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MAX8903A Evaluation Kit

General Description

The MAX8903A evaluation kit (EV kit) is a fully assembled and tested circuit board for evaluating the 2A, 1-cell Li+ DC-DC battery charger. The EV kit charges a single-cell lithium-ion (Li+) battery from a DC input (AC adaptor) or a USB 100mA/500mA source and provides system power from the DC input, USB input, or battery. Battery charge current and SYS current limit are independently set. Charge current and DC converter output current limit can be set up to 2A, respectively. The USB input current can be set to 100mA or 500mA and USB suspend mode is also supported. Power not used by the system is available to charge the battery.

The EV kit comes standard with the MAX8903A installed. However, the EV kit can also be used to evaluate the MAX8903B–MAX8903E and MAX8903Y by replacing the MAX8903A (U1) with the preferred IC.
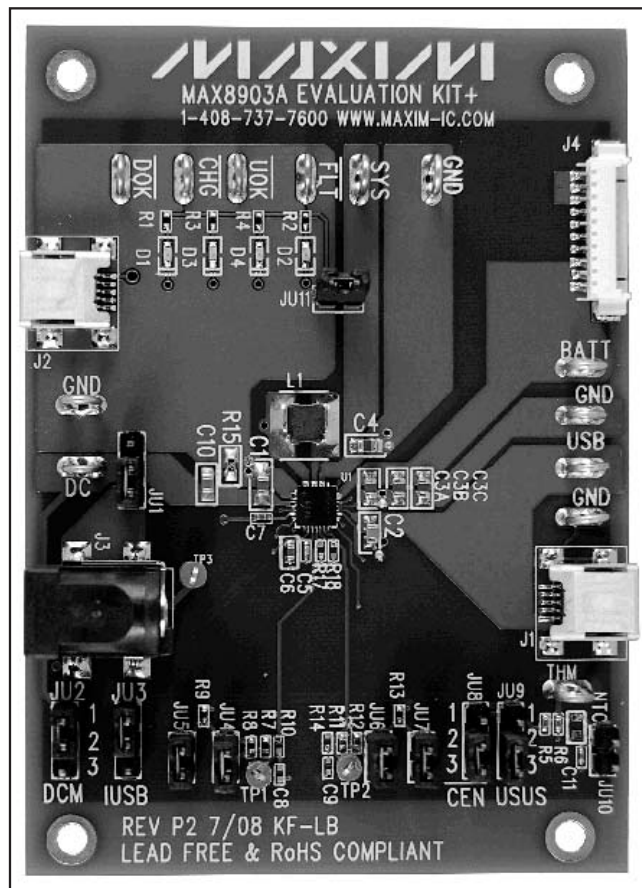

Figure 1. MAX8903A EV Kit Photo

Features

♦ **DC-DC Converter Output Current-Limit Adjustment Range of 0.5A to 2A (EV Kit Standard Configuration: 2A)**

♦ **Battery Charger Current-Limit Adjustment Range of 0.5A to 2A (EV Kit Standard Configuration: 1A)**

♦ **USB Current Limit of 100mA or 500mA**

♦ **Efficient 4MHz Switching DC-DC Converter Powers System Load and Charger**

♦ **Instant On—Works with No Battery or Low Battery**

♦ **28-Pin, 4mm x 4mm Thin QFN Package with Exposed Pad**

♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX8903AEVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	2.2µF ±10%, 16V X5R ceramic capacitor (0805) TDK C2012X7R1C225K or equivalent
C2	1	4.7µF ±10%, 25V X5R ceramic capacitor (0805) Murata GRM21BR61E475KA12L or equivalent
C3A, C4	2	10µF ±10%, 10V X5R ceramic capacitors (0805) Taiyo Yuden LMK212BJ106KG or equivalent
C5, C7	2	0.1µF ±10%, 10V X7R ceramic capacitors (0402) TDK C1005X5R1A104K or equivalent
C6	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) Taiyo Yuden LMK107BJ225MA or equivalent

Evaluates: MAX8903A–MAX8903E/MAX8903Y

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

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C8, C9, C11	0	Not installed, capacitors (0402)
C10	1	4.7µF ±10%, 16V X5R ceramic capacitor (0805) Taiyo Yuden EMK212BJ475K or equivalent
D1, D3, D4	3	Small green LEDs Panasonic LNJ308G8PRA
D2	1	Small red LED Panasonic LNJ208R8ARA
J1, J2	2	USB type-AB right-angle mini jacks Molex 56579-0576
J3	1	2.1mm male power connector CUI Inc. PJ-002A-SMT
J4	1	1.25mm (0.049in) surface-mount, right-angle pitch header, lead-free, 10 circuits Molex 53261-1071
JU1, JU2, JU3, JU8, JU9	5	3-pin headers Sullins PEC36SAAN Digi-Key S1012E-36-ND
JU4–JU7, JU10, JU11	6	2-pin headers Sullins PEC36SAAN Digi-Key S1012E-36-ND

DESIGNATION	QTY	DESCRIPTION
L1	1	1µH, 2.8A, 54mΩ inductor (4.1mm x 4.1mm x 1.2mm) TOKO A1101AS-1R0 (DEA4012CK series)
NTC	0	100kΩ NTC thermistor (0402) Murata NCP15WF104J03RC
R1–R4	4	2.2kΩ ±5% resistors (0402)
R5	1	100kΩ ±1% resistor (0402)
R6, R10, R14, R17, R18	0	Not installed, resistors (0402)
R7, R8	2	3.01kΩ ±1% resistors (0402)
R9	1	6.04kΩ ±1% resistor (0402)
R11, R12	2	604Ω ±1% resistors (0402)
R13	1	1.21kΩ ±1% resistor (0402)
R15	1	0.56Ω ±1% resistor (0603) Panasonic ERJ-3RQJR56V
U1	1	1-cell Li+ charger (28 TQFN-EP*) Maxim MAX8903AETI+
—	10	Shunts (see Table 1) Digi-Key S900-ND or equivalent
—	1	PCB: MAX8903A EVALUATION KIT+

EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
CUI Inc.	503-612-2300	www.cui.com
Digi-Key Corp.	800-344-4539	www.digikey.com
Molex	800-768-6539	www.molex.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Sullins Electronics Corp.	760-744-0125	www.sullinselectronics.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 MAX8903 when contacting these component suppliers.*

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Quick Start

Recommended Equipment

- MAX8903A EV kit
- Adjustable DC power supply capable of greater than 6V at 3A
- Battery or simulated battery
    1-cell Li+ or Li-poly battery (Figure 2A)
    Simulated battery—preloaded power supply (Figure 2B)
- Two digital multimeters (DMM)
- Up to 3A adjustable load
- Three 10A ammeters

Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation. Use twisted wires of appropriate gauge that are as short as possible to connect the battery and power sources.

1) Preset the DC power supply to 6V. Turn off the power supply. **Caution: Do not turn on the power supply until all connections are completed.**

2) Preset the adjustable load to 0A.

3) Connect the EV kit to the power supply, battery or preloaded power supply, adjustable load, and meters, as shown in Figure 3.

4) Ensure that the EV kit has the jumper settings shown in Figure 3 and Table 1.

5) Turn on the power supply.

6) Verify that the voltage at SYS is approximately 4.4V and that the current from BATT into the battery is 0A.

7) Remove the shunt from pins 1-2 of jumper JU8 and place the shunt on pins 2-3 of jumper JU8.

8) If $3V \leq V_{BAT} \leq 4.1V$ for MAX8903A/MAX8903B/MAX8903C, or $3V \leq V_{BAT} \leq 4.0V$ for MAX8903D/MAX8903E/MAX8903Y, verify that the current from BATT into the battery is approximately 1A.

9) Increase the load current on SYS to 1A.

10) Verify that the voltage on SYS remains approximately equal to V_{BATT}.

11) Verify that the charge current into the battery remains near 1A.

12) Increase the load current on SYS to 1.5A.

13) Verify that the voltage on SYS remains approximately equal to V_{BATT}.

14) Verify that the charge current into the battery decreased to approximately 0.5A.

15) Increase the load current on SYS to 2.5A.

16) Verify that current out of the battery (from the battery to SYS) is near 0.5A.

_Detailed Description of Hardware

Adjusting the EV Kit for In-Circuit Evaluation

Verify that the AC adapter source current limit is higher than the SYS and BAT current requirements. Note that if SYS current demand exceeds the DC-DC converter output current limit, then the battery will help supply the extra current. The DC-DC converter output current limit can also be adjusted on the MAX8903A EV kit by replacing R7 or adjusting JU4 and JU5. Verify that the USB source supplies at least 500mA. Verify the maximum charge current rating or desired charge current
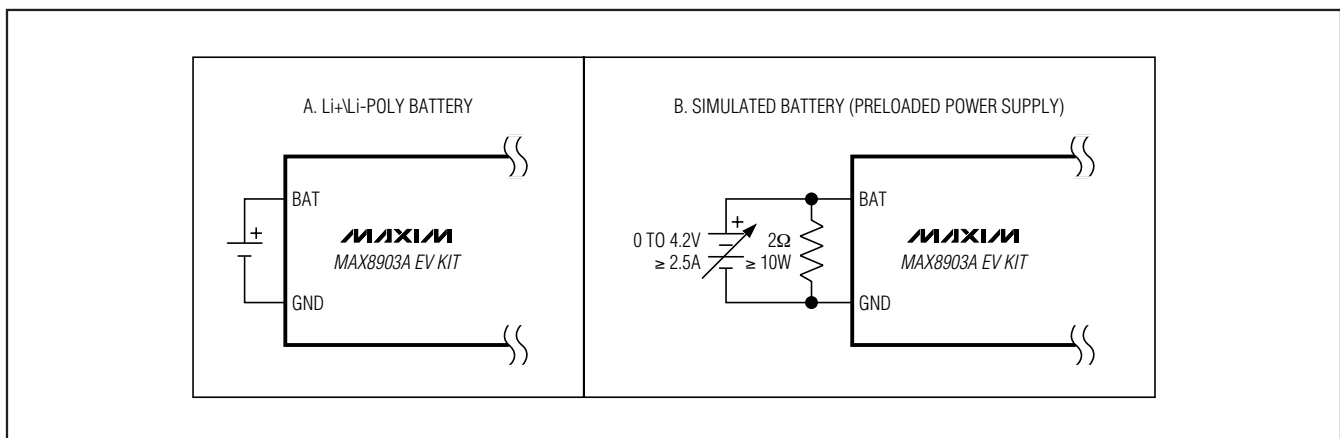

