MAXIM

MAX6948 Evaluation Kit

Evaluates: MAX6948B

General Description

The MAX6948 evaluation kit (EV kit) provides a proven design to evaluate the MAX6948B 5-port, constant-current LED driver with PWM intensity control and integrated boost converter in a 25-bump WLP package. The EV kit also includes Windows® 2000-, Windows XP®-, and Windows Vista®-compatible software that provides a simple graphical user interface (GUI) for exercising the features of the MAX6948B. The MAX6948 EV kit PCB comes with a MAX6948BGWA+ installed.

The MAX6948 EV kit boost converter drives 6 high-brightness white LEDs in series with 30mA (typ). The boost converter features 10-bit PWM dimming, standby mode, input current limit, and overvoltage protection.

The MAX6948 EV kit's I/O ports drive LEDs or act as open-drain GPIO port expanders. Jumpers easily switch between the two functions. The ports feature selectable constant-current sinking, fading, and 8-bit PWM.

Features

♦ 2.7V to 5V V+ Supply Range

♦ Boost Converter Drives 6 Series White LEDs

♦ Boost Output PWM Dimming

♦ Selectable Current Sinks for LEDs

♦ Windows 2000-, Windows XP-, and Windows Vista (32-Bit)-Compatible Software

♦ USB-PC Connection (Cable Included)

♦ Proven PCB Layout

♦ Fully Assembled and Tested

Ordering Information

PART	TYPE
MAX6948EVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3–C10, C17, C21–C25, C28, C30, C33	18	0.1µF ±10%, 16V X7R ceramic capacitors (0603) TDK C1608X7R1C104K
C2, C13, C15, C27, C29, C31	6	10µF ±20%, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J106M
C11, C12	2	10pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H100J
C14, C16, C34	3	1µF ±20%, 6.3V X5R ceramic capacitors (0603) TDK C1608X5R0J105K
C18, C19	2	22pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H220J
C20	1	3300pF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H332K
C26	1	0.22µF ±10%, 50V X5R ceramic capacitor (0805) TDK C2012X5R1H224K

DESIGNATION	QTY	DESCRIPTION
C32	1	0.1µF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H104K
C35, C36	0	Not installed, ceramic capacitors (0402)
D1	1	Green LED (0603)
D2	1	40V, 500mA Schottky diode (SOD323) Central Semi CMDSH05-4
D3–D8	6	White surface-mount LEDs (3mm x 2mm)
D9, D10	2	Orange LEDs (1206)
D11	1	RGB LED (3.2mm x 3.6mm)
H1	0	Not installed, dual-row (2 x 5) 10-pin header
J1	1	Dual-row (2 x 4) 8-pin header
JU1–JU10	10	3-pin headers
JUA–JUE	0	Not installed, headers—shorted (PCB trace)

Windows, Windows XP, and Windows Vista are registered trademarks of Microsoft Corp.

MAXIM _____ *Maxim Integrated Products* 1

MAX6948 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
L1	1	10µH ±20% inductor (3mm x 3.2mm) TOKO 1098AS-100M
P1	1	USB type-B right-angle female receptacle
R1	1	220Ω ±5% resistor (0603)
R2, R15–R19	6	10kΩ ±5% resistors (0603)
R3	1	2.2kΩ ±5% resistor (0603)
R4	1	1.5kΩ ±5% resistor (0603)
R5, R6	2	27Ω ±5% resistors (0603)
R7, R8, R10–R13	0	Not installed, resistors (0603)
R9	1	20kΩ ±5% resistor (0603)
R14	1	6.65Ω ±1% resistor (0603)
SW0–SW4	5	Momentary 6mm pushbutton switches
TP1, TP2, TP3	3	Red multipurpose test points
TP4	1	Black multipurpose test point
TP10	1	Red miniature test point
TP5–TP9, TP11–TP18	0	Not installed, miniature test points
U1	1	I^{2}C backlight and port expander (25 WLP) Maxim MAX6948BWA+

DESIGNATION	QTY	DESCRIPTION
U2	1	Low-cost microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
U3	1	93C46 type (64k x 16) 3-wire EEPROM (8 SO)
U4	1	UART-to-USB converter (32 TQFP)
U5	1	3.3V regulator (5 SC70) Maxim MAX8511EXK33+T (Top Mark: AEI)
U6	1	2.5V regulator (5 SC70) Maxim MAX8511EXK25+T (Top Mark: ADV)
U7, U8	2	Level translators (10 µMAX®) Maxim MAX1840EUB+
Y1	1	16MHz crystal (HCM49) Hong Kong X'tals SSM1600000E18FAF
Y2	1	6MHz crystal (HCM49) Hong Kong X'tals SSL6000000E18FAF
—	11	Shunts
—	1	PCB: MAX6948 EVALUATION KIT+

*EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centralsemi.com
Hong Kong X'tals Ltd.	852-35112388	www.hongkongcrystal.com
TOKO America, Inc.	408-432-8281	www.tokoam.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: Indicate that you are using the MAX6948 when contacting these component suppliers.

µMAX is a registered trademark of Maxim Integrated Products, Inc.

MAXIM

MAX6948 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX6948.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
USB_DRIVER_HELP.PDF	USB driver installation help file

Quick Start

Required Equipment

- MAX6948 EV kit (USB cable included)
- 4V, 1A power supply
- User-supplied Windows 2000, Windows XP, or Windows Vista PC 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 operating system.

Procedure

The MAX6948 EV kit is fully assembled and tested. Follow the steps below to verify board operation:

1) Visit **www.maxim-ic.com/evkitsoftware** to download the latest version of the EV kit software, 6948Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.

2) 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.

3) Verify that all jumpers are in their default positions, as shown in Table 1.

4) Connect the USB cable from the PC to the EV kit board. A **New Hardware Found** window pops up when installing the USB driver for the first time. If a window is not seen that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.

5) 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\MAX6948** (default installation directory) using the **Browse** button. During device driver installation, Windows may show a warning message indicating that the device driver Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the USB_DRIVER_HELP.PDF document included with the software for additional information.

6) Connect the positive terminal of the power supply to the V+ pad. Connect the ground terminal of the power supply to the GND pad nearest V+.

7) Set the power supply to 4V and enable the output.

8) Start the MAX6948 EV kit software by opening its icon in the **Start | Programs** menu. The EV kit software main window appears, as shown in Figure 1.

9) The MAX6948 GUI indicates if the USB hardware is connected in the lower-left status bar. The lower-right status bar indicates if the USB hardware has detected the MAX6948B I^2C address. If the I^2C address is located, it is shown in the **I2C Address** drop-down list.

10) Select the **Static Constant-Current Sink** radio button in the **P0 (0x00)** group box to illuminate LED D9. Select the **PWM Output** radio button in the **P1 (0x01)** group box to activate the scrollbar that illuminates D10. Move the scrollbar to the middle.

11) Click on the **Boost** tab. Uncheck the **Boost Converter Standby** checkbox to take the boost converter out of standby. In the **Boost Configuration (0x20 & 0x21)** group box, move the scrollbar to the middle.

12) Once the EV kit is configured, check the **RUN** checkbox located in the **Configuration (0x10)** group box to take the device out of shutdown. With **AutoWrite** checked, move the **Intensity** scrollbar in the **Boost** tab and observe that the white LEDs' brightness vary. Click on the **P0/P1** tab and move the scrollbar associated with **P1 (0x01)**. Observe that LED D10 brightens and dims as the scrollbar changes. LED D9 should be at full brightness.

MAX6948 Evaluation Kit

__Detailed Description of Software

The main window of the evaluation kit is shown in Figure 1.

The MAX6948 EV kit GUI has a **WRITE** and **READ** button for each register. The **AutoWrite** checkbox can be checked to have the software automatically perform write and read operations. This feature allows the user to change states without pressing the **WRITE** and **READ** buttons. By default, **AutoWrite** is enabled at startup. If the MAX6948B is not detected, **AutoWrite** stays checked and reads back 0x00 for all registers. If the MAX6948B is later detected, the **AutoWrite** checkbox is not checked.

