19-5262; Rev 0; 11/11

MAX5974C Evaluation Kit
Evaluates: MAX5974C

General Description

The MAX5974C evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board featuring the MAX5974C active-clamped, spread-spectrum, current-mode PWM controller for Power-over-Ethernet (PoE) powered device (PD) applications. The EV kit is a 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 galvanically isolated 25W, 250kHz switching-frequency, active-clamped, synchronous-rectified forward DC-DC converter using the IC. The device circuit achieves high efficiency up to 93.5% using a forward DC-DC converter topology. The surface-mount transformer provides up to +1500V galvanic isolation for the output. The EV kit output voltage is configured for +5V and provides up to 4.7A load current.

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

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 an unshielded 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 +37V to +57V wall adapter power source, applied at the PWR+ and PWR- 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.

Features

- **IEEE 802.3af/at-Compliant PD Interface Circuit**
- **-39V to -57V Startup Input Voltage Range**
- **Demonstrates an Isolated 25W Active-Clamped, Synchronous-Rectified Forward DC-DC Converter**
- **Demonstrates Up to 93.5% Efficiency**
- **Isolated +5V Output at 4.7A**
- **PD Detection and Configurable Classification Signatures**
- **Inrush Current Limit of 180mA (max)**
- **2-Event Classification or Wall Adapter Detect Output**
- **Internal UVLO at +38V**
- **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.**

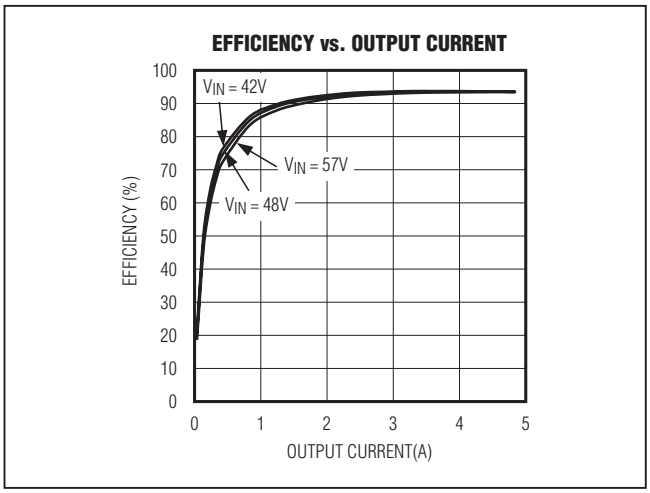

Figure 1. MAX5974C EV Kit Efficiency vs. Output Current at V_{IN} = 42V, 48V, and 57V

IEEE is a registered service mark of the Institute of Electrical and Electronics Engineers, Inc.

MagJack is a registered trademark of Bel Fuse Inc.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C6	2	1µF ±10%, 100V X7R ceramic capacitors (1210) AVX 12101C105KAT9A
C2	1	0.1µF ±10%, 100V X7R ceramic capacitor (0805) TDK C2012X7R2A104K
C3	1	0.056µF ±10%, 16V X7R ceramic capacitor (0402) Murata GRM155R61C563K
C4	1	22µF ±10%, 25V X7R ceramic capacitor (1210) Murata GRM32ER61E226K
C5	1	0.047µF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H473K
C7	1	33µF ±20%, 63V aluminum electrolytic capacitor (8.3mm x 8.3mm) Panasonic EEE1JA330P
C8, C9	2	100µF ±20%, 6.3V X5R ceramic capacitors (1210) TDK C3225X5R0J107M
C10	1	22µF ±10%, 10V X7R ceramic capacitor (1210) Murata GRM32ER71A226K
C11	0	Not installed, ceramic capacitor (1210)
C12	1	0.1µF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H104K
C13	1	0.1µF ±10%, 100V X7S ceramic capacitor (0603) TDK C1608X7S2A104K
C14	1	0.01µF ±10%, 10V X5R ceramic capacitor (0402) Murata GRM155R61A103K
C15	1	1µF ±10%, 10V X5R ceramic capacitor (0402) Murata GRM155R61A105K
C16, C20, C23, C26	0	Not installed ceramic capacitors (0402)
C17	1	4700pF ±10%, 250V X7R ceramic capacitor (1206) AVX 1206PC472KAT1A

