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MAX17094 Evaluation Kit

Evaluates: MAX17094

General Description

The MAX17094 evaluation kit (EV kit) is a fully assembled and tested surface-mount PCB that provides the voltages and features required for active-matrix, thin-film transistor (TFT), liquid-crystal displays (LCDs). The EV kit contains a high-performance step-up switching regulator, a 250mA low-dropout (LDO) linear regulator, a high-speed op amp, a digitally adjustable VCOM calibrator, and seven high-voltage level-shifting buffers for scan-driver applications.

The EV kit operates from a DC supply voltage from +1.8V to +5.5V. The step-up switching regulator is configured for a +8V output providing at least 300mA from a +2.5V input. The positive charge pump is configured for a +21.5V output providing up to 30mA. The negative charge pump is configured for a -6.5V output providing up to 30mA. The op amp is capable of providing up to ±150mA peak and features a programmable output voltage initially configured for +3.2V. The low-voltage, low-dropout linear regulator can provide at least 250mA. The high-voltage, level-shifting scan driver buffers seven logic inputs and shifts them to a desired level to drive TFT LCD row logic.

The MAX17094 EV kit demonstrates low quiescent current and high efficiency (> 85%) for maximum battery life. Operation at 1.2MHz allows the use of tiny surface-mount components. The MAX17094 thin QFN package (0.8mm max height), with low-profile external components, allows this circuit to be less than 2mm high.

The MAX17094 EV kit provides an on-board I^{2}C/SMBus™ interface and connects to the computer through the universal serial bus (USB) port. The EV kit includes Windows® 2000/XP® and Windows Vista®-compatible software that provides a graphical user interface (GUI) for control of the MAX17094's programmable features.

Features

♦ **+1.8V to +5.5V Input Range**

♦ **Adjustable 450kHz to 1.2MHz Step-Up Switching Frequency**

♦ **Output Voltages**
    +8V Output at 300mA (Step-Up Switching Regulator)
    +21.5V Output at 30mA (Positive Charge Pump)
    -6.5V Output at 30mA (Negative Charge Pump)
    +2.5V at 250mA (Linear Regulator)
    ±150mA High-Current Op-Amp Output

♦ **Resistor-Adjustable Switching Regulator and Op-Amp Output Range**

♦ **Digitally Programmable Op-Amp Output Voltage**

♦ **+30V to -10V High-Voltage Level-Shifting Drivers**

♦ **> 85% Efficiency (Step-Up Switching Regulator)**

♦ **On-Board I^{2}C/SMBus Interface Control through USB**

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

♦ **2mm Low-Profile Surface-Mount Components**

♦ **Lead(Pb)-Free and RoHS Compliant**

♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX17094EVKIT+	EV Kit

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J475K TDK C1608X5R0J475K
C2, C3	2	1µF ±20%, 6.3V X5R ceramic capacitors (0402) Murata GRM155R60J105K TDK C1005X5R0J105M
C5	1	10µF ±20%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J106M TDK C1608X5R0J106K

DESIGNATION	QTY	DESCRIPTION
C6–C9, C14, C16–C19, C34	10	0.1µF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K TDK C1608X7R1H104K
C10	0	Not installed, ceramic capacitor (0805)
C11, C12	2	4.7µF ±10%, 16V X5R ceramic capacitors (0805) Murata GRM21BR61C475K Taiyo Yuden EMK212BJ475KG

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MAX17094 Evaluation Kit

DESIGNATION	QTY	DESCRIPTION
C13	1	1000pF ±10%, 50V X7R ceramic capacitor (0402) Murata GRM155R71H102K TDK C1005X7R1H102K
C15	1	0.47µF ±10%, 25V X5R ceramic capacitor (0603) Murata GRM188R71E474K TDK C1608X5R1E474K
C20–C27	8	100pF ±5%, 50V C0G ceramic capacitors (0402) Murata GRM1555C1H101J TDK C1005C0G1H101J
C28, C29, C31, C58–C65	0	Not installed, ceramic capacitors (0402)
C30	0	Not installed, through-hole OS-CON capacitor (OSCON-B)
C32	0	Not installed, ceramic capacitor (0603)
C33	1	15pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H150J TDK C1005C0G1H150J
C35	1	0.22µF ±10%, 16V X7R ceramic capacitor (0603) Murata GRM188R71C224K TDK C1608X7R1C224K
C36–C39, C42, C44	6	1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C105K TDK C1608X5R1C105K
C40, C43, C45	3	10µF ±10%, 16V X5R ceramic capacitors (0805) KEMET C0805C106K4PACTU
C41, C48–C53, C57	8	0.1µF ±10%, 16V X7R ceramic capacitors (0603) TDK C1608X7R1C104K Murata GRM188R71C104K
C46, C47	2	22pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H220J or TDK C1608C0G1H220J
C54, C55	2	10pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H100J TDK C1608C0G1H100J

