19-5740; Rev 0; 1/11

MAX5971A Evaluation Kit

Evaluates: MAX5971A

General Description

The MAX5971A evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board featuring an Ethernet single-port power-sourcing equipment (PSE) circuit for -54V supply rail systems. The IEEE® 802.3af/at-compliant MAX5971A PSE controller IC, in a 28-pin TQFN package, features an internal n-channel power MOSFET forming the main PSE circuit on the EV kit. The IC is used in power-over-Ethernet (PoE) applications requiring DC power over a single Ethernet network port.

The EV kit requires a -32V to -60V power supply (-54V supply rail) capable of supplying 1A or more to the EV kit for powering the powered device (PD) through the 10/100/1000BASE-TX Ethernet network port. The EV kit demonstrates PD discovery, classification, current-limit control, and other functions of an IEEE 802.3af/at-compliant PSE.

The IC controls the -54V DC power to the Ethernet network port by sensing current through the port and controlling the IC's internal power MOSFET. The current is fed to a 1 x 1 gigabit MagJack® module at the EV kit's Ethernet output port.

The EV kit demonstrates the full functionality of the IC's operational modes, such as configurable high-power modes (programmable up to 40W), PD detection, PD classification, overcurrent protection, current fold-back, undervoltage/overvoltage protection, and AC-/DC-disconnect monitoring. All these features are configurable on the EV kit, with additional test points for voltage probing and current measurements provided. The EV kit can also be configured for midspan or end-point network operation.

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MagJack is a registered trademark of Bel Fuse Inc.

Features

- **IEEE 802.3af/at-Compliant PSE Circuit**
- **High-Power Class 5 Mode Configurable Up to 40W**
- **-32V to -60V Input Voltage Providing 1A**
- **Ethernet Network Ports**
  RJ45 10/100/1000BASE-TX Ethernet Network Data Input Port
  RJ45 10/100/1000BASE-TX Ethernet Network PSE Output Port
- **Demonstrates IC's Internal Power Switch and Current Sensing**
- **Demonstrates Standard and Legacy PD Detection and Classification**
- **Configurable for Midspan or End-Point Mode**
- **Configurable AC/DC Load-Removal Detection and Disconnect Monitoring**
- **Convenient Voltage and Current Test Points**
- **Demonstrates the EV Kit Circuit's Output Port LED-Status Indicator**
- **Proven PCB Layout**
- **Fully Assembled and Tested**

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	47µF ±20%, 100V electrolytic capacitor (12.5mm x 13.5mm) Panasonic EEEFK2A470AQ
C2, C3, C5	3	0.1µF ±10%, 100V X7R ceramic capacitors (0603) Murata GRM188R72A104KA35B
C4	1	0.47µF ±10%, 100V X7R ceramic capacitor (0805) Murata GRM21BR72A474KA73B
C6	1	0.1µF ±10%, 16V X7R ceramic capacitor (0603) Murata GRM188R71C104K
C12	1	1000pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H102K

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D1, D3	2	100V, 150mA small-signal diodes (SOD323) Fairchild 1N4148WS
D2	1	58V, 600W transient-voltage suppressor (SMB) Vishay SMBJ58A
D4	1	100V, 1A general-purpose diode (SMA) Diodes Inc. S1B
GND (x2), RTN, VEE	4	Uninsulated panel-mount banana jacks
J1	1	RJ45 connector module jack (8-8)
J2	1	RJ45 1 x 1Gb MagJack, 1000 Base-T, 1 x 1 port, voice-over-IP magnetics (700mA DC) Bel Fuse Inc. 0826-1X1T-GH-F
JU1–JU6	6	2-pin headers
L1	1	10mH, 17mA inductor Coilcraft DS1608C-106
R1	1	9.09kΩ ±1%, 1/2W resistor (2010) Panasonic ERJ-12SF9091U
R3, R10–R13, R15, R16	7	1kΩ ±5% resistors (0402)
R4	1	2.2MΩ ±5% resistor (0805)
R5, R6	0	Not installed, resistors (1206)
R7, R8	2	0Ω ±5% resistors (1206)
R9	0	Not installed, resistor (0402)
R29	1	5.1kΩ ±5% resistor (0603)
SW1	1	Microminiature pushbutton switch
TP1, TP3–TP6, TP9, TP10	7	Miniature PC test points, yellow
TP2	1	Miniature PC test point, red
TP11, TP13	2	Miniature PC test points, black
U1	1	Single-port PSE controller (28 TQFN-EP*) Maxim MAX5971AETI+
—	4	Rubber bumpers
—	6	Shunts (JU1–JU6)
—	1	PCB: MAX5971A EVALUATION KIT+

**EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Bel Fuse Inc.	201-432-0463	www.belfuse.com
Coilcraft, Inc.	847-639-6400	www.coilcraft.com
Diodes Incorporated	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Vishay	402-563-6866	www.vishay.com

Note: *Indicate that you are using the MAX5971A when contacting these component suppliers.*

Quick Start

Required Equipment

- MAX5971A EV kit
- -32V to -60V, 1A capable DC power supply
- Voltmeter for confirming output voltage

Warning: The GND banana jack is more positive than the VEE banana jack. Use an isolated oscilloscope for probing with respect to VEE.

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) Verify that a shunt is not installed on jumpers JU1 (ILIM1, Class 0–Class 4), JU2 (ILIM2, Class 0–Class 4), JU3 (PWM enabled), JU4 (midspan mode), and JU6 (AC disconnect).
2) Verify that a shunt is installed on jumper JU5 (legacy mode disabled).
3) Connect the -32V to -60V DC power supply to the metal VEE banana jack and the supply ground to the metal GND banana jack. Do not turn on the power supply until all connections are completed.
4) Connect a PD to the Ethernet output port J2 RJ45 connector on the EV kit's MagJack module J2 RJ45 connector. This step is optional if network connectivity and/or a PD are not required.
5) Connect the EV kit's network input LAN RJ45 port (J1) to the corresponding PD LAN connection. This step is optional if network connectivity is not required.
6) Turn on the power supply and set it to -54V.
7) Test points TP11, TP13 (VEE), and TP2 (GND) are provided throughout the PCB to observe the desired signals with an oscilloscope or voltage meter. **Use an isolated oscilloscope for probing with respect to VEE or RTN.**
8) Pressing pushbutton switch SW1 shuts down the PSE output DC power and resets U1.

Detailed Description of Hardware

The MAX5971A EV kit features a 10/100/1000BASE-TX Ethernet single-port PSE controller circuit for -54V supply rail systems. The EV kit's PSE circuit uses the IEEE 802.3af/at-compliant MAX5971A PSE controller featuring an integrated n-channel power MOSFET and an on-board single 1 x 1Gb MagJack module (integrated in J2) to form the basic portion of a PSE circuit. The EV kit has been designed as an IEEE 802.3af/at-compliant PSE and demonstrates all the required functions, such as PD discovery, classification, current-limit control of a connected PD at the Ethernet output port, and AC-/DC-disconnect detection.

The EV kit's PSE circuit requires a -32V to -60V power supply (-54V supply rail) capable of supplying 1A to the EV kit's GND and VEE steel banana jacks or PCB pads.

The IC controls the -54V DC power to the output port by regulating the port's current. The current is fed to the 10/100/1000BASE-TX magnetic output module connected to the J2 Ethernet output port RJ45 jack. An IEEE 802.3af/at-compliant PD connects to Ethernet output port J2 on the EV kit. The PD can be located within 350ft from the EV kit when connected with a twisted 4-pair Ethernet cable. The 10/100/1000BASE-TX magnetic module (J2) is decoupled to the EV kit's chassis ground internally. The EV kit's isolated chassis ground (CHASSIS_GND) PCB pad connects to the network system ground.

The EV kit starts up in automatic operation mode and demonstrates PD detection, PD classification, overcurrent protection, current foldback, undervoltage/overvoltage protection (+28.5V, +62.5V (typ), respectively (GND - V_{EE})), AC-/DC-disconnect monitoring, and high-power Class 5 mode operation. The Class 5 overcurrent and current-limit protection can be reconfigured through jumpers. PD-blocking diode D4 can be bypassed to reduce power dissipation when AC-disconnect monitoring is not required. The port's AC-detection circuit resistor-capacitor network (R3, C4) can be reconfigured as well. The output port also features a 600W unidirectional overvoltage-transient suppressor diode (D2) and decoupling capacitor (C5) for transient protection at the output port.

