19-5989; Rev 0; 8/11

MAX5974E Evaluation Kit
Evaluates: MAX5974E

General Description

The MAX5974E evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board featuring the MAX5974E spread-spectrum, current-mode PWM controller for Power-over-Ethernet (PoE) powered device (PD) applications. The EV kit circuit is a nonisolated, compact, and low-cost design used in Power-over-LAN (PoLAN) applications requiring DC power from an Ethernet network port for PDs such as IP phones, wireless access nodes, and security cameras.

The EV kit features a Class 2 PD with a 200kHz switching frequency flyback DC-DC converter using the IC. The circuit achieves high efficiency up to 91% using a synchronous rectifier. The surface-mount transformer provides energy storage for the output, which is configured for +3.3V and provides up to 1.8A load current.

The EV kit includes the MAX5969B IEEE® 802.3af/at-compliant PD interface-controller IC that provides PD detection signature, PD classification signature, inrush current control, undervoltage lockout (UVLO), and current limit after the PD is on.

The EV kit circuit receives its power from IEEE 802.3af/at-compliant power-sourcing equipment (PSE). The PSE provides the required -39V to -57V DC power over a twisted-pair Ethernet network cable to the EV kit's RJ45 MagJack®. The EV kit features a 1 x 1Gb RJ45 MagJack and two full-bridge diodes for separating the DC power provided by an endspan or midspan Ethernet system.

The EV kit circuit can also be powered by a +39V to +57V wall-adapter power source applied at the WAD_IN and WAD_GND PCB pads. When a wall-adapter power source is detected, it always takes precedence over the PSE source, allowing the wall adapter to power the EV kit.

Warning: The EV kit is designed to operate with high voltages. Dangerous voltages are present on this EV kit and on equipment connected to it. Users who power up this EV kit or power the sources connected to it must be careful to follow safety procedures appropriately to work with high-voltage electrical equipment.

Under severe fault or failure conditions, this EV kit may dissipate large amounts of power, which could result in the mechanical ejection of a component or of component debris at high velocity. Operate this kit with care to avoid possible personal injury.

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MagJack is a registered trademark of Bel Fuse Inc.

Features

- **IEEE 802.3af/at-Compliant PD Interface Circuit**
- **-39V to -57V Startup Input Voltage Range**
- **91% Efficiency (at VIN = +48V)**
- **Nonisolated +3.3V Output at 1.8A**
- **PD Detection and Configurable Classification Signatures**
- **2-Event Classification and Wall-Adapter Detect Output**
- **Inrush Current Limit of 180mA (max)**
- **Internal UVLO at -38.6V**
- **Evaluates Endspan and Midspan Ethernet Systems**
- **Simplified Wall-Adapter Interface**
- **Proven PCB Layout**
- **Fully Assembled and Tested**

