19-1004; Rev 1; 9/08

MAX8798 Evaluation Kit/Evaluation System

Evaluate: MAX8798

General Description

The MAX8798 evaluation system (EV system) consists of the MAX8798 evaluation kit (EV kit) and the Maxim CMAXQUSB command module. A Windows® 2000/XP/Vista®-compatible software is also available for use with the EV system (MAX8798EVCMAXQU+) and can be downloaded from www.maxim-ic.com/evkitsoftware.

The MAX8798 EV kit (MAX8798EVKIT+) is a fully assembled and tested surface-mount printed-circuit board (PCB) that provides the features required for active-matrix, thin-film transistor (TFT) liquid-crystal displays (LCDs). The EV kit contains a step-up switching regulator, positive two-stage charge pump, negative two-stage charge pump, digitally adjustable VCOM calibration device with nonvolatile memory, SMBus™-compatible interface, high-speed operational amplifier (op amp), and high-voltage, level-shifting scan driver for thin TFT-LCD applications.

The EV kit operates from a DC supply voltage from +1.8V to +6V. The step-up switching regulator is configured for a +8V output providing at least 300mA from a +2.2V input. The positive charge pump is configured for a +21V output providing at least 20mA. The negative charge pump is configured for a -13V output providing at least 20mA. The op amp is capable of providing up to ±150mA peak and features a programmable output voltage initially configured for +3.2V. The high-voltage level-shifting scan driver buffers inputs from STV, CPV, and OE pads and shifts them to a desired level to drive TFT-LCD row logic.

The MAX8798 EV kit demonstrates low quiescent current and high efficiency (> 85%) for maximum battery time per charge. Operation at 1.2MHz allows the use of tiny surface-mount components. The MAX8798 thin QFN package (0.8mm max height), with low-profile external components, allows this circuit to be less than 1.2mm high.

The Maxim CMAXQUSB command module provides the SMBus-compatible interface and is connected to a PC through the universal serial bus (USB) port. The MAX8798 EV kit software provides a graphical user interface (GUI) for exercising the MAX8798 features.

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SMBus is a trademark of Intel Corp.

Features

- **+1.8V to +6V Input Range**
- **Output Voltages**
  - **+8V Output at 300mA (+2.2V Input Step-Up Switching Regulator)**
  - **+21V Output at 20mA (Positive Charge Pump)**
  - **-13V Output at 20mA (Negative Charge Pump)**
  - **±150mA High-Current Op-Amp Output**
- **Resistor-Adjustable Switching Regulator and Op-Amp Output Range**
- **Digitally Programmable Op-Amp Output Voltage**
- **+35V to -25V High-Voltage Level-Shifting Drivers**
- **Greater than 85% Efficiency (Step-Up Switching Regulator)**
- **1.2MHz Step-Up Switching Frequency**
- **SMBus-Compatible Interface**
- **Windows 2000/XP/Vista (32-Bit)-Compatible Software**
- **1.2mm Low-Profile Surface-Mount Components**
- **Lead-Free and RoHS Compliant**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX8798EVKIT+	EV Kit
MAX8798EVCMAXQU+	EV System

+Denotes lead-free and RoHS compliant.

Note: *The Maxim command module (CMAXQUSB) is required when using the MAX8798 EV kit software.*

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	10µF ±20%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J106M or equivalent
C2, C18, C19, C20	0	Not installed, ceramic capacitors (0603)
C3	1	220pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H221KA TDK C1608X7R1H221K or equivalent
C4	1	0.047µF ±10%, 50V X5R ceramic capacitor (0603) Murata GRM188R71H473K TDK C1608X7R1H473K or equivalent

For pricing, delivery, and ordering information, please contact Maxim Direct 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX8798 Evaluation Kit/Evaluation System

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C5	1	0.22µF ±20%, 16V X5R ceramic capacitor (0603) TDK C1608X5R1C224M or equivalent
C6, C7	2	1µF ±20%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A105M or equivalent
C8–C16	9	0.1µF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H104K or equivalent
C17	0	Not installed, electrolytic capacitor (6.3mm x 5mm)
C21, C22	2	4.7µF ±10%, 16V X5R ceramic capacitors (1206) Murata GRM319R61C475KA88D TDK C3216X5R1C475K
C23	0	Not installed, ceramic capacitor (1206)
D1	1	1A, 30V Schottky diode (S-Flat) Central CMMSH1-40LEADFREE Nihon EP10QY03 Toshiba CRS02(TE85L)
D2–D5	4	200mA, 100V dual diodes (SOT23) Fairchild MMBD4148SE (Top Mark: D4) Central CMPD7000LEADFREE (Top Mark: C5C)
J1	1	Dual-row (2 x 10) right-angle receptacle
JU1, JU2	2	2-pin headers
L1	1	3.6µH, 1.8A power inductor Sumida CMD6D11BHPNP-3R6MC
OECON	0	Not installed, test point
R1, R6, R7	3	200kΩ ±1% resistors (0603)
R2	1	36.5kΩ ±1% resistor (0603)
R3	1	60.4kΩ ±1% resistor (0603)
R4	1	10Ω ±5% resistor (0603)
R5, R15	2	100kΩ ±5% resistors (0603)
R8	1	24.9kΩ ±1% resistor (0805)
R9	1	20kΩ ±5% resistor (0603)
R10, R11	2	200Ω ±5% resistors (0603)
R12, R13, R14	3	10kΩ ±5% resistors (0603)
R16	0	Not installed, resistor—short (PC trace) (0603)
U1	1	Maxim internal-switch boost regulator MAX8798ETX+ (36-pin thin QFN, 6mm x 6mm)
—	2	Shunts
—	1	PCB: MAX8798 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centralsemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Nihon Inter Electronics Corp.	847-843-7500	www.niec.co.jp
Sumida Corp.	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com
Toshiba America Electronic Components, Inc.	949-623-2900	www.toshiba.com/taec

