



# MAX8804Z Evaluation Kit

## General Description

The MAX8804Z evaluation kit (EV kit) is a fully assembled and tested PCB that demonstrates the highly integrated MAX8804Z linear battery charger for single-cell lithium-ion (Li+) batteries. The EV kit safely charges a single Li+ battery to 4.2V. The EV kit accepts a 4.15V to 30V DC source voltage or a 4.15V to 16V USB input voltage, but disables charging when either input voltage exceeds 7.5V to protect against unqualified or faulty input sources. A simple single-wire SET input to the EV kit allows the user to enable/disable the charger or program the charge current and top-off threshold. Three LEDs on the EV kit indicate the power-OK, USB power status, and charger status. The MAX8804Z EV kit can also evaluate the MAX8804V/MAX8804W/MAX8804Y. To evaluate the MAX8804V/MAX8804W/MAX8804Y, order a free sample along with this EV kit.

## Features

- ◆ Complete Charger for Single-Cell Li+ Battery
- ◆ Dual-Input, 30V AC Adapter/16V USB
- ◆ No External FET, Blocking Diode, or Sense Resistor Required
- ◆ Automatic USB/AC Adapter Input Selection
- ◆ Easy Programmable Fast-Charge Current and Top-Off Threshold
- ◆ Proprietary Die Temperature Regulation Control
- ◆ ±5% Fast-Charge Current-Limit Accuracy
- ◆ Battery-Pack Detection Input (MAX8804V/MAX8804W)
- ◆ Power-Present and Charger-Status Outputs
- ◆ No Prequalification Charge (MAX8804Y)
- ◆ Tiny 2mm x 3mm Thermally Enhanced TDFN Package
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX8804ZEVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	1µF ±10%, 35V X5R ceramic capacitors (0603) Taiyo Yuden GMK107BJ105KA
C3	1	2.2µF ±10%, 10V X5R ceramic capacitor (0603) Taiyo Yuden LMK107BJ225KA
C4	1	0.1µF ±10%, 10V X5R ceramic capacitor (0402) Taiyo Yuden LMK105BJ104KV
C5	1	33pF ±10%, 50V C0G ceramic capacitor (0402) Taiyo Yuden UMK105CG330KV
D1, D2, D3	3	Green LEDs Agilent HSMG-C150
D4	1	Bias resistor transistor ON Semiconductor DTC144E
J1	1	Male, USB type-B right-angle connector Digi-Key AE9925-ND Assmann AU-Y1007-R
JU1	1	3-pin header Sullins PTC36SAAN Digi-Key S1012-36-ND

DESIGNATION	QTY	DESCRIPTION
JU2	1	2-pin header Sullins PTC36SAAN Digi-Key S1012-36-ND
R1, R2, R3	3	330Ω ±5% resistors (0603)
R4, R5, R7	3	100kΩ ±5% resistors (0402)
R6	1	1kΩ ±5% resistor (0402)
R8	1	4.7kΩ ±5% resistor (0603)
S1	1	Momentary pushbutton switch Panasonic EVQ-PHP03T Digi-Key P8048STR-ND
U1	1	High-voltage, dual-input, USB/AC adapter charger (8 TDFN-EP*) Maxim MAX8804ZETA+ (Top Mark: AAC)
U2	1	ICM7555ISA+ or Digi-Key LM555CM-ND
—	1	PCB: MAX8804Z Evaluation Kit+

\*EP = Exposed pad.



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## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Agilent Technologies	877-424-4536	www.agilent.com
Digi-Key Corp.	800-344-4539	www.digikey.com
ON Semiconductor	602-244-6600	www.onsemi.com
Taiyo Yuden	847-925-0888	www.yuden.co.jp

**Note:** Indicate that you are using the MAX8804Z when contacting these component suppliers.

## Quick Start

### Recommended Equipment

Before beginning, the following equipment is needed:

- Two variable 6V power supplies capable of 750mA
- One voltmeter
- One-cell Li+ battery

### Procedure

The MAX8804Z EV kit is a fully assembled and tested surface-mount PCB. Follow the steps below to verify board operation. **Caution: Do not turn on the power supplies until all connections are completed.**

- 1) Place the JU1 shunt across pins 1-2 to set the EV kit for DC charge mode.
- 2) Verify that jumper JU2 is open.
- 3) Preset a power supply to 5V and the second power supply to 3.3V. Turn off the power supplies.
- 4) Connect the positive lead of the 5V power supply to the DCIN pad. Connect the negative lead of the 5V power supply to the GND pad.
- 5) Connect the positive lead of the 3.3V power supply to the VLOGIC pad. Connect the negative lead of the 3.3V power supply to the GND pad.
- 6) Connect the voltmeter from the BAT pad to the GND pad.
- 7) Turn on the power supplies.
- 8) Verify that the  $\overline{\text{POK}}$  LED (D2) turns on to indicate power OK.
- 9) Verify that the voltage is 4.2V at the BAT pad.
- 10) **Observe correct Li+ battery polarity.** Connect the positive terminal of the Li+ battery to the BAT pad. Connect the negative terminal of the Li+ battery to the GND pad.

