19-1011; Rev 0; 10/07

MAX8663 Evaluation Kit

General Description

The MAX8663 evaluation kit (EV kit) is a fully assembled and tested circuit board that evaluates the MAX8663 power-management IC. The MAX8663 integrates two synchronous step-down regulators, four low-dropout linear regulators (LDOs), and a linear charger for a single-cell Li-ion (Li+)/Li-polymer 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.

Features

- **Two High-Efficiency 1MHz Synchronous Rectified Step-Down Regulators**
- **Four LDO Regulators with Jumper-Selectable Output Voltages**
- **Single-Cell Li+/Li-Polymer Charger**
- **Smart Power Selector (SPS)**
- **Power-OK, Charger Status, and Timeout Fault Indicators**
- **40-Pin, 5mm x 5mm x 0.8mm Thin QFN Package**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX8663EVKIT+	EV Kit

+Denotes lead-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4, C6, C10, C11	5	10µF ±10%, 16V X5R ceramic capacitors (0805) Taiyo Yuden EMK212BJ106KG
C2	1	0.1µF ±10%, 10V X5R ceramic capacitor (0402) Murata GRM155R61A104K TDK C1005X5R1A104K Taiyo Yuden LMK105BJ104KV
C3, C7_2	0	Not installed, capacitors (0805)
C5_1, C5_2	2	10µF ±10%, 6.3V X5R ceramic capacitors (0805) Murata GRM219R60J106K
C7_1	1	47µF ±20%, 6.3V X5R ceramic capacitor (0805) Taiyo Yuden JMK212BJ476MG
C8, C9	2	1µF ±10%, 16V X5R ceramic capacitors (0603) Murata GRM188R61C105K Taiyo Yuden EMK107 BJ105KA
C12	0	Not installed, capacitor (0402)
C13	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J475K Taiyo Yuden JMK107BJ475MA
C14, C16	2	1.0µF ±10%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J105K
C15	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM185R60J225K Taiyo Yuden JMK107BJ225KA
C17	0	Not installed, capacitor (1210)
C18	1	4.7pF ±0.1pF, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H4R7B
C19	1	33pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H330J
C20	1	6800pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H682K
C21	1	10,000pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H103K
C22	1	22,000pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H223K

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C23	1	68,000pF ±10%, 25V X7R ceramic capacitor (0603) Murata GRM188R71E683K
D1, D2	2	Green LEDs Agilent HSMG-C150
JU1–JU6	6	2-pin headers, 36-pin headers, 0.1in centers (comes in 36-pin strips, cut to fit) Sullins PTC36SAAN Digi-key S1012-36-ND
JU7–JU19	13	3-pin headers, 36-pin headers, 0.1in centers (comes in 36-pin strips, cut to fit) Sullins PTC36SAAN Digi-key S1012-36-ND
L1	1	3.3µH inductor TOKO DE2818C 1072AS-3R3M, 1.6A, 50mΩ (2.8mm x 3.0mm x 1.8mm)
L2	1	4.7µH inductor TOKO DE2818C 1072AS-4R7M, 1.3A, 70mΩ (2.8mm x 3.0mm x 1.8mm)
P1	1	2.1mm/5.5mm closed-frame power jack CUI, Inc. PF-002AH-SMT
P2	1	USB mini AB receptacle connector Cypress Industries CCMUSBAB-32005-700
P4	1	1.25mm (0.049in) pitch header, surface-mount, right angle, lead-free, 10 circuits Molex 53261-1071 Digi-key WM7628CT-ND