DESIGNATION	QTY	DESCRIPTION
C18	1	2200pF ±20%, 250VAC X7R ceramic capacitor (2220) Murata GA355QR7GF222KW
C19	1	6800pF ±10%, 25V X7R ceramic capacitor (0402) Murata GRM155R71E682K
C21	1	0.1µF ±10%, 16V ceramic capacitor (0402) Murata GRM155R71C104K
C22	1	1000pF ±10%, 1500V X7R ceramic capacitor (1210) AVX 1210SC102KATA
C24	1	330pF ±10%, 50V X7R ceramic capacitor (0402) Murata GRM155R71H331K
C25	1	0.015µF ±10%, 25V ceramic capacitor (0402) TDK C1005X7R1E153K
D1, D2	2	200V, 1A bridge rectifier diodes (Mini-DIP) Diodes Inc. HD01-T
D3	1	600W, 58V TVS diode (SMB) Diode Inc. SMBJ58A
D4, D5, D8, D10	4	100mA, 80V diodes (SOD323) Diodes Inc. 1N4148WS
D6	1	22V zener diode (SOD123) Fairchild MMSZ5251B
D7	1	100V, 2A Schottky diode (SMB) Diodes Inc. B2100-13-F
D9, D11	2	200mA, 200V diodes (S-Mini2) Panasonic DA2J108
J1	1	Modular side-entry, 8-position jack assembly
L1	1	3300µH, 0.024A inductor Coilcraft LPS4018-335ML
L2	1	6.8µH, 8.5A inductor Pulse PG0702.682NL
L3	1	3.3µH, 2.6A inductor Cooper Bussmann SD53-3R3-R
N1, N2	2	25V, 58A n-channel MOSFETs (PowerPak 8 SO) Infineon BSC050NE2LS
N4	1	-150V, -0.42A p-channel transistor (6 SC70) Vishay Si1411DH

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
N5	1	150V, 2.3A n-channel transistor (6 SuperSOT) Fairchild FDC86244
PGND, +5V	2	Uninsulated banana jacks
Q1	0	Not installed, npn transistor (SOT23)
Q2	0	Not installed, pnp transistor (SOT23)
R1	1	30.1kΩ ±1% resistor (0603)
R2, R17, R47	0	Not installed, resistors (0402)
R4	1	30.9Ω ±1% resistor (0805)
R5	1	59kΩ ±5% resistor (0603)
R6	1	16.9kΩ ±1% resistor (0402)
R7	1	34kΩ ±1% resistor (0402)
R8	1	1.5MΩ ±1% resistor (0603)
R9	1	100kΩ ±5% resistor (0402)
R10	1	2kΩ ±1% resistor (0402)
R12, R13	2	10Ω ±5% resistors (0805)
R14	1	24.9kΩ ±1% resistor (0603)
R15	1	34.8kΩ ±1% resistor (0402)
R16	1	0Ω ±5% resistor (0402)
R18	1	499Ω ±1% resistor (0402)
R19, R23	2	10Ω ±5% resistors (0603)
R20	1	10kΩ ±1% resistor (0603)
R21, R25	2	0.4Ω ±1%, 1/2 W resistors (1206) IRC LRC-LRF-1206LF-01-R400-F
R26, R48	2	100Ω ±1% resistors (0402)
R27	1	100kΩ ±1% resistor (0402)
R28	1	36.5kΩ ±1% resistor (0402)
R29	1	162kΩ ±1% resistor (0402)
R30	1	121kΩ ±1% resistor (0402)
R31	1	4.99kΩ ±1% resistor (0402)
R32	1	1kΩ ±1% resistor (0402)
R33	1	1kΩ ±1% resistor (0402)
R34	1	4.02kΩ ±1% resistor (0402)