DESIGNATION	QTY	DESCRIPTION
C56	1	0.033µF ±10%, 16V X5R ceramic capacitor (0603) Taiyo Yuden EMK107BJ333KA
C66–C73	8	3900pF ±10%, 50V X7R ceramic capacitors (0402) Murata GMD155R71H392K
D1, D2, D3	3	30V, 200mA dual diodes (3 SOT23) Zetex BAT54S Fairchild BAT54S
D4	1	30V, 1A Schottky diode (S-Flat) Toshiba CRS02
H1	0	Not installed, 2 x 5-pin JTAG header
JU1, JU3–JU11, JU14–JU21	18	3-pin headers
JU2	1	2-pin header
JU12, JU13	0	Not installed, 2-pin headers
L1	1	4.1µH, 1.95A, 57MΩ inductor (6mm x 6mm x 2mm) Sumida CDRH5D18NP-4R1NC Coiltronics SD6020-4R1-R
L2	1	Ferrite bead (0603) TDK MMZ1608R301A Murata BLM18SG700 TN1
P1	1	USB type-B right-angle PC-mount receptacle
R1	1	63.4kΩ ±1% resistor (0402)
R2, R16, R17	3	200kΩ ±1% resistors (0402)
R3	1	36.5kΩ ±1% resistor (0402)
R4	1	40.2kΩ ±1% resistor (0402)
R5	1	6.81kΩ ±1% resistor (0402)
R6	1	15kΩ ±1% resistor (0402)
R7, R9–R15, R28, R29	10	100kΩ ±5% resistors (0402)
R8, R32, R33, R34	0	Not installed, resistors (0603)
R18	1	21kΩ ±1% resistor (0402)
R19, R20	2	0Ω resistors (0402)
R21	1	24.9kΩ ±1% resistor (0402)
R22, R23, R26, R27, R48–R59	16	604Ω ±1% resistors (1206)
R24	1	80.6kΩ ±1% resistor (0402)

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R25	0	Not installed, resistor—shorted by PCB trace (0603)
R30, R31	2	10kΩ ±5% resistors (0402)
R35	1	169kΩ ±1% resistor (0603)
R36	1	100kΩ ±1% resistor (0603)
R37, R38	2	27Ω ±5% resistors (0603)
R39	1	1.5kΩ ±5% resistor (0603)
R40	1	2.2kΩ ±5% resistor (0603)
R41	1	470Ω ±5% resistor (0603)
R42	1	10kΩ ±5% resistor (0603)
R43–R47	0	Not installed, resistors—shorted by PCB trace (0402)
SW1	1	7-position low-profile surface-mount DIP switch
SW2	1	2-position low-profile surface-mount DIP switch
U1	1	Internal switch boost regulator (48 TQFN-EP*) Maxim MAX17094ETM+

DESIGNATION	QTY	DESCRIPTION
U2	1	Microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
U3	1	2.5V LDO regulator (5 SO70) Maxim MAX8511EXK25+
U4	1	Adjustable output LDO regulator (5 SO70) Maxim MAX8512EXK+
U5	1	UART-to-USB converter (32 TQFP) FTDI FT232BL
U6	1	93C46 type (64k x 16) 3-wire EEPROM (8 SO) Atmel AT93C46EN-SH-B
U7, U8	2	Logic-level translators (10 µMAX®) Maxim MAX1840EUB+
Y1	1	16MHz crystal
Y2	1	6MHz crystal
—	19	Shunts
—	1	PCB: MAX17094 EVALUATION KIT+

EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Cooper Bussmann	916-941-1117	www.cooperet.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
KEMET Corp.	864-963-6300	www.kemet.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Sumida Corp.	847-545-6700	www.sumida.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
Toshiba America Electronic Components, Inc.	949-623-2900	www.toshiba.com/taec
Zetex Semiconductors	631-543-7100	www.zetex.com

Note: *Indicate that you are using the MAX17094 when contacting these component suppliers.*

MAX17094 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX17094.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
TROUBLESHOOTING_USB.PDF	USB driver installation help file

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MAX17094 Evaluation Kit

Quick Start

Recommended Equipment

- 1.8V to 5.5V, 2A DC power supply
- User-supplied Windows 2000/XP or Windows Vista 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.

Procedure

The MAX17094 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 JU2.

2) Set an external power supply to ≈ +3.3V. Connect the positive terminal of the power supply to the VIN pad. Connect the negative terminal of the power supply to the PGND pads closest to VIN.

3) Turn on the power supply and verify that the step-up switching regulator output (MAIN) is +8V.

4) Verify that the positive charge-pump supply (VP) is approximately +24V.

5) Verify that the negative charge-pump supply (VN) is approximately -8.8V.

6) Verify that the linear regulator output (VLOGIC) is approximately 2.5V.

7) Visit **www.maxim-ic.com/evkitsoftware** to download the latest version of the MAX17094 EV kit software, MAX17094Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.

8) 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.

9) Connect the USB cable from the PC to the EV kit 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 30 seconds, 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.

10) 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\MAX17094** (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 included with the software for additional information.

11) Start the MAX17094 EV kit software by opening its icon in the **Start | Programs** menu.

12) Normal device operation is verified when **MAX17094 device connected** appears in the **status bar** on the MAX17094 EV kit main window (Figure 1).