DESIGNATION	QTY	DESCRIPTION
PSL1, PSL2	2	1 x 3 pads (0805) Default PSL1-2, PSL2-2 0Ω resistor (0805)
R1, R4	2	2kΩ ±1% resistors (0805)
R2	0	Not installed, resistor (1206)
R3	0	Not installed, resistor (0603)
R5	1	464kΩ ±1% resistor (0402)
R6, R8	2	200kΩ ±1% resistors (0402)
R7	1	60.4kΩ ±1% resistor (0402)
R9	1	1.5kΩ ±1% resistor (0402)
R10	0	Not installed, resistor (0402)
R11	1	2.4kΩ ±1% resistor (0805)
R12	1	3.2kΩ ±1% resistor (0805)
R13	1	8.0kΩ ±1% resistor (0805)
R14, R15	2	Bourns 50kΩ 3296 trimming potentiometers
R16, R18	0	Not installed, resistors (0805)
R17	1	10.0kΩ ±1% resistor (0805)
R19, R20	2	560kΩ ±5% resistors (0805)
R27	0	Not installed, resistor (1206)
U1	1	MAX8663ETL+ (40-pin thin QFN, 5mm x 5mm x 0.8mm)
—	1	PCB: MAX8663EVKIT+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Agilent Technologies	877-424-4536	www.agilent.com
CUI, Inc.	800-275-4899	www.cui.com
Cypress Industries	866-844-6699	www.cypressindustries.com
Molex	800-786-6539	www.molex.com
Murata	814-237-1431	www.murata.com
Taiyo Yuden	847-925-0888	www.yuden.co.jp
TDK	847-803-6100	www.component.tdk.com
TOKO	847-297-0070	www.toko.com

Note: *Indicate you are using the MAX8663 when contacting these manufacturers.*

Recommended Equipment

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

Quick Start

Procedures

The MAX8663 EV kit is a fully assembled and tested surface-mount board. Follow the steps below to verify board operation:

1) Enable outputs OUT1, OUT2, OUT4, OUT5, OUT6, and OUT7 by placing shunts across pins 1-2 of JU7, JU8, JU10, JU11, JU12, and JU13. See Table 1. Table 2 shows default EV kit output voltages and maximum currents.
2) Set the OUT4, OUT5, OUT6, and OUT7 output voltages by setting shunts JU17 and JU18 as shown in Table 3. Note that the JU17 and JU18 jumper settings are read only on power-up. Changes to these jumpers after power-up are ignored.
3) Place the JU9 shunt across pins 2-3 to allow OUT1 and OUT2 to enter skip mode at light loads.
4) Place the JU14 and JU15 shunts across pins 2-3 and 1-2 to set a 500mA USB input current limit.
5) Place the JU16 shunt across pins 2-3 to enable the battery charger.
6) Verify that the JU2.1 shunt is installed to set the charge current limit to 0.972A.
7) Verify that the JU3.4 shunt is installed to set the 5h fast-charge fault timer limit.

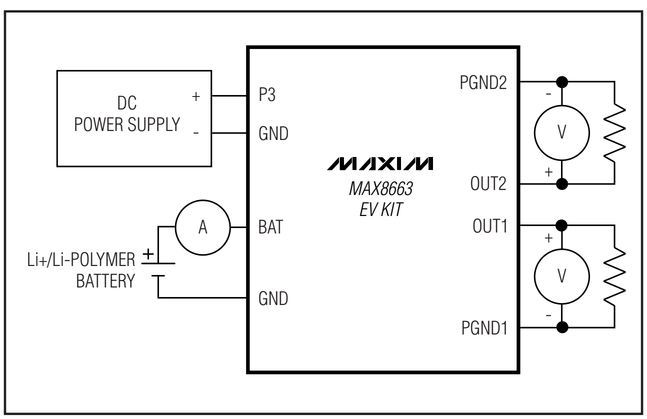

Figure 1. Test Procedure Setup (Caution: Do Not Exceed 5.5V at V_L)

8) Verify that JU5 and JU6 shunts are installed to set the $\overline{POK}$ LED (D1) and the $\overline{CHG}$ LED (D2) on.
9) Place the JU19 shunt across pins 1-2.
10) Preset the power supply to 5V. Turn the power supply off. **Caution: Do not turn on the power supply until all connections are completed.**
11) Make connections to the EV kit as shown in Figure 1, except do not connect the battery until step 16.
12) Turn on the 5V power supply.
13) Verify that the $\overline{POK}$ LED (D1) turns on to indicate power-ok.
14) Verify that the voltage across the OUT1 and PGND1 pads is 3.3V.
15) Verify that the voltage across the OUT2 and PGND2 pads is 1.3V.
16) Verify that OUT4, OUT5, OUT6, and OUT7 are at the voltages set by jumpers JU17 and JU18 (see Table 3).
17) Verify that the voltage at the BAT pad is 4.2V.
18) **Observe correct Li+/Li-polymer cell polarity.** Connect a single-cell Li+/Li-polymer battery across the BAT and GND pads.
19) Verify that the $\overline{CHG}$ LED (D2) turns on. The $\overline{CHG}$ LED turns on during prequalification and fast-charge conditions. The $\overline{CHG}$ LED turns off when the battery-charging current drops to 7.5% of the fast-charge current, indicating charging is complete.