Figure 2. Battery Options for Evaluating the MAX8903A EV Kit
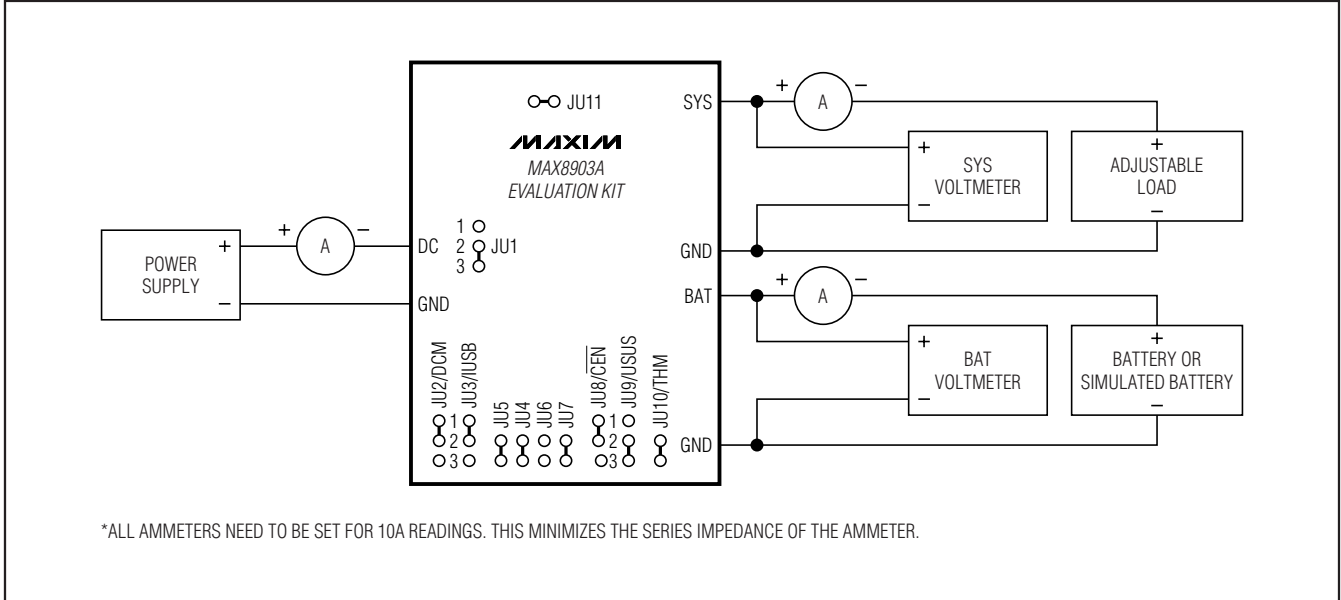
MAX8903A Evaluation Kit

Figure 3. Connection Diagram and Default Jumper Connections

Table 1. Jumper Settings (JU1–JU11)

JUMPER	LABEL	DEFAULT POSITION	DESCRIPTION	
			PINS 1-2	PINS 2-3
JU1	—	Pins 2-3 shunted	Use the DC pad or J2 as the DC input	Use the DC pad or J3 as the DC input
JU2	DCM	Pins 1-2 shunted	Configures DC input as adapter source (see Table 2)	Configures DC input for USB power (see Table 2)
JU3	IUSB	Pins 1-2 shunted	With DCM pins 1-2 shunted, IUSB sets 500mA USB charge current	With DCM pins 2-3 shunted, IUSB sets 100mA USB charge current
JU4	—	Shunted	Shorts out R8 (see Table 3)	
JU5	—	Shunted	Shorts out R9 (see Table 3)	
JU6	—	Open	Shunting JU6 shorts out R12 (see Table 4)	
JU7	—	Shunted	Shorts out R13 (see Table 4)	
JU8	$\overline{CEN}$	Pins 1-2 shunted	Disables the battery charger (when the charger is off, SYS remains on)	Enables the battery charger (when the charger is on, SYS remains on)
JU9	USUS	Pins 2-3	USB suspend mode	USB not suspended
JU10	THM	Shunted	Connects THM to GND to bypass thermistor function	
JU11	—	Shunted	Indicator LED anodes connected to SYS	

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rating of the battery. Ensure that the charge current setting of the EV kit does not exceed the battery rating, or replace resistor R11 (or adjust JU6 and JU7) as required. See the *Adjusting the DC-DC Converter Output Current Limit and BAT Fast-Charge Current Limit* section for more details.

Adjusting the DC-DC Converter Output Current Limit and BAT Fast-Charge Current Limit

Input and charger current limits are set, as shown in Table 2. It is often preferable to change the input current limit as the input power source is changed. The MAX8903A facilitates this by allowing different input current limits for the DC and USB inputs.

The SYS voltage regulates to three different regulation points depending on the state of the MAX8903:

1) If $\overline{CEN}$ is high to disable the charger, or charging is done, the SYS voltage regulates to 4.4V.

2) When charging the battery with $V_{BAT} < V_{SYSMIN}$, the SYS voltage regulates to $V_{SYSMIN} + 0.2V$ and stays above V_{SYSMIN} during transient loads.

3) When charging the battery with $V_{BAT} > V_{SYSMIN}$, the SYS voltage is regulated at the battery voltage for lowest power dissipation.

When the input current limit is reached, the first action taken by the MAX8903 is to reduce battery charge current. This allows the charging current to be programmed for the fastest charge time, without dropping the SYS load at load currents that would cause the input supply regulation current to be exceeded.

If, after the charge current is reduced to 0mA, the load at SYS still exceeds the input current limit, the battery helps supply power to support the system load.

The MAX8903 features flexible input connections (at the DC and USB inputs) and current-limit settings (set by DCM and IUSB) to accommodate nearly any input power configuration. However, it is expected that most systems use one of two external power schemes: separate connections for USB and an AC adapter, or a single connector that accepts either USB or the AC adapter output. Input and charger current limits are shown in Table 2.

Table 2. Input Limiter Control Logic

POWER SOURCE	$\overline{DOK}$	$\overline{UOK}$	DCM	IUSB	USUS	DC STEP-DOWN OUTPUT CURRENT LIMIT	USB INPUT CURRENT LIMIT	MAXIMUM CHARGE CURRENT***
AC Adapter at DC Input	L	X	H	X	X	$6000/R_{IDC}$		Lesser of $1200/R_{ISET}$ and $6000/R_{IDC}$
USB Power at DC Input	L	X	L	L	L	100mA	USB input off. DC input has priority.	Lesser of $1200/R_{ISET}$ and 100mA
	L	X	L	H	L	500mA		Lesser of $1200/R_{ISET}$ and 500mA
	L	X	L	X	H	USB suspend		0
USB Power at USB Input, DC Unconnected	H	L	X	L	L	No DC input	100mA	Lesser of $1200/R_{ISET}$ and 100mA
	H	L	X	H	L		500mA	Lesser of $1200/R_{ISET}$ and 500mA
	H	L	X	X	H		USB suspend	0
DC and USB Unconnected	H	H	X	X	X		No USB input	0

*** *Charge current cannot exceed the input current limit. Charge may be less than the maximum charge current if the total SYS load exceeds the input current limit.*

X = Don't care.

