General Description

The MAX8967 evaluation kit (EV kit) is a fully assembled and tested PCB for evaluating the MAX8967, which is a µPMIC with two step-down switching converters and six LDOs. The step-down converters deliver up to 2A of output current independently. Two of the LDOs deliver a load current up to 300mA, while four of the LDOs deliver up to 150mA. Both step-down converters have remote sense, allowing accurate load regulation. The device operates over a 2.6V to 5.5V input supply range.

The IC supports dynamic adjustment of the output voltage through its I²C interface. Each step-down converter has two register settings for output voltage and a setting for ramp rate. Each step-down converter has a dedicated enable pin and a dedicated VID_ pin to toggle between the two programmed output voltages. Additionally, an interrupt output is provided, allowing the device to signal its master.

Features

- Two 2A Step-Down Converters (OUT1, OUT2)
  - Programmable Output Voltage (0.6V to 3.3875V in 50mV Steps) Through I²C Bus
  - Programmable Output-Voltage Slew Rate (12.5mV/µs to 50mV/µs)
  - Dynamic Switching Between Two Output Voltages Through VID_ Pins
  - 4.4MHz Step-Down Switching Allows for 1µH Inductors
- Two 300mA LDOs, Four 150mA LDOs
  - COUT = 1µF for All LDOs
- RoHS Compliant

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	1µF ±10%, 6.3V X5R ceramic capacitor (0402) TDK C1005X5R0J105K Murata GRM155R61A105K
C2	1	0.1µF ±10%, 10V X5R ceramic capacitor (0402) TDK C1005X5R1A104K Taiyo Yuden LMK105BJ104KV Murata GRM155R61A104K
C3, C4	2	2.2µF ±10%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A225K Taiyo Yuden LMK107BJ225KA-T Murata GRM188R61A225K
C5, C6	2	10µF ±10%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A106KT Taiyo Yuden LMK107BBJ106MALT
C7, C8	2	22µF ±20%, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J226K Murata GRM21BR60J226M Taiyo Yuden JMK212ABJ226MG-T
C9–C16	8	1µF ±10%, 10V X7R ceramic capacitors (0603) TDK C1608X7R1A105K Murata GRM188R71A105K
J1	1	20-pin (2 x 10) right-angle receptacle Samtec INC SSW-110-02-S-D-RA
JU1	1	3-pin header Digi-Key S1012E-36-ND
JU2–JU9	8	2-pin headers Digi-Key S1012E-36-ND
L1, L2	2	1µH, 2.8A inductors (2.5mm x 2.0mm x 1.0mm) TOKO DFE252010R-H-1R0N

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R1, R2	2	2.2kΩ ±5% resistors (0402)
R3	1	100kΩ ±5% resistor (0402)
R5–R9	5	0Ω ±5% resistors (0402)
U1	1	Dual step-down converter, 6 LDO PMIC (30 WLP) Maxim MAX8967EWV+

DESIGNATION	QTY	DESCRIPTION
U2	1	150mA LDO (5 SC70) Maxim MAX8891EXK18+T
—	1	PCB: MAX8967EVKIT+

Component Suppliers

SUPPLIER	PHONE	WEB
Digi-Key Corp.	800-344-4539	www.digikey.com
Murata Electronics North America, In.	770-436-1300	www.murata-northamerica.com
Samtec, Inc.	800-726-8329	www.samtec.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
TOKO America, Inc.	847-297-0070	www.tokoam.com

Note: *Indicate that you are using the MAX8967 when contacting these component suppliers.*

MAX8967 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX8967.EXE	Application program
UNINSTALL.EXE	Uninstalls the EV kit software
USB_Driver_Help.PDF	USB driver installation help file

Quick Start

Recommended Equipment

- MAX8967 EV kit test fixture
- I²C command module, CMAXQUSB or MINIQUSB (USB cable included)
- Power supply (PS1) capable of sourcing 5A
- Digital multimeter with current-measurement capability (DMM1)
- Electronic load (EL1)

Note: In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows operating system.

Procedure

The EV kit is a fully assembled and tested surface-mount board. Follow the steps below and Figure 1 to set up and verify the device and board operation:

1) Verify that the EV kit jumpers are configured in their default positions, as shown in Table 1.
2) Visit **www.maximintegrated.com/tools/evkit** to download the latest version of the EV kit software, 8967Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file. The CMAXQUSB or MINIQUSB firmware can also be found at the same link. (The EV kit is compatible with both the CMAXQUSB and MINIQUSB interface boards.)
3) Install the EV kit software and USB interface firmware on your computer by running the INSTALL.EXE program inside the temporary folder. The EV kit program files are copied and icons are created in the Windows **Start | Programs** menu.
4) Connect the USB cable from the PC to the CMAXQUSB/MINIQUSB interface board. A **Building Driver Database** window pops up in addition to a **New Hardware Found** message when installing the USB driver for the first time. If you do not see a window that is similar to the one described above after

30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.

