



# MAX9796 Evaluation Kit

## General Description

The MAX9796 evaluation kit (EV kit) is a fully assembled and tested printed-circuit board (PCB) that evaluates the MAX9796 ultra-low EMI, 2.3W filterless Class D audio power amplifier with 50mW DirectDrive™ headphone amplifier. The MAX9796 EV kit offers highly programmable and flexible input and output routing, which allows many combinations of balanced and single-ended signals to be connected. The MAX9796 EV kit also includes Windows 2000/XP/Vista® (32-bit)-compatible software that provides a simple graphical user interface (GUI) for exercising the MAX9796's features.

## Features

- ◆ 2.3W Speaker Output (4Ω, V<sub>DD</sub> = 5V)
- ◆ 50mW DirectDrive Headphone Amplifier
- ◆ Highly Programmable Input and Output Modes
- ◆ Controlled Through USB
- ◆ Proven PCB Layout
- ◆ Windows 2000/XP/Vista (32-Bit)-Compatible Evaluation Software
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX9796EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

Windows Vista is a registered trademark of Microsoft Corp.

## Component List

DESIGNATION	QTY	DESCRIPTION
C1–C6	6	100pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608COG1H101J
C7, C8, C12, C27, C28, C31, C36–C39, C41, C43, C48	13	0.1μF ±10%, 25V X7R ceramic capacitors (0603) TDK C1608X7R1E104K
C9, C10, C42, C45, C47	5	10μF ±10%, 10V X5R ceramic capacitors (0805) Murata GRM21BR61A106K
C11	1	0.01μF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H103K
C13–C23, C44, C46	13	1μF ±10%, 16V X7R ceramic capacitors (0603) TDK C1608X7R1C105K
C24, C25	0	Not installed, ceramic capacitors (0603)
C26	1	0.47μF ± 10% 16V X7R ceramic capacitor (0603) TDK C1608X7R1C474K
C29, C30	2	0.033μF ±10% 50V X7R ceramic capacitors (0603) TDK C1608X7R1H333K
C32, C33	2	10pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608COG1H100J
C34, C35	2	22pF ±5%, 50V C0G ceramic capacitors (0603) TDK C1608COG1H220J

DESIGNATION	QTY	DESCRIPTION
C40	1	3300pF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H332K
D1	1	Green LED (0603)
FB1–FB6	6	50mA ferrite beads (0603) Murata BLM18HK102SN1
FB7, FB8	0	Not installed, ferrite beads—short (PCB trace) (0603)
FB9, FB10	2	3A ferrite beads (1206) Fair-Rite 2512067007Y3
HPJK	1	3.5mm surface-mount stereo headphone jack
HPL, HPR, OUTL+, OUTL-	0	Not installed, test points
J1 USB	1	USB series type B right-angle PC-mount receptacle
JU1–JU5	5	Single-row, 2-pin headers
JU6	1	Single-row, 3-pin header
L1, L2	0	Not installed, inductors
R1, R2, R14	0	Not installed, resistors (0603) R1 and R2 are open; R14 is short (PCB trace)
R3, R4	2	22Ω ± 5% resistors (0603)
R5, R6, R13	3	1.5kΩ ±5% resistors (0603)
R7	1	2.2kΩ ±5% resistor (0603)
R8	1	10kΩ ±5% resistor (0603)
R9, R10	2	27Ω ±5% resistors (0603)
R11	1	220Ω ±5% resistor (0603)
R12	1	470Ω ±5% resistor (0603)



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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
U1	1	2.3W, high-power class D audio subsystem with DirectDrive headphone amplifiers (36-bump* UCSP™, 3mm x 3mm) Maxim MAX9796EBX+T
U2	1	16-bit RISC microcontroller (68-pin QFN-EP**) Maxim MAXQ2000-RAX+
U3	1	93C46 type (8-pin SOIC) 3-wire EEPROM
U4	1	UART-to-USB converter (32-pin TQFP, 7mm x 7mm) FTDI FT232BL
U5	1	3.3V, 120mA LDO regulator (5-pin SC70) Maxim MAX8511EXK33+T
U6	1	2.5V, 120mA LDO regulator (5-pin SC70) Maxim MAX8511EXK25+T
Y1	1	16MHz crystal
Y2	1	6MHz crystal
—	6	Shunts (JU1–JU6)
—	1	PCB: MAX9796 Evaluation Kit+
<b>OPTIONAL FILTER COMPONENTS</b>		
C24, C25	2	1000pF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H102K
FB7, FB8	2	2A ferrite beads (0603) TDK MPZ1608S221A
L1, L2	2	33µH ± 20%, 1.4A inductors TOKO B1000AS-330M

\*Four center bumps depopulated.

\*\*EP = Exposed pad.

UCSP is a trademark of Maxim Integrated Products, Inc.