EV Kit On-Board Current-Limit Adjustment

The MAX8903's DC-DC converter output current limit can be adjusted on the EV kit by shunting JU4, JU5, or both. See Table 3 for jumper and resistor combinations and corresponding current limits. The BAT fast-charge current limit can be adjusted by shunting JU6, JU7, or both. See Table 4 for jumper and resistor combinations and corresponding fast-charge current limits.

Thermistor (THM)

The EV kit comes with a thermistor preinstalled on the NTC footprint. To evaluate the MAX8903A with a battery-pack thermistor, remove the thermistor and connect to the EV kit using the THM pad. Details of thermistors are covered in the MAX8903 IC data sheet. To disable the thermistor function, shunt jumper JU10.

Charge Timers

A fault timer prevents the battery from charging indefinitely. The fault prequalification and fast-charge timers are controlled by the capacitance at CT (C5).

$$t_{PREQUAL} = 33\,min \times \frac{C5}{0.15\mu F}$$

($t_{PREQUAL}$ is when $V_{BATT} < 3V$).

$$t_{FST-CHG} = 660\,min \times \frac{C5}{0.15\mu F}$$

$$t_{TOP-OFF} = 15s\,(MAX8903A/C/D/Y)$$

$$t_{TOP-OFF} = 132\,min \times \frac{C_{CT}}{0.15\mu F}\,(MAX8903B/E)$$

While in fast-charge mode, a large system load or device self-heating could cause the MAX8903 to reduce charge current. Under these circumstances, the fast-charge timer is slowed by 2x if the charge current drops below 50% of the programmed fast-charge level, and suspended if the charge current drops below 20% of the programmed level. The fast-charge timer is not affected at any current if the charger is regulating the BAT voltage at 4.2V (i.e., the charger is in voltage mode).

Indicator LEDs

Indicator LEDs are provided for $\overline{CHG}$, $\overline{FLT}$, $\overline{DOK}$, and $\overline{UOK}$. The $\overline{CHG}$ LED (D3) is on when the battery charger is in its prequalification and fast-charge states. The $\overline{FLT}$ LED (D2) is on when the battery charger has entered a fault state after the charge timer expires. The $\overline{DOK}$ LED (D1) is on when $4.15V < V_{DC} < 16V$. The $\overline{UOK}$ LED (D4) is on when the source at USB is $4.1V < V_{USB} < 6.6V$. Refer to the MAX8903 IC data sheet for more details regarding $\overline{CHG}$, $\overline{FLT}$, $\overline{DOK}$, and $\overline{UOK}$.

Charge Enable ($\overline{CEN}$)

When $\overline{CEN}$ is low, the charger is on. When $\overline{CEN}$ is high, the charger turns off. $\overline{CEN}$ does not affect the SYS output, which remains on. In many systems, there is no need for the system controller (typically a microprocessor) to disable the charger, because the MAX8903 Smart Power Selector™ circuitry independently manages charging and adapter/battery power hand-off. In these situations, $\overline{CEN}$ may be connected to ground.

Table 3. DC-DC Converter Output Current Limit (JU4, JU5)

JUMPER		RESISTORS FROM IDC TO GND	RESISTANCE FROM IDC TO GND (Ω)	SYS CURRENT LIMIT (A)
JU4	JU5			
Open	Open	R7 + R8 + R9	12k	0.5
Open	Shunt	R7 + R8	6k	1
Shunt	Open	R7 + R9	9k	0.66
Shunt	Shunt	R7	3k	2

Table 4. BAT Fast-Charge Current Limit (JU6, JU7)

JUMPER		RESISTORS FROM IDC TO GND	RESISTANCE FROM IDC TO GND (Ω)	BAT FAST-CHARGE CURRENT LIMIT (A)
JU6	JU7			
Open	Open	R11 + R12 + R13	2.4k	0.5
Open	Shunt	R11 + R12	1.2k	1
Shunt	Open	R11 + R13	1.8k	0.66
Shunt	Shunt	R11	604	2

