



# MAX134 Evaluation Kit

Evaluates: MAX134

## General Description

The MAX134 evaluation kit (EV kit) provides a proven design to evaluate the MAX134 3¾-digit digital multi-meter. The EV kit measures volts, ohms, or milliamps, with conversion results displayed on a 4-digit LCD display. An on-board MAXQ2000 microcontroller controls the MAX134, the LCD display, and communicates with a PC over an optoisolated USB link. Software included with the EV kit demonstrates the features of the MAX134 and is provided as an aid in software development. In addition to the microcontroller code, the EV kit includes an application program compatible with Windows XP®, Windows Vista®, and Windows® 7. This program provides a graphical user interface (GUI) to control the MAX134 registers and view conversion results.

**Warning:** For safety reasons, the input voltage is limited to 40V (max). Be sure to read the information contained in the *Multiple Grounds* section.

## Features

- ◆ Windows XP-, Windows Vista-, and Windows 7-Compatible Software
- ◆ USB-PC Connection (Cable Included)
- ◆ Powered by Three AA Batteries (Not Included)
- ◆ Optional 9V Battery Operation
- ◆ Measures Voltage and Resistance on Multiple Ranges (40V Max)
- ◆ Measures Current on a Fixed 400mA Range
- ◆ On-Board LCD Display of Conversion Results
- ◆ Proven PCB Layout
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX134EVKIT#	EV Kit

#Denotes an RoHS-compliant device that may include lead(Pb) that is exempt under the RoHS requirements.

## Component List

DESIGNATION	QTY	DESCRIPTION
B1	1	3-cell AA battery holder Keystone 2464
C1, C2, C3, C14, C17, C22, C30, C34, C37, C38, C41, C44, C47	13	1µF ±20%, 16V X5R ceramic capacitors (0805) TDK C2012X5R1C105M
C4	0	Not installed, ceramic capacitor (1206)
C5–C8, C18, C36, C39, C43, C53	0	Not installed, ceramic capacitors (0805)
C9	1	10pF ±5%, 100V ceramic capacitor (0805)
C10, C11, C54	3	0.047µF ±10%, 50V ceramic capacitors (0805)
C12	1	4700pF ±2.5% polypropylene capacitor (radial) WIMA FKP24700/63/2.5

DESIGNATION	QTY	DESCRIPTION
C13, C19, C20, C23–C27, C32, C33, C49, C50	12	0.1µF ±20%, 25V ceramic capacitors (0805)
C15, C16, C21, C29, C31, C35, C40, C42	8	0.01µF ±10%, 50V ceramic capacitors (0805)
C28, C45, C46, C56	4	10µF ±20%, 16V ceramic capacitors (1206) KEMET C1206C106M4PAC TDK C3216X5R1C106M
C48	1	100µF ±20%, 6.3V ceramic capacitor (1210) TDK C3225X5R0J107M
C51, C52	2	10µF ±10%, 25V ceramic capacitors (1206) Murata GRM31CR61E106K
C55	1	0.22µF ±10%, 50V ceramic capacitor (0805) TDK C2012X7R1H224KT

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D1	1	5V shunt reference diode (3 SC70) Maxim LM4050AIX3-5.0
D2	1	Dual signal diode, common cathode (3 SOT23) Central Semi CMPD2838 Lead Free
D3	1	Signal diode (3 SOT23) Central Semi CMPD4448 Lead Free
D4	1	Dual Schottky diode, series (3 SOT23) Central Semi CMPD6263S Lead Free
F1	1	0.75A PICO fuse (axial) Littelfuse 0263.750MXL
J1, J2, J3	3	Red banana jacks
J4	1	Black banana jack
J5	1	2 x 5 header (with pin 7 removed)
J6	1	USB B connector AMP/Tyco 787780-1
JU1, JU4	2	3-pin headers
JU2, JU3, JU5, JU6	4	2-pin headers
JU7, JU8	0	Not installed, 2-pin headers—shorted (PCB trace)
LCD1	1	4½-digit, 3.3V LCD display
PT1	1	Peizo audio transducer CUI Inc. CMT-1603
Q1	1	General-purpose npn transistor (3 SOT23) Central Semi CMPT3904 Lead Free
R1	1	1.6k $\Omega$ PTC thermistor (radial) Vishay 2381 660 93034
R2	1	64.9k $\Omega$ $\pm$ 1% resistor (0805)
R3	1	49.9k $\Omega$ $\pm$ 1% resistor (0805)
R4	1	50k $\Omega$ 11-turn trim potentiometer Murata PVG5H503C01R00
R5	0	Not installed, 1/2W axial resistor

DESIGNATION	QTY	DESCRIPTION
R6	1	10M $\Omega$ $\pm$ 1% resistor (1206)
R7	1	1.10M $\Omega$ $\pm$ 1% resistor (0805)
R8	1	100k $\Omega$ $\pm$ 1% resistor (0805)
R9	1	10k $\Omega$ $\pm$ 1% resistor (0805)
R10	1	1k $\Omega$ $\pm$ 1% resistor (0805)
R11, R12, R39	3	249k $\Omega$ $\pm$ 1% resistors (0805)
R13	1	1 $\Omega$ $\pm$ 1%, 1/2W resistor (2010)
R14	1	1.00M $\Omega$ $\pm$ 1% resistor (0805)
R15	1	1.20M $\Omega$ $\pm$ 1% resistor (0805)
R16, R17	2	301k $\Omega$ $\pm$ 0.1% resistors (1206)
R18, R33, R37, R40, R54, R60, R61, R64	8	10k $\Omega$ $\pm$ 5% resistors (0805)
R19, R20	2	33.2 $\Omega$ $\pm$ 1% resistors (0805)
R21, R22, R25, R26, R31, R32	6	1.5k $\Omega$ $\pm$ 5% resistors (0805)
R23, R24, R46, R52	4	1k $\Omega$ $\pm$ 5% resistors (0805)
R27, R28, R29, R30, R62, R63	6	510 $\Omega$ $\pm$ 5% resistors (0805)
R34	1	169k $\Omega$ $\pm$ 1% resistor (0805)
R35, R38, R41	3	75 $\Omega$ $\pm$ 5% resistors (0805)
R36	1	80.6k $\Omega$ $\pm$ 1% resistor (0805)
R42	1	16k $\Omega$ $\pm$ 5% resistor (0805)
R43, R47, R48	3	300k $\Omega$ $\pm$ 5% resistors (0805)
R44, R45	2	100k $\Omega$ $\pm$ 5% resistors (0805)
R49, R58	2	51k $\Omega$ $\pm$ 5% resistors (0805)
R50	1	2.2M $\Omega$ $\pm$ 1% resistor (0805)
R51, R55, R56	3	10k $\Omega$ $\pm$ 0.1% resistors (1206) Vishay/Dale TNPW120610K0BEEN
R53	1	390k $\Omega$ $\pm$ 5% resistor (0805)
R57	1	200k $\Omega$ $\pm$ 5% resistor (0805)
R59	1	20 $\Omega$ $\pm$ 5% resistor (0805)
SW1	1	3-pole, 4-position rotary switch
SW2	1	Right-angle slide switch
SW3	1	Side-mount pushbutton switch (SMD)
TP1, TP6	2	Red test points (through hole)
TP2–TP5, TP10–TP21	0	Not installed, test points