5) Follow the directions of the **Add New Hardware Wizard** to install the USB device driver. Choose the **Search for the best driver for your device** option. Specify the location of the device driver to be **C:\Program Files\MAX8967** (default installation directory) using the **Browse** button. During device driver installation, Windows may show a warning message indicating that the device driver that Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the USB_Driver_Help.PDF file for additional information.
6) If using the CMAXQUSB command module, ensure that the shunt on jumper JU1 is the same voltage as VIO. If VIO is 1.8V, leave jumper JU1 open and disconnect pullups in the CMAXQUSB and use the pullup resistors in the EV kit.
7) Carefully connect the boards by aligning the 20-pin connector of the EV kit with the 20-pin header of the CMAXQUSB/MINIQUSB interface board. Gently press them together.
8) Preset PS1 to 4.2V and turn off. Once the power supply is turned off connect PS1 to IN1/IN2 and to GND.
9) Preset EL1 to 2A and turn off. Once the load is turned off connect EL1 to OUT1 and to GND.
10) Connect DMM1 across buck output OUT1.
11) Turn on PS1.
12) Start the EV kit software by opening its icon at **Start | Programs | MAX8967 EVALUATION KIT**
13) Normal device operation is verified when **EVKIT CONNECTED** is displayed. **Note:** All default EV kit software settings are used for the remainder of the test procedure.)
14) Verify the voltage read by the DMM1 is approximately the default voltage.
15) Turn on electronic load EL1 and verify that the voltage read by DMM1 is approximately the default voltage.
16) Use the EV kit GUI to change the output voltage. Verify that the output voltage is on target while maintaining a 2A load current.

Table 1. Default Jumper Settings (JU1–JU9)

JUMPER	SHUNT POSITION	FUNCTION
JU1	1-2	Enables 1.8V LDO output for circuit logic
JU2	Installed	Connects INA to IN1/IN2
JU3	Installed	Connects INB to IN1/IN2
JU4	Installed	Connects EN1 to 1.8V
JU5	Installed	Connects EN2 to 1.8V
JU6	Not installed	Connects VID1 to 1.8V
JU7	Not installed	Connects VID2 to 1.8V
JU8	Installed	Connects SCL to 1.8V
JU9	Installed	Connects SDA to 1.8V

17) Turn off EL1.
18) Disconnect EL1 and DMM1 and install on OUT2.
19) Repeat steps 14–17 for the second step-down converter.
20) Disconnect all test leads from the EV kit.

Detailed Description of Hardware

The MAX8967's two ultra-low I_Q step-down converters are ideal for powering modems, applications processor cores, memory, system I/O, and other supplies in handheld devices. In normal operation, these step-down converters consume only 16µA (typ) of quiescent current. In green mode, the quiescent current is reduced to 5µA (typ) per converter, with reduced load capability. Each step-down converter can be independently put into green mode by writing a bit in its control register.

Step-Down Converters

Each step-down converter provides internal feedback, minimizing external component count. Both step-down converter output voltages are programmed through the IC's serial interface. A 4.4MHz switching frequency minimizes external component size. Dynamic voltage scaling is available to reduce power consumption in sleep mode. Both step-down converters feature automatic transition from skip mode (PFM) to forced-PWM (FPWM) operation. FPWM operation can be enabled by writing a bit in a control register.

Voltage Control Using VID_

Both step-down converters feature VID_ control to reduce power consumption in the loads such as modem and applications processor cores. Each VID_ control (JU6 and JU7 in Figure 1) allows the converter to transition between two states set up in advance using I²C. Essentially, two voltage states are accessible without the overhead associated I²C control. VID_ control allows the core voltages to be reduced when the processor clock is throttled back. When exiting sleep mode (by changing the state of VID_), the normal core voltages are restored, providing the optimal operating condition for best system performance.

Remote Output-Voltage Sensing

Each step-down converter's output features remote output-voltage sensing for improved output-voltage accuracy when the output load is far from the IC. The SNSP_ and SNSN_ inputs connect across the load, with the SNSN_ connected to ground, and SNSP_ connected to the output at the edge of the EV kit. OUT1 uses R5 and R6 (Figure 1) and OUT2 uses R7 and R8 for the remote sense. All remote-sense resistors are 0Ω by default.

The remote-sense feature requires a 1V or greater difference between AV and OUT_ for best performance. The remote-sense feature can be disabled through registers to reduce quiescent current consumption. In addition, this feature is disabled during green mode operation.

Output-Voltage Slew Rate

Both step-down converters feature an adjustable slew rate when increasing or decreasing output voltage. The nominal slew rate is 12.5mV/µs. Two additional slew rates are provided (25mV/µs and 50mV/µs), so that faster and slower slew rates can be programmed. An option for fastest possible ramp rate is also provided to allow the converter to operate at current limit for the fastest possible slew rate.

