MAX16141A Evaluation Kit

Evaluates: MAX16141A

General Description

The MAX16141A evaluation kit (EV kit) is a complete, fully assembled, and tested ideal diode controller circuit that demonstrates the system protection capability of the MAX16141A. The EV kit is designed to evaluate the MAX16141A's response to reverse current, overcurrent, input overvoltage/undervoltage, short circuit, and over-temperature faults in a system. A high-power TVS footprint provides the option to evaluate the MAX16141A EV kit's performance against the ISO-7637 and ISO-16750 automotive-safety standards. The undervoltage and overvoltage thresholds are set to 8.6V/36.2V, respectively. The EV kit PCB is available with the MAX16141AAAF/VY+ Installed.

Features

- 8.6V Undervoltage Threshold and 36.2V Overvoltage Threshold
- Optional TVS Footprint Facilitates Automotive Transients Testing
- Output Short Circuit Protection
- Proven 2-Layer 2oz Copper PCB Layout
- Demonstrates Compact Solution Size
- Fully Assembled and Tested

***Ordering Information* appears at end of data sheet.**

Quick Start

Required Equipment

- MAX16141A EV Kit
- 40V, 10A DC Power Supply
- 2 Digital Multimeter (DMM)
- 2-Channel Scope Oscilloscope

Procedure

The EV kit is fully assembled and tested. Follow these steps to verify the board operation.

Caution: Do not turn on the power supply until all connections are completed.

1) Verify the shunts are installed in their respective default positions for jumpers JU1 to JU3 (Tables 1 to 3).
2) Connect the power supply between the IN and SYSGND terminal posts.
3) Connect the DMM#1 between the IN and SYSGND terminal posts, and DMM#2 between the OUT and SYSGND posts.
4) Connect Channel 1 probe of the oscilloscope to the GATE and Channel 2 of the Oscilloscope to the OUT of the EV kit.
5) Turn on the power supply.
6) Manually sweep the power supply from 8.6V to 36.2V. Verify the output voltage at OUT approximately follows the input voltage at IN.
7) Increase the input voltage to 37V.
8) Verify the output voltage is 0V (overvoltage protection).
9) Set the input voltage to 12V and verify the OUT is also about 12V.
10) Using an insulated shorting cable, take cautions to hold the insulated parts of the shorting cable while shorting OUT to SYSGND, and verify the gate voltage is 0V on the Channel 2 of the Oscilloscope (short circuit protection).
11) Remove the shorting cable between OUT and SYSGND. Verify the output voltage and gate voltage return to their correct voltage levels.
12) Decrease the input voltage to 7V.
13) Verify the output voltage is approximately 0V and the gate voltage is pulled to ground (undervoltage protection).

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Detailed Description of Hardware

The MAX16141A EV kit evaluates the MAX16141A, an ideal diode controller device that protects systems against fault conditions such as reverse current, overcurrent, input overvoltage/undervoltage, short circuit, and overtemperature. The MAX16141A EV kit is designed to disable the gate drive when the input voltage (VIN) moves outside of the programmed undervoltage/overvoltage window-threshold levels and when the load current exceeds the programmed current limit of 5A (typ). See Tables 1, 2, and 3 for more detail on jumpers configuration.

Enable Input (EN)

Jumper (JU1) allows connecting the shutdown input (SHDN) of the MAX16141A to the VCC through a pullup resistor (R12) for normal operation. To place the MAX16141A EVKIT in shutdown mode, uninstall the JU1 and allow R15 (not installed) to pull the EN to ground. When the EN is pulled low, the gate voltage of the MAX16141A is pulled to the ground, and the Internal TERM switch disconnects from the resistive divider network connected to UVSET and OVSET. See Table 1 for the JU1 jumper settings.

