



# MAX9939 Evaluation Kit

## General Description

The MAX9939 evaluation kit (EV kit) is a fully assembled and tested surface-mount PCB that evaluates the MAX9939 SPI™-programmable gain amplifier (PGA). Its internal op amp is configured as a multiple-feedback active filter by default, but can also be reconfigured so the MAX9939 operates as a differential-input, differential-output programmable gain amplifier. The EV kit features an on-board microcontroller, which receives commands from a PC through the USB port. The EV kit can be powered directly from the USB bus or from a single-supply voltage of 2.9V to 5.5V.

The EV kit also includes Windows® 2000/XP- and Windows Vista®-compatible software that provides a simple user interface for exercising the MAX9939 features. The program is menu driven and offers a graphical user interface (GUI) complete with control buttons and status displays. The GUI demonstrates the programmable gains from 0.2V/V to 157V/V and the input offset voltage compensation features of the MAX9939 IC.

## Features

- ◆ Powered Directly from a USB Port
- ◆ On-Board Microcontroller to Generate SPI Commands
- ◆ Easy-to-Use, Menu-Driven Software
- ◆ Surface-Mount Components
- ◆ Lead(Pb)-Free and RoHS Compliant
- ◆ Fully Assembled and Tested

## Ordering Information

| PART          | TYPE   |
|---------------|--------|
| MAX9939EVKIT+ | EV Kit |

+ Denotes lead(Pb)-free and RoHS compliant

## Component List

| DESIGNATION                  | QTY | DESCRIPTION  |
|------------------------------|-----|--|
| C1, C2, C4–C8, C12, C17, C19 | 10  | 0.1μF ±10%, 16V X7R ceramic capacitors (0603)<br>Murata GRM188R71C104K<br>TDK C1608X7R1C104K   |
| C3                           | 1   | 4.7μF ±10%, 6.3V X5R ceramic capacitor (0603)<br>Murata GRM188R60J475K<br>TDK C1608X5R0J475K   |
| C13, C15                     | 2   | 10μF ±20%, 16V X5R ceramic capacitors (1206)<br>Murata GRM31CR61C106M or<br>TDK C3216X5R1C106M |
| C9                           | 1   | 0.033μF ±10%, 25V X7R ceramic capacitor (0603)<br>Murata GRM188R71E333K<br>TDK C1608X7R1E333K  |
| C10, C11                     | 2   | 22pF ±5%, 50V C0G ceramic capacitors (0603)<br>Murata GRM1885C1H220J<br>TDK C1608C0G1H220J     |

| DESIGNATION | QTY | DESCRIPTION  |
|-------------|-----|--|
| C14         | 1   | 1μF ±10%, 16V X5R ceramic capacitor (0603)<br>Murata GRM188R61C105K<br>TDK C1608X5R1C105K    |
| C16, C18    | 2   | 10pF ±5%, 50V C0G ceramic capacitors (0603)<br>Murata GRM1885C1H100J<br>TDK C1608C0G1H100J   |
| C20         | 1   | 4700pF ±10%, 50V X7R ceramic capacitor (0603)<br>Murata GRM188R71H472K<br>TDK C1608X7R1H472K |
| C21         | 1   | 220pF ±10%, 50V X7R ceramic capacitor (0603)<br>Murata GRM188R71H221K<br>TDK C1608X7R1H221K  |
| C22         | 0   | Not installed, capacitor (0603)  |
| D1          | 1   | Green LED (0805)   |
| FB1         | 1   | 70Ω, 4A ferrite bead (0603)<br>TDK MMZ1608R301A<br>Murata BLM18SG700 TN1                     |

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**For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).**

