



# MAX9702 Evaluation System/Evaluation Kit

## General Description

The MAX9702 evaluation system (EV system) consists of a MAX9702 evaluation kit (EV kit) and a Maxim CMODUSB command module. The MAX9702 EV kit is a fully assembled and tested circuit board that evaluates the MAX9702 and MAX9702B. The MAX9702/MAX9702B are high-efficiency, filterless Class D stereo power amplifiers and DirectDrive™ stereo headphone amplifiers. The input selection and gain value are configured using an I<sup>2</sup>C-compatible interface.

Order the complete EV system (MAX9702EVCMODU) for a comprehensive evaluation of the MAX9702/MAX9702B using a PC. Order the EV kit (MAX9702EVKIT) if the CMODUSB command module has already been purchased with a previous Maxim EV system or for custom use in other microcontroller-based ( $\mu$ C) systems.

The EV kit comes with the MAX9702ETI installed. Contact the factory for free samples of the pin-compatible MAX9702BETI to evaluate this part.

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## Features

- ◆ Single-Supply Operation (2.5V to 5.5V)
- ◆ No LC Output Filter Required
- ◆ No DC-Blocking Capacitors Required
- ◆ Mono/Stereo/Mix/Mute Input MUX
- ◆ 95% Efficiency ( $R_L = 8\Omega$ ,  $P_{OUT} = 1.1W$ )
- ◆ Proven PC Board Layout
- ◆ Windows® 98SE/2000/XP-Compatible Evaluation Software
- ◆ Fully Assembled and Tested

## Ordering Information

PART	INTERFACE TYPE
MAX9702EVKIT	User-Supplied I <sup>2</sup> C Master
MAX9702EVCMODU	Windows Software

**Note:** The MAX9702 EV kit software is included with the MAX9702 EV kit but is designed for use with the complete EV system. The EV system includes both the Maxim command module (CMODUSB) and the EV kit. If the Windows software will not be used, the EV kit board can be purchased without the Maxim command module.

To evaluate the MAX9702BETI, request a free sample when ordering the MAX9702EVKIT. The MAX9702 EV kit software also supports the MAX9702B.

## Component List

### MAX9702 Evaluation System

PART	QTY	DESCRIPTION
MAX9702EVKIT	1	MAX9702 EV Kit
CMODUSB	1	CMODUSB Command Module

### MAX9702 EV Kit

DESIGNATION	QTY	DESCRIPTION
C1, C8, C14, C23	0	Not installed, 0.068 $\mu$ F $\pm$ 10%, 10V X7R ceramic capacitors (0603)
C2, C7, C16, C21	0	Not installed, 100pF $\pm$ 5%, 10V C0G ceramic capacitors (0603)
C3, C9, C17, C22	0	Not installed, 0.033 $\mu$ F $\pm$ 10%, 10V X7R ceramic capacitors (0603)
C4, C18	0	Not installed, 0.15 $\mu$ F $\pm$ 10%, 10V X7R ceramic capacitors (0603)
C6, C10–C13, C15, C25–C28	10	1 $\mu$ F $\pm$ 10%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A105K

DESIGNATION	QTY	DESCRIPTION
C20	1	100pF $\pm$ 5%, 10V C0G ceramic capacitors (0402) TDK C1005C0G1H101K
C24	1	10 $\mu$ F $\pm$ 20%, 10V X5R ceramic capacitors (0805) TDK C2012X5R0J106M
J1	1	20-pin, 2 x 10 right-angle female receptacle
J4	1	3.5mm surface-mount stereo headphone jack
JU1	1	3-pin header
JU2	1	5-pin header
JU3	1	2-pin header
L1–L4	0	Not installed, 15 $\mu$ H $\pm$ 20%, 1.4A power inductors TOKO A915AY-150M
R1, R4, R6, R8	0	Not installed, 22 $\Omega$ $\pm$ 5% resistors (0603)



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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R2, R3	0	Not installed, 1.5k $\Omega$ $\pm$ 5% resistors (0603)
R7	1	49.9 $\Omega$ $\pm$ 1% resistor (0402)
TP2, TP4-TP7, TP11, TP12	0	Not installed, test points
T1, T2	0	Not installed, 50VDC, 1ADC, 800 $\Omega$ at 100MHz common-mode chokes TDK ACM4532-801-2P

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
TDK	847-803-6100	www.component.tdk.com

**Note:** Indicate you are using the MAX9702 when contacting the component supplier.

## Quick Start

### Recommended Equipment

- The MAX9702EVCMODU evaluation system
  - MAX9702EVKIT
  - CMODUSB command module (USB cable included)
- Power supply: +2.5V to +5.5V at 1.5A (V<sub>DD</sub>)
- Two audio sources, one stereo and one mono
- Two 8 $\Omega$  speakers
- Stereo 16 $\Omega$  headphone with 3.5mm plug
- A user-supplied Windows 98SE/2000/XP PC
- A spare USB port on the PC