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	0	Not installed, ceramic capacitor (0805)
C2, C18	2	0.1µF ±10%, 100V X7R ceramic capacitors (0805) TDK C2012X7R2A104K
C3, C12	2	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104k
C4	1	10µF ±10%, 25V X7R ceramic capacitor (1206) Murata GRM31CR61E106K
C5	1	10µF ±20%, 16V X5R ceramic capacitor (0603) Murata GRM188R60J106M
C6, C13	2	1µF ±10%, 100V X7R ceramic capacitors (1206) TDK C3216X7R2A105K
C7	1	22µF ±20%, 63V electrolytic capacitor (6.6mm x 6.6mm) Panasonic EEEFK1J220XP
C8	1	1000pF ±10%, 1500V X7R ceramic capacitor (1808) AVX 1808SC102KAT1A
C9	1	330pF ±20%, 50V X7R ceramic capacitor (0603) Murata GRM188R72A331M
C10, C11	2	100µF ±20%, 6.3V X5R ceramic capacitors (1210) Murata GRM32ER60J0J107M
C14	1	0.01µF ±10%, 25V X7R ceramic capacitor (0603) Murata GRM188R71E103K
C15	1	0.047µF, 10V X7R ceramic capacitor (0603) AVX 0603ZG473ZAT2A
C16	1	100pF, 25V X7R ceramic capacitor (0603) AVX 06033C102MAT2A
C17	1	0.1µF, 25V X5R ceramic capacitor (0603) Murata GRM188R61E104K
C19	1	1000pF, 25V X5R ceramic capacitor (0603) Murata GRM188R61H102K
C20, C22	2	2200pF, 100V X5R ceramic capacitors (0603) Murata GRM188R72A222K
C21	1	0.22µF, 25V X5R ceramic capacitor (0603) Murata GRM188R61E224KA88B
C23	0	Not installed, ceramic capacitor (0603)
D1, D2	2	100V, 0.8A bridge rectifiers (MiniDIP) Diodes Inc. HD01-T
D3	1	Transient voltage suppressor (SMB) Diodes Inc. SMBJ58A-13-F (Top Mark: NG)
D4	1	60V, 500mA Schottky diode (SOD123)
D6	0	Not installed, TVS diode (SMA)
D7	0	Not installed, diode (SMA)
D8	1	100V, 2A Schottky diode (SMB) Diodes Inc. ES2B-13-F
D10	1	80V, 100mA switching diode (SOD323) Diodes Inc. 1N4148WS
D11	0	Not installed, zener diode (SOT23)
J1	1	Modular 8-position, side-entry jack assembly
L1	1	80V, 2A common-mode choke TDK ZJYS81R5-2P24 or Sumida CPFC74NP-4251-T11
L2	1	3.3µH, 2.6A inductor Cooper Bussmann SD53-3R3-R
L3	1	50V, 2A common-mode choke TDK ZJYS51R5-2P-01 or Sumida CPFC74NP-PS02H2A20
N1	1	30V, 5.3A n-channel MOSFET (SOT23), International Rectifier IRLML0030TRPbF
N2	1	150V, 1.6 A, 261mΩ n-channel MOSFET (3 SuperSOT) Fairchild FDN86246
Q1	0	Not installed, npn transistor (SOT23)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
Q2	0	Not installed, pnp transistor (SOT23)
R1	1	24.9kΩ ±1% resistor (0603)
R2 , R19	2	10Ω ±5% resistors (0603)
R3	1	49.9Ω ±1% resistor (0603)
R4	1	66.5Ω ±1% resistor (0805)
R5	1	59kΩ ±1% resistor (0603)
R6	1	22.1kΩ ±1% resistor (0603)
R7	1	34kΩ ±1% resistor (0603)
R8	1	1.5MΩ ±1% resistor (0603)
R9, R13, R27	3	100kΩ ±1% resistors (0603)
R10	1	1kΩ ±1% resistor (0603)
R11, R12, R34, R37, R38, R41, R42	0	Not installed, resistors (0603)
R14	1	100Ω ±1% resistor (0603)
R15	1	43.2kΩ ±1% resistor (0603)
R16, R46	2	0Ω ±5% resistors (0603)
R17	1	1MΩ ±5% resistor (0603)
R18	1	4.02kΩ ±1% resistor (0603)
R20, R23, R24, R40	0	Not installed, resistors (0805)
R21	1	0.43Ω ±1%, 1/4W resistor (1206)
R22	1	10Ω ±5% resistor (0805)
R25	0	Not installed, resistor (1206)