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## Component List (continued)

| DESIGNATION               | QTY | DESCRIPTION                                    |
|---------------------------|-----|--|
| H1                        | 0   | Not installed, 2 x 5-pin JTAG header           |
| H2                        | 0   | Not installed, 2 x 6-pin JTAG header           |
| IN_DIFF,<br>OUT_DIFF      | 2   | 75Ω BNC PCB-mount connectors                   |
| JU1                       | 1   | 3-pin header                                   |
| P1                        | 1   | USB type-B right-angle PC-mount receptacle     |
| R1, R2                    | 2   | 27Ω ±5% resistors (0603)                       |
| R3                        | 1   | 1.5kΩ ±5% resistor (0603)                      |
| R4, R7                    | 2   | 470Ω ±5% resistors (0603)                      |
| R5                        | 1   | 2.2kΩ ±5% resistor (0603)                      |
| R6                        | 1   | 10kΩ ±5% resistor (0603)                       |
| R8, R17, R24,<br>R25      | 4   | 0Ω resistors (0603)                            |
| R9, R10, R11,<br>R22, R23 | 0   | Not installed, resistors (0603)                |
| R12–R16                   | 0   | Not installed, resistors—short PC trace (0603) |
| R18, R19                  | 2   | 66.5kΩ ±1% resistors (0603)                    |
| R20                       | 1   | 121kΩ ±1% resistor (0603)                      |
| R21                       | 1   | 1.21kΩ ±1% resistor (0603)                     |

| DESIGNATION | QTY | DESCRIPTION  |
|-------------|-----|--|
| U1          | 1   | SPI programmable gain amplifier (10 μMAX®)<br>Maxim MAX9939AUB+      |
| U2          | 1   | Low-voltage level translator (14 TSSOP)<br>Maxim MAX3390EEUD+        |
| U3          | 1   | Low-power 16-bit microcontroller (68 QFN-EP*)<br>Maxim MAXQ2000-RAX+ |
| U4          | 1   | LDO regulator (5 SO70)<br>Maxim MAX8511EXK25+                        |
| U5          | 1   | UART-to-USB converter (32 TQFP)<br>FTDI FT232BL                      |
| U6          | 1   | 93C46 3-wire 16-bit EEPROM (8 SO)<br>Atmel AT93C46A-10SU-2.7         |
| Y1          | 1   | 16MHz crystal  |
| Y3          | 1   | 6MHz crystal   |
| —           | 1   | Shunt  |
| —           | 1   | PCB: MAX9939 Evaluation Kit+   |

\*EP = Exposed pad.

## Component Suppliers

| SUPPLIER                       | PHONE        | WEBSITE               |
|--------------------------------|--------------|-----------------------|
| Murata Manufacturing Co., Ltd. | 770-436-1300 | www.murata.com        |
| TDK Corp.                      | 847-803-6100 | www.component.tdk.com |

**Note:** Indicate that you are using the MAX9939 when contacting these component suppliers.

## MAX9939 EV Kit Files

| PART                | DESCRIPTION                                |
|---------------------|--|
| INSTALL.EXE         | Installs the EV kit files on your computer |
| MAX9939.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          |

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## Quick Start

### Recommended Equipment

Before beginning, the following equipment is needed:

- A user-supplied Windows 2000/XP/Vista-compatible PC with a spare USB port
- Signal generator
- Oscilloscope

**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 MAX9939 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution:** Do not turn on power supplies until all connections are completed.

- 1) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to download the latest version of the EV kit software, 9939Rxx.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 a shunt is installed across pins 2-3 of jumper JU1 (USB powered).
- 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 that is similar to the one described above is not seen 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\MAX9939** (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.

ument included with the software for additional information.

- 6) Start the EV kit software by opening its icon in the **Start | Programs** menu. The EV kit software main window appears, as shown in Figure 1. Observe as the program automatically detects the MAX9939 EV kit and starts the main program.
- 7) Set the signal generator to produce an output signal of 25mV peak-to-peak at a frequency of 1kHz.
- 8) Connect the signal generator to the IN\_DIFF BNC connector.
- 9) Connect the oscilloscope to the OUT\_DIFF BNC connector.
- 10) Enable the signal generator.
- 11) Adjust the gain and offset settings using the provided software. See the *Detailed Description of Software* section to evaluate the features of the EV kit.
- 12) Monitor and verify the output with the oscilloscope.

