General Description

The MAX16126/MAX16127 evaluation kits (EV kits) demonstrate high overvoltage protection of the MAX16126/MAX16127 devices for automotive applications that must survive load-dump and high-voltage transient conditions. The fully assembled and tested surface-mount EV kit board provides two circuits: One full-featured solution and one minimum parts-count circuit. The full-featured solution exercises all the features of the devices and allows -60V to +90V protection beyond the 3V to 30V operating range. The minimum parts-count solution provides a cost-effective option using a small 3A, dual MOSFET and reduced 0 to +60V voltage range.

Features

- Dual Circuits
  - Full-Featured Solution (-60V to +90V)
  - Minimum Parts-Count Solution (0 to +60V)
- Robust Reverse-Battery Protection (Circuit 1)
- Positive Input Supply Voltage Protection Range Extended Beyond +90V (Circuit 1)
- Adjustable Undervoltage and Overvoltage Thresholds
- Adjustable Undervoltage Set for 8V
- Adjustable Overvoltage Threshold Set for 32.1V
- Enable Input/Flag Output
- Proven PCB Layout
- Fully Assembled and Tested

Ordering Information *appears at end of data sheet.*

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C8	2	0.1µF ±10%, 250V X7R ceramic capacitors (1206) Murata GRM31CR72E104K TDK C3216X7R2E104K
C3, C9	0	Not installed, ceramic capacitors (0805)
C4, C10	2	330µF, 35V electrolytic capacitors (10mm x 10.2mm x 12mm) Panasonic EEE-FK1V331GP
C6, C12	2	0.22µF ±10%, 100V X7R ceramic capacitors (0805) Murata GRM21AR72A224KAC5#
COM, IN, OUT, SYSGND (x2)	5	20G tinned copper bus wire from/ into "U" shaped loops (0.25in off the PCB)
D1	1	75V zener diode (SMA) Central Semi CMZ5946B
D3, D6	2	15V zener diodes (SOT23) Central Semi CMPZ5245B Diodes Inc. MMBZ5245B-7-F
D4, D7	2	Green LEDs (1206)

DESIGNATION	QTY	DESCRIPTION
D5	1	100V, 250mA Schottky diode (SOD323) NXP BAT46WJ,115
FLAG, FLAG1, RUN, RUN1	4	Test points (5000)
IN, OUT, SYSGND (x2)	4	Banana jacks
JU1–JU4	4	2-pin headers, 0.1in centers
Q1, Q2	2	100V, 50A n-channel MOSFETs (DPAK) Fairchild FDD86110 IR IRFR4510PbF
Q3	1	Dual n-channel MOSFET (PowerPAK, 8 SO) Vishay Si7964DP
R1, R20	2	57.6kΩ ±1% resistors (0603)
R2, R4, R21, R23	4	10kΩ ±1% resistors (0603)
R3A, R15A	2	See the *EV Kit-Specific Component List*

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R3B, R15B	2	See the *EV Kit-Specific Component List*
R5	1	100Ω ±5% resistor (1210) CRCW1210100RNEAHP
R6, R7, R25, R26	4	100kΩ ±5% resistors (0603)
R8, R17	2	2.2kΩ ±1% resistors (0603)
R9, R16	2	56Ω ±5% resistors (0603)

DESIGNATION	QTY	DESCRIPTION
R10	1	10Ω ±5% resistor (0603)
R11, R14, R19	0	Not installed, resistors (0603)
R12, R13, R24	3	1kΩ ±5% resistors (0603)
U1, U2	2	See the *EV Kit-Specific Component List*
—	4	Shunts
—	1	PCB: MAX16126/7 EVALUATION KIT

EV Kit-Specific Component List

EV KIT	DESIGNATION	QTY	DESCRIPTION
MAX16126EVKIT#	R3A, R15A	0	Not installed, resistors (0603)
	R3B, R15B	2	249kΩ ±1% resistors (0603)
	U1, U2	2	Load-dump/reverse-voltage protection circuit (12 TQFN-EP*) Maxim MAX16126TCA+
MAX16127EVKIT#	R3A, R15A	2	249kΩ ±1% resistors (0603)
	R3B, R15B	0	Not installed, resistors (0603)
	U1, U2	2	Load-dump/reverse-voltage protection circuit (12 TQFN-EP*) Maxim MAX16127TC+

*EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	631-435-1110	www.centralsemi.com
Diodes Incorporated	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
International Rectifier	310-322-3331	www.irf.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
NXP Semiconductors	408-474-8142	www.nxp.com
Panasonic Corp.	800-344-2112	www.panasonic.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

Note: Indicate that you are using the MAX16126 and/or MAX16127 when contacting these component suppliers.