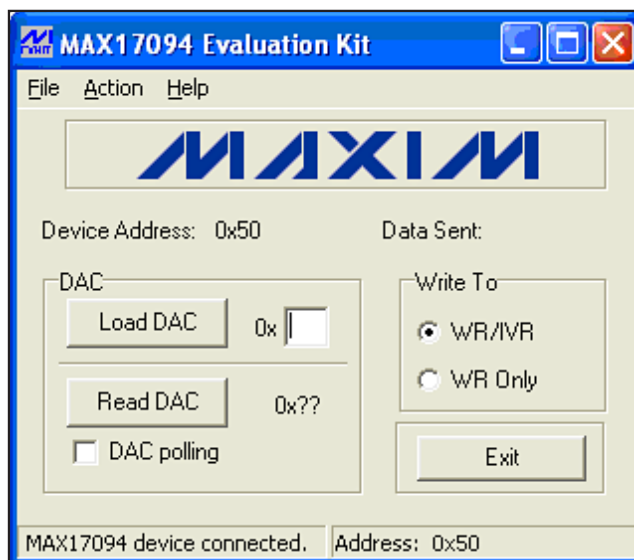13) Verify that the output of the high-speed op amp (VCOM) is approximately +3.2V.

Figure 1. MAX17094 EV Kit Software Main Window

__Detailed Description of Hardware

The MAX17094 EV kit contains a high-performance step-up switching regulator, a 250mA LDO, a positive two-stage charge pump, a negative single-stage charge pump, a high-speed op amp, and seven high-voltage level-shifting buffers for scan-driver applications. The EV kit operates from a DC power supply between +1.8V and +5.5V that provides at least 2A.

As configured, the step-up switching regulator (VMAIN) generates a +8V output and provides at least 300mA. The step-up switching-regulator output voltage can be adjusted up to +14V with different feedback resistors (see the *Output-Voltage Selection* section).

The GON consists of two positive charge-pump stages to generate approximately +21.5V and provides up to 30mA. The GOFF consists of a single negative charge-pump stage to generate approximately -6.5V and provides up to 30mA. Loading GON and GOFF reduces the available VMAIN current proportionally.

The op-amp output (VCOM) is SMBus programmable and is configured for a +2.4V to +4V output-voltage range. VCOM can source or sink peak current up to 150mA. The output-voltage range can be reconfigured to other voltages with voltage-divider resistors R16 and R17. Refer to the *Setting the VCOM Adjustment Range* section in the MAX17094 IC data sheet for more details.

The seven logic-level to high-voltage level-shifting buffers can buffer seven logic inputs (A2–A8) and shift them to a desired level (Y2–Y8) to drive TFT LCD row logic. Each buffer outputs the voltage on the GOFF pin (set through JU1) when its respective input is logic-low. Each buffer (Y2–Y6) outputs the voltage-on GON1 (set through JU3) when its respective input is logic-high. Similarly, Y7 and Y8 output the voltage on GON2 (set through JU4).

The seven switches within SW1 are used to select logic levels on A2–A8 for testing purposes. Set each switch

open when driving A2–A8 with external logic. Use jumpers JU14–JU18 to select between capacitive loads on outputs Y2–Y8 and YDCHG for testing purposes.

GOFF Power Supply (JU1)

The MAX17094 EV kit incorporates jumper JU1 to provide an option to supply the gate-off (GOFF) supply. GOFF can be supplied either through the on-board negative charge pump (VN) or with an externally applied voltage at the GOFF pad. See Table 1 for jumper JU1 configuration.

Enable (JU2)

The MAX17094 EV kit incorporates jumper JU2 to enable/disable the IC outputs. When EN is pulled low, the DC-DC converter and op amp are disabled. The high-voltage drivers and LDO will remain active if sufficient voltage is available for operation. See Table 2 for jumper JU2 configuration.

GON1, GON2 Power Supply (JU3, JU4)

The MAX17094 EV kit incorporates jumpers JU3 and JU4 to provide an option to supply the gate-on (GON1, GON2) supplies. GON1 and GON2 can be supplied either through the on-board positive charge pump (VP) or with an externally applied voltage at the respective GON_ pad. See Table 3 for jumpers JU3 and JU4 configuration.

Table 2. Jumper JU2 Functions

SHUNT POSITION	EN PIN	EV KIT OUTPUTS
Installed*	Connected to VIN	Outputs enabled (MAIN = +8V)
Not installed	Pulled to AGND through R7	Outputs disabled (MAIN ≈ VIN)

*Default position.

Table 1. Jumper JU1 Functions

SHUNT POSITION	GOFF PIN
1-2*	Supplied on board through negative charge pump (VN)
2-3	External user-supplied voltage applied at GOFF pad

*Default position.

Table 3. Jumper JU3, JU4 Functions

SHUNT POSITION	GON_ PIN
1-2*	Supplied on board through positive charge pump (VP)
2-3	External user-supplied voltage applied at GON_ pad

*Default position.

Level-Shifter Logic-Level Inputs (JU5–JU11)

The MAX17094 level-shifter inputs can be supplied either using the on-board logic or from an externally applied signal through configuration of jumpers JU5–JU11. Additionally, when using on-board logic, SW1 controls the logic levels based on its own settings. When SW1 is on, the logic input is high. When SW1 is off, the logic input is pulled low through a 100kΩ pull-down resistor. See Table 4 for jumpers JU5–JU11 configuration.

Level-Shifter Output Loading (JU14–JU21)

The MAX17094 EV kit incorporates jumpers JU14–JU21 to provide loading options at the level-shifter outputs, YDCHG and Y2–Y8. See Table 5 for jumpers JU14–JU21 configuration.

