



MAX8648 Evaluation Kit

General Description

The MAX8648 evaluation kit (EV kit) is a fully assembled and tested printed-circuit board (PCB) for evaluating the ultra-efficient charge pump for six white/RGB LEDs in a 3mm x 3mm thin QFN IC package. This MAX8648 EV kit drives six white LEDs (WLEDs) or one RGB LED module. The EV kit includes three pulse generators that are used for testing the single-wire, serial-pulse dimming of the MAX8648 IC.

The MAX8648 EV kit can also evaluate the MAX8647 when using the Maxim CMAXQUSB+ command module. To evaluate the MAX8647, order the MAX8648 EV kit, the CMAXQUSB+ command module, and a free sample of the MAX8647ETE+. The CMAXQUSB+ command module is required for SMBus™ control of the MAX8647. The MAX8647 evaluation software can be downloaded from the Maxim website at www.maxim-ic.com/evkitsoftware.

SMBus is a trademark of Intel Corp.

DESIGNATION	QTY	DESCRIPTION
C1–C5	5	1µF ±20%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A105K
C6, C8, C10	3	1000pF ±10%, 50V X7R ceramic capacitors (0402) TDK C1005X7R1H102K
C7, C9, C11	3	2.2µF ±10%, 6.3V X5R ceramic capacitors (0603) TDK C1608X5R0J225K
D1–D6	6	White LEDs Nichia NSCW215T
D7	1	RGB LED Lumex SML-LX2832SISUGSBC
D8, D9, D10	3	100mA, 30V Schottky diodes (SOD523) Central Semiconductor CMOSH-3
J1	1	Dual 2 x 10-pin right-angle receptacle

Features

- ◆ MAX8648 EV Kit Powers Up to Six WLEDs or One RGB LED Module
- ◆ Adaptive Current Regulators
- ◆ 24mA to 0.1mA Dimming Range
Serial-Pulse Dimming Logic (MAX8648)
I²C Interface (MAX8647)
- ◆ 2% (Max) Accuracy ±0.4% (Typ) Current Matching
- ◆ Low 70µA Quiescent Current
- ◆ Low 1µA Shutdown Current
- ◆ Thermal T_A Derating Function
- ◆ 2.7V to 5.5V Supply Voltage Range
- ◆ 16-Pin, 3mm x 3mm Thin QFN IC Package
- ◆ Fully Assembled and Tested

Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX8648EVKIT+	0°C to +70°C*	16 Thin QFN-EP** (3mm x 3mm)

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

*This limited temperature range applies to the EV kit PCB only. The MAX8648 IC temperature range is -40°C to +85°C.

**EP = Exposed paddle.

Component List

DESIGNATION	QTY	DESCRIPTION
JU1–JU9, JU11	10	3-pin headers
JU10, JU12, JU13, JU14	4	2-pin headers
R1, R2	2	24Ω ±1% resistors (0402)
R3, R4	2	Not installed, resistors (0402)
R5, R6, R7	3	2.2kΩ ±1% resistors (0402)
S1, S2, S3	3	Momentary pushbutton switches
U1	1	MAX8648ETE+ (16-pin, 3mm x 3mm thin QFN-EP) (Top Mark: AFE)
U2, U3, U4	3	MAX6816EUS+T (4-pin SOT143) (Top Mark: KABA)
—	7	Shunts, 2 position
—	1	PCB: MAX8648 Evaluation Kit+



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Quick Start

Recommended Equipment

- One 2.7V to 5.5V power supply or a Li+ battery capable of delivering 0.5A

Procedure

The MAX8648 EV kit is fully assembled and tested. Follow the steps below to verify board operation. EV kit connection diagram is shown in Figure 1. Default jumper settings are shown in Table 1 and Figure 1.

Caution: Do not turn on the power supply until all connections are completed.

- 1) Preset the power supply between 2.7V and 5.5V.
- 2) Turn off the power supply.
- 3) On the MAX8648 EV kit, verify jumpers according to Table 1.
- 4) Connect the positive power-supply terminal to the pad on the EV kit labeled VIN.
- 5) Connect the power-supply ground terminal to the pad on the EV kit labeled GND.
- 6) Turn on the power supply.
- 7) Verify that all six WLEDs are lit.