Green Mode Operation

In green mode, the quiescent current of each of the step-down converters is reduced from 16µA (typ) to 5µA (typ). If the output voltages are adjusted during green mode, slew rate is very slow. Also, output current is limited to 5mA. Green mode is enabled by the EV kit GUI in the appropriate converter's control register. Each converter can be individually selected to enter green mode.

LDO Regulators

The IC provides six LDOs with adjustable outputs with independent enable and disable control. In addition, each LDO has a special green mode that reduces the quiescent current to 1.5µA (typ). In green mode, each regulator supports a load of up to 10mA. The load-regulation performance degrades proportionally with the reduced load current.

Soft-Start and Dynamic Voltage Change

The LDO regulators have a programmable soft-start rate. When an LDO is enabled, the output voltage ramps to its final voltage at a slew rate of either 5mV/µs or 100mV/µs, depending on the state of the LDO_SS bit.

The 5mV/µs ramp rate limits the input inrush current to approximately 5mA on a 300mA regulator with a 1µF output capacitor and no load. The 100mV/µs ramp rate results in a 100mA inrush current with a 1µF output capacitor and no load, but achieves regulation within 50µs. The soft-start ramp rate is also the rate of change at the output when switching dynamically between two output voltages without disabling.

Overvoltage Clamp

Each LDO has an overvoltage clamp that allows it to sink current when the output voltage is above its target voltage. This overvoltage clamp is default enabled, but can be disabled through the EV kit GUI. Refer to the MAX8967 IC data sheet for scenarios that pertain to the overvoltage clamp safety feature.

