19-5083; Rev 0; 12/09

MAX97002 Evaluation Kit

Evaluates: MAX97002

General Description

The MAX97002 evaluation kit (EV kit) is a fully assembled and tested PCB that evaluates the MAX97002 mono Class D audio power amplifier and stereo Class H DirectDrive® headphone amplifier communicating over a 2-wire I²C interface. The EV kit features an on-board microcontroller for communicating with the I²C interface of the MAX97002. Pads are provided for accessing the analog inputs and amplifier outputs.

The MAX97002 EV kit requires a 2.7V to 5.5V supply for PVDD and a 1.8V supply for VDD.

Windows® 2000-, Windows XP®-, and Windows Vista®-compatible software is provided to facilitate configuration. The software controls an on-board microcontroller over USB, which generates I²C commands.

Features

- **Proven Audio PCB Layout**
- **On-Board USB Interface Circuit Generates I²C-Compatible Signals**
- **PCB Pads for User-Supplied I²C-Compatible Signals**
- **Surface-Mount Components**
- **Windows 2000-, Windows XP-, and Windows Vista (32-Bit)-Compatible Software**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX97002EVKIT+	EV Kit

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3–C10, C17	10	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K
C2	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J475K
C11, C12	2	10pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H100J
C13, C15, C32, C34	4	10µF ±10%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J106M
C14, C16, C22–C25, C35–C38	10	1µF ± 10%, 10V X5R ceramic capacitors (0402) Murata GRM155R61A105K
C18, C19	2	22pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H220J
C20	1	3300pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H332K
C26–C29, C39–C42	0	Not installed, ceramic capacitors (0402)
C31, C33	2	0.1µF ±10%, 16V X7R ceramic capacitors (0402) Murata GRM155R71C104K
C43–C47	5	0.22µF ±10%, 10V X5R ceramic capacitors (0402) Murata GRM155R61A224K
D1	1	Green LED (0603)
GND	1	Black miniature test point
HPJK	1	3.5mm stereo phone jack, SMT (3-position nonswitch)
HPL	1	White miniature test point
HPR	1	Red miniature test point
JINA1, JINB1	2	White RCA jacks (left)
JINA2, JINB2	2	Red RCA jacks (right)
JU1, JU2	2	2-pin headers
L1, L2	0	Not installed, inductors (provided with EV kit) TOKO A916CY-220M
OUT-, OUT+	2	1-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.

MAX97002 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
P1	1	USB mini type-B receptacle connector
R1, R10–R13, R18, R19	7	0Ω ±5% resistors (0402)
R2	1	220Ω ±5% resistor (0603)
R3	1	10kΩ ±5% resistor (0603)
R4	1	2.2kΩ ±5% resistor (0603)
R5, R8, R9	3	1.5kΩ ±5% resistor (0603)
R6, R7	2	27Ω ±5% resistors (0603)
R14, R15	2	10Ω ±1% resistors (0402)
R16, R17	0	Not installed, resistors (0603)
R20, R21	2	0Ω ±5% resistors (0603)
R22, R23	2	22Ω ±5% resistors (0402)
TP1, TP2	0	Not installed, multipurpose test points
U1	1	Mono Class H speaker with DirectDrive headphone amplifier (20 WLP) Maxim MAX97002EWP+
U2	1	32-bit microcontroller (68 QFN-EP*) Maxim MAXQ2000-RAX+
U3	1	93C46 type 3-wire EEPROM (8 SO)
U4	1	UART-to-USB converter (32 TQFP)
U5	1	3.3V regulator (5 SC70) Maxim MAX8511EXK33+ (Top Mark: AEI)
U6	1	2.5V regulator (5 SC70) Maxim MAX8511EXK25+ (Top Mark: ADV)
Y1	1	16MHz crystal (HCM49) Hong Kong X'tals SSM16000N1HK188F0-0
Y2	1	6MHz crystal (HCM49) Hong Kong X'tals SSL60000N1HK188F0-0
—	1	USB high-speed A-to-mini B cable, 2m
—	2	Shunts
—	1	PCB: MAX97002 EVALUATION KIT+

**EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Hong Kong X'tals Ltd.	852-35112388	www.hongkongcrystal.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
TOKO America, Inc.	800-745-8656	www.tokoam.com

Note: *Indicate that you are using the MAX97002 when contacting these component suppliers.*

MAX97002 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX97000_1_2.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

Quick Start

Required Equipment

- 5V, 1A DC power supply (PVDD)
- 1.8V, 100mA DC power supply (VDD)
- Speaker
- Headphones
- User-supplied Windows 2000, Windows XP, or Windows Vista PC with a spare USB port
- MAX97002 EV kit (cable included)

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 MAX97002 EV kit is fully assembled and tested. Follow the steps below to verify board operation:

1) Visit **www.maxim-ic.com/evkitsoftware** to download the latest version of the EV kit software, MAX97000_1_2xx.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.
3) Verify that shunts are installed on jumpers JU1 and JU2. This configures the I²C inputs to receive signals from the USB interface circuitry.
4) Verify that a shunt is installed on jumper JU3.
5) 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 is not seen that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.
6) Follow the directions of the **Found New Hardware** window to install the USB device driver. Manually specify the location of the device driver to be **C:\Program Files\MAX97000_1_2** (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.
7) Connect the 5V power supply across the PVDD and GND pads.
8) Connect the 1.8V power supply across the VDD and GND pads.
9) Connect the speaker across the OUT+ and OUT- test points.
10) Connect the headphones to HPJK.
11) Enable the power supplies.
12) Start the MAX97002 EV kit software by selecting its icon in the **Start | Programs** menu.
13) Observe as the program automatically detects the address of the MAX97002 and starts the main program.
14) The MAX97002 is now ready for evaluation.