Table 1. MAX8648 EV Kit Default Jumper Settings

JUMPER	SHUNT POSITION
USING EV KIT PULSE CIRCUITS	
JU1	Pins 2-3
JU2	Open
JU3	Pins 1-2
JU4	Pins 2-3
JU5	Open
JU6	Pins 1-2
JU7	Pins 2-3
JU8	Open
JU9	Pins 1-2
JU10	Open
WLED	
JU11	Pins 2-3
JU12	Open
JU13	Open
JU14	Open

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centralsemi.com
Kamaya, Inc.	260-489-1533	www.kamaya.com
Lumex Inc.	800-278-5666	www.lumex.com
Nichia Corp.	248-352-6575	www.nichia.com
Panasonic Corp.	714-373-7939	www.panasonic.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

Note: Indicate that you are using the MAX8648 when contacting these component suppliers.

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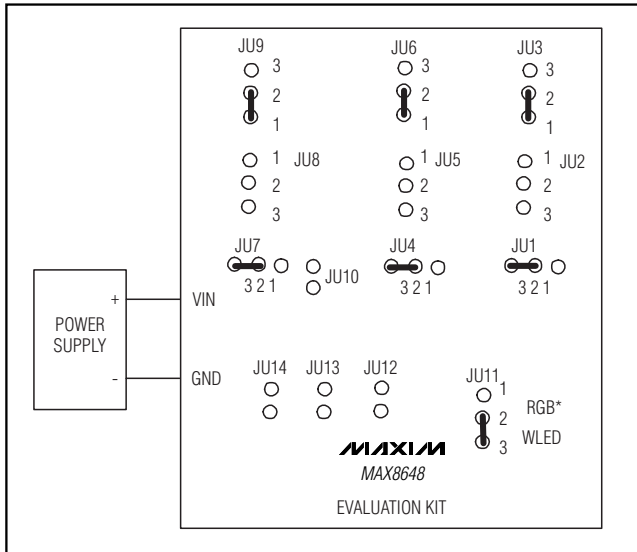


Figure 1. Connection Diagram and Default Jumper Connections

Detailed Description

LED Dimming Using the EV Kit Pulse-Generating Circuitry

At power-up, the MAX8648 sets the initial LED current to 24mA. To test the dimming feature, verify that the jumper settings in Table 1 are complete, then press any of the three buttons labeled S1, S2, or S3. S1 circuitry controls the dimming for LED1, LED2, and LED3; S2 circuitry controls the dimming for LED4 and LED5; and S3 circuitry controls the dimming for LED6. Each press of the button (pulse) dims the LEDs to the current level listed in Table 2. Due to the logarithmic response of the human eye, it takes several pulses to visually notice dimming. The 30th pulse reduces the current to 0.1mA. The 31st pulse sets the LED current back to 24mA.

If dimming control is not required, EN_ work as simple 100% brightness or off controls. See Table 3 for jumper settings when using EN_. Drive EN_ high to enable the LEDs, or drive EN_ low to disable. The IC is shut down when all three EN_ are low for 4ms or longer.

Table 2. MAX8648 Pulse-Dimming Steps vs. LED Currents

MAX8648 PULSE-DIMMING STEPS	LED CURRENTS (mA)
Startup or EN_ high	24
1	22.4
2	20.8
3	19.2
4	17.6
5	16
6	14.4
7	12.8
8	11.2
9	9.6
10	8
11	6.4
12	5.6
13	4.8
14	4
15	3.2
16	2.8
17	2.4
18	2
19	1.6
20	1.4
21	1.2
22	1
23	0.8
24	0.7
25	0.6
26	0.5
27	0.4
28	0.3
29	0.2
30	0.1
31	24

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Single-Wire Pulse Dimming Using External Pulse Generators

To use an external pulse generator, see Table 3 for proper jumper settings. Connect the external pulse-generator output to ENA, ENB, or ENC to enable single-wire pulse dimming of the respective LEDs. The ground of the external pulse generator should be connected to the EV kit pad labeled GND. When EN₋ go high, the respective LEDs are enabled at full brightness. Each subsequent low-going pulse (1μs to 500μs pulse width) reduces the LED current, as shown in Table 2. The 30th pulse reduces current to 0.1mA. The 31st pulse sets the LED current back to 24mA. Figure 2 shows a timing diagram for single-wire pulse dimming.

Using EN₋ I/O Pads Independently

When driving the I/O pads externally, observe the logic voltage levels. The input-high voltage is 1.4V (min) and the input-low voltage is 0.4V (max). The initial t_{HI}, t_{SHDN}, t_{HI}, and t_{LO} timing, shown in Figure 2, are still true when driving the I/O pads externally.

