19-0830; Rev 0; 5/07

MAX8662 Evaluation Kit

Evaluates: MAX8662

General Description

The MAX8662 evaluation kit (EV kit) is a fully assembled and tested printed-circuit board (PCB) that evaluates the MAX8662 power-management IC. The MAX8662 integrates two synchronous rectified step-down regulators, a step-up regulator driving two to seven white LEDs (WLEDs), four low-dropout linear regulators (LDOs), and a linear charger for a single-cell Li-ion (Li+) battery. Maxim's Smart Power Selector™ (SPS) safely distributes power between an external power source (AC adapter, auto adapter, or USB source), battery, and the system load.

Smart Power Selector is a trademark of Maxim Integrated Products, Inc.

Features

- **Two 95%-Efficient 1MHz Synchronous Rectified Step-Down Regulators**
- **One 1MHz Step-Up WLED Driver**
- **Four LDO Regulators with Jumper-Selectable Output Voltages**
- **Single-Cell Li+ Charger**
- **Smart Power Selector (SPS)**
- **Power-OK, Charger Status, and Timeout Fault Indicators**
- **LED Analog Brightness and PWM Dimming Control**
- **48-Pin, 6mm x 6mm x 0.8mm Thin QFN IC Package**
- **Fully Assembled and Tested**

Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX8662EVKIT+	0°C to +70°C*	48 Thin QFN-EP** (6mm x 6mm x 0.8mm)

+Denotes a lead-free and RoHS-compliant EV kit.

**This limited temperature range applies to the EV kit PCB only. The MAX8662 IC temperature range is -40°C to +85°C.*

***EP = Exposed paddle.*

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4, C6, C10, C11	5	10µF ±10%, 16V X5R ceramic capacitors (0805) Taiyo Yuden EMK212BJ106KG
C2, C3	2	0.1µF ±10%, 10V X5R ceramic capacitors (0402) Murata GRM 155R61A104KA01 TDK C1005X5R1A104K Taiyo Yuden LMK105BJ104KV
C5_1, C5_2	2	10µF ±10%, 6.3V X5R ceramic capacitors (0805) Murata GRM219R60J106KE19
C7_1	1	47µF ±20%, 6.3V X5R ceramic capacitor (0805) Taiyo Yuden JMK212BJ476MG-B
C7_2, C24	0	Not installed, capacitors (0805)
C8, C9, C13	3	1µF ±10%, 16V X5R ceramic capacitors (0603) Murata GRM188R61C105KA93B Taiyo Yuden EMK107 BJ105KA

DESIGNATION	QTY	DESCRIPTION
C12	1	680pF ±10%, 50V X7R ceramic capacitor (0402) Murata GMD155R71H681KA
C14	1	0.1µF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H104KA93 Taiyo Yuden UMK107BJ104KA
C15	1	0.22µF ±10%, 10V X5R ceramic capacitor (0402) Murata GRM155R61A224KE19
C16	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J475KE19 Taiyo Yuden JMK107BJ475MA
C17, C19	2	1µF ±10%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J105KA01

MAX8662 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C18	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM185R60J225KE26 Taiyo Yuden JMK107BJ225KA
C20	1	4.7pF ±5%, 50V C0G ceramic capacitor (0402) Murata GJM1555C1H4R7BB01B
C21	1	33pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1535C1H330JDD5
C22, C25	0	Not installed, capacitors (1210)
C23	1	10pF ±5%, 50V C0G ceramic capacitor (0402) Murata GJM1555C1H100JB01 TDK C1005C0G1H100D
C26	0	Not installed, capacitor (0402)
C27, C28, C29	3	0.068µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C683KA
$\overline{CEN}$, EN1–EN7, PEN1, PEN2, PWM, SL1, SL2	13	3-pin headers
D1	1	30V, 200mA Schottky diode (SOD323) Central CMDSH2-3
D2–D8	7	30mA surface-mount WLEDs Nichia #NSCW215T
D9, D10	2	Green LEDs Agilent HSMG-C150
D11	1	75V, 250mA silicon switching diode (SOD523) Central CMOD4448
JU1, JU2, JU5–JU11	9	2-pin headers
JU3	0	Not installed, jumper (cut here—short)
JU4	0	Not installed, jumper (cut here—open)
L1	1	3.3µH inductor TOKO DE2818C 1072AS-3R3M (1.6A, 50mΩ, 2.8mm x 3mm x 1.8mm)
L2	1	4.7µH inductor TOKO DE2818C 1072AS-4R7M (1.3A, 70mΩ, 2.8mm x 3mm x 1.8mm)
L3	1	22µH inductor Murata LQH32CN220K53 (250mA, 0.71Ω, 3.2mm x 2.5mm x 1.55mm)
R1, R7	2	2kΩ ±1% resistors (0805)
R2	1	464kΩ ±1% resistor (0402)
R3, R5, R12	3	200kΩ ±1% resistors (0402)
R4	1	60.4kΩ ±1% resistor (0402)
R6	1	10kΩ ±1% resistor (0805)
R8	1	3kΩ ±1% resistor (0402)
R9	1	7.87kΩ ±1% resistor (0402)
R10	1	1.3MΩ ±1% resistor (0402)
R11	1	100kΩ ±1% resistor (0402)
R13	1	1kΩ resistor (0402)
R14, R15, R16	0	Not installed, resistors (0402)
R17	1	5.23kΩ ±1% resistor (0603)
R18	1	4.64kΩ ±1% resistor (0603)
R19, R20	2	6.04kΩ ±1% resistors (0402)
R21, R22	2	0Ω resistors (0805)
U1	1	MAX8662ETM+ (48-pin thin QFN-EP, 6mm x 6mm x 0.8mm)
—	1	PCB: MAX8662 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Agilent Technologies	877-424-4536	www.agilent.com
Central Semiconductor	631-435-1110	www.centralsemi.com
Murata Mfg. Co., Ltd.	814-237-1431	www.murata.com
Nichia Corp.	248-349-9800	www.nichia.com
Taiyo Yuden	847-925-0888	www.yuden.co.jp
TDK Corp.	847-803-6100	www.component.tdk.com
TOKO	847-297-0070	www.toko.com

Note: *Indicate that you are using the MAX8662 when contacting these component suppliers.*

Quick Start

Recommended Equipment

- Variable 9V power supply
- One-cell Li+ battery
- Two voltmeters
- One ammeter
- Load resistors or electronic loads capable of 1.2A