Table 1. SHDN (JU1)

JU1 SHUNT POSITION	DESCRIPTION
Installed*	Enabled. SHDN = VCC (through pullup resistor R12)
Not Installed	Disabled. SHDN = SYSGND (through internal pulldown)

**Default position.*

Table 2. SLEEP (JU2)

JU2 SHUNT POSITION	DESCRIPTION
Installed	SLEEP (pullup through resistor R13)
Not Installed*	SLEEP (pulldown through R16)

**Default position.*

Table 3. GATE Snubber (JU3)

JU3 SHUNT POSITION	DESCRIPTION
Installed	GATE snubber (R3 and C7) added
Not Installed*	GATE snubber (R3 and C7) removed

**Default position.*

Sleep Mode Input (SLEEP)

Jumper (JU2) allows connecting the sleep input (SLEEP) of the MAX16141A to the GND for normal operation through a pulldown resistor (R16) or sleep mode through a pullup (R13). In the sleep mode, the GATE pulls low and allows 400µA of load current though the body diode of the N2. Refer to the device data sheet for more details. See Table 2 for the JU2 jumper settings.

GATE Snubber

Jumper (JU3) allows the gate of the MAX16141A to be connected to the RC snubber network, R19, and C9. The RC snubber slows down the gate voltage ramp rate and helps control inrush current control during power-up when the output of the MAX16141A is connected to a high capacitive load. However, connecting the snubber to the GATE of the MAX16141A slows the reverse voltage blocking response time. Furthermore, the MAX16141A is designed for a specific ramp rate based on the value of the resistor connected from the GRC to ground (R7). Refer to the Electrical Characteristics table or the device data sheet for more detail. If the RC snubber causes longer time for the GATE to reach the maximum voltage level than the value set up by R7, the gate drive switches to a fast mode and forces the gate voltage to transition to its final value. Depending on the output capacitor, a fast transition of the gate voltage could trigger the overcurrent protection and disable the gate drive. To avoid power-up interruption, the RC snubber must be scaled accordingly. Refer to the Electrical Characteristics table for the gate charge current specifications for different ramp rate calculations.

Overvoltage Protection

The MAX16141A EV kit shuts down the output when the input voltage exceeds the upper input voltage limit set by resistors R11 and R9 between the TERM and OVSET pins of the MAX16141A. Use the following equation to set the overvoltage threshold for the MAX16141A EV kit.

$$R11 = ((V_{OV\_TH} \times R9)/V_{TH})) - (R9 + 700\Omega)$$

where, V_{OV_TH} is the desired overvoltage threshold, R9 = 10kΩ, V_{TH} = 0.5V (typ) threshold for OVSET, and 700Ω is the TERM switch typical resistance.

Undervoltage Protection

The MAX16141A EV kit shuts down the output when the input voltage drops below the lower input voltage limit set by resistors R10 and R8 between the TERM and UVSET pins of the MAX16141A. Use the following equation to set the undervoltage threshold for the MAX16141A EV kit:

$$R10 = ((V_{UV\_TH} \times R8)/V_{TH})) - (R8 + 700\Omega)$$

where, V_{UV_TH} is the desired undervoltage threshold, R8 = 10kΩ, V_{TH} = 0.5V (typ) threshold for UVSET,

and 700Ω is the TERM switch typical resistance.

Overcurrent Protection

The MAX16141A EV kit shuts down the output when the load current exceeds the current limit set by the OC_ THRESHOLD (refer to the MAX16141A IC data sheet), and the sense resistor R1 between RS and OUT of the MAX16141A. Use the following equation to set the overcurrent limit for the MAX16141A EV kit:

$$R_{SENSE} = (V_{RS}-V_{OUT})/I_{OCTH}$$

where, R_{SENSE} is the sense resistor between RS and OUT in Ohms, (V_{RS}-V_{OUT}) is the overcurrent threshold in volts (refer to the IC data sheet for the proper value), and I_{OCTH} is the desired overcurrent threshold in amperes.