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
TDK Corp.	847-803-6100	www.component.tdk.com
TOKO America, Inc.	847-297-0070	www.tokoam.com

**Note:** Indicate that you are using the MAX9796 when contacting these component suppliers.

## MAX9796 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX9796.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

Before beginning, the following equipment is needed:

- 5V, 1.5A power supply
- Stereo audio source (i.e., CD player, MP3 player)
- One 4Ω (or 8Ω) speaker
- The MAX9796 EV kit (included with USB cable)
- A user-supplied Windows 2000/XP/Vista (32-bit) PC with a spare USB port

**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 2000/XP/Vista (32-bit) operating system.

### Procedure

Do not turn on the power supply until all connections are made:

- 1) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to download the latest version of the EV kit software, 9796Rxx.ZIP. Save the EV kit software to a temporary folder and unzip the 9796Rxx.ZIP file.
- 2) Install the MAX9796 evaluation software on your computer by running the INSTALL.EXE program. The program files are copied and icons are created in the Windows **Start | Programs** menu.
- 3) Make sure the shunts of all jumpers on the MAX9796 EV kit are in the following default positions:
 

JU1:	(Open)	INA2 input active
JU2:	(Open)	INB2 input active
JU3:	(Open)	INC2 input active
JU4:	(1-2)	SDA connected to on-board microcontroller
JU5:	(1-2)	SCL connected to on-board microcontroller
JU6:	(1-2)	Normal operation

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- 4) Connect the speaker across OUT+ and OUT- test points.
- 5) Connect the positive terminal of the 5V power supply to the VDD pad and the ground terminal of the power supply to the GND pad.
- 6) Connect the stereo audio source across the INA1, INA2, and GND pads, across the INB1, INB2, and GND pads, or across the INC1, INC2, and GND pads.
- 7) Turn on the power supply, and then turn on the audio source.
- 8) Connect the USB cable from the PC to the MAX9796 EV kit board. A **Found New Hardware Wizard** window pops up if this is the first time the EV kit board is connected to the PC. If you do not see a window that is similar to the one described above after 30s, remove the USB cable from the MAX9796 EV kit and reconnect it. Administrator privileges are required to install the USB device driver. Refer to the USB\_Driver\_Help.PDF document included with the software if you have any problems during this step.
- 9) Follow the directions of the **Found 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\MAX9796** (default installation directory) using the **Browse** button.

- 10) Start the MAX9796 EV kit software by opening its icon in the **Start** menu.
- 11) Check the **Power Up** checkbox in the **Control Register** panel.
- 12) Ensure the audio signal is audible in the speaker. The EV kit software automatically detects the MAX9796 EV kit, enables the mono Class D speaker amplifier, and mixes the stereo input signal to a mono signal. The mono signal is sent to the mono Class D output.

## Detailed Description of Software

The MAX9796 EV kit GUI software provides an easy user interface (Figure 1) to control the programmable features of the MAX9796. To start the MAX9796 EV kit GUI software, double click the MAX9796 EV kit icon created during installation. The user will have to wait approximately 2s while the software detects the MAX9796 EV kit.

