19-6165; Rev 0; 12/11

MAX14972 Evaluation Kit
Evaluates: MAX14972

General Description

The MAX14972 evaluation kit (EV kit) provides a proven design to evaluate the MAX14972 dual SuperSpeed USB 3.0 equalizer/redriver utilizing programmable input equalization and output deemphasis to reduce deterministic jitter, restore output levels, and meet USB 3.0 compliance. This allows optimal placement of key SuperSpeed USB 3.0 components and allows longer circuit-board traces or cables. The EV kit PCB contains four sections: application circuit, characterization circuit, and two calibration traces.

The application circuit is designed to demonstrate the IC's use in equalizing/redriving the USB signals. This section of the EV kit operates from a +5.0V USB supply that is regulated by an on-board +3.3V LDO regulator powering the U1 device. All PCB signal traces in the application circuit are a combination of 100Ω differential and 50Ω single-ended controlled-impedance traces.

The characterization circuit is provided for eye diagram evaluation using SMA connectors and controlled-impedance traces. This section is powered by an external +3.0V to +3.6V power supply.

The calibration trace section is provided as a reference to deembed the performance of the IC from the traces and SMA connectors.

The IC is available in a 24-pin (4.0mm x 4.0mm) TQFN package with an exposed pad.

Features

- **Application Circuit with USB 3.0 Input/Output Connectors**
- **Eye Diagram Test Circuit with SMA Inputs/Outputs**
- **Calibration Traces (50Ω Load Trace and Through Trace)**
- **Proven PCB Layout**
- **Fully Assembled and Tested**

***Ordering Information* appears at end of data sheet.**

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4, C5–C8, C11–C16, C18–C23, C25–C28	22	0.1µF ±10%, 6.3V X5R ceramic capacitors (0402) Murata GRM155R60J104K
C2, C3, C17, C24	4	4.7µF ±10%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J475K
C9	1	22µF ±20%, 6.3V X5R ceramic capacitor (0805) Murata GRM21BR60J226M
C29, C30	0	Not installed, ceramic capacitors (0402)
D1	1	Green LED (0603)
JU1–JU9, JU11–JU15	14	3-pin headers

DESIGNATION	QTY	DESCRIPTION
JU10	1	2-pin header
P1	1	USB 3.0 type-B connector
P2	1	USB 3.0 type-A connector
P3	1	Mini-USB type-B connector
P4–P13	10	Edge-mount SMA connectors
R1	1	220Ω ±5% resistor (0402)
R2–R5	4	49.9Ω ±1% resistors (0402)
U1, U3	2	Dual super-speed USB 3.0 equalizer/redrivers (24 TQFN-EP) Maxim MAX14972CTG+
U2	1	3.3V LDO (6 SOT23) Maxim MAX6329SLUT+
—	15	Shunts
—	1	PCB: MAX14972 EVALUATION KIT

Component Supplier

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com

Note: *Indicate that you are using the MAX14972 when contacting this component supplier.*

Quick Start

Required Equipment

- MAX14972 EV kit
- User-supplied Windows® 7 PC with a spare USB 3.0 port
- USB 3.0 A-to-B cable
- USB 3.0 device (e.g., +4GB hard drive)

Note: In the following sections, text in **bold and underlined** refers to items from the Windows operating system.

Procedure

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

1) Verify that jumpers JU1–JU10 are in their default positions, as shown in Table 1.
2) Connect the USB 3.0 A-to-B cable from the PC to the USB 3.0 type-B connector (P1) on the EV kit.
3) Connect the USB 3.0 device to the USB 3.0 type-A connector (P2) on the EV kit.
4) Verify that the PC has detected the USB 3.0 device.
5) Move the data from the PC to the USB 3.0 device.
6) A popup window appears showing the data transferring from the PC to the USB 3.0 device. Within this window, select the **More details** button to monitor the data transfer rate under the **Speed** listing (MB/s). After half the data is transferred, verify that the speed is approximately 100MB/s. The speed may vary depending on the exact system configuration. If the speed is below 50MB/s, then the source has defaulted to USB 2.0.

Detailed Description of Hardware

The MAX14972 EV kit provides a proven design to evaluate the MAX14972 dual SuperSpeed USB 3.0 equalizer/redriver. The EV kit is divided into four sections: application circuit, characterization circuit, and two calibration traces.

The application circuit on the top of the EV kit utilizes both 100Ω differential and 50Ω single-ended controlled-impedance traces and provides connectors for a USB 3.0 host and device. These features demonstrate the IC in a USB 3.0 environment.

The characterization circuit utilizes both 100Ω differential and 50Ω single-ended controlled-impedance traces and SMA connectors. This enables evaluation of eye diagrams, return loss, and other frequency measurements. A separate +3.3V power supply must be connected between the VCC3_U3 and GND PCB pads on the EV kit.

The lower half of the EV kit provides two sets of calibration traces that are matched to the trace lengths in the characterization circuit. These traces provide a reference for determining the performance of the MAX14972 (U3) device only, when evaluated in the characterization circuit.

Table 1. Application Circuit Default Shunt Positions

JUMPER	SHUNT POSITION
JU1–JU4	Not installed
JU5, JU6, JU9	1-2
JU7, JU8	2-3
JU10	Installed

Application Circuit

The application circuit provides the means for evaluating the IC in a USB 3.0 application. This section of the EV kit provides USB 3.0 host and device connectors (P1 and P2).