Shutdown Mode

The MAX8648 shuts down when all three EN₋ are held low for 4ms or longer. In shutdown, NEG₋ is pulled to GND with a 10kΩ internal resistor. See Table 4 for proper jumper settings.

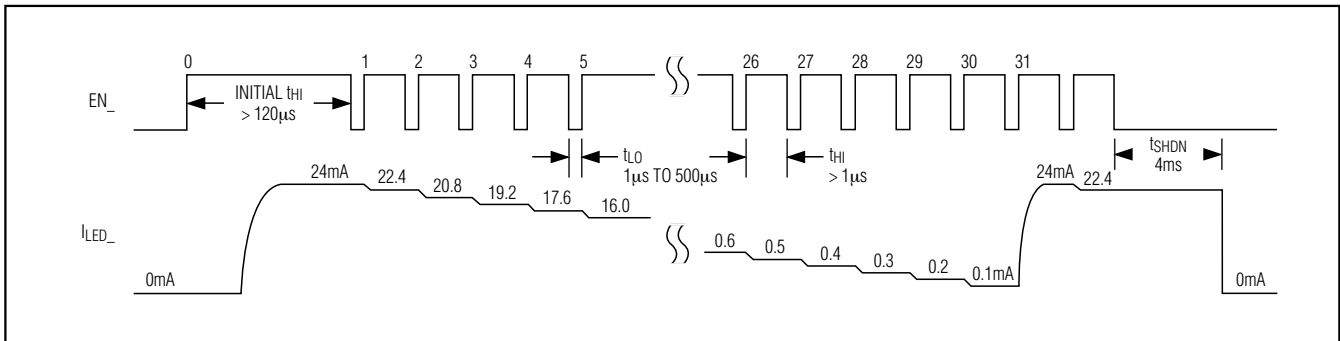


Figure 2. EN₋ Serial Pulse-Dimming Timing Diagram

Table 3. MAX8648 Jumper Connections for Different Evaluation Methods

JUMPER	SHUNT POSITION		
	USING EV KIT PULSE CIRCUITS	USING JUMPERS FOR 100% BRIGHTNESS	USING ENA/ENB/ENC I/O PADS
JU1	Pins 2-3	Open	Open
JU2	Open	Pins 1-2	Open
JU3	Pins 1-2	Open	Open
JU4	Pins 2-3	Open	Open
JU5	Open	Pins 1-2	Open
JU6	Pins 1-2	Open	Open
JU7	Pins 2-3	Open	Open
JU8	Open	Pins 1-2	Open
JU9	Pins 1-2	Open	Open
JU10	Open	Open	Open

Table 4. MAX8648 Shutdown Table

JUMPER	SHUNT POSITION	
	USING EV KIT PULSE CIRCUITS	USING JUMPERS FROM EN ₋
JU1	Pins 2-3	Open
JU2	Open	Pins 2-3
JU3	Pins 2-3	Open
JU4	Pins 2-3	Open
JU5	Open	Pins 2-3
JU6	Pins 2-3	Open
JU7	Pins 2-3	Open
JU8	Open	Pins 2-3
JU9	Pins 2-3	Open
JU10	Open	Open

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RGB Jumper Settings

To drive the RGB, move the shunt on jumper JU11 from pins 2-3 to pins 1-2. Also, shunt jumpers JU12, JU13, and JU14. Make all jumper settings prior to power-up. See Table 5 for proper jumper settings.

Table 5. RGB Jumper Settings

JUMPER	SHUNT POSITION
JU11	Pins 1-2
JU12	Shunted
JU13	Shunted
JU14	Shunted

Evaluating the MAX8647

The MAX8648 EV kit can also evaluate the MAX8647 when using the CMAXQUSB+ command module. To evaluate the MAX8647, order the MAX8648 EV kit, the CMAXQUSB+ command module, and a free sample of the MAX8647ETE+. The CMAXQUSB+ command module is required for SMBus control of the MAX8647. The Windows® 98SE/2000/XP-compatible EV software can be downloaded from the Maxim website (www.maxim-ic.com/evkitsoftware).

Remove the MAX8648 from the MAX8648 EV kit and replace with the MAX8647. See Table 6 for proper jumper settings.

The MAX8647 EV kit software provides a graphical user interface (GUI) for exercising the MAX8647 features.