11) Verify that the  $\overline{\text{CHG}}$  LED (D1) turns on. The  $\overline{\text{CHG}}$  LED turns on during prequalification and fast-charge conditions. The  $\overline{\text{CHG}}$  LED turns off when the battery-charging current drops below the top-off threshold current.

12) Turn off the power supplies and disconnect the battery. Place the JU1 shunt across pins 2-3 to set USB charge mode. Then repeat from step 3 using the USBIN pad.

## Detailed Description

### Input Source

The MAX8804V/MAX8804W/MAX8804Y/MAX8804Z are designed to charge a single-cell Li+ battery from a 4.15V to 7.0V DC source voltage or USB input voltage. The IC accepts DC input voltages up to 30V and USB input voltages up to 16V, but disables charging when the input voltage exceeds 7.5V. A male, USB type-B jack is available to connect the MAX8804Z EV kit to a standard 100mA/500mA USB port to power the EV kit.

### Charging Profile

The MAX8804V/MAX8804W/MAX8804Y/MAX8804Z dual-input linear battery chargers use voltage, current, and thermal-control loops to charge and protect a single Li+ battery. When a Li+ battery with a cell voltage below 2.5V is inserted, the MAX8804V/MAX8804W/MAX8804Z charger enters the prequalification stage where it precharges that cell with 95mA. The  $\overline{\text{CHG}}$  indicator output is driven low to indicate entry into the prequalification state. When battery voltage exceeds 2.5V, the charger soft-starts as it enters the fast-charge state. The MAX8804Y eliminates the prequalification state and enters fast charge when the battery is inserted. In the MAX8804V/MAX8804W/MAX8804Y/MAX8804Z, the fast-charge current level is programmed by a simple single-wire SET input. As the battery voltage approaches 4.2V, the charging current is reduced. If the battery current drops below the top-off current threshold, the  $\overline{\text{CHG}}$  indicator goes high impedance, signaling that the battery is fully charged. The ICs then enter a constant voltage-regulation mode to maintain the battery at full charge.

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Evaluates: MAX8804V/MAX8804W/MAX8804Y/MAX8804Z

**Table 1. SET Truth Table**

SET	V <sub>DC</sub>	V <sub>USB</sub>	CHARGER STATUS
0	Invalid	Invalid	Off
0	Invalid	Valid	Off
0	Valid	Invalid	DC charging mode enabled/USB charging mode disabled
0	Valid	Valid	DC charging mode enabled/USB charging mode disabled
1	Invalid	Invalid	Off
1	Invalid	Valid	DC charging mode disabled/USB charging mode enabled
1	Valid	Invalid	Off
1	Valid	Valid	Off

**Note:** This table is true when DETBAT = low for the MAX8804V/MAX8804W. When DETBAT = high, the MAX8804V/MAX8804W enter shutdown.

### SET Input

SET is a logic input for selecting the DC/USB charging mode and charging current. Drive SET low or leave it unconnected to enable DC charging mode. Drive SET high to enable USB charging mode (see Table 1).

SET can also be driven by series pulses to program the charging current in both DC and USB mode. Pulse-generating circuitry is included on the EV kit to program

the charge current and top-off threshold. With the JU1 shunt across pins 1-2, pressing the S1 switch generates pulses to program the DC charging current, as shown in Tables 2, 3, and 4. With the JU1 shunt across pins 2-3, pressing the S1 switch generates pulses to program the USB charging current, as shown in Tables 5 and 6. Refer to the MAX8804V/MAX8804W/MAX8804Y/MAX8804Z IC data sheet for timing diagrams.