The **I2C Address** drop-down list has a feature to **AutoDetect**. The user has the option to choose their own I^{2}C address from the list, even if that address is not detected. When an address is selected that is not detected, the software GUI displays **MAX6948 Not Connected** in the lower-right status bar.

Boost Converter

The **Boost** tab sheet (Figure 2) is used for enabling the boost converter and driving the white LEDs. The input voltage is boosted to drive 6 series high-brightness white LEDs. The output voltage can be boosted to 28V (max), but the EV kit output is between 18V and 22V because the converter acts to drive a constant current of 30mA (typ) that can be PWMed. The 10-bit PWM requires writing to the **Boost Configuration (0x20 & 0x21)** group box. The boost status register contains status information on the boost converter and a single write bit. The **Boost Status (0x22)** group box's single write bit is the **Boost Converter Standby** checkbox.

Table 1. MAX6948 EV Kit Jumper Description

| JUMPER	SHUNT POSITION	DESCRIPTION
J1	1-2*	AD0 connects to GND (0x40)
	3-4	AD0 connects to VDD (0x48)
	5-6	AD0 connects to SDA (0xC8)
	7-8	AD0 connects to SCL (0xC0)
JU1	1-2	External SDA
	2-3*	MAXQ2000 microcontroller-generated SDA
JU2	1-2*	MAXQ2000 microcontroller-generated SCL
	2-3	External SCL
JU3	1-2	External RST
	2-3*	MAXQ2000 microcontroller-generated reset
JU4	1-2*	VDD is powered from V+ supply
	2-3	VDD is powered from an external supply
JU5	1-2*	VLED is powered from V+ supply
	2-3	VLED is powered from an external supply
JU6	1-2*	Connects P0 to D9 (LED driver)
	2-3	Connects P0 to pushbutton switch and pullup resistor (GPIO)
JU7	1-2	Connects P1 to pushbutton switch and pullup resistor (GPIO)
	2-3*	Connects P1 to D10 (LED driver)
JU8	1-2*	Connects P2 to D11 (blue) (LED driver)
	2-3	Connects P2 to pushbutton switch and pullup resistor (GPIO)
JU9	1-2*	Connects P3 to D11 (green) (LED driver)
	2-3	Connects P3 to pushbutton switch and pullup resistor (GPIO)
JU10	1-2*	Connects P4 to D11 (red) (LED driver)
	2-3	Connects P4 to pushbutton switch and pullup resistor (GPIO)

*Default position.

MAXIM
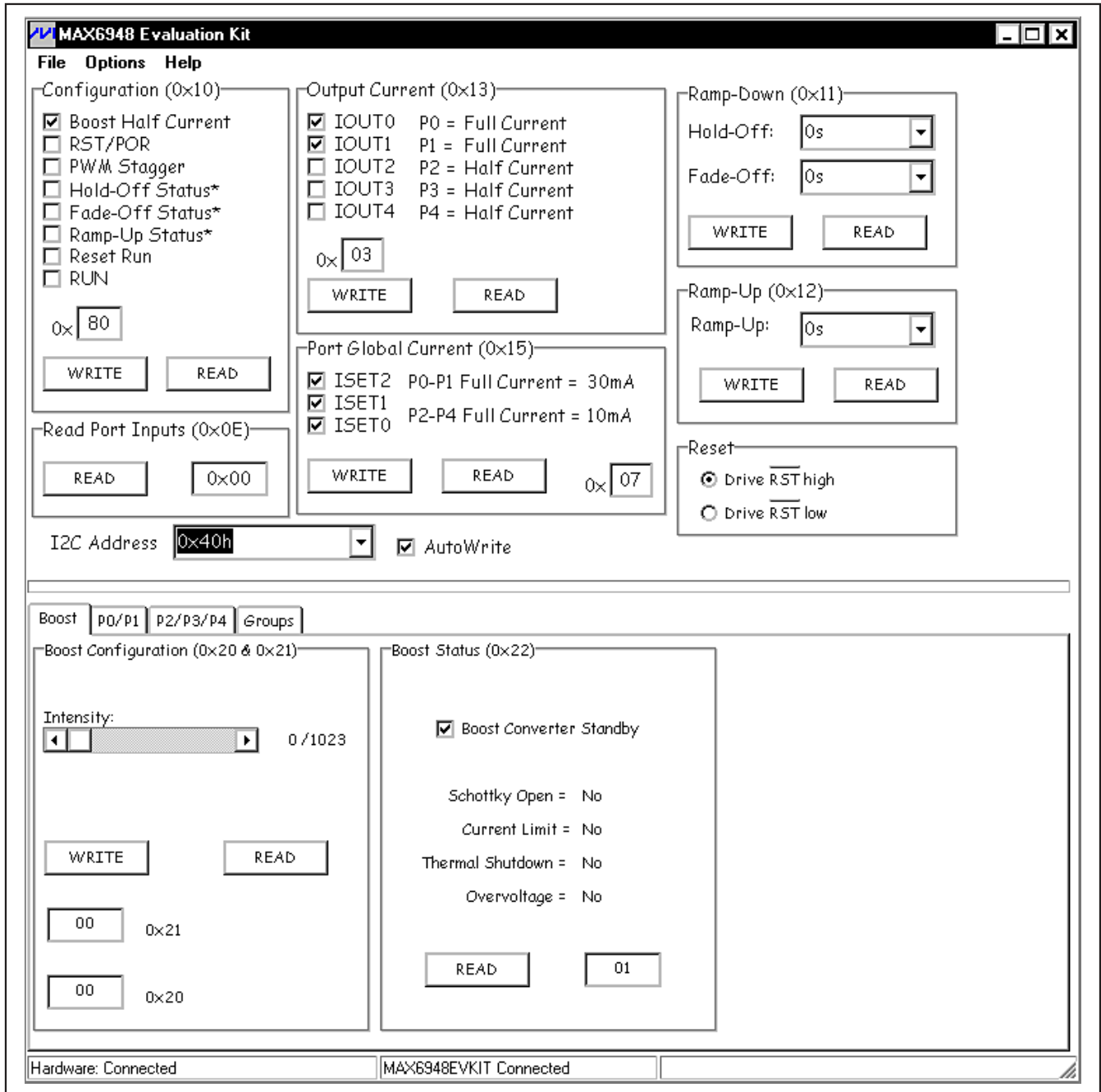
Figure 1. MAX6948 EV Kit Software Main Window (P0/P1 Tab)

MAX6948 Evaluation Kit

Unchecking the **Boost Converter Standby** checkbox enables the boost converter.