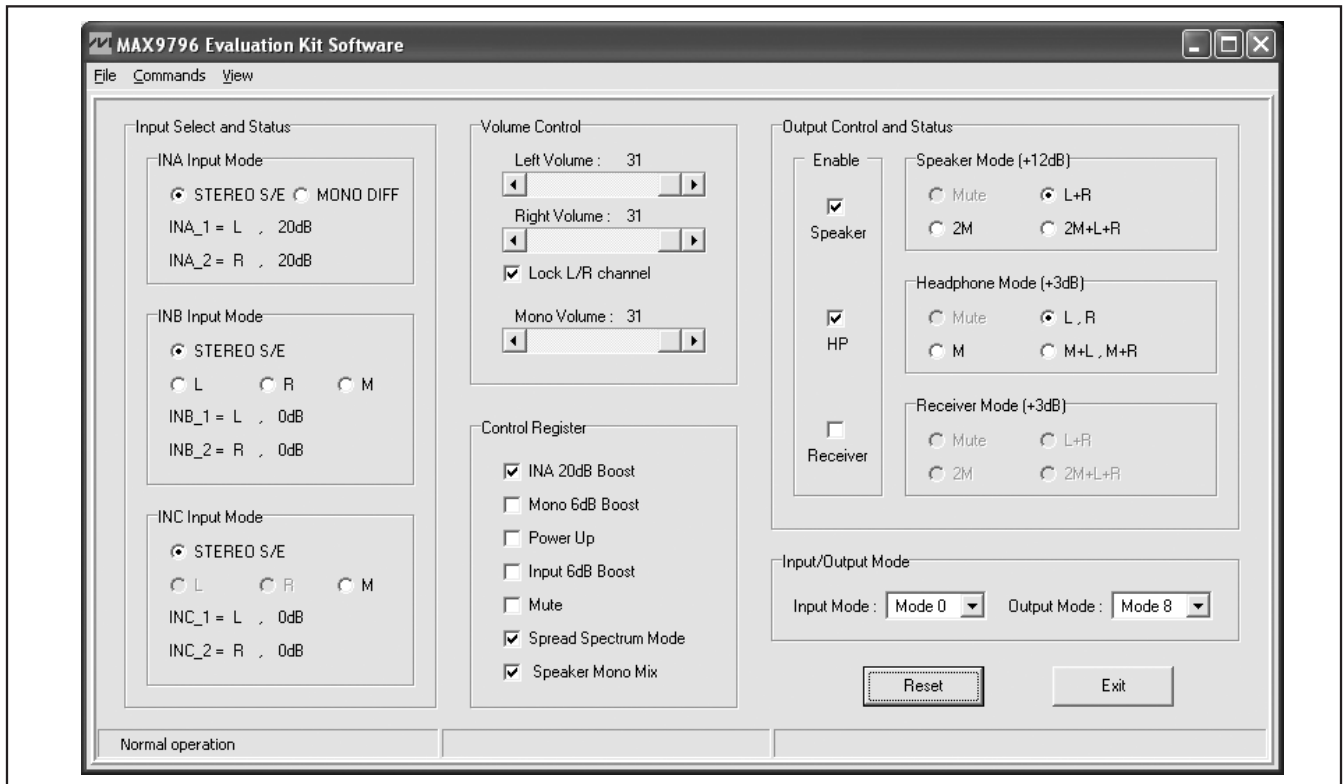


Figure 1. MAX9796 EV Kit Software GUI Window

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## Input Select and Status

The **Input Select and Status** group box gives the capability to select the input mode between single-ended stereo, right-channel differential, left-channel differential, and mono differential for input channels INA, INB, and INC.

The **Input Select and Status** group box also displays the current volume settings for INA, INB, and INC. INA can be configured to accept a stereo single-ended signal or a differential mono signal. Click the **STEREO S/E** radio button to configure INA for a stereo single-ended signal. Click the **MONO DIFF** radio button to configure INA for a mono differential input signal.

INB and INC can be configured to accept a stereo single-ended signal or a differential signal. Check the **L**, **R**, or **M** radio buttons to configure the input to accept a differential signal and route that signal to either the right, left, or mono mixer. Refer to the functional diagram in the MAX9796 IC data sheet for details.

The input mode is also selectable using the **Input Mode** drop-down list inside the **Input/Output Mode** group box. Refer to the MAX9796 IC data sheet for details.

## Output Select and Status

The output mode of the speaker, headphone, and receiver amplifiers can be controlled within the **Output Control and Status** group box.

The output mode of the speaker, headphone, and receiver amplifiers can also be selected using the **Output Mode** drop-down list inside the **Input/Output Mode** group box. Refer to the MAX9796 IC data sheet for details.

## Input/Output Mode

The input and output modes are selectable using the pulldown menus inside this panel. Refer to the MAX9796 IC data sheet for details.

## Volume Control

The scrollbars inside the **Volume Control** group box individually control the volume setting of the MAX9796's left channel, right channel, and mono channel. If the **Lock L/R channel** checkbox is checked, the volume of both left and right channels will be equal and change simultaneously.

The current volume settings for INA, INB, and INC inside the **Input Select and Status** group box will be updated automatically as the volume control scrollbar is moved.

## Control Register

The **Control Register** group box contains checkboxes for the remaining settings. These checkboxes control the INA gain boost, receiver gain boost, power up, 6dB input gain boost, mute control, and Class D oscillator mode. Check the **INA 20dB Boost** checkbox to apply an extra 20dB of gain to the INA path. Checking the **Mono 6dB Boost** checkbox applies 6dB of gain to the mono channel. Check the **Power Up** checkbox to enable the MAX9796 EV kit, clear the checkbox to shut down the kit. **Input 6dB Boost** applies an additional 6dB of gain to all the input paths. Check **Mute** to mute the outputs. Check **Spread Spectrum Mode** to enable the low-EMI spread-spectrum mode. Check **Speaker Mono Mix** to enable mono mixing for the speaker amplifier. If this box is not checked, only the left channel will play at speaker output. Clear **Speaker Mono Mix** if the inputs are configured for mono differential.

## Reset and Exit Buttons

There are two buttons at the bottom-right corner of the MAX9796 EV kit software GUI window: **Reset** and **Exit**.

Press the **Reset** button to reestablish the connection between the PC and the EV kit, and return the MAX9796 EV kit to its power-on-reset setting.

Press the **Exit** button to quit the MAX9796 EV kit software.

## Detailed Description of Hardware

The MAX9796 EV kit board provides a proven layout for evaluating the MAX9796. The EV kit comes with MAX9796EBX+.

## Input Mode Setting

The audio input terminals on the MAX9796 EV kit are flexible and can be configured as mono single-ended inputs, stereo single-ended inputs, or differential inputs. Any of the inputs can be routed to left, right, or mono input mixers. Jumpers JU1, JU2, JU3 can be used to ground INA2, INB2, and INC2, respectively. See Table 1 for jumpers JU1, JU2, and JU3 configuration.