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
U1	1	3¾-digit digital multimeter (44 PLCC) Maxim MAX134CQH+
U2	1	1.25V voltage reference (8 SO) Maxim MAX6190BESA+
U3	1	Low-power LCD microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
U4	0	Not installed
U5	1	Octal level translator (20 TSSOP) Maxim MAX3002EUP+
U6	1	Quad level translator (14 TSSOP) Maxim MAX3377EEUD+
U7	1	3.3V regulator with reset (6 SOT23) Maxim MAX6349TLUT+
U8, U9, U11	3	Dual phototransistor optocouplers (8 SO) Vishay Semiconductors ILD217T
U10	1	USB controller (32 LQFP) Maxim MAX3420EECJ+

DESIGNATION	QTY	DESCRIPTION
U12	1	Switched capacitor voltage inverter (5 SOT23) Maxim MAX828EUK+
U13	1	Quad op amp (14 SO) Maxim MAX4164ESD+
U14, U15	2	Dual op amp (10 µMAX®) Maxim MAX9913EUB+
Y1	1	32kHz (12.5pF load) crystal (SMD) ECS, Inc. ECS-.327-12.5-17X-TR
Y2	1	8MHz resonator (SMD) AVX Corp. PBRC-8.00HR
Y3	1	32kHz (6pF load) crystal (SMD) ECS, Inc. ECS-.327-6-17X-TR
Y4	1	12MHz resonator (SMD) AVX Corp. PBRC-12.00HR
—	6	Shunts (JU1–JU6)
—	1	Pointer knob for SW1
—	1	USB high-speed A-to-B cable, 6ft
—	1	PCB: MAX134 EVALUATION KIT#

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

\*EP = Exposed pad.

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corporation	843-946-0238	www.avx.com
Central Semiconductor Corp.	631-435-1110	www.centalsemi.com
CUI Inc.	503-612-2300	www.cui.com
ECS, Inc. International	800-237-1401	www.ecsxtal.com
KEMET Corp.	864-963-6300	www.kemet.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com
WIMA	914-347-2474	www.wima.com

**Note:** Indicate that you are using the MAX134 when contacting these component suppliers.

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## MAX134 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit on your computer
MAX134.EXE	Application program
UNINSTALL.INI	Uninstalls the EV kit software
134MAXQ.ZIP	MAXQ2000 source code

## Quick Start

### Required Equipment

- MAX134 EV kit (USB cable included)
- Three AA batteries
- User-supplied Windows XP, Windows Vista, or Windows 7 PC with a spare USB port
- Test leads with standard banana plug connectors
- Input-voltage source, current source, or resistor to be measured

**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

**Warning:** For safety reasons, the input voltage is limited to 40V (max). Be sure to read the information contained in the *Multiple Grounds* section before connecting test equipment.

**Note:** Batteries must be used to power the MAX134 EV kit. Replacing the batteries with an external power supply may create a ground loop that could damage the board.

The EV kit is fully assembled and tested. Operation in each of the functions (VOLTS, 400mV, KOhms, or 400mA) can be verified without connecting to a PC. Follow the steps below to verify board operation:

- 1) Verify that the power switch (SW2) is in the off position and insert three AA batteries.
- 2) Verify that all jumpers are in their default positions, as listed in Table 1.
- 3) Place the function selection switch (SW1) in the 400mA position.
- 4) Slide power switch SW2 to the on position.
- 5) The LCD display should indicate 000.0.

### Voltmeter Operation

- 1) Place the SW1 switch in the VOLTS position.
- 2) Insert test leads into J1 (VOLTS) and J4 (COM).
- 3) Connect the leads to a known voltage source ( $\pm 40V$  max).
- 4) The input voltage should appear on the LCD.

### 400mV Operation

- 1) Place the SW1 switch in the 400mV position.
- 2) Insert test leads into J2 (400mV/KOhms) and J4 (COM).
- 3) Connect the leads to a known voltage source ( $\pm 400mV$ ).
- 4) The input voltage should appear on the LCD.

### KOhms Operation

- 1) Place the SW1 switch in the KOhms position.
- 2) Insert test leads into J2 (400mV/KOhms) and J4 (COM).

**Table 1. Jumper Functions (JU1–JU6)**

JUMPER	SHUNT POSITION	DESCRIPTION
JU1	1-2*	MAX134 VREF = 545mV
	2-3	MAX134 VREF is determined by potentiometer R4
JU2	1-2*	Normal battery connection
	Open	Place an ammeter across JU2 to measure battery current
JU3	1-2*	Configuration for 3 AA batteries (MAX828 input to BATT+)
	Open	Configuration for 9V battery (MAX828 disconnected)
JU4	1-2*	Configuration for 3 AA batteries (V- to MAX828 output)
	2-3	Configuration for 9V battery (V- connected to BATT-)
JU5	1-2*	Normal operation
	Open	Remove when measuring battery current
JU6	1-2*	Normal operation
	Open	Remove when measuring battery current

\*Default position.

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- 3) Connect the leads to a known resistor (0 to 4MΩ).
- 4) The resistor value (in kilohms) should appear on the LCD.

### 400mA Operation

- 1) Place the SW1 switch in the 400mA position.
- 2) Insert test leads into J3 (400mA) and J4 (COM).
- 3) Connect the leads to a known current source ( $\pm 400\text{mA}$ ).
- 4) The input current should appear on the LCD.

**Note:** There is a 0.75A fuse (F1) in series with J3. This fuse protects the current-sense resistor.

### Software Installation

The EV kit application program allows the user to set the MAX134 input registers and enable the various MAX134 features. Follow the steps below to install the program:

- 1) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to download the latest version of the EV kit software, 134Rxx.ZIP. Save the 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) Set up the EV kit to make measurements in one of the modes listed in the *Procedure* section.
- 4) Connect the USB cable from the EV kit to an available USB port on the PC. The software uses the human interface device (HID) drivers present in Windows XP and Windows Vista, so no additional drivers are loaded. The PC should indicate that new hardware has been found and the driver located for the EV kit.
- 5) Start the EV kit software by opening the icon in the **Start | Programs** menu. The EV kit window appears, as shown in Figure 1.
- 6) Clicking on the **Connect** menu item in the main menu bar connects the application program to the board. Connection status is shown in the status bar at the bottom of the window. The displayed readings are now updated at the end of each conversion.