I/O Configuration

The MAX6948B has five I/O ports that can be configured individually or in groups. The GUI has two tabs for the I/O ports (**P0/P1** and **P2/P3/P4**) to be individually configured (Figures 3 and 4). Once a port tab has been selected, the group box allows the user to configure the port as **High Impedance** (default), **Logic-Low**, **Static Constant-Current Sink**, **Logic-High / Logic Input**, or **PWM Output**. Be careful when configuring ports
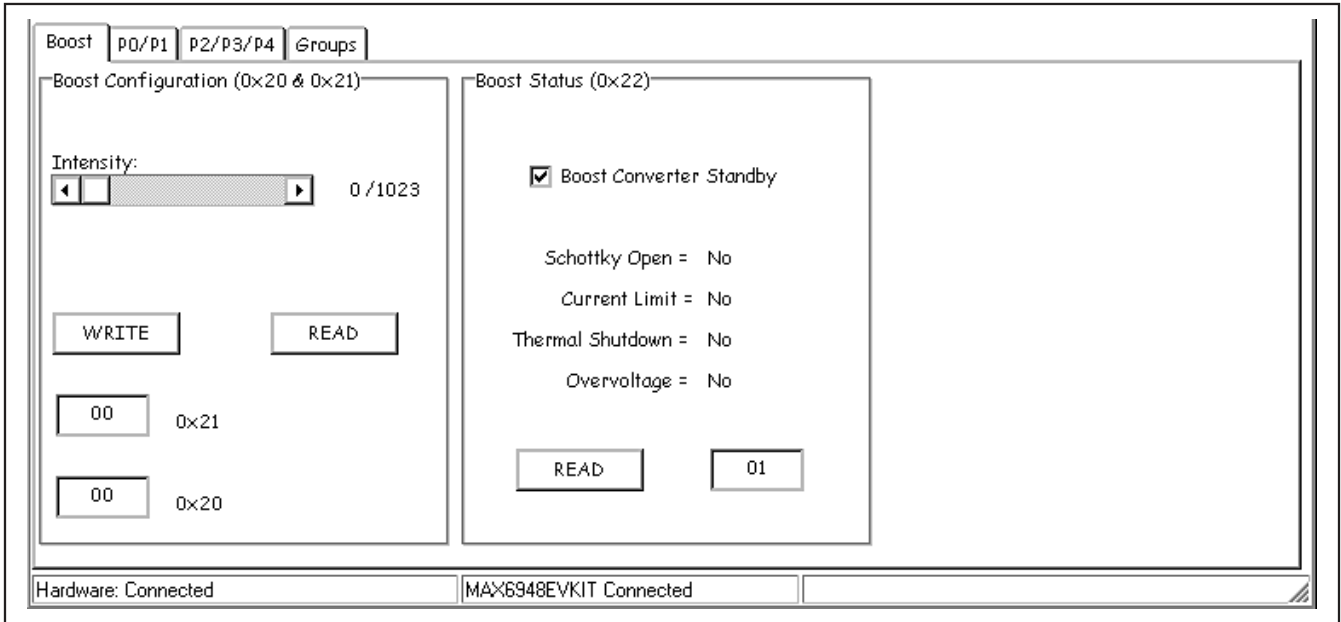
Figure 2. Boost Configuration Tab
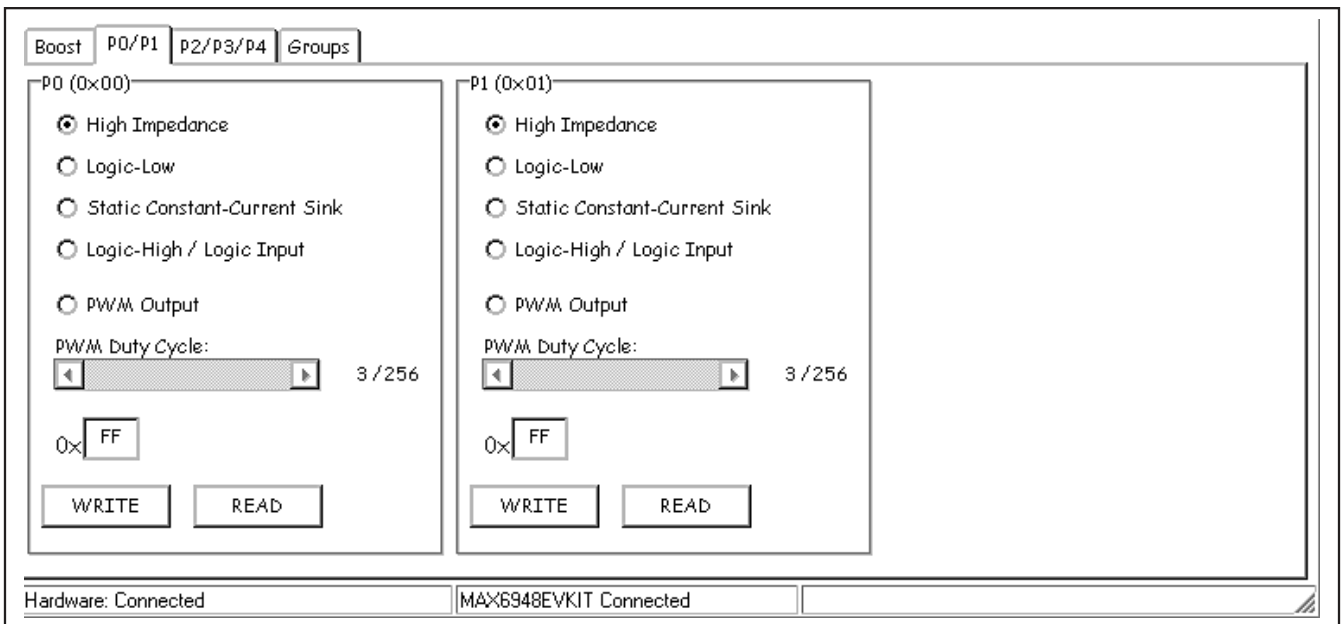
Figure 3. P0/P1 I/O Configuration Tab

MAXIM

between open-drain I/O and LED drivers. For driving LEDs, a series resistor is not needed. For open-drain I/O, a pullup resistor is needed. If the MAX6948 EV kit jumper settings are configured for driving LEDs and the user selects **Logic-Low** or **Logic-High / Logic Input**, a message box warns the user to change the shunt to the appropriate jumper setting. A corresponding message box does not appear when switching from GPIO to driving LEDs. Selecting **Logic-Low** without the correct jumper setting can damage the LED and the MAX6948B.

The **Groups** tab sheet has the same settings and allows multiple ports to be configured at the same time (Figure 5).

Reading Input Ports
Ports are set to logic inputs by selecting the **Logic-High / Logic Input** radio button. The shunts on JU6–JU10 need to be set to the appropriate jumper position. GPIO operation requires that the ports are pulled up with a pullup resistor. A pushbutton switch to GND is included to drive the port signal low. When a port is selected as **High Impedance**, **Logic-Low**, **Static Constant-Current Sink**, or **PWM Output**, reading the port input state returns 0.

PWM Dimming
Select the PWM duty cycle by clicking the **PWM Output** radio button and moving the **PWM Duty Cycle** scrollbar. If **AutoWrite** is selected, brightening and dimming can be seen as the scrollbar is moved. If the **Groups** tab is selected and all ports are configured to a certain setting, selecting the individual port's tab does not show that setting unless the **READ** button is pressed.

Ramp and Fade
The MAX6948B features ramping and fading intensities. Ramping and fading features are for the ports only. The boost converter is not affected by these settings.

Selectable Current Sinks
P0 and P1 ports have a maximum sink current of 30mA while the P2, P3, and P4 ports have a maximum sink current of 10mA. The **Port Global Current (0x15)** group box (Figure 1) selects the maximum current for the ports and the **Output Current (0x13)** group box selects whether the maximum current for each individual port is full current or half current.
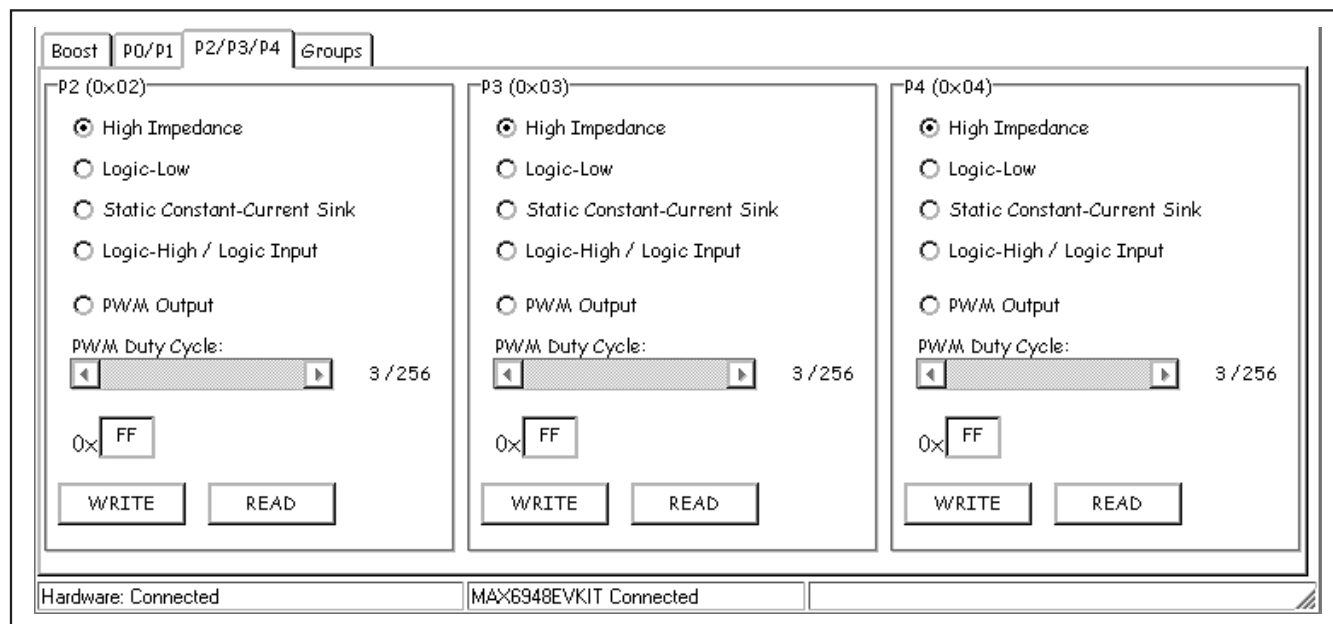