Procedure

The MAX8662 EV kit is a fully assembled and tested surface-mount PCB. Follow the steps below to verify board operation:

1) Enable outputs OUT1–OUT7 by placing a shunt across pins 1-2 of EN1–EN7 (Table 1).
2) Set the OUT4–OUT7 outputs voltages by setting shunts SL1 and SL2, as shown in Table 3. Note that the SL1 and SL2 jumper settings are read-only on power-up. Changes to these jumpers after power-up are ignored.
3) Place the pulse-width modulation (PWM) shunt across pins 2-3 to allow OUT1 and OUT2 to enter skip mode at light loads.
4) Verify that the JU1 and JU2 shunts are installed to set LEDs on and LED current to 20mA.
5) Place the PEN1 and PEN2 shunts across pins 2-3 and 1-2 to set a 500mA USB input current limit.
6) Place the $\overline{CEN}$ shunt across pins 2-3 to enable the battery charger.
7) Verify that the JU5 shunt is installed and the JU6 shunt is not installed to set the charge current limit to 1A.
8) Verify that at least one of shunts JU9, JU10, and JU11 are installed to have long fault timer limits for normal operation.
9) Preset the power supply to 5V. Turn the power supply off. **Caution: Do not turn on the power supply until all connections are completed.**
10) Make connections to the EV kit, as shown in Figure 1, but do not connect the battery until step 18.
11) Turn on the power supply.
12) Verify that the $\overline{POK}$ LED (D9) turns on to indicate power-OK.
13) Verify that the voltage across the OUT1 and PGND1 pads is 3.3V.
14) Verify that the voltage across the OUT2 and PGND2 pads is 1.3V.
15) Verify that the WLEDs (D2–D8) are on.
16) Verify that OUT4–OUT7 are at the voltages set by jumpers SL1 and SL2 (Table 3).
17) Verify that the voltage at the BAT pad is 4.2V.
18) **Observe correct Li+ cell polarity.** Connect a single-cell Li+ battery across the BAT and BGND pads.
19) Verify that the $\overline{CHG}$ LED (D10) turns on. The $\overline{CHG}$ LED turns on during prequalification and fast-charge conditions and turns off when the battery charging current drops to 7.5% of the fast-charge current and charging is completed.
20) Turn off the power supply and remove JU9, JU10, and JU11 shunts.
21) Turn on the power supply again and verify that the $\overline{CHG}$ LED blinks and the charging stops in a preset short time, approximately 3min.

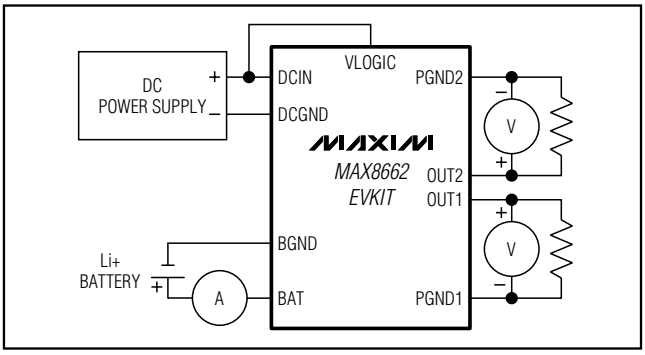

Figure 1. Test Procedure Setup

Table 1. Jumper Functions

JUMPER	POSITION		
	1-2	2-3	OPEN
EN1	Enable OUT1*	Disable OUT1	Drive EN1 with an external source
EN2	Enable OUT2*	Disable OUT2	Drive EN2 with an external source
EN3	Enable OUT3*	Disable OUT3	Drive EN3 with an external source
EN4	Enable OUT4*	Disable OUT4	Drive EN4 with an external source
EN5	Enable OUT5*	Disable OUT5	Drive EN5 with an external source
EN6	Enable OUT6*	Disable OUT6	Drive EN6 with an external source
EN7	Enable OUT7*	Disable OUT7	Drive EN7 with an external source

**Default position.*

Table 2. Default EV Kit Output Voltages and Maximum Currents

OUTPUT	VOLTAGE (V)	MAXIMUM CURRENT (mA)
OUT1	3.3	1200
OUT2	1.3	900
OUT4	3.3	500
OUT5	3.3	150
OUT6	3.3	300
OUT7	3.3	150

Detailed Description

Smart Power Selector (SPS)

SPS seamlessly distributes power between the external input, the battery, and the system load. The basic functions of SPS are:

1) With both the external power supply and battery connected:
   a) When the system-load requirements exceed the capacity of the external power input, the battery supplies supplemental current to the load.
   b) When the system-load requirements are less than the capacity of the external power input, the battery is charged with residual power from the input.

Table 3. SL1 and SL2 Output-Voltage Selection

SL1	SL2	OUT4 (V)	OUT5 (V)	OUT6 (V)	OUT7 (V)
Open	Open	3.3	3.3	3.3	3.3
2-3	Open	3.3	2.85	1.85	1.85
1-2	Open	2.85	2.85	1.85	1.85
Open	2-3	3.3	2.85	2.85	1.85
2-3	2-3	2.5	3.3	1.5	1.5
1-2	2-3	2.5	3.3	1.5	1.3
Open	1-2	1.2	1.8	1.1	1.3
2-3	1-2	3.3	2.85	1.5	1.5
1-2	1-2	1.8	2.5	3.3	2.85

2) When the battery is connected and there is no external power input, the system is powered from the battery.
3) When an external power input is connected and there is no battery, the system is powered from the external power input.

DC Input Current-Limit Selection (PEN1/PEN2)

The input current limit can be set to a variety of values, as shown in Table 4. When the PEN1 input is low, a USB source is expected at DC and the current limit is set to either 95mA or 475mA by PEN2. When PEN1 is high, an AC adapter is expected at DC and the current limit is set by a programming resistor at PSET (R8, R19, R20). The DC input current limit is calculated as from:

$$I_{DC\_LIM} = 2000 \times (1.5V / R_{PSET})$$

Table 4. DC Input Current and Charger Current Limit Select

$\overline{CEN}$	PEN1	PEN2	DC INPUT CURRENT LIMIT	EXPECTED INPUT TYPE	CHARGER CURRENT LIMIT
2-3	2-3	2-3	95mA	100mA USB	$1556 \times (1.5V / R_{ISET})$
2-3	2-3	1-2	475mA	500mA USB	$1556 \times (1.5V / R_{ISET})$
2-3	1-2	X	$2000 \times (1.5V / R_{PSET})$	AC adapter	$1556 \times (1.5V / R_{ISET})$
1-2	X	2-3	Off	USB suspend	Off
1-2	2-3	1-2	475mA	500mA USB	Off
1-2	1-2	1-2	$2000 \times (1.5V / R_{PSET})$	AC adapter	Off

X = Don't care.