DESIGNATION	QTY	DESCRIPTION
R35	1	7.5kΩ ±1% resistor (0402)
R36	1	2.49kΩ ±1% resistor (0402)
R37	1	1MΩ ±5% resistor (0402)
R38, R39, R44, R45	0	Not installed, resistors (0603)
R40, R41, R42, R43	4	75Ω ±5% resistors (0603)
R46	1	0Ω ±5% resistor (0603)
RJ45	1	RJ45 MagJack 1G-Ethernet, 802.3af/at standard Bel Fuse Inc. 0826-1X1T-GH-F
TPGND	1	Black test point
TP5V	1	Red test point
T1	1	0.50:0.25:0.25:1 forward transformer (10 EP13) Cooper Bussmann CTX03-18842-R
U1	1	Active-clamped PWM controller (16 TQFN-EP) Maxim MAX5974CETE+ (Top Mark: AIA)
U2	1	IEEE802.3at-compliant powered device (10 TDFN-EP) Maxim MAX5969BETB+ (Top Mark: AWP)
U3	1	70V, 200% to 400% CTR phototransistor (4 DIP, surface mount) Fairchild FOD817CSD (Top Mark: TAI_)
U4	1	1.24V shunt regulator (5 SOT23)
—	1	PCB: MAX5974C EVALUATION KIT

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corporation	843-946-0238	www.avxcorp.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
Infineon Technologies AG	919-998-5334	www.infineon.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
Pulse Engineering	858-674-8100	www.pulseeng.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

Note: *Indicate that you are using the MAX5974C when contacting these component suppliers.*

Quick Start

Required Equipment

- MAX5974C 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. Ethernet 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 VDD and VSS PCB pads on the EV kit. Connect the power-supply positive terminal to the VDD pad and the negative terminal to the VSS PCB pad.
2) Activate the PSE power supply or turn on the external DC power supply.
3) Using a voltmeter, verify that the EV kit provides +5V across the +5V and PGND PCB pads. **PGND is galvanically isolated from the EV kit's input VDD and VSS PCB pads.**

Detailed Description of Hardware

The MAX5974C EV kit is a fully assembled and tested surface-mount circuit board that evaluates the MAX5974C active-clamped, 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 galvanically isolated 25W DC-DC converter using the active-clamped, current-mode PWM controller IC in a forward-feedback topology. The EV kit receives power from an IEEE 802.3af/at-compliant PSE and a UTP 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 Ethernet jack J1 for interfacing to the Ethernet data signals. PCB pads VDD and VSS are available for powering the EV kit, if network connectivity is not required.

The EV kit output voltage is configured for +5V and provides up to 4.7A output current. The EV kit circuit achieves up to 93.5% efficiency using MOSFETs N1 and N2 for synchronous rectification on the secondary side. Transformer T1 provides up to 1500V galvanic isolation for the output. Isolated feedback voltage is achieved using optical coupler U3 and voltage regulator U4. Current-sense resistors R21 and R25 limit the peak current through transistor N5 and primary transformer T1. Capacitor C17 and transistor N4 form a clamping network that protects transformer T1 against saturation due to reverse current, by monitoring the voltage across the IC's CS input during auxiliary driver N4 off-time.

The EV kit also demonstrates the full PD functionality of the MAX5969B (U2), such as PD detection signature, PD classification signature, inrush current control, and UVLO. Resistors R14 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 wall adapter power source in the +37V to +57V range is applied at the PWR+ and PWR- 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 PWR+ and PWR- PCB 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 4 (12.95W to 25.5W) PD classification by resistor R4. To reconfigure the PD classification, replace surface-mount 0805 resistor R4. Table 1 lists the PD classification options.