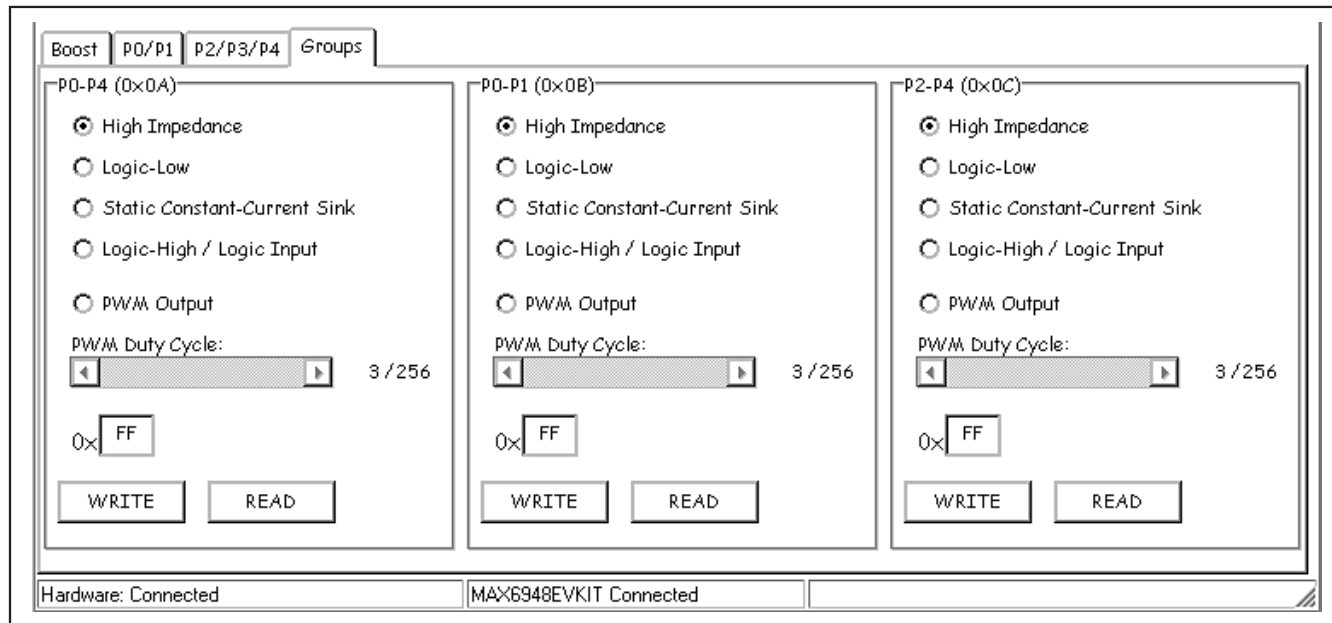*Figure 4. P2/P3/P4 I/O Configuration Tab*

Figure 5. Groups Configuration Tab

Reset

The reset signal can be driven high or low in the **Reset** group box (Figure 1). The functionality of $\overline{RST}$ depends on whether the **Reset Run** or **RST/POR** checkbox in the **Configuration (0x10)** group box is checked. Driving $\overline{RST}$ low disables I2C communication to read or write to the MAX6948 registers. The previously programmed settings are stored internally.

Reset Run

The reset run feature allows toggling the $\overline{RST}$ signal to enter normal operation with the RUN bit enabled without writing to the configuration register. The reset run bit in the configuration register needs to be set initially with I2C.

Reset POR

When the **RST/POR** checkbox is checked, driving $\overline{RST}$ low causes the MAX6948 to enter shutdown. All registers are reset to their default values, when $\overline{RST}$ is returned high.

Advanced User Interface

A serial interface can be used by advanced users by selecting **Options | Interface (Advanced Users)** from the menu bar.

For I2C, click on the **2-wire interface** tab shown in Figure 6. Press the **Hunt for active listeners** button to obtain the current MAX6948 slave address in the **Target Device Address** combo box. In the **General commands** tab sheet, select **1 - SMBusWriteByte(addr,cmd, data8)** in the **Command** drop-down list. Enter the desired values into the **Command byte** and **Data Out** combo boxes and then press the **Execute** button. Read operations work in a similar manner.

_Detailed Description of Hardware

The MAX6948 EV kit provides a proven layout for the MAX6948B. Jumper block J1 selects the I2C device address (see Table 1). Various test points are available for accessing the MAX6948B pins. All ports have LEDs and pushbutton switches. Jumper settings must be set appropriately when using the ports as GPIO or LED drivers. Ports P0 and P1 have a peak LED current of 30mA while P2, P3, and P4 have a peak LED current of 10mA. Ports P2, P3, and P4 connect to a single RGB LED.

Note: The forward voltage of blue LEDs may exceed the minimum V+ supply voltage of the MAX6948B.

Power Supplies

The MAX6948 EV kit requires a power supply capable of 500mA to test the boost converter. By default, V+ is set to VLED and VDD. The LED voltage range is up to 5V, independent of V+ and VDD. To set the port (VLED) voltage independent of V+, move the shunt on JU5 to the 2-3 position and provide a positive voltage on the EXT_LED pad. To set a different voltage for VDD from V+, move the shunt on JU4 to the 2-3 position and provide a positive voltage on the EXT_VDD pad.
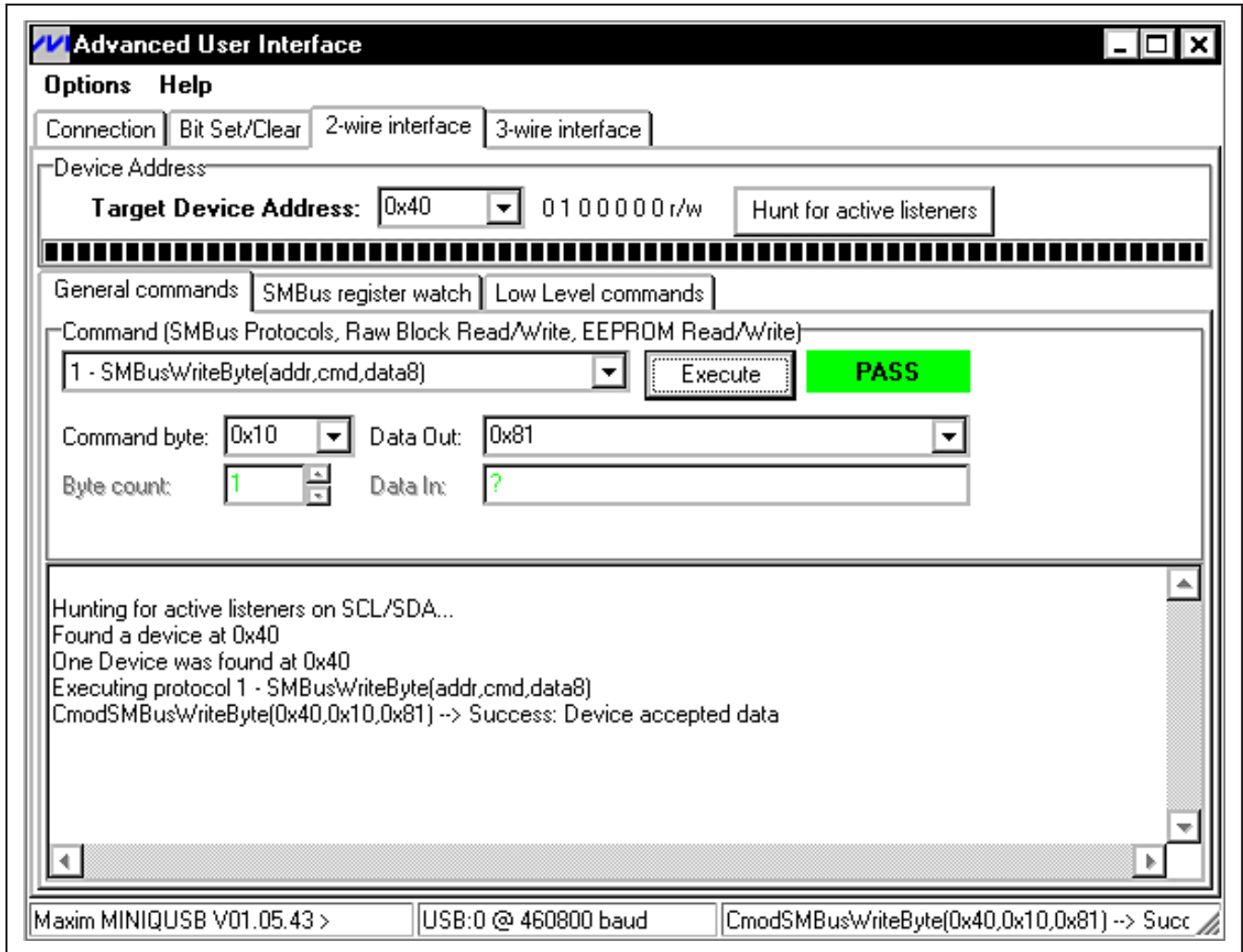
MAXIM