Output-Voltage Selection

The MAX17094 EV kit's step-up switching-regulator output (VMAIN) is set to +8V by feedback resistors R2 and R3. To generate output voltages other than +8V (up to +14V), select different external voltage-divider resistors, R2 and R3. Note that changing the VMAIN voltage setting changes the VN and VP charge-pump output voltages. Refer to the *Main Step-Up Regulator* and *Output-Voltage Selection* sections in the MAX17094 IC data sheet for more information.

__Detailed Description of Software

The MAX17094 device includes a calibrator 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 from a current source connected to the POS terminal of the op amp. This is accomplished by programming the desired setting into the device's 7-bit internal DAC. The MAX17094 supports four different I^2C slave addresses; configure SW2 to select between different addresses. Refer to the MAX17094 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 MAX17094 EV kit software, the device's 7-bit internal DAC is configured by entering an appropriate DAC setting into the **Load DAC** edit box. The DAC setting can be set from 0x00 ($VCOM_{MIM}$) to 0x7F ($VCOM_{MAX}$). The DAC setting is written to the device by pressing the **Load DAC** button (Figure 1).

Reading 7-Bit DAC

The MAX17094 7-bit DAC is read by either pressing the **Read DAC** button or by checking the **DAC polling** checkbox. When checked, the software continuously reads and displays the DAC's current setting.

Access Control Register

The **Write To** group box is used to select whether volatile (WR) or nonvolatile (IVR) memory is accessed during read and write cycles involving the data register. When the **WR/IVR** radio button is selected, data on the data register is written to both the WR and IVR. When the **WR Only** radio button is selected, data on the data register is written to the WR only.

Simple SMBus Commands

There are two methods for communicating with the MAX17094: through the MAX17094 EV kit software main window (Figure 1), or through the interface window available by selecting the **Action | Interface Diagnostic Window** 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 6 for details regarding SMBus commands.

The **Command byte** and **Data Out** combo 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 2 for an illustration of this tool.

Table 4. Jumper JU5–JU11 Functions

SHUNT POSITION	A2–A8 INPUT PINS
1-2	Supplied through external signal applied at A2–A8 pad
2-3*	Supplied on board based on SW1 states

*Default position.

Table 5. Jumper JU14–JU21 Functions

SHUNT POSITION	YDCHG, Y2–Y8 PINS
1-2*	Minimum loading
2-3	Maximum loading

*Default position.

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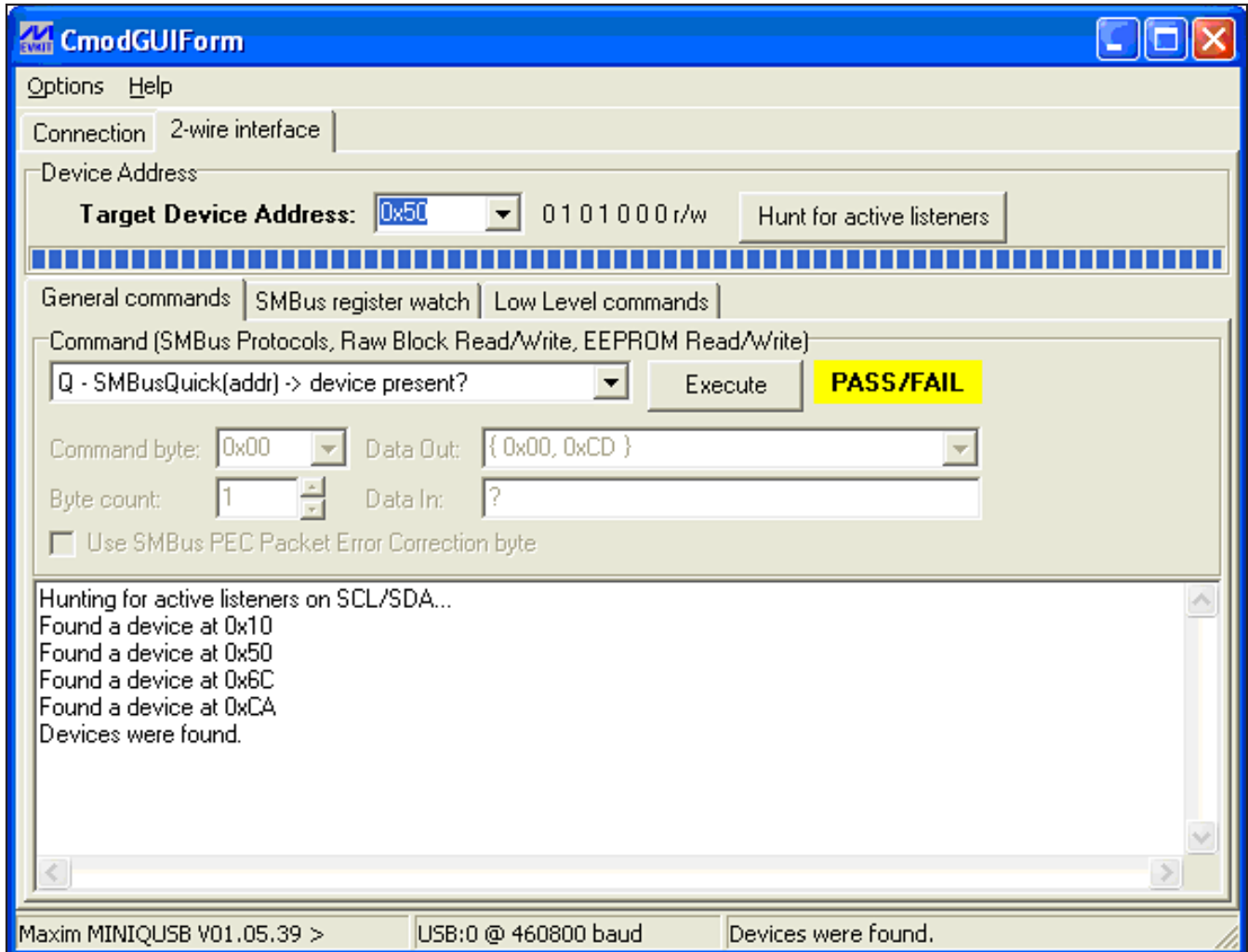
Figure 2. Command Module Interface Window