The Maxim CMAXQUSB+ command module provides the SMBus interface and is connected to the computer through the universal serial bus (USB) port.

Using SDA, SCL, and VDD I/O Pads Independently

When driving the SDA, SCL, and VDD pads externally, observe all voltage and timing requirements described in the MAX8647/MAX8648 IC data sheet.

Table 6. Jumper Connections for Evaluating the MAX8647

JUMPER	SHUNT POSITION	
	USING THE CMAXQUSB+	USING VDD/SDA/SCL I/O PADS
JU1	Pins 1-2	Open
JU2	Open	Open
JU3	Open	Open
JU4	Pins 1-2	Open
JU5	Open	Open
JU6	Open	Open
JU7	Pins 1-2	Open
JU8	Open	Open
JU9	Open	Open
JU10	Shunted	Open

Windows is a registered trademark of Microsoft Corp.

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MAX8647 Quick Start

Recommended Equipment

- MAX8648 EV kit with the MAX8647 IC installed
- CMAXQUSB+ command module (USB cable included)
- 5V power supply
- A user-supplied Windows 98SE/2000/XP computer with a spare USB port

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 98SE/2000/XP operating system.

Procedure

Follow the steps below to verify board operation.

Caution: Do not turn on the power supply until all connections are completed.

- 1) Verify that the jumpers on the MAX8648 EV kit, with the MAX8647 IC installed, are configured for use with the CMAXQUSB+, as shown in Table 6.
- 2) On the CMAXQUSB+ command module, ensure that the shunt on jumper JU1 is in the 3.3V position.
- 3) Connect the positive terminal of the DC power supply to the EV kit pad labeled VIN; connect the ground terminal to the GND pad.
- 4) Visit the Maxim website (www.maxim-ic.com/evkit-software) to download the latest version of the EV kit software, 8647Rxx.ZIP. Save the EV kit software to a temporary folder and unzip the ZIP file.
- 5) Install the EV kit software on your computer by running the INSTALL.EXE program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs** menu.
- 6) Carefully connect the boards by aligning the 20-pin J1 connector of the MAX8648 EV kit with the 20-pin P3 header on the CMAXQUSB+ interface board. Gently press them together.
- 7) Connect the USB cable from the PC to the CMAXQUSB+ board. A **Building Driver Database** window pops up in addition to a **New Hardware Found** message if this is the first time the EV kit board is connected to the PC. If you do not see a window that is similar to the one described above after 30 seconds, remove the USB cable from the CMAXQUSB+ and reconnect it. Administrator privileges are required to install the USB device driver on Windows 2000 and XP. Refer to the TROUBLESHOOTING_USB.PDF document included with the software if you have any problems during this step.

- 8) 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\MAX8647** (default installation directory) using the **Browse** button.
- 9) Start the MAX8647 EV kit software by opening its icon in the **Start | Program** menu.
- 10) Normal device operation is verified when **MAX8647 device connected** is displayed at the bottom of the MAX8647 EV kit window.

Note: Once operational, the software enables all LEDs and configures I_{LED} to 0.2mA. The device's actual power-on-reset state is $I_{LED} = 0mA$.

User-Interface Panel

The program's main window (Figure 3) provides controls to configure the LED current and enable/disable each LED. When disabled, the LED current is effectively set to 0mA; when re-enabled, the LED current is restored to its previous setting. The slide bars are used to adjust the LED current, which is displayed to the right of each section.

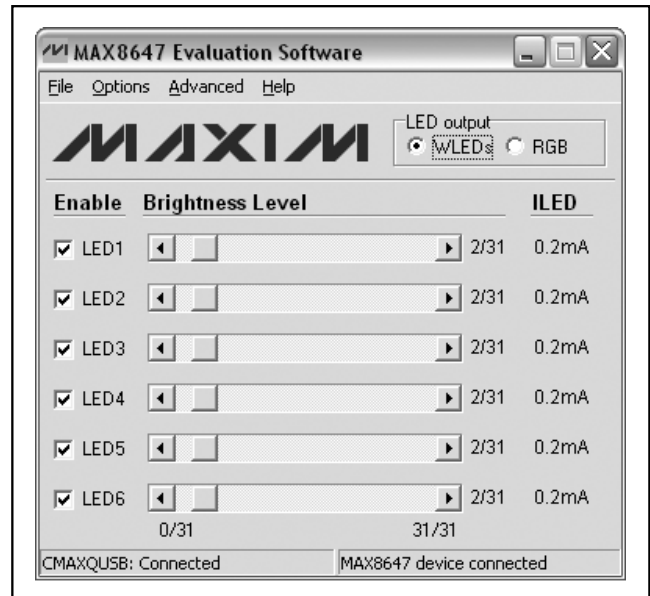


Figure 3. MAX8647 Software Main Window (MAX8647 IC Installed on the MAX8648 EV Kit)

