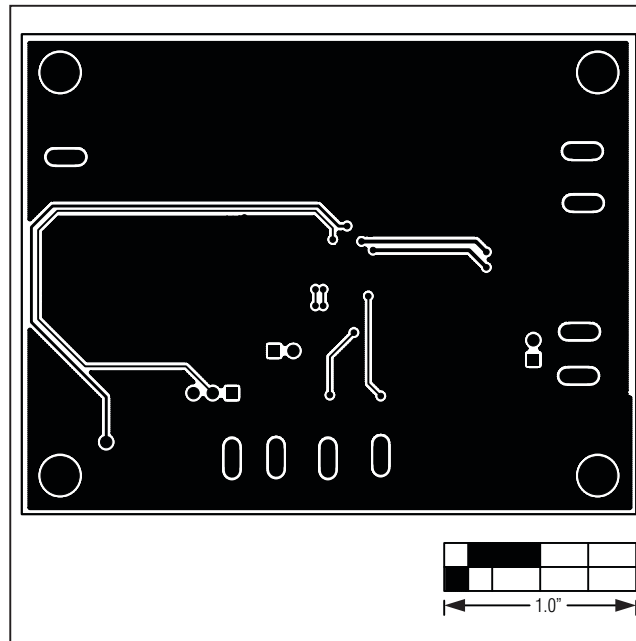


Figure 4. MAX16838 EV Kit PCB Layout—Solder Side

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