Smart Power Selector is a trademark of Maxim Integrated Products, Inc.
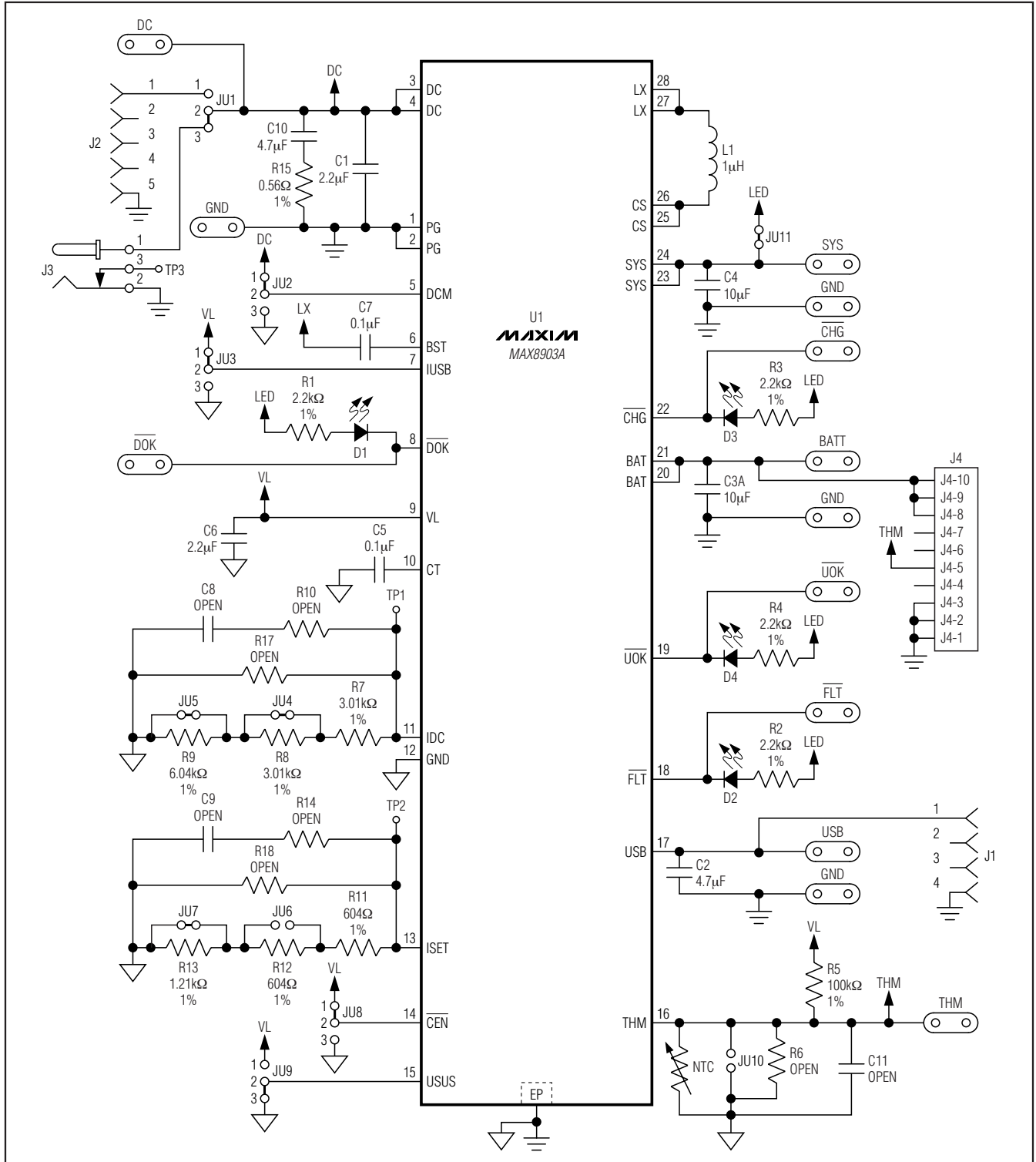
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Figure 4. MAX8903A EV Kit Schematic