DESIGNATION	QTY	DESCRIPTION
R26	1	499Ω ±5% resistor (0603)
R28	1	49.9kΩ ±1% resistor (0603)
R30–R33	4	75Ω ±5% resistors (0805)
R35	1	4.12kΩ ±1% resistor (0603)
R36	1	2.43kΩ ±1% resistor (0603)
R39	1	10Ω ±1% resistor (0603)
RJ45	1	RJ45 MagJack 1G Ethernet, 802.3af/at standard Bel Fuse Inc. 0826-1X1T-GH-F
T1	1	7.5W flyback transformer (8 EP10) Sumida CEP1110-PS10-200 or Coilcraft P0E70P-50L_
TP1	1	Small red test point
TP2	1	Small black test point
U1	1	Current-mode PWM controller (16 TQFN-EP) Maxim MAX5974EETE+
U2	1	IEEE 802.3af/at-compliant PD interface (10 TDFN-EP) Maxim MAX5969BETB+
—	4	Rubber bumpers
—	1	PCB: MAX5974E EVALUATION KIT

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corporation	843-946-0238	www.avx.com
Bel Fuse Inc.	201-432-0463	www.belfuse.com
Coilcraft, Inc.	847-639-6400	www.coilcraft.com
Cooper Bussmann	916-941-1117	www.cooperet.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
Panasonic Corp	800-344-2112	www.panasonic.com
Sumida	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: *Indicate that you are using the MAX5974E when contacting these component suppliers.*

Quick Start

Required Equipment

- MAX5974E EV kit
- IEEE 802.3af/at-compliant PSE and Category 5e Ethernet network cable
- -48V, 1A-capable DC power supply
- Voltmeter

Hardware Connections

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) Use one of the following methods to power the EV kit:
   - **If network connectivity is required:** Connect a Category 5e Ethernet network cable from the EV kit input port RJ45 MagJack connector (RJ45) to the corresponding PSE Ethernet LAN connection, which provides power to the EV kit. A modular RJ45 jack (J1) provides an interface with the Ethernet data signals only.
   - **If network connectivity is not required:** Connect a -48V DC power supply between the V+ and V- PCB pads on the EV kit. Connect the power-supply positive terminal to the V+ pad and the negative terminal to the V- pad.
2) Activate the PSE power supply or turn on the external DC power supply.
3) Using the voltmeter, verify that the EV kit provides +3.3V across the 3.3V and RTN PCB pads.

Detailed Description of Hardware

The MAX5974E EV kit is a fully assembled and tested surface-mount circuit board that evaluates the MAX5974E nonisolated, synchronous, current-mode PWM controller. The EV kit features a powered Ethernet port, a data-only Ethernet port, and a MAX5969B IEEE 802.3af/at-compliant network PD interface-controller IC.

The EV kit is a nonisolated 7W DC-DC current-mode PWM controller using a flyback DC-DC converter topology. The EV kit receives power from an IEEE 802.3af/at-compliant PSE and a Category 5 cable connected to the EV kit's RJ45 MagJack. The EV kit uses a 1 x 1Gb RJ45 MagJack and two diode-bridge power rectifiers (D1, D2) to separate the -57V DC power sent by the PSE. The EV kit accepts power from an endspan or midspan PSE network configuration. The EV kit also provides an RJ45 jack (J1) for interfacing to the Ethernet data signals. PCB pads V+ and V- are available for powering the EV kit if network connectivity is not required. Common-mode chokes L1 and L3 are provided for EMI filtering at the EV kit power-supply (V+, V-) and wall-adapter (WAD_IN, WAD_GND) inputs, respectively.

The EV kit output voltage is configured for +3.3V and provides up to 1.8A output current while achieving up to 91% efficiency. Transformer T1 is used for providing the operating voltage at the IC's IN input. PCB pad D11 is available for clamping the IN input when driving the EN input using an external source. Secondary-side regulation is achieved through feedback resistors R3, R35, and R36 to set the output voltage, in addition to filtering components C21 and R14. Current-sense resistors R21 and R25 limit the peak current through transistor N2 and primary winding of transformer T1. Optional diodes D6 and D7 PCB footprints are provided for limiting the voltage spikes across T1 during N2 turn-off time, if required.

The EV kit also demonstrates the full PD functionality of the device, such as PD detection signature, PD classification signature, inrush current control, and UVLO. Resistors R1 and R4 set the PD detection signature and the PD classification signature, respectively.