### Procedure

**Do not turn on the power until all connections are made.**

- 1) On the CMODUSB command module, ensure the shunt of J1 is in the position 2-3 (3.3V).
- 2) For the MAX9702 EV kit, ensure the shunts are in the default positions as follows.
  - JU1: 1-2 (powered up).
  - JU2: 1-4 (SPP mode with  $f_s = 1150\text{kHz} \pm 50\text{kHz}$ ).
  - JU3: 1-2 (enable headphone sensing).
- 3) Carefully connect the boards by aligning the MAX9702 EV kit's 20-pin connector with the 20-pin header of the CMODUSB command module. Gently

DESIGNATION	QTY	DESCRIPTION
U1	1	MAX9702ETI (28-pin TQFN)
None	3	Shunts
None	1	MAX9702 EV kit PC board
None	1	MAX9702 EV kit software

## MAX9702EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX9702.EXE	Application program
HELPPFILE.HTM	Help file
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software

press them together. The two boards should be flush against each other.

- 4) Connect the right-channel speaker across the SR+ and SR- test points.
- 5) Connect the left-channel speaker across the SL+ and SL- test points.
- 6) Connect the right channel of the stereo audio source output to INR.
- 7) Connect the left channel of the stereo audio source output to INL.
- 8) Connect the mono audio source output to INM.
- 9) Connect the positive terminal of the power supply to the VDD pad and the power-supply ground terminal to the GND pad next to the VDD pad.
- 10) Install the MAX9702 evaluation software on your computer by running the INSTALL.EXE program on the installation CD-ROM. The program files are copied and icons are created for them in the Windows **Start** Menu.
- 11) Connect the included USB cable from the PC to the CMODUSB command module. A **Building Driver Database** window should pop up in addition to a **New Hardware Found** message. If a window similar to the one described above does not appear after 30 seconds, then remove the USB cable from the CMODUSB command module and reconnect it again. Administrator privileges are required to install the USB device driver on Windows 2000 and XP.

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- 12) 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:\MAX9702** using the **Browse** button.
- 13) Start the MAX9702 EV kit software by opening its icon in the **Start** Menu.
- 14) Turn on the power supply.
- 15) Start the MAX9702 program by opening its icon in the **Start** Menu.
- 16) The default I<sup>2</sup>C device slave address is for the MAX9702. To evaluate the MAX9702B, use the mouse to click the correct I<sup>2</sup>C slave address located in the **Device Slave Address** Combo box.

## Detailed Description of Software

Figure 1 shows the evaluation software's main window.

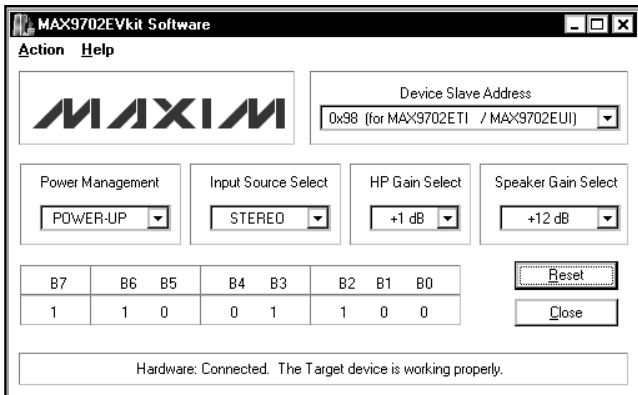


Figure 1. MAX9702 Evaluation Software's Main Window

The **Device Slave Address** combo box shown in Figure 2 allows the user to select the correct I<sup>2</sup>C address by the device part number.

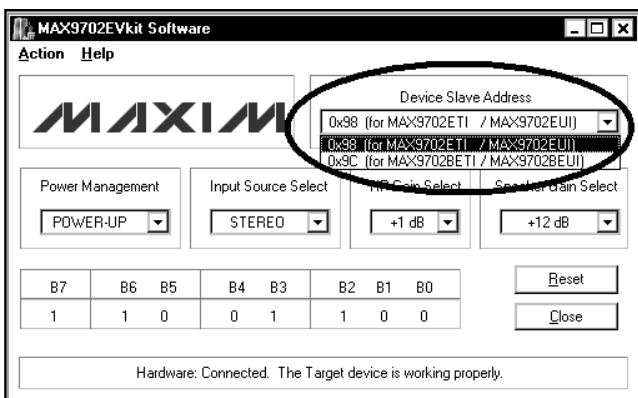


Figure 2. Device Slave Address Combo Box

In Figure 3, the **Power Management** combo box controls bit 7 of MAX9702 command register. B7 determines whether the MAX9702 is in normal mode (i.e., powered up) or soft-shutdown mode. The default setting is **POWER\_UP**.