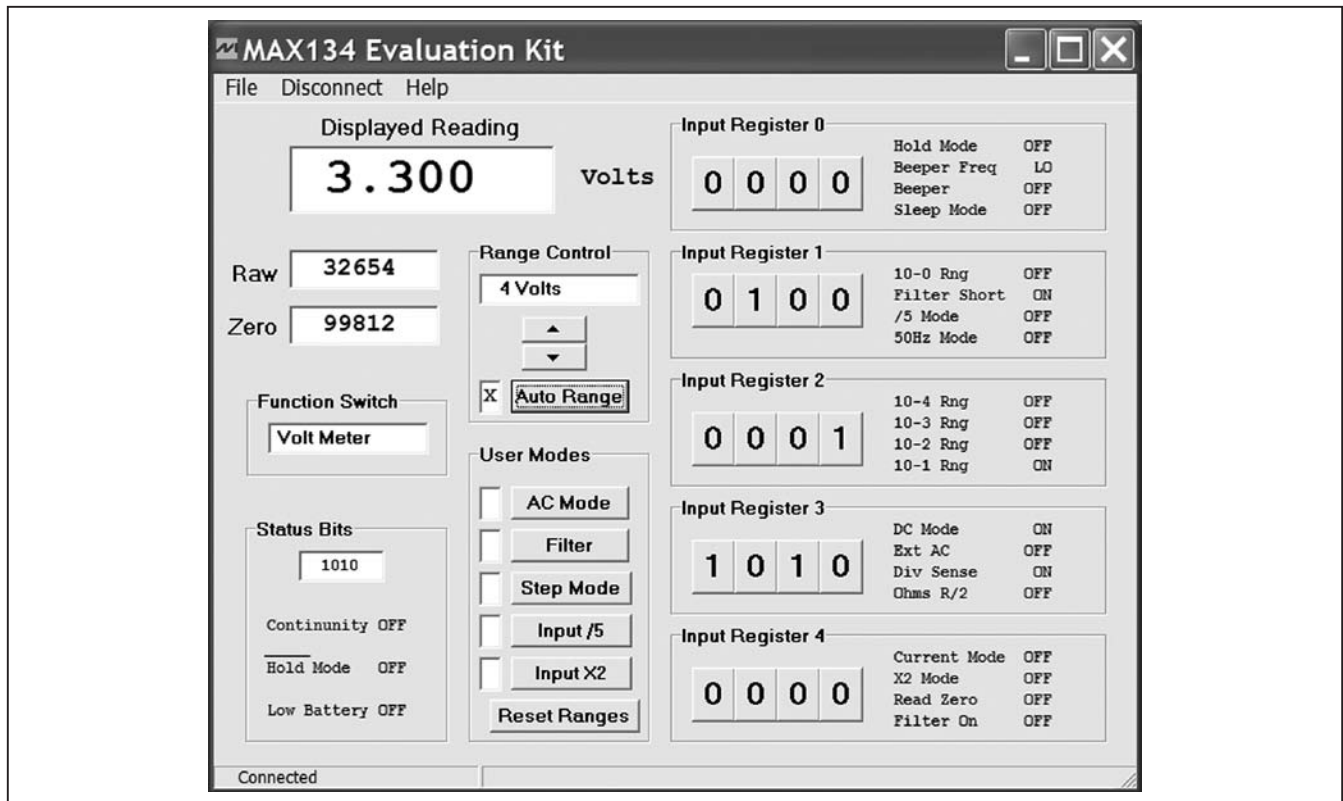


Figure 1. MAX134 EV Kit Application Program User Interface



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## \_\_Detailed Description of Software

There are actually two programs required for the MAX134 EV kit. The first is the program running in the MAXQ2000 microcontroller located on the board. This C program, written using the Rowley CrossStudio compiler, can be modified for use in digital multimeters with or without the USB option. The second program is the application program running on a PC. This program serves as the user interface to monitor and control the operation of the board. The various MAX134 registers can be controlled and the conversion results displayed. Figure 1 shows the user interface.

The application display of Figure 1 consists of several sections. The value displayed on the board's LCD display is in the upper left-hand corner. The raw MAX134 ADC reading and the last zero reading appear just below. The displayed reading and raw ADC value are updated at the end of each conversion. Values from REG0–REG4 are displayed as the raw reading. The **Displayed Reading** is the **Raw** reading minus the **Zero** reading. The demonstration program updates the zero-reading display every 25th conversion—more frequently than required by typical applications.

To the right of the reading values is the **Range Control** group box. By default, the system operates in the autoranging mode, but the range can be manually set using the **Up/Down** controls in the group box. The system is returned to autoranging by pressing the **Auto Range** button.

The position of the function-selector switch (SW1) appears in the **Function Switch** group box. The switch is a 3-pole, 4-position rotary switch that configures the MAX134 input for each function.

The **Status Bits** group box displays the contents of the MAX134 read-only status register. The register is read at the end of each conversion. The most significant bit (MSB) is always 1. The other three bits indicate continuity, hold mode, and low battery. Refer to the MAX133/MAX134 IC data sheet for more information.

The last values written to the MAX134 input registers (**Input Register 0–Input Register 4**) appear down the right side of the display. Each register bit toggles when

the user clicks on the displayed bit value. Some configurations, such as the AC mode and filter mode, require multiple bits to be set for proper operation. Buttons are provided in the **User Modes** group box to activate or clear several MAX134 features. The **AC Mode**, **Filter**, **Input /5**, and **Input X2** buttons set or clear the MAX134 register bits as required. The **Reset Ranges** button returns contents of REG0–REG4 to the default value for all functions.

The **Step Mode** button in the **User Modes** group box commands the MAXQ2000 to control the MAX134's conversion cycle using the Hold bit. This method allows faster range changes when operating in the autorange mode. Refer to the MAX133/MAX134 IC data sheet for a detailed explanation of this procedure.

## \_\_Detailed Description of Hardware

The MAX134 EV kit board consists of the MAX134 and associated components, a MAXQ2000 microcontroller, LCD display, level translators, an optoisolated MAX3420 USB controller, and power-supply circuits. A MAX4164 quad op amp generates the various supply voltages. The MAX4164's total supply current is less than using multiple independent regulators.

### 9V Operation

Because the EV kit is normally connected to a PC, the board is configured to operate from three AA batteries for greater battery life. The batteries yield more than 100 hours of operation when connected to a PC. Powering the optoisolators consumes much of the power in this configuration. For a conventional digital multimeter, without the USB connection to a host, the system can operate from a single 9V battery. Battery life can be improved by reducing the MAXQ2000's clock frequency.

To configure the board for 9V operation, set the power switch (SW1) to the off position, remove the AA battery cells, remove the shunt from JU3, and move the shunt on JU4 to the 2-3 position (see Table 2). Damage to the board can occur if the shunts are not set correctly before connecting a 9V battery. Connect a 9V battery to the BATT+ and BATT- terminals. To monitor the battery-drain current, replace the shunt across JU2 with an ammeter and remove the shunts from JU5 and JU6.

**Table 2. Optional Battery Configuration**

BATTERY	SHUNT POSITION		TYPICAL BATTERY CURRENT (mA)	
	JU3	JU4	WITHOUT A PC	WITH A PC
Three 1.5V cells	1-2	1-2	8.5	24
One 9V cell	Open	2-3	4.5	12

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Batteries must be used to power the board to prevent ground loops that can damage the board (see the *Multiple Grounds* section).

## Maximum Input Voltage

There are two reasons the input voltage is limited to 40V. First, there is a safety concern. All components on the board are essentially at the potential connected to the COM (J4) jack. Connecting the COM jack to an unsafe voltage makes the entire board hazardous to touch. Secondly, the input resistor (R6) is a size 1206 resistor that cannot withstand large input voltages.

## MAXQ2000 Microcontroller

The MAXQ2000 was selected for its low-power requirement and the ability to drive the LCD display directly. The 4-digit LCD display is multiplexed 3:1. The MAXQ2000 produces the special multilevel signals required for the display. Refer to the MAXQ2000 IC data sheet for a detailed description of the multilevel waveforms.

## AC Input Mode

The MAX134 divider stage scales AC input signals using the same input divider as DC signals. AC signals are then processed by an on-board AC-DC converter before being sent to the MAX134's analog-to-digital converter stage.

The EV kit has an on-board AC-DC converter consisting of two MAX9913 dual op amps performing a full-wave conversion of AC input signals. Activating the AC mode requires clearing the MAX134 DC bit and setting the EXT AC bit to route the signal through the AC-DC converter. The MAX9913's are taken out of shutdown by clearing the MAXQ2000 P2.7 bit. All three bits toggle when the **AC Mode** button in the **User Modes** group box is pressed.

Provisions on the board allow users to substitute an external AC-DC converter. Cutting the PCB traces across JU8 and JU9 removes the on-board AC-DC converter. The user then connects an external converter to the JU8 and JU9 pins attached to the MAX134.

## Reference Voltage

The MAX134 reference input requires 545mV when operating in 60Hz mode, and 655mV when operating in 50Hz mode. The on-board MAX6190 (U2) and a precision resistor-divider (R2 and R3) provide 545mV for default operation. A potentiometer (R4) allows the reference voltage to be set to 655mV or any other voltage in the MAX134's reference-voltage range. To operate in 50Hz, move the shunt on JU1 to the 2-3 position to select the variable input, adjust R4 for 655mV (measured on pin 3 of JU1), and use the application program to set the **50Hz**

**Mode** bit (Input Register 1, bit 0). Use the COM jack (J4) for the ground connection when measuring the reference voltage.