Short Circuit Protection

The MAX16141A EV kit shuts down the output if the output is shorted to the ground. The output resumes normal level, same as the input, when the short at the output is removed. During overcurrent load/short circuit condition, the MAX1614A enters 300ms (typ) auto-retry mode. Refer to the device data sheet for more details.

Current-Sense Filter

The MAX16141A EV kit features an optional differential-mode RC filter (R5, R17, and C7) footprint close to the sense resistor R1 to avoid the false overcurrent detection caused by inrush current during power-up. The values for the RC filter components are system dependent and must be calculated based on the expected input voltage rise time output load capacitance.

Increased Input Protection Range

The MAX16141A EV kit is designed to handle input transients that exceed the MAX16141A's designed protection range of 60V to -36V. The provided footprints for an external TVS diode (D6) and a Schottky diode D7 allow to evaluate/test the EV kit for correct performance. However, proper components must be selected by consulting the manufacturers of the TVS and Schottky diodes to ensure they provide the needed system protection.

Voltage Limiter Mode

The MAX16141A EV kit provides the option to configure the board voltage in a limiter mode using R3. In the voltage-limiter mode, the MAX16141A monitors the output voltage for overvoltage fault set by the resistive-divider network formed by R3 and R9 from the OUT to OVSET and COM (chip ground). During the overvoltage condition, the output is regulated at the overvoltage-threshold voltage and continues to supply power to the downstream device. If the overvoltage condition lasts long enough to heat the MOSFET, the MAX16141A reaches thermal limit and pulls the gate low until the device cools by 15°C.

Use the following equation to set the overvoltage limit for the MAX16141A EV kit:

$$R3 = ((V_{OV\_TH} \times R9)/(V_{TH})) - (R9 + 700\Omega)$$

where, V_{OV_TH} is the desired overvoltage threshold, R9 = 10kΩ, V_{TH} = 0.5V (typ) threshold for OVSET, and 700Ω is the TERM switch typical resistance.

Component Suppliers

SUPPLIER	PHONE NUMBER	WEBSITE
Central Semiconductor	631-435-1110	www.centralsemi.com
Murata	770-436-1300	www.murata.com
Vishay Semiconductors	402-563-6866	www.vishay.com
Panasonic	800-344-2112	www.panasonic.com
TDK	847-803-6100	www.component.tdk.com
Kemet	408-433-9931	www.kemet.com
On Semiconductor	800-282-9855	www.onsemi.com

*N**ote:** Indicate using the MAX16141A when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX16141AEVKIT#	EV Kit

#Denotes RoHS compliance

MAX16141A EV Kit Bill of Materials

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	0.1µF ±10%, 100V X7R ceramic capacitors (1206) Murata: GRM31CR72E104KW03, GRM319R72A104KA01 TDK: C3216X7R2A104K160AA Kemet: C1206C104K1RAC
C3	1	0.33µF ±10%, 250V X7R ceramic capacitor (1812) Murata, GRM43DR72E334KW01
C4	1	330µF ±20%, 35V (case _G) electrolytic capacitor, Panasonic: EEE-FK1V331GP
C5, C6	2	Not installed, capacitor (0805)
C7	1	Not installed, capacitor (0603)
C8	1	1000pF ±5%, 50V X7R ceramic capacitors (0603) Murata: GRM1885C1H102JA01 TDK: C1608C0G1H102J080
C9	1	0.01µF ±10%, 100V X7R ceramic capacitors (0805) Murata: GRM21BR72A103KA01 TDK: C0805C103K1RA
COM, IN, OUT, SYSGND (X2)	5	20G tinned copper bus wire from / into “U” shaped loops (0.25in off the PCB)
D1	1	Not Installed, 15V, Zener diode (SOD-123)
D2	1	5.1V, Zener diode (SOD-123) Central Semi. CMHZ5231B
D4	1	60V, 250mA diode (MICROMELF) Vishay, BAV300
D5	1	75V, 300mA diode (SOD-123) DIODE, BAS16-7-F
D6	1	TVS diode, (SMTO-263) Littlefuse
D7	1	100V, 3A Schottky diode (CASE 403A) On Semiconductors: NRVTSS3100E