Note: *Indicate that you are using the MAX8798 when contacting these component suppliers.*

MAX8798 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX8798.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
TROUBLESHOOTING_USB.PDF	USB driver installation help file

Quick Start

Recommended Equipment

Before beginning, the following equipment is needed:

- +1.8V to +6V, 2A DC power supply for PIN
- MAX8798 EV system
  MAX8798 EV kit
  CMAXQUSB command module (USB cable included)
- A user-supplied Windows 2000/XP/Vista-compatible PC with a spare USB port
- Voltmeter

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.

Hardware Procedure

The MAX8798 EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are completed.**

1) Verify that a shunt is installed across jumper JU1.
2) Verify that no shunt is installed across jumper JU2.
3) Connect the positive terminal of the power supply to the PIN pad. Connect the negative terminal of the power supply to the GND pads closest to PIN.
4) Turn on the power supply and verify that the step-up switching regulator output (MAIN) is +8V.
5) Verify that the gate-on supply (GON) is approximately +21V.
6) Verify that the gate-off supply (GOFF) is approximately -13V.
7) Verify that the output of the high-speed op amp (VCOM) is approximately +3.2V.

For instructions on selecting the step-up switching regulator feedback and op-amp divider resistors for other output voltages, see the *Output-Voltage Selection* section.

Software Procedure

With the EV kit powered on, perform the following steps to verify software operation:

1) On the CMAXQUSB command module, ensure that the shunt on jumper JU1 is in the +3.3V position.
2) To enable the MAX8798, ensure that a shunt is installed on jumper JU1 of the MAX8798 EV kit.
3) Visit **www.maxim-ic.com/evkitsoftware** to download the latest version of the MAX8798 EV kit software, MAX8798Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.
4) 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 I Programs** menu.
5) Carefully connect the boards by aligning the MAX8798 EV kit's 20-pin J1 connector with the CMAXQUSB board's 20-pin P3 connector. Gently press them together. The two boards should be flush against each other.
6) 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 when installing the USB driver for the first time. If you do not see a window 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 2000/XP/Vista.
7) 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\MAX8798** (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 TROUBLESHOOTING_USB.PDF document for additional information.
8) Start the MAX8798 EV kit software by opening its icon in the **Start I Programs** menu.
9) Normal device operation is verified when **MAX8798 connected** is displayed in the **status bar** on the MAX8798 EV kit main window (Figure 1).

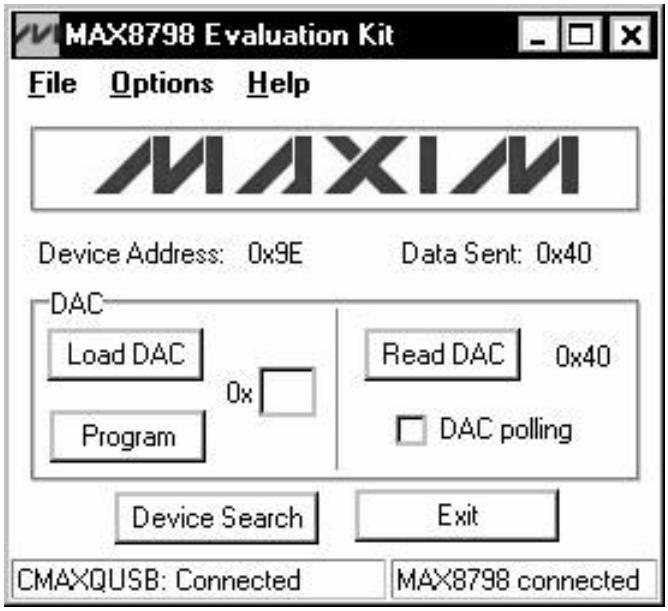

Figure 1. MAX8798 EV Kit Software Main Window

_Detailed Description of Hardware

The MAX8798 EV kit contains a step-up switching regulator, positive two-stage charge pump, negative two-stage charge pump, digitally adjustable VCOM calibration device with nonvolatile memory, SMBus-compatible interface, high-speed operational amplifier (op amp), and high-voltage level-shifting scan driver for thin TFT-LCD applications. The EV kit can operate from a single DC power supply between +1.8V to +6V that can provide at least 2A.

As configured, the step-up switching regulator (MAIN) generates a +8V output and can provide at least 200mA from a +1.8V input. It also provides at least 300mA from a +2.2V input and 600mA from a +4.5V input. The step-up switching-regulator output voltage can be adjusted up to +18V with different feedback resistors (see the *Output-Voltage Selection* section).

The GON consists of two positive charge-pump stages to generate approximately +21V and can provide greater than 20mA. The GOFF consists of two negative charge-pump stages to generate approximately -13V and can provide greater than 20mA. Loading GON and GOFF reduces the available MAIN current proportionally.

The op-amp output (VCOM) is SMBus programmable and is configured for an output-voltage range of +2.4V to +4V. VCOM can source or sink peak current up to 150mA. The output-voltage range can be reconfigured to other voltages with voltage-divider resistors R6 and R7. Refer to the *Setting the VCOM Adjustment Range* section in the MAX8798 IC data sheet for more details.