## Power-Supply Circuit

A MAX4164 quad op amp is used to generate the regulated supplies and reset signal required for the various circuit elements. The quad, low-power op amp requires less battery drain than using separate linear regulators for the supplies.

The digital ground level for the MAX134 and the microcontroller circuitry is set at 5V below the battery positive terminal. Additional voltages of 2.5V and 3.3V above the digital ground level supply the microcontroller circuitry.

The fourth amplifier generates the reset signal that occurs on power-up and when the Reset button located on the top edge of the board is pressed.

In addition to these voltages, the MAX134 internally generates an analog ground approximately 3V below the battery positive terminal. This is the analog ground that is connected to the COM input jack.

## Multiple Grounds

In addition to the digital and analog grounds previously described, there is a third ground plane on the board. The third ground is optoisolated from the others and only the elements associated with the USB connections are connected to it. The optoisolators allow the USB cable to be connected to a PC without interaction with the analog input.

The MAX134 fixes the analog ground level at approximately 3V below the battery positive terminal. The digital ground is set at 5V below the battery positive terminal. Care must be taken to connect to only one of these ground levels to avoid a ground-loop condition that could damage the board. For normal operation, analog ground (the COM jack connected to the circuit being measured) must be the only external ground connection.

The safest and easiest way to monitor digital waveforms or the MAX134 analog signals is to connect all measurement equipment to the analog ground available through the COM jack. Ensure that all inputs are earth-ground referenced or battery powered to prevent damage. As stated above, the on-board digital ground is approximately 2V below the analog ground level and therefore the digital signal's low state is approximately -2V.

Test equipment can be connected to the digital ground (TP6) only if a battery is used as the measurement input voltage or the evaluation board is measuring a resistor value.

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### **JTAG Connection**

J5 is the JTAG connection for programming the MAXQ2000. Because the JTAG connects the digital ground to an external ground, all other connections must be removed before connecting the JTAG. Disconnecting inputs from J1–J4 removes the possibility of a ground loop.

Programming the MAXQ2000 requires more current than the MAX4164 is specified to deliver, so additional drive current is provided by placing shunts on JU5 and JU6.

The shunts can remain in place for normal operation with no impact, but should be removed when making supply current measurements.

Failure to remove test-equipment connection, analog inputs, the USB connection, or to install the shunts on JU5 and JU6 could cause errors when trying to program the MAXQ2000. Low battery voltage could also be another cause of errors when programming the MAXQ2000.



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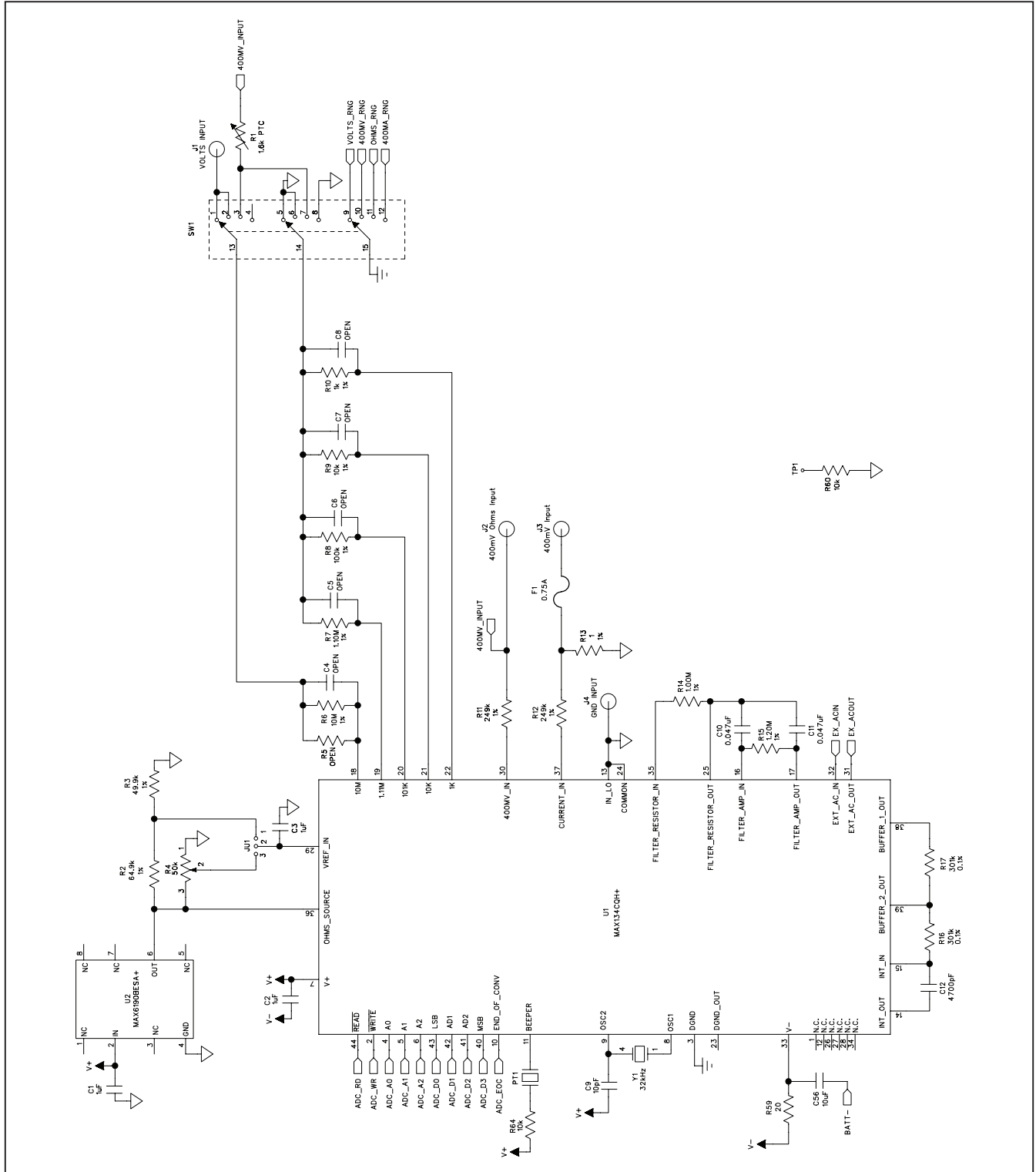


Figure 2a. MAX134 EV Kit Schematic (Sheet 1 of 5)