R_{ISET} is the resistance between ISET node and GND and R_{PSET} is the resistance between PSET and GND.

See Table 5 for the DC input current-limit setting and configurations for jumpers JU7 and JU8.

An exception is when the battery charger is disabled ($\overline{CEN}$ high) with PEN2 low, where the MAX8662 enters USB-suspend mode.

Table 5. DC Input Current-Limit Setting

JUMPER POSITION		CHARGE CURRENT (A)
JU7	JU8	
Open	Open	1.0
Open	Short	1.5
Short	Open	1.5
Short	Short	2.0

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

The $\overline{POK}$ LED (D9) is a visual indicator of power-OK status. When the voltage at DC is between the undervoltage and the overvoltage thresholds, and is greater than the BAT voltage, $\overline{POK}$ pulls low to indicate that input power is OK. Otherwise $\overline{POK}$ is high impedance. $\overline{POK}$ is not affected by PEN1, PEN2, or $\overline{CEN}$ and also remains active in thermal overload.

Battery Charger

With a valid AC adapter/USB voltage present, the battery charger initiates a charge cycle when the charger is enabled. If the battery voltage is less than the BAT prequalification threshold (3V), the charger enters prequalification mode in which the battery charges at 10% of the maximum set fast-charge current. This slow charge ensures that the battery is not damaged by fast-charge current while deeply discharged. Once the battery voltage rises to 3V, the charger transitions to fast-charge mode and applies the maximum charge current. As charging continues, the battery voltage rises until it reaches the battery regulation voltage (4.2V) where charge current starts tapering down. When charge current decreases to 7.5% of fast-charge current, the charger enters top-off mode. Top-off charging continues for 30min, then all charging stops. If the battery voltage subsequently drops below the 4.1V recharge threshold, fast charging restarts and the timers reset.

The charger can be enabled or disabled with jumper $\overline{CEN}$.

Charge Current

ISET adjusts the MAX8662 charging current to match the capacity of the battery. A resistor from ISET to ground (R9, R17, R18) sets the maximum fast-charge current, the charge current in prequal, and the charge-current threshold below which the battery is considered completely charged. Calculate these thresholds as follows:

$$I_{CHG-MAX} = 1556 \times 1.5V / R_{ISET}$$

$$I_{PRE-QUAL} = 10\% \times I_{CHG-MAX}$$

$$I_{TOP-OFF} = 7.5\% \times I_{CHG-MAX}$$

See Table 6 for the charge-current setting and configurations for jumpers JU5 and JU6.

Table 6. Charge-Current Setting

JUMPER POSITION		CHARGE CURRENT (A)
JU5	JU6	
Open	Open	0.30
Open	Short	0.75
Short	Open	0.80
Short	Short	1.25

Charge Timer

The MAX8662 features a fault timer for safe charging. If prequalification charging or fast charging does not complete within the time limits programmed by the timer capacitor at CT (C12, C27, C28, C29), the charger stops charging and the $\overline{CHG}$ LED blinks at a 1Hz rate to indicate the fault. Charging can be resumed by either toggling $\overline{CEN}$ or cycling the DC input voltage.

$$t_{PREQUAL} = 30min \times \frac{C_{CT}}{0.068\mu F}$$

$$t_{FST-CHG} = 300min \times \frac{C_{CT}}{0.068\mu F}$$

When the charger exits fast-charge mode, $\overline{CHG}$ goes high impedance and top-off mode is entered. Top-off time is also determined by C_{CT}:

$$t_{TOP-OFF} = 30min \times \frac{C_{CT}}{0.068\mu F}$$

See Table 7 for the charge-timer setting and configurations for jumpers JU9, JU10, and JU11.

Table 7. Charge-Timer Setting

JUMPER POSITION (JU9, JU10, and JU11)	PREQUALIFICATION CHARGE TIMER (min)	FAST-CHARGE TIMER (min)
All open	0.3	3
Only one jumper	30.3	303
Two jumpers short	60.3	603
All short	90.3	903

Charge Status Output ($\overline{CHG}$)

The $\overline{CHG}$ LED (D10) indicates charge status. The LED is on ($\overline{CHG}$ low) when the charger is in the prequalification or fast-charge mode. It is off ($\overline{CHG}$ high impedance) when the charger is disabled in top-off mode or in done mode.

The charger enters fault status when the charge timer expires before the charging completes. In this state, the $\overline{CHG}$ LED pulses at 1Hz to indicate that a fault occurred.

Battery Charger Thermistor Input (THM)

Battery or ambient temperature can be monitored with a negative temperature coefficient (NTC) thermistor installed in place of R6, or connected from the THM pad to GND with R6 removed. Charging is then allowed when the thermistor temperature is within the allowable range. The charger enters a temperature suspend state when the thermistor resistance falls below 3.97kΩ (too hot, over +50°C) or rises above 28.7kΩ (too cold, below 0°C).

Regulator Outputs (OUT1, OUT2, and OUT4–OUT7)

The MAX8662 EV kit has seven power-supply outputs: two step-down converters (OUT1 and OUT2), one step-up WLED driver (OUT3), and four LDO regulators (OUT4–OUT7). Refer to the MAX8662/MAX8663 IC data sheet for more information on these regulators.

Each regulator output is individually enabled or disabled with jumpers EN1–EN7 (Table 1).

The OUT1/OUT2 voltages can be set between 0.98V and V_{IN} by connecting FB1/FB2 to the center of a resistive voltage-divider between OUT1/OUT2 and GND. Refer to the *Setting OUT1 and OUT2 Output Voltage* section of the MAX8662/MAX8663 IC data sheet for more information.

The output voltages for OUT4–OUT7 are set by jumpers SL1 and SL2. See Table 3 and refer to the *Linear Regulators (OUT4, OUT5, OUT6, and OUT7)* section of the MAX8662/MAX8663 IC data sheet for more information.