Table 6. SMBus Commands

CONTROL	SMBus COMMAND	FORMAT
Load DAC	SMBusWriteByte	Input the desired 7-bit DAC setting into the **Data Out** combo box. The 7-bit DAC value should be stored in the lower 7 bits (b6–b0) of the byte; the MSB is ignored.
Read DAC	SMBusReadByte	Receives 8 bits from the device. The lower 7 bits correspond to the current DAC setting and the MSB is ignored.
Device search	SMBusQuick	Search for device address shown in the **Target Device Address** combo box. The MAX17094 device address can be 50, 52, 54, or 56.
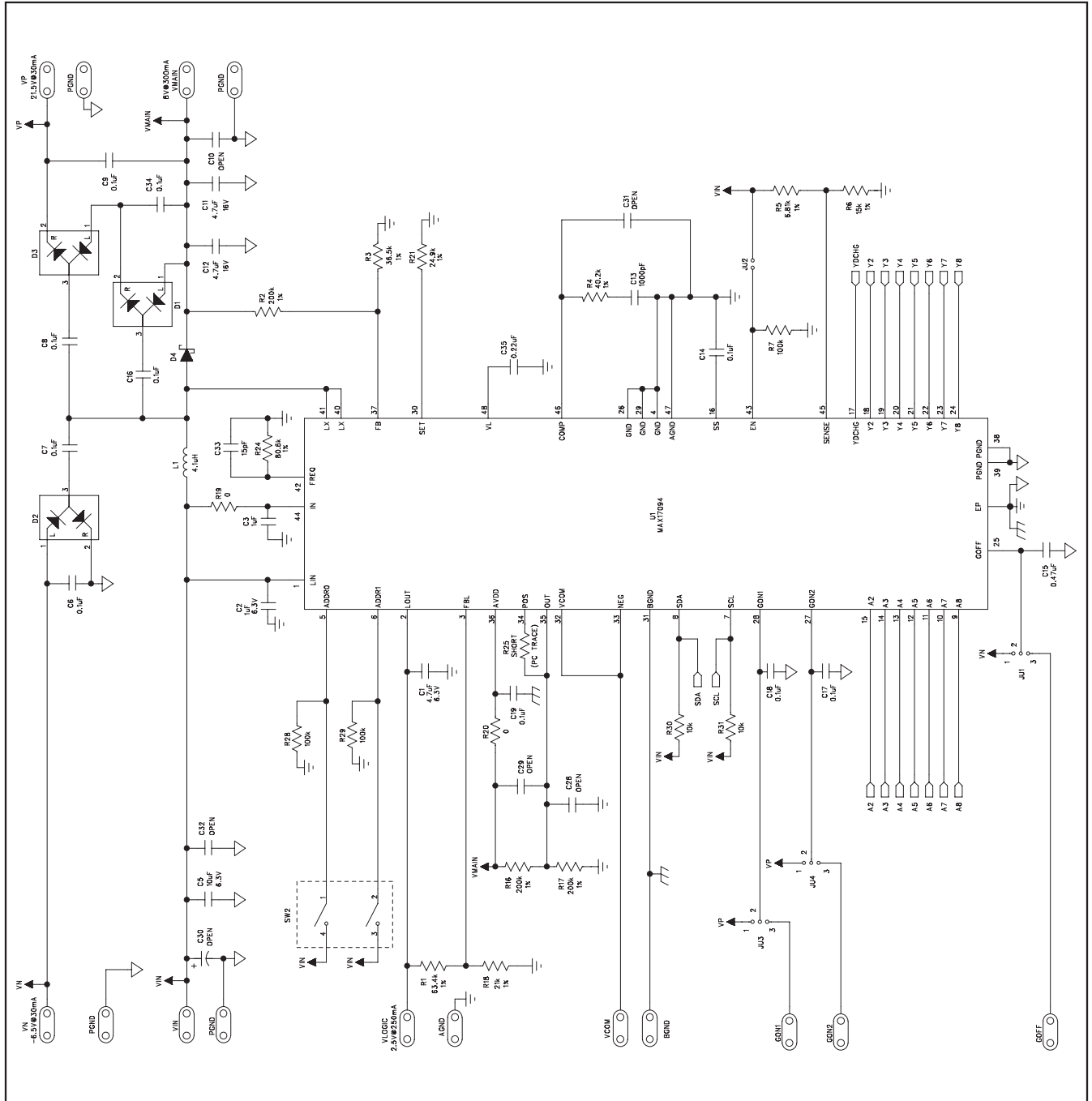
Figure 3a. MAX17094 EV Kit Schematic (Sheet 1 of 3)
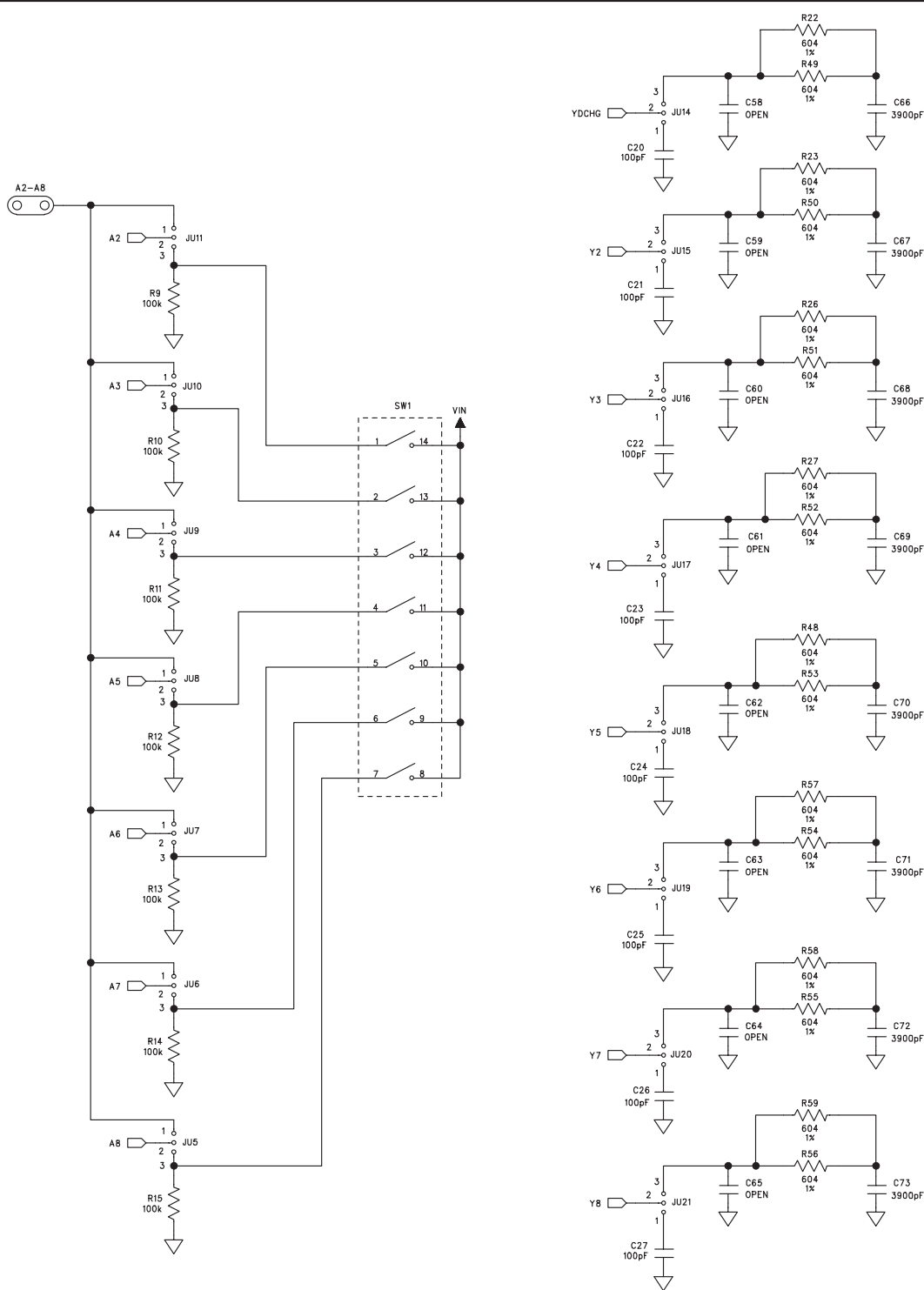
Figure 3b. MAX17094 EV Kit Schematic (Sheet 2 of 3)
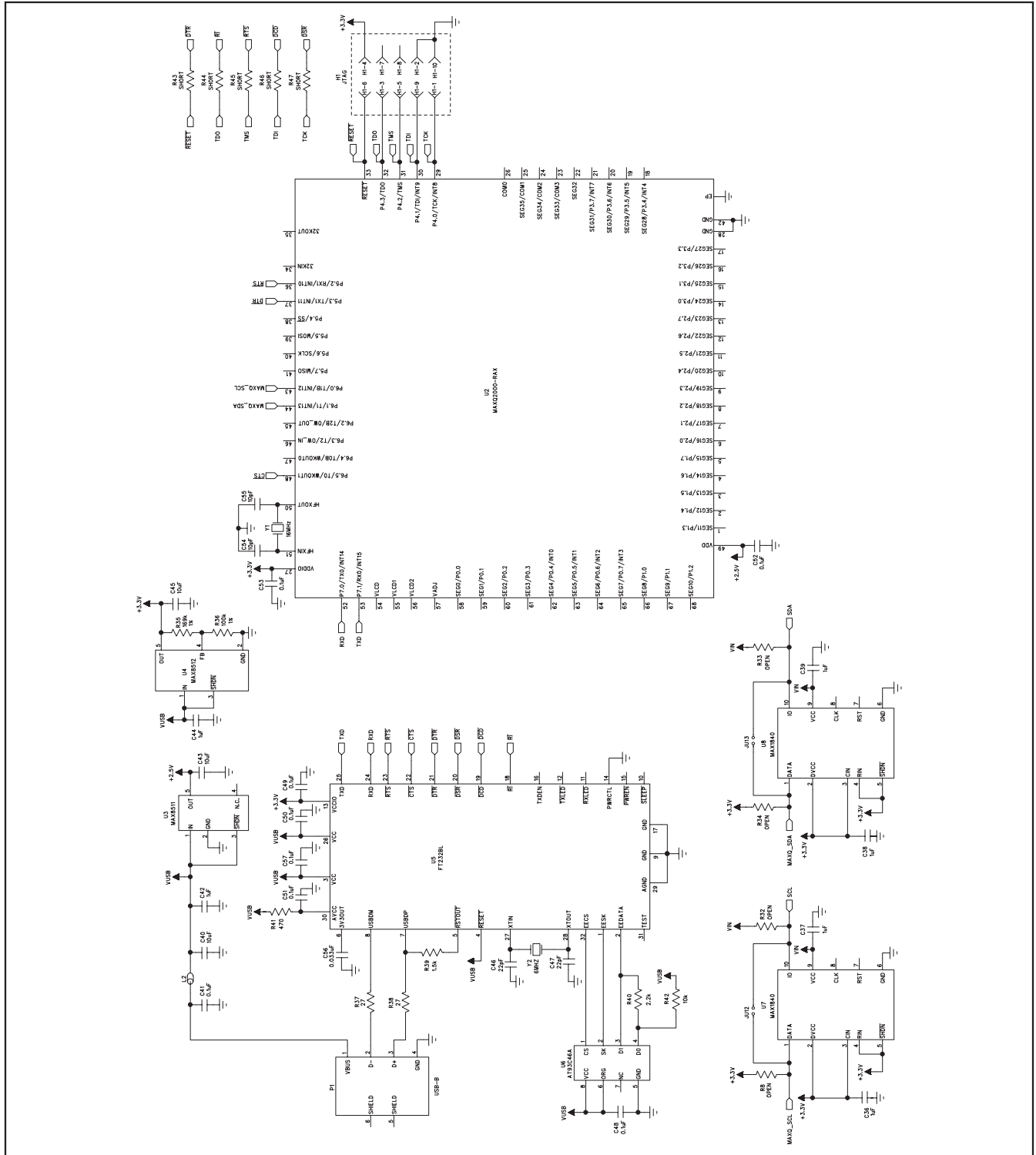
Figure 3c. MAX17094 EV Kit Schematic (Sheet 3 of 3)

