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MAX5474 Evaluation Kit

Evaluates: MAX5474/MAX5475

General Description

The MAX5474 evaluation kit (EV kit) is an assembled and tested printed-circuit board (PCB) that evaluates the MAX5474 IC. The MAX5474 is a 32-tap, 50kΩ non-volatile, linear-taper digital potentiometer. Windows® 2000/XP/Vista-compatible software is available to provide a convenient user interface for exercising the MAX5474 features.

The MAX5474 EV kit provides three options to control the MAX5474 wiper position using logic-input signals. The MAX5474 logic-input signals can be controlled by an on-board USB interface circuit, PCB interfacing pads, or switches on the EV kit circuit for stand-alone operation.

The EV kit can operate from a 3.3V source generated from the USB interface circuit or from a 2.7V to 5.25V external DC power supply. The EV kit can also evaluate the MAX5475 (100kΩ) after IC replacement (U1).

Features

♦ **2.7V to 5.25V Single-Supply Operation**

♦ **Power-On Recall of Wiper Position from Nonvolatile Memory**

♦ **On-Board USB Interface Circuit**

♦ **USB Powered**

♦ **USB-PC Connection (Cable Included)**

♦ **Stand-Alone Operation Using On-Board Switches**

♦ **PCB Pads for User-Supplied Microcontroller Interface Signals**

♦ **PCB Pads for Potentiometer Signals (L, W, H)**

♦ **Proven USB-Compatible PCB Layout**

♦ **Evaluates the MAX5474/MAX5475 in 8-Pin SOT23 Package**

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

♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX5474EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3–C10, C17, C21–C26	16	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K TDK C1608X7R1C104K
C2, C13, C15	3	10µF ±20%, 6.3V X5R ceramic capacitors (0805) Murata GRM21BR60J106M TDK C2012X5R0J106M
C11, C12	2	10pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H100J TDK C1608C0G1H100J
C14, C16, C27	3	1µF ±10%, 10V X5R ceramic capacitors (0603) Murata GRM188R61A105K TDK C1608X5R1A105K

DESIGNATION	QTY	DESCRIPTION
C18, C19	2	22pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H220J TDK C1608C0G1H220J
C20	1	3300pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H332K TDK C1608X7R1H332K
D1	1	Green LED (0603) Panasonic LNJ314G8TRA
FB1	0	Not installed, ferrite-bead inductor—short (PC trace) (0603)
H1	0	Not installed, dual-row 10-pin (2 x 5) header
J1	0	Not installed, dual-row 10-pin (2 x 5) header—short
JU1	1	3-pin header
JU2, JU3, JU4	3	3-way, 4-pin headers

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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.

MAX5474 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
JU5, JU6	2	2-pin headers
P1	1	USB type-B right-angle male receptacle
R1	1	0Ω ±5% resistor (0603)
R2	1	220Ω ±5% resistor (0603)
R3	1	10kΩ ±5% resistor (0603)
R4	1	2.2kΩ ±5% resistor (0603)
R5	1	1.5kΩ ±5% resistor (0603)
R6, R7	2	27Ω ±5% resistors (0603)
R8	0	Not installed, resistor (0402)
R9, R10	2	100kΩ ±5% resistors (0603)
R11	1	51kΩ ±5% resistor (0603)
SW1, SW2	2	Single-pole/double-throw (SPDT) slide switches
SW3	1	Momentary pushbutton switch
U1	1	Maxim 32-tap, 50kΩ nonvolatile, linear-taper digital potentiometer MAX5474EKA+T (8-pin SOT23)
U2	1	Maxim microcontroller Maxim MAXQ2000-RAX+ (68-pin QFN-EP, 10mm x 10mm)

DESIGNATION	QTY	DESCRIPTION
U3	1	93C46 type 3-wire EEPROM (8-pin SO), 16-bit architecture Atmel AT93C46A-10SU-2.7
U4	1	UART-to-USB converter (TQFP-32L, 7mm x 7mm) FTDI FT232BL
U5	1	Maxim 3.3V regulator MAX8511EXK33+T (5-pin SC70)
U6	1	Maxim 2.5V regulator MAX8511EXK25+T (5-pin SC70)
U7, U8	2	Maxim low-voltage logic-level translators MAX3374EEKA+T (8-pin SOT23)
U9	1	Maxim CMOS switch debouncer MAX6816EUS+T (4-pin SOT143)
Y1	1	16MHz crystal Citizen HCM49-16.000MABJ-UT
Y2	1	6MHz crystal Citizen HCM49-6.000MABJ-UT
—	6	Shunts
—	1	USB high-speed A-to-B cable, 6ft
—	1	PCB: MAX5474 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
Panasonic Corp.	800-344-2112	www.panasonic.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: *Indicate that you are using the MAX5474 when contacting these component suppliers.*