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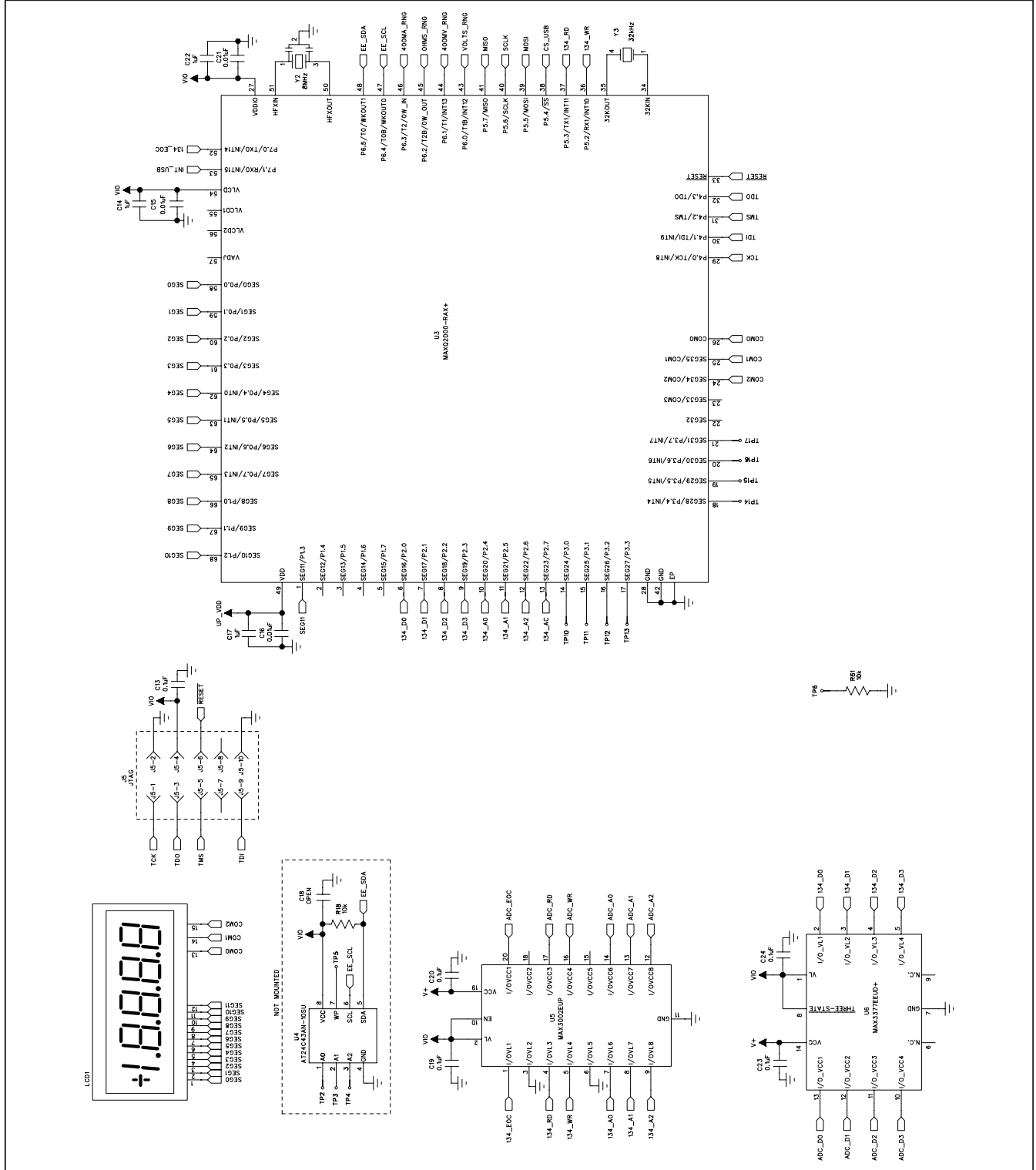


Figure 2b. MAX134 EV Kit Schematic (Sheet 2 of 5)

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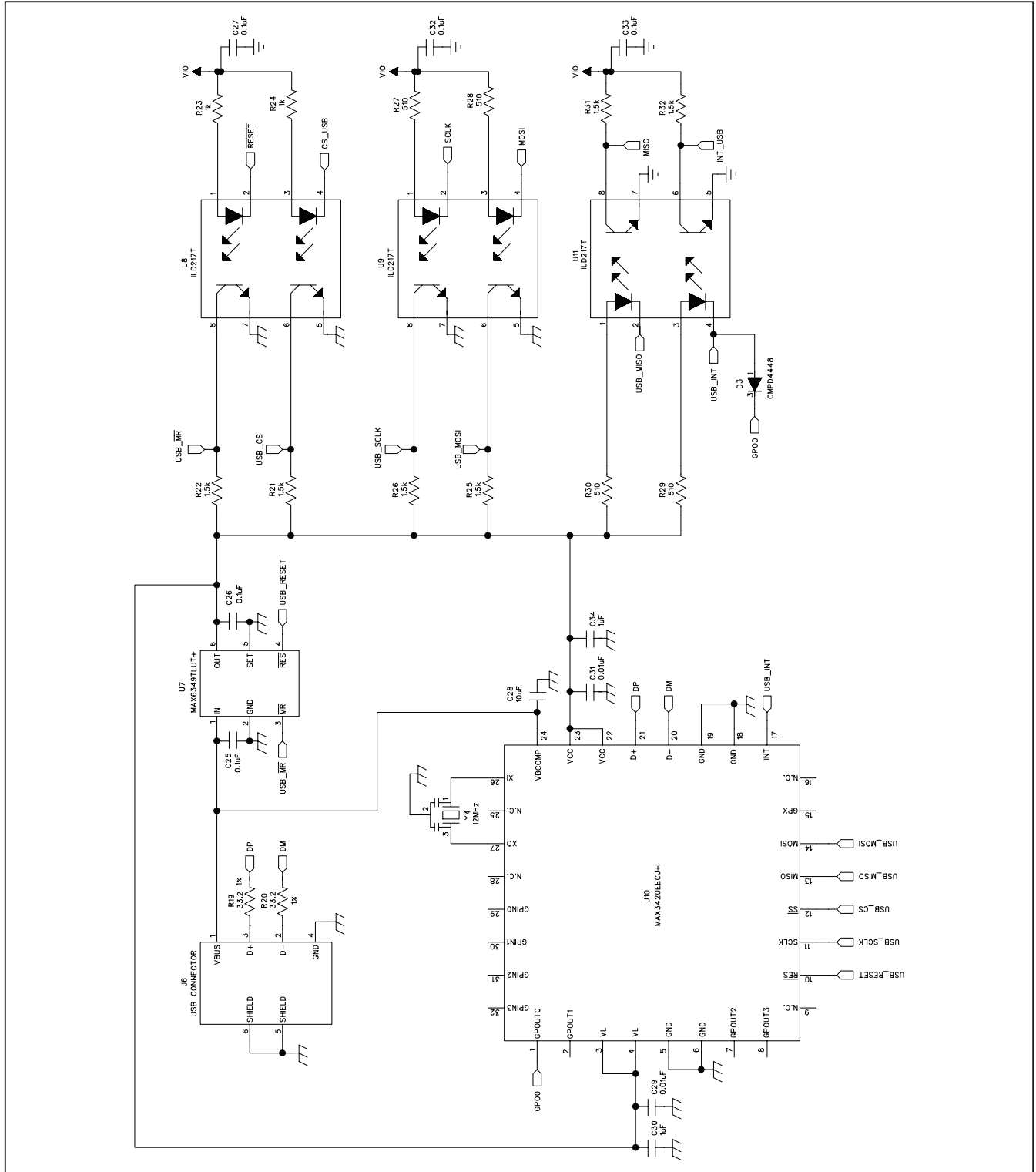


Figure 2c. MAX134 EV Kit Schematic (Sheet 3 of 5)