**Table 2. MAX8804Y/MAX8804Z DC Charging Current Programming by Series Pulses**

PULSE NUMBER	DEFAULT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
I <sub>CHG</sub> (mA)	500	500	500	500	550	550	550	550	600	600	600	600	450	450	450
Top-Off Current Threshold (mA)	80	90	100	70	80	90	100	70	80	90	100	70	80	90	100
PULSE NUMBER	DEFAULT	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th
I <sub>CHG</sub> (mA)	—	450	400	400	400	400	650	650	650	650	700	700	700	700	500
Top-Off Current Threshold (mA)	—	70	80	90	100	70	80	90	100	70	80	90	100	70	80

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**Table 3. MAX8804W DC Charging Current Programming by Series Pulses**

PULSE NUMBER	DEFAULT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
I <sub>CHG</sub> (mA)	450	450	450	450	550	550	550	550	500	500	500	500	400	400	400
Top-Off Current Threshold (mA)	80	90	100	70	80	90	100	70	80	90	100	70	80	90	100
PULSE NUMBER	—	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th
I <sub>CHG</sub> (mA)	—	400	600	600	600	600	650	650	650	650	700	700	700	700	450
Top-Off Current Threshold (mA)	—	70	80	90	100	70	80	90	100	70	80	90	100	70	80

**Table 4. MAX8804V DC Charging Current Programming by Series Pulses**

PULSE NUMBER	DEFAULT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
I <sub>CHG</sub> (mA)	450	450	450	450	550	550	550	550	500	500	500	500	400	400	400
Top-Off Current Threshold (mA)	120	140	180	200	120	140	180	200	120	140	180	200	120	140	180
PULSE NUMBER	—	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th
I <sub>CHG</sub> (mA)	—	400	600	600	600	600	650	650	650	650	700	700	700	700	450
Top-Off Current Threshold (mA)	—	200	120	140	180	200	120	140	180	200	120	140	180	200	120

### DC Charging Mode

The MAX8804V/MAX8804W/MAX8804Y/MAX8804Z automatically select between either a USB or AC adapter input source. Drive SET low or leave it unconnected to enable DC charging mode. Subsequent pulses on SET program the charging current and the top-off threshold. There are seven fast-charge current options and four top-off threshold options. Pulse SET high (1 $\mu$ s to 1ms pulse width) subsequently to realize charging current and top-off threshold programming and transition. After the 28th pulse, the MAX8804V/MAX8804W/MAX8804Y/MAX8804Z return to the default mode and start a new cycle. See Tables 2, 3, and 4 to set the desired charging current and top-off threshold. Drive SET high longer than 2ms to disable DC charging control circuitry.

### USB Charging Mode

Drive SET high to enable USB charging mode when the USB input is valid. Subsequent low pulses with 1 $\mu$ s to 1ms pulse width on SET program the fast-charging current from 95mA, 380mA, to 475mA for the MAX8804Y/MAX8804Z, and from 380mA, 475mA, to 95mA for the MAX8804V/MAX8804W, and then repeat a new cycle as shown in Tables 5 and 6. Drive SET low or leave it unconnected longer than 2ms to disable USB charging control circuitry.

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**Table 5. MAX8804Y/MAX8804Z  
USB Charging Current Programming by  
Series Pulses**

PULSE NUMBER	DEFAULT	1st	2nd	3rd
I <sub>CHG</sub> (mA)	95	380	475	95
Top-Off Current Threshold (mA)	80	80	80	80

### **Charging-Status Output ( $\overline{\text{CHG}}$ )**

The  $\overline{\text{CHG}}$  LED (D1) indicates charging status. The LED is on ( $\overline{\text{CHG}}$  low) when the charger is in the prequalification or fast-charge mode. It is off ( $\overline{\text{CHG}}$  high impedance) when the charger reaches the top-off mode for more than 4ms, indicating that charging is done.

### **Power-OK Output ( $\overline{\text{POK}}$ )**

The  $\overline{\text{POK}}$  LED (D2) is a visual indicator of power-OK status. When a valid input at either DC or USB is detected greater than 4.15V and exceeds the battery voltage by 250mV,  $\overline{\text{POK}}$  pulls low to indicate that the input power is OK. Otherwise,  $\overline{\text{POK}}$  is high impedance.  $\overline{\text{POK}}$  status is maintained regardless of SET status.

### **USB Power Status Output ( $\overline{\text{USBPWR}}$ ) (MAX8804Y/MAX8804Z Only)**

The  $\overline{\text{USBPWR}}$  LED (D3) indicates USB power status output. The LED is on ( $\overline{\text{USBPWR}}$  low) when  $V_{\text{USB}} > V_{\text{UVLO}}$  and  $V_{\text{USB}} - V_{\text{BAT}} > 250\text{mV}$ . Otherwise, it is high impedance.  $\overline{\text{USBPWR}}$  indicates the USB input presence regardless of SET status and charger status.