Input Supply (VCC3)

The application circuit must be powered by a +3.0V to +3.6V supply. Table 2 lists two ways to get this voltage, through the +3.3V on-board LDO (U2) or by connecting directly to a user-supplied +3.0V to +3.6V supply. When using the on-board regulator, the LDO can be powered by connecting a USB cable from the PC to the Mini-USB connector (P3) or USB 3.0 connector (P1). If the green LED (D1) is turned on, it indicates that power from the USB is present. When the jumper JU10 (see Table 3) shunt is installed, power is taken from the USB. The other option is to remove the shunt from JU10 and apply +3.0V to +3.6V between the VCC3 and GND PCB pads on the EV kit.

Compliance Mode (U1)

The IC features a compliance mode that forces the device to remain in the active state. Jumpers JU1 and

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JU2 utilize this feature. See Table 4 to select the desired mode of operation for the IC.

Programmable Input Equalization (U1)

The IC features flexible compensation for varied input-board trace, connector, or cable losses. The EQ1 and EQ2 pins of the IC are used to set the equalization for channels 1 and 2. See Table 5 to configure the desired equalization settings for the EQ1 and EQ2 pins.

Table 2. U2 Power Option (JU9)

SHUNT POSITION	IN PIN (U2)	DESCRIPTION
Not installed	Connected to an external supply	Apply a +5.0V external supply between the VCC5 and GND PCB pads on the EV kit.
1-2*	Connected to +5.0V from the USB 3.0 type-B connector (P1)	Connect a USB 3.0 A-to-B cable from the PC to the P1 connector on the EV kit.
2-3	Connected to +5.0V from the USB mini-B connector (P3)	Connect an A-to-mini-B cable from the PC to the P3 connector on the EV kit.

**Default position.*

Table 3. U1 Power Option (JU10)

SHUNT POSITION	VCC PIN (U1)	DESCRIPTION
Installed*	Connected to the on-board LDO output	U1 powered by the LDO output, +3.3V
Not installed	Connected to an external supply	U1 powered by the external +3.0V to +3.6V supply

**Default position.*

Table 4. Compliance Mode Truth Table (JU1, JU2)

SHUNT POSITION		DESCRIPTION
JU1 (ENRXD)	JU2 (CM)	
2-3	2-3	Power-down
2-3	1-2	Power-down
1-2 or not installed*	2-3 or not installed*	Normal operation
1-2 or not installed*	1-2	Compliance mode

**Default position.*

Programmable Output Deemphasis (U1)

The OS1 and OS2 pins of the IC are used to set the transition bit amplitude for channels 1 and 2. See Table 6 to configure the desired nontransition bit amplitude for the OS1, OS2, DE1, and DE2 pins.

The DE1 and DE2 pins of the U1 device are used to set the nontransition bit amplitude for channels 1 and 2. See Table 7 to configure the desired nontransition bit amplitude for the DE1 and DE2 pins.

Table 5. Equalization Setting (JU3, JU4)

SHUNT POSITION	EQ1/EQ2 PIN (U1)	EQUALIZATION (dB)
Not installed*	Not connected	0
1-2	Connected to VCC3	10
2-3	Connected to GND	6

**Default position.*

Table 6. Transition Bit Output Amplitude Setting (JU5–JU8)

SHUNT POSITION		AMPLITUDE (mV_{P-P})
JU7/JU8 (OS_ PIN)	JU5/JU6 (DE_ PIN)	
2-3*	2-3	1120
2-3*	Not installed	940
2-3*	1-2*	1210
1-2 or not installed	2-3	1180
1-2 or not installed	Not installed	1010
1-2 or not installed	1-2*	1270

**Default position.*

Table 7. Nontransition Bit Amplitude Setting (JU5, JU6)

SHUNT POSITION	DE_ PIN (U1)	AMPLITUDE (mV_{P-P})
Not installed	Not connected	640
1-2*	Connected to VCC3	940
2-3	Connected to GND	840

**Default position.*

Characterization Circuit

The characterization circuit is provided as a separate test circuit for high-frequency evaluation of the MAX14972 (U3) device. The characterization circuit section allows for detailed analysis on a pair of inputs over a single channel, since all channel inputs have similar performance by design. This circuit provides differential SMA inputs/outputs with a combination of controlled-impedance traces.

The redriver output settings can be optimized for various USB 3.0 loading conditions by installing optional output loading capacitors C29 and C30. These may represent additional ESD protection devices or USB 3.0 connector loading.

Input Supply (VCC_U3)

The characterization circuit is powered by an external +3.0V to +3.6V power supply connected between the VCC_U3 and GND PCB pads on the EV kit. The application circuit GND is not electrically continuous with the characterization circuit GND in this section.

Characterization Circuit Settings

Since only channel 1 is used in the characterization circuit, use jumpers JU11–JU15 to configure the MAX14972 (U3) device properly (see Tables 8–11).

Calibration Traces

The bottom section of the EV kit provides two sets of calibration traces. The calibration traces are length-matched to the traces going from the SMA connector to the MAX14972 (U3) device of the characterization circuit. The first calibration trace (load) includes 50Ω load termination resistors (R2, R5) and the second calibration trace (Thru) is a through trace.