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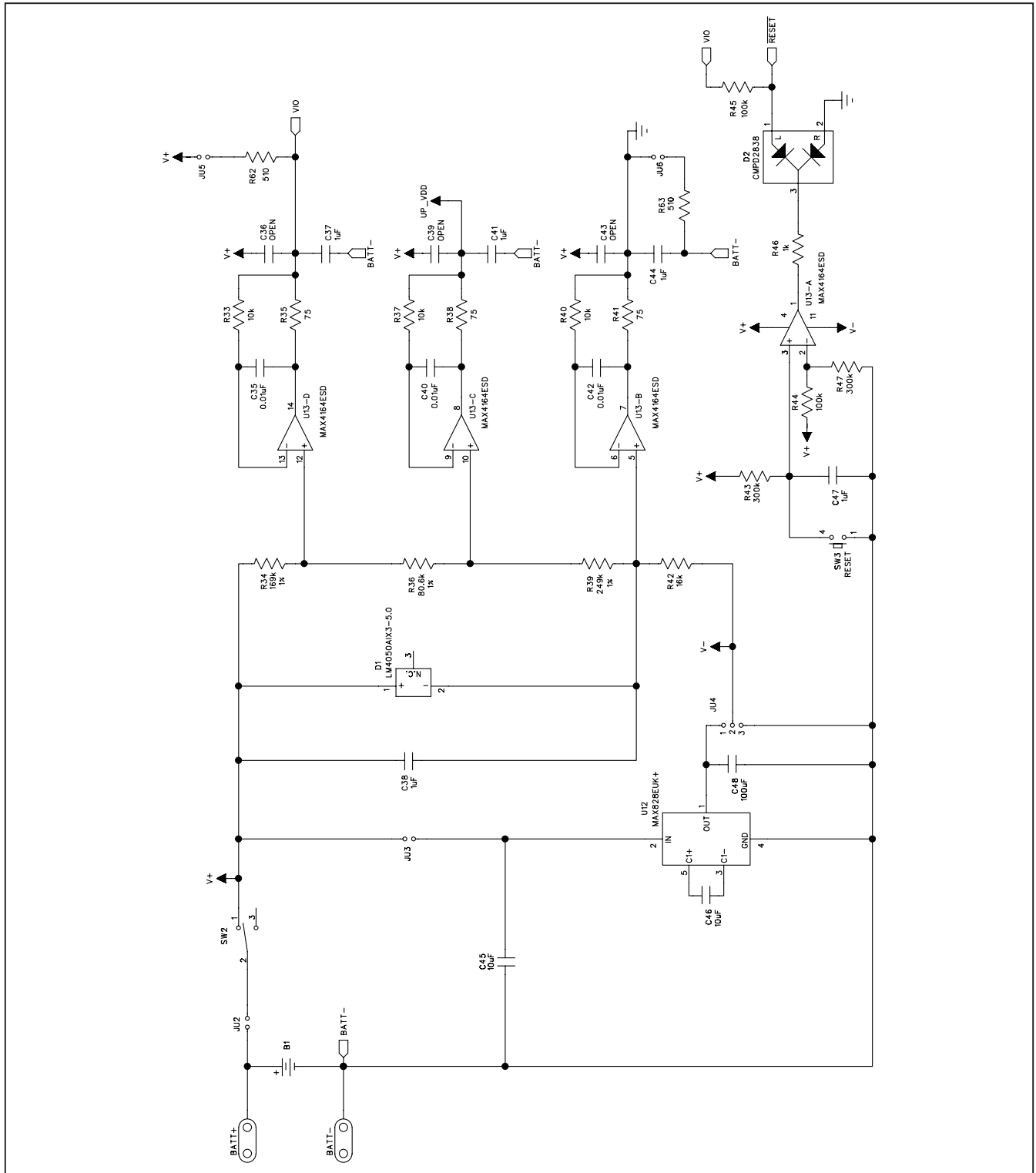


Figure 2d. MAX134 EV Kit Schematic (Sheet 4 of 5)



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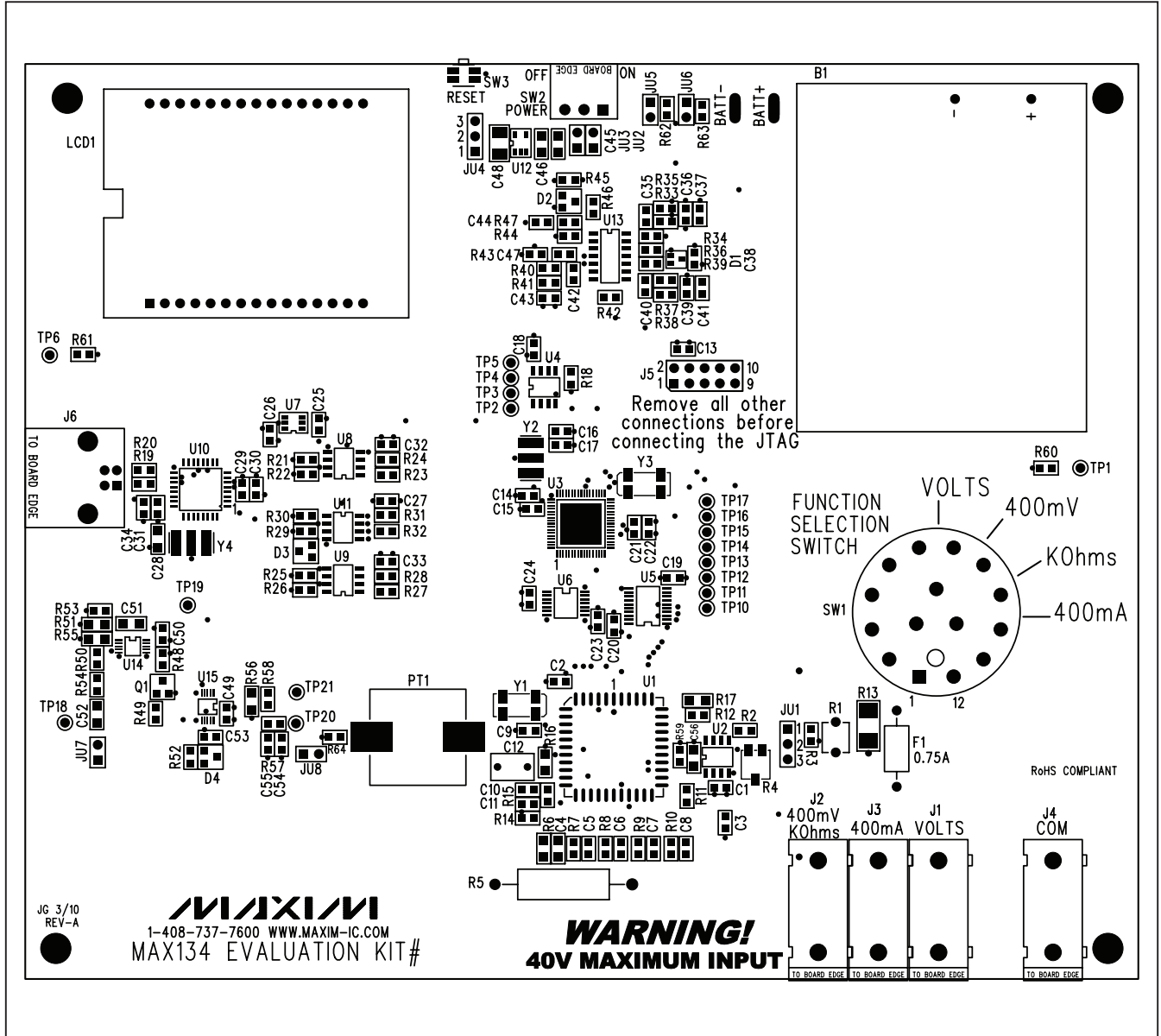