The MAX8798 includes a 3-channel, high-voltage level-shifting driver for driving row-driver functions on the panel glass. CKV, CKVB, and STVP pads are the outputs of the driver. The outputs swing between GON and GOFF according to the input logic levels on the STV, CPV, and OE pads and the IC's internal logic. Refer to the *High-Voltage Level-Shifting Scan Driver* section in the MAX8798 IC data sheet for more details.

Jumper Selection (JU1, JU2)

The MAX8798 EV kit incorporates jumper JU1 to enable/disable the IC outputs and jumper JU2 to enable/disable write protection. When write protection is enabled, all SMBus commands are ignored by the device. This prevents device detection and changing of the VCOM calibrator settings. See Table 1 for jumper JU1 functions and Table 2 for jumper JU2 functions.

Table 1. Jumper JU1 Functions

SHUNT POSITION	$\overline{SHDN}$ PIN	EV KIT OUTPUTS
Installed*	$\overline{SHDN}$ connected to PIN	Outputs enabled (MAIN = +8V)
Not installed	$\overline{SHDN}$ connected to GND through R5	Outputs disabled (MAIN ≈ PIN)

**Default position.*

Table 2. Jumper JU2 Functions

SHUNT POSITION	WPN PIN	VCOM CALIBRATOR WRITE PROTECTION
Installed	WPN connected to GND	Enabled
Not installed*	WPN connected to VDD through R15	Disabled

**Default position.*

Output-Voltage Selection

The MAX8798 EV kit's step-up switching-regulator output (MAIN) is set to +8V by feedback resistors R1 and R2. To generate output voltages other than +8V (up to +18V), select different external voltage-divider resistors, R1 and R2.

Note that changing the MAIN voltage setting changes the GON and GOFF charge-pump output voltages. The voltage range on GOFF is limited to -25V and the voltage range of GON is limited to +35V. Setting the MAIN voltage above +12V will require reconfiguring the charge pumps to avoid exceeding +35V on GON and -25V on GOFF.

In addition, output capacitors C21 and C22 are rated for +16V. To set MAIN for greater than +16V, use higher voltage-rated capacitors. Refer to the *Main Step-Up Regulator, Output-Voltage Selection* section in the MAX8798 IC data sheet for instructions on selecting resistors R1 and R2.

Detailed Description of Software

The MAX8798 device includes a calibrator that is used for adjusting an LCD's backplane voltage (VCOM) in TFT-LCD displays. The VCOM voltage is adjusted by controlling the amount of sink current drawn by the calibrator. This is accomplished by programming the desired setting into the device's 7-bit internal DAC. The software also facilitates reading of the device and programming of the device's internal EEPROM. Refer to the MAX8798 IC data sheet for further details.

Loading 7-Bit DAC Setting

The DAC setting corresponds to a certain sink-current level, which in turn corresponds to a specific VCOM voltage. With the MAX8798 EV kit software, the device's 7-bit internal DAC is configured by entering an appropriate DAC setting into the **DAC** edit box. The DAC setting can be set from 0x00 ($VCOM_{MAX}$) to 0x7F ($VCOM_{MIN}$). The DAC setting is written to the device by pressing the **Load DAC** button (Figure 1).

Reading 7-Bit DAC

The MAX8798 7-bit DAC is read by either pressing the **Read DAC** button or by checking the **DAC polling** checkbox. When checked, the software will continuously read and display the DAC's current setting.

Programming EEPROM

The current DAC setting can be programmed into the device's internal EEPROM by entering an appropriate DAC setting into the **DAC** edit box and pressing the **Program** button. Pressing the **Program** button will also load the current setting into the DAC. Each time the device is powered on, the DAC is loaded with the setting stored in the device's EEPROM. Programming is only possible when GON is greater than +16V.

Simple SMBus Commands

There are two methods for communicating with the MAX8798: through the MAX8798 EV kit software main window (Figure 1), or through the interface window available by selecting the **Options | Interface** menu item from the menu bar. The Maxim command module interface window (Figure 2) includes a **2-wire interface** tab that allows for execution of the **SMBusSendByte()**, **SMBusReceiveByte()**, and **SMBusQuick()** commands. See Table 3 for details regarding SMBus commands.

The **Command byte** combo box accepts numeric data in binary, decimal, or hexadecimal. Hexadecimal numbers should be prefixed by $ or 0x. Binary numbers must be exactly eight digits. See Figure 2 for an illustration of this tool.