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**Table 1. Input Signal Connection (Jumpers JU1, JU2, JU3)**

JUMPER	SHUNT POSITION	IN_2 PCB PAD CONNECTION	EV KIT FUNCTION
JU1	Installed	INA2 PCB pad connected to ground	Connect a mono single-ended signal to INA1
	Not installed	INA2 PCB pad unconnected	Connect stereo single-ended signals or a differential signal to INA1 and INA2
JU2	Installed	INB2 PCB pad connected to ground	Connect a mono single-ended signal to INB1
	Not installed	INB2 PCB pad unconnected	Connect stereo single-ended signals or a differential signal to INB1 and INB2
JU3	Installed	INC2 PCB pad connected to ground	Connect a mono single-ended signal to INC1
	Not installed	INC2 PCB pad unconnected	Connect stereo single-ended signals or a differential signal to INC1 and INC2

### Outputs

The MAX9796 EV kit allows connection of stereo headphones, a mono receiver speaker, and a mono loudspeaker. A 3.5mm headphone jack is provided to connect stereo headphones. The mono receiver speaker output is labeled OTRX. Connect the receiver speaker between OTRX and one of the adjacent GND pads. Connect the mono loudspeaker between the OUT+ and OUT- test points.

### Class D and EMI Filtering

Two types of filters are available on the Class D output. One filter is an LCR filter intended to be used to connect the Class D output to an audio analyzer or oscilloscope. Install inductors L1 and L2 (provided in the EV kit's shipping box) to complete the LCR circuit. The output of this filter is between FOUT+ and FOUT-.

The second filter is an EMI filter consisting of ferrite beads and capacitors. The ferrite beads and capacitors are included in the MAX9796 EV kit's shipping box. Install the EMI filter by cutting open the shorting trace across the FB7 and FB8 component PC pads and installing the ferrite beads. Also install the included capacitors on pads C24 and C25. Be sure to remove inductors L1 and L2 before EMI testing is started. Connect the load across test points OUT+ and OUT-.

### MAX9796 I<sup>2</sup>C Address

The MAX9796 is an I<sup>2</sup>C/SMBus slave device that can only be written to. The slave address is fixed to 10011010 in binary or 0x9A in hex.

### Power Supply

The MAX9796 EV kit board is powered from both a user-supplied +2.7V to +5.5V supply, and the +5V USB supply. U1 is powered by a user-provided DC power supply connected between the VDD and GND pads. All other support devices are powered from the USB supply.

### Hardware Shutdown Control

Jumper JU6 controls the hardware shutdown function of the MAX9796 EV kit. This will shut down the entire MAX9796 and reset all the registers to their power-on defaults. See Table 2 for shutdown shunt positions.

**Table 2. Hardware Shutdown (Jumper JU6)**

SHUNT POSITION	SHDN PIN	EV KIT FUNCTION
1-2	Connected to VDD	Normal operation
2-3	Connected to FGND ground	Power-down mode

### User-Supplied I<sup>2</sup>C Interface

To use the MAX9796 EV kit with a user-supplied I<sup>2</sup>C interface, remove the shunts on jumper JU4 and JU5. Connect SDA, SCL, and GND lines from the user-supplied I<sup>2</sup>C interface to the corresponding pads on the MAX9796 EV kit board. Depending on the configuration of the user-supplied I<sup>2</sup>C interface, it may be necessary to install I<sup>2</sup>C pullup resistors R1 and R2. See Table 3 for jumpers JU4 and JU5 configuration.

**Table 3. I<sup>2</sup>C Signal Connection (Jumpers JU4, JU5)**

SHUNT POSITION	EV KIT FUNCTION
Installed	I <sup>2</sup> C communication controlled through USB and on-board circuitry
Not installed	Connect user-supplied I <sup>2</sup> C interface to SCL, SDA, and GND PCB pads