Table 1. Enable Jumper Functions

JUMPER	POSITION		
	1-2	2-3	OPEN
JU7	Enable OUT1*	Disable OUT1	Drive EN1 with an external source.
JU8	Enable OUT2*	Disable OUT2	Drive EN2 with an external source.
JU10	Enable OUT4*	Disable OUT4	Drive EN4 with an external source.
JU11	Enable OUT5*	Disable OUT5	Drive EN5 with an external source.
JU12	Enable OUT6*	Disable OUT6	Drive EN6 with an external source.
JU13	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

Table 3. SL1 and SL2 Output Voltage Selection

JU17 (SL1)	JU18 (SL2)	OUT4 (V)	OUT5 (V)	OUT6 (V)	OUT7 (V)
Open	Open	3.30	3.30	3.30	3.30
2-3	Open	3.30	2.85	1.85	1.85
1-2	Open	2.85	2.85	1.85	1.85
Open	2-3	3.30	2.85	2.85	1.85
2-3	2-3	2.50	3.30	1.50	1.50
1-2	2-3	2.50	3.30	1.50	1.30
Open	1-2	1.20	1.80	1.10	1.30
2-3	1-2	3.30	2.85	1.50	1.50
1-2	1-2	1.80	2.50	3.30	2.85

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 x (1.5V / R_{ISET})
2-3	2-3	1-2	475mA	500mA USB	1556 x (1.5V / R_{ISET})
2-3	1-2	X	2000 x (1.5V / R_{PSET})	AC adapter	1556 x (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 x (1.5V / R_{PSET})	AC adapter	Off

X = Don't care.
R_{ISET} is the resistance between ISET and GND; and R_{PSET} is the resistance between PSET and GND.

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:

- 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.
- When the battery is connected and there is no external power input, the system is powered from the battery.
- 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. The DC input current limit is calculated from:

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

An exception is when the battery charger is disabled ($\overline{CEN}$ high) with PEN2 low, where the MAX8663 enters USB suspend mode.

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

The $\overline{POK}$ LED (D1) 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 3.0V, 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, charging restarts and the timers reset.

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

Charge Current

ISET adjusts the MAX8663 charging current to match the capacity of the battery. A resistor from ISET to ground (R10, R11, R12, R13, or R14) 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:

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

$$I_{PREQUAL} = 10\% \times I_{CHG\text{-}MAX}$$

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

See Table 5 for the charge-current setting and jumper JU2 configurations.

Table 5. Charge-Current Setting

JU2 POSITION	CHARGE CURRENT (A)
JU2.1 Short	0.972
JU2.2 Short	0.729
JU2.3 Short	0.292
JU2.4 Short	Adjustable

Charge Timer

The MAX8663 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, C20, C21, C22, or C23), the charger stops charging and the $\overline{CHG}$ LED (D2) blinks at a 1Hz rate to indicate the fault. Charging can be resumed by either toggling $\overline{CEN}$ or cycling the DC input voltage.

The MAX8663 supports values of C_{CT} from 0.01µF to 1µF:

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

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

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 6 for the charge-timer setting and jumper JU3 configurations.

Table 6. Charge-Timer Setting

JU3 POSITION	PREQUALIFICATION CHARGE TIMER (min)	FAST-CHARGE TIMER (min)
JU3.1 Short	3.0	30
JU3.2 Short	4.4	44
JU3.3 Short	9.7	97
JU3.4 Short	30.0	300

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

The $\overline{CHG}$ LED (D2) 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 connected from the THM pad to GND. 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). Adjust potentiometer R15 to simulate the temperature change and verify the THM function. R16, R17, and R18 are available for further THM evaluation.