MAX5474 EV Kit Software Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on the computer
MAX5474.EXE	Application program
USB_Driver_Help.PDF	USB driver installation help file
FTD2XX.INF	USB driver file
UNINST.INI	Uninstalls the EV kit software

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Quick Start

Recommended Equipment

Before beginning, the following equipment is needed:

- Maxim MAX5474 EV kit (USB cable included)
- User-supplied Windows 2000/XP/Vista-compatible PC with a spare USB port
- One ohmmeter

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 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) Visit www.maxim-ic.com/evkitsoftware to download the latest version of the EV kit software, 5474Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.

2) Install the EV kit software on the 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 on pins 1-2 of jumper JU1. This configures the MAX5474 IC's VDD to 3.3V from the USB interface circuit.

4) Verify that a shunt is installed on pins 1-3 of jumpers JU2, JU3, and JU4. This configures the logic-input pins to receive signals from the USB interface circuit.

5) Verify that no shunt is installed on jumpers JU5 and JU6, the L PCB pad is not connected to GND, and the H PCB pad is not connected to the W PCB pad.

6) Connect the ohmmeter across the W and L PCB pads.

7) Connect the USB cable from the PC to the MAX5474 EV kit. 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 a window similar to the one described above does not appear after 30s, remove the USB cable from the board and recon-

nect it. Administrator privileges are required to install the USB device driver on Windows 2000/XP/Vista.

8) 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\MAX5474** (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 for additional information.

9) Start the MAX5474 EV kit software by opening its icon in the **Start | Programs** menu.

10) The software automatically searches for the MAX5474. After successful connection, the EV kit software main window appears in the upper-left corner of the window. Select the **Up/Down** buttons to change the wiper position, or enter the desired wiper position into the **Wiper Input** combo box (see Figure 1).

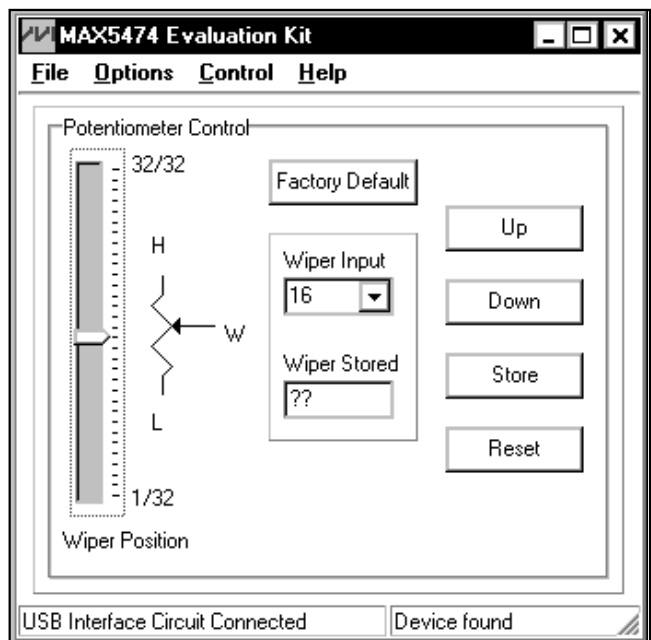See the *Detailed Description of Software* section for more information on the software features.

Figure 1. MAX5474 Evaluation Kit Software Main Window

MAX5474 Evaluation Kit

_Detailed Description of Hardware

The MAX5474 EV kit demonstrates the MAX5474, a 32-tap, 50kΩ nonvolatile, linear-taper digital potentiometer IC's features. The EV kit uses a MAX5474 IC in an 8-pin SOT23 package on a proven two-layer PCB design. The MAX5474 EV kit provides two options to power the MAX5474 IC. It can operate from the 3.3V supply generated from the USB interface circuit, or from a user-supplied 2.7V to 5.25V external DC power supply. The USB interface circuit features MAX3374 low-voltage logic-level translators (U7 and U8) for 2.7V to 5.25V operation.

Nonvolatile Memory

Programming Nonvolatile (NV) Memory in Stand-Alone Operation

In stand-alone operation, the MAX5474 wiper position is stored in nonvolatile memory whenever the SPDT slide switch SW1 ($\overline{CS}$) is moved from $\overline{EN}$ to DIS (rising edge) and the pushbutton switch SW3 ($\overline{INC}$) is not depressed (high). The wiper returns to this stored position upon power-up.