## Detailed Description of Software

The MAX9939 EV kit software GUI (Figure 1) is a Windows program that provides a convenient means to control the MAX9939. By updating the **Gain/Offset Setting** group box or **Shutdown** checkbox, the correct SPI-compatible write operation is generated to update the internal registers of the MAX9939. Note, updating only the select radio group does not modify the internal registers.

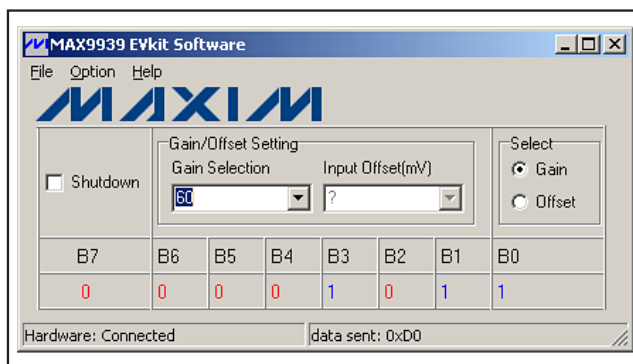


Figure 1. MAX9939 EV Kit Software Main Window

### Select

The **Select** radio group of the MAX9939 EV kit GUI controls the SEL bit to select which internal register is written to. Select **Gain** to write to the gain register or select **Offset** to write to the input offset voltage trim register.

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### Programming Gain and Input Offset Voltage

The **Gain/Offset Setting** group box of the MAX9939 EV kit software controls the data written to the two internal registers of the MAX9939 IC. The **Gain Selection** drop-down list writes to the gain register to set the gain of the amplifier. The **Input Offset(mV)** drop-down list writes to the input offset voltage (V<sub>OS</sub>) register to cancel the inherent offset voltage of the amplifier. Refer to Tables 3 and 4 in the MAX9939 IC data sheet for gain and input offset voltage settings.

### Shutdown

The **Shutdown** checkbox of the MAX9939 EV kit GUI allows the user to place the device in a low-power shut-

down mode with only the digital part of the chip staying active. Leave the **Shutdown** checkbox unchecked for normal circuit operation.

### General-Purpose 3-Wire (SPI) Interface Utility

The general-purpose **3-wire interface** utility (Figure 2) can also be used to communicate with the MAX9939 using low-level SPI commands. Select the **Options | Interface** menu item and select the **3-wire interface** tab to access the utility. The utility configures the 3-wire serial-interface parameters, such as MSB position, CPOL, CPHA, MOSI/MISO inverted logic, CS active state (high or low), SPI clock (SCLK) speed, and custom selection of SPI signal pins. The data to be sent is