The EV kit circuit accepts power from a wall-adapter DC power source. When a +39V to +57V wall-adapter power source is applied at the WAD_IN and WAD_GND PCB pads, it always takes precedence over the PSE source, allowing the wall adapter to power the EV kit circuit. When applying a valid voltage source between the WAD_IN and WAD_GND pads, the MAX5969B internal isolation switch disconnects VSS from RTN, which allows the wall adapter to supply power to the EV kit.

PD Classification Signature

The EV kit is configured for a Class 2 (3.84W to 6.49W) PD classified by resistor R4. To reconfigure the PD classification, replace surface-mount 0805 resistor R4. Table 1 lists the PD classification options.

Table 1. PD Classification Signature Selection

CLASS	MAXIMUM POWER USED BY PD (W)	RESISTOR R4 (Ω)
0	0.44 to 12.95	615
1	0.44 to 3.84	117
2	3.84 to 6.49	66.5
3	6.49 to 12.95	43.7
4	12.95 to 25.5	30.9
5	> 25.5	21.3

Wall-Adapter Power Source (WAD_IN, WAD_GND)

The EV kit can also accepts power from a wall-adapter DC power source applied at the WAD_IN and WAD_GND PCB pads. The wall-adapter power-source operating-voltage range must be within -36V to -57V for the EV kit.

When the wall-adapter power source is above +27.5V (typ), it takes precedence over the PSE source. Once the wall-adapter power source is detected, the MAX5969B internal isolation switch disconnects VSS from RTN. The wall-adapter power is supplied to VDD (through diode D8) and RTN. Once it takes over, the classification process is disabled. Resistors R27 and R28 are available for adjusting the EV kit wall-adapter voltage for disabling the PoE source.

If the wall-adapter power source is below +27V, the PoE provides power through the device's RTN after a successful detection and classification. Diode D8 prevents the PoE from back driving the wall-adapter power source.

Ethernet Data-Signal Interfacing

The EV kit features a modular RJ45 jack (J1) to interface with the Ethernet data signals. J1 is provided for interfacing the EV kit with the Ethernet data signals only. Refer to the RJ45 MagJack data sheet on the Bel Fuse website prior to interfacing the EV kit's J1 modular RJ45 jack with the Ethernet data signals.