Figure 3. MAX134 EV Kit Component Placement Guide—Component side



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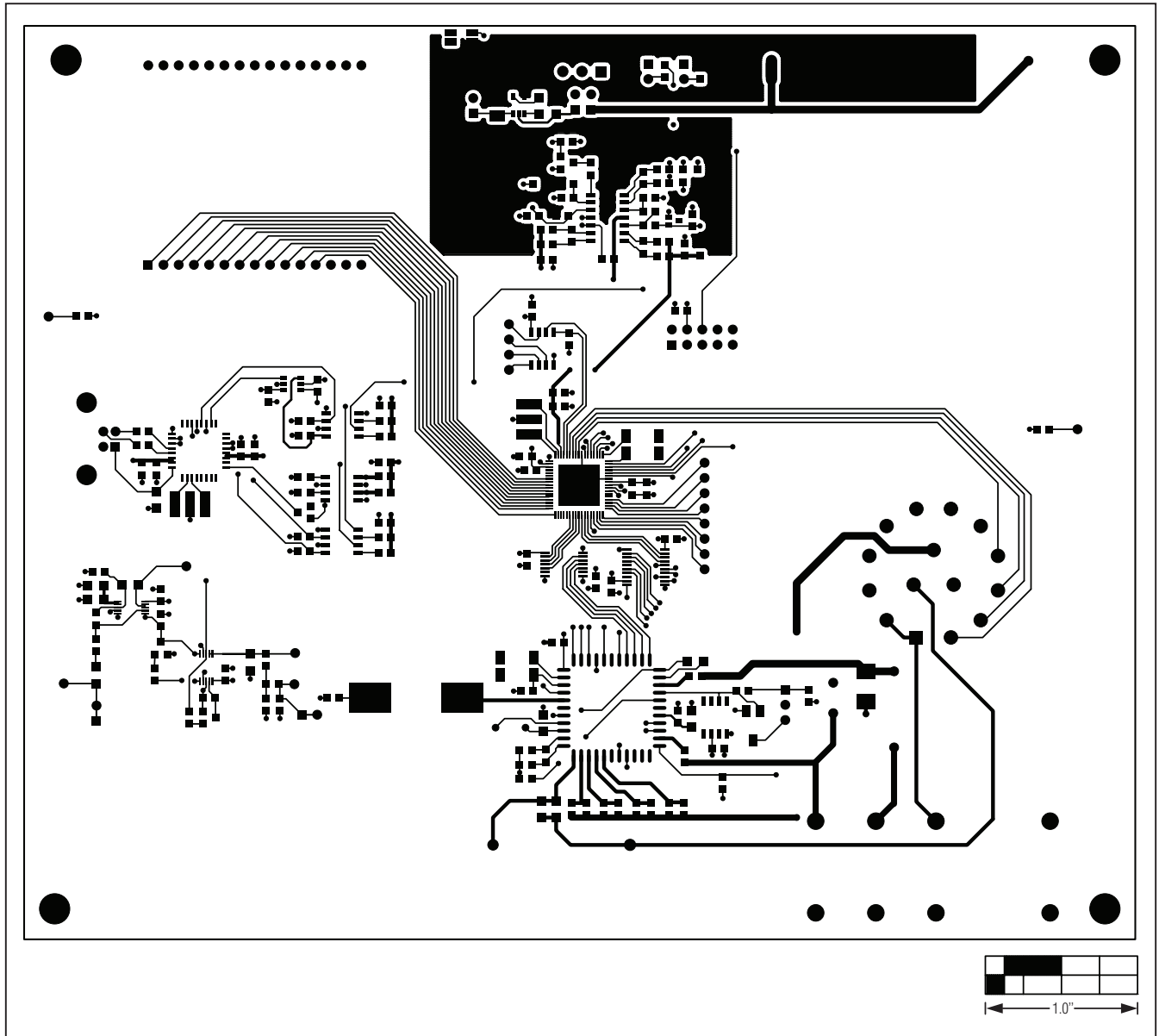


Figure 4. MAX134 EV Kit PCB Layout—Component Side

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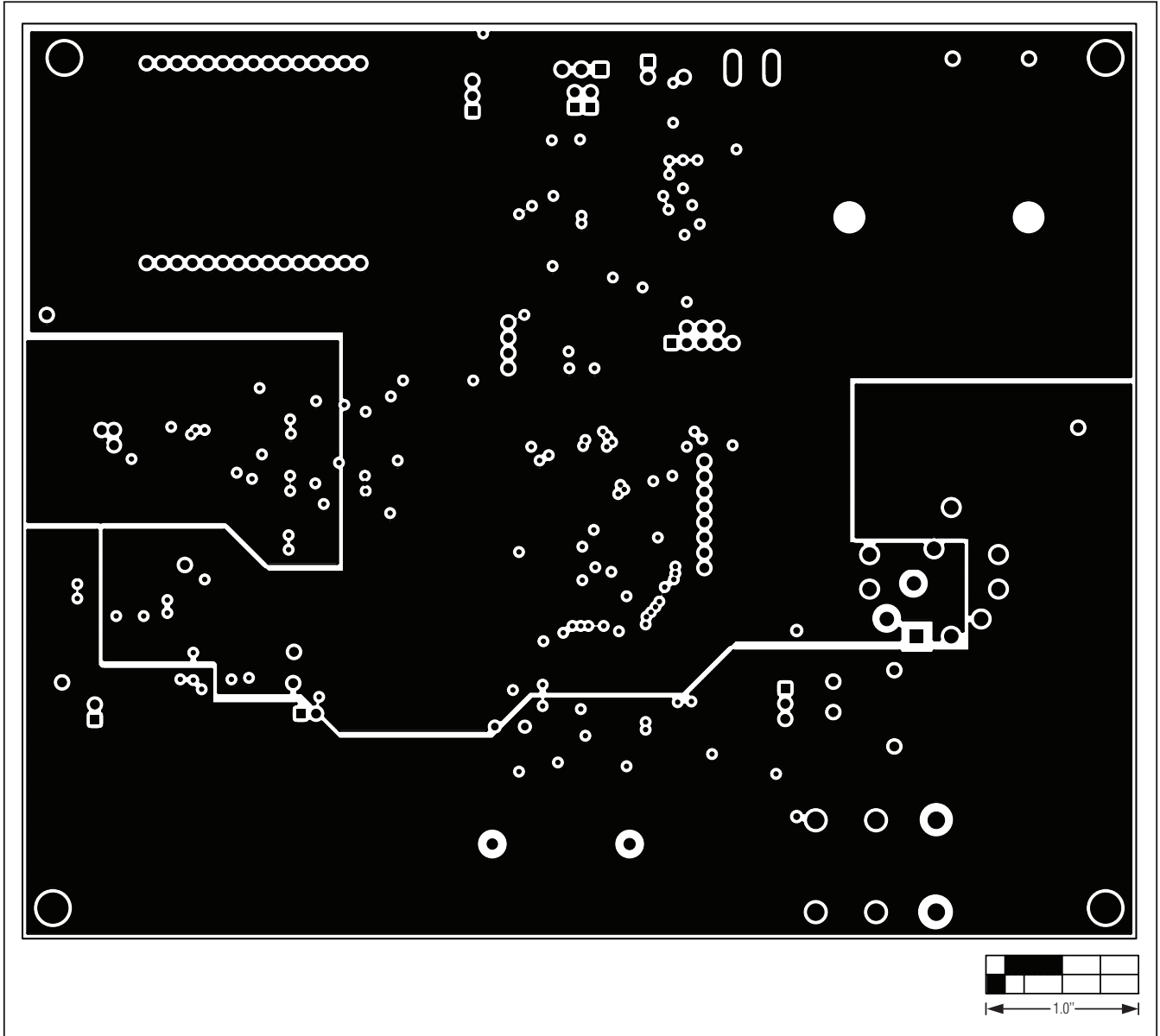