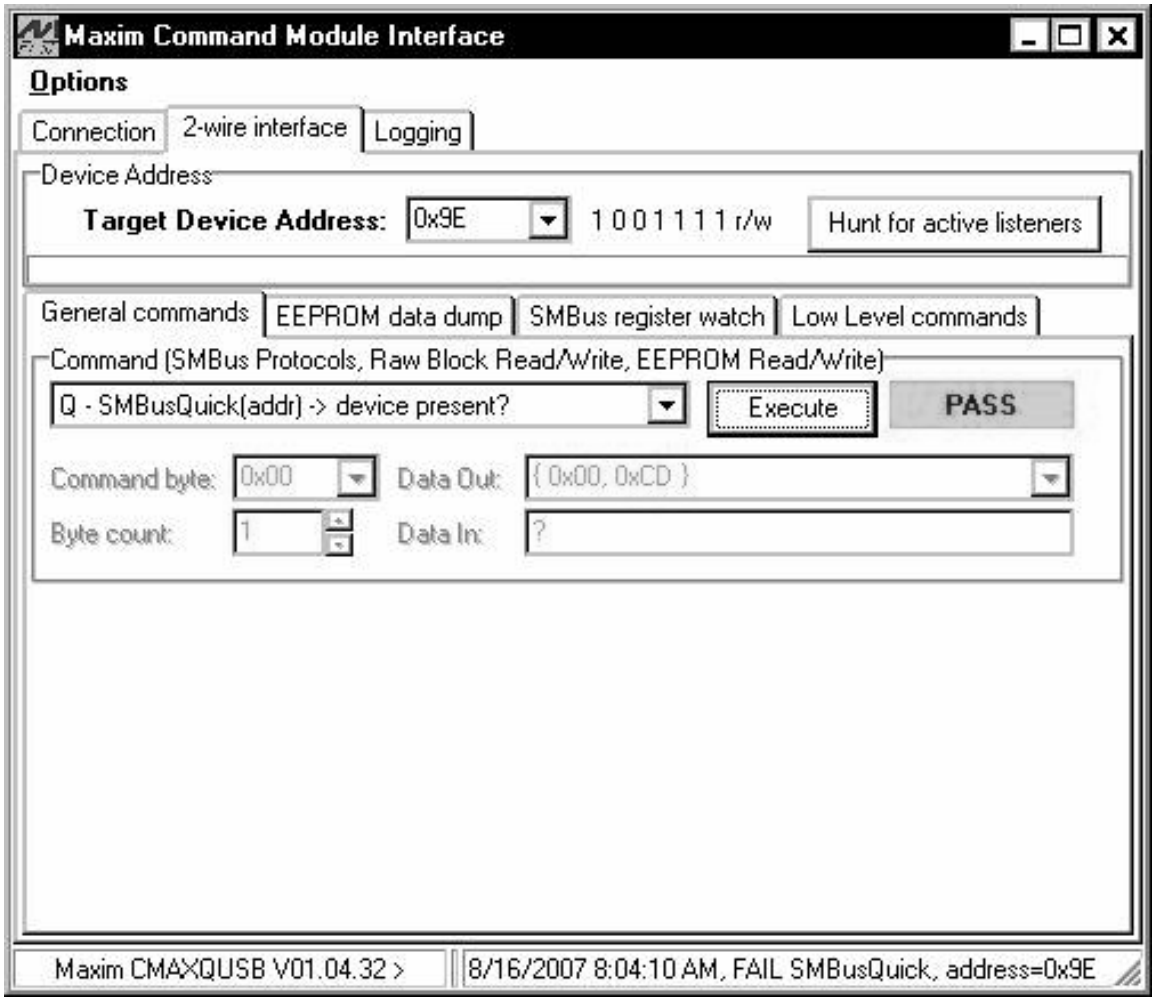

Figure 2. Command Module Interface Window

Table 3. SMBus Commands

CONTROL	SMBus COMMAND	FORMAT
Load DAC	SMBusSendByte	Input the desired 7-bit DAC setting into the **Command byte** combo box. The 7-bit DAC value should be stored in the upper 7 bits (b7-b1) of the byte, with the LSB = 1.
Load DAC/program EEPROM	SMBusSendByte	Input the desired 7-bit DAC setting into the **Command byte** combo box. The 7-bit DAC value should be stored in the upper 7 bits (b7-b1) of the byte, with the LSB = 0.
Read DAC	SMBusReceiveByte	Receives 8 bits from the device. The upper 7 bits correspond to the current DAC setting and the LSB = 0.
Device search	SMBusQuick	Search for device address shown in the **Target Device Address** combo box. The MAX8798 device address is 0x9E.