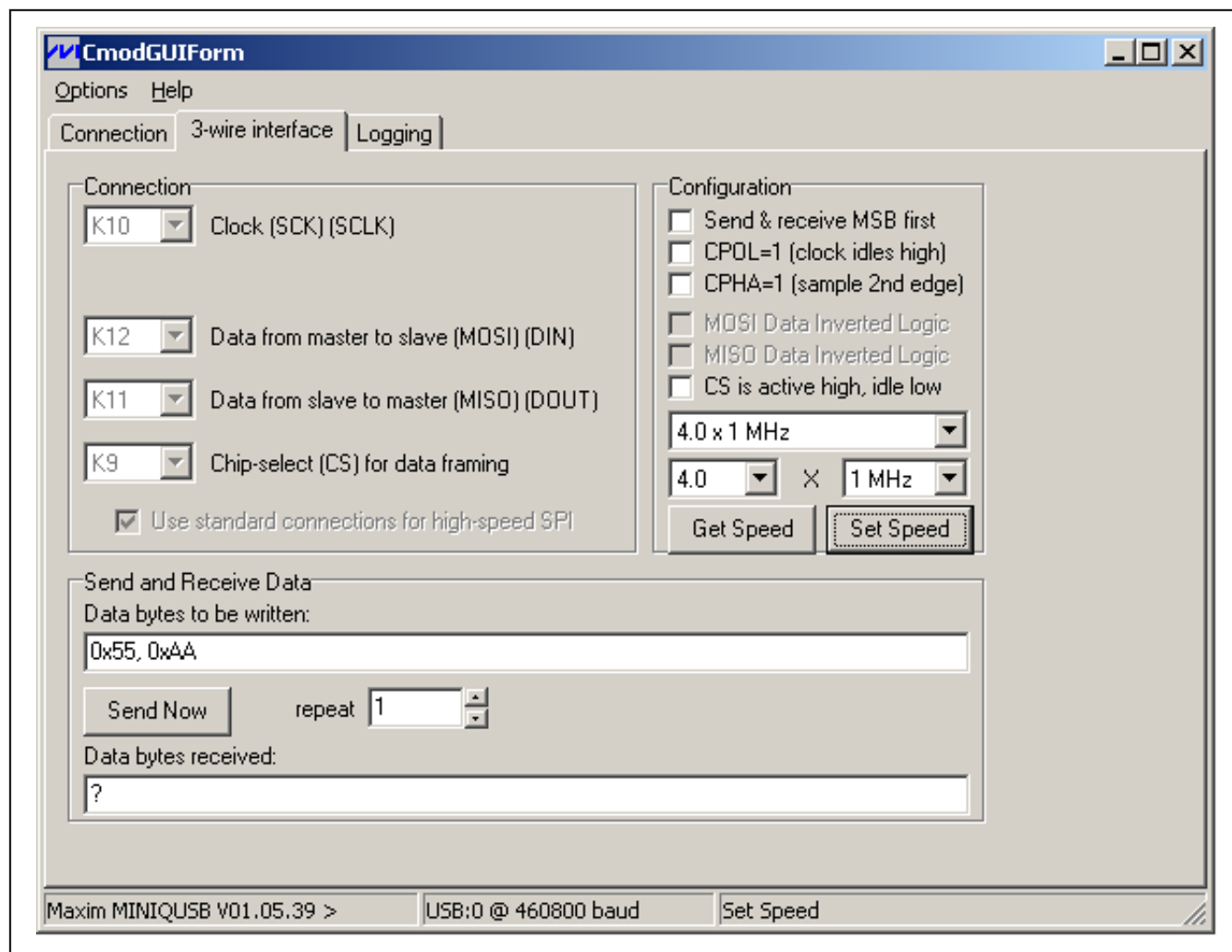


Figure 2. MAX9939 Interface Diagnostic Window

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8-bit data represented by a two-digit hexadecimal code. The code is entered in the **Data bytes to be written** edit box and transmitted by pressing the **Send Now** button.

### Detailed Description of Hardware

#### **Power Input**

The MAX9939 EV kit operates from a single supply VCC between 2.9V to 5.5V. Using 3-pin jumper JU1, the EV kit can be powered through the host PC's USB port or by an external power supply. By default, a shunt is installed across pins 2-3 and the USB provides 5V (+5VUSB) to power the EV kit. Install a shunt across pins 1-2 to use an external power supply applied at the VCC pad. Table 1 lists the selectable jumper options.

**Table 1. Jumper JU1 Functions (VCC)**

| SHUNT POSITION | VCC DESCRIPTION   |
|----------------|---|
| 1-2            | EV kit requires an external power supply applied at the VCC pad |
| 2-3*           | EV kit is powered through the host PC's USB port (+5VUSB)       |

\*Default position.

#### **Default Configuration as an Active Filter**

The MAX9939 EV kit comes standard with the MAX9939 configured as an anti-aliasing filter to provide a cutoff frequency to maximize the Nyquist bandwidth of an ADC. The external resistors and capacitors are chosen to create a 1.3kHz lowpass, 3rd-order, 0.1dB Chebyshev multiple-feedback active filter. Refer to the *Applications Information* section in the MAX9939 IC data sheet for a more detailed description of using the MAX9939 IC as an active filter.