**Table 6. MAX8804V/MAX8804W  
USB Charging Current Programming by  
Series Pulses**

PULSE NUMBER	DEFAULT	1st	2nd	3rd
I <sub>CHG</sub> (mA)	380	475	95	380
Top-Off Current Threshold (mA)	80	80	80	80

### **Battery Pack Detection Input ( $\overline{\text{DETBAT}}$ ) (MAX8804V/MAX8804W Only)**

The  $\overline{\text{DETBAT}}$  input is pulled up to an internal 3V supply through a 63k $\Omega$  resistor. Installing a shunt on jumper JU2 allows SET to control the charger. The MAX8804V/MAX8804W enter shutdown when the shunt on jumper JU2 is removed.

### **Thermal-Regulation Control**

The thermal-regulation loop limits the MAX8804V/MAX8804W/MAX8804Y/MAX8804Z die temperature to +105°C by reducing the charge current as necessary. This feature not only protects the ICs from overheating, but also allows a higher charge current at room temperature, without risking damage to the system.

### **Evaluating the MAX8804V/MAX8804W/MAX8804Y**

For evaluating the MAX8804V/MAX8804W/MAX8804Y, carefully remove the MAX8804Z IC (U1) and install the MAX8804V/MAX8804W/MAX8804Y IC. All other components remain the same.

**Evaluates: MAX8804V/MAX8804W/MAX8804Y/MAX8804Z**

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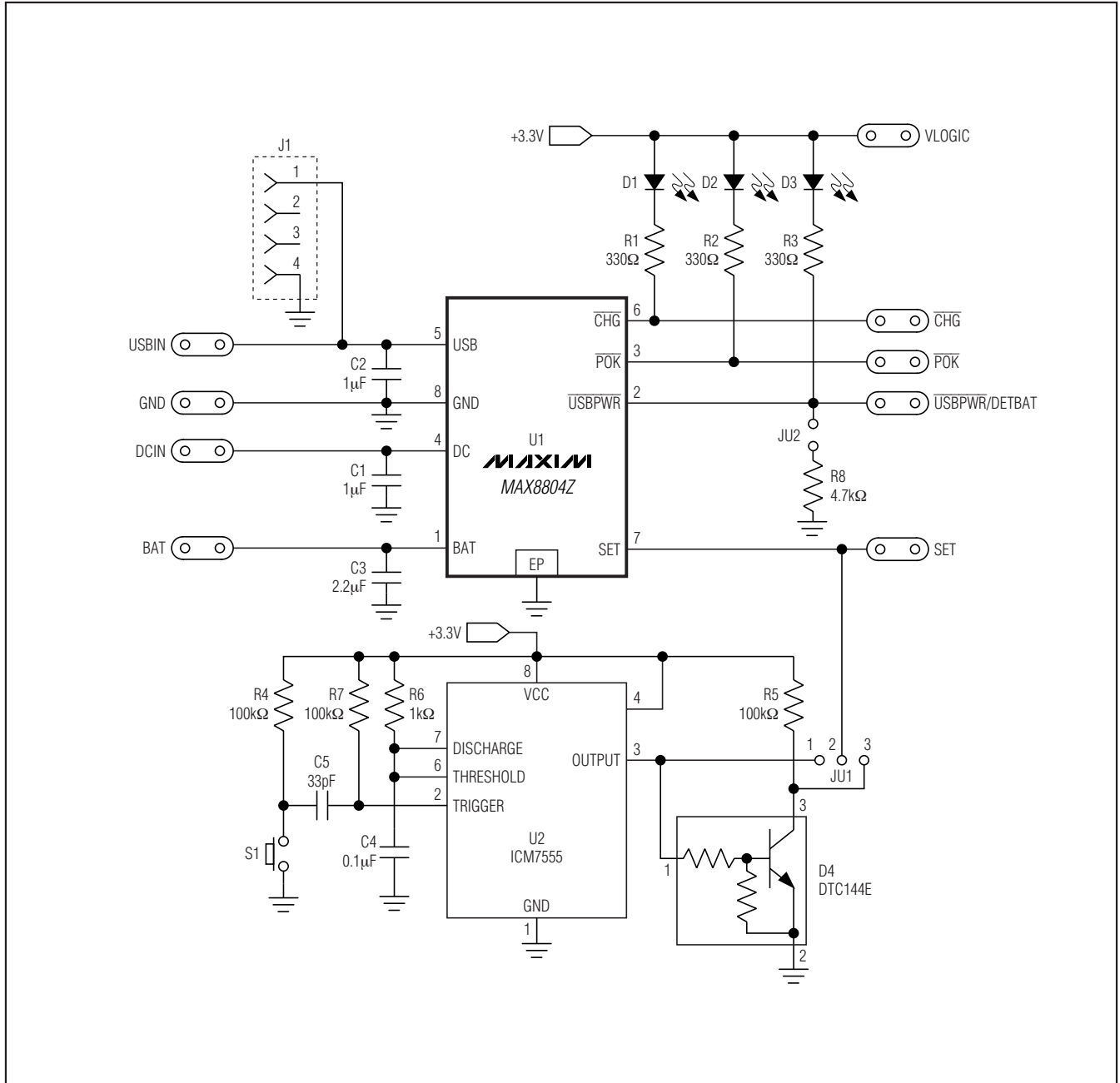