The EV kit software also provides additional features in its menu bar. The **Options** pulldown menu provides three current settings that, when selected, are applied to each LED. The settings are **Power-on-Reset (0mA)**, **2.8mA**, and **24mA**. An **Output** option is also provided

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in this menu, allowing the user to select either WLEDs or RGB as the output type. When **RGB LED** is selected, the LED2, LED3, and LED5 outputs are disabled. Only LED1, LED4, and LED6 are utilized when the output is an RGB LED. The **LED output** radio buttons provide an alternate method for selecting the output type.

The **Help** pulldown menu provides access to the software's **Help** document and version information. The **Advanced** pulldown menu opens the **Maxim Command Module Interface** window that allows for low-level communication with the device. See the *Simple SMBus Commands* section for more details.

Simple SMBus Commands

There are two methods for communicating with the MAX8647: through the normal user-interface panel (Figure 3), or through the SMBus commands available by selecting **2-wire Interface** from the **Advanced** pulldown menu. The **Maxim Command Module Interface** window (Figure 4) pops up and includes a **2-wire interface** tab that allows for execution of the **SMBusSendByte()** command. Refer to the MAX8647/MAX8648 IC data sheet for command-byte format.

The **SMBus dialog** boxes accept numeric data in binary, decimal, or hexadecimal. Hexadecimal numbers should be prefixed by \$ or 0x. Binary numbers must be exactly eight digits. See Figure 4 for an illustration of this tool.