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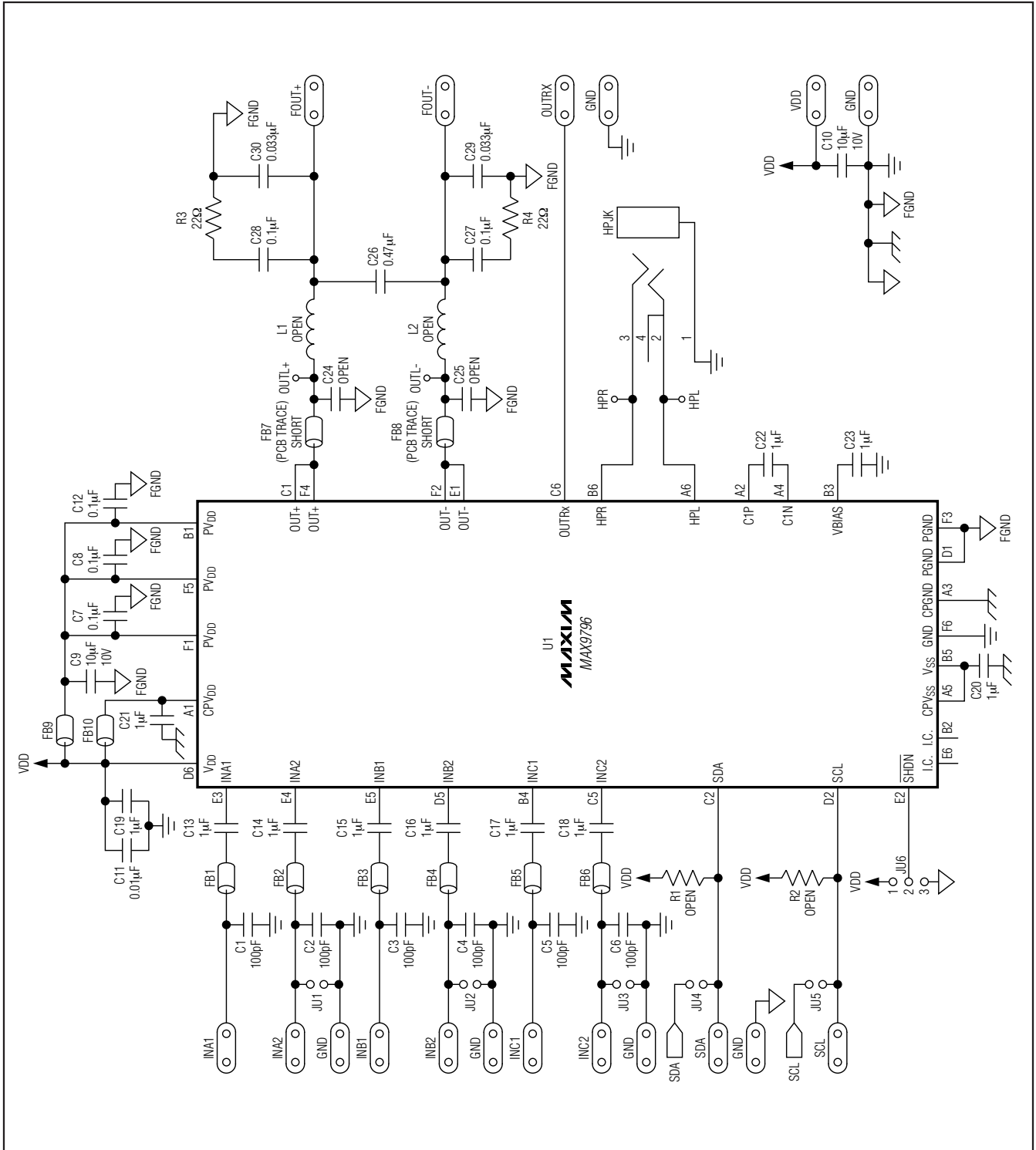


Figure 2a. MAX9796 EV Kit Schematic (Sheet 1 of 3)

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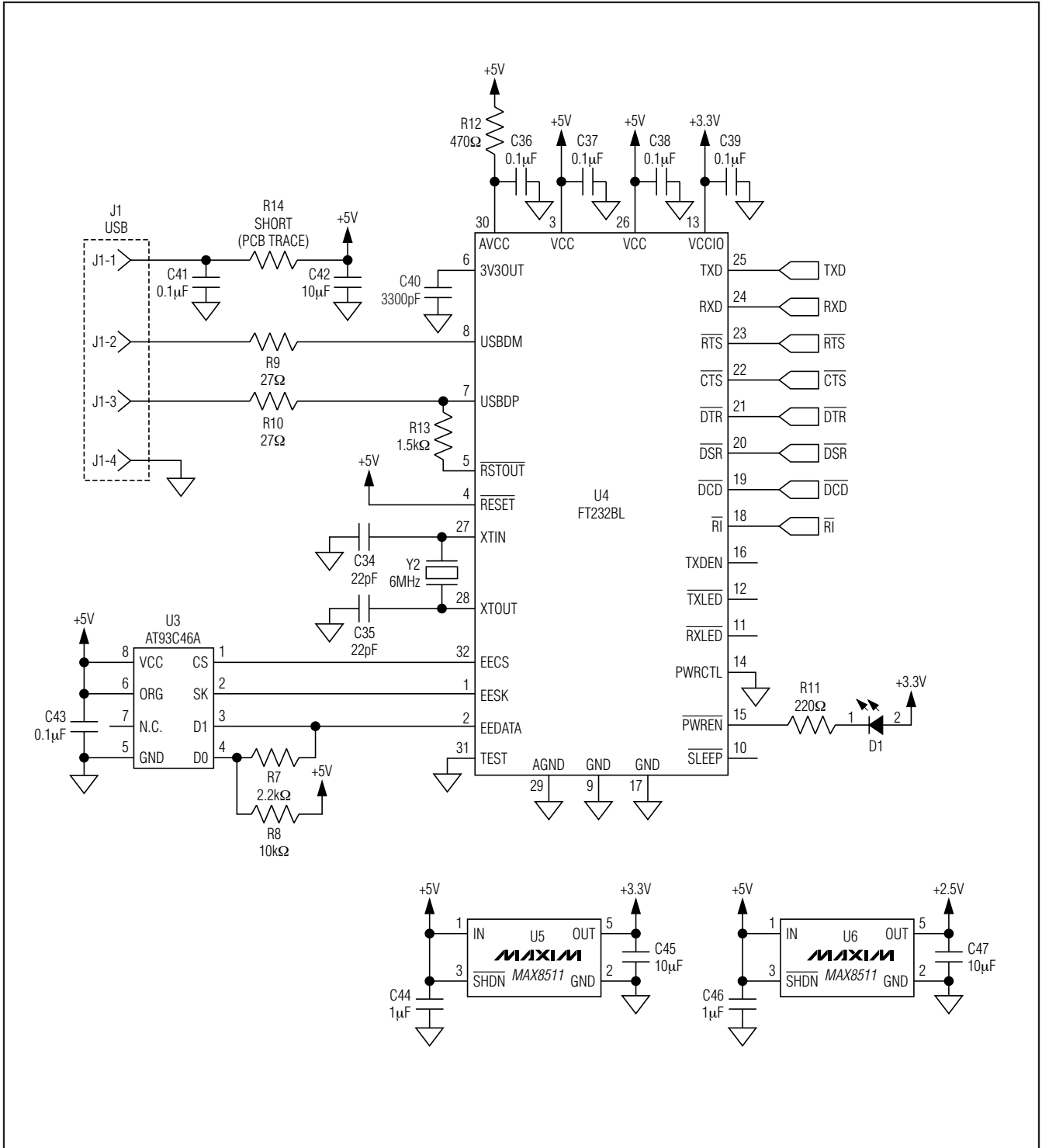