/MAXIM
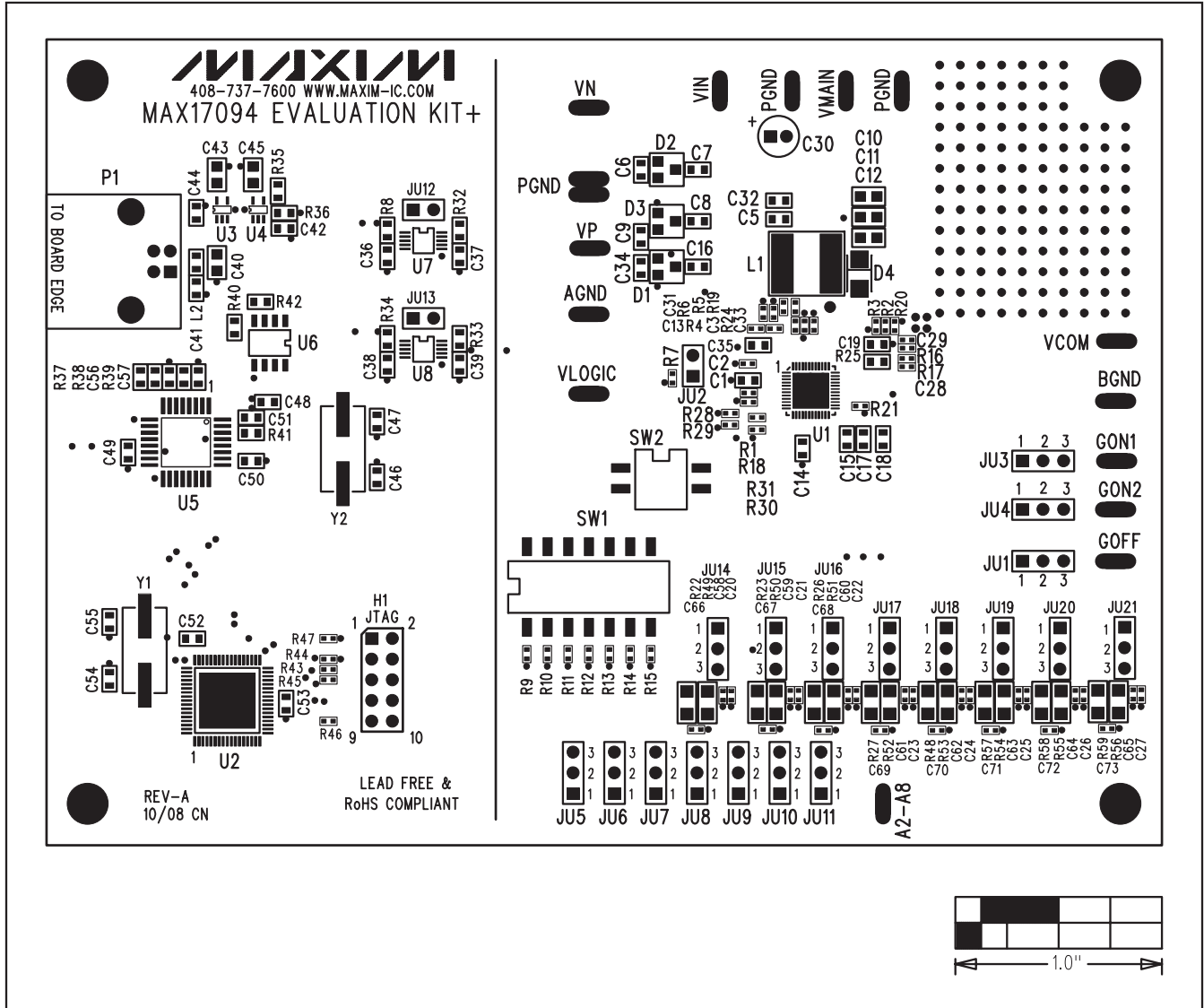
Figure 4. MAX17094 EV Kit Component Placement Guide—Component Side