Figure 5. MAX134 EV Kit PCB Layout—Ground Planes

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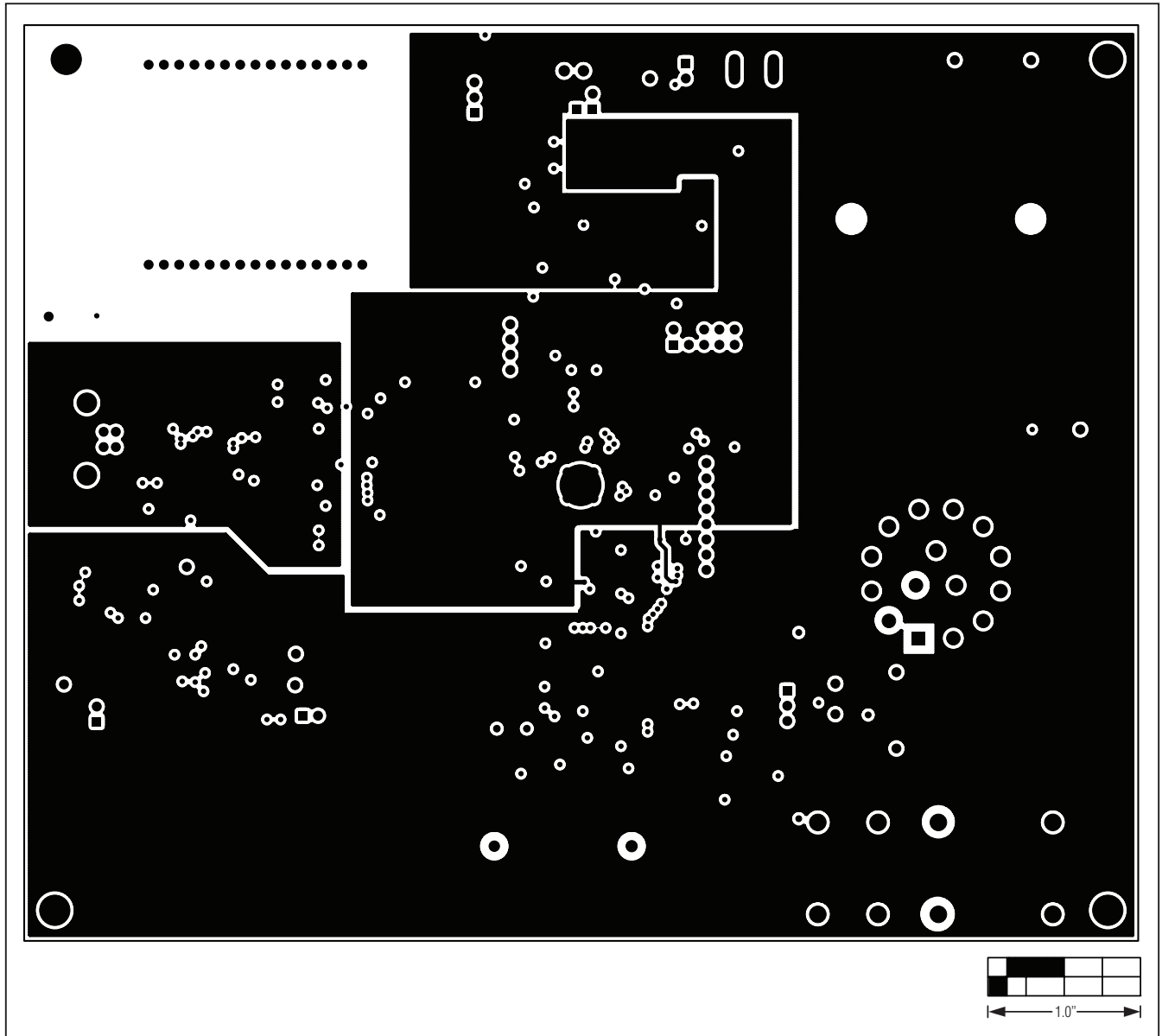


Figure 6. MAX134 EV Kit PCB Layout—Supply Planes

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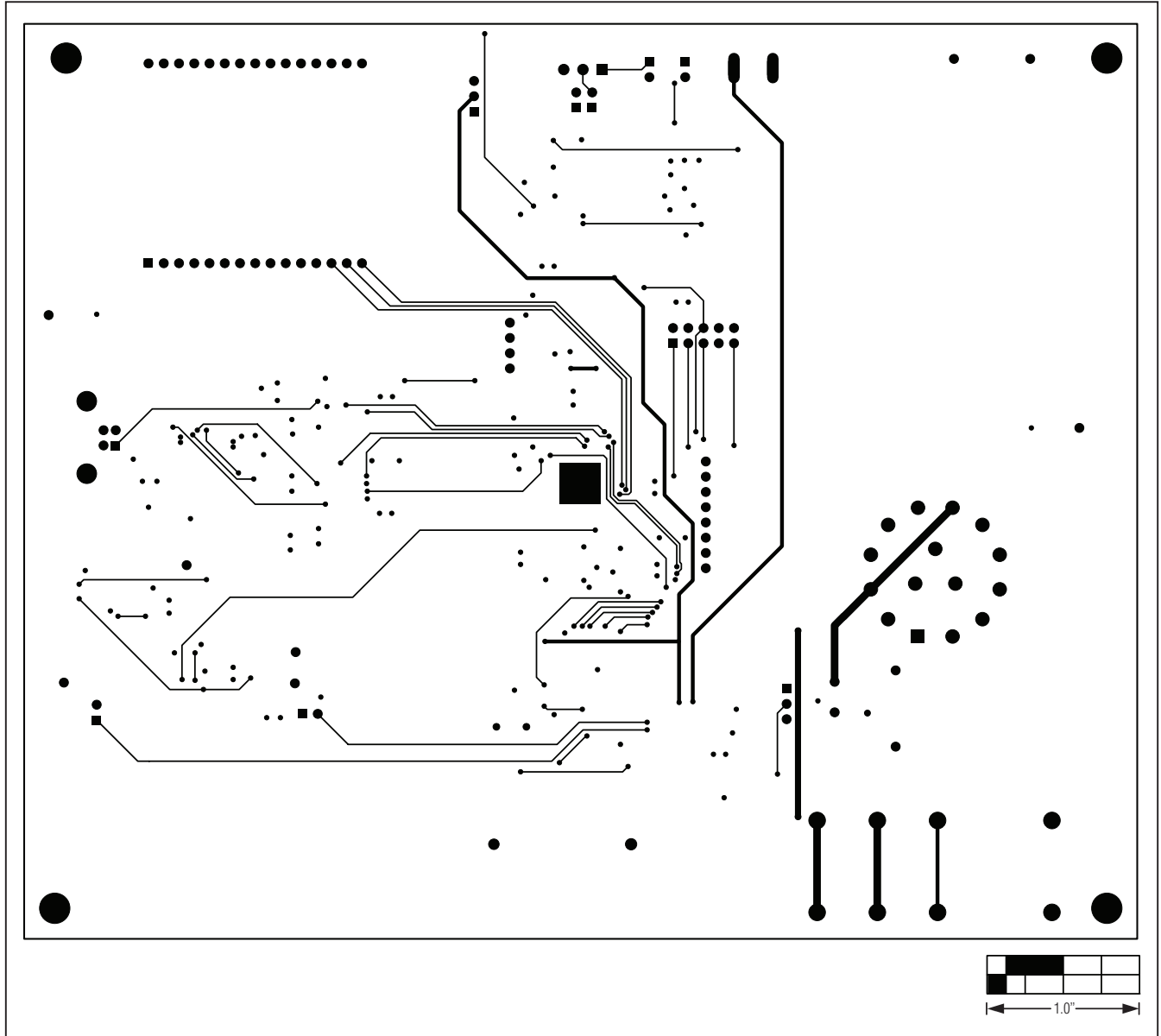


Figure 7. MAX134 EV Kit PCB Layout—Solder Side

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## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	04/10	Initial release	—

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