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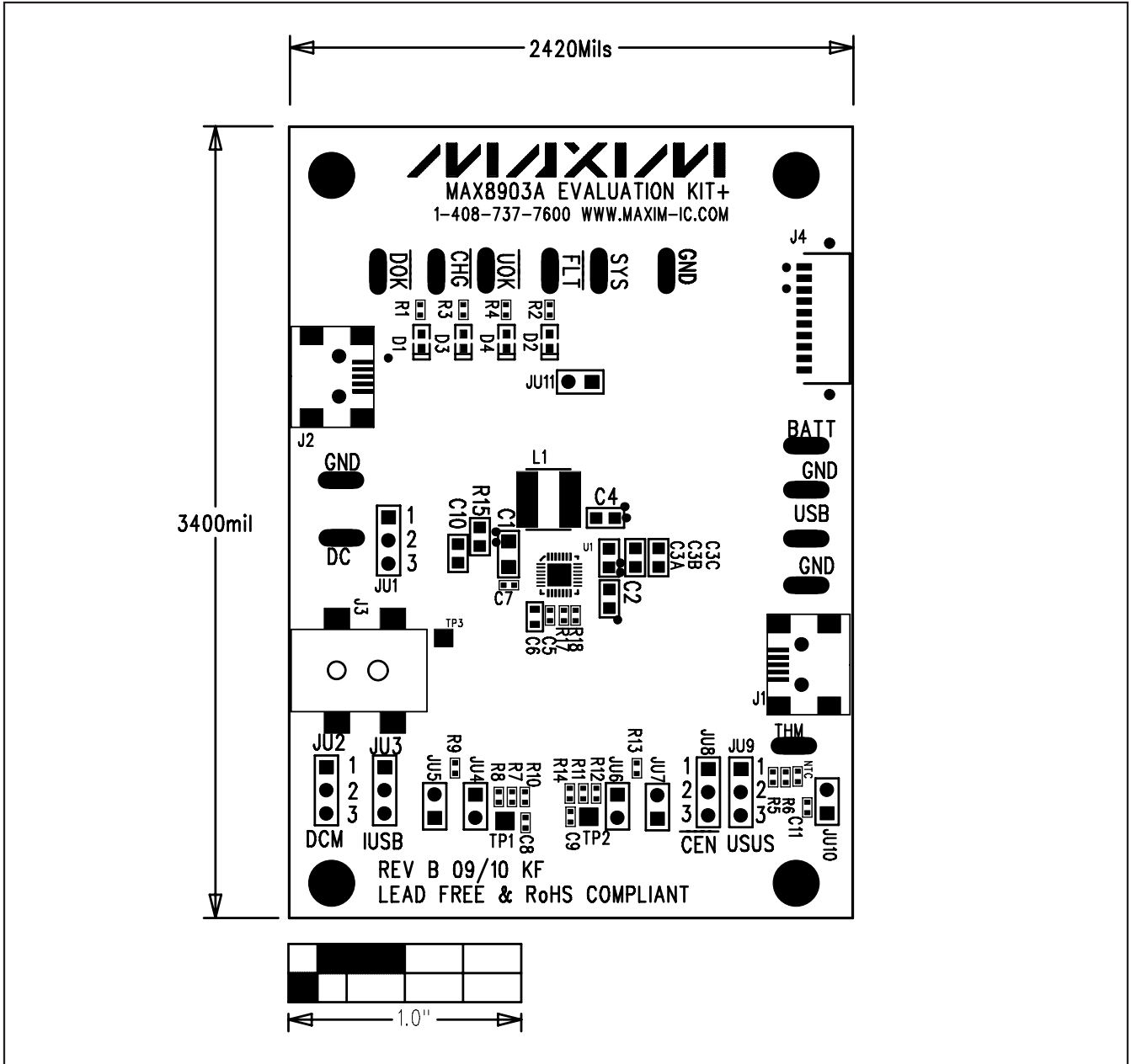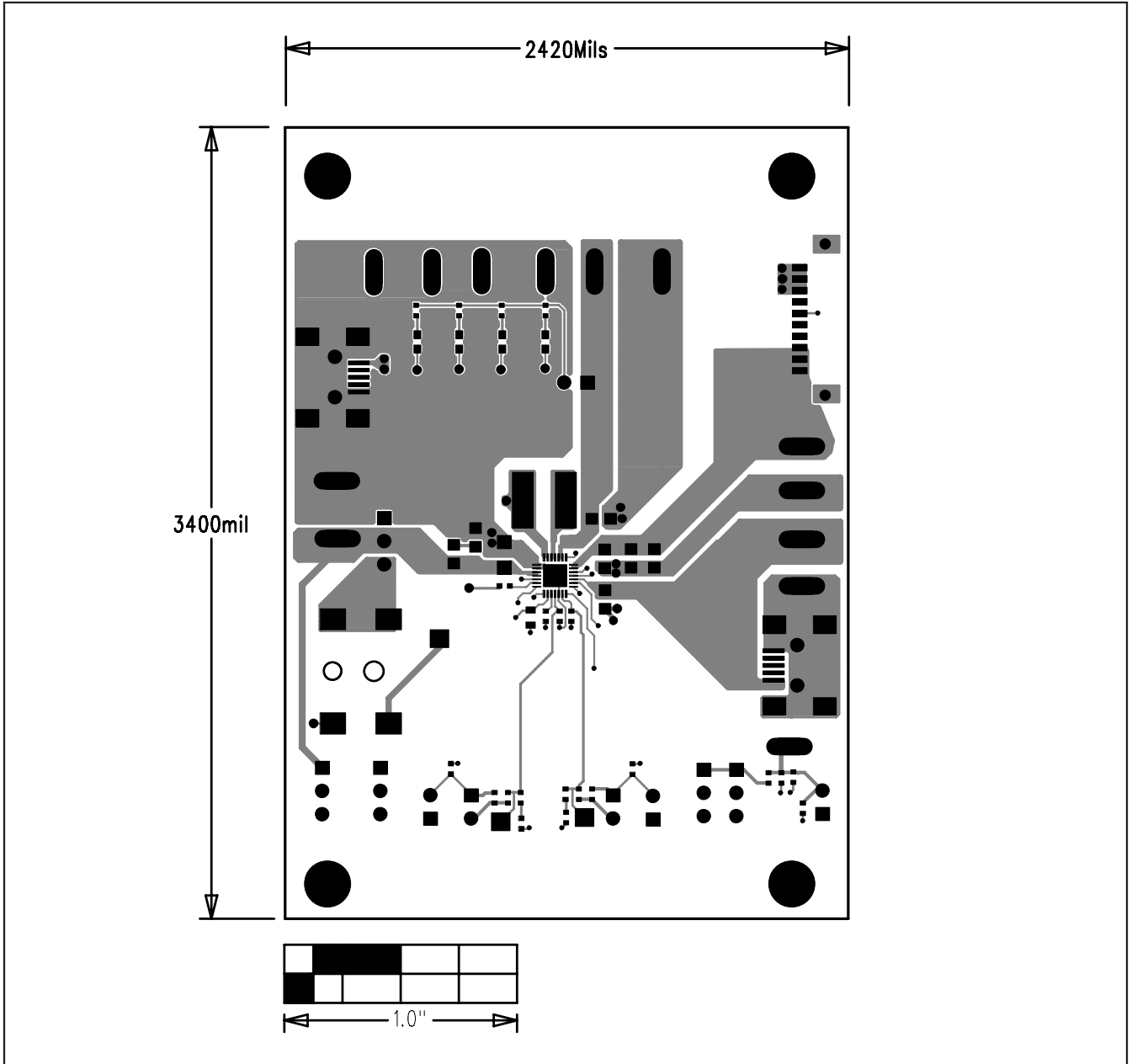
Figure 5. MAX8903A EV Kit Component Placement Guide—Top Layer