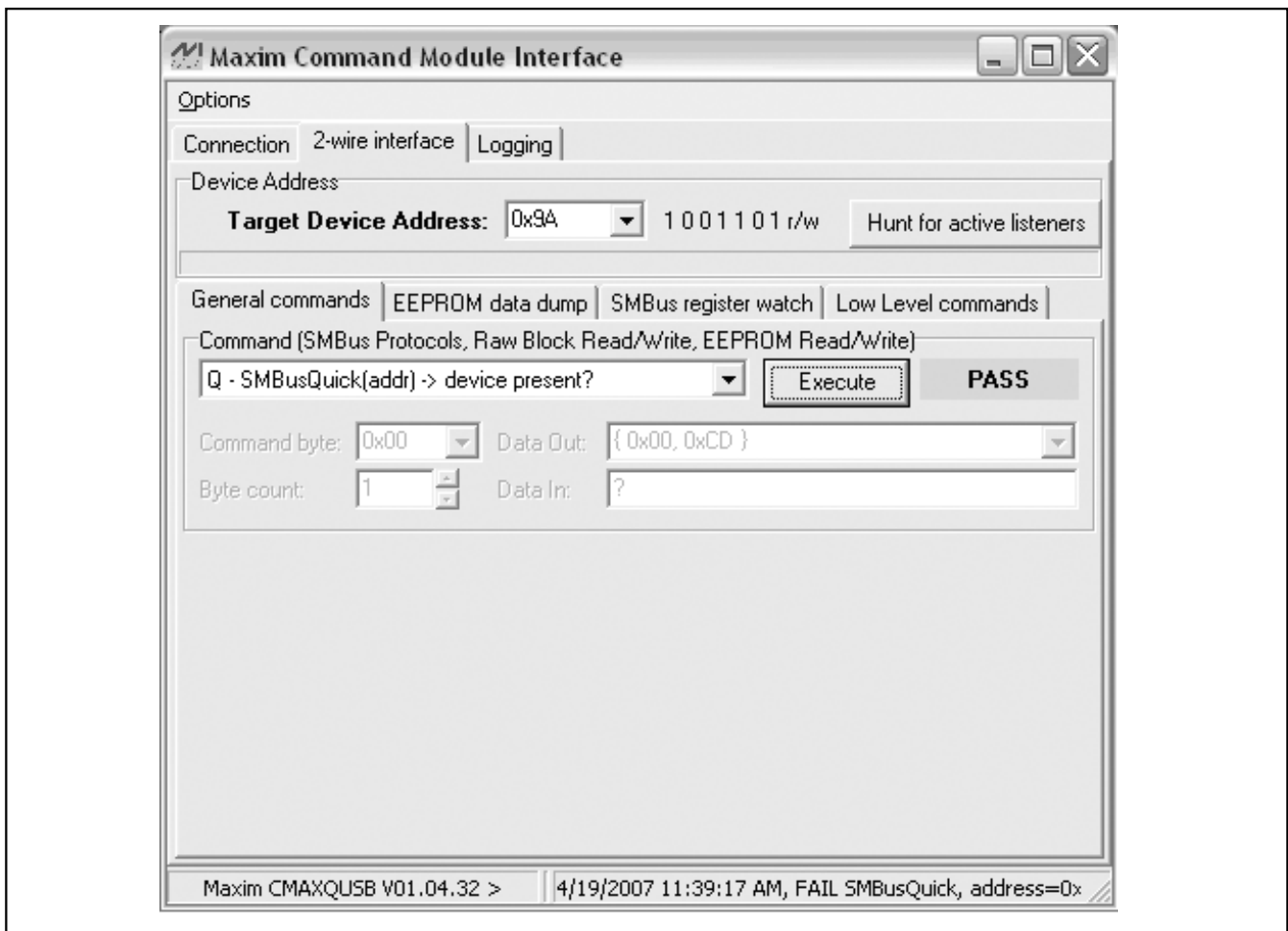


Figure 4. Maxim Command Module Interface Window

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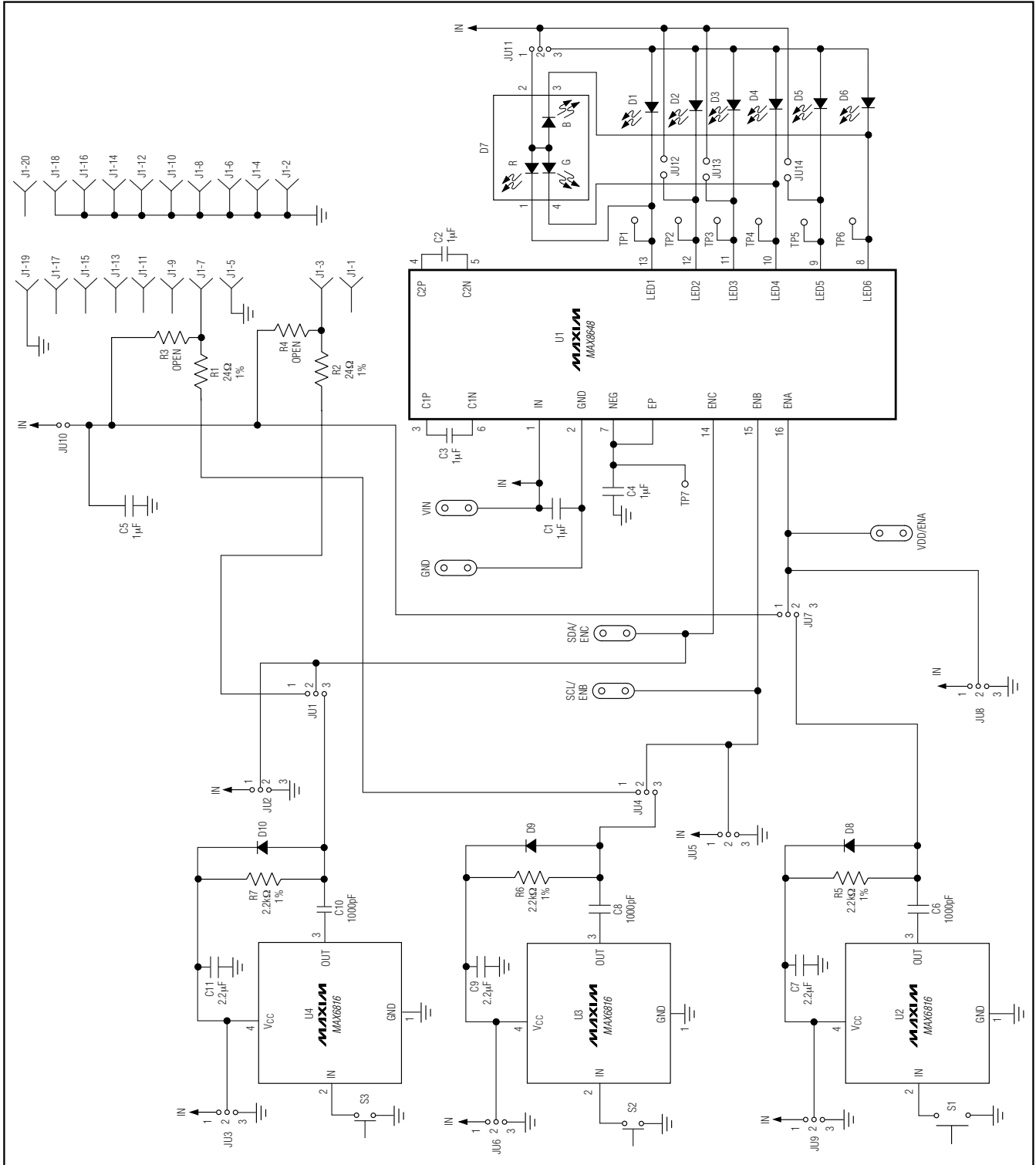