Detailed Description of Software

Note: Text in **bold** refers to items in the EV kit software.

Graphical User Interface (GUI)

The MAX97002 EV kit software GUI (Figures 1 and 2) provides a convenient way to test the features of the MAX97002. Figure 1 shows the MAX97002 EV kit software's **Main Control** tab, while Figure 2 shows the **Registers** tab. Actions on the two tabs generate I²C commands to update the MAX97002 internal memory registers.

The MAX97002 EV kit software **Main Control** tab (Figure 1) divides the EV kit functions into logical blocks. The MAX97002 EV kit software **Registers** tab (Figure 2) displays each register's individual bit logic-level status. A data bit in bold indicates a logic-high, while a non-bolded data bit indicates a logic-low. Clicking on the individual data bit toggles the bit and performs a write command. The new command is shown in the edit box at the right. Write commands can be written to the registers alternatively by typing a hex value in the edit box and pressing Enter on the keyboard.

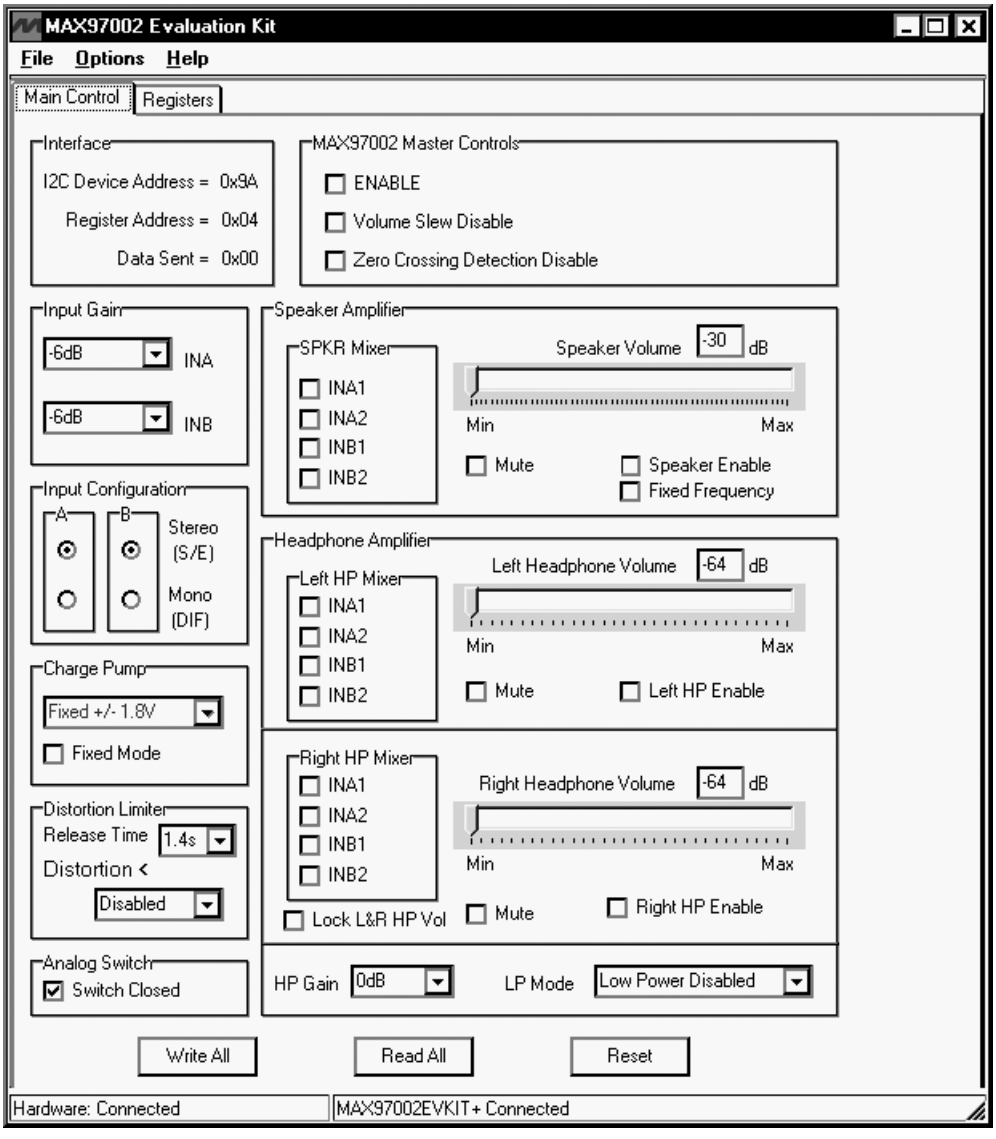

Figure 1. MAX97002 Evaluation Kit Software (Main Control Tab)