Figure 6. MAX8903A EV Kit PCB Layout—Top Layer

MAX8903A Evaluation Kit
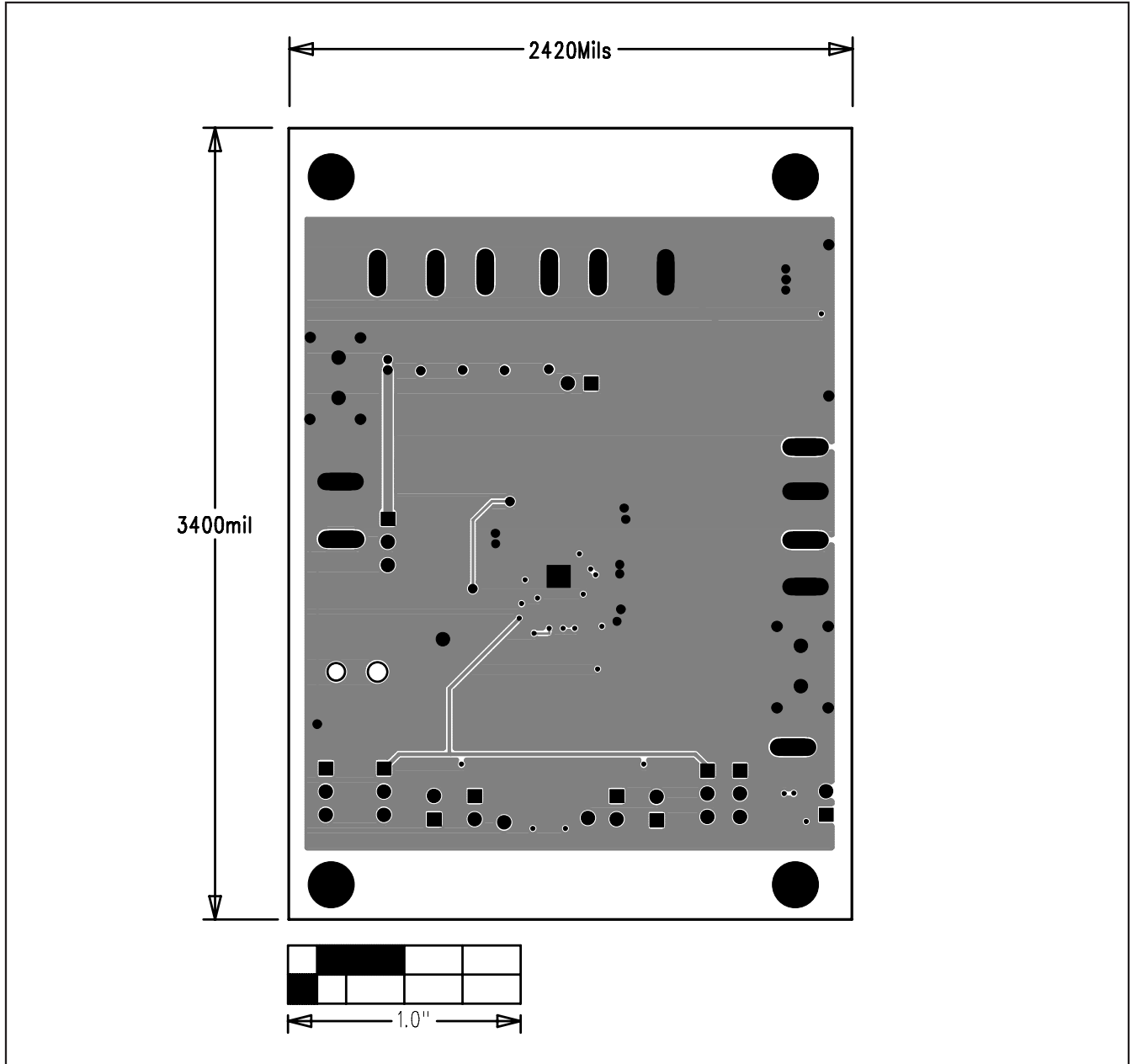

Figure 7. MAX8903A EV Kit PCB Layout—Inner Layer 2

/VI/IXI/VI
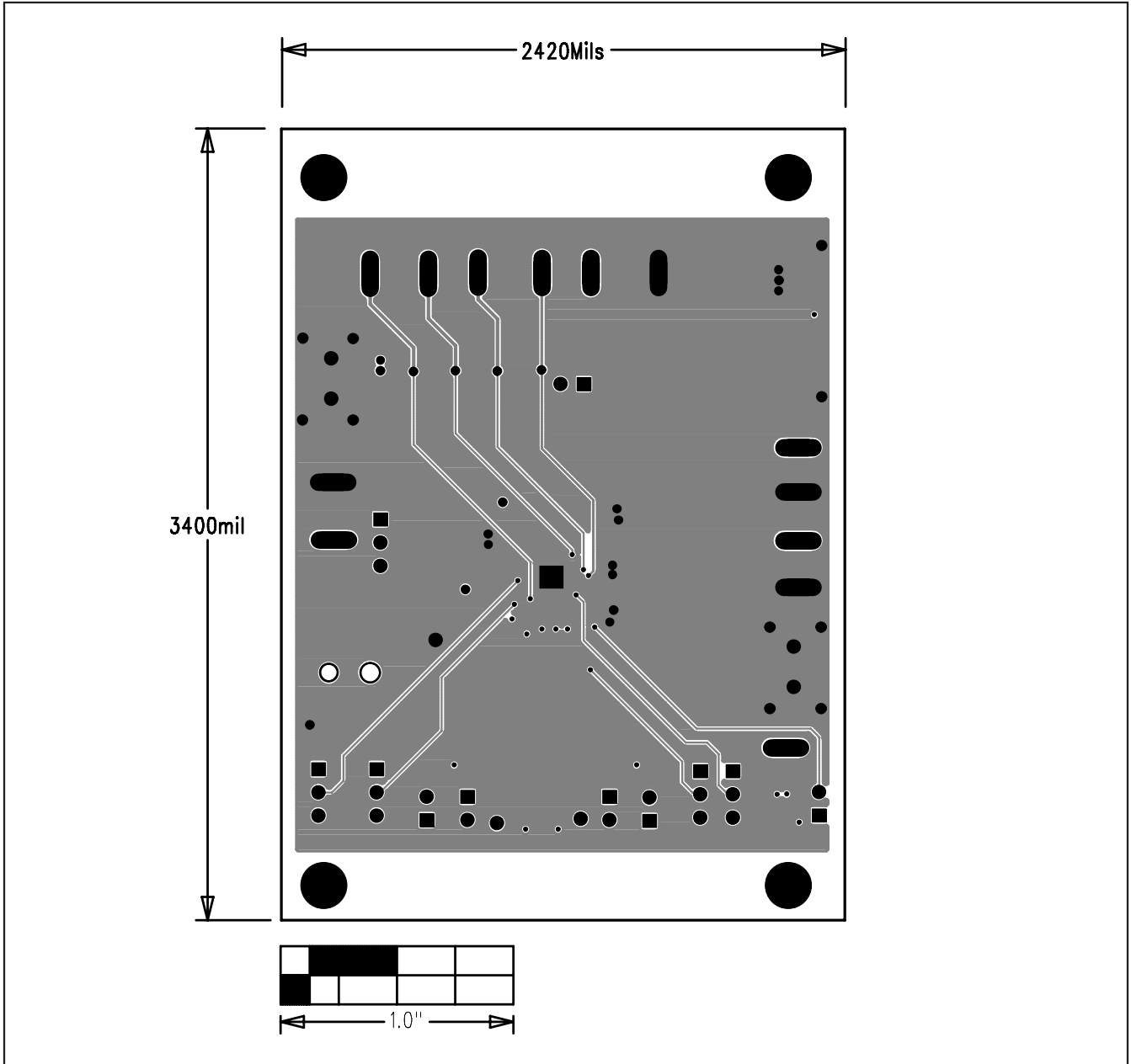
Figure 8. MAX8903A EV Kit PCB Layout—Inner Layer 3