Figure 5. MAX8648 EV Kit Schematic

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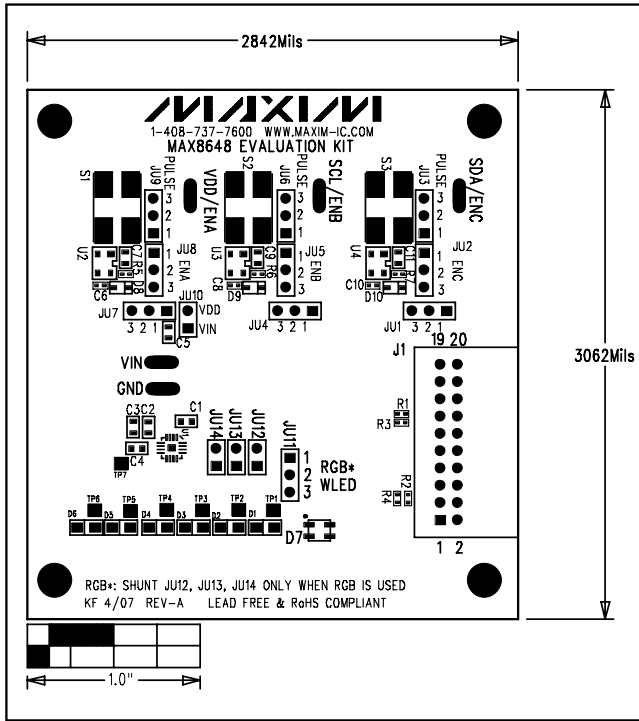


Figure 6. MAX8648 EV Kit Component Placement Guide—Component Side

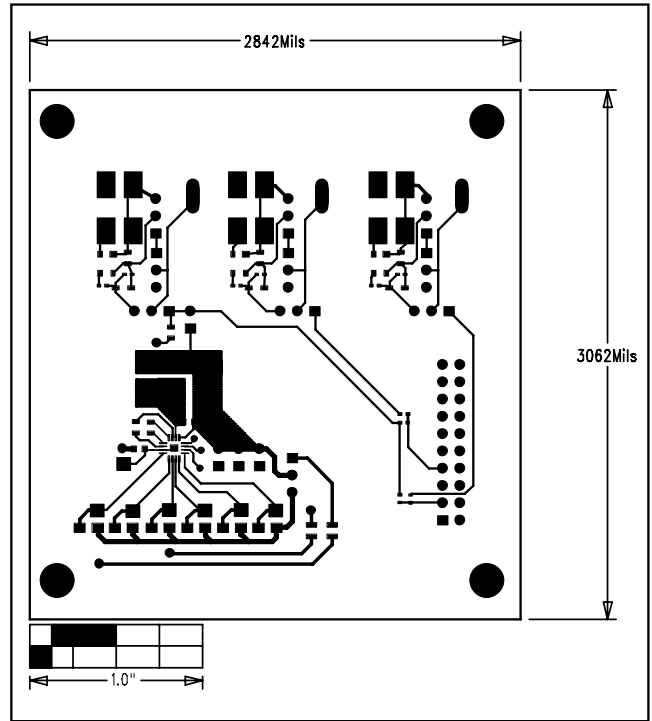


Figure 7. MAX8648 EV Kit PCB Layout—Component Side