The IC features an internal triangular-wave oscillator for AC-disconnect detection and can be bypassed to operate in DC-disconnect detection mode. The internal oscillator can be shut down using jumper JU6 if AC-disconnect detection is not required.

Test points and jumpers have been provided for voltage probing and current measurements of the power circuit. **Additionally, since the GND is more positive than VEE or RTN, use an isolated oscilloscope when probing signals with respect to VEE or RTN.** Yellow and green LEDs on output module J2 indicate when the port's power is turned on and the PoE status, respectively.

The EV kit can also be reconfigured for interfacing without connecting to an Ethernet system. Banana jacks are included for the PSE, GND, and RTN output power sources for this method of evaluation. **Since the GND is more positive than VEE or RTN, use an isolated oscilloscope when probing signals with respect to VEE or RTN.**

Jumper Selection

The EV kit features several jumpers to reconfigure the EV kit for various PSE configurations, operating modes, and PD requirements.

High-Power Class 5 and ILIM1/ILIM2 Selection

The EV kit features two jumpers to configure the IC's PSE PD classification mode and Class 0–Class 4 or high-power Class 5 mode. Jumper JU1 sets the IC's ILIM1 configuration and jumper JU2 sets the ILIM2 configuration. Table 1 lists the jumper options for the modes used to detect a valid PD connected to the PSE Ethernet output port. Refer to the MAX5971A IC data sheet for more information on all available classification modes.

LED Driver PWM Enable and Port PoE Status

The EV kit features a 2-pin jumper (JU3) to enable or disable the IC's internal PWM driver for the LED pin. The IC's LED pin also serves as a port-status indicator using the LED driver. The RJ45 connector (J2), providing data and power at the output port, features 2 LEDs: a yellow LED indicating that the EV kit is powered by -54V and a green port-status LED. Table 2 lists the LED driver jumper options and Table 3 provides the port status. Refer to the MAX5971A IC data sheet for more information on the multifunction LED features.

Midspan/End-Point PoE Selection and Configuration

The EV kit features a 2-pin jumper (JU4) to set the IC for midspan or end-point operation. The PSE circuit must also be reconfigured for operating in a midspan or end-point configuration. Table 4 lists the jumper options and Table 5 lists the PSE circuit resistor changes for the two configurations of operation. In Table 5, installed resistors are 0Ω 1206 surface-mount components. Refer to the MAX5971A IC data sheet for more information on the configurations.

Table 1. Jumpers JU1, JU2 Functions (ILIM1, ILIM2)

IC CLASSIFICATION	ILIM1 PIN (JU1)	ILIM2 PIN (JU2)	OVERCURRENT THRESHOLD (mA)	CURRENT LIMIT (mA)
Class 0–Class 4*	Not installed	Not installed	Class 5 disabled	Class 5 disabled
Class 5	Installed	Not installed	748	850
Class 5	Not installed	Installed	792	900
Class 5	Installed	Installed	836	950

**Default position.*

Note: *Refer to the MAX5971A IC data sheet for more information on Class 0–Class 4 overcurrent and current-limit information.*

Table 2. Jumper JU3 Functions (PWMEN)

SHUNT POSITION	PWMEN PIN	LED PWM OPERATION
Not installed*	Internally pulled high	Enabled
Installed	Connected to VEE through resistor R12	Shutdown

**Default position.*

Table 3. Green LED Status

GREEN LED	J2 PORT STATUS
Off	Not powered or disconnected
On	Powered, valid PD
Blinking 2 flashes	Overcurrent fault during power-on
Blinking 5 flashes	Detected invalid low/high discovery signature resistance

Table 4. Jumper JU4 Functions (MIDSPAN)

SHUNT POSITION	MIDSPAN PIN	PoE CONFIGURATION
Not installed*	Internally pulled high	Midspan
Installed	Connected to VEE through resistor R13	Endpoint