Figure 6. Advanced User Interface Window (2-Wire Interface Tab)

User-Supplied I2C Interface

The MAX6948 EV kit uses the on-board SDA and SCL by default. For user-supplied I2C, change the shunt position on JU1 and JU2 to the appropriate position. JU1 connects SDA and JU2 connects SCL. If supplying I2C, make sure to pull up the SDA and SCL lines to VDD or an external voltage.

The $\overline{RST}$ signal is supplied by default by the MAXQ2000. Change the shunt position to the appropriate setting on JU3 and apply the signal to the EXT_RST pad for a user-supplied reset signal.

Ports

Each port is connected to a jumper that switches between an LED and open-drain GPIO with a pushbutton switch. The LEDs are referenced to V+ while open-drain GPIOs are referenced to VDD. If V+ is different from VDD, change shunts appropriately.

Boost Converter

The boost converter drives 6 series white LEDs with approximately 30mA of current. The V+ voltage is boosted to the appropriate voltage to drive the series LEDs. A greater number of white LEDs can be driven or white LEDs with a higher forward voltage can be accommodated because the maximum output is 28V before the overvoltage protection kicks in.

Evaluates: MAX6948B
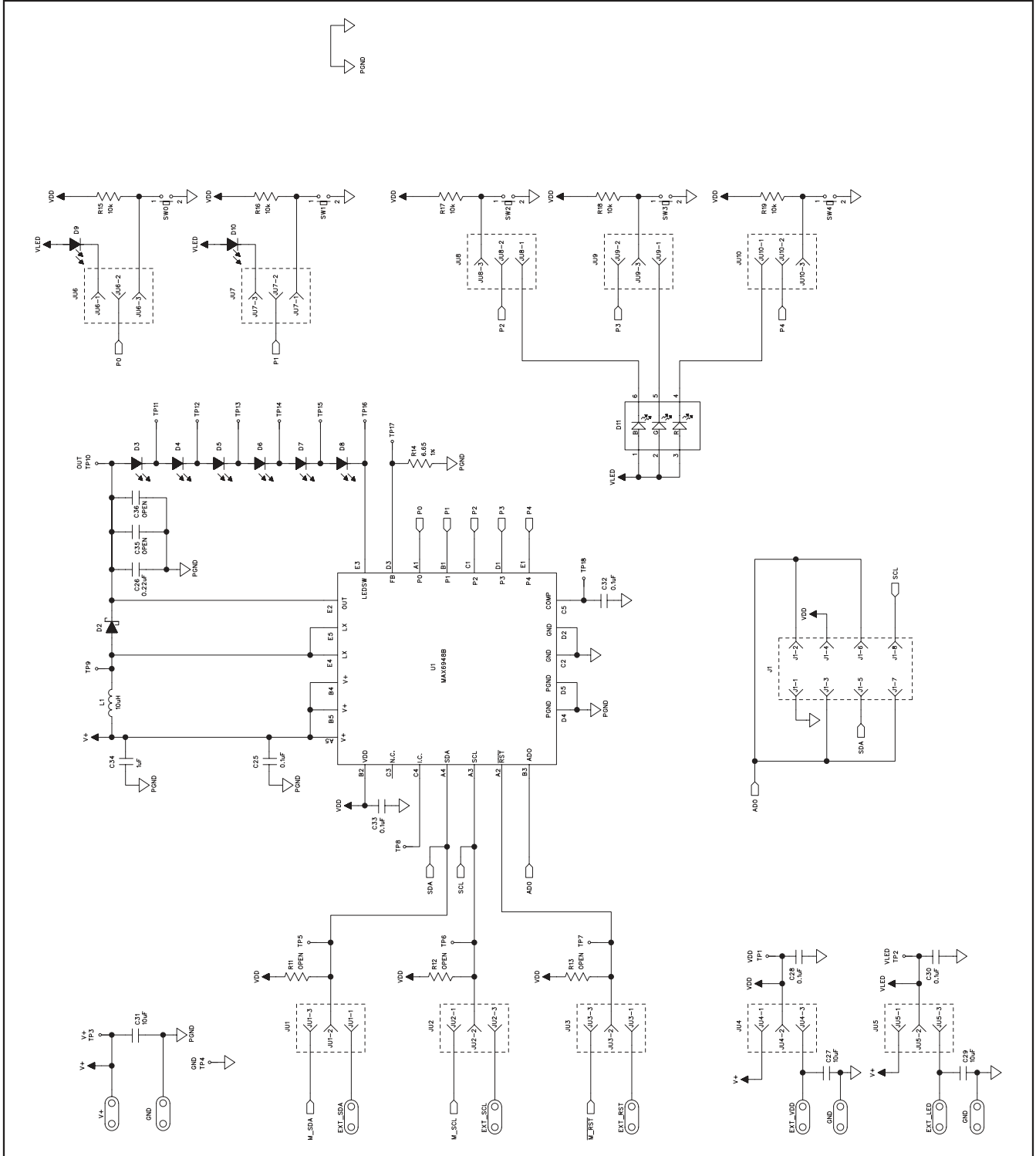
Figure 7a. MAX6948 EV Kit Schematic (Sheet 1 of 3)