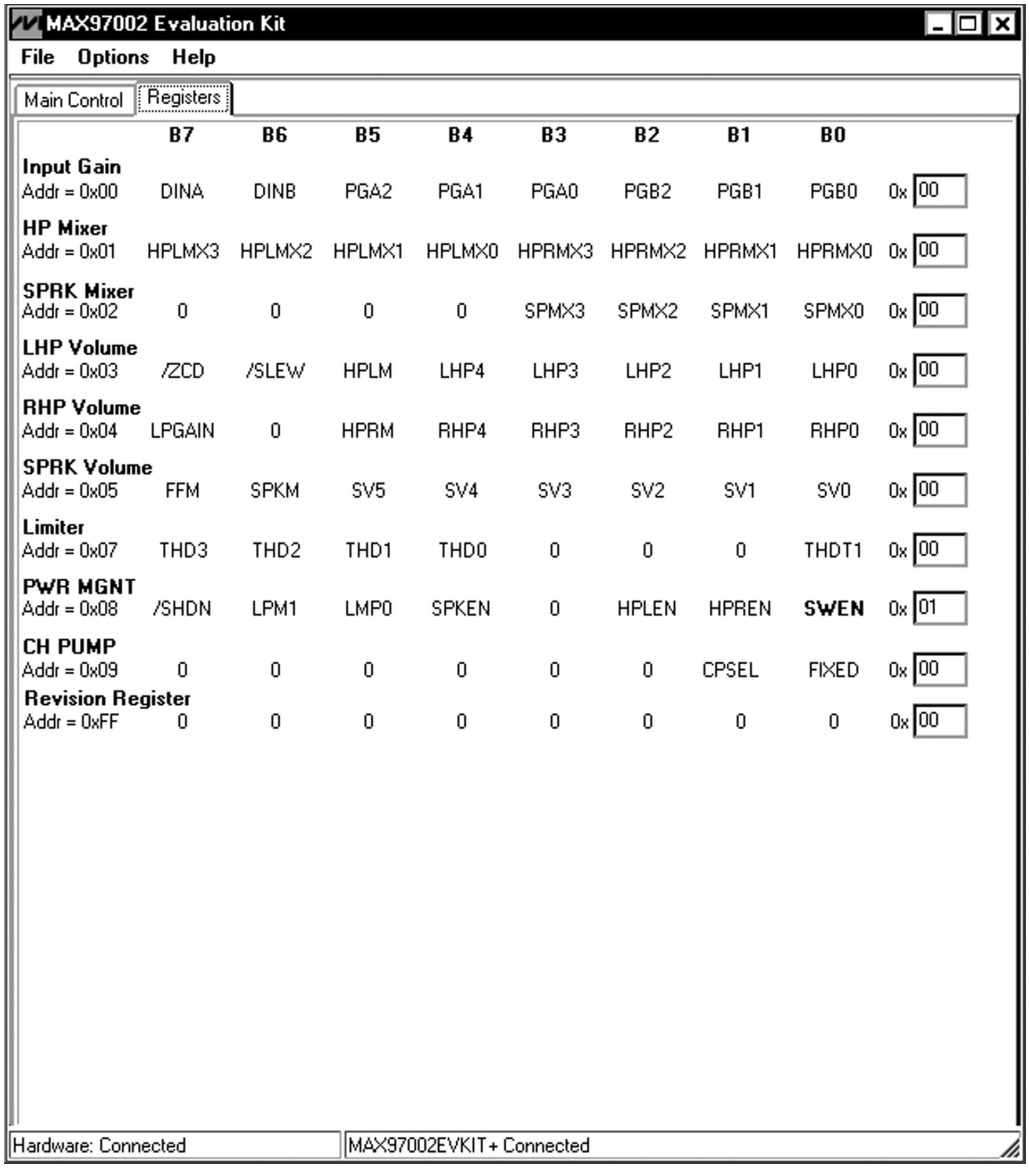

Figure 2. MAX97002 Evaluation Kit Software (Registers Tab)

Software Startup

Upon starting the program, the MAX97002 EV kit software automatically searches for the USB interface circuit and then for the MAX97002 device address. The MAX97002 EV kit enters the normal operating mode when the USB connection is detected and has found the device address. If the USB connection is not detected, the software prompts the user to retry or enter the demo mode.

Demo Mode

The MAX97002 EV kit software enters the demo mode when the USB connection is not detected, or by selecting the **Options | Demo Mode** menu item in the 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. If the USB cable is connected to the EV kit, but power is not applied to PVDD, the EV kit GUI acts like it is in demo mode. In such a case, the EV kit is connected to the PC through USB and I²C commands can be sent to the MAX97002, but without power, the MAX97002 does not acknowledge the I²C commands. When power is applied, press the **Reset** button to detect the presence of the MAX97002.

Write All/Read All/Reset

The **Write All** button writes the current settings to all of the registers on the GUI. The EV kit software GUI performs I²C write commands as changes occur on the GUI. The **Read All** button changes the GUI settings to match the MAX97002 register settings. To change settings one time, enter demo mode by selecting the **Options | Demo Mode** menu item, change the GUI to the required settings, exit demo mode by selecting **Options | Demo Mode**, and then press the **Write All** button. If further changes are not required, enter demo mode to disable communication to the MAX97002. To obtain the MAX97002 settings, exit demo mode and press the **Read All** button. The **Reset** button clears the EV kit software GUI and reprograms the MAX97002 to default values.