Software Operation

In software operation, the MAX5474 wiper position is stored in nonvolatile memory when the **Store** button is pressed. The MAX5474 wiper returns to this position upon power-up. After powering up the EV kit, before changing the wiper position from the nonvolatile memory position, press the **Reset** button to reinitialize the wiper to a known position (midscale). **Reset** does not overwrite the MAX5474 nonvolatile memory; press the **Factory Default** button to reset the NV memory to the factory-preset position (midscale). See the *Detailed Description of Software* section for more information.

Jumper and Switch Functions

Using an External DC Power Supply

The MAX5474 EV kit can be powered by an external 2.7V to 5.25V DC power supply. To connect the EV kit to an external power supply, disconnect the USB cable and install a shunt on pins 2-3 of jumper JU1. Turn off the power supply and connect the power-supply ground terminal to the EV kit GND pad and the power-supply positive terminal to the VIN pad. Table 1 lists the various options for powering the MAX5474 EV kit.

Table 1. JU1 Jumper Functions (V_{DD})

SHUNT POSITION	V_{DD} PIN CONNECTED TO	EV KIT POWERED FROM
1-2*	3.3V	USB interface circuit
Open	No connect	Do not use (EV kit will not be powered)
2-3	VIN	External power supply

*Default position.

Interface Control Signals

The MAX5474 EV kit circuit features three logic-input signals to control the MAX5474 wiper position. The chip-select ($\overline{CS}$), up/down (U/$\overline{D}$), and increment ($\overline{INC}$) interface signals are controlled by the on-board USB interface circuit or the PCB pads, along with user-supplied external control signals, or stand-alone operation using switches on the EV kit. Jumpers JU2, JU3, and JU4 select the interface-signal-control sources for the MAX5474 IC. Table 2 lists the various options for configuring logic-input signal controls.

Table 2. JU2, JU3, JU4 Jumper Functions ($\overline{CS}$, U/$\overline{D}$, $\overline{INC}$)

SHUNT POSITION	INTERFACE CONTROL SIGNALS CONNECTED TO	INTERFACE SIGNALS CONTROLLED BY
1-2	PCB pads	User-supplied external signals (EV kit software not updated)
1-3*	USB interface circuit	USB interface circuit and EV kit software
1-4	Switches	Stand-alone operation, switches SW1, SW2, SW3 (EV kit software not updated): • SW1 controls the $\overline{CS}$ signal • SW2 controls the U/$\overline{D}$ signal • SW3 controls the $\overline{INC}$ signal
Open	No connect	Do not use this configuration

*Default position.

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The stand-alone-operation switches can be used to store the MAX5474 wiper position into nonvolatile memory. To store the MAX5474 wiper position into nonvolatile memory, set the wiper to the desired position and slide the SPDT switch SW1 ($\overline{CS}$) from $\overline{EN}$ to DIS (rising edge), while pushbutton switch SW3 ($\overline{INC}$) is not depressed (high). The wiper returns to this stored position upon power-up.

Voltage-Divider with Ground Reference

The MAX5474 EV kit provides an option to configure the MAX5474 as a voltage-divider referenced to ground (GND). To configure the EV kit as a voltage-divider referenced to ground, connect the L PCB pad to GND using jumper JU5, connect the voltage source to the H PCB pad, and the application input signal to the W PCB pad. Jumper JU5 connects or disconnects the L signal from GND. Table 3 lists the JU5 jumper options.

Table 3. JU5 Jumper Functions (L Signal and GND)

SHUNT POSITION	L PIN CONNECTED TO	EV KIT FUNCTIONS
Not installed*	L PCB pad	Potentiometer or variable resistor
Installed	GND	Voltage-divider with ground reference

Default position.

Variable Resistor or Potentiometer

The MAX5474 EV kit configures the MAX5474 as a potentiometer by default. The EV kit provides an option to reconfigure the MAX5474 as a variable resistor by connecting the MAX5474 IC's H and W pins. To reconfigure the MAX5474 as a variable resistor, install a shunt on jumper JU6. Table 4 lists the JU6 jumper options.

Table 4. JU6 Jumper Functions (H and W pins)

SHUNT POSITION	H AND W PINS	EV KIT FUNCTIONS
Not installed*	Not connected	Potentiometer
Installed	Connected	Variable resistor

Default position.