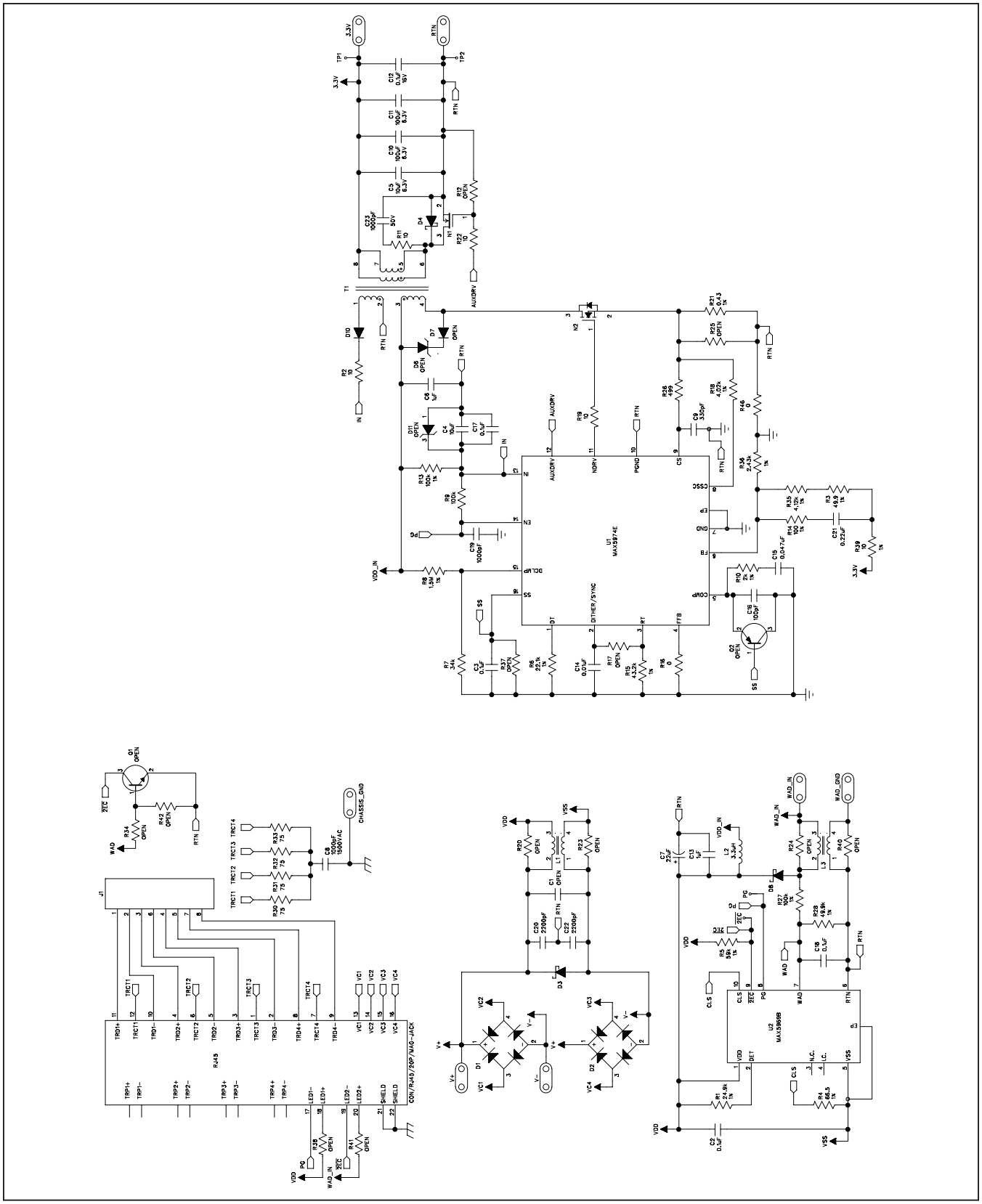

Figure 1. MAX5974E EV Kit Schematic

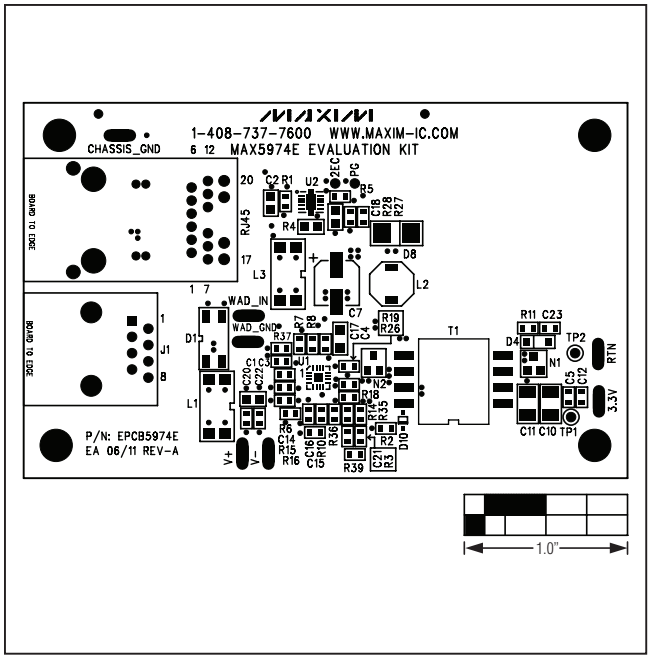

Figure 2. MAX5974E EV Kit Component Placement Guide—Component Side

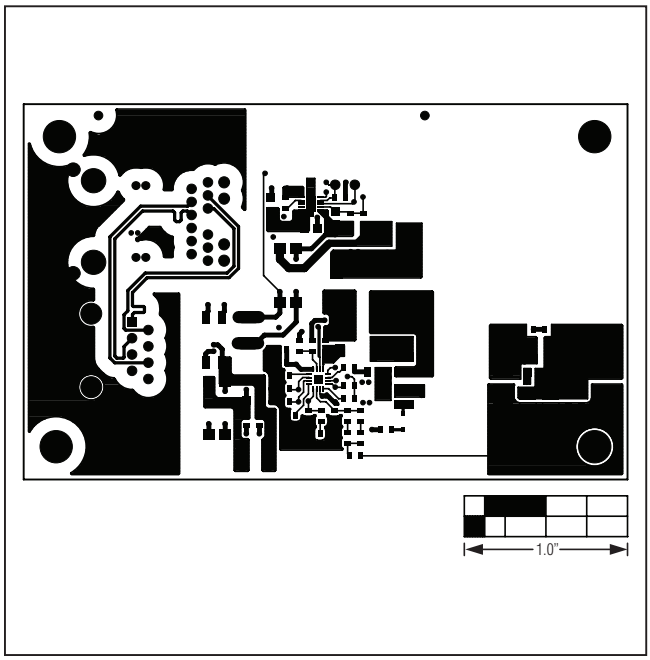