MAX97002 Master Controls

The EV kit software's **MAX97002 Master Controls** group box contains **ENABLE**, **Volume Slew Disable**, and **Zero Crossing Detection Disable** checkboxes. The **ENABLE** checkbox, which is also called the software shutdown, enables or disables the MAX97002. The **Volume Slew Disable** checkbox, when checked, disables the volume slewing. The **Zero Crossing Detection Disable** checkbox disables the zero-crossing detection (ZCD) during a volume change operation when checked. When enabled (unchecked), the ZCD forces all volume adjustment to be made when the output signal is crossing zero, thus reducing audio clicks during volume changes.

Input Gain

The MAX97002 EV kit software's **Input Gain** group box selects the input channel preamp gain for the MAX97002. The MAX97002 input channel preamp gain is selectable among **-6dB**, **-3dB**, **0dB**, **+3dB**, **+6dB**, **+9dB**, and **+18dB**.

Charge Pump

The MAX97002 features an internal charge pump for Maxim's Class H DirectDrive architecture. The charge pump can operate in two modes, fixed mode and high-efficiency mode. By default, the MAX97002 charge pump operates in high-efficiency mode. High-efficiency mode on the charge pump dynamically changes the internal supply rails. To have fixed internal supply rails, check the **Fixed Mode** checkbox in the **Charge Pump** group box. Within fixed mode, there are two options for the supply rails shown in the drop-down list, **±1.8V** and **±0.9V**.

Distortion Limiter

The distortion limiter limits distortion based on the defined THD level and has programmable release time.

Switch Enable

The MAX97002 features an internal switch that can bypass the Class D amplifier and allow an external amplifier to power the same speaker connected to the MAX97002 EV kit without requiring external switches. Connect the external amplifier output to COM1 and COM2, and enable in the software by checking the **Switch Closed** checkbox in the **Analog Switch** group box.

Low-Power Mode

The MAX97002's low-power mode minimizes current consumption when only using the headphone amplifier. Low-power mode transmits a single-ended audio signal to the headphone amplifier from either INA or INB, or a differential signal from INA and INB. Low-power mode can be enabled by selecting **LP Mode** from the drop-down list. The volume control and mixer are bypassed in this mode.

Mixer

The speaker, left headphone, and right headphone each have an independent mixer. The MAX97002 EV kit accepts a pair of single-ended audio inputs for stereo operation, or a pair of differential audio inputs for mono operation. The single-ended input signals for the speaker and headphones are defined as IN_1 (left) and IN_2 (right). In the **Input Configuration** group box, select **Stereo (S/E)** for single-ended stereo operation or **Mono**

(DIF) for differential mono operation. Depending on the selection, the speaker and headphone mixers provide options for selecting the audio source for the **SPKR Mixer**, **Left HP Mixer**, and **Right HP Mixer**.

Speaker Amplifier

The MAX97002 EV kit software's **Speaker Amplifier** group box contains the speaker mixer, speaker volume, and speaker-enable control. Check the **Speaker Enable** checkbox to enable the speaker amplifier. The **Speaker Volume** track bar sets the speaker volume between **-30dB** (min) to **+20dB** (max). Alternatively, the user can enter a numerical value inside the **Speaker Volume** edit box.

Headphone Amplifier

The **Headphone Amplifier** group box enables or disables the headphone outputs. The **Left Headphone Volume** and **Right Headphone Volume** track bars set the headphone volume. The **Left HP Enable** and **Right HP Enable** checkboxes enable the headphone amplifiers.

The **Left Headphone Volume** and **Right Headphone Volume** track bars set the left and right headphone volume, respectively, to between **-64dB** (min) to **+6dB** (max). Alternatively, the user can enter a numerical value inside the **Left Headphone Volume** and **Right Headphone Volume** edit boxes.

I²C Interface Indicator

The MAX97002 EV kit software **Interface** group box displays the MAX97002's **I2C Device Address**, **Register Address**, and the last **Data Sent**. The MAX97002 I²C device address is internally set to 0x9A.

Simple I²C Commands

There are three methods for communicating with the MAX97002 EV kit, through the **Main Control** tab (Figure 1), the **Registers** tab (Figure 2), or by using low-level SMBus™ commands available in the **Advanced User Interface** window (Figure 3). Select the **Options | Interface (Advanced User Interface)** menu item to display the **Advanced User Interface** window that allows I²C operations, such as **SMBusReadByte** and **SMBusWriteByte**.