#### **Evaluating the EV Kit as a Differential-Input, Differential-Output PGA**

The MAX9939 EV kit can also be evaluated as a differential-input, differential-output programmable gain amplifier by configuring the output stage as follows:

- 1) Remove R24, R25, C20, and C21.
- 2) Replace R20 with a 0 $\Omega$  resistor.
- 3) Replace R18 and R19 with 10k $\Omega$  resistors.
- 4) If an anti-aliasing filter is required, replace C2, C22 and R21, R22 capacitor/resistor values as required. If an anti-aliasing filter is not required, replace R21 and R22 with 0 $\Omega$  resistors while leaving C2 and C22 open.
- 5) Utilize the OUT\_DIFF BNC connector to analyze the differential output. **Caution: Ensure that pin 2 of the IN\_DIFF BNC connector and pin 2 of the OUT\_DIFF BNC connector are isolated from each other (i.e., not shorted together).**



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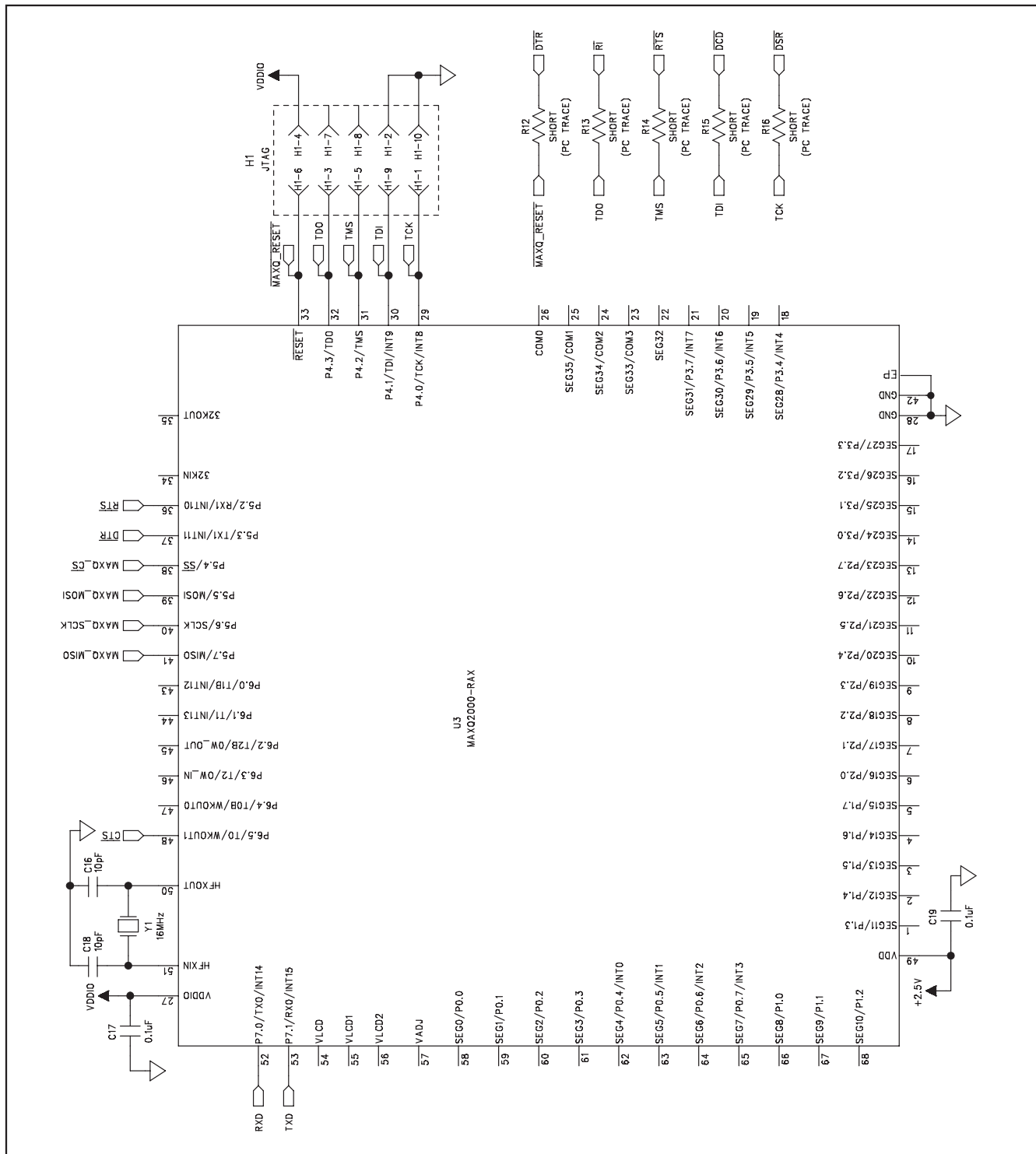