Step-Up Converter with WLED Driver

The step-up WLED driver is enabled or disabled with jumper EN3. With the JU1 and JU2 shunts on, WLEDs (D2–D8) are turned on. LED current is set by the voltage at BRT. Adjust V_{BRT} from 50mV to 1.5V to set the LED current from 1mA to 30mA. EN3 can also be driven by a logic-level PWM brightness control signal, such as that supplied by a microcontroller. The allowed PWM frequency range is from 1kHz to 100kHz. A 100% duty cycle corresponds to full current set by the BRT node.

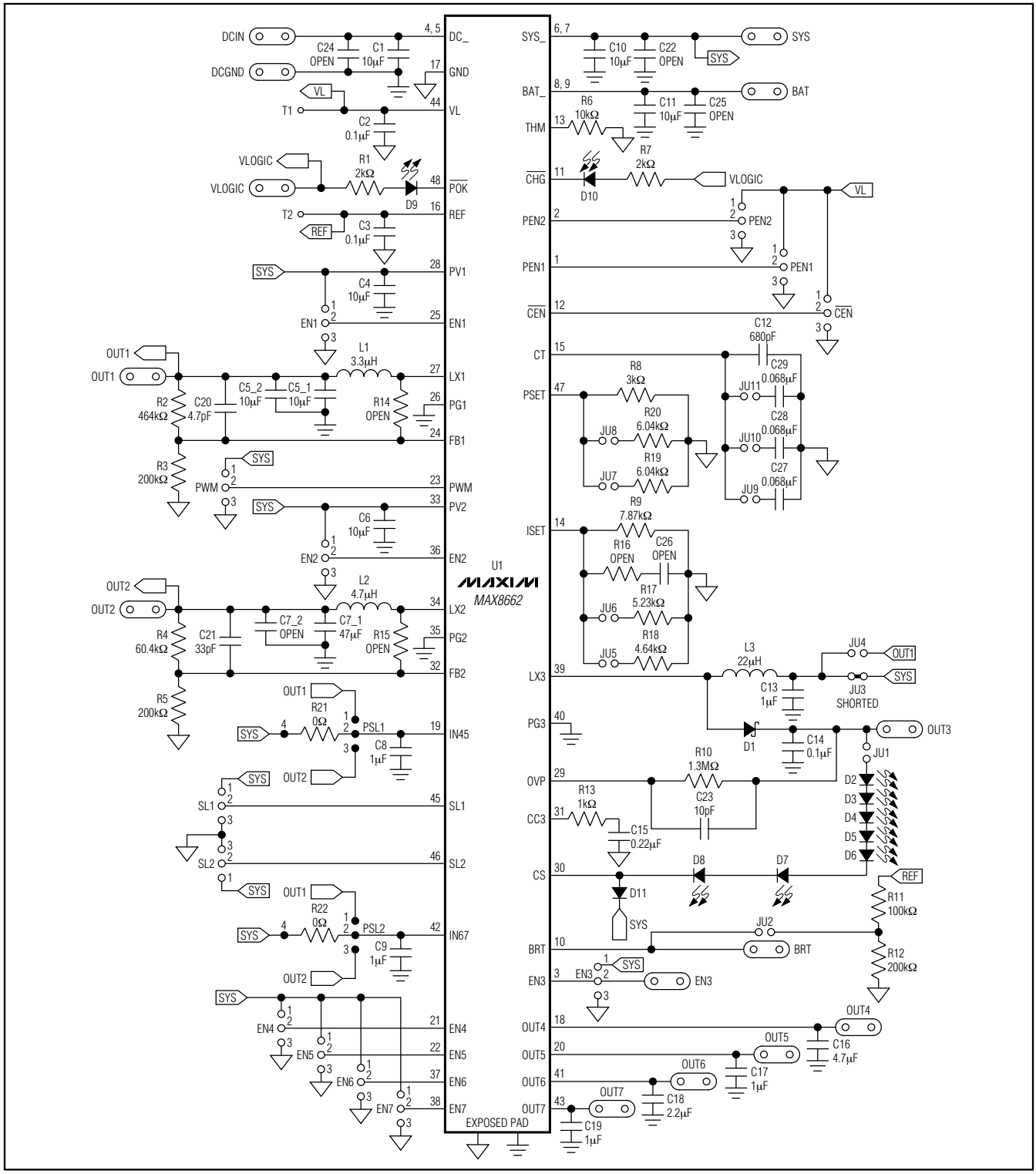

Figure 2. MAX8662 EV Kit Schematic

MAX8662 Evaluation Kit

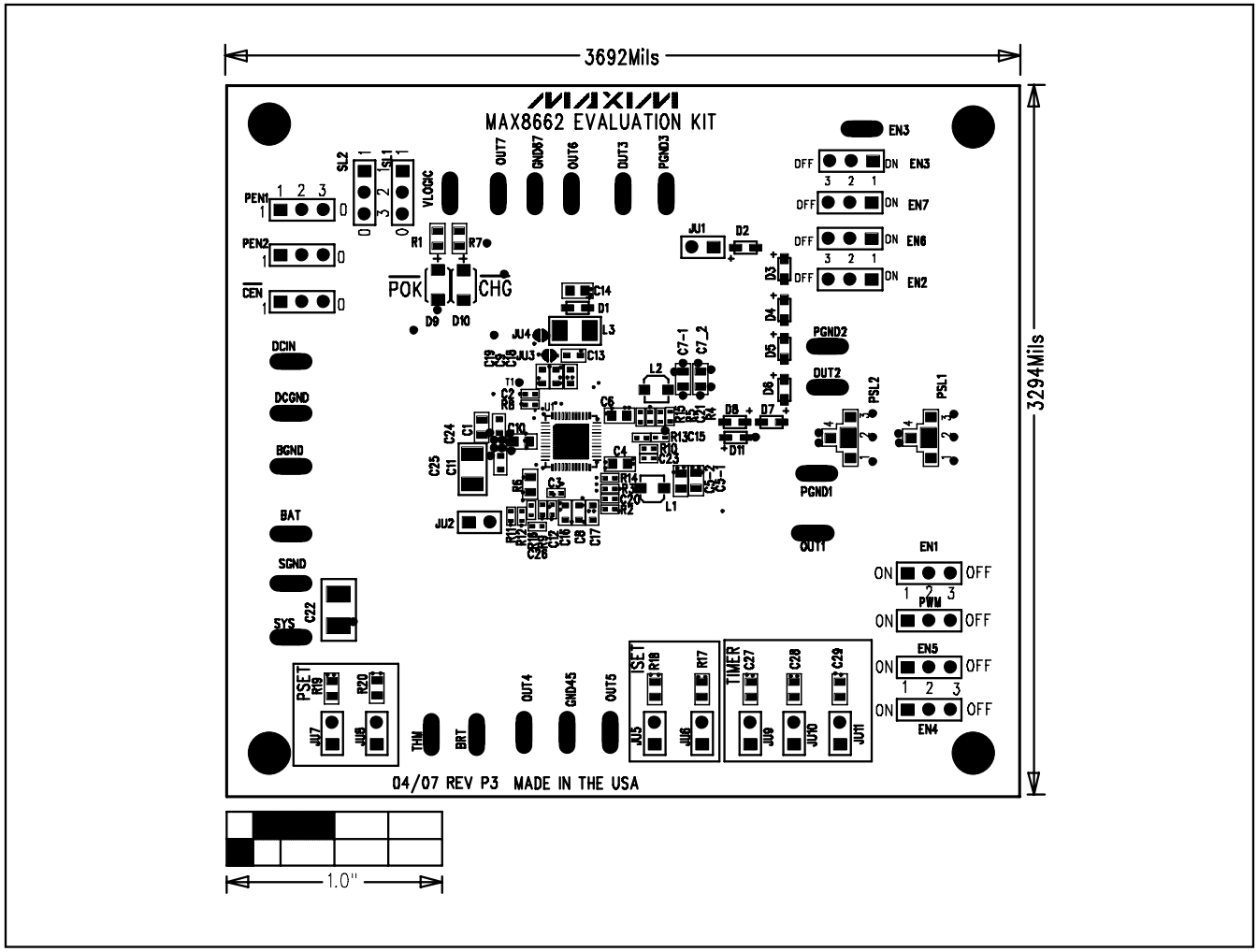

Figure 3. MAX8662 EV Kit Component Placement

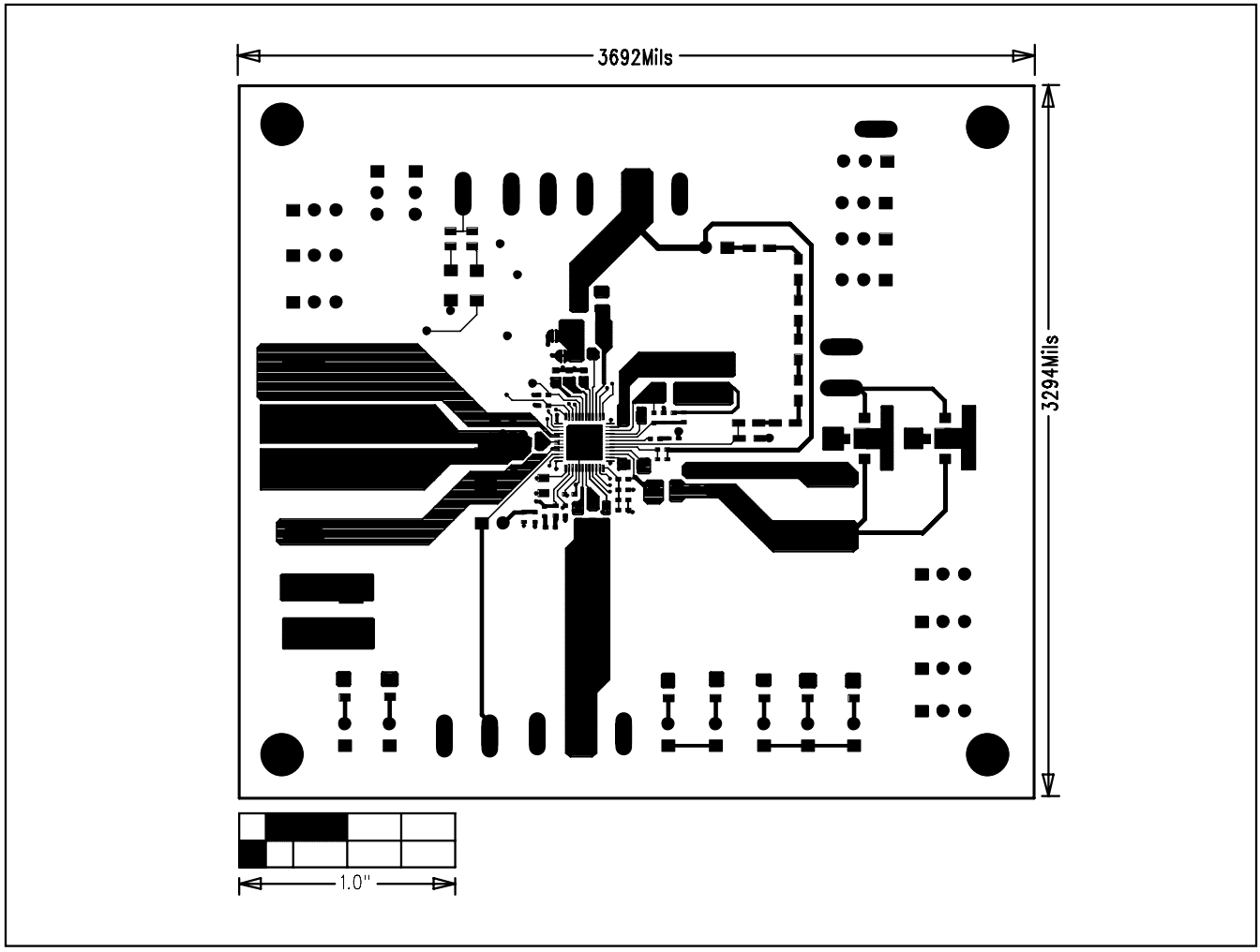

