19-0965; Rev 0; 8/07

# MAX16812 Evaluation Kit

Evaluates: MAX16812

## General Description

The MAX16812 evaluation kit (EV kit) demonstrates the MAX16812 peak-current-mode PWM high-brightness LED (HBLED) driver IC. The MAX16812 EV kit is configured in a step-up/step-down topology with peak-current-mode and average LED current control for the external LEDs. The EV kit is capable of supplying stable LED output currents up to 360mA and operates at supply voltages between 7V and 28V. The maximum output voltage of the LED string can be up to 15V.

The MAX16812 EV kit features two different types of dimming controls, using either an analog linear input voltage or a digital PWM input signal to control the LEDs' brightness. This EV kit also has an undervoltage lockout (UVLO) feature that disables the EV kit and overvoltage protection to protect the EV kit under no-load conditions. The MAX16812 EV kit is a fully assembled and tested surface-mount printed-circuit board (PCB).

## Features

- **7V to 28V Wide Supply Voltage Range**
- **Peak-Current-Mode Control**
- **Up to 360mA Output Current**
- **Analog Linear Dimming Control**
- **PWM Dimming Control**
- **Programmable Switching Frequency**
- **Shutdown Control**
- **Output Overvoltage Protection**
- **Fully Assembled and Tested**

## Ordering Information

| PART | TYPE |
|---|---|
| MAX16812EVKIT+ | EV Kit |

*+Denotes lead-free and RoHS-compliant.*

## Component List

| DESIGNATION | QTY | DESCRIPTION |
|---|---|---|
| C1, C9, C10, C11 | 4 | 4.7µF ±10%, 50V X7R ceramic capacitors (1210) Murata GRM32R71H475K |
| C2, C18 | 2 | 0.1µF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K |
| C3, C8 | 2 | 3.3µF ±10%, 16V X7R ceramic capacitors (0805) Murata GRM21BR71C335KA73 |
| C4, C6 | 2 | 0.22µF ±10%, 25V X7R ceramic capacitors (0603) Murata GRM188R71E224K |
| C5, C15, C16, C17 | 4 | 1000pF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H102K |
| C7 | 1 | 220pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H221K |
| C12 | 1 | 1µF ±10%, 16V X7R ceramic capacitor (0603) Murata GRM188R71C105K |
| C13 | 1 | 0.47µF ±10%, 25V X7R ceramic capacitor (0805) Murata GRM219R71E474K |
| C14 | 1 | 0.047µF ±10%, 25V X7R ceramic capacitor (0603) Murata GRM188R71E473K |
| C19, C20 | 0 | Not installed, capacitors |
| D1 | 1 | 3A, 60V Schottky diode (SMB) Diodes Inc. B360B |
| D2 | 1 | 150mA, 100V diode (SOD-323) Diodes Inc. 1N4148WS-7-4 |
| JU1 | 1 | 3-pin header |
| JU2, JU3 | 2 | 2-pin headers |
| L1 | 1 | 68µH, 3A inductor Coilcraft DO3340P-683ML |
| N1 | 1 | 60V, 4.3A n-channel MOSFET (6-pin SuperSOT) Fairchild Semiconductor FDC5612 |
| R1 | 1 | 100kΩ ±1% resistor (0603) |
| R2, R9 | 2 | 100kΩ potentiometers (single turn) |
| R3 | 1 | 1kΩ ±1% resistor (0603) |
| R4, R15 | 2 | 10kΩ ±1% resistors (0603) |

# MAX16812 Evaluation Kit

## Component List (continued)

| DESIGNATION | QTY | DESCRIPTION |
|---|---|---|
| R5 | 1 | 2.49kΩ ±1% resistor (0603) |
| R6 | 1 | 113kΩ ±1% resistor (0603) |
| R7 | 1 | 100Ω ±5% resistor (0603) |
| R8 | 1 | 200kΩ ±1% resistor (0603) |
| R10, R11 | 2 | 0.6Ω ±1%, 500mW sense resistors (1206) IRC/TT Electronics LRC-LRF-1206LF-01-R600-F |
| R12 | 1 | 10Ω ±1% resistor (0603) |
| R13 | 1 | 1.8Ω ±1%, 250mW sense resistor (1206) Panasonic ERJ-8RQF1R8V |
| R14 | 1 | 1.5Ω ±1%, 250mW sense resistor (1206) Panasonic ERJ-8RQF1R5V |
| R16 | 1 | 2.32kΩ ±1% resistor (0603) |
| TP1, TP2, TP3 | 3 | PC mini red test points |
| U1 | 1 | Maxim integrated high-voltage LED driver with analog and PWM dimming control MAX16812ATI+ (28-pin TQFN, 5mm x 5mm x 0.8mm) |
| — | 3 | Shunts |
| — | 1 | PCB: MAX16812 Evaluation Kit+ |