Quick Start

Recommended Equipment

- MAX16126/MAX16127 EV kit
- ±25V, 50W DC power supply
- Electronic load
- Oscilloscope
- Digital voltmeter

Procedure (Full-Featured Solution: Circuit 1)

The 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.**

1) Connect a DC power supply (0 to +35V) across the IN and SYSGND PCB pads.

2) Connect a voltmeter or oscilloscope and a load (if desired) between the OUT and SYSGND PCB pads.

3) Verify that a shunt is installed across jumper JU1, connecting $\overline{\text{SHDN}}$ to IN.

4) Turn on the power supply and increase the input voltage. The output turns on when the input voltage exceeds +8V, the undervoltage set point. Increase the input voltage; for the MAX16126, the output turns off when the input voltage exceeds +32.1V, the overvoltage set point. For the MAX16127, the output stays limited at +32V at the overvoltage condition. Refer to the MAX16126/MAX16127 IC data sheet for more details.

Detailed Description of Hardware

The MAX16126/MAX16127 EV kits demonstrate a high overvoltage protection circuit for automotive applications that must survive load-dump and high-voltage transient conditions. Additional zener diodes at the input of the ICs provide extended positive voltage-range protection against higher voltage transients. The EV kits provide two separate circuits for evaluation: A full-featured solution and a minimum parts-count solution. The full-featured solution provides a robust -60V to +90V protection range. The minimum parts-count solution supports a protection range of 0 to +60V.

The dual MOSFET (circuit #2) supplies 3A, while the MOSFETs of the full-featured circuit (circuit #1) will supply 5A when the input voltage remains between the input UVP and OVP limits.

Overvoltage Protection

The devices feature overvoltage protection that monitors either the input (MAX16126) or the output (MAX16127) for overvoltage conditions through a resistive divider. The MAX16126 features switch-mode fault management for overvoltage conditions, while the MAX16127 features voltage limiter-mode fault management for overvoltage conditions.

Switch-Mode Fault Protection (MAX16126)

The MAX16126 features a switch-mode fault protection that monitors the input voltage and turns off the back-to-back MOSFETs by pulling the GATE to ground when an overvoltage or undervoltage condition occurs. Depending on the device configuration, during an overvoltage condition, the MAX16126 either latches off or enters an autoretry mode during the overvoltage condition. Refer to the MAX16126/MAX16127 IC data sheet for more details. For the latchoff version, the latch is cleared by cycling the input voltage (IN) below the undervoltage-lockout threshold or by toggling $\overline{\text{SHDN}}$. Use the following formula to set a different overvoltage threshold for the MAX16126:

$$R3B = \left(\frac{V_{OVTH} \times R4}{V_{TH}} \right) - (R4 + 700\Omega)$$

where R4 is 10kΩ (typ), V_{TH} is +1.225V for the OVSET threshold, V_{OVTH} is the desired overvoltage threshold, and 700Ω is the typical on-resistance of the TERM switch. This equation applies to the full-featured solution circuit (circuit 1). For the minimum parts-count solution (bottom portion), replace R3B = R15B and R4 = R23.

Voltage Limiter-Mode Fault Protection (MAX16127)

The MAX16127 features a limiter-mode fault protection that monitors the output voltage for an overvoltage condition using a resistive divider between OUT and OVSET. During the overvoltage condition, the output is regulated at the overvoltage-threshold voltage and continues to supply power to downstream devices. If the overvoltage condition lasts long enough to heat the MOSFETs, the MAX16127 could reach thermal limit and pull the GATE low until the device cools by 20°C. Use the following formula to set a different overvoltage threshold for the MAX16127:

$$R3A = \left(\frac{V_{OVTH} \times R4}{V_{TH}} \right) - (R4),$$

where R4 is 10kΩ (typ), V_{TH} is +1.225V for the OVSET threshold, and V_{OVTH} is the desired overvoltage threshold. This equation applies to the full-featured solution circuit (top portion). For the minimum parts-count solution (circuit 2), replace R3A = R15A and R4 = R23.