Figure 4. MAX8662 EV Kit PCB Layout—Top Layer 1

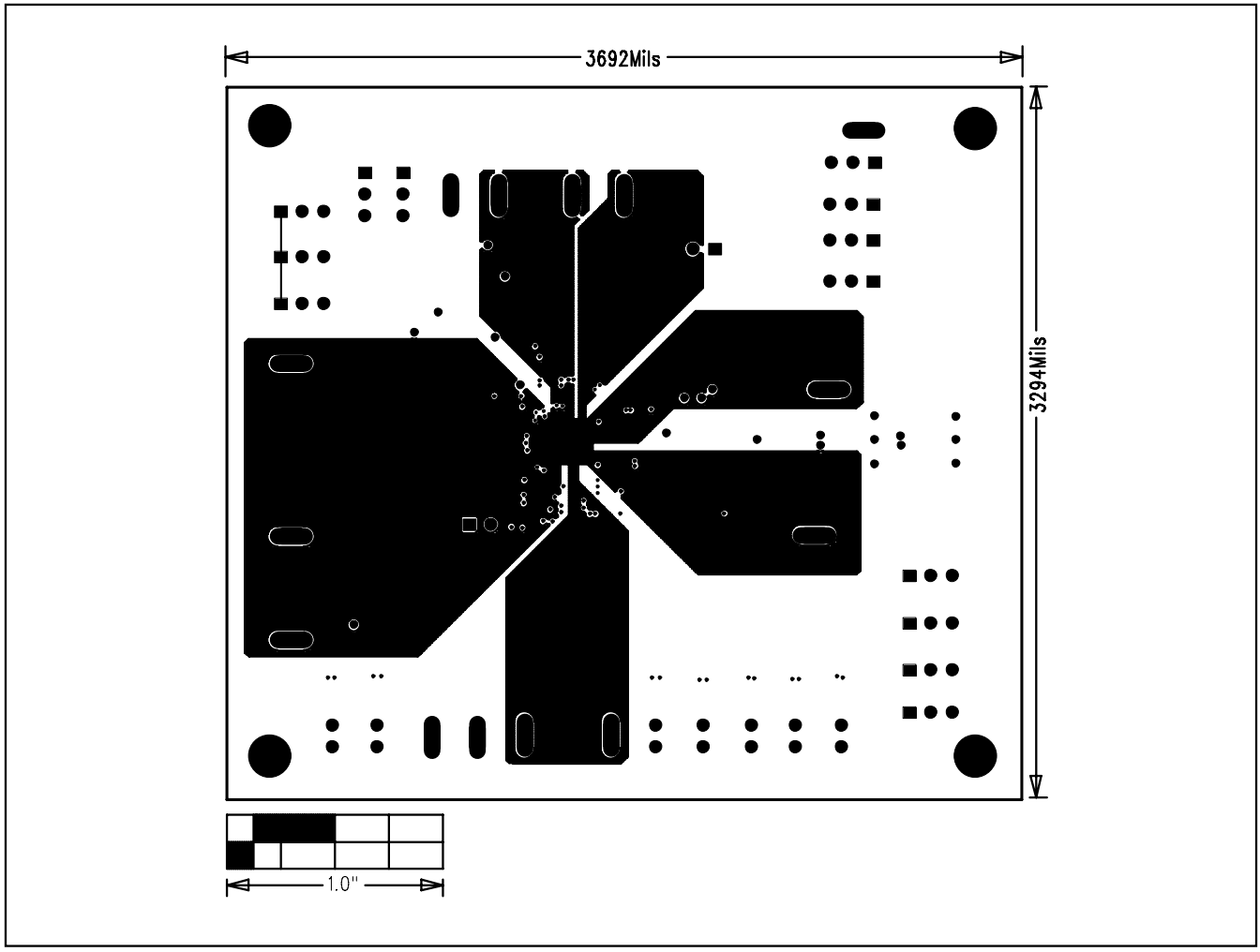

Figure 5. MAX8662 EV Kit PCB Layout—PGND Layer 2

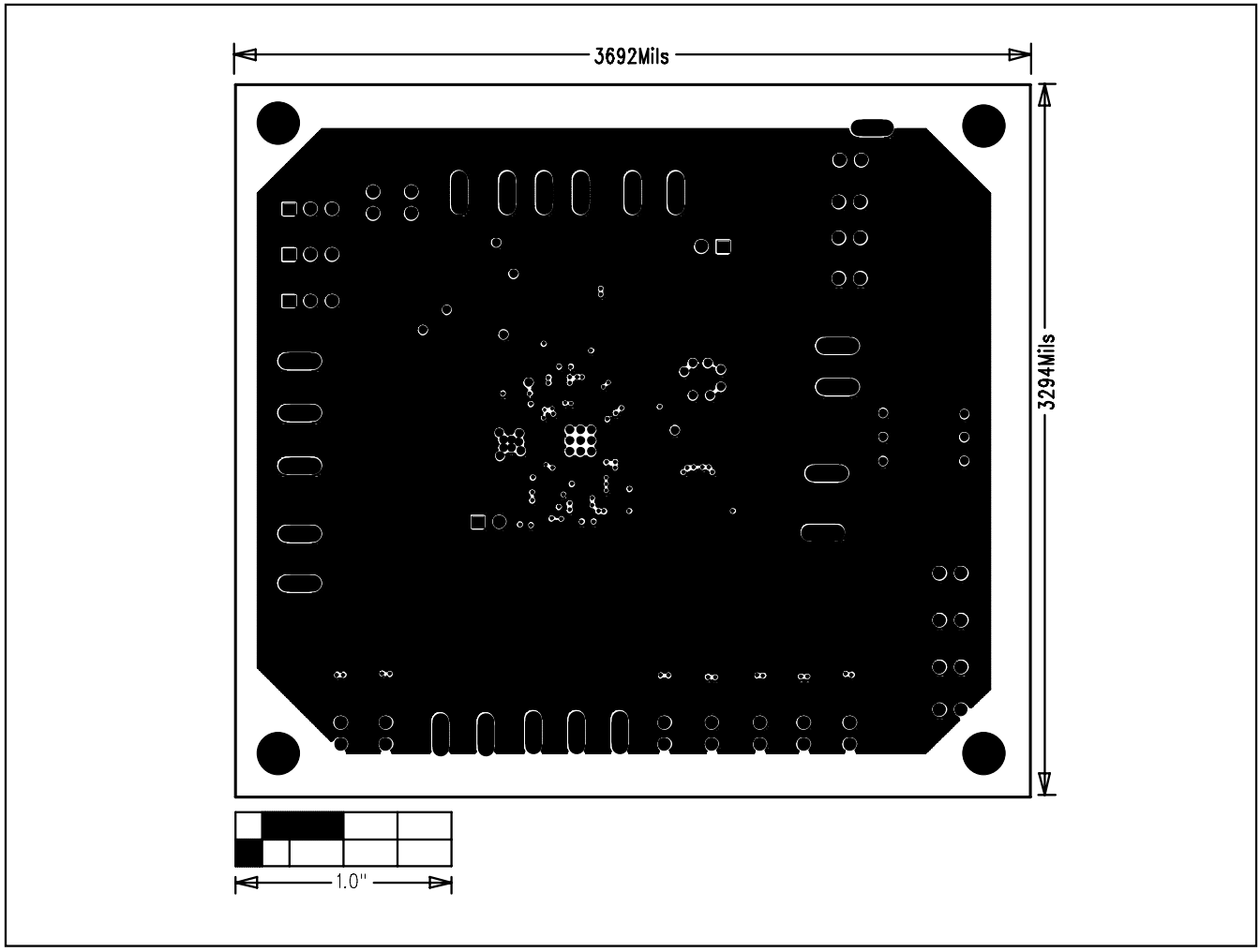

Figure 6. MAX8662 EV Kit PCB Layout—SYS Power Layer 3

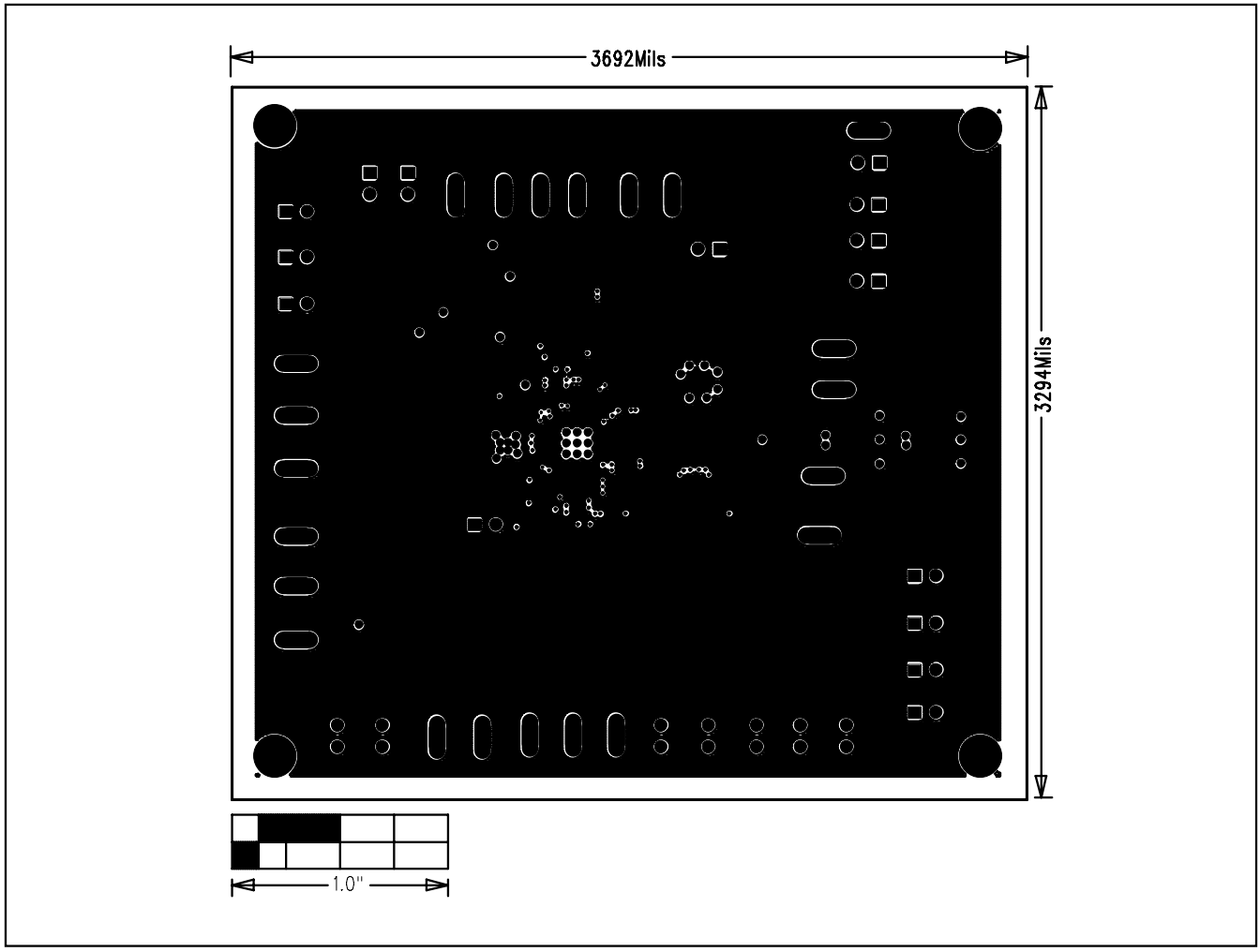