Evaluates: MAX6948B
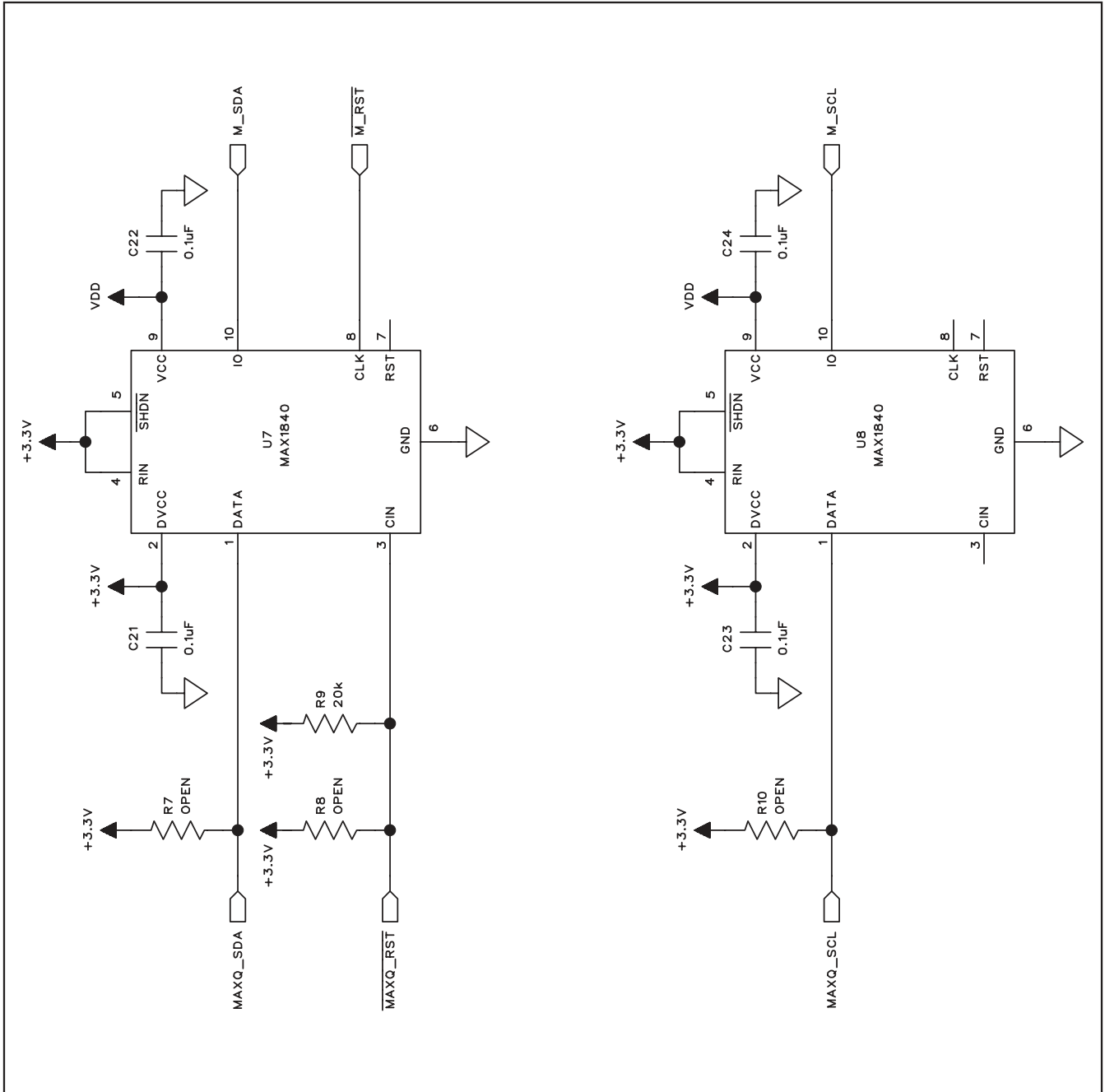
Figure 7b. MAX6948 EV Kit Schematic (Sheet 2 of 3)
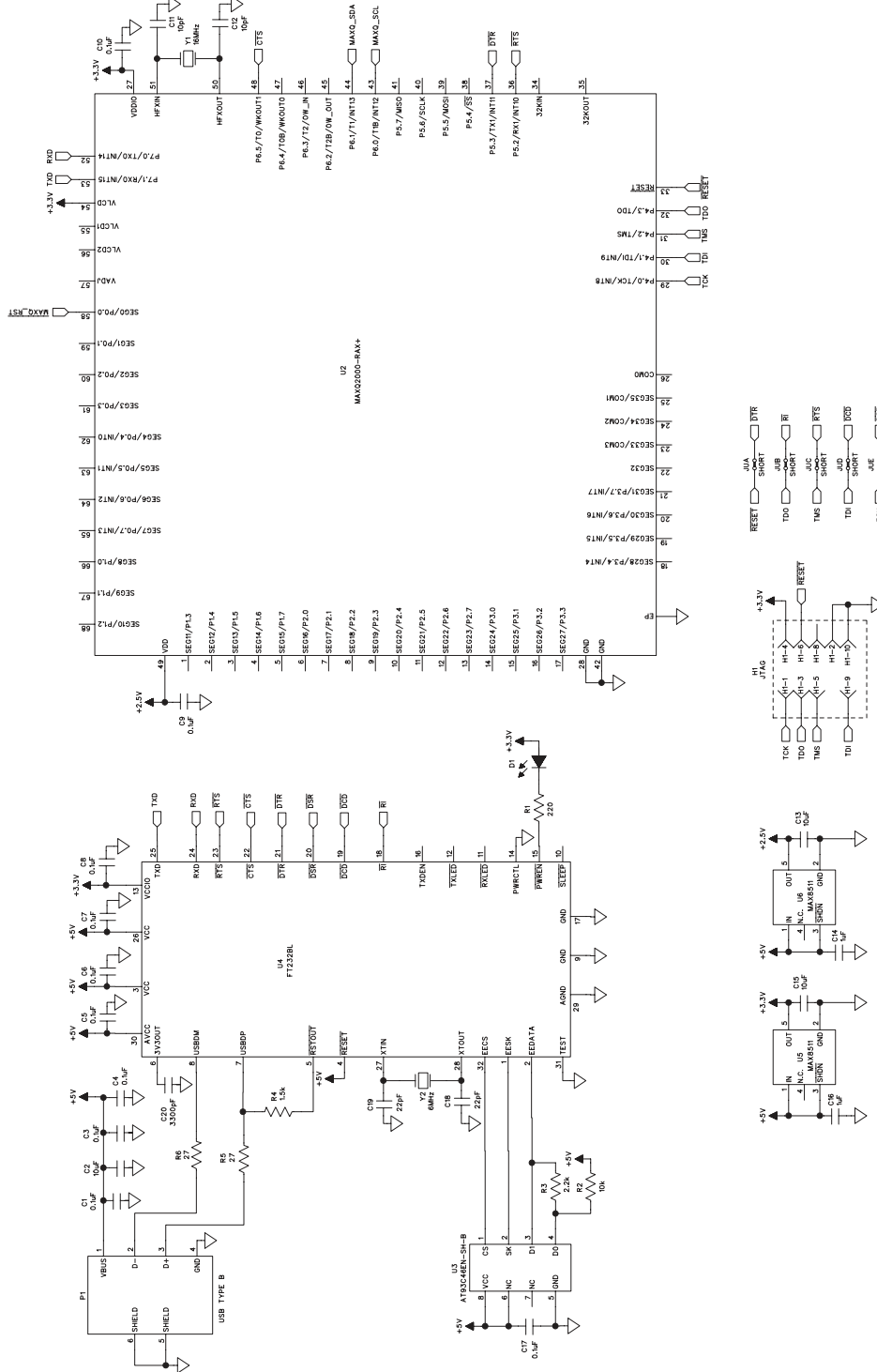
Figure 7c. MAX6948 EV Kit Schematic (Sheet 3 of 3)
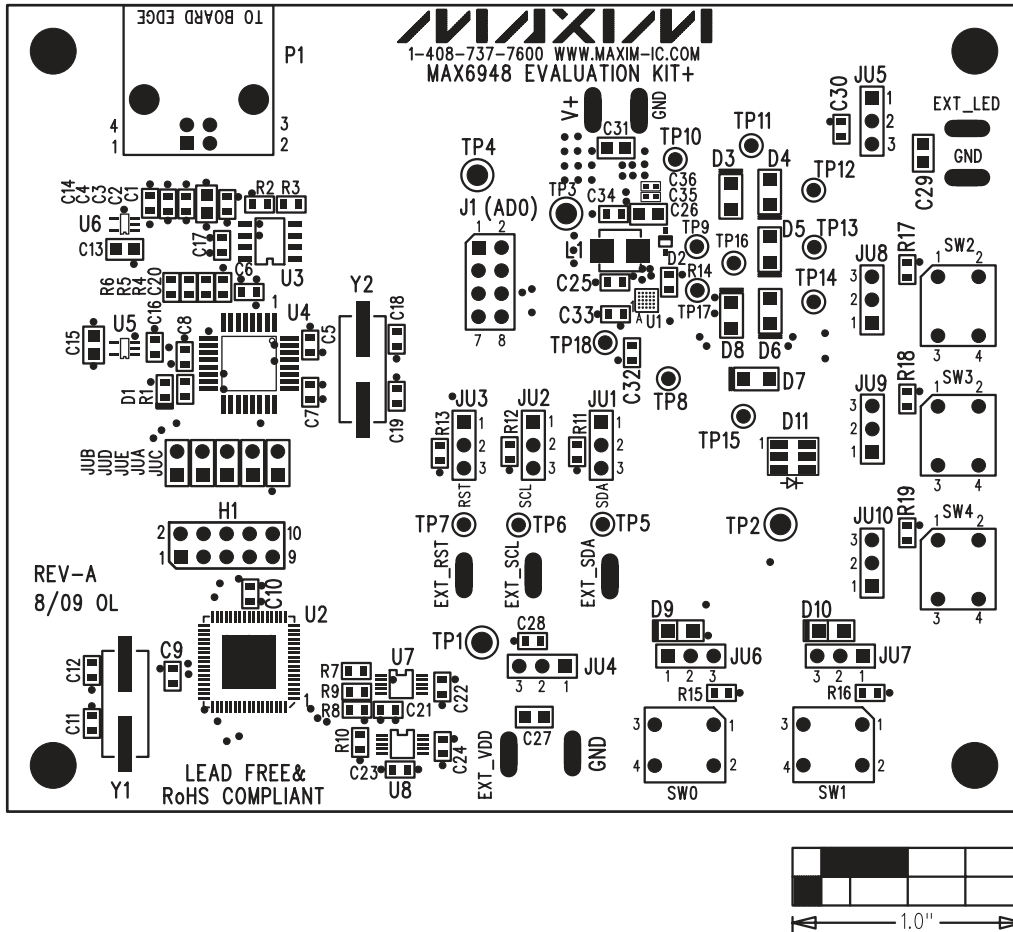
Figure 8. MAX6948 EV Kit Component Placement Guide—Component Side