Figure 3b. MAX9939 EV Kit Schematic (Sheet 2 of 3)

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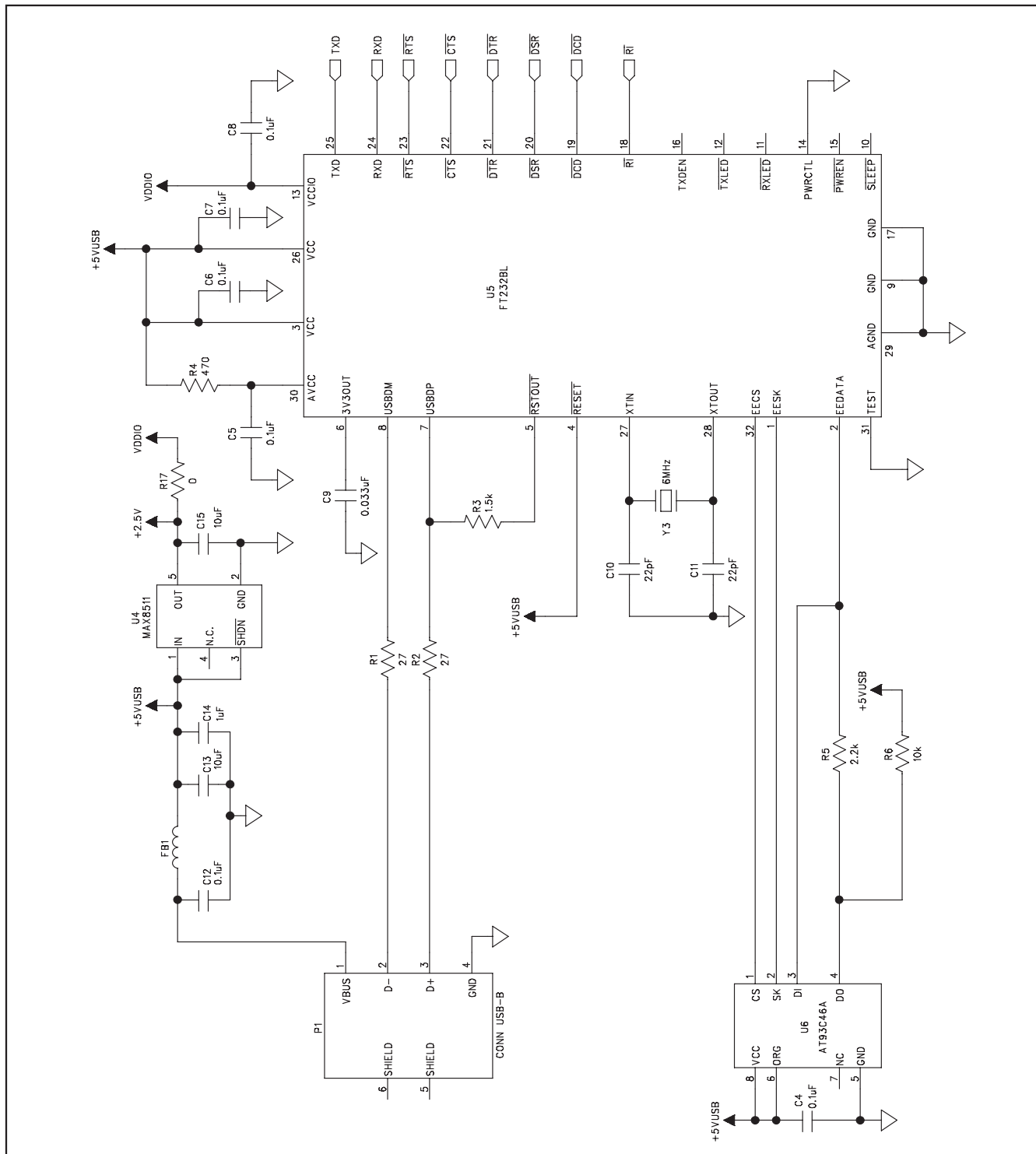