## Component Suppliers

| SUPPLIER | PHONE | WEBSITE |
|---|---|---|
| Coilcraft, Inc. | 847-639-6400 | www.coilcraft.com |
| Diodes Inc. | 805-446-4800 | www.diodes.com |
| Fairchild Semiconductor | 888-522-5372 | www.fairchildsemi.com |
| IRC/TT Electronics | 361-992-7900 | www.irctt.com |
| Murata Mfg. Co., Ltd. | 770-436-1300 | www.murata.com |
| Panasonic Corp. | 714-373-7366 | www.panasonic.com |

***Note:*** *Indicate that you are using the MAX16812 when contacting these component suppliers.*

## Quick Start

### Recommended Equipment

Before beginning, the following equipment is needed:

- 5V to 28V, 2A power supply
- Two digital voltmeters
- A series-connected LED string rated at 350mA (15V, max)
- One current probe to measure LED current

### Procedures

The MAX16812 EV kit is fully assembled and tested. Follow the steps below to verify operation. **Caution: Do not turn on the power supply until all connections are completed. Avoid powering up the EV kit without connecting a load to the LED+ and LED- pads.**

1) Connect the power supply's positive terminal to the VIN PCB pad on the EV kit. Connect the power supply's ground terminal to PGND PCB pad.
2) Connect digital voltmeters across the IN and PGND PCB pads and the LED+ and LED- PCB pads.
3) Install a shunt across jumper JU1 (MAX16812 EV kit enabled).
4) Install a shunt across jumper JU2 and verify that a shunt is not installed across jumper JU3 (analog dimming control).
5) Connect the anode-end of the LED string to the LED+ pad.
6) Connect the cathode-end of the LED string to the LED- pad.
7) Adjust potentiometer R9 clockwise.
8) Clip the current probe across the LED wire to measure the LED current.
9) Turn on the power supply and increase the input voltage to 7V.
10) Adjust potentiometer R2 counterclockwise until the LED current amplitude is 350mA.
11) Measure the voltage between the LED+ to LED- PCB pads.

## Detailed Description

The MAX16812 evaluation kit (EV kit) demonstrates the MAX16812 IC peak-current-mode PWM HBLED driver. The MAX16812 EV kit is configured in a step-up/step-down topology with peak-current-mode and average LED current control for a string of user-supplied external HBLEDs. The EV kit is capable of supplying stable LED output currents up to 350mA and operates at supply voltages between 7V and 28V.

The MAX16812 EV kit sets the inductor peak current to 2A using parallel resistors R10 and R11. The average LED current is set to a maximum of 360mA using parallel resistors R13 and R14, and by adjusting potentiometer R2.

The MAX16812 EV kit is set to a 300kHz switching frequency using resistor R8. Refer to the *Internal Oscillator Switching Frequency* section in the MAX16812 IC data sheet for information on setting other switching frequencies. A PCB pad is available to monitor the MAX16812 reference voltage output (REF). A PCB pad is also provided for the external LED intensity voltage-control input DIM.

### Input Supply UVLO

Jumper JU1 controls the MAX16812 EV kit enable mode. Place a shunt across pins 1-2 to enable the MAX16812 EV kit when VIN voltage rises above the IC's 5V UVLO default threshold. Place a shunt across pins 2-3 to disable the EV kit. See Table 1 for JU1 jumper selection.

**Table 1. JU1 Jumper Selection (EN)**

| SHUNT POSITION | EN PIN | EV KIT FUNCTION |
|---|---|---|
| 1-2 | Connected to IN | Enabled |
| 2-3 | Connected to GND | Disabled |

### Peak Inductor Current-Limit Setting

The parallel combination of current-sense resistors R10 and R11 sets the EV kit's peak inductor current limit to 2A. Use the following equation to calculate the peak current limit:

$$I_{ILIM} = \frac{600mV}{R_{TOTAL}}$$

where $I_{ILIM}$ is the inductor peak current and $R_{TOTAL}$ is the total parallel resistance placed at the R10 and R11 PCB pads.