Figure 2b. MAX9796 EV Kit Schematic (Sheet 2 of 3)

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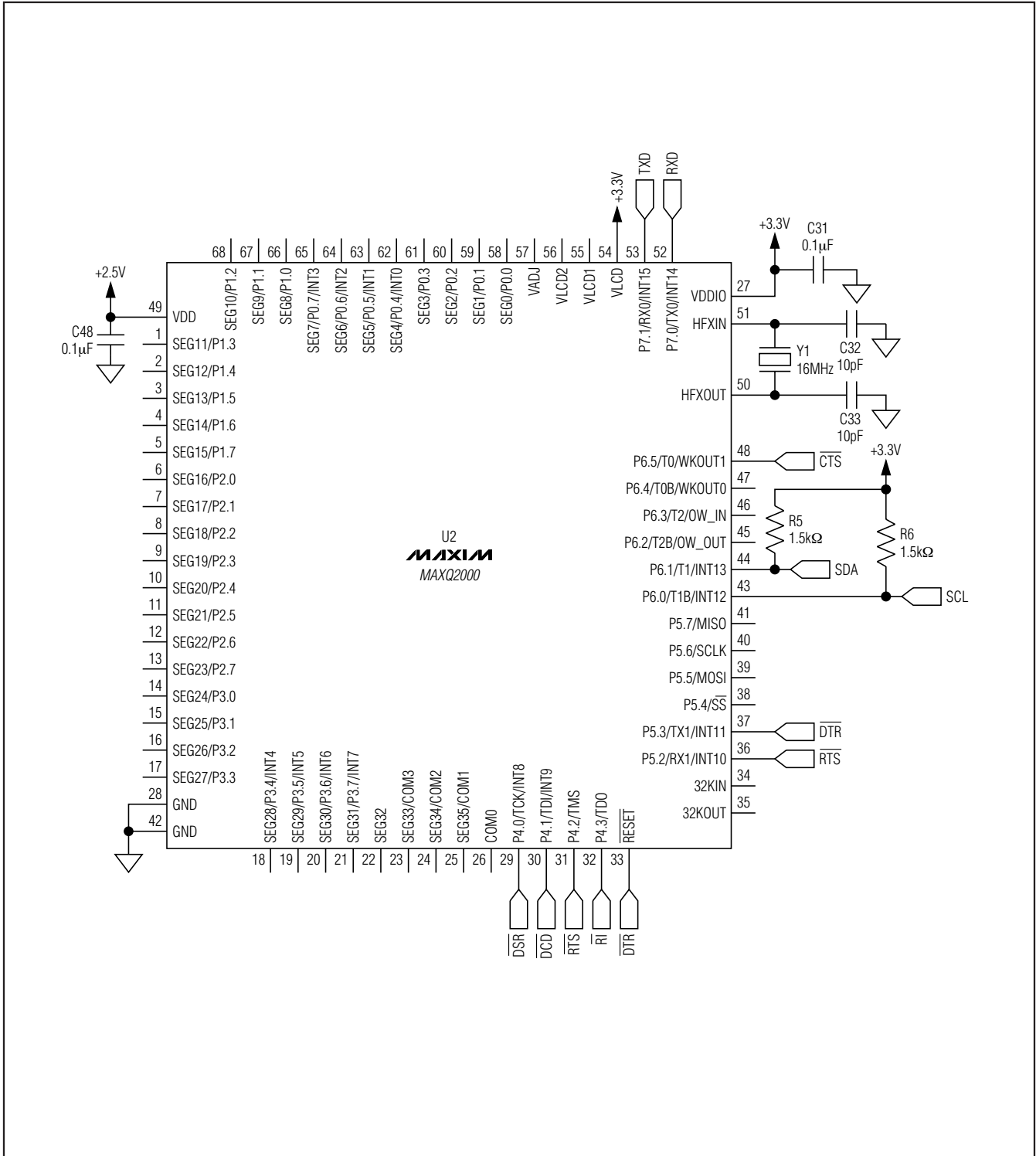