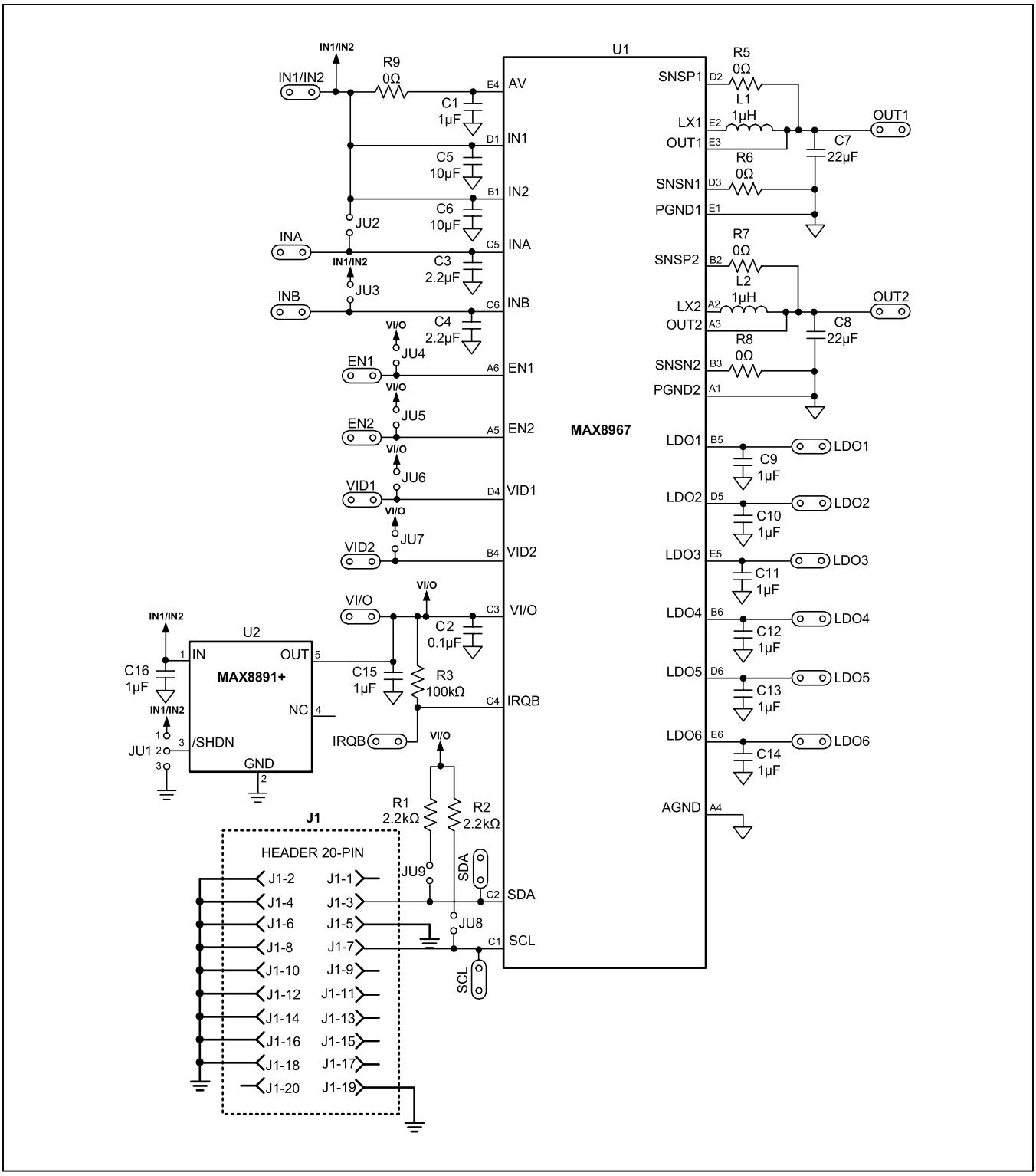

Figure 1. MAX8967 EV Kit Schematic

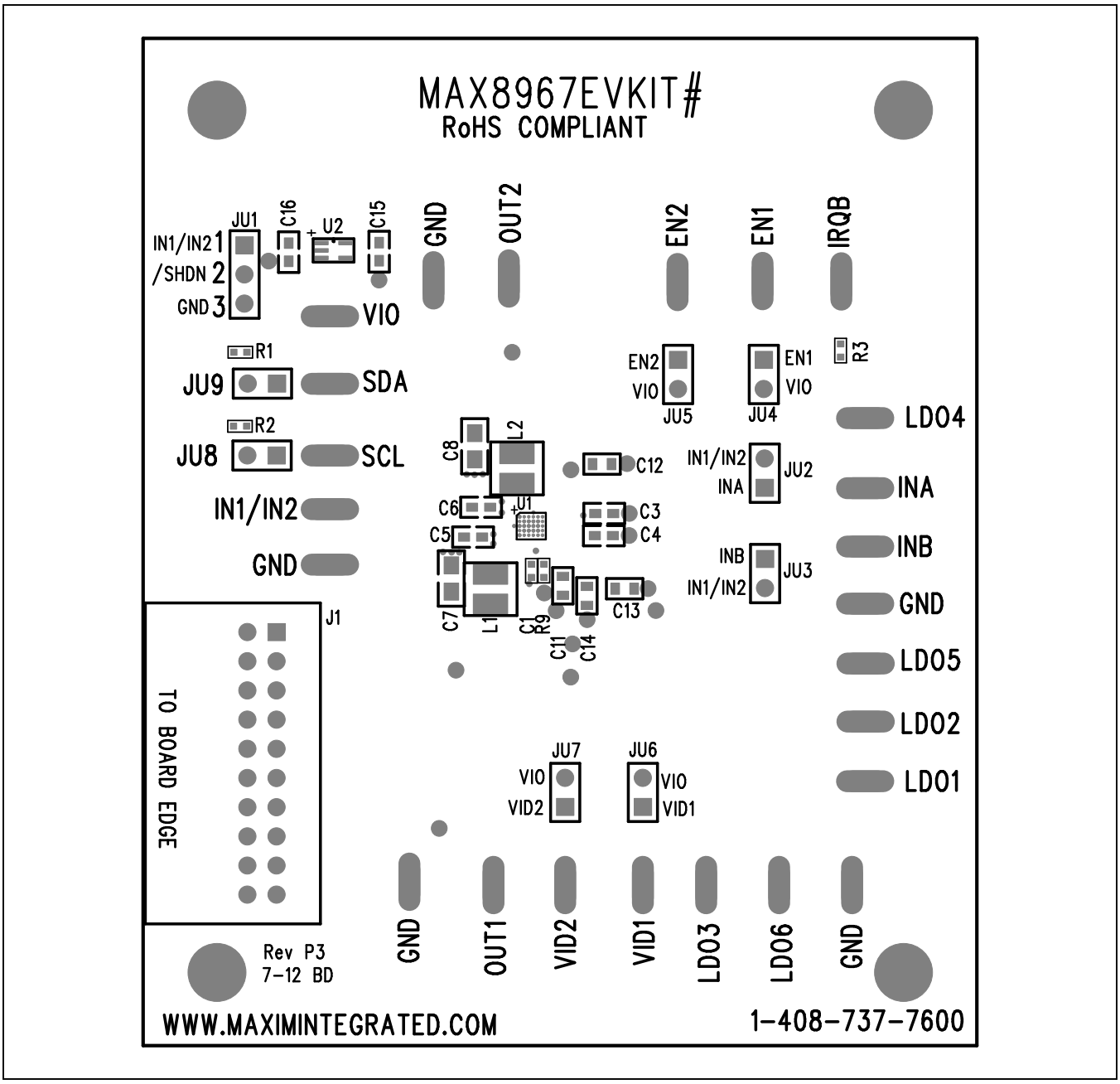

Figure 2. MAX8967 EV Kit Component Placement Guide—Component Side