Refer to the *Internal Switching MOSFET Current Limit* section in MAX16812 IC data sheet for additional information on setting the peak current-limit threshold.

### Setting External LEDs Current

Resistors R13 and R14 set the MAX16812 EV kit average LED current up to a maximum 360mA. The potentiometer R2 allows the external LED current to be adjusted from 175mA (min) to 360mA (max). The LED string current can be programmed using the following equation:

$$I_{LED}(A) = \frac{V_{REFI}}{4 \times 0.82\Omega}$$

where $I_{LED}$ is the LED current, $V_{REFI}$ is the voltage at TP1, and 0.82Ω is the parallel resistance of R13 and R14.

### PWM Dimming Control (Jumpers JU2 and JU3)

PWM dimming is achieved by turning on and off the MOSFET (N1) in series with the LED string. LED dimming is achieved on the MAX16812 EV kit by applying a digital PWM signal or an analog DC voltage at the DIM PCB input pad, or by adjusting potentiometer R9.

The voltage at the MAX16812 DIM pin can be adjusted using potentiometer R9 to control the external LEDs' brightness. When adjusting the DC voltage using R9, install a shunt across jumper JU2 and remove the shunt at jumper JU3. The MAX16812 IC DIM pin voltage can be monitored by placing a voltmeter across the DIM and AGND PCB pads. LED dimming can also be accomplished by removing the shunt at jumper JU2 and connecting an external power source at the DIM PCB pad. The DC voltage at the DIM PCB pad sets the MAX16812 duty cycle of the driver controlling the gate of the dimming MOSFET (N1), which controls the external LED brightness.

Use the following equation to calculate the voltage at the DIM PCB pad, necessary for the N1 dimming FET output duty cycle (D):

$$DIM \approx D \times 1.24V$$

where DIM is the DC voltage at the MAX16812 EV kit DIM PCB pad in volts and D is the output duty cycle of the LED current.

To control LED dimming using a PWM signal at the DIM PCB pad, remove the shunt from jumper JU2 and place a shunt across jumper JU3. Connect a digital PWM signal with a 5V TTL or 3.3V CMOS logic level and switching frequencies up to 2kHz. See Table 2 for jumpers JU2 and JU3 settings for PWM dimming operation.

## Table 2. PWM Dimming Operation (Jumpers JU2 and JU3)

| SHUNT POSITION | | EV KIT DIMMING OPERATION |
|---|---|---|
| JU2 | JU3 | |
| Not installed | Not installed | Analog DC voltage applied at DIM PCB pad |
| Not installed | Installed | PWM signal applied at DIM PCB pad |
| Installed | Not installed | Analog DC voltage at DIM pin adjusted using potentiometer R9 |
| Installed | Installed | Not applicable |

For additional information on operating the MAX16812 EV kit in linear dimming or PWM dimming operation, refer to the *PWM Dimming* section in the MAX16812 IC data sheet.

During PWM dimming, there may be audible noise due to the piezo effect of the output capacitors connected at LED+. To alleviate the audible noise, remove ceramic capacitors C9, C10, and C11, and add electrolytic capacitors at the C19 and C20 pads. For proper PWM dimming operation, when using electrolytic capacitors, it may be required to change some of the compensation components.

### Output Overvoltage Protection

The maximum voltage on the LED+ pin is limited to 54.4V with respect to GND, by a feedback network formed by resistors R5 and R6. When the voltage at LED+ exceeds the programmed 54.4V threshold, PWM switching is terminated and no further energy is transferred to the load connected between LED+ and LED-.

**If the MAX16812 EV kit is turned on with no load, the voltage at LED+ may rise to unsafe levels. Even though the EV kit has overvoltage protection, it is recommended to connect the specified load before powering up the EV kit.** Refer to the *Setting the Overvoltage Threshold* section in the MAX16811/MAX16812 IC data sheet for setting the overvoltage threshold.