MAX6948 Evaluation Kit
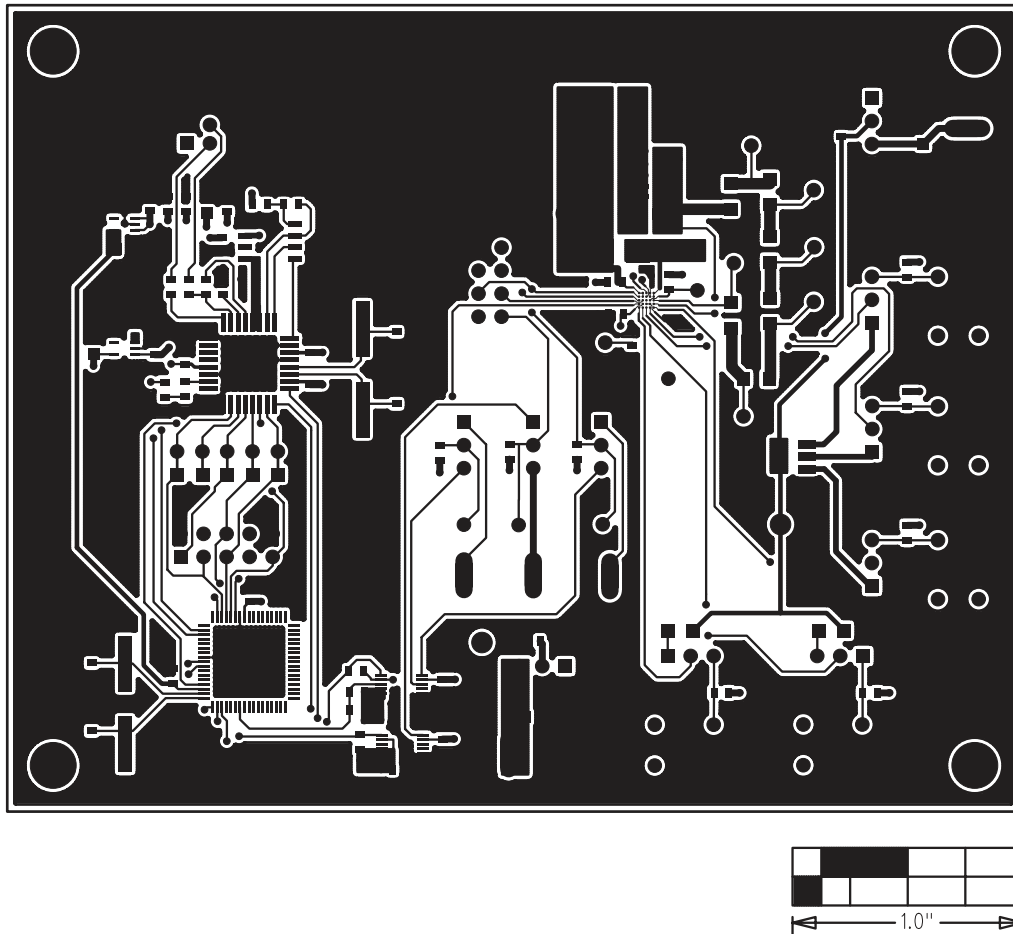
Figure 9. MAX6948 EV Kit PCB Layout—Component Side

Figure 10. MAX6948 EV Kit PCB Layout—Layer 2
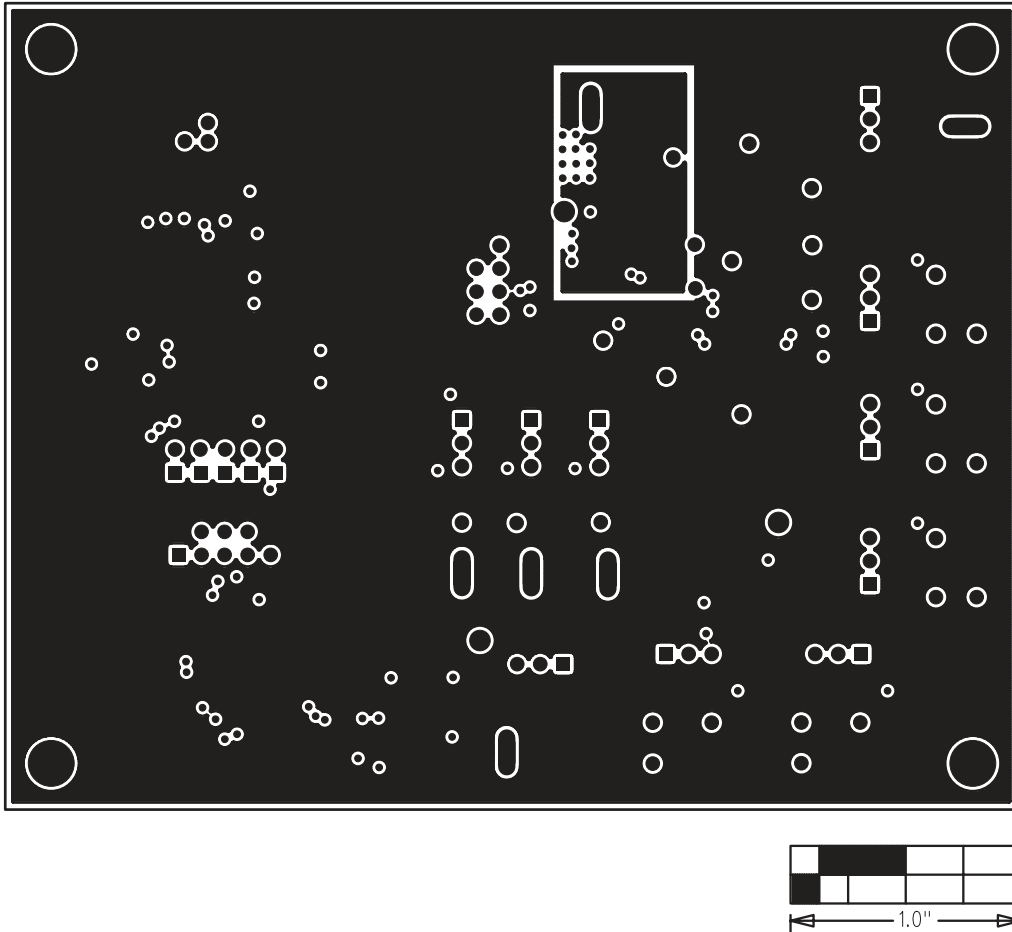
✓∧XI✓∧