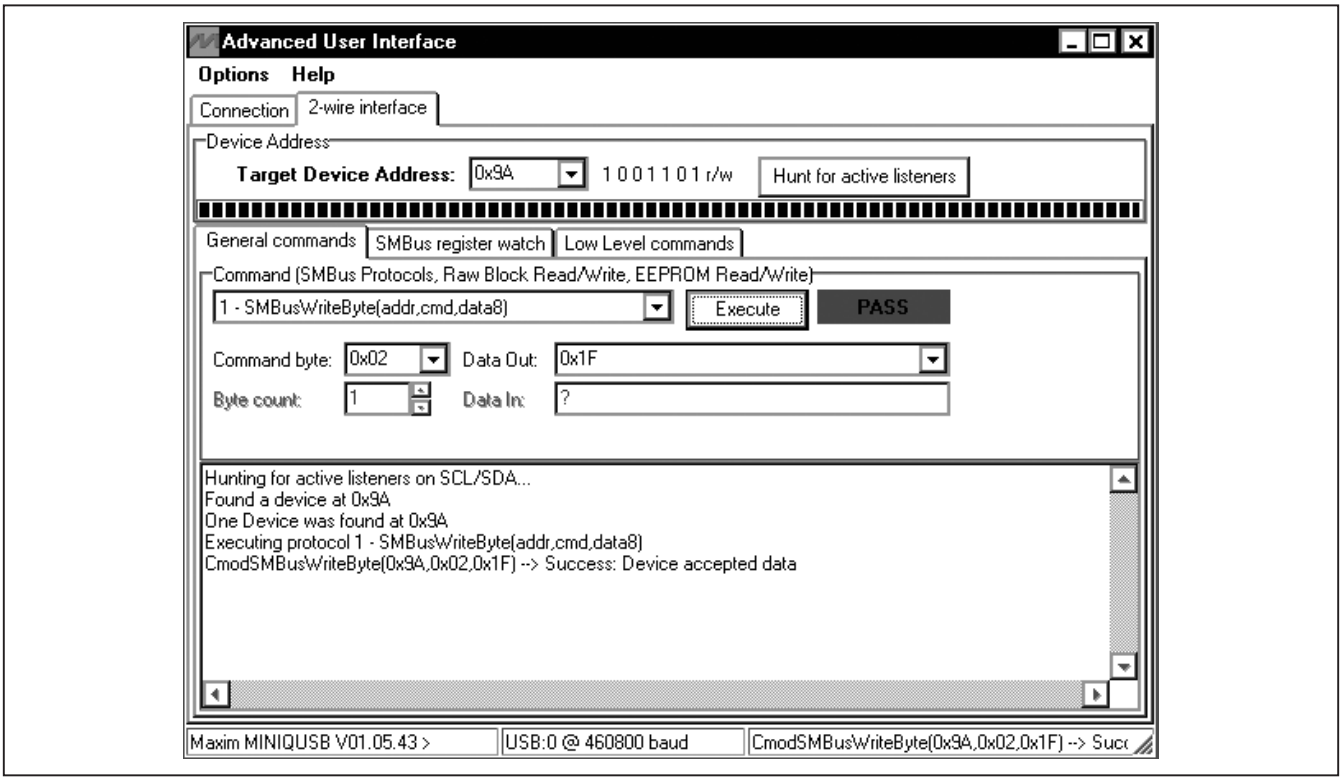

Figure 3. Advanced User Interface Window (2-Wire Interface Tab Sheet)

SMBus is a trademark of Intel Corp.

Detailed Description of Hardware

The MAX97002 EV kit evaluates the MAX97002 Class D audio amplifier and stereo DirectDrive headphone amplifier that communicate over I²C. The EV kit demonstrates the MAX97002 features, such as user-defined input configuration, input gain, input source, output enable, and volume control.

The MAX97002 EV kit uses the MAX97002 IC in a 20-bump WLP (2mm x 2mm) package on a proven four-layer PCB design. The EV kit operates from a 2.7V to 5.5V supply for PVDD and a 1.8V supply for VDD.

Filterless Output

The MAX97002 EV kit filterless outputs (OUT+/OUT-) can be connected directly to a speaker load without any filtering. Use the OUT+/OUT- test points to connect the speaker directly to the MAX97002 outputs using a twisted-pair cable. Do not install inductors L1 and L2 for maximum efficiency.

Filtered Output

Audio analyzers typically cannot accept pulse-width-modulated (PWM) signals at their inputs. Therefore, the MAX97002 EV kit includes a pair of lowpass filters at the output to ease evaluation. To use the filtering output pads (FOUT+/FOUT-), install inductors L1 and L2 (provided with the EV kit), connect the load between FOUT+ and FOUT-, and connect the filtered output to the audio analyzer. The lowpass filters at the speaker outputs are optimized for an 8Ω speaker.

Table 1. MAX97002 Jumper Table

JUMPER	SHUNT POSITION	DESCRIPTION
JU1	Closed*	On-board I²C (connects on-board SCL signal to the SCL pad)
	Open	User-supplied I²C (open the jumper and apply the SCL signal to the SCL pad)
JU2	Closed*	On-board I²C (connects on-board SDA signal to the SDA pad)
	Open	User-supplied I²C (open the jumper and apply the SDA signal to the SDA pad)