Figure 1. MAX8804Z EV Kit Schematic

# MAX8804Z Evaluation Kit

Evaluates: MAX8804V/MAX8804W/MAX8804Y/MAX8804Z

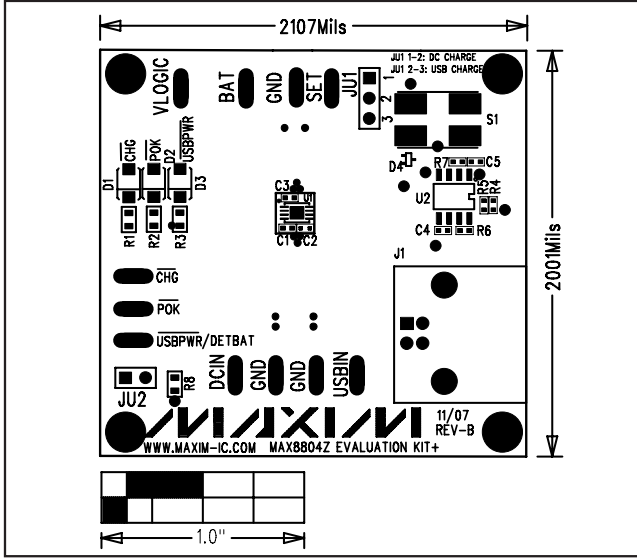


Figure 2. MAX8804Z EV Kit Component Placement Guide—Component Side

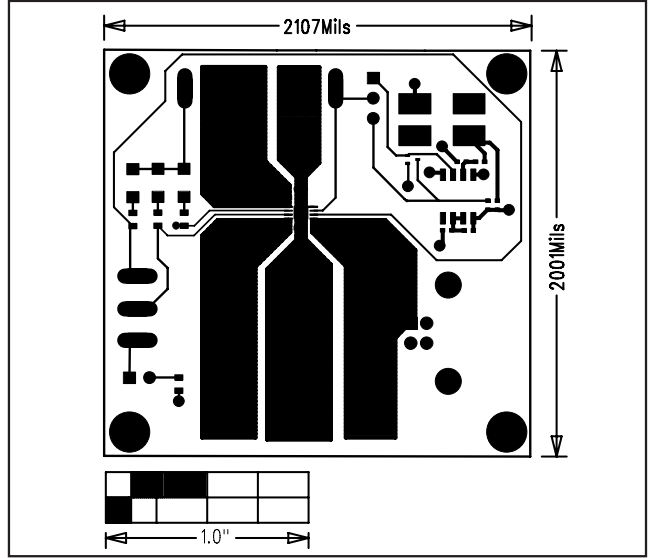


Figure 3. MAX8804Z EV Kit PCB Layout—Top Layer

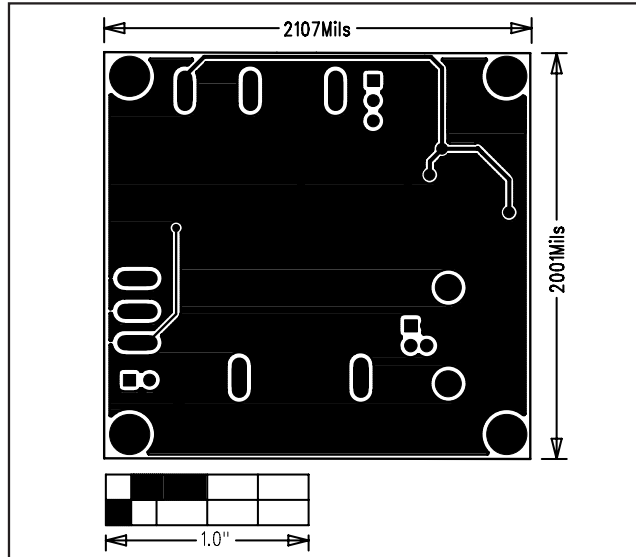


Figure 4. MAX8804Z EV Kit PCB Layout—Bottom Layer

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