Figure 3c. MAX9939 EV Kit Schematic (Sheet 3 of 3)



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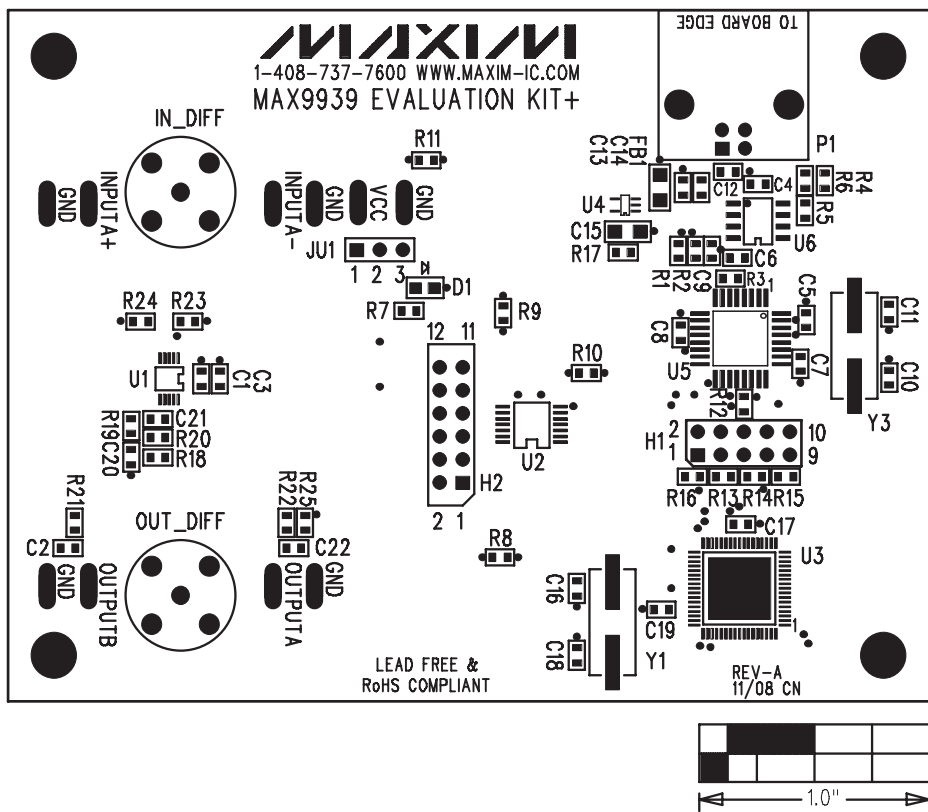