Table 8. Compliance Mode Truth Table (JU11, JU12)

SHUNT POSITION		DESCRIPTION
JU11 (ENRXD PIN)	JU12 (CM PIN)	
2-3	2-3	Power-down
2-3	1-2	Power-down
1-2 or not installed*	2-3 or not installed*	Normal operation
1-2 or not installed*	1-2	Compliance mode

**Default position.*

Table 9. Equalization Setting (JU13)

SHUNT POSITION	EQ1 PIN (U3)	EQUALIZATION (dB)
Not installed*	Not connected	0
1-2	Connected to VCC3	10
2-3	Connected to GND	6

**Default position.*

Table 10. Transition Bit Output Amplitude Setting (JU14, JU15)

SHUNT POSITION		AMPLITUDE (mVp-p)
JU15 (OS1 PIN)	JU14 (DE1 PIN)	
2-3 *	2-3	1120
2-3*	Not installed	940
2-3*	1-2*	1210
1-2 or not installed	2-3	1180
1-2 or not installed	Not installed	1010
1-2 or not installed	1-2*	1270

**Default position.*

Table 11. Nontransition Bit Amplitude Setting (JU14)

SHUNT POSITION	DE1 PIN (U3)	AMPLITUDE (mV_{P-P})
Not installed	Not connected	640
1-2*	Connected to VCC3	940
2-3	Connected to GND	840

**Default position.*

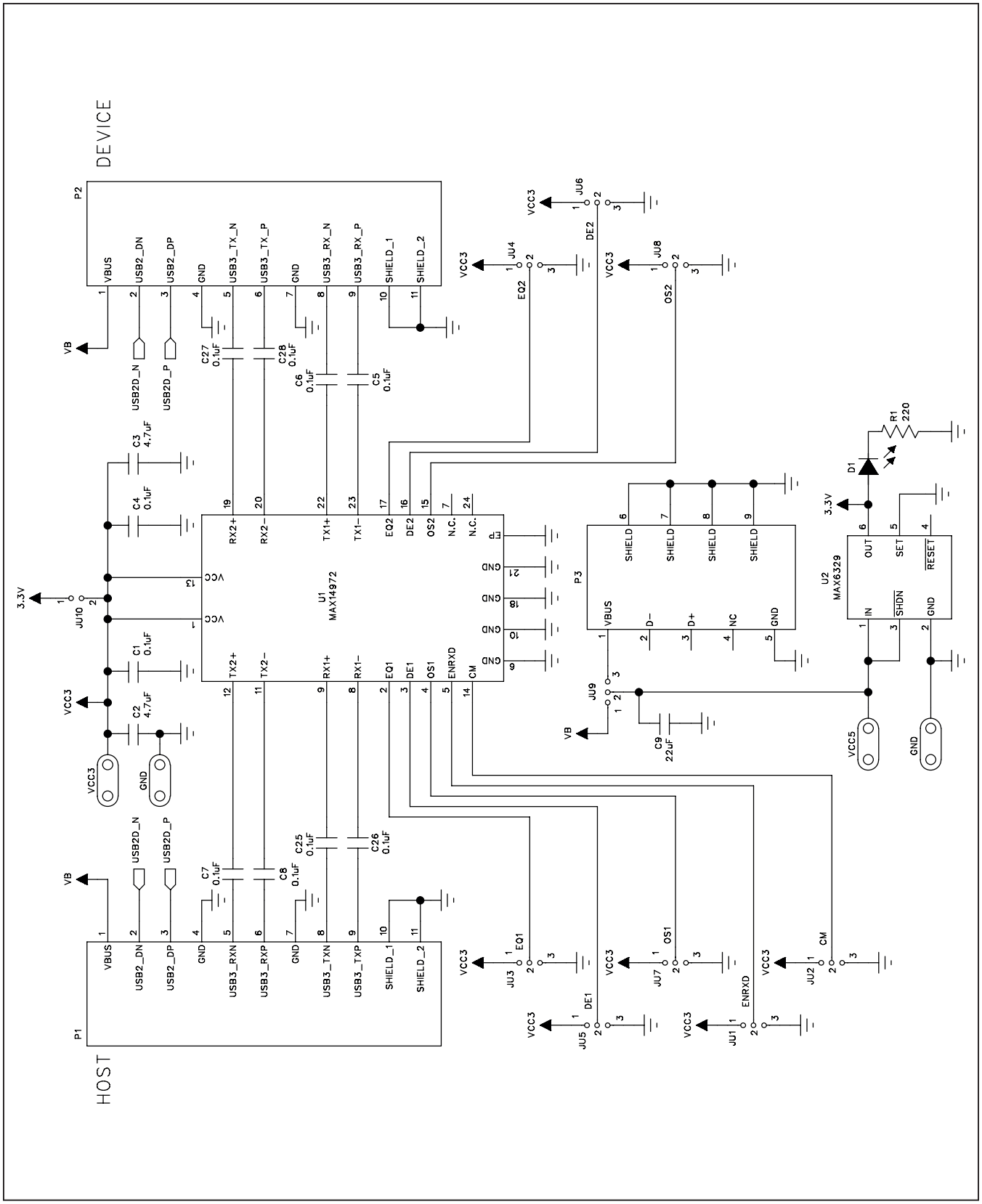

Figure 1a. MAX14972 EV Kit Schematic (Sheet 1 of 3)