Wall Adapter Power Source (PWR+, PWR-)

The EV kit can also accept power from a wall adapter DC power source, applied at the PWR+ and PWR- PCB pads. The wall adapter power-source operating-voltage range must be within +37V to +57V for the EV kit.

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

When the wall adapter power source is above +33.6V 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 D7) 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 PSE source.

When the wall adapter power source is below +27V the PSE provides power through the RTN pin on U2. Diode D7 prevents the PSE from backdriving the wall adapter power source when it is below +7V.

Ethernet Data-Signal Interfacing

The EV kit features Ethernet 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 jack with the Ethernet data signals.

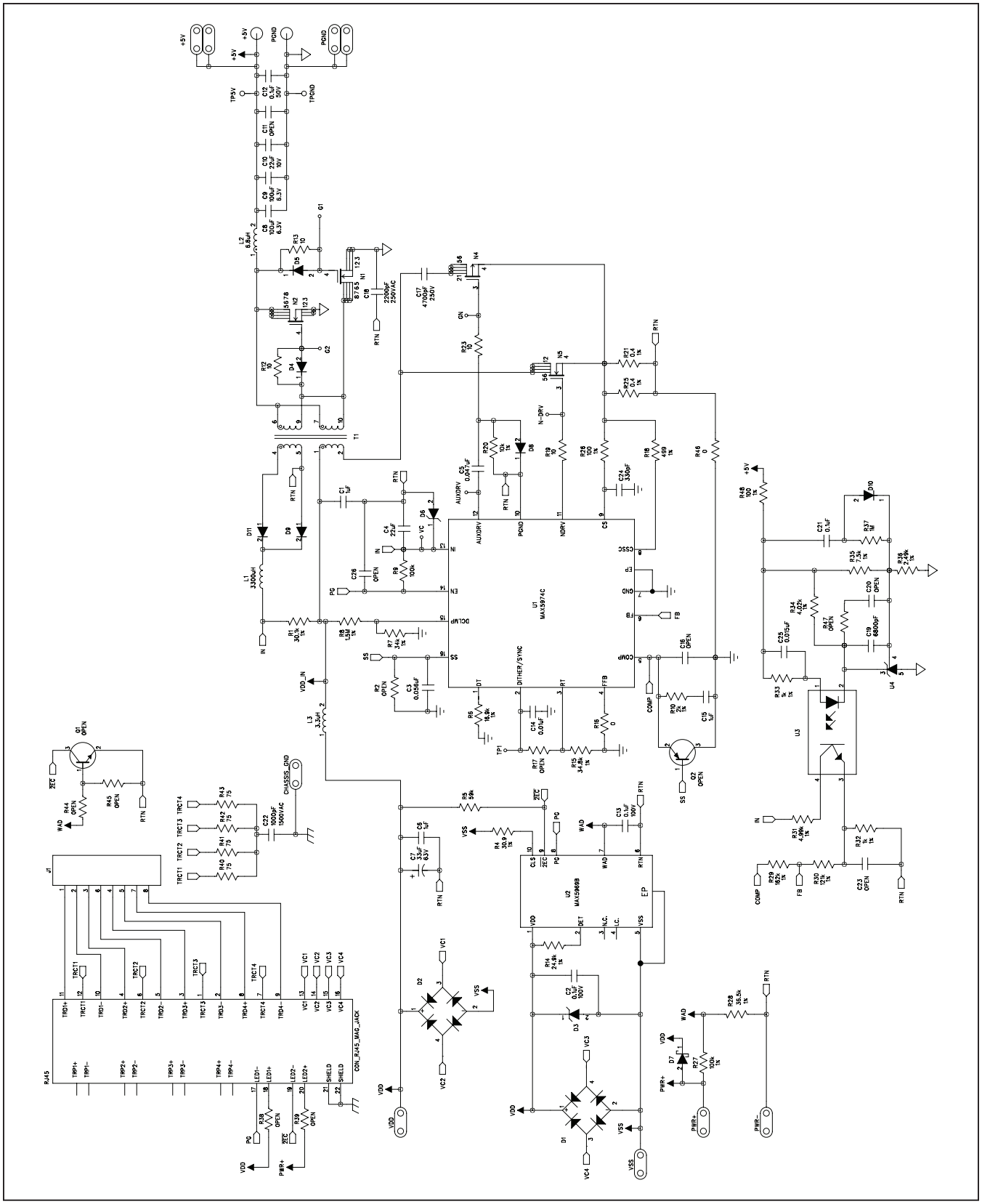