Undervoltage Protection

The devices monitor the input voltage for undervoltage conditions using a resistive divider between TERM and UVSET (TERM connects to IN through an internal switch when $V_{\overline{SHDN}}$ goes high). When the input voltage drops below the programmed threshold, the GATE voltage goes low and the MOSFETs turn off. When the input voltage exceeds the undervoltage threshold, the GATE voltage goes high turning on the MOSFETs. Use the following formula to set a different undervoltage threshold:

$$R1 = \left(\frac{V_{UVTH} \times R2}{V_{TH}} \right) - (R2 + 700\Omega),$$

where R2 is 10kΩ (typ), V_{TH} is +1.225V for the UVSET threshold, and 700Ω is the typical on-resistance of the TERM switch. This equation applies to the full-featured solution circuit (circuit 1). For the minimum parts-count solution (circuit 2), replace R1 = R20 and R2 = R20.

Extended Input-Voltage Protection Range (Circuit 1)

The full-featured solution tolerates -60V to +90V transients. To increase the positive input-voltage protection range beyond the positive absolute maximum ratings, the EV kit includes a zener diode (D1) between the input supply (IN) of the device and COM. To increase the negative input-voltage protection range, a diode between COM (ground of the protection device) and SYSGND (ground carrying load current), D5 must be installed. A series surface-mount resistor (R5) from IN to the supply input of the EV kit limits the current drawn by the zener diodes. The size of the series resistor is critical to the proper operation of the device. Higher resistor values support high overvoltage transients, but interfere with the undervoltage-threshold set point. However, lower resistor values contribute to the power loss through the zener diodes.

Load Dump

Load dump is a common event in automotive systems and occurs when the alternator charging the battery suddenly disconnects from the battery terminals, causing the alternator voltage to spike due to the large capacitance of the battery removed. As the battery is disconnected, the alternator voltage jumps very high and the devices protect the sensitive circuit blocks during this event.

Shutdown Input ($\overline{SHDN}$)

The devices feature a shutdown input. For normal operation, a shunt should be installed across jumpers JU1 and JU3. To disable the output, remove the shunts on JU1 and JU3 and an internal 1µA shutdown current pulls $\overline{SHDN}$ low or drives the RUN/RUN1 test points low. See Table 1 for JU1 and JU3 jumper settings.

Optional RC Load at GATE for Inrush Control

The EV kits feature an optional RC (R13/C6 and R24/C12) at the GATE pin of the device that is connected through jumpers JU2 and JU4. If necessary to slow down the turn-on time of the GATE of the MOSFET(s), install a shunt across JU2 and JU4. By default, JU2 and JU4 are not connected.