Regulator Outputs (OUT1, OUT2, OUT4–OUT7)

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

Each regulator output is individually enabled or disabled with jumpers JU7, JU8, JU10–JU13, respectively (see Table 1).

The OUT1/OUT2 voltages can be set between 0.98V and V_{DC} 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 data sheet.

The output voltages for OUT4–OUT7 are set by jumpers JU17 and JU18. See Table 3 and refer to the *Linear Regulators (OUT4, OUT5, OUT6, and OUT7)* section of the MAX8662/MAX8663 data sheet.

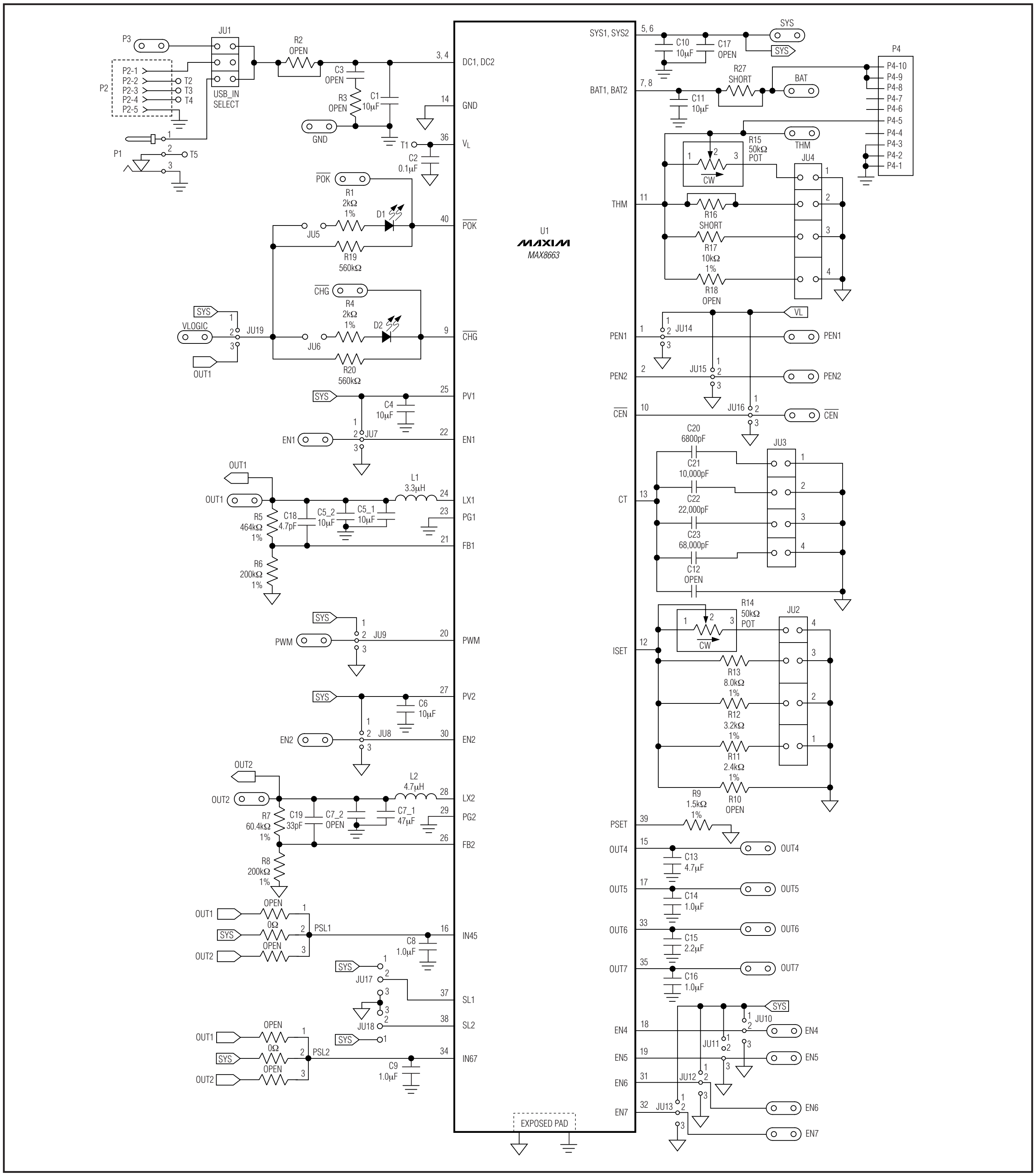

Figure 2. MAX8663 EV Kit Schematic

MAX8663 Evaluation Kit

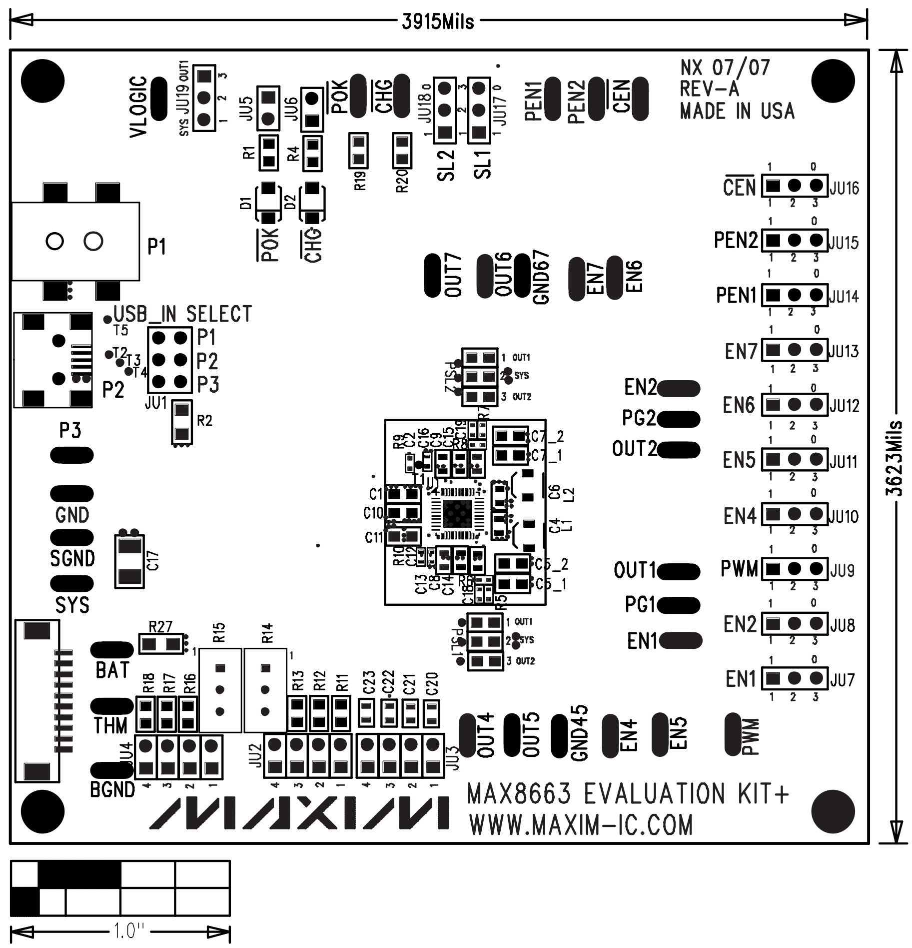