Stand-Alone Operation Switches (SW1, SW2, SW3)

The MAX5474 EV kit features three switches to control the MAX5474 interface signals for stand-alone operation. SPDT slide switches SW1 and SW2 control the $\overline{CS}$ and U/$\overline{D}$ signals, respectively, and pushbutton switch SW3 controls the $\overline{INC}$ signal. The $\overline{CS}$, U/$\overline{D}$, and $\overline{INC}$ signals interact to control the wiper position of the MAX5474. Table 5 lists the functions of switches SW1, SW2, and SW3 for stand-alone operation. Refer to the *Truth Table* in the MAX5474 IC data sheet for specific switch sequence.

Table 5. Stand-Alone Operation for SW1, SW2, SW3 Switch Functions ($\overline{CS}$, U/$\overline{D}$, $\overline{INC}$ Signals)

SWITCH	LOGIC-INPUT PINS	LOGIC-INPUT PINS FUNCTION
SW1	$\overline{CS}$	High = U1 disabled Low = U1 enabled
SW2	U/$\overline{D}$	High = Increment up Low = Decrement down
SW3	$\overline{INC}$	Increment if: $\overline{CS}$ = low, U/$\overline{D}$ = high, and $\overline{INC}$ = ↓ Decrement if: $\overline{CS}$ = low, U/$\overline{D}$ = low, and $\overline{INC}$ = ↓

↓ = *High-to-low transition.*

Note: For stand-alone operation:

1) To power the EV kit, connect an external power supply to V_{IN} and GND and install a shunt on pins 2-3 of jumper JU1 (see Table 1).

2) To utilize the switches, install a shunt across pins 1-4 of jumpers JU2, JU3, and JU4 (see Table 2).

Evaluating the MAX5475

The MAX5475 is similar to the MAX5474, but has an end-to-end resistance of 100kΩ. To evaluate the MAX5475, order a free sample of the MAX5475 and replace IC U1. The software is compatible with the MAX5475 IC.

MAX5474 Evaluation Kit

__Detailed Description of Software

The MAX5474 EV kit software graphical user interface (GUI) is a Windows program that provides a convenient means to control the MAX5474, as shown in Figure 1.

Text in **bold** denotes user-selectable features in the MAX5474 EV kit software. A mouse or the keyboard's **TAB** key is used to navigate various items on the main window. The bottom left-side status bar of the main window provides the USB interface circuit communication status. The bottom right-side status bar indicates the presence or absence of the MAX5474 IC and operational status.

Software Startup

Upon starting the program, the MAX5474 EV kit software automatically detects for the USB and interface circuit connection. The MAX5474 EV kit enters normal operating mode when the USB connection is detected. The software **Wiper Position** and **Wiper Input** are initialized to midscale position at startup. Software initialization sets the volatile register of the MAX5474 IC to midscale. The NV memory remains unchanged. If the USB connection is not detected, the software prompts the user to retry, exit the program, or enter the demo mode.

Demo Mode

The MAX5474 EV kit software can enter the demo mode, when the USB connection is not detected, by pressing the **Cancel** button in the MAX5474 *Evaluation Kit Interface Circuit Popup Window* (Figure 2). The software can also enter the demo mode at any time using the **Options | Demo Mode** pulldown menu item in the software main window. When in demo mode, all software communication to the EV kit circuit is disabled; however, most of the software GUI is functional. Demo mode allows the user to evaluate the software without hardware connectivity. To exit demo mode, select **Options | Demo Mode** again from the pulldown menu.

Note: When reentering normal operating mode from the demo mode, the MAX5474 wiper position must be reset. Reset the wiper by pressing the **Reset** button. See the *Nonvolatile Memory* section for more details.

Wiper Position

Moving the **Wiper Position** track bar will update and display the MAX5474 wiper position. Pressing the **Store** button stores the MAX5474 wiper to the nonvolatile memory. Pressing the **Reset** button synchronizes the software and wiper position by returning the MAX5474 wiper to the midscale position.

The **Wiper Input** combo box accepts and displays a number between 1 and 32 for the wiper input. The **Wiper Input** also features a drop-down menu that stores the last four user entries. After pressing the **Store** button, the **Wiper Stored** edit box displays the MAX5474 IC's stored wiper position, and is read only.

Up and Down

Pressing the **Up** button increments the wiper one tap position, while pressing the **Down** button decrements the wiper one tap position. These buttons also move the **Wiper Position** track bar to the respective position.

Nonvolatile Memory

The MAX5474 wiper position is stored in nonvolatile memory when the **Store** button is pressed. The MAX5474 wiper returns to this position upon power-up. To demonstrate the nonvolatile memory feature in software operation, press the **Store** button to store the wiper position to the nonvolatile memory. Power cycle the EV kit by removing the shunt from jumper JU1 and reinstalling the shunt after 5s or longer (to allow discharge of bypass capacitors). ***Do not restart the software.*** Use an ohmmeter to verify the resistance between the L and W PCB pads.