Figure 5. MAX17094 EV Kit PCB Layout—Component Side

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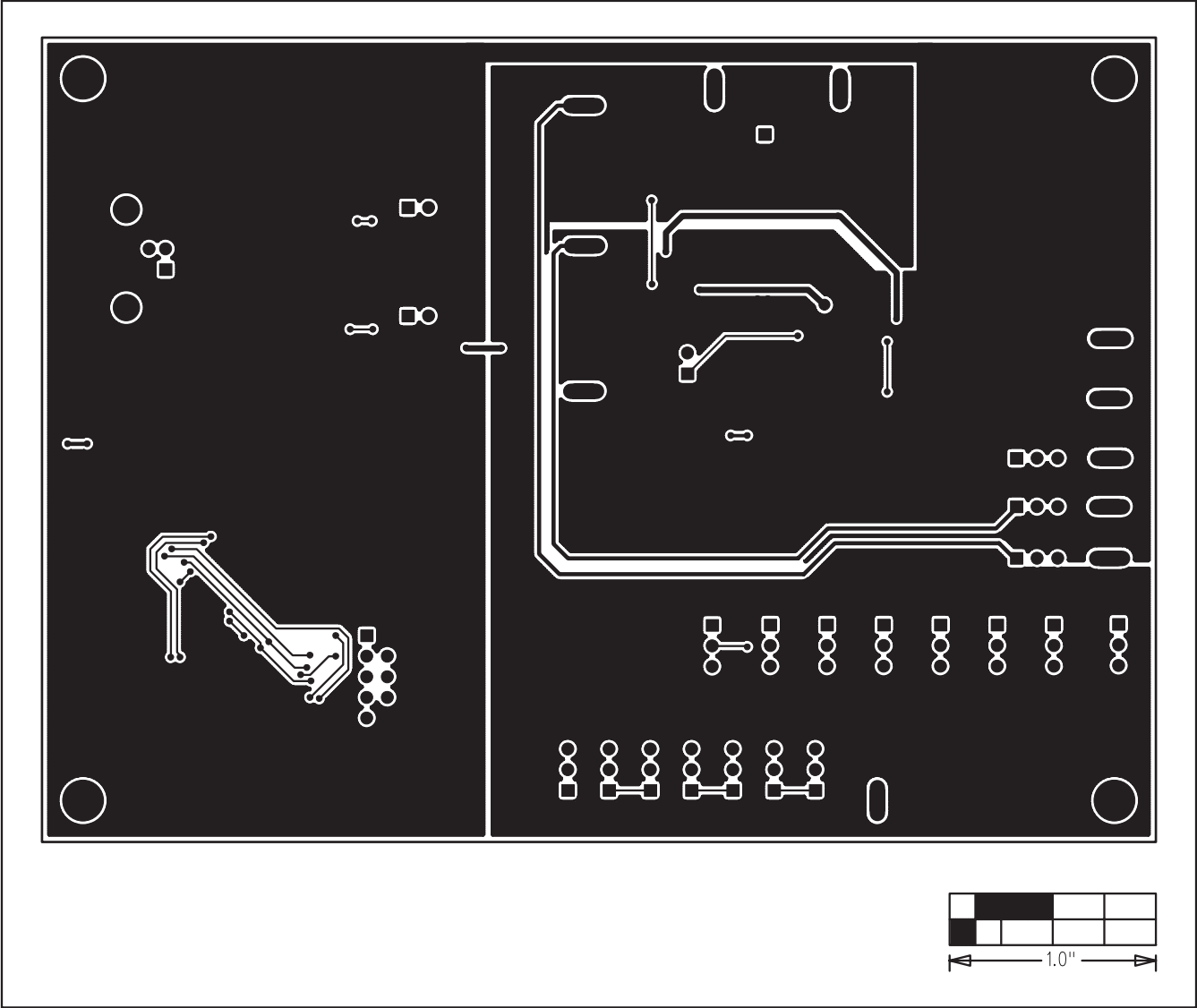
Figure 6. MAX17094 EV Kit PCB Layout—Solder Side

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