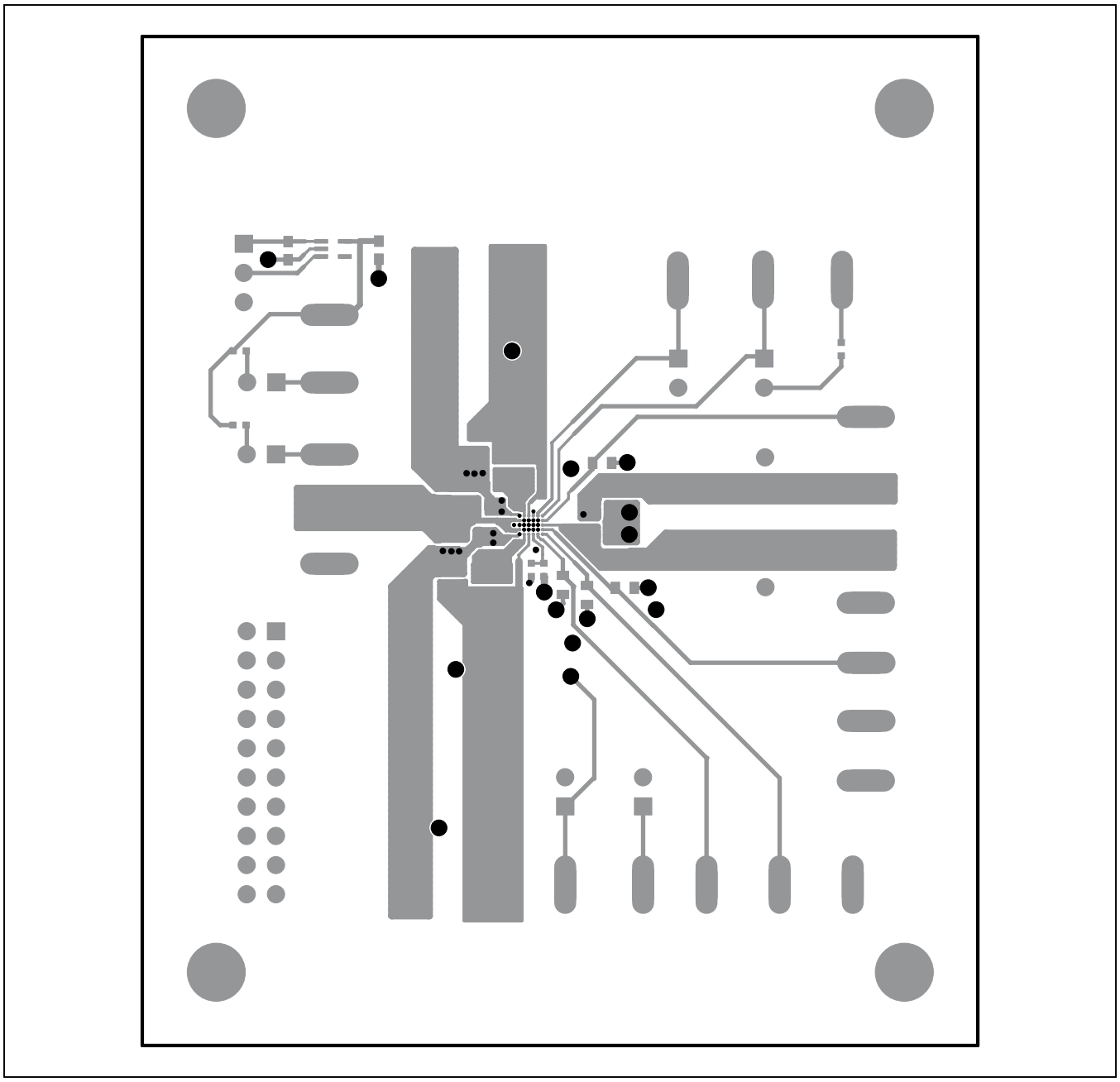

Figure 3. MAX8967 EV Kit PCB Layout—Component Side

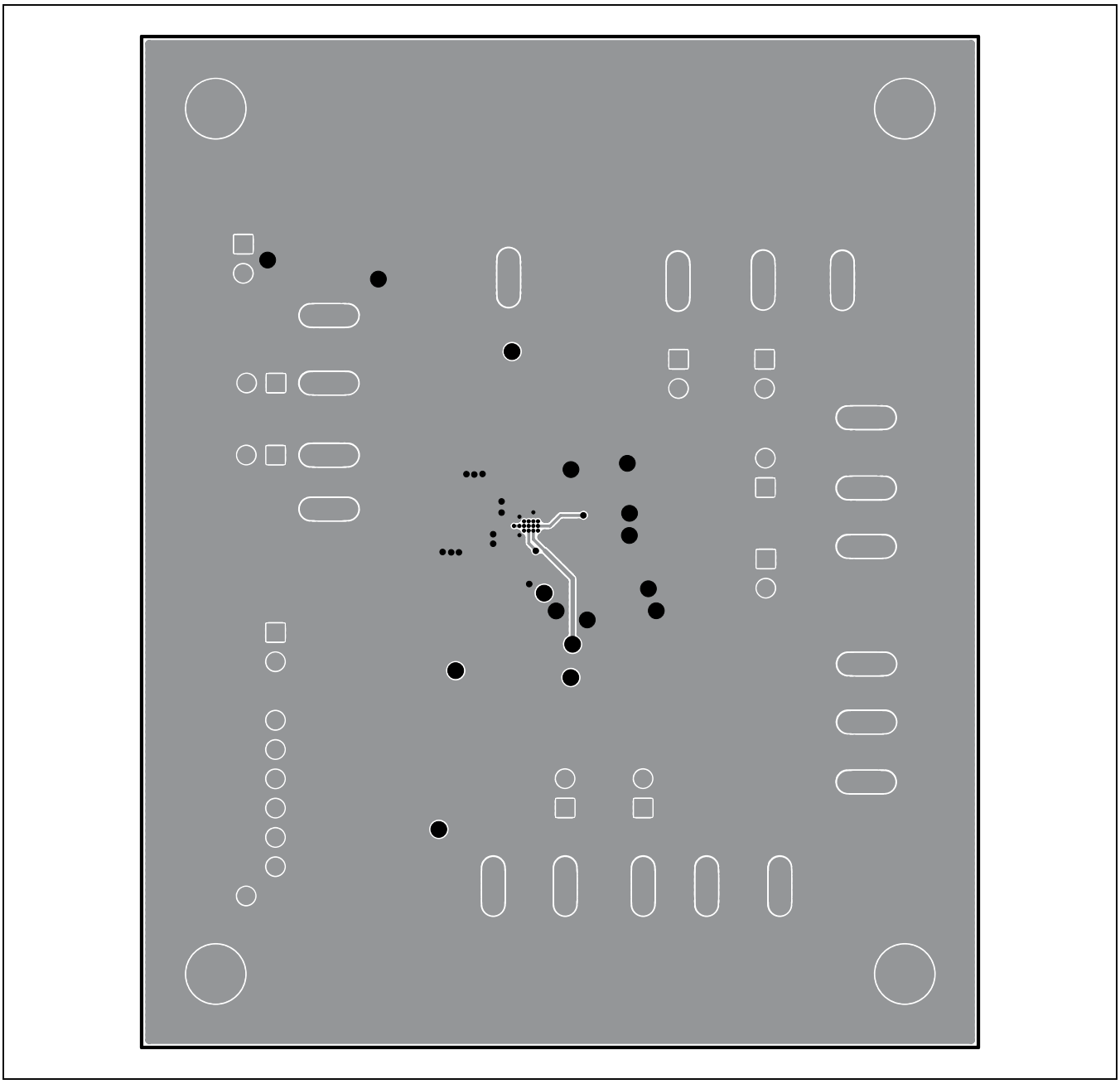