Figure 3. MAX5974E EV Kit PCB Layout—Component Side

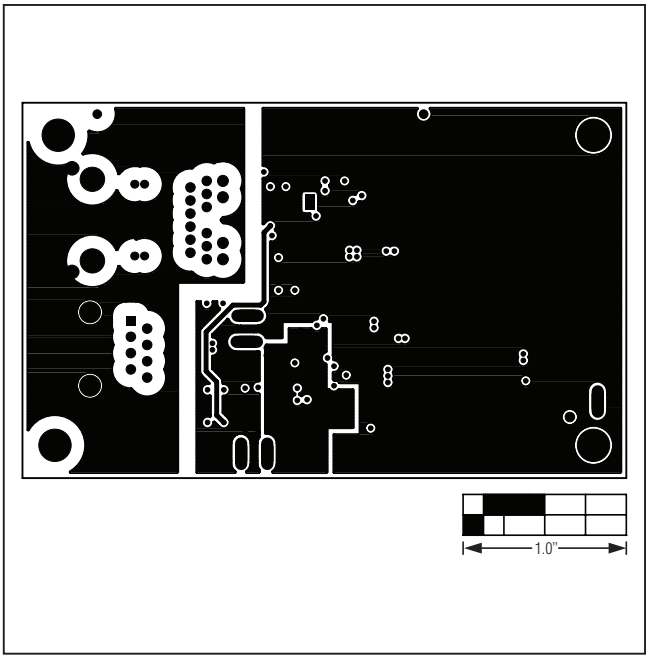

Figure 4. MAX5974E EV Kit PCB Layout—GND Layer 2

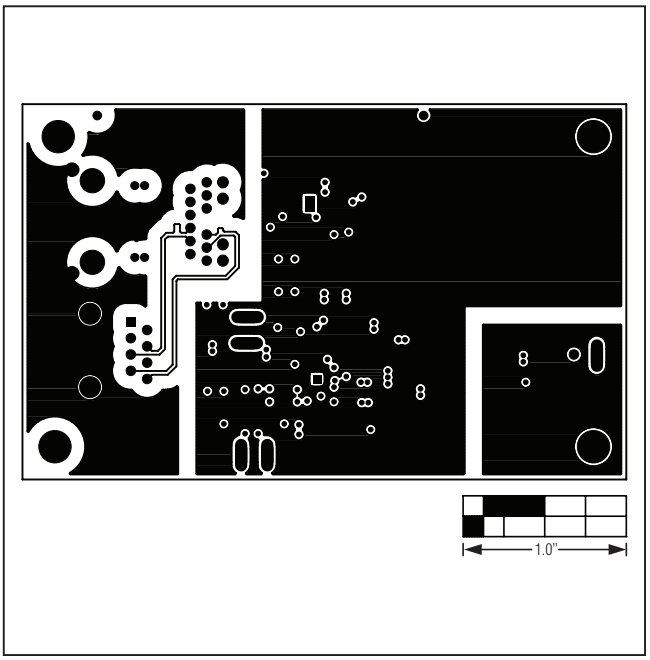

Figure 5. MAX5974E EV Kit PCB Layout—Signal Layer 3

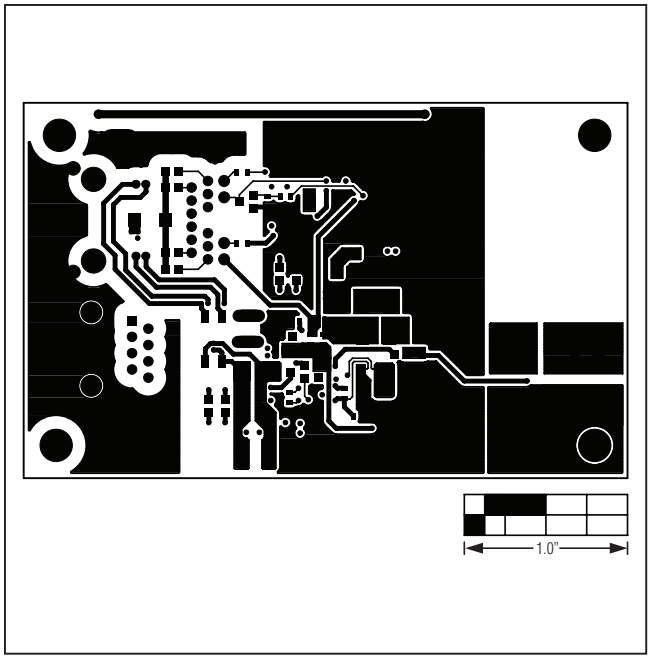