Perform a **Reset** to synchronize the software and MAX5474 IC wiper position. Pressing the **Reset** button does not overwrite the MAX5474 nonvolatile memory.

Factory Default

Pressing the **Factory Default** button resets the wiper position in the MAX5474 volatile and nonvolatile memory to the factory-default position. The factory-default wiper position in the volatile and nonvolatile memory is at midscale.
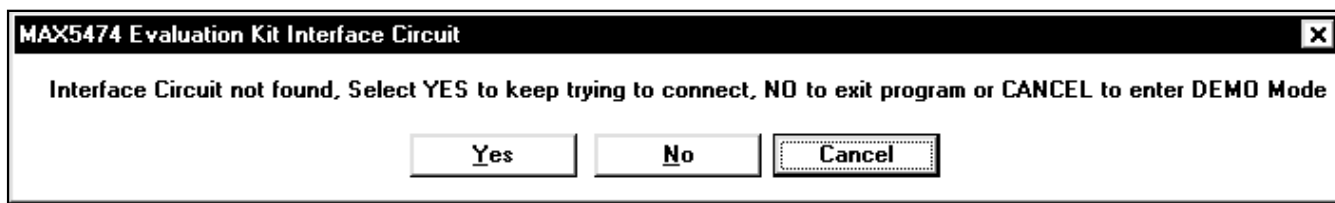

Figure 2. MAX5474 Evaluation Kit Interface Circuit Popup Window

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MAX5474 Evaluation Kit

Keyboard Navigation

Press the **TAB** key to select each GUI control. The selected control is indicated by a dotted outline. Using **SHIFT+TAB** moves the selection to the previously selected control. Buttons respond to the keyboard's **SPACE** bar. Some controls respond to the keyboard **UP** and **DOWN** arrow keys. Activate the program's menu bar by pressing the **F10** key, and then press the letter of the desired menu item. Most menu items have one letter underlined, indicating their shortcut key.

General Troubleshooting

Problem: Software reports it cannot find the interface circuit.

- Is the interface circuit power LED lit?

- Is the USB cable connected?

- Has Windows plug-and-play detected the board? Bring up Control Panel-->System-->Device Manager and look at what device nodes are indicated for USB. If there is an "unknown device" node attached to the USB, delete it (this forces plug-and-play to try again).

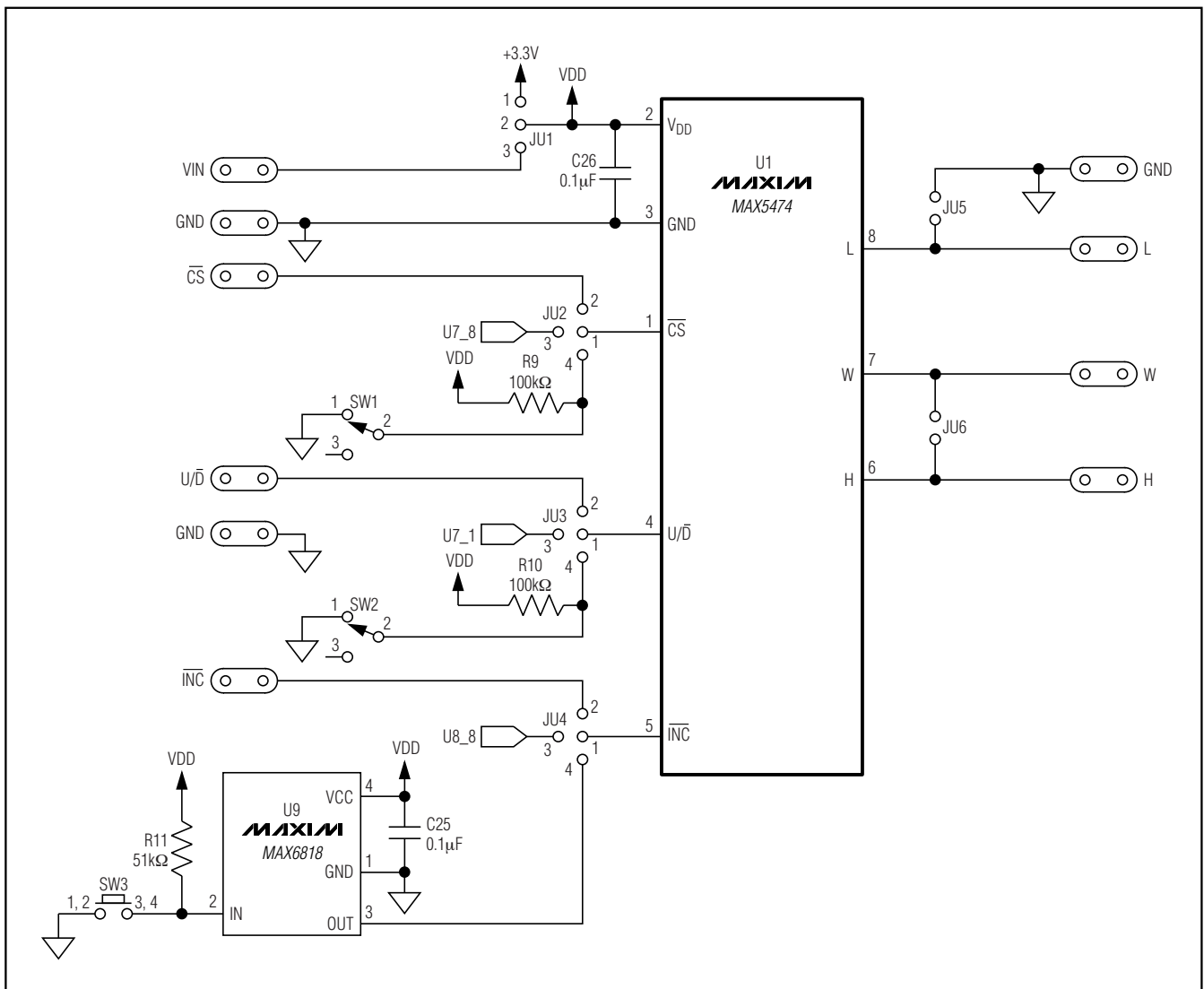- Are jumpers JU1–JU4 properly configured for USB operation?