Figure 3. MAX8663 EV Kit Component Placement Guide—Component Side

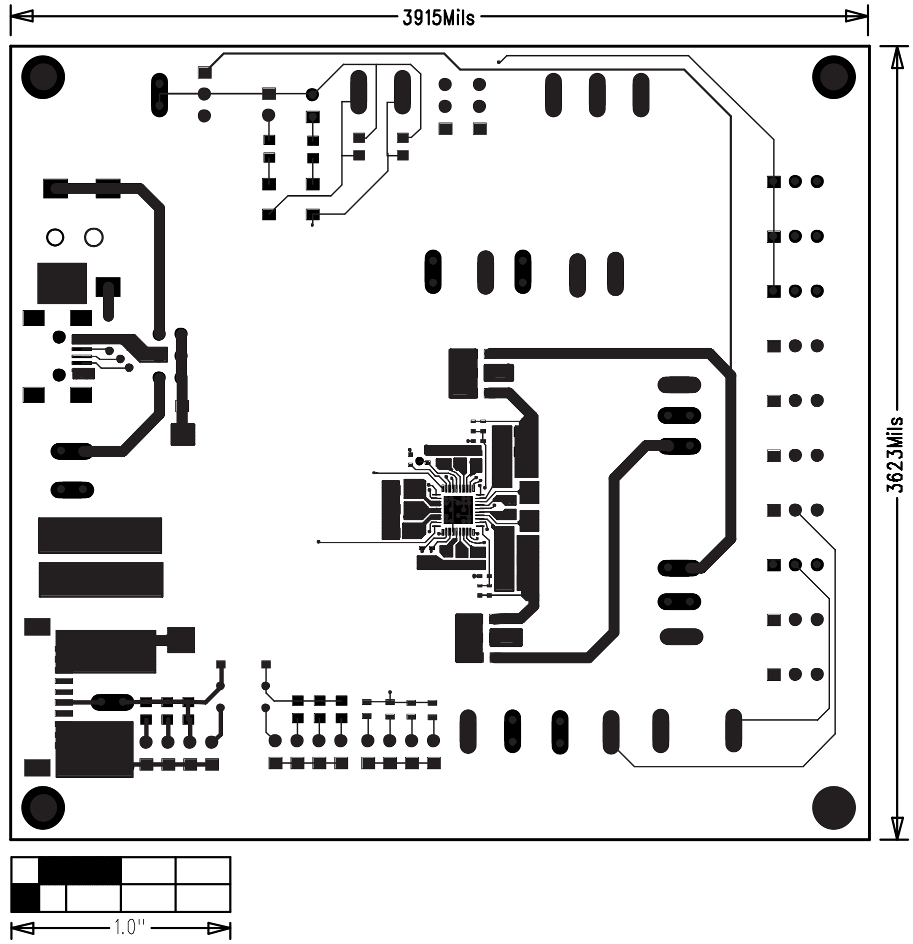

Figure 4. MAX8663 EV Kit PCB Layout—Top Layer 1

MAX8663 Evaluation Kit

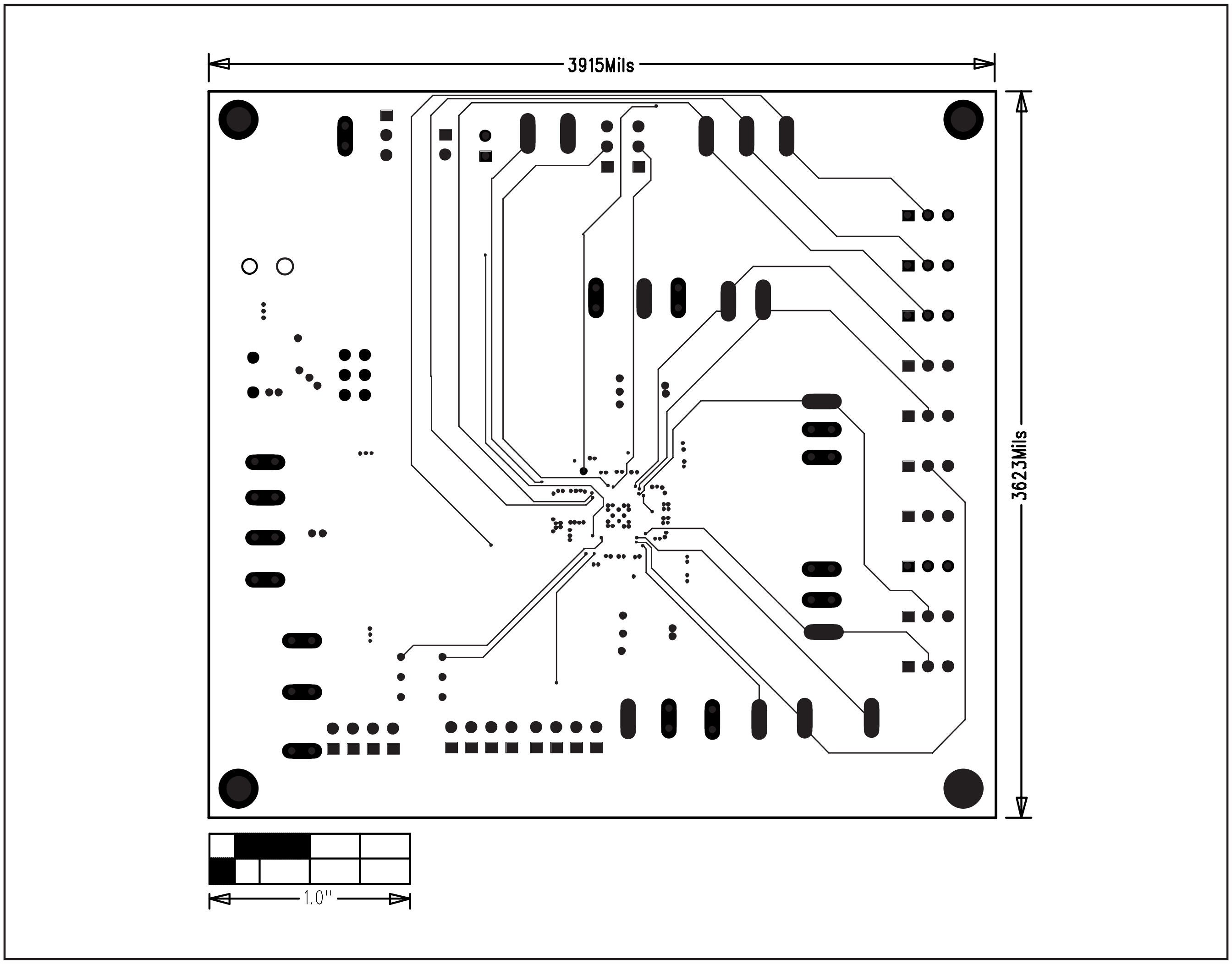