Evaluates: MAX8903A–MAX8903E/MAX8903Y
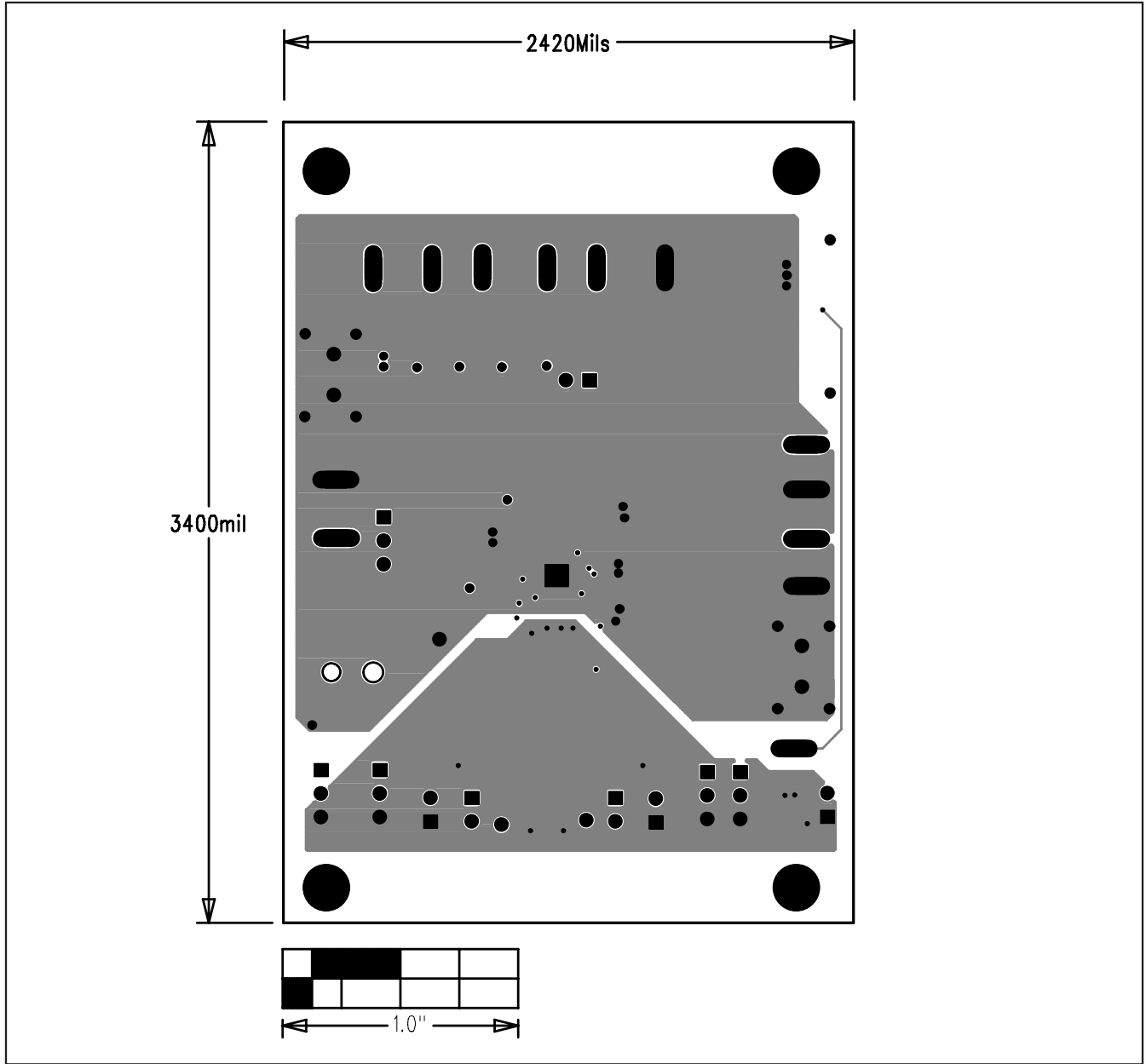
Figure 9. MAX8903A EV Kit PCB Layout—Bottom Layer

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MAX8903A Evaluation Kit

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/09	Initial release	—
1	8/09	Added MAX8903C and MAX8903D to parts evaluated	1–12
2	10/10	Added MAX8903B, MAX8903E, and MAX8903Y to parts evaluated	1–12

Evaluates: MAX8903A–MAX8903E/MAX8903Y

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