Figure 2b. MAX9796 EV Kit Schematic (Sheet 3 of 3)



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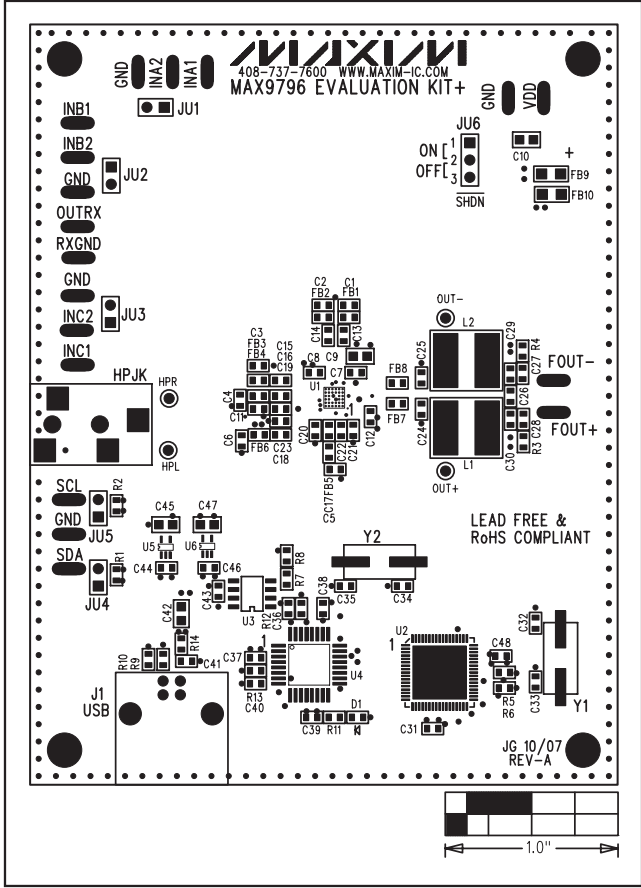