**Default position.*

Table 5. PSE Circuit Resistor Changes for Midspan/End-Point Configuration

CONFIGURATION	RESISTOR			
	R5	R6	R7	R8
Midspan*	Not installed	Not installed	Installed	Installed
End point	Installed	Installed	Not installed	Not installed

**Default position.*

Table 6. Jumper JU5 Legacy Modes

SHUNT POSITION	LEGACY PIN	LEGACY MODE
Not installed	Internally pulled high	Enabled, detect high capacitance
Installed*	Connected to VEE through resistor R15	Disabled

**Default position.*

Legacy High-Capacitance-Detection Operation

The EV kit features a 2-pin jumper (JU5) to set the IC's initial startup legacy operational mode. In legacy mode, PD signature capacitances up to 47µF (typ) are accepted. Table 6 lists the jumper options. Refer to the MAX5971A IC data sheet for more information.

AC-Disconnect Monitoring Oscillator and AC-/DC-Disconnect Operation

The EV kit features a 2-pin jumper (JU6) to disable the IC's internal triangular-wave oscillator at the OSC pin. The oscillator is used for AC-disconnect monitoring of the PD and is disabled for DC-disconnect operation. For AC-disconnect operation, the internal oscillator is used along with RCD components R3, C4, D3, and blocking-diode D4. Perform a power-on or reset the IC using push-button switch SW1 to affect the changes.

For DC-disconnect operation, shut down the internal oscillator by installing a shunt on jumper JU6. Then remove resistor R3 and install a 0Ω 0402 surface-mount resistor on R9 to bypass blocking-diode D4. Diode D3 remains installed. Refer to the *AC Disconnect Monitoring* and *DC Disconnect Monitoring* sections in the MAX5971A IC data sheet for additional information. Table 7 lists the jumper options for the oscillator and AC/DC configurations. Refer to the MAX5971A IC data sheet for more information.

Reset and Automatic Operation

The EV kit features pushbutton switch SW1 to reset the IC or set the IC's initial startup operational mode. Table 8 lists the switch options.

Operation Without an Ethernet Connection

For operation greater than 35W, the RJ45 jack (J2) cannot be used. The EV kit features PCB pads and banana jacks to interface directly with the output port power. Use the GND and RTN PCB pads or jacks to access the output port's power without an Ethernet connection.

IC Pins Signal Measurements

The EV kit features test points to facilitate voltage measuring at each port's respective LED, ILIM1, ILIM2, PWMEN, MIDSPAN, LEGACY, and EN pins on the IC. For the VEE connection, test points TP11 and TP13 can be used.

The output port current can be measured by replacing any output port single resistor—R5 or R6 when operating in midspan and R7 or R8 when operating in end point. Replace the respective resistor with a 1Ω ±1% 1206 surface-mount resistor.

Table 7. Jumper JU6 OSC and AC-/DC-Disconnect Detection Functions

SHUNT POSITION	OSC PIN	RESISTOR		DISCONNECT-DETECTION MODE
		R3	R9	
Installed	Connected to VEE	Not installed	Installed	DC-disconnect detection
Not installed*	Connected to VEE through capacitor C6	Installed	Not installed	AC-disconnect detection (uses the IC's internal oscillator)

**Default position.*

Table 8. Switch SW1 Operational Modes (EN)

SWITCH POSITION	EN PIN	EV Kit OPERATION MODE
Not pressed	Internally pulled high	Automatic
Pressed	Connected to VEE through resistor R16	Shutdown or reset