MAX6948 Evaluation Kit
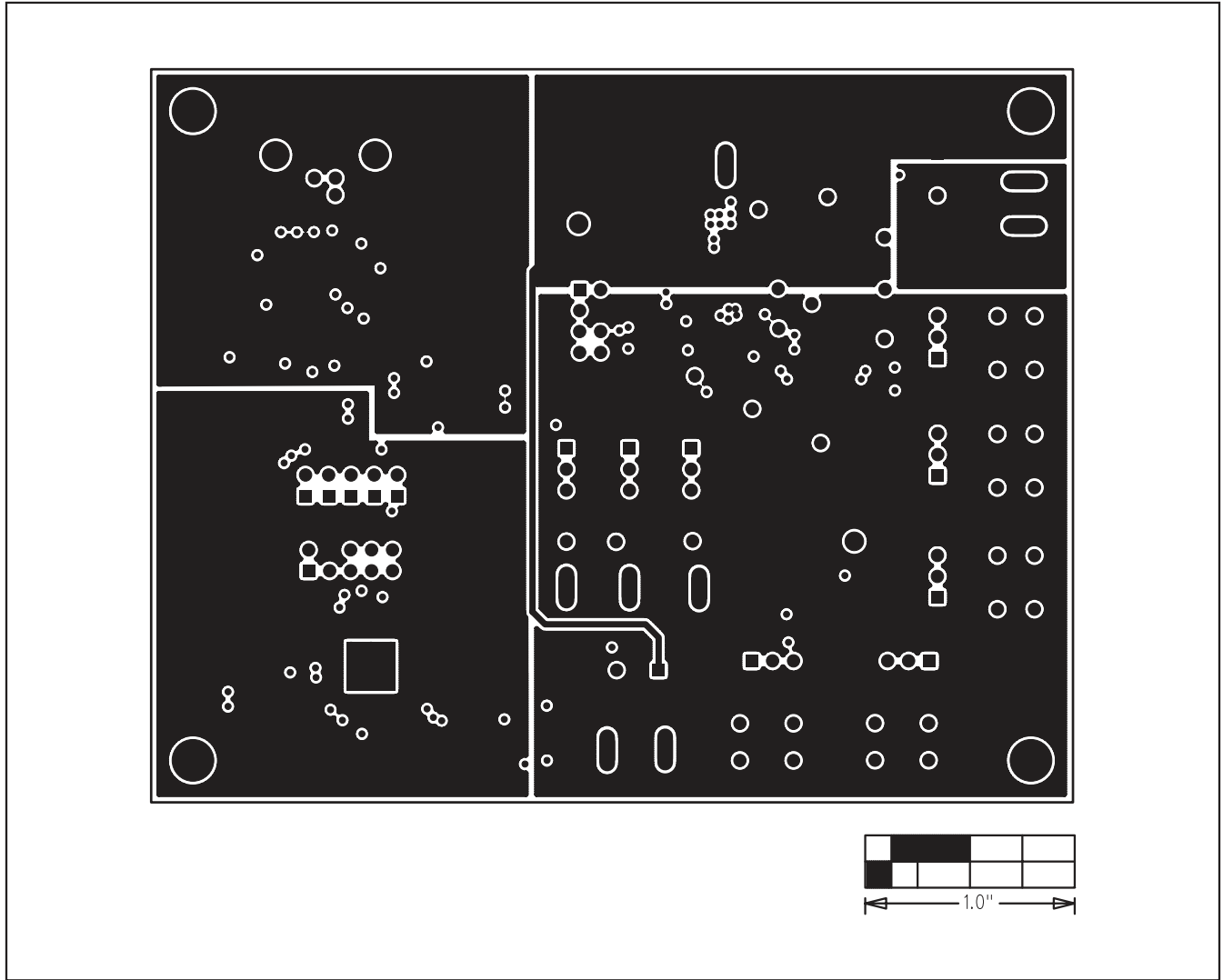
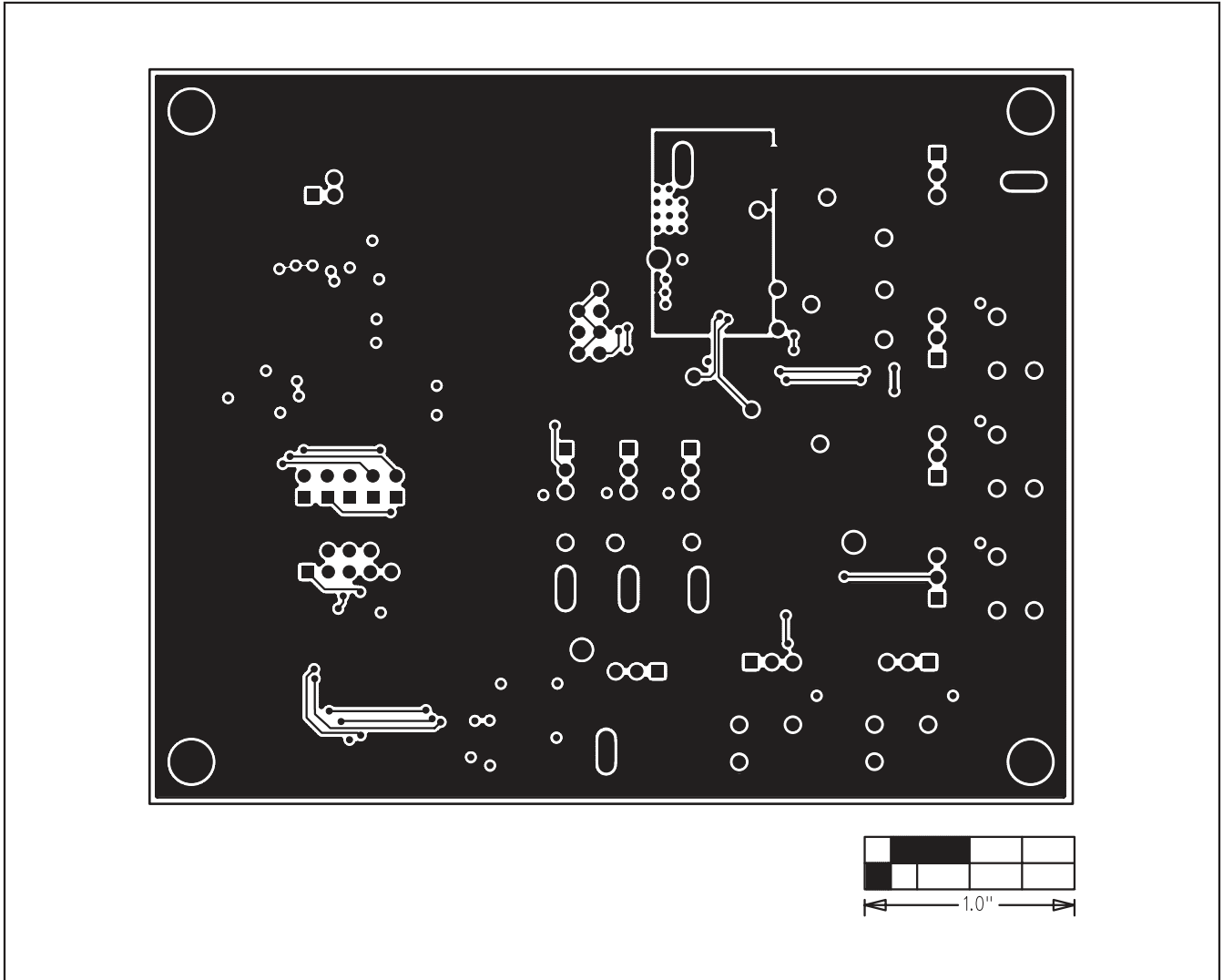Figure 11. MAX6948 EV Kit PCB Layout—Layer 3

Evaluates: MAX6948B

Figure 12. MAX6948 EV Kit PCB Layout—Solder Side