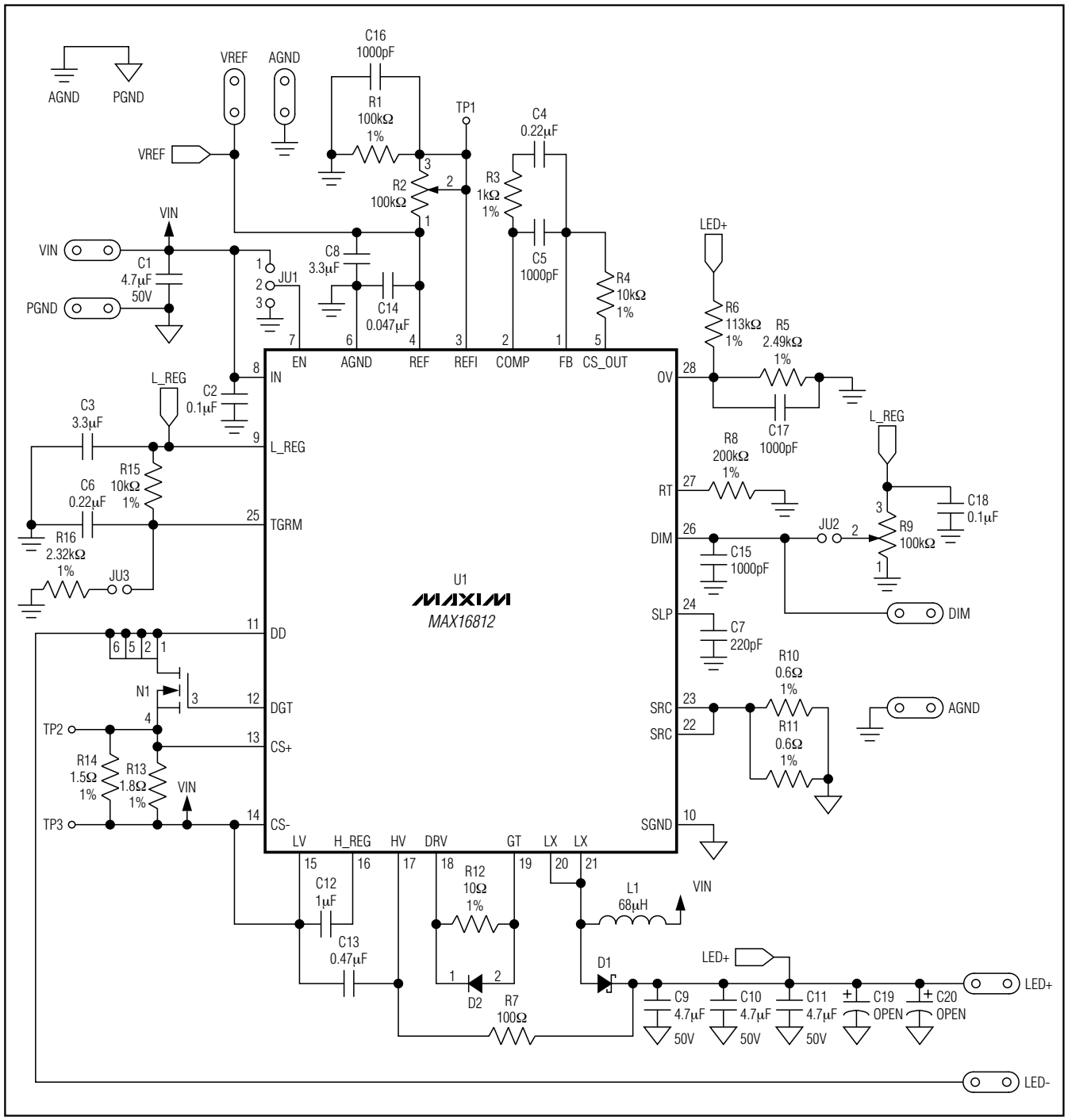


*Figure 1. MAX16812 EV Kit Schematic*

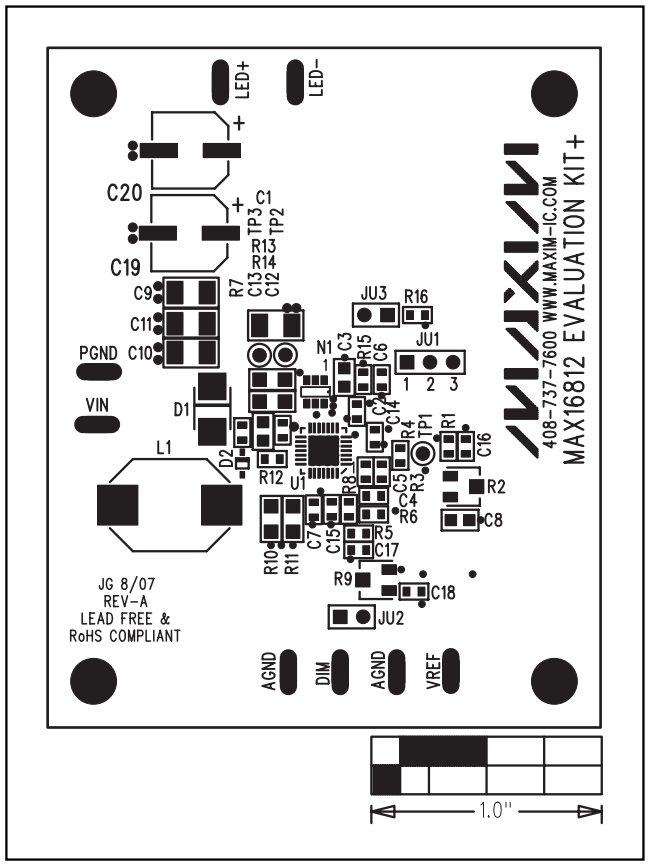


*Figure 2. MAX16812 EV Kit Component Placement Guide—Component Side*