**Default position.*

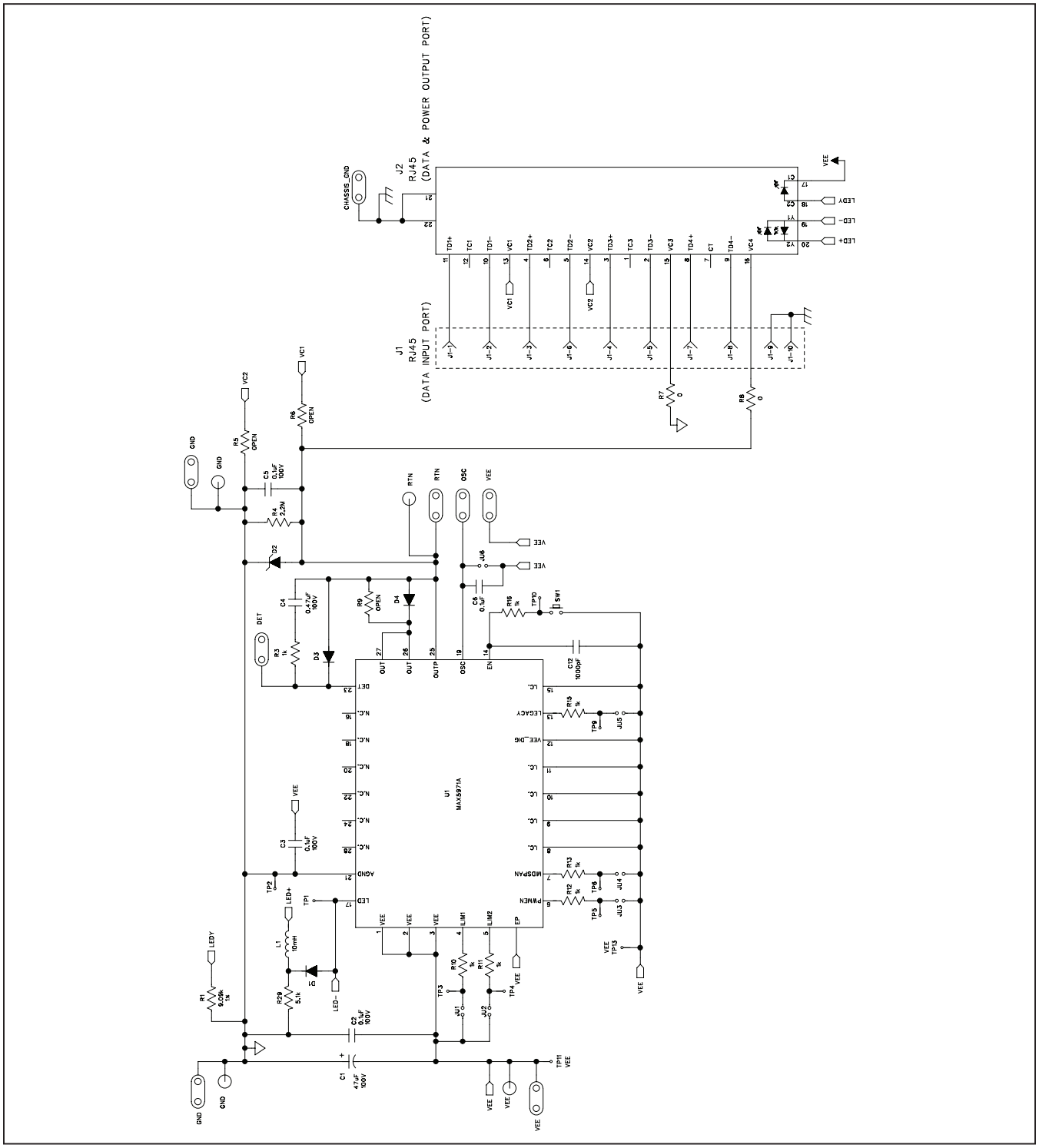

Figure 1. MAX5971A EV Kit Schematic—Controller Circuit

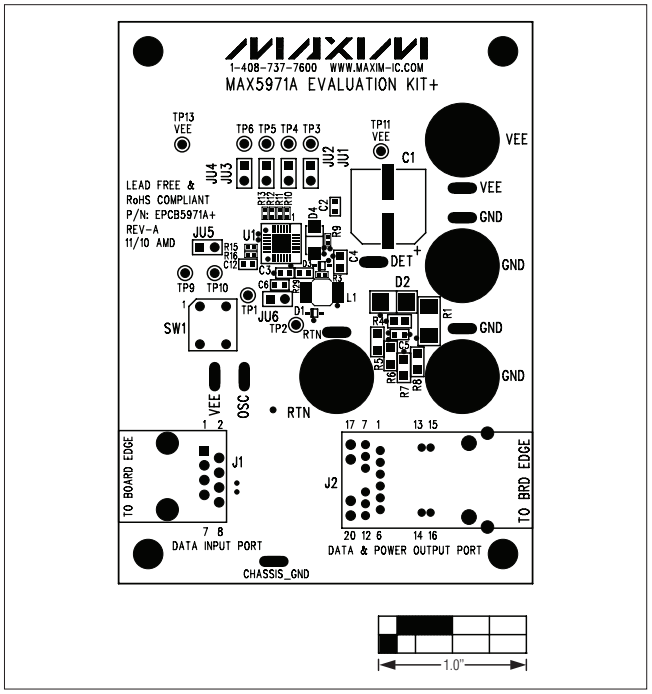

Figure 2. MAX5971A EV Kit Component Placement Guide—Component Side

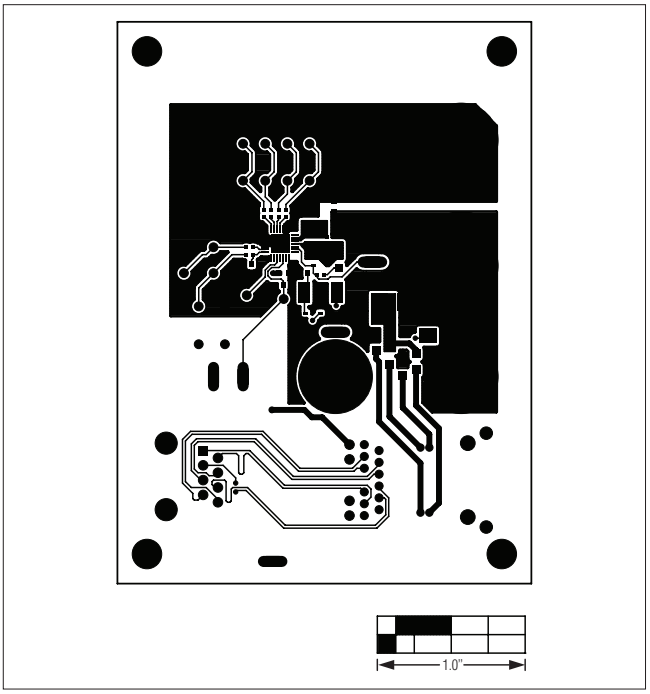