Figure 6. MAX5974E EV Kit PCB Layout—Solder Side

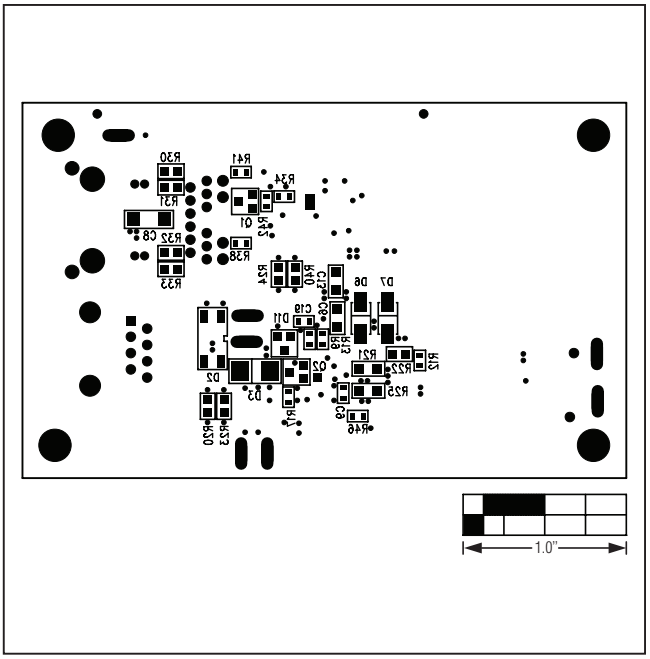

Figure 7. MAX5974E EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX5974EEVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	8/11	Initial release	—