Figure 2. MAX5974C EV Kit Schematic

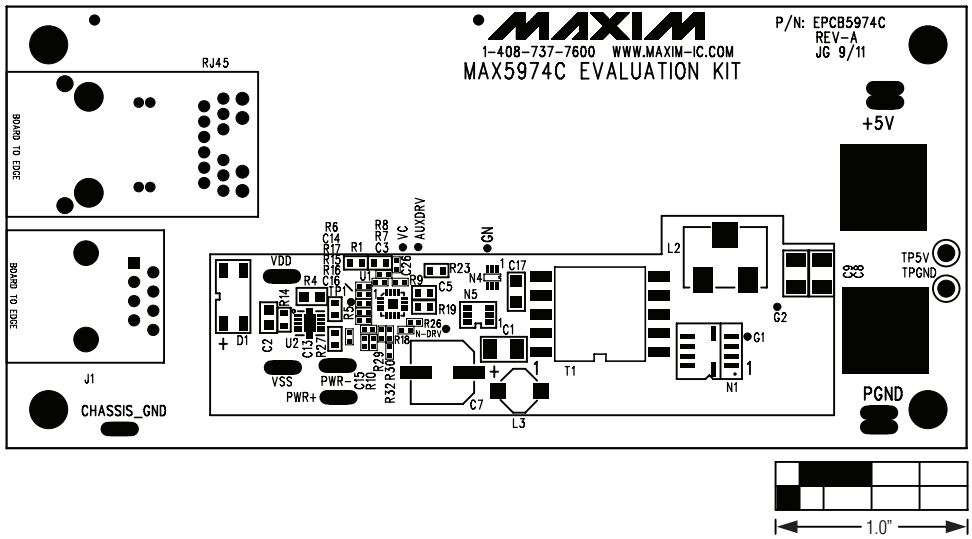

Figure 3. MAX5974C EV Kit Component Placement Guide—Component Side

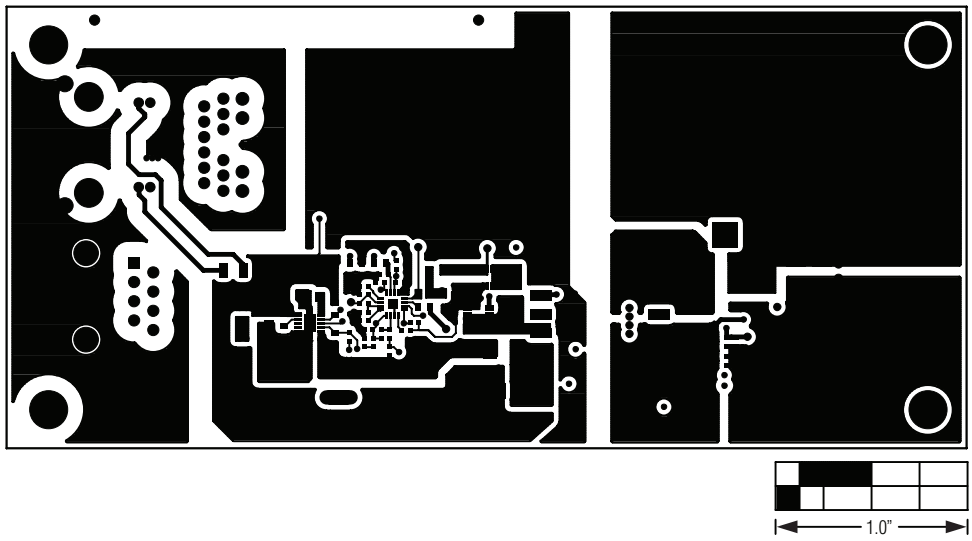

Figure 4. MAX5974C EV Kit PCB Layout—Component Side

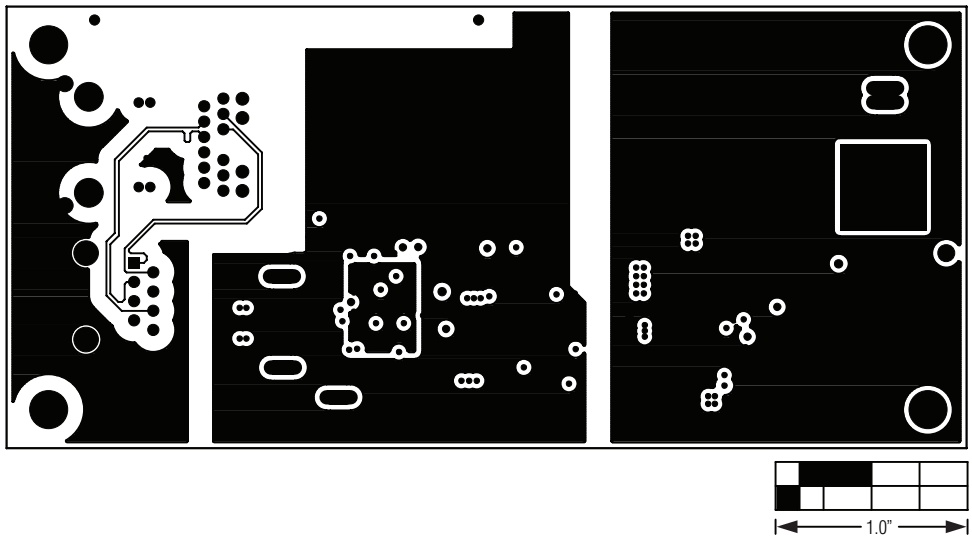

Figure 5. MAX5974C EV Kit PCB Layout—GND Layer 2

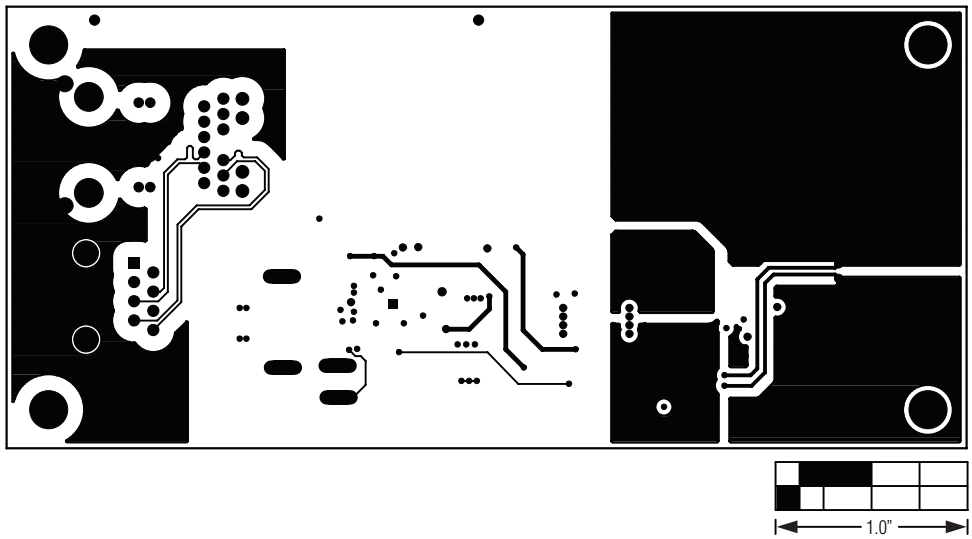

Figure 6. MAX5974C EV Kit PCB Layout— Signal Layer 3