**Default position.*

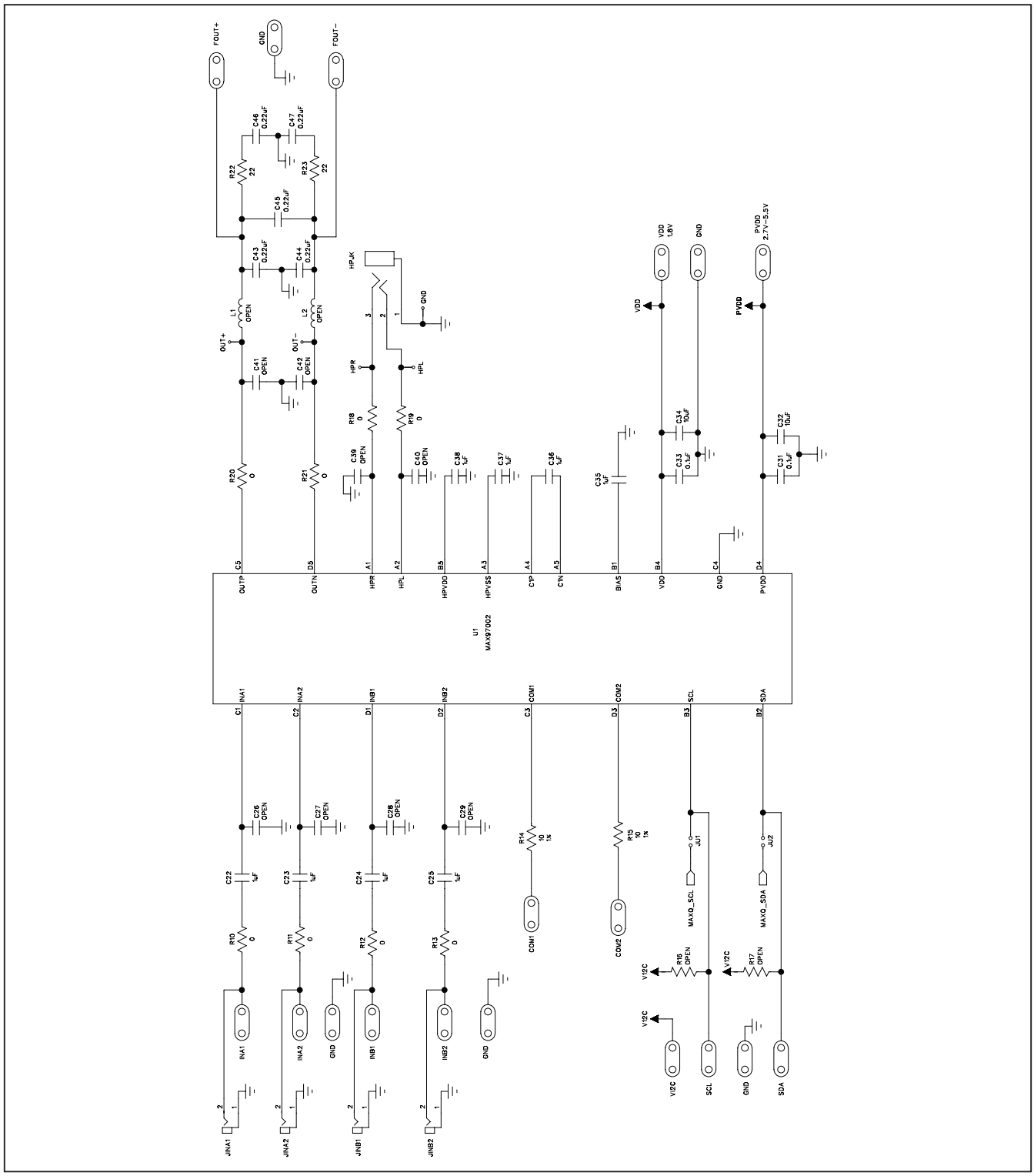

Figure 4a. MAX97002 EV Kit Schematic (Sheet 1 of 2)