Figure 5. MAX8663 EV Kit PCB Layout—Logic Signal Layer 2

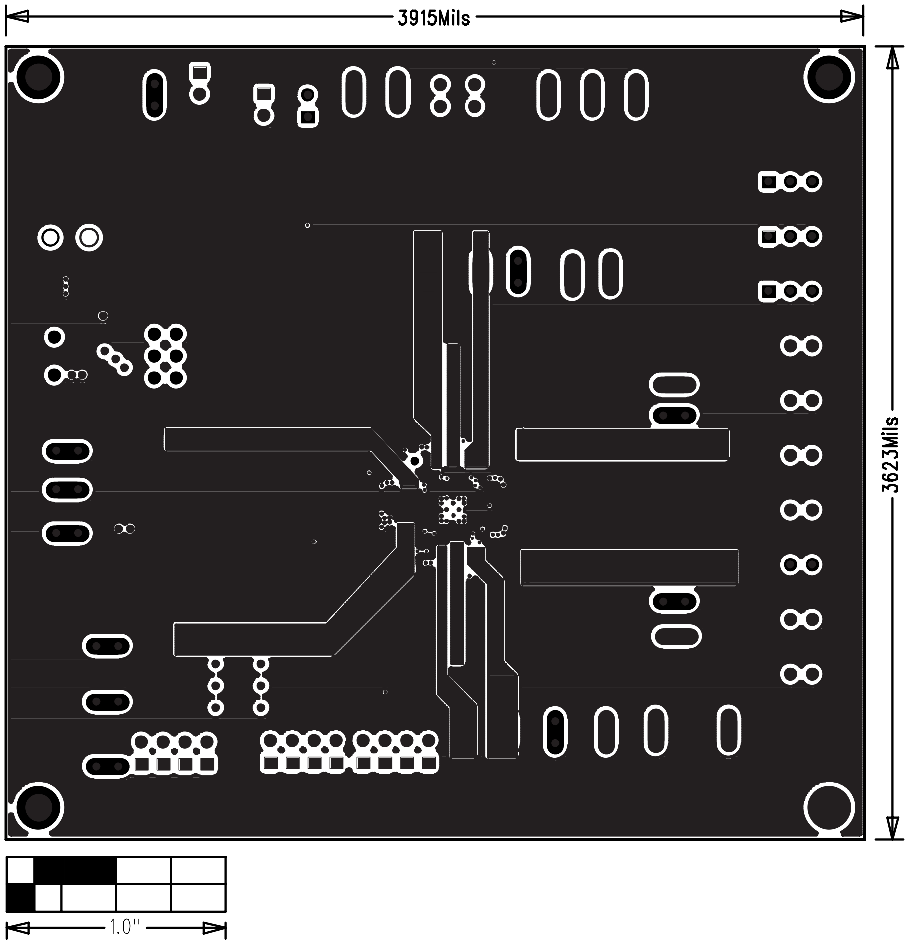

Figure 6. MAX8663 EV Kit PCB Layout—Power Layer 3

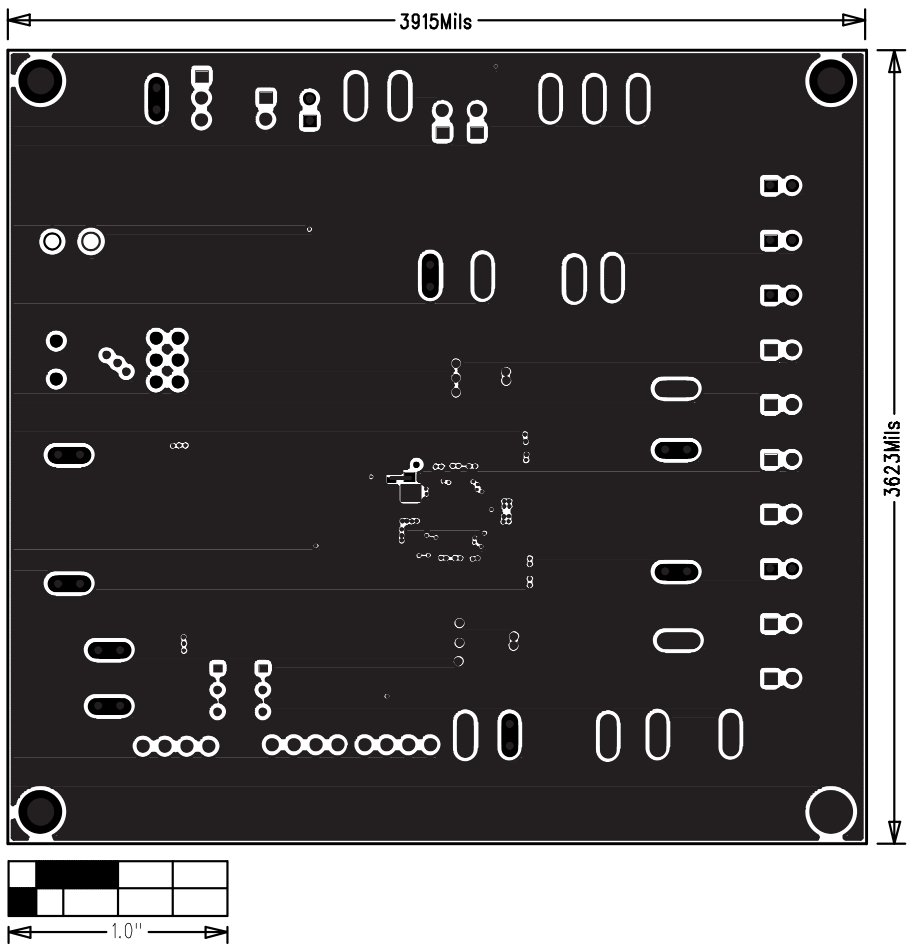

Figure 7. MAX8663 EV Kit PCB Layout—GND Layer 4