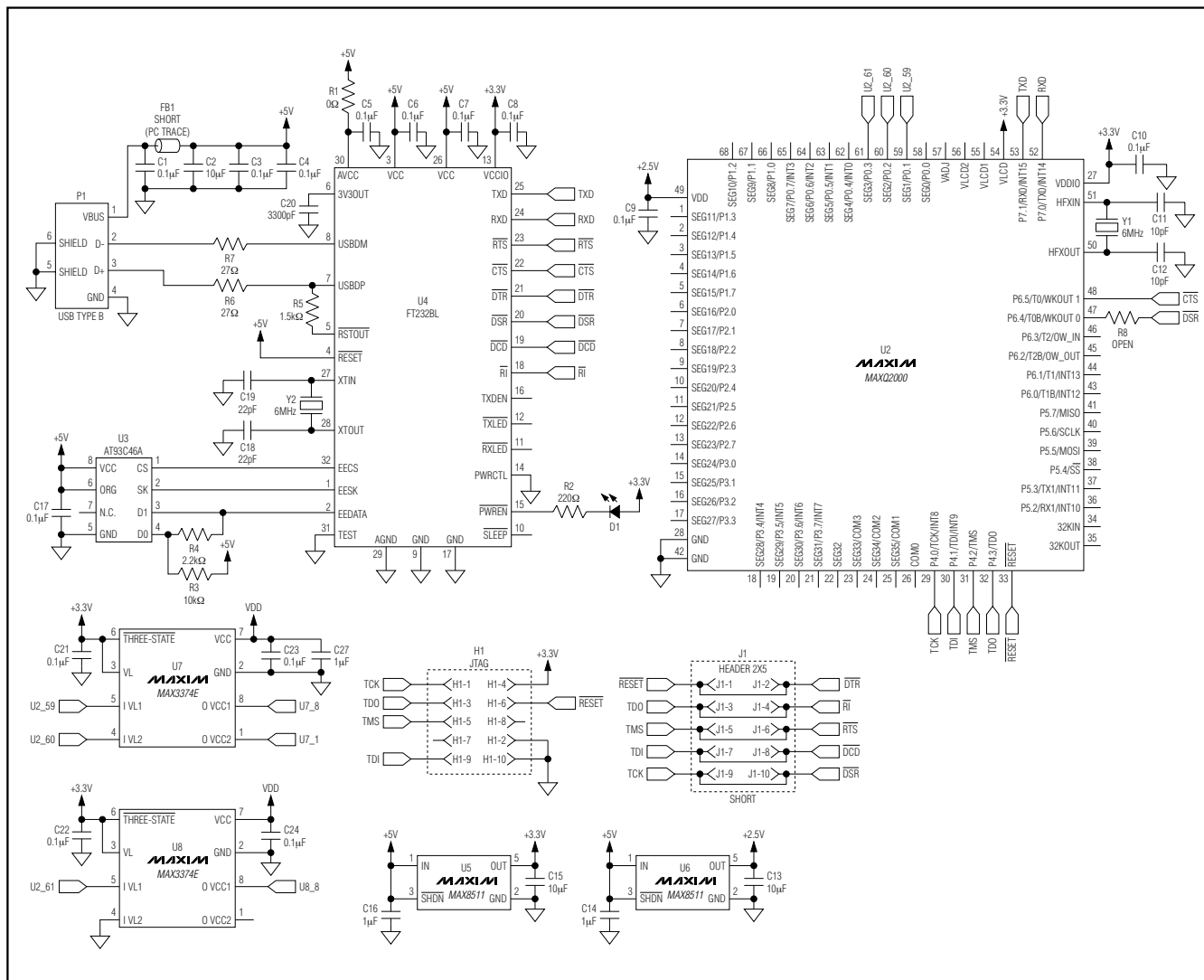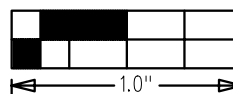*Figure 3a. MAX5474 EV Kit Schematic (Sheet 1 of 2)*