Figure 4. MAX8967 EV Kit PCB Layout—Inner Layer 2

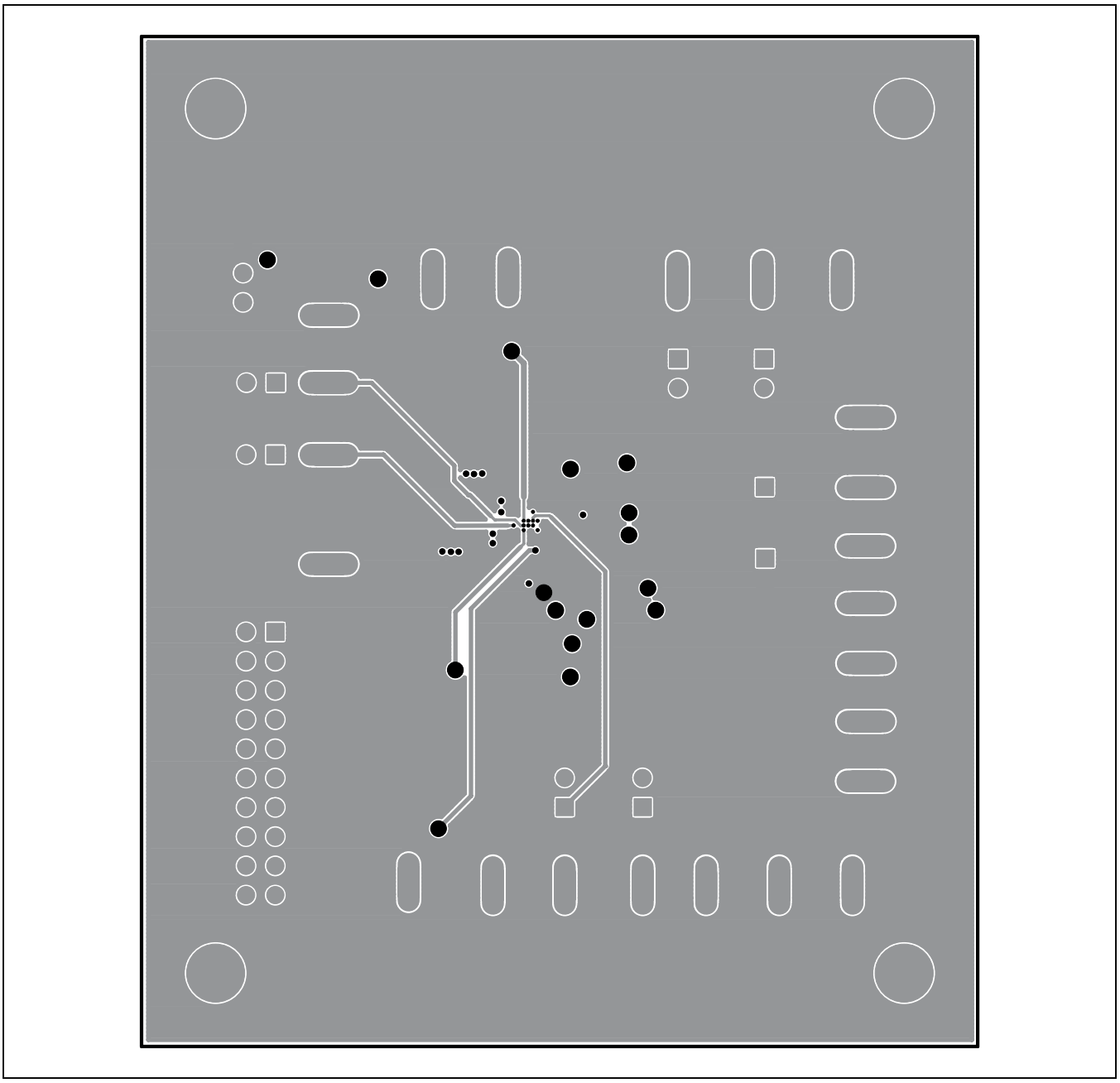

Figure 5. MAX8967 EV Kit PCB Layout—Inner Layer 3

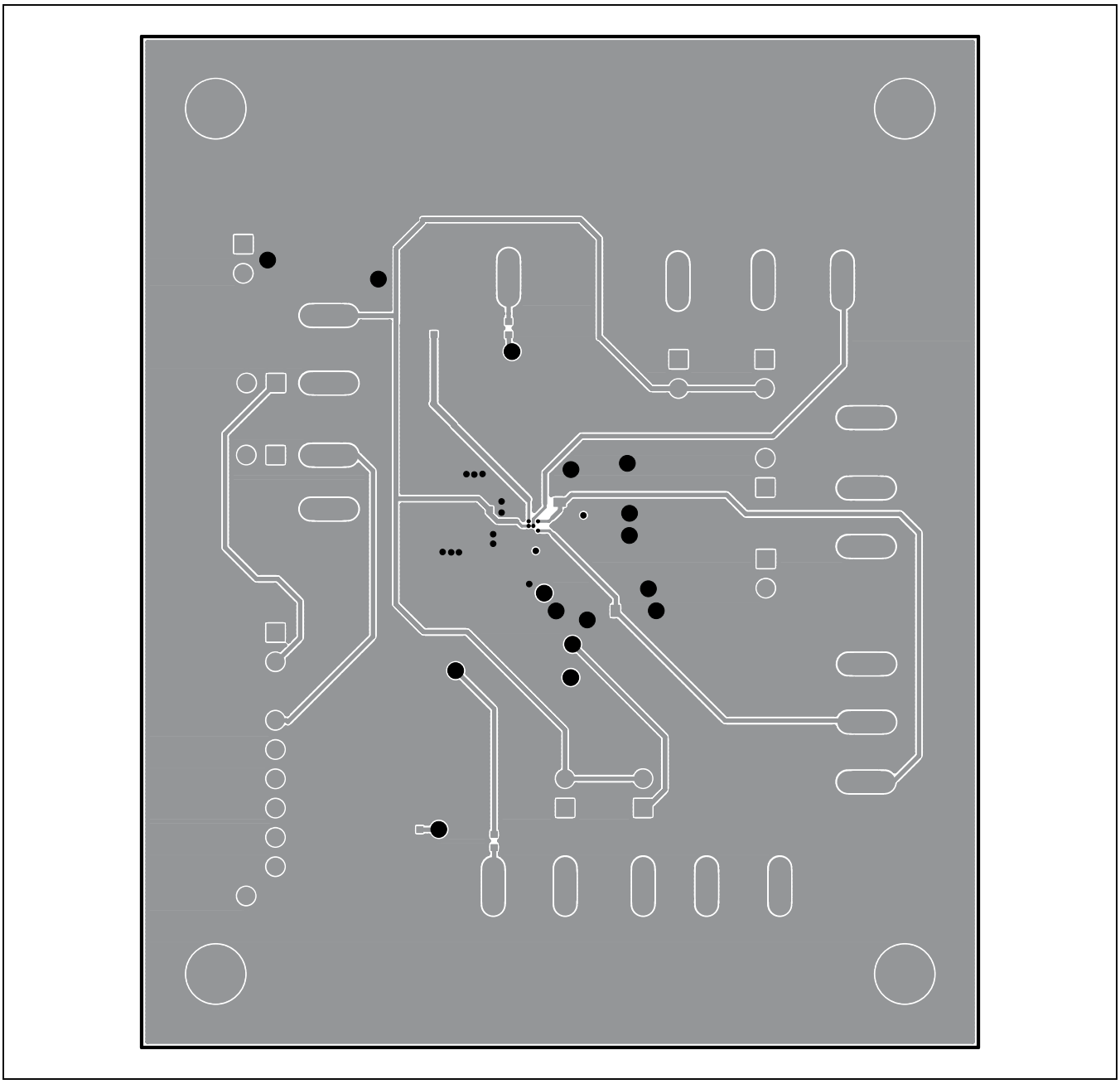