DESIGNATION	QTY	DESCRIPTION
EN, FAULT, GATE, OVSET, SLEEP, UVSET	6	Test point (5002) Keystone
IN, OUT, SYSGND(X2)	4	Banana jacks
JU1-JU3	3	2-pin headers, 0.1in centers
IN1, IN2	2	100V, 41A, n-channel MOSFETs (DPAK), On Semiconductor: NVD6824NLT4G-VF01
Q1	1	65V, 100mA pnp transistor (SOT-23) On Semiconductor: BC846BLT3G
R1	1	0.005Ω ±1% sense resistor (2728)
R2	1	10Ω ±1% resistor (1206)
R4	1	100Ω ±5% resistor (0603)
R5, R17, R21	3	0Ω ±1% resistor (0603)
R6, R7	2	10kΩ ±5% resistor (0603)
R8, R9	2	10kΩ ±1% resistor (0603)
R10	1	162kΩ ±1% resistor (0603)
R11	1	175kΩ ±1% resistor (0603)
R12-R14, R20	4	100kΩ ±1% resistor (0603)
R16	1	40kΩ ±5% resistor (0603)
R18	1	0Ω ±5% resistor (0603)
R19	1	1kΩ ±5% resistor (0603)
R22	1	0.5Ω ±1% resistor (0603)
U1	1	MAX16141AAAF/VY+
-	3	Shunts
-	1	PCB: MAX16141A EVALUATION KIT