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Figure 3b. MAX5474 EV Kit Schematic (Sheet 2 of 2)

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Figure 4. MAX5474 EV Kit Component Placement Guide—Component Side
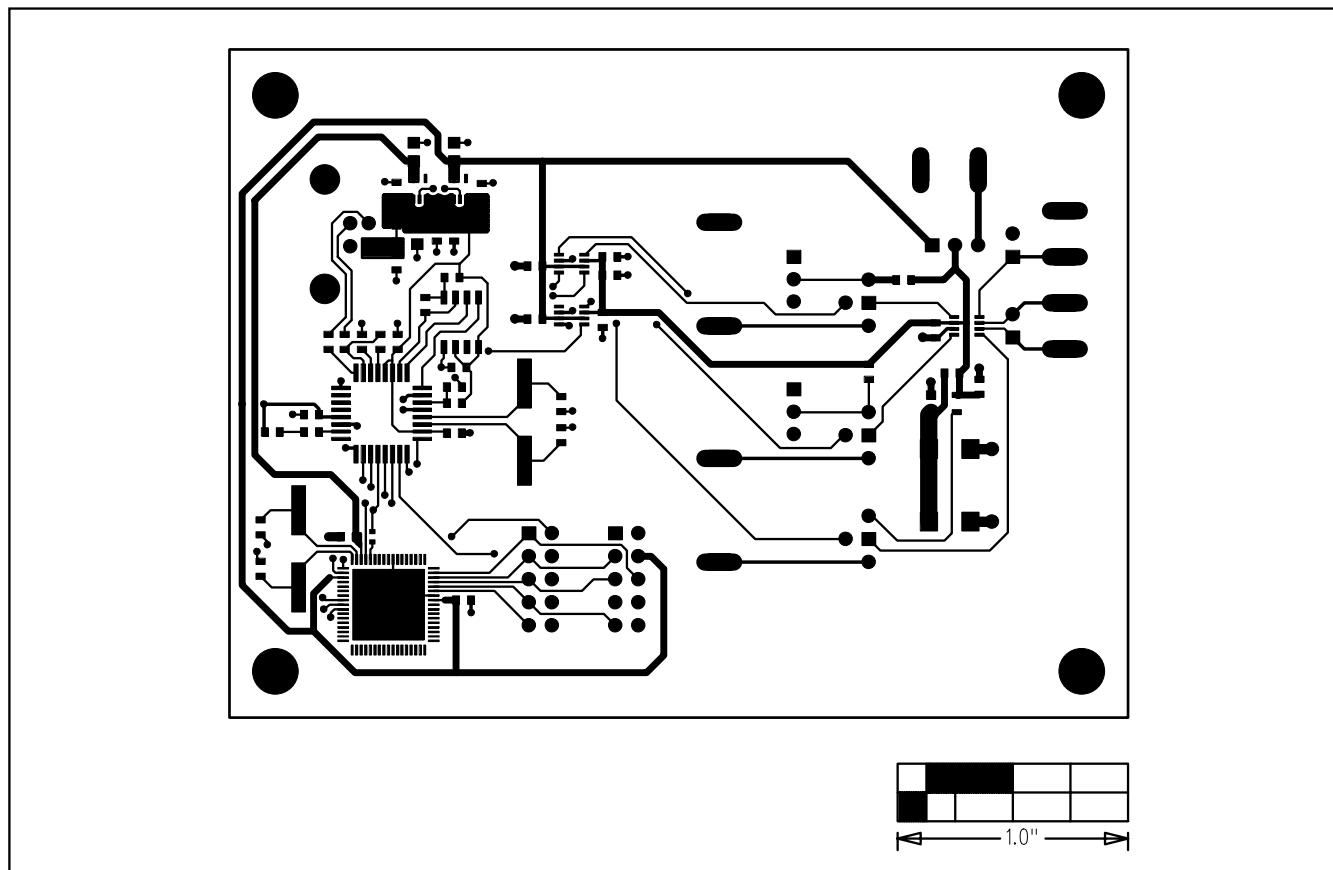
Figure 5. MAX5474 EV Kit PCB Layout—Component Side