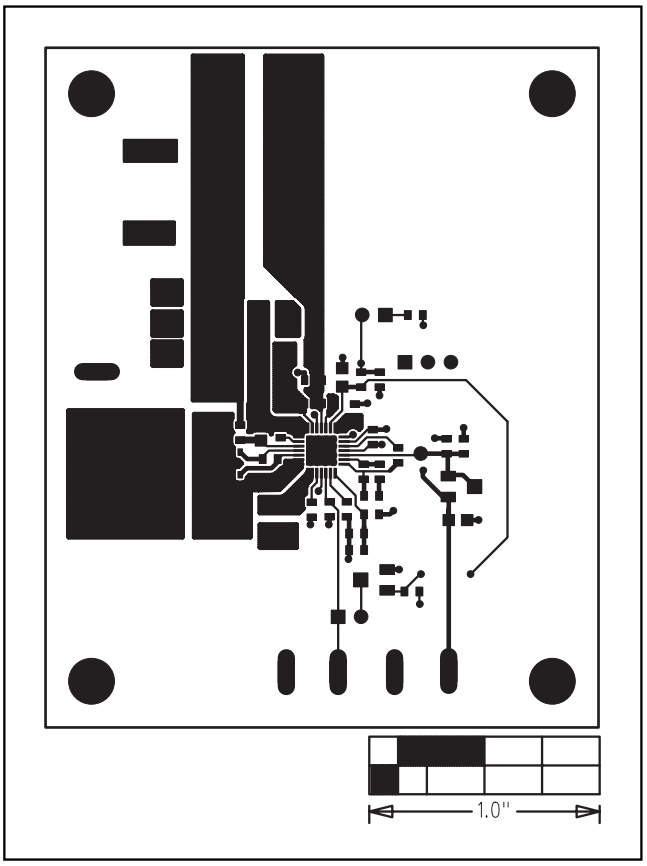


*Figure 3. MAX16812 EV Kit PCB Layout—Component Side*

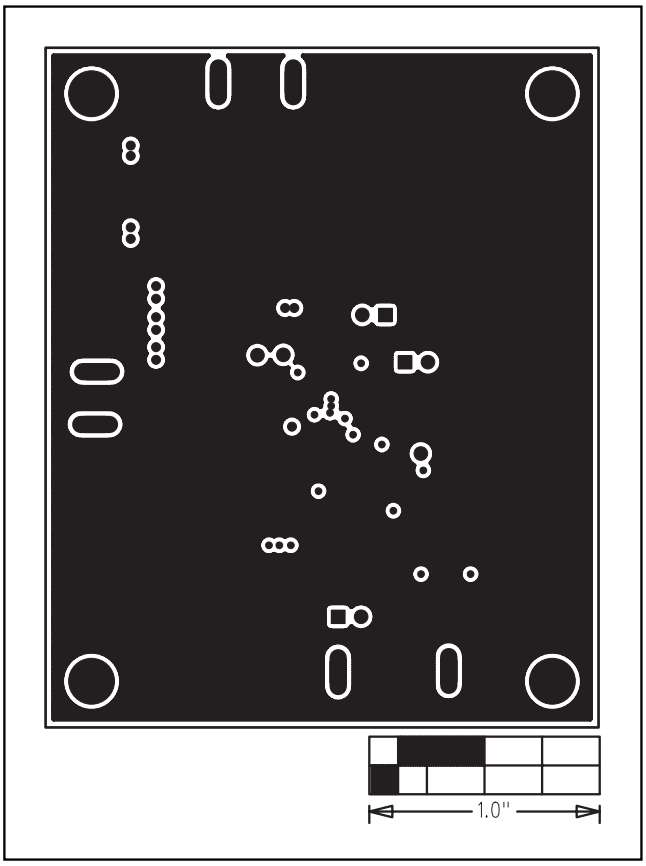


Figure 4. MAX16812 EV Kit PCB Layout—GND Layer 2