MAX16141A EV Kit Schematic

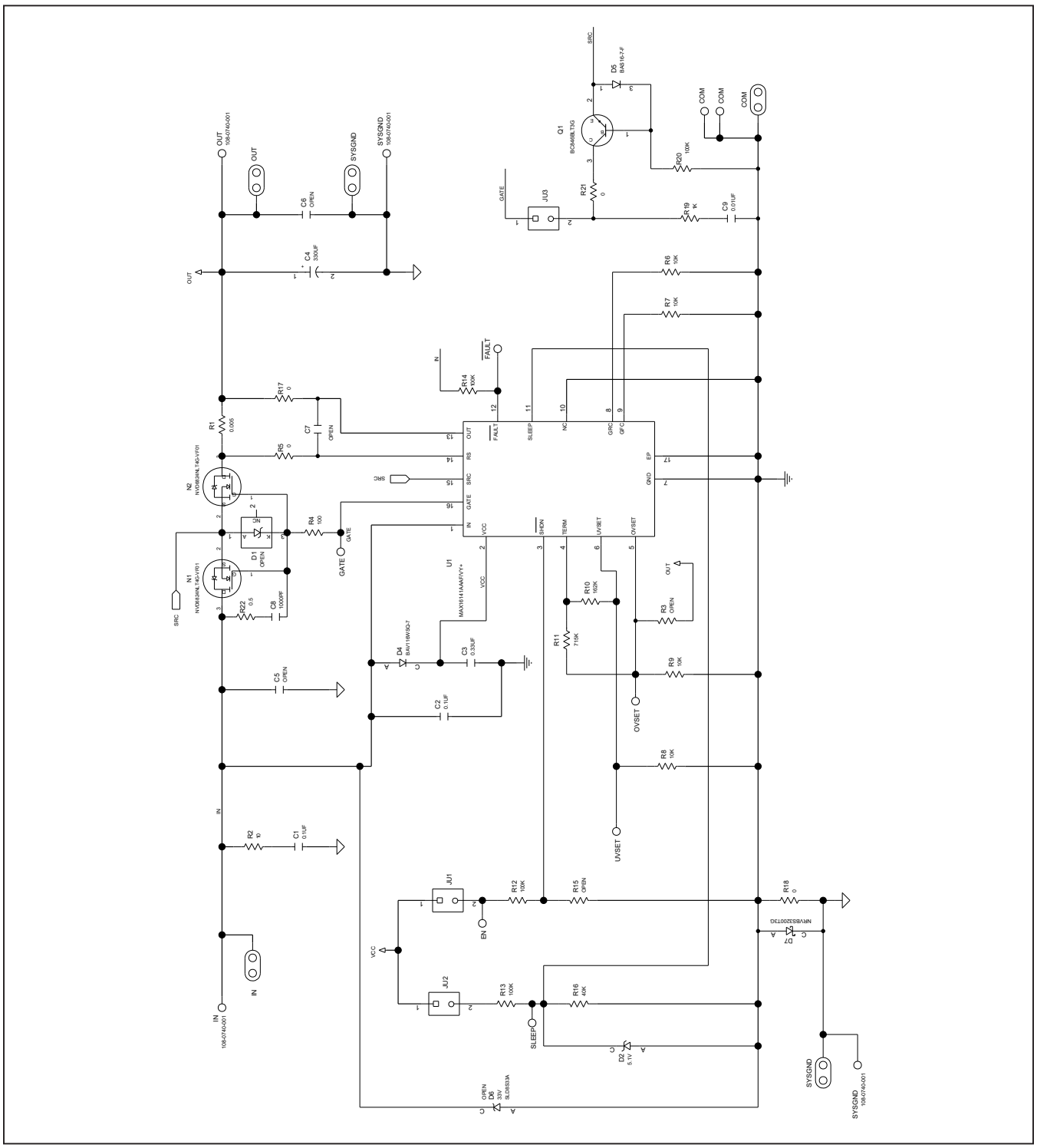

Figure 1. MAX16141AEV Kit Schematic

MAX16141A EV Kit PCB Layouts

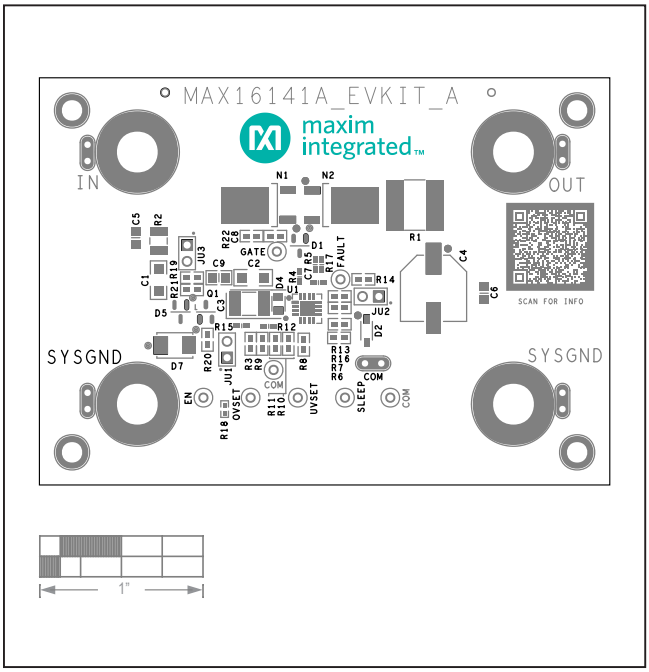

Figure 2. MAX16141A EV Kit Component Placement Guide—Component Side

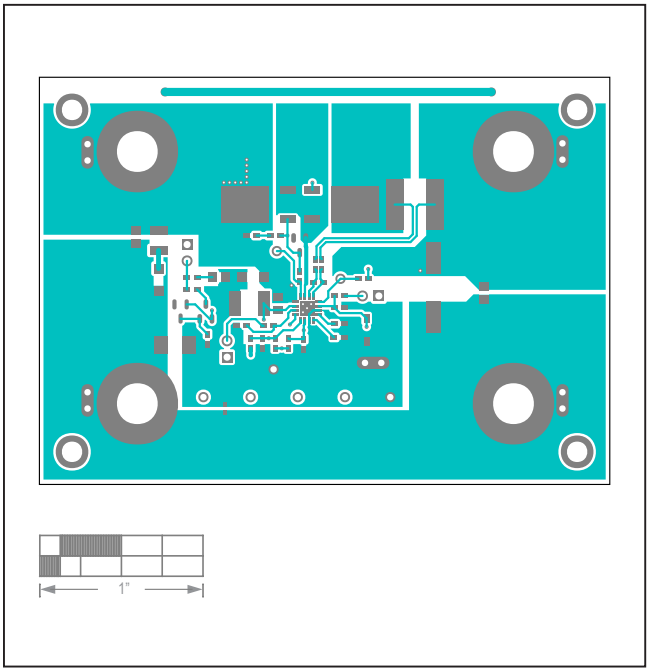