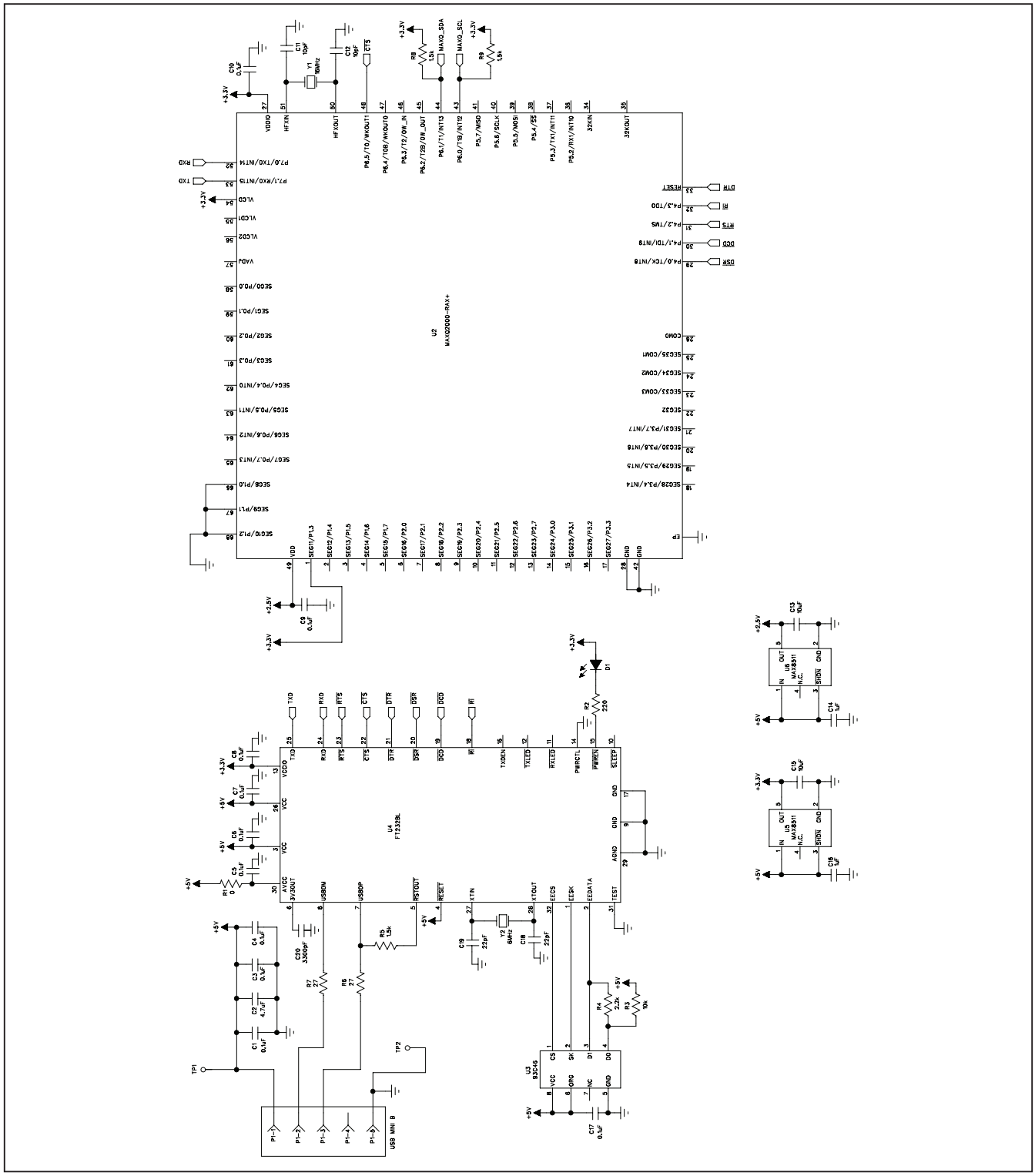

Figure 4b. MAX97002 EV Kit Schematic (Sheet 2 of 2)