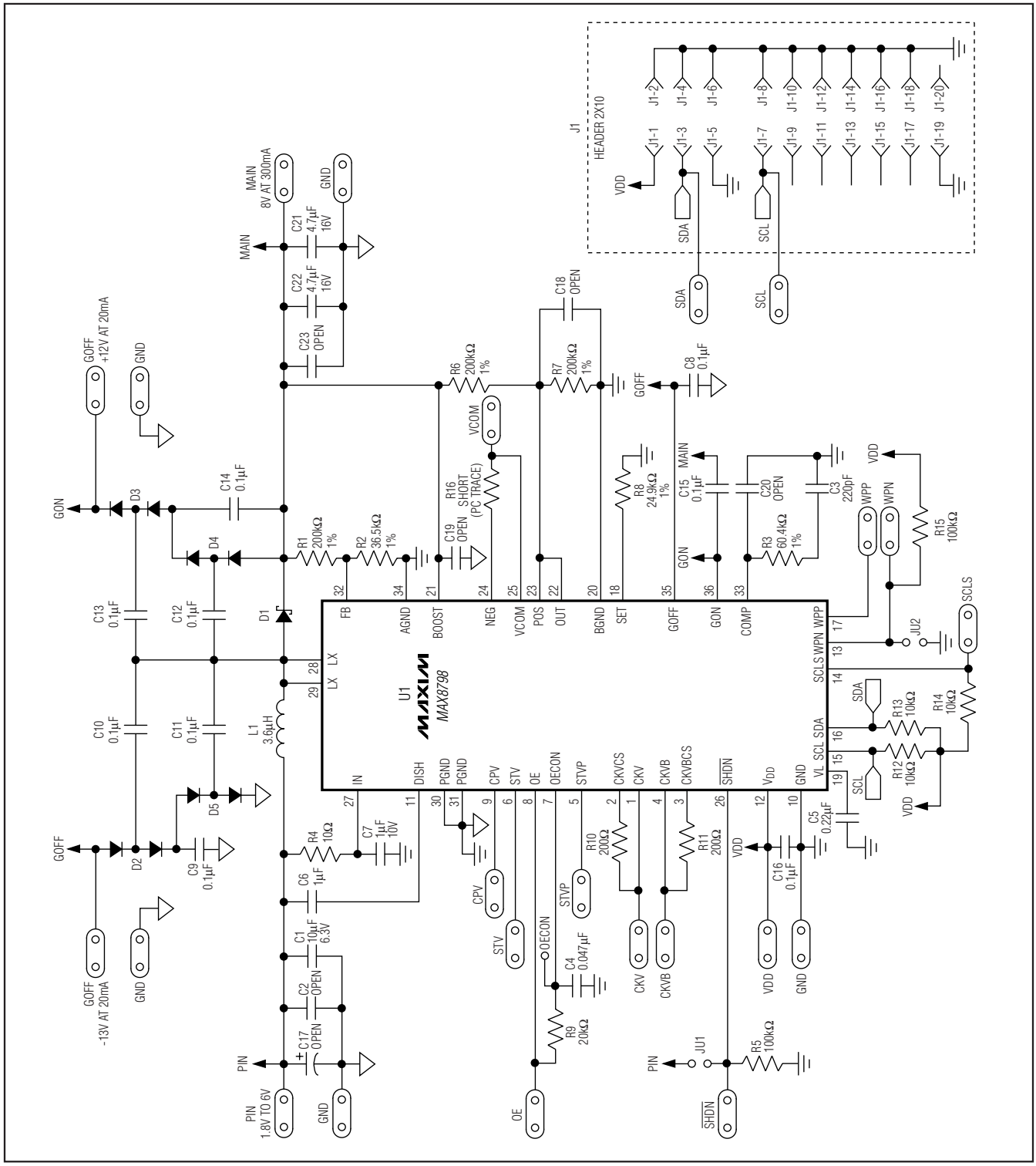

Figure 3. MAX8798 EV Kit Schematic

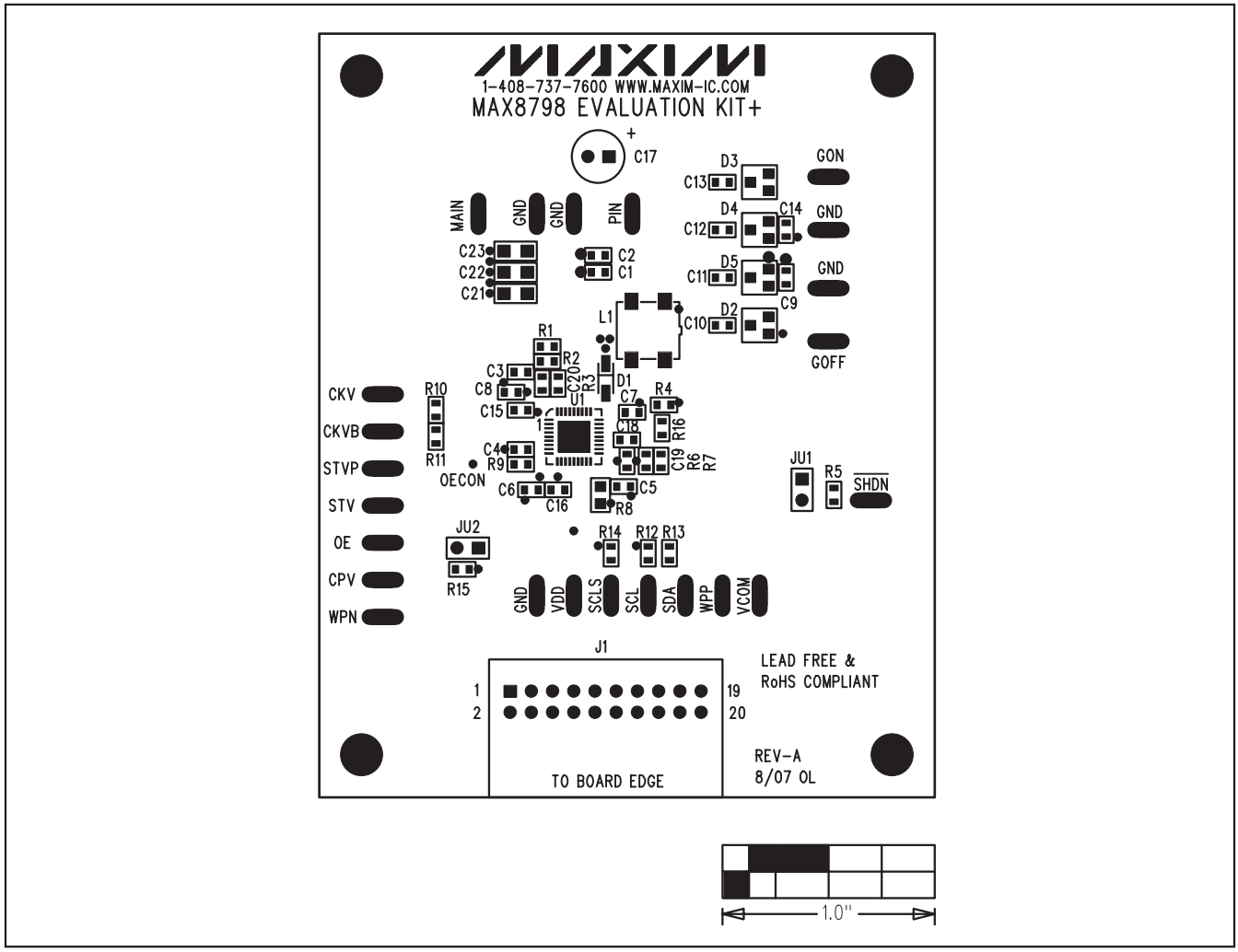

Figure 4. MAX8798 EV Kit Component Placement Guide—Component Side