Figure 3. MAX16141A EV Kit PCB Layout—Component Side

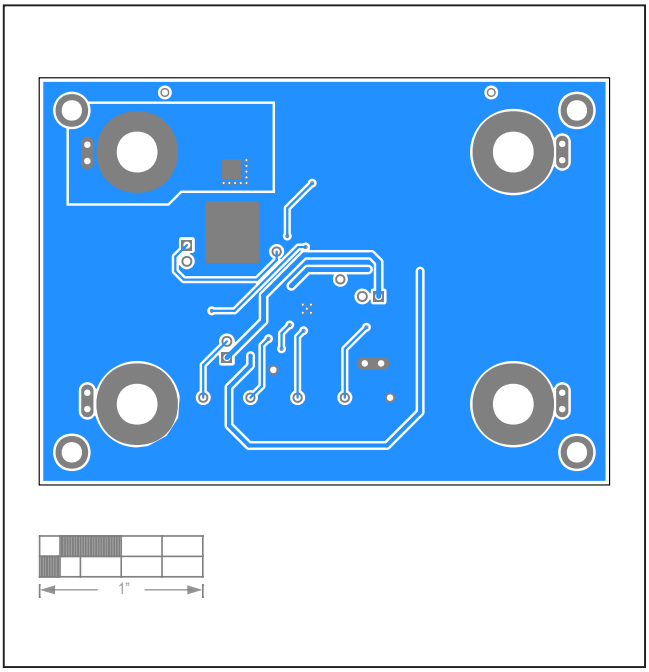

Figure 4. MAX16141A EV Kit PCB Layout—Bottom Side

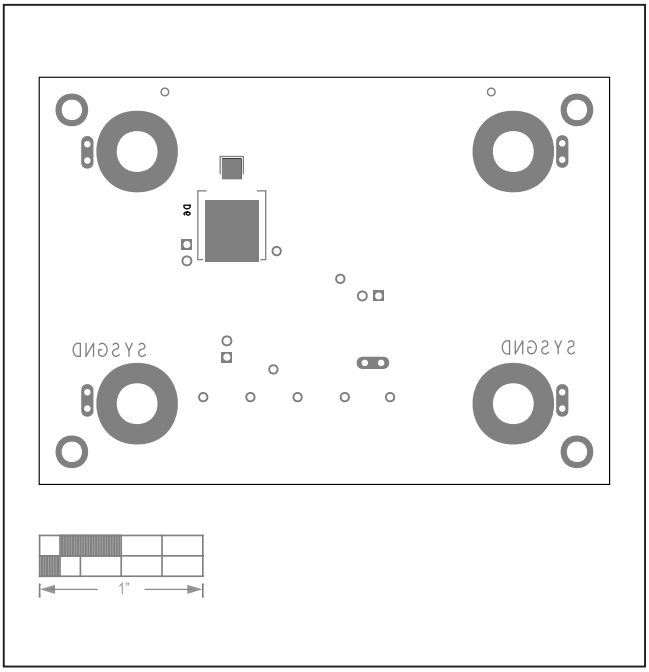

Figure 5. MAX16141A EV Kit PCB Layout—Silk Bottom Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/20	Initial release	—