Table 1. Shutdown Input ($\overline{SHDN}$ Jumper JU1, JU3 Settings

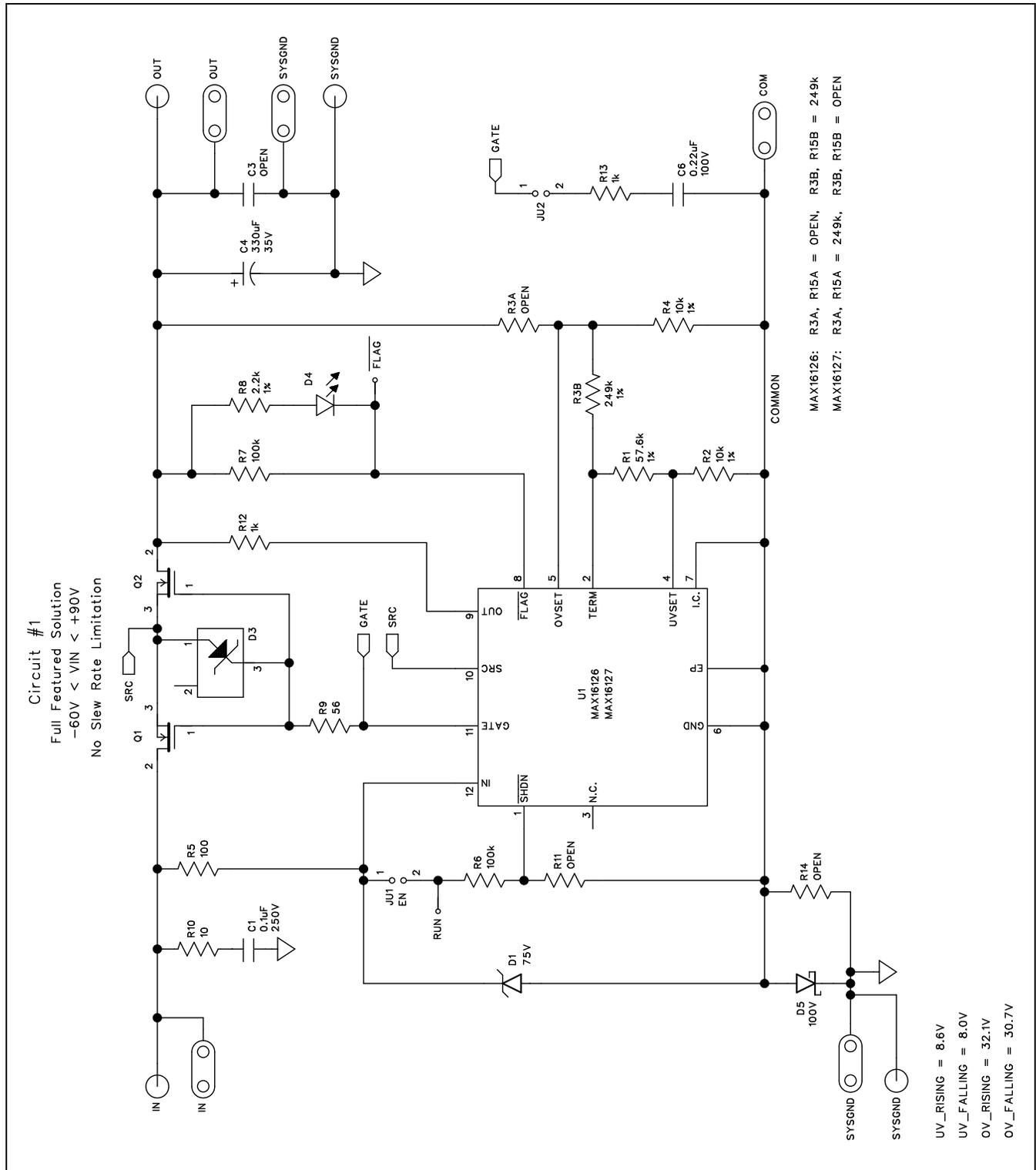| SHUNT POSITION	$\overline{SHDN}$ PIN	DEVICES
Installed*	Connected to IN	Enabled
Not installed	Internally pulled low through 1µA shutdown current or the RUN/RUN1 test point can be driven low.	Disabled

*Default position.

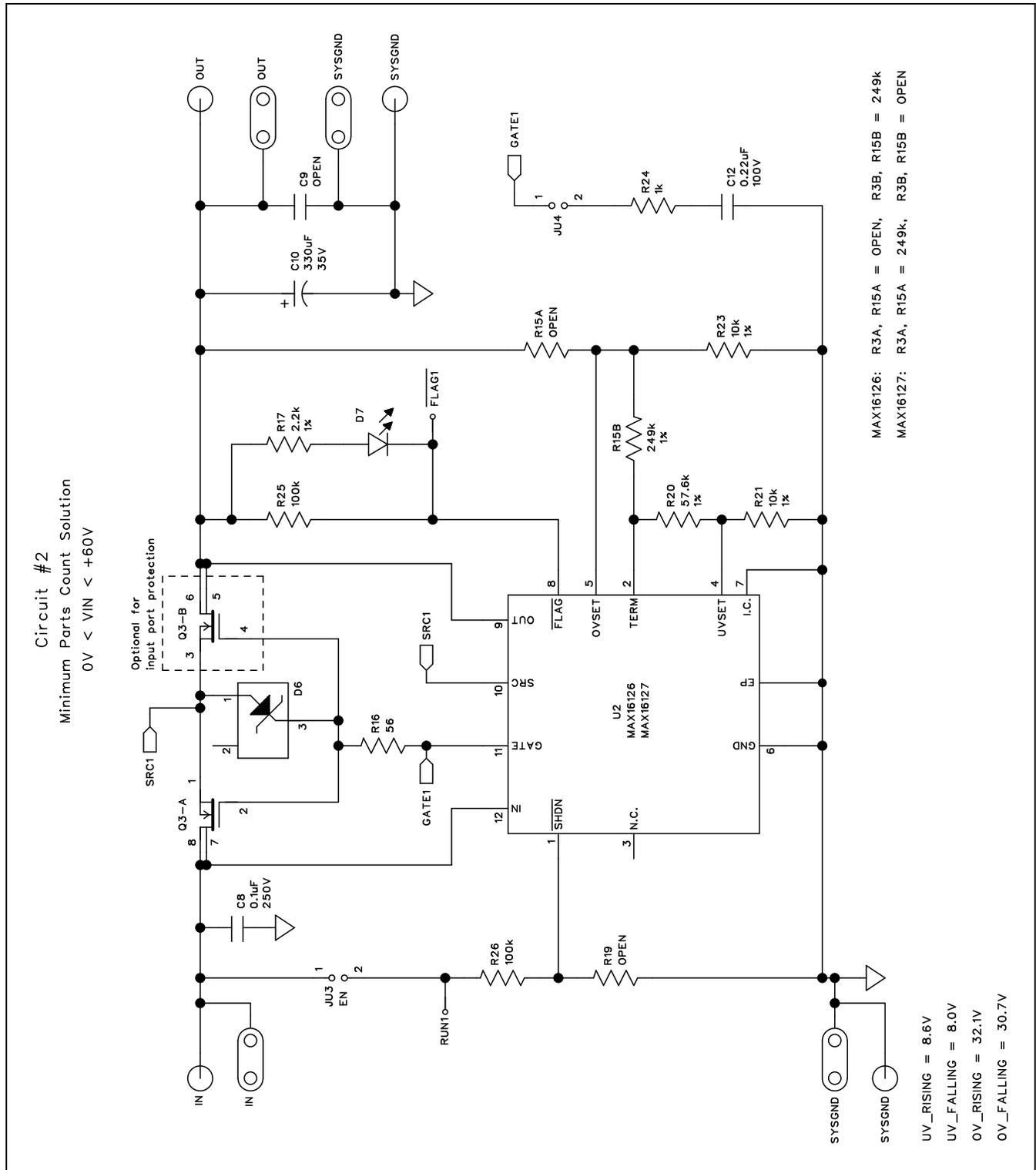Figure 1a. MAX16126/MAX16127 EV Kit Schematic (Sheet 1 of 2)—Circuit 1