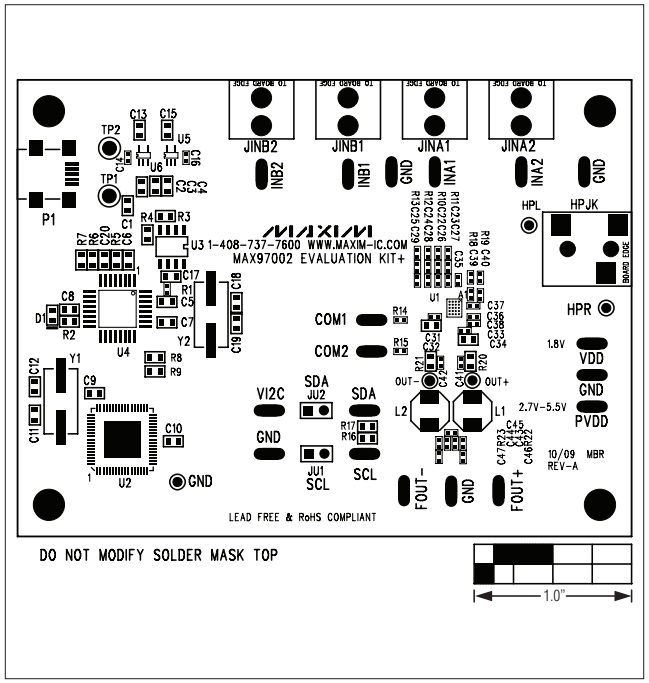

Figure 5. MAX97002 EV Kit Component Placement Guide—Component Side

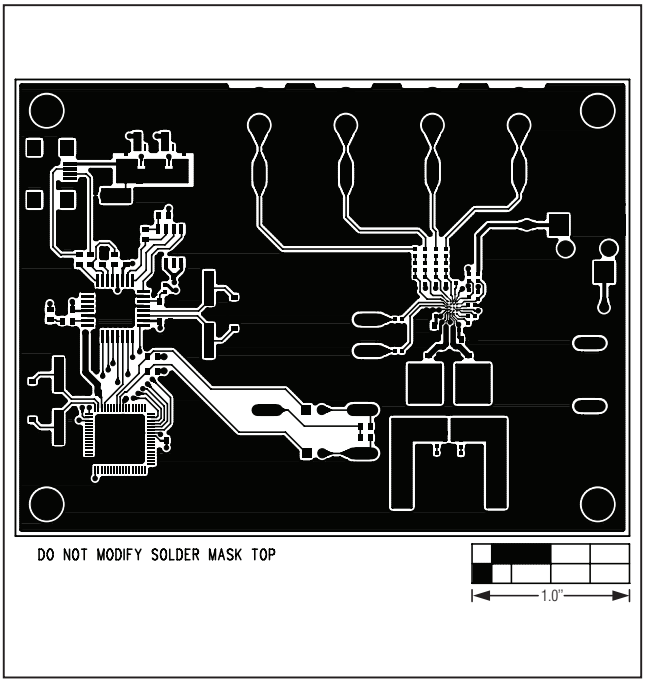

Figure 6. MAX97002 EV Kit PCB Layout—Component Side

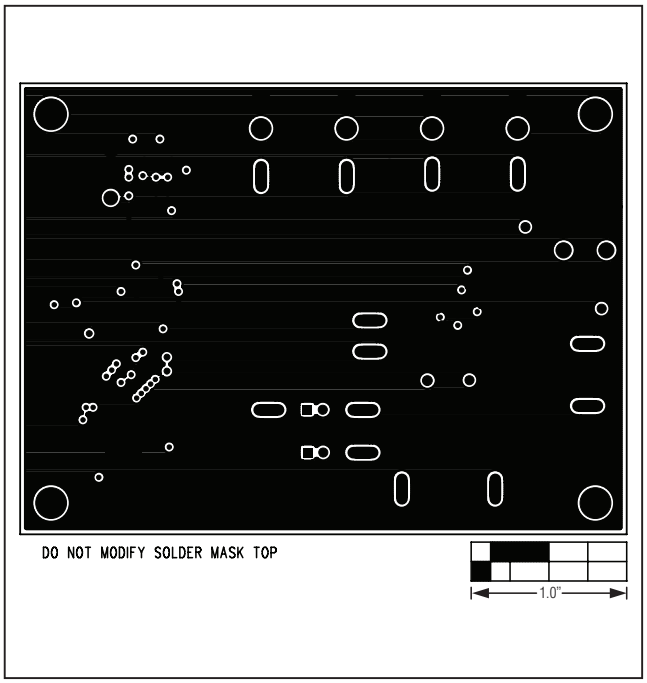

Figure 7. MAX97002 EV Kit PCB Layout—GND Layer 2

MAX97002 Evaluation Kit

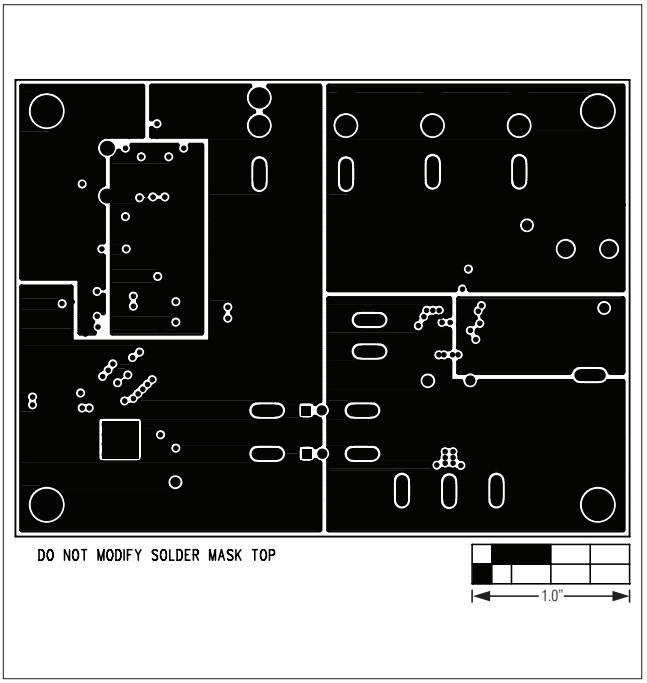

Figure 8. MAX97002 EV Kit PCB Layout—Power Layer 3

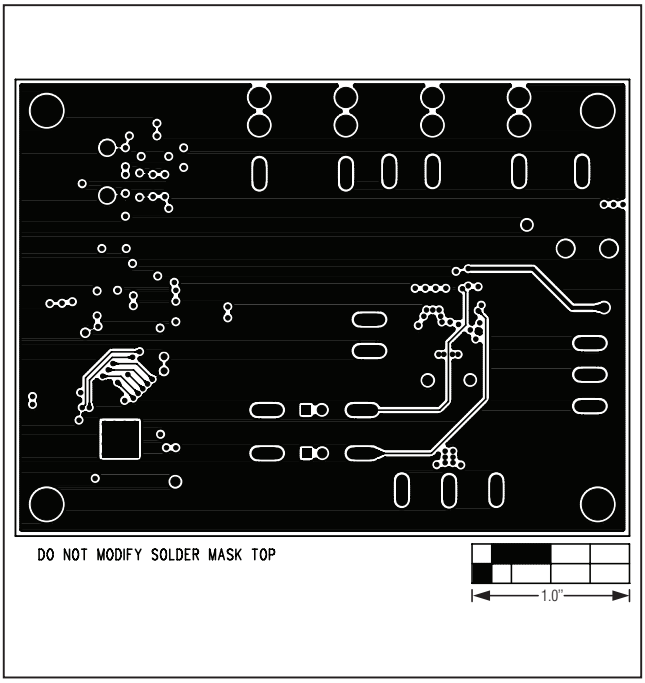

Figure 9. MAX97002 EV Kit PCB Layout—Solder Side

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