Figure 3. MAX5971A EV Kit PCB Layout—Component Side

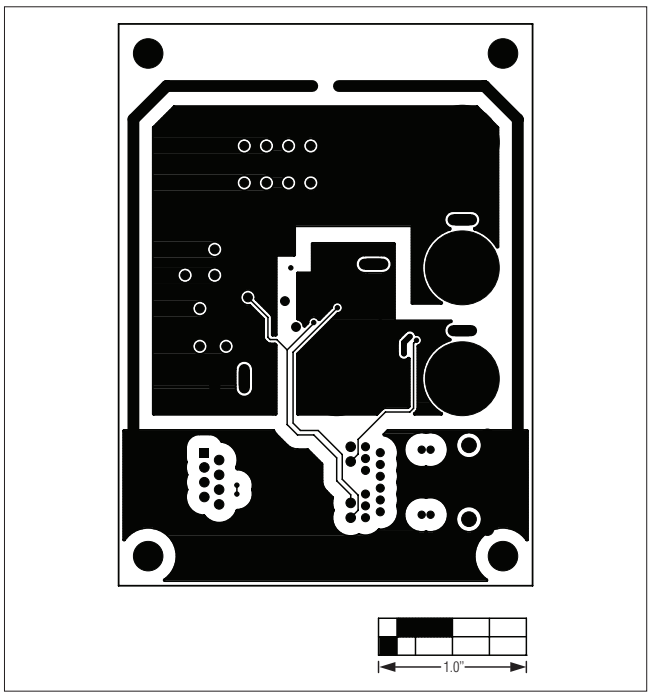

Figure 4. MAX5971A EV Kit PCB Layout—Solder Side

Ordering Information

PART	TYPE
MAX5971AEVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/11	Initial release	—