Figure 3. MAX9796 EV Kit Component Placement Guide—Component Side

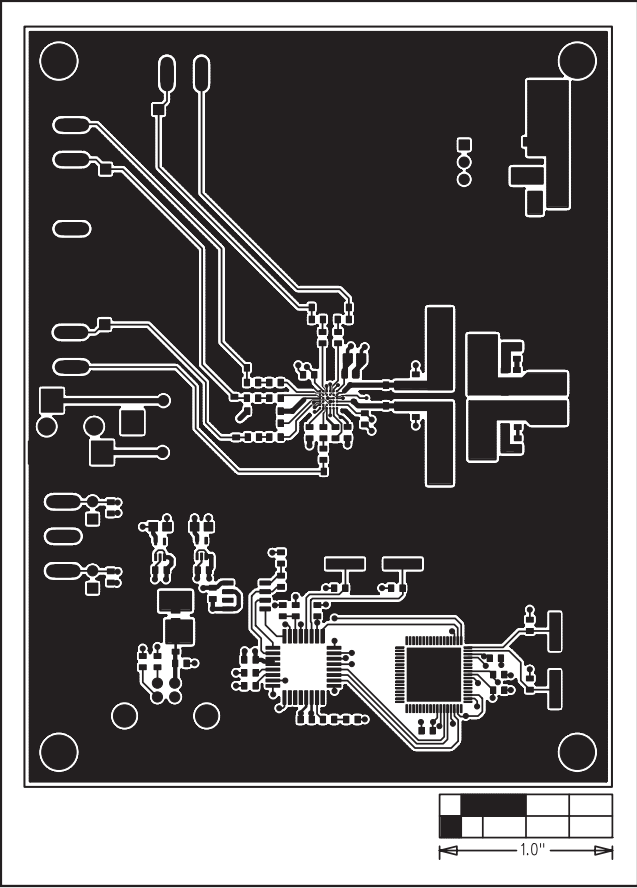


Figure 4. MAX9796 EV Kit PCB Layout—Component Side

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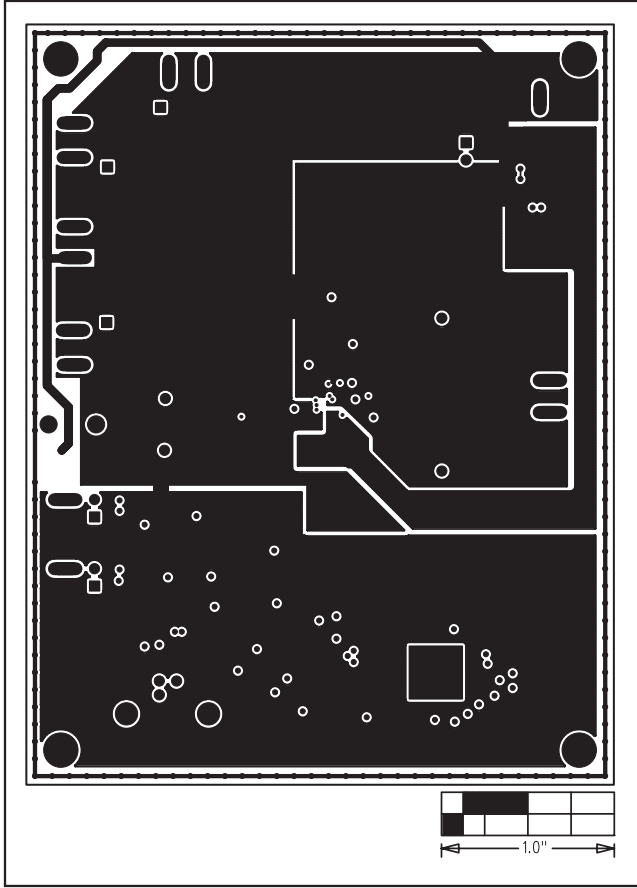


Figure 5. MAX9796 EV Kit PCB Layout—Layer 2 (GND)

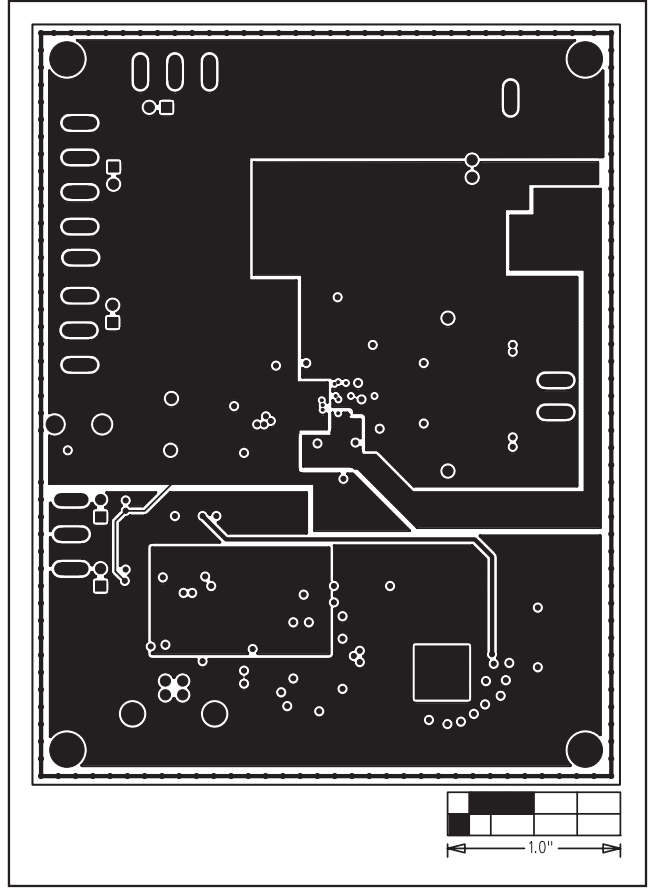


Figure 6. MAX9796 EV Kit PCB Layout—Layer 3 (Power)

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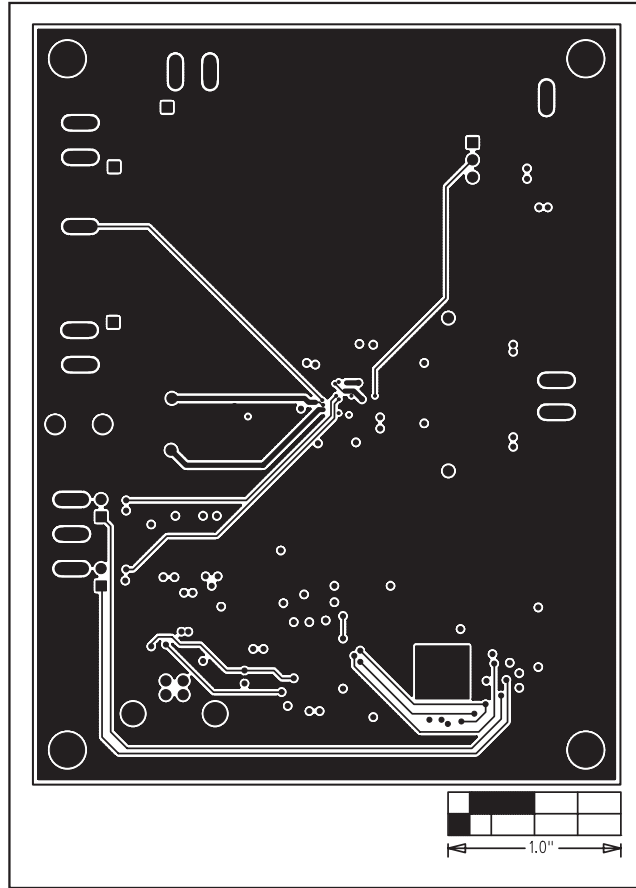


Figure 7. MAX9796 EV Kit PCB Layout—Solder Side

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