Figure 1b. MAX16126/MAX16127 EV Kit Schematic (Sheet 2 of 2)—Circuit 2
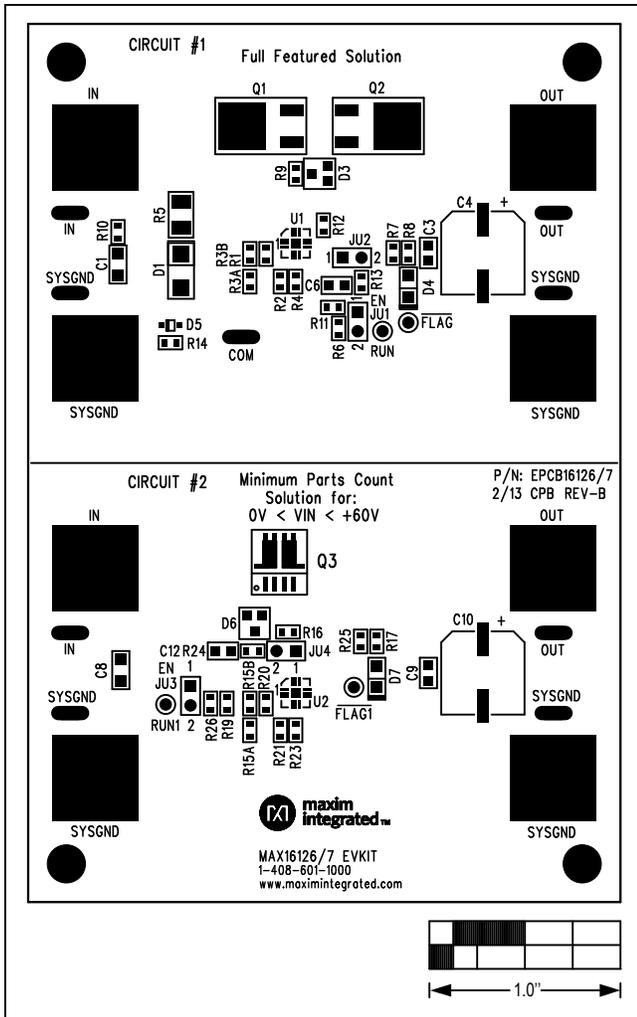
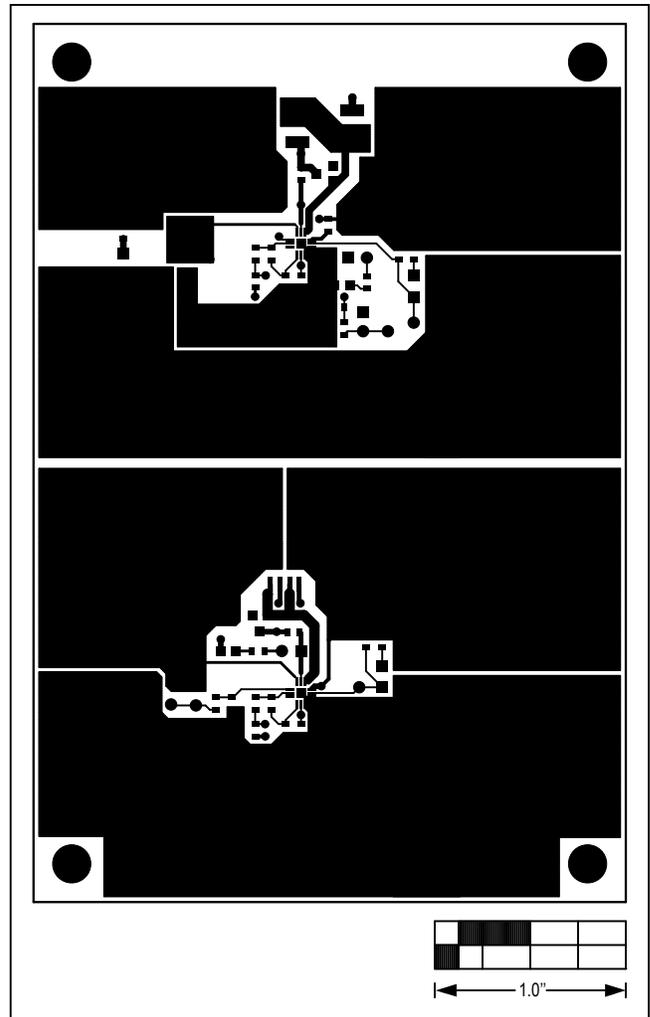Figure 2. MAX16126/MAX16127 EV Kit Component Placement Guide—Component Side