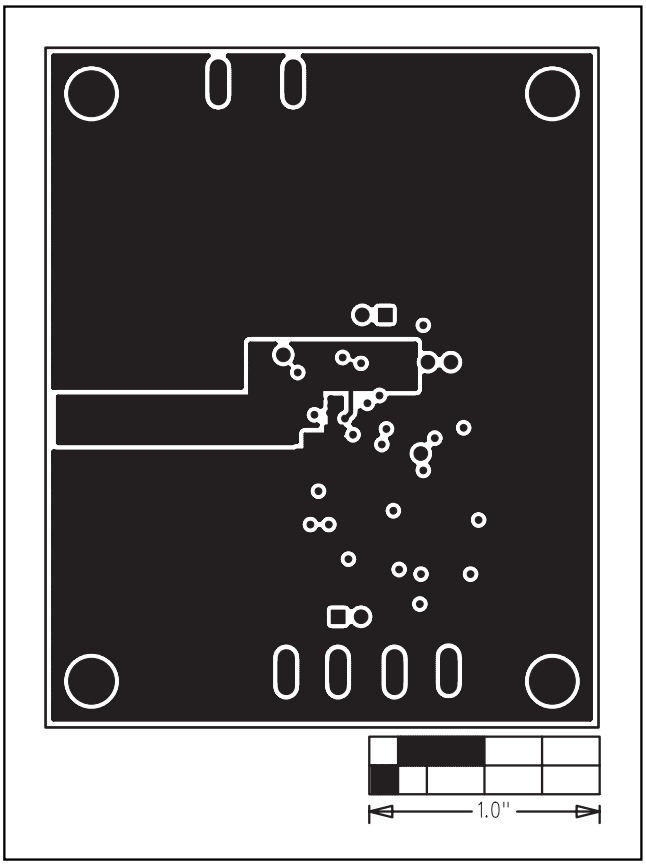


Figure 5. MAX16812 EV Kit PCB Layout—VCC Layer 3

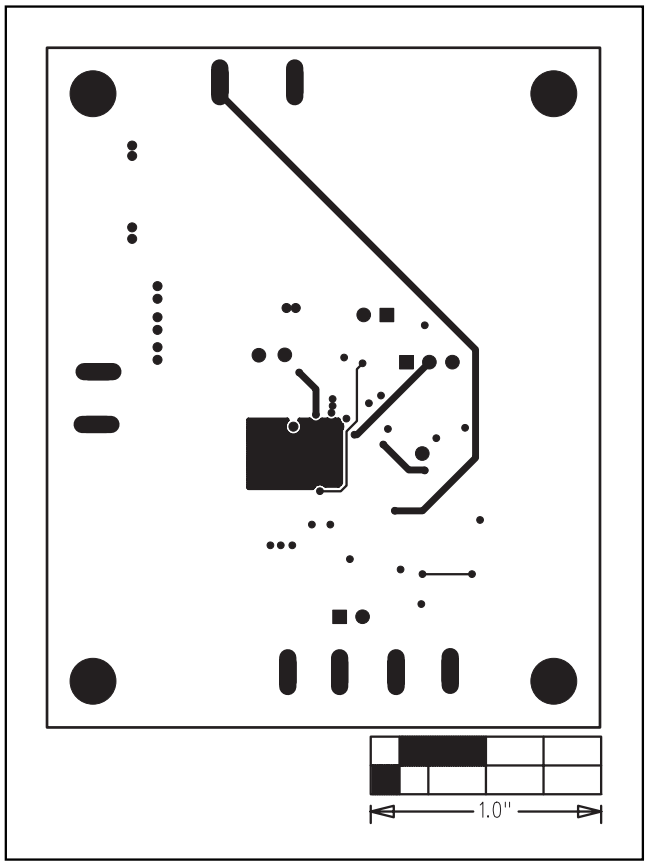


*Figure 6. MAX16812 EV Kit PCB Layout—Solder Side*