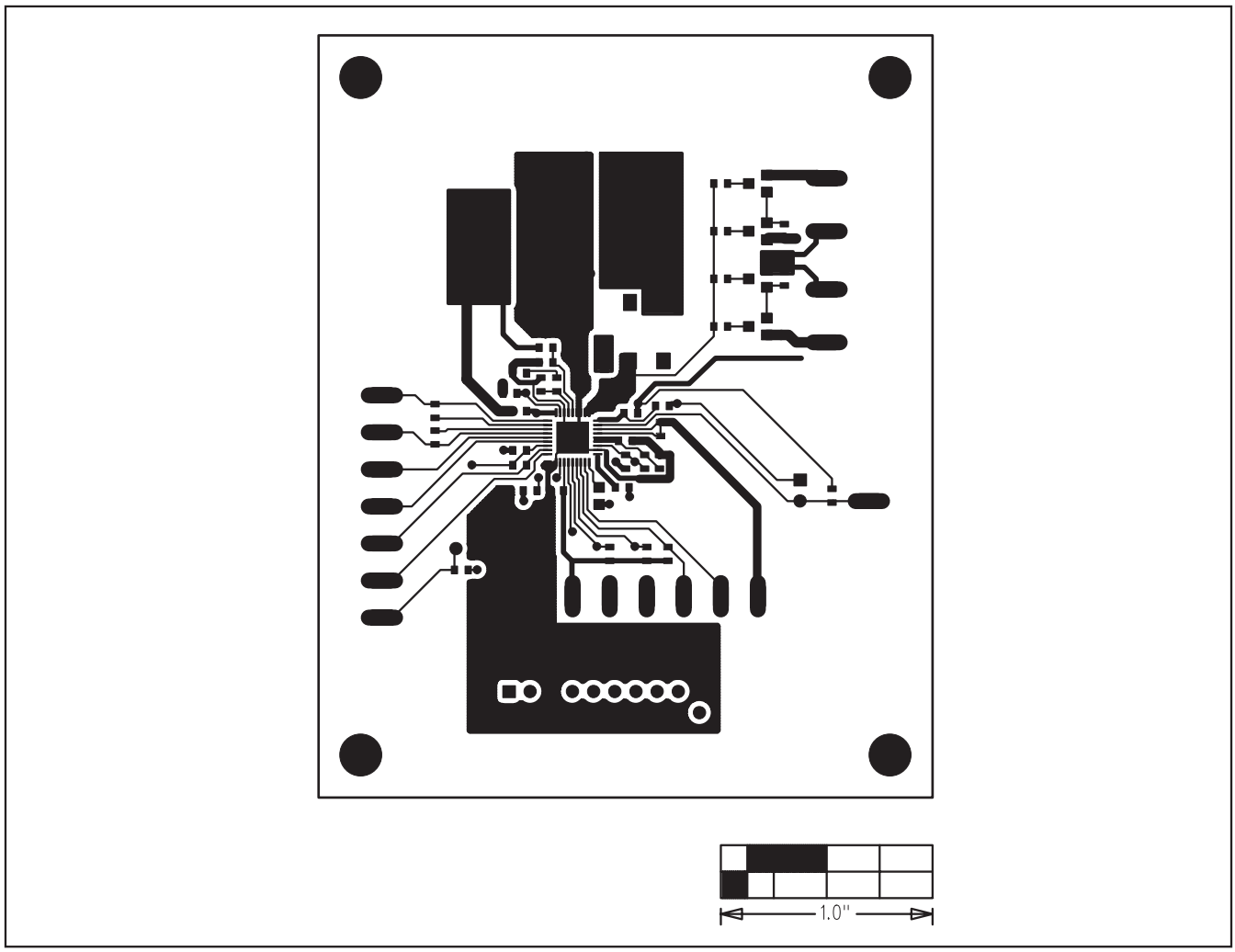

Figure 5. MAX8798 EV Kit PCB Layout—Component Side

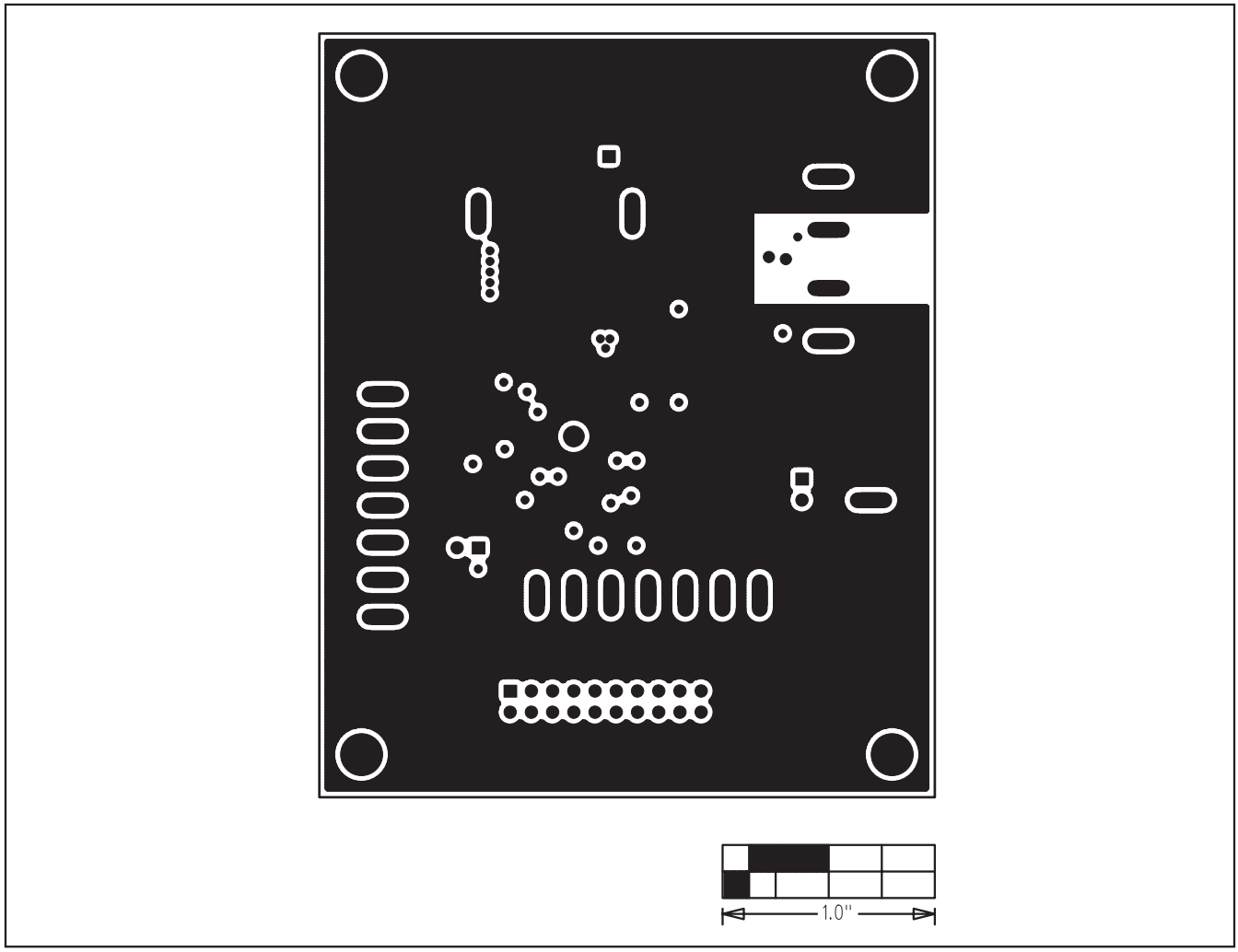

Figure 6. MAX8798 EV Kit PCB Layout—Layer 2