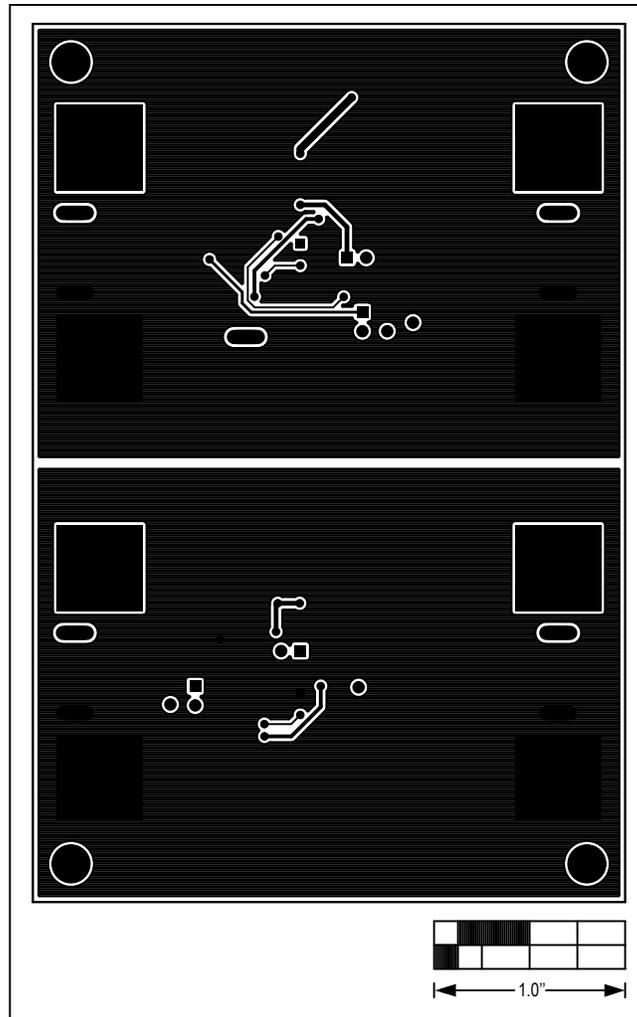Figure 3. MAX16126/MAX16127 EV Kit PCB Layout—Component Side

Figure 4. MAX16126/MAX16127 EV Kit PCB Layout—Solder Side

Ordering Information

PART	TYPE
MAX16126EVKIT#	EV Kit
MAX16127EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/13	Initial release	—

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Тел: +7 (812) 336 43 04 (многоканальный)
Email: org@lifeelectronics.ru

www.lifeelectronics.ru