Figure 6. MAX8967 EV Kit PCB Layout—Solder Side

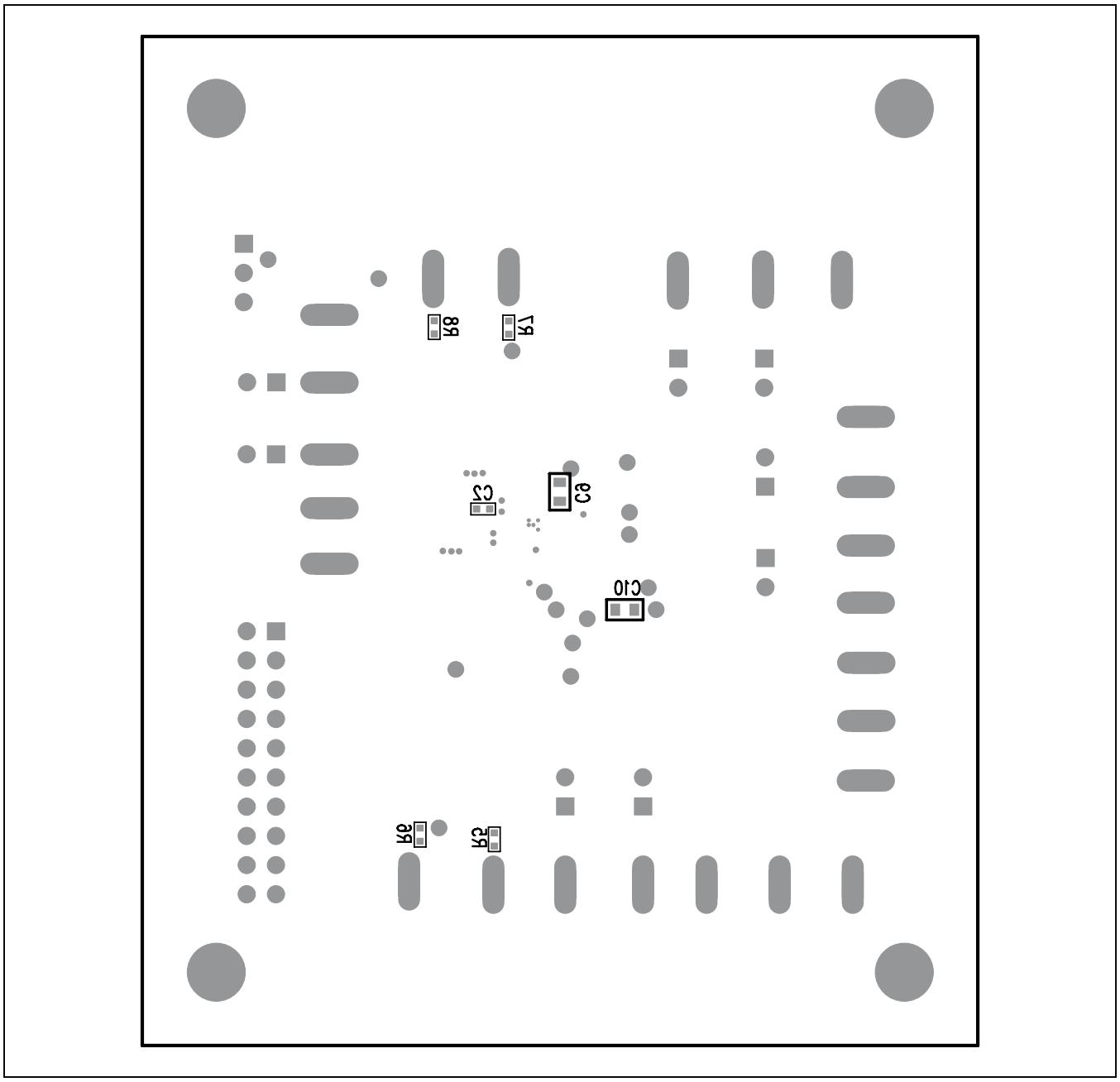

Figure 7. MAX8967 EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX8967EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/12	Initial release	—

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

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