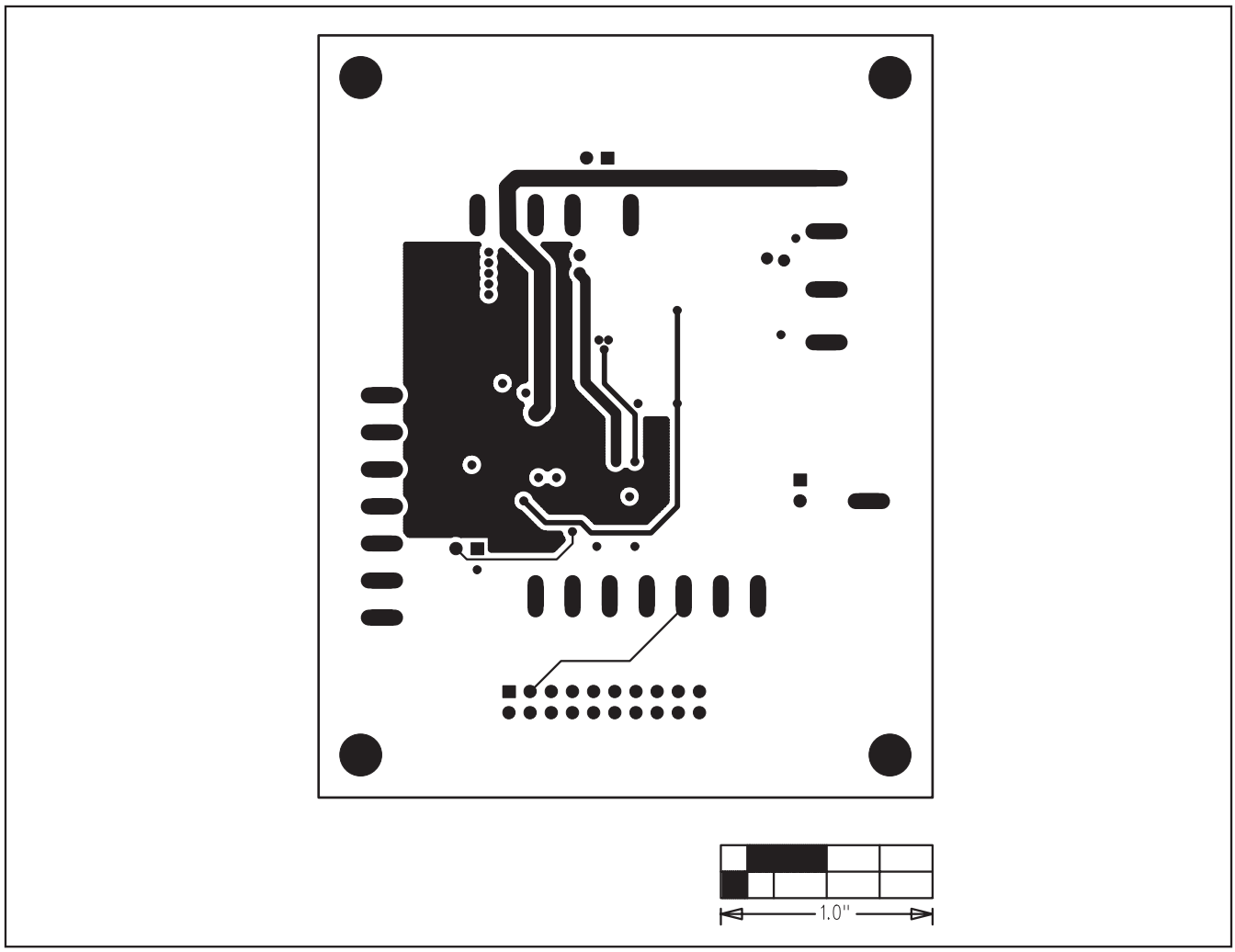

Figure 7. MAX8798 EV Kit PCB Layout—Layer 3

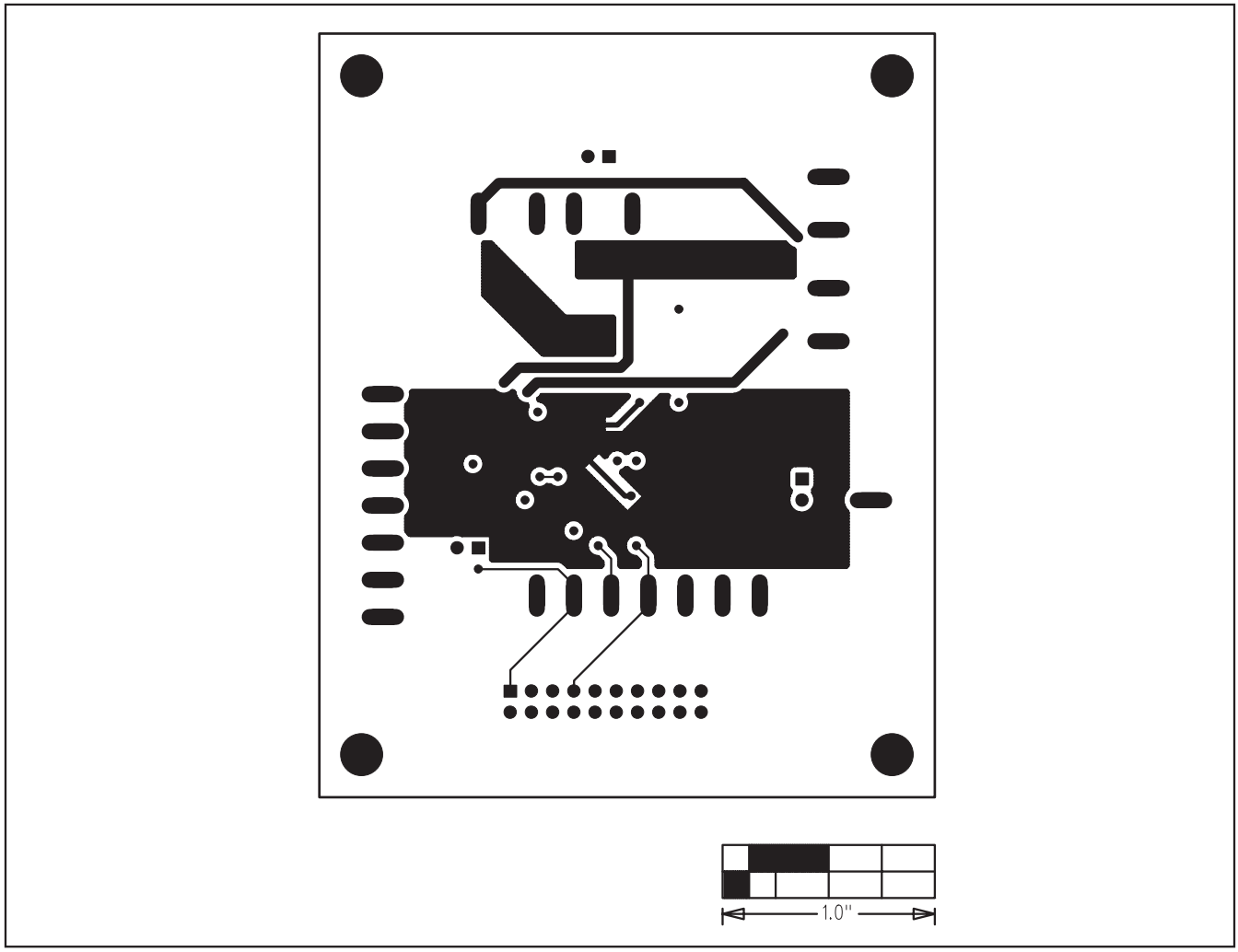

Figure 8. MAX8798 EV Kit PCB Layout—Solder Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/07	Initial release	—
1	9/08	Corrected part number for component L1.	2

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