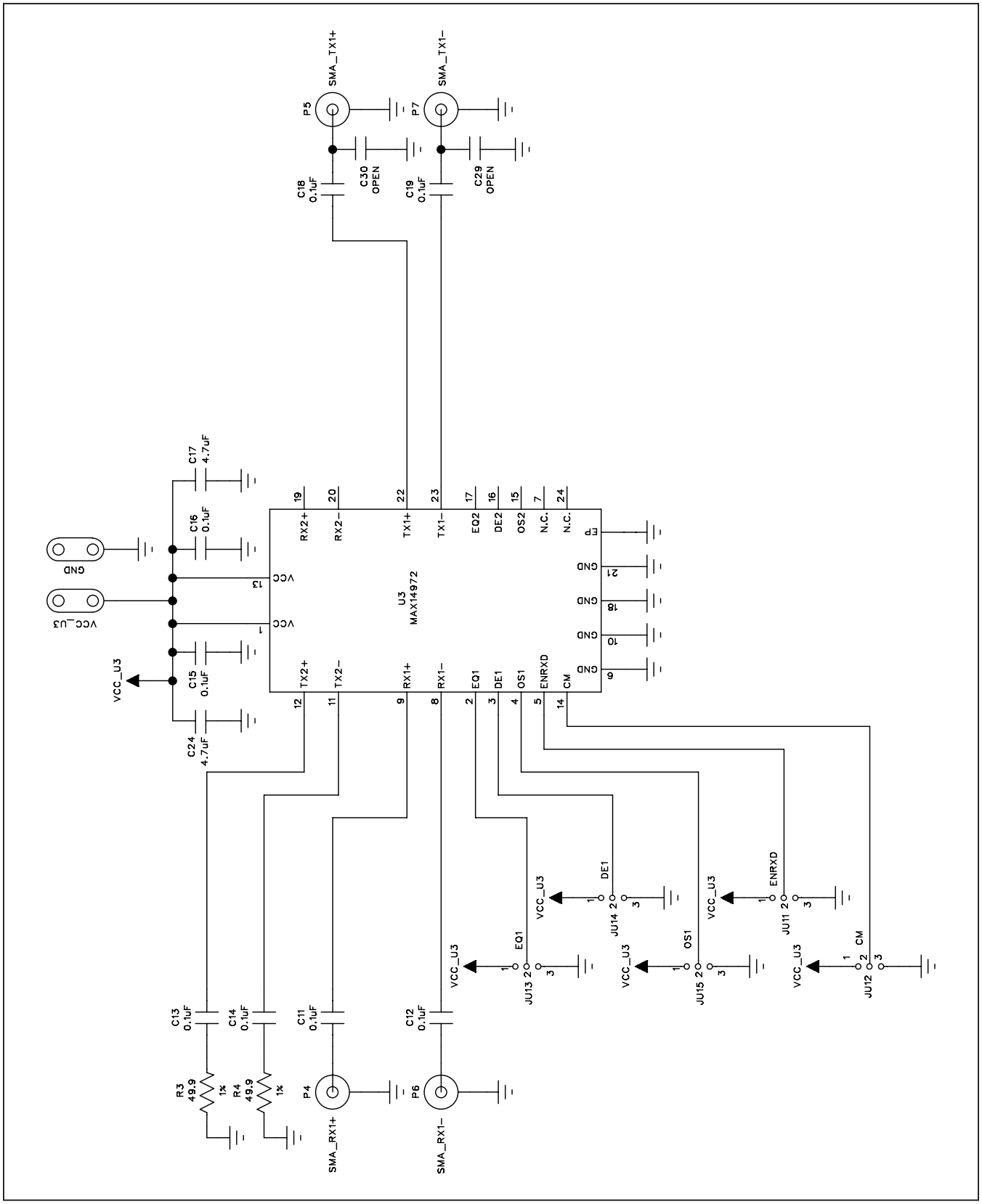

Figure 1b. MAX14972 EV Kit Schematic (Sheet 2 of 3)

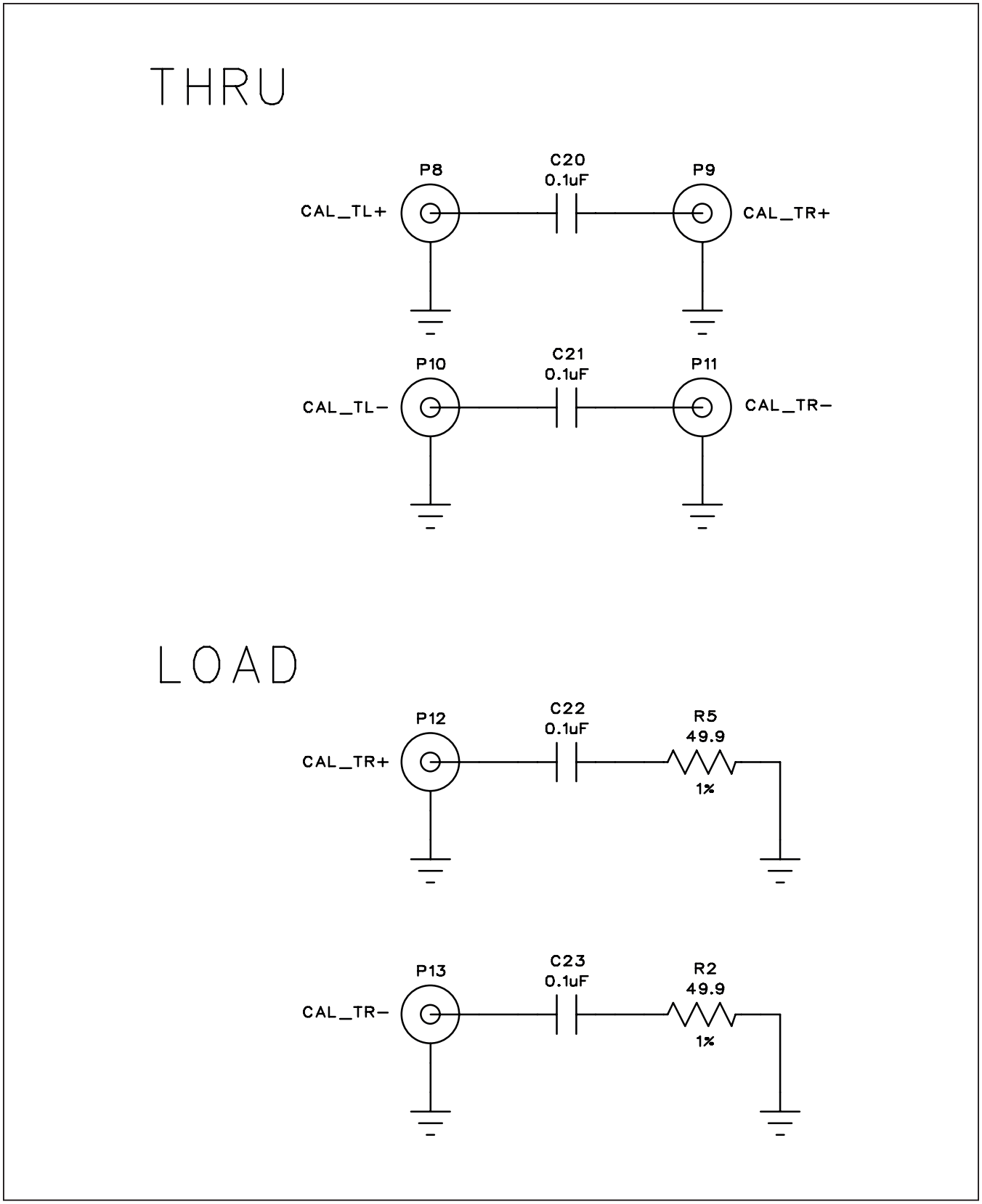

Figure 1c. MAX14972 EV Kit Schematic (Sheet 3 of 3)

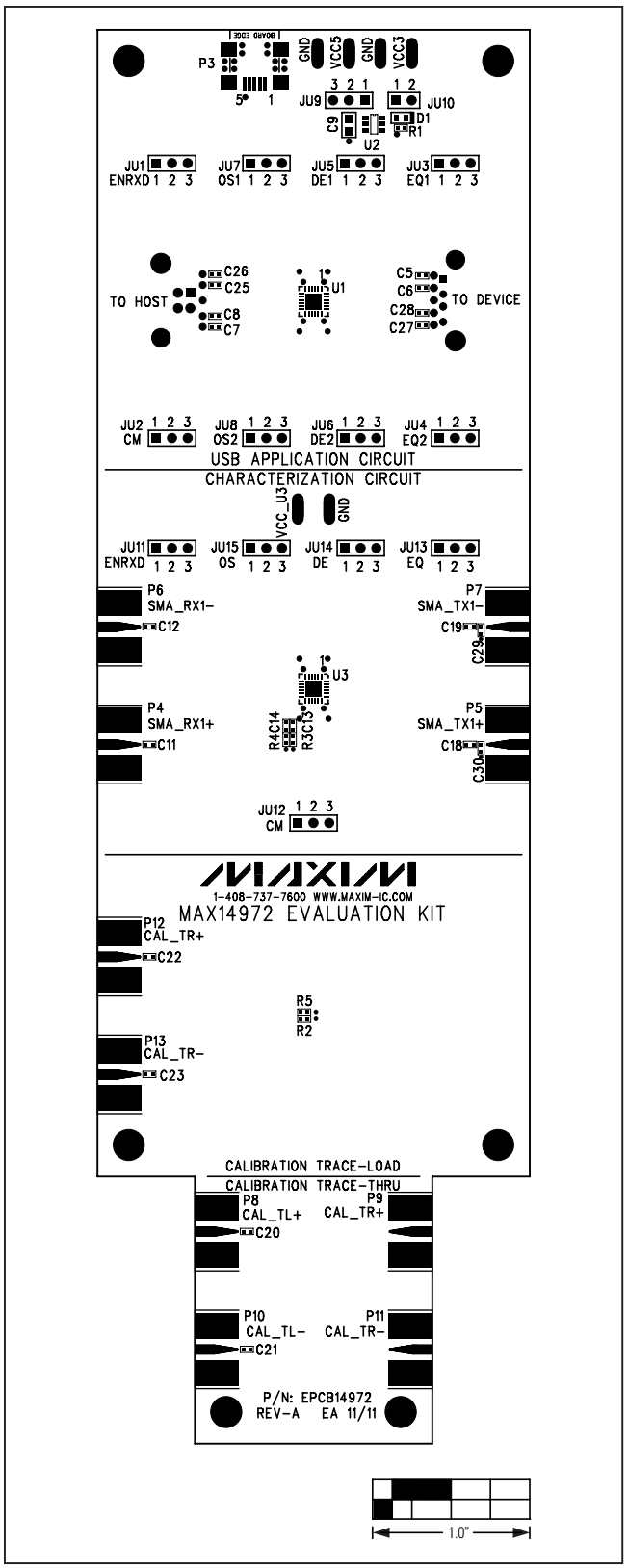

Figure 2. MAX14972 EV Kit Component Placement Guide—Component Side

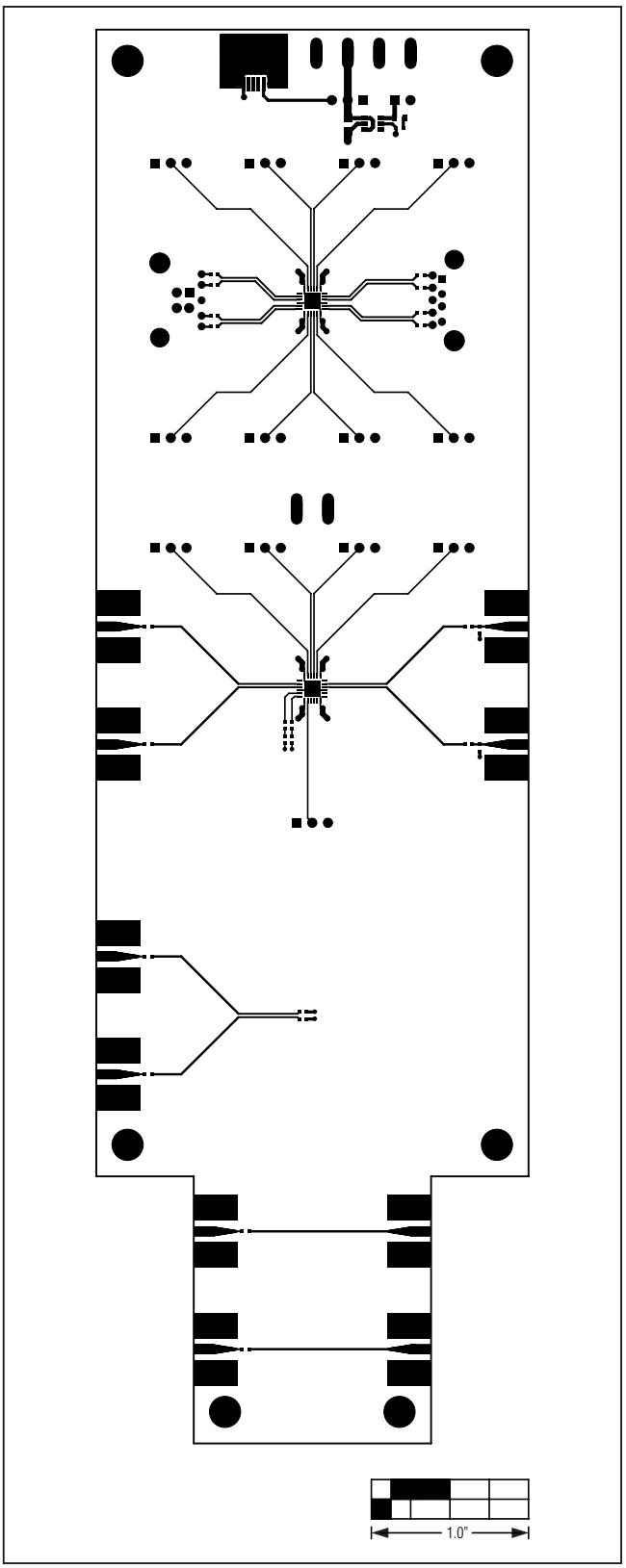

Figure 3. MAX14972 EV Kit PCB Layout—Component Side

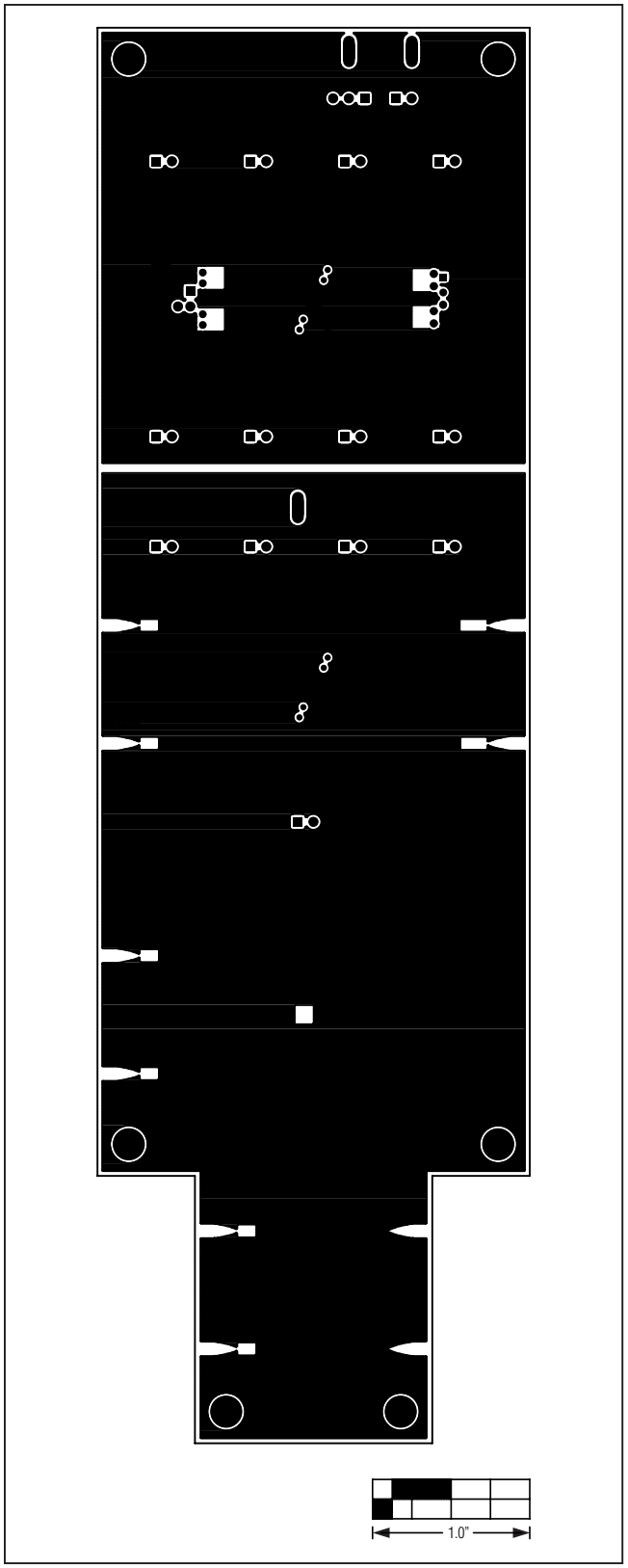

Figure 4. MAX14972 EV Kit PCB Layout—Inner Layer 2

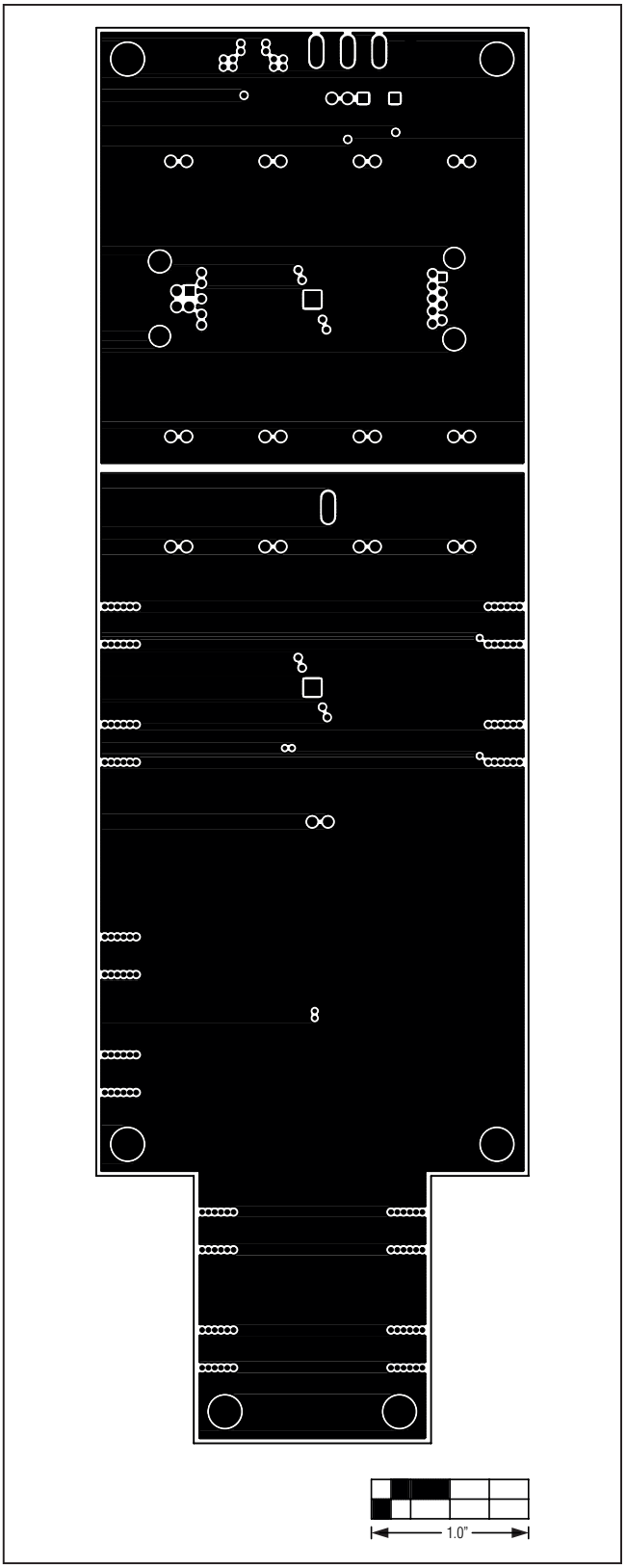

Figure 5. MAX14972 EV Kit PCB Layout—Inner Layer 3

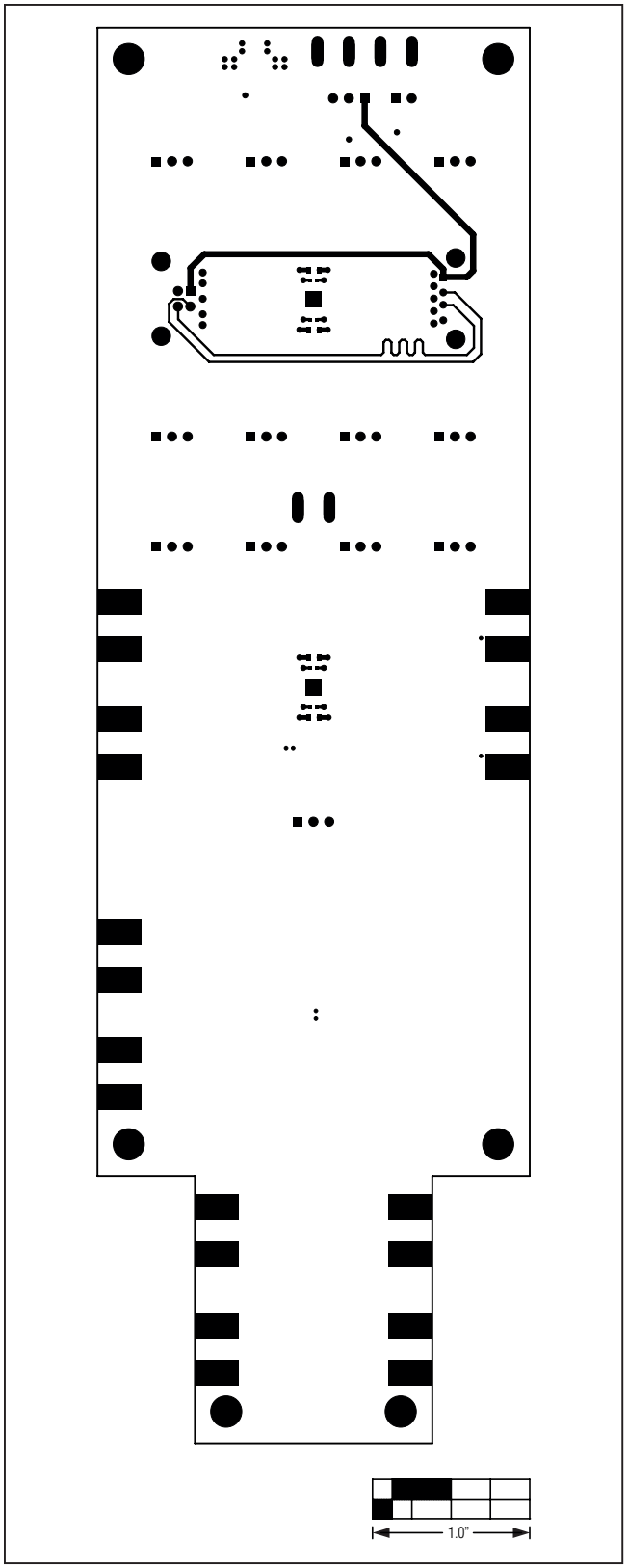

Figure 6. MAX14972 EV Kit PCB Layout—Solder Side

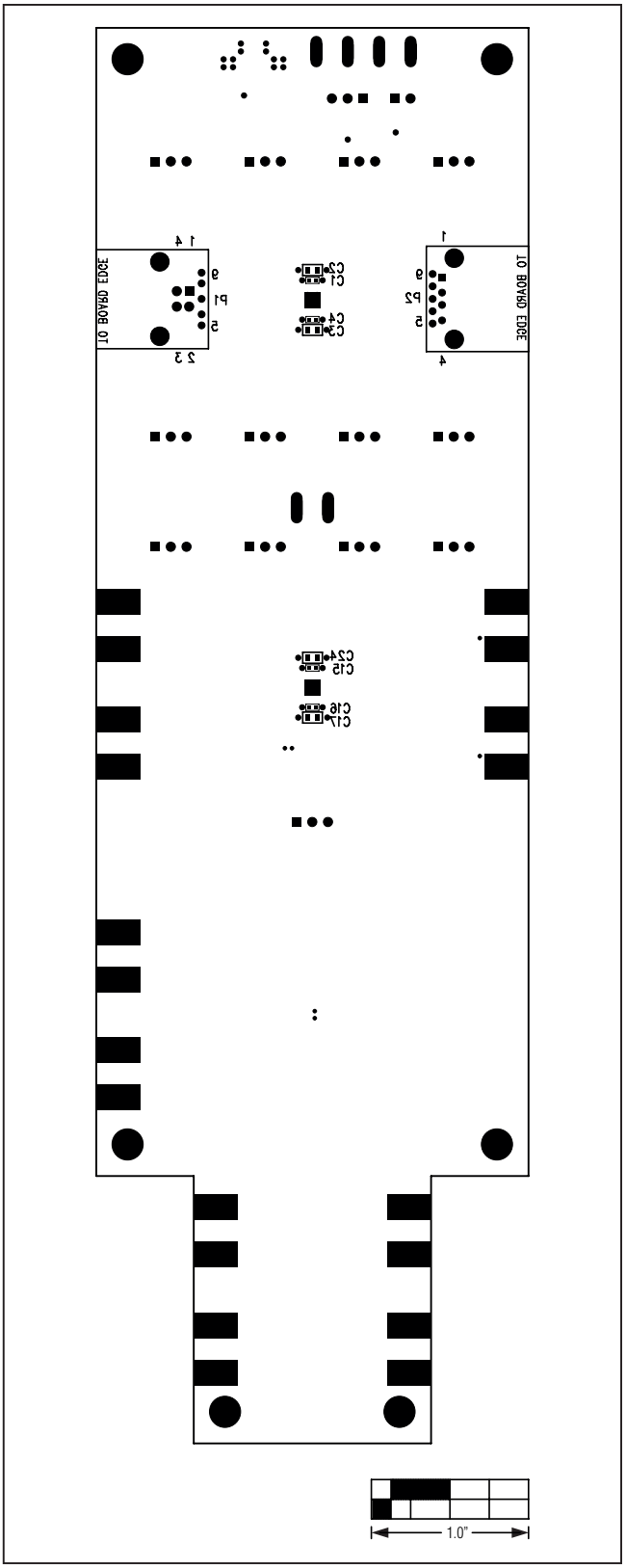

Figure 7. MAX14972 EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX14972EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/11	Initial release	—