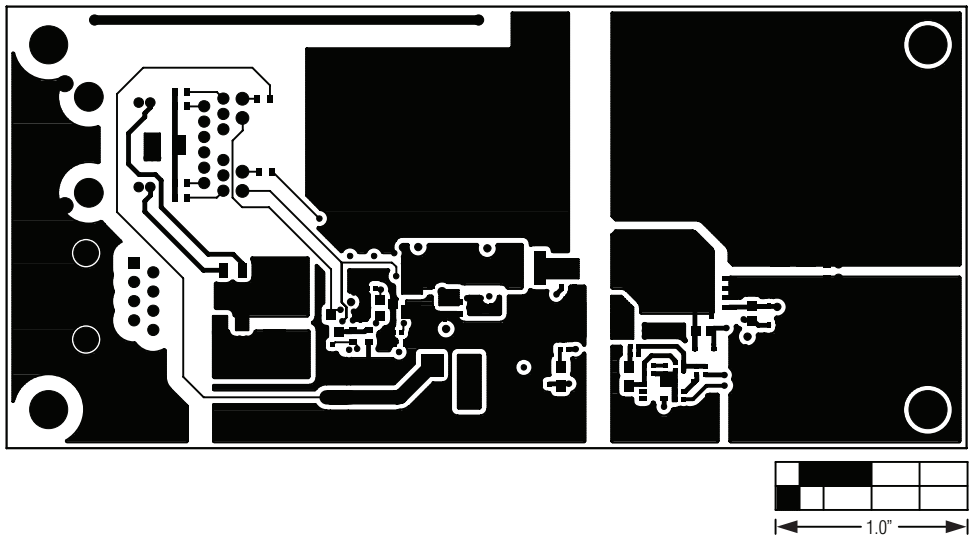

Figure 7. MAX5974C EV Kit PCB Layout—Solder Side

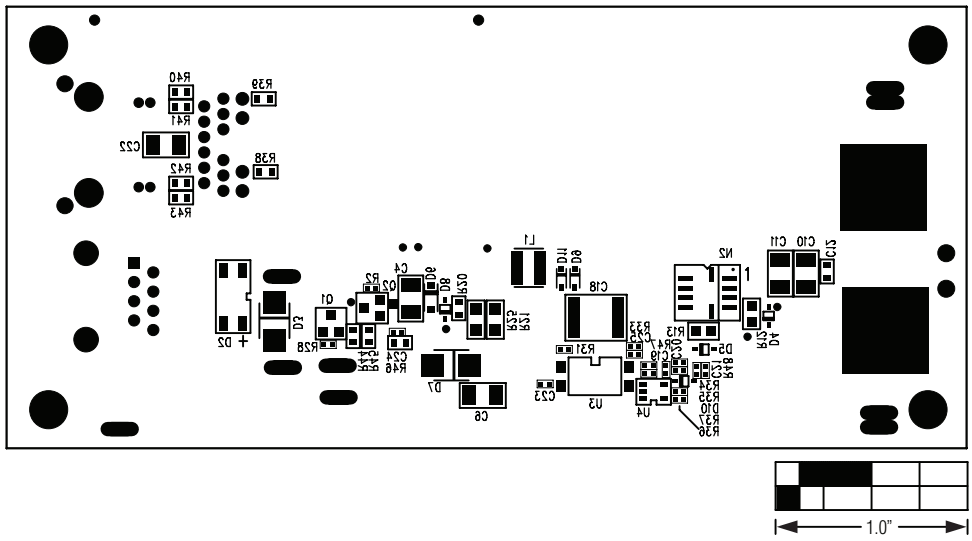

Figure 8. MAX5974C EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX5974CEVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

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

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Analog Devices Inc.:

MAX5974CEVKIT