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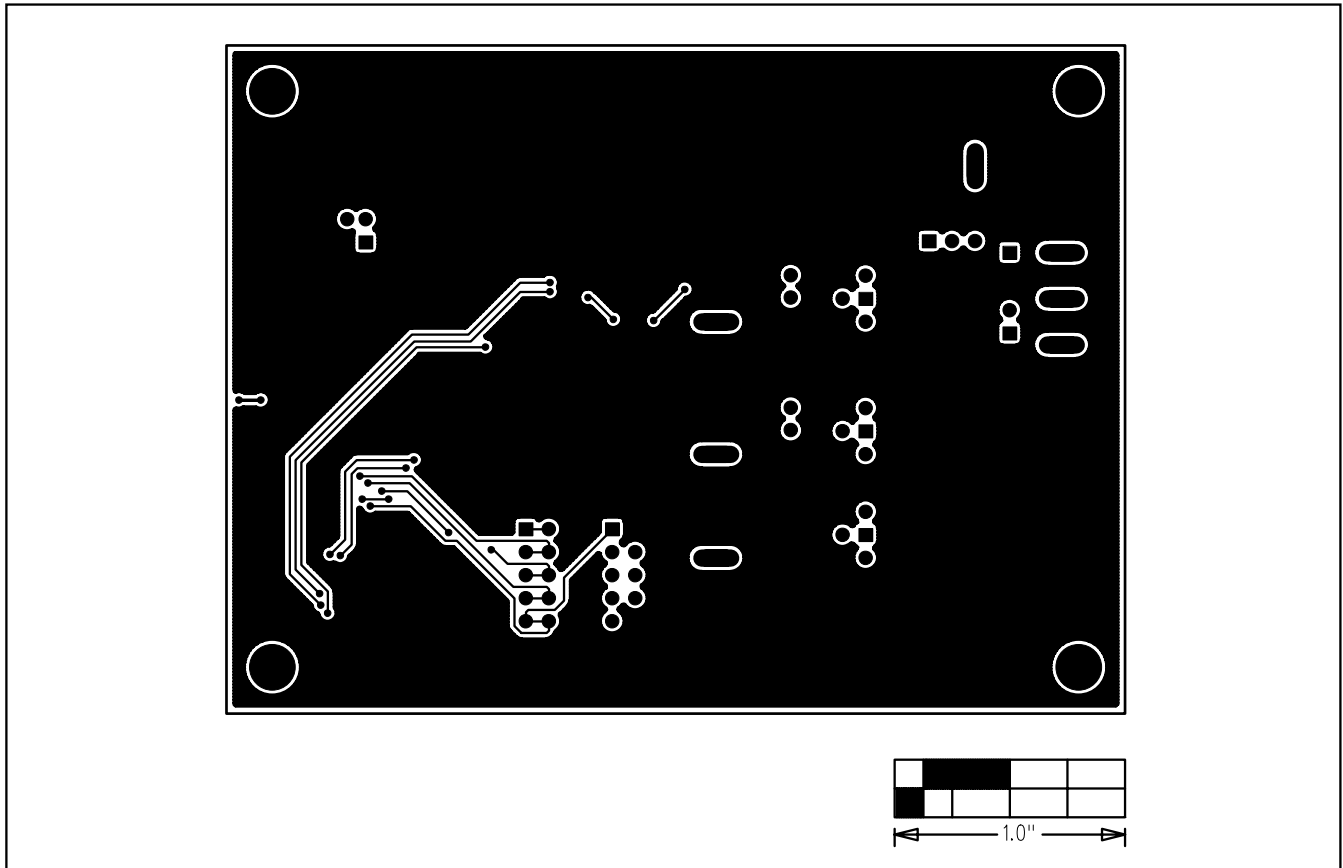
Figure 6. MAX5474 EV Kit PCB Layout—Solder Side

1.0"

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