Figure 7. MAX8662 EV Kit PCB Layout—AGND Layer 4

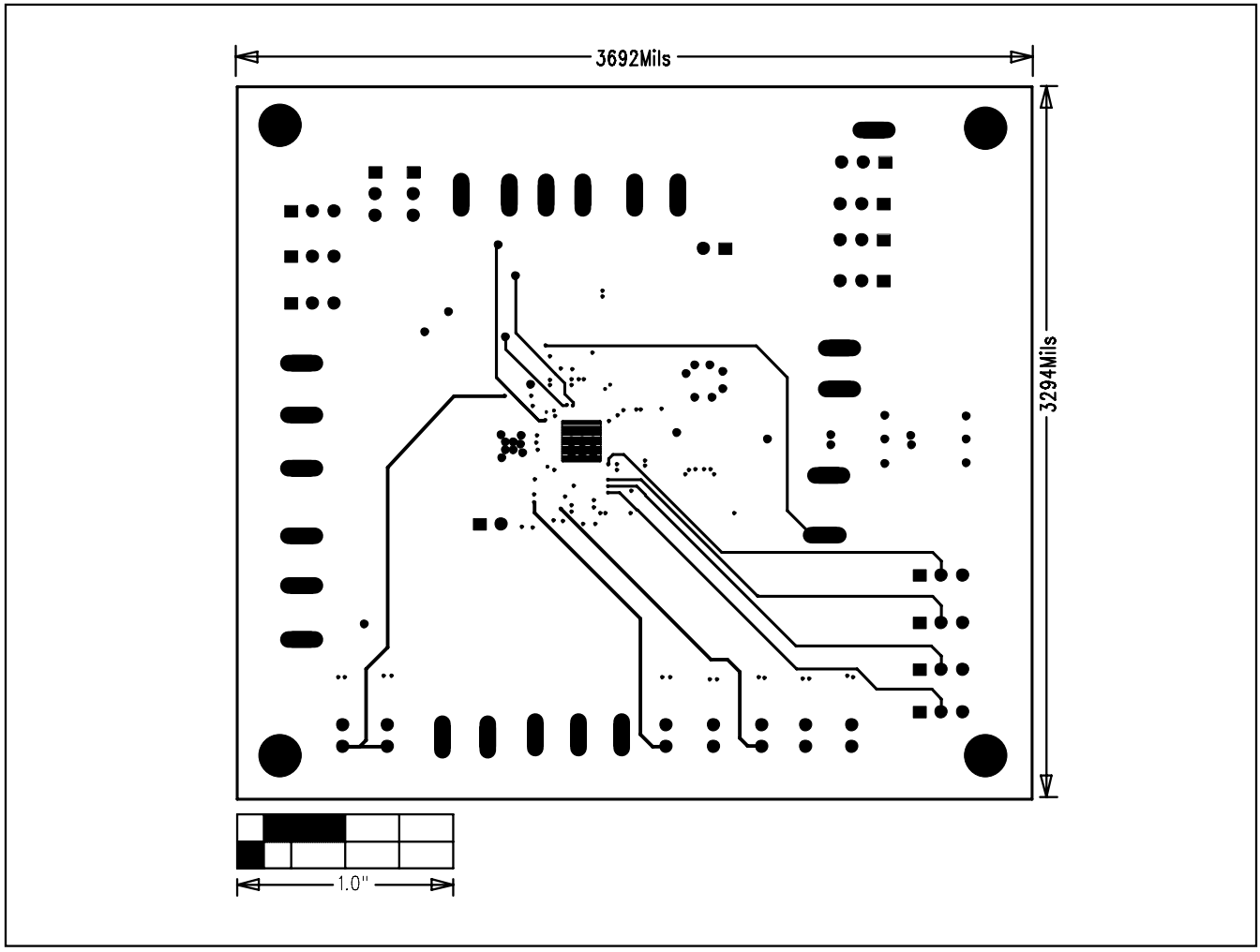

Figure 8. MAX8662 EV Kit PCB Layout—Routing Layer 5

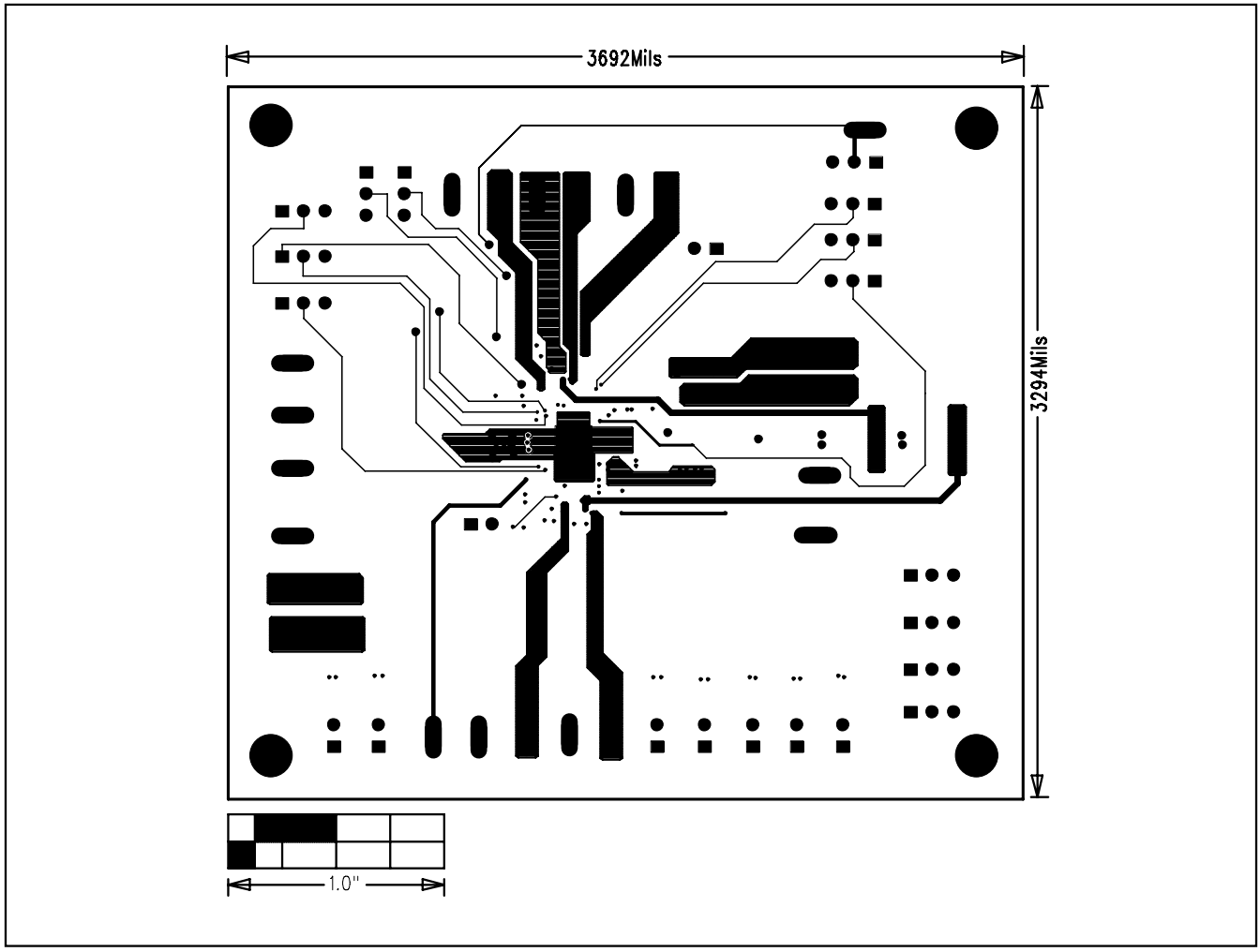

Figure 9. MAX8662 EV Kit PCB Layout—Bottom Layer 6