Figure 4. MAX9939 EV Kit Component Placement Guide—Component Side

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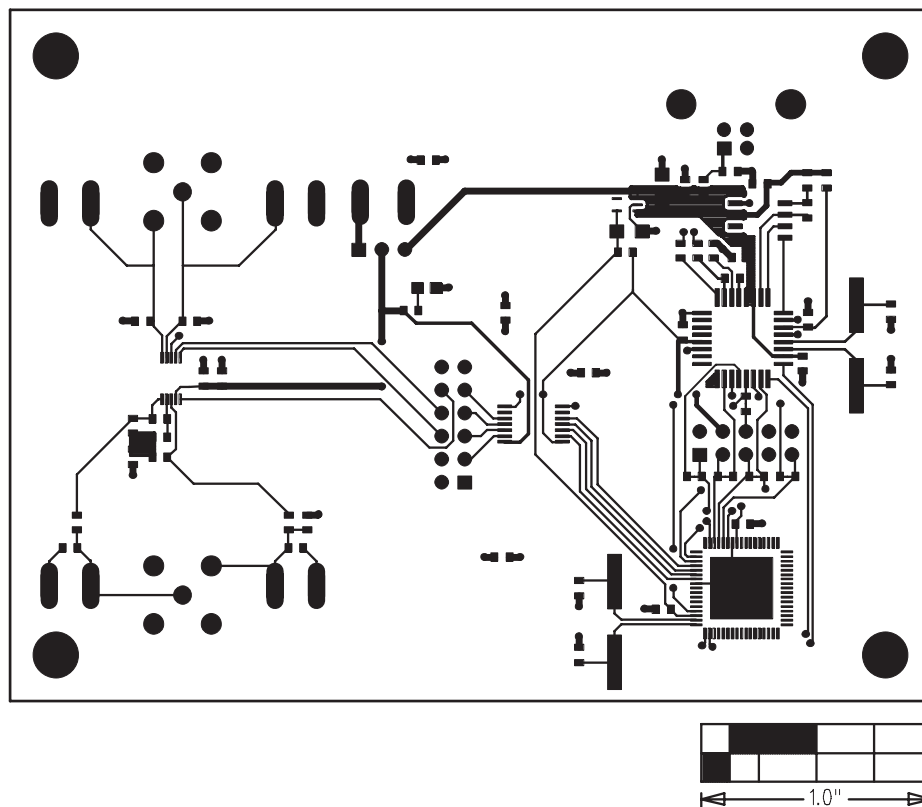


Figure 5. MAX9939 EV Kit Component PCB Layout—Component Side

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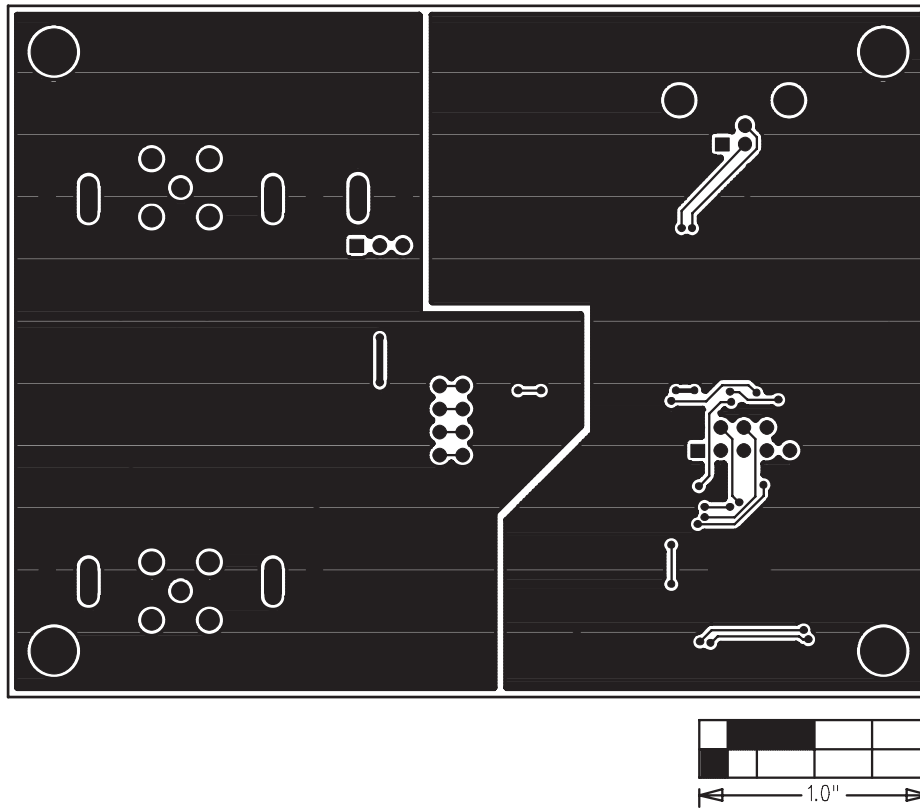


Figure 6. MAX9939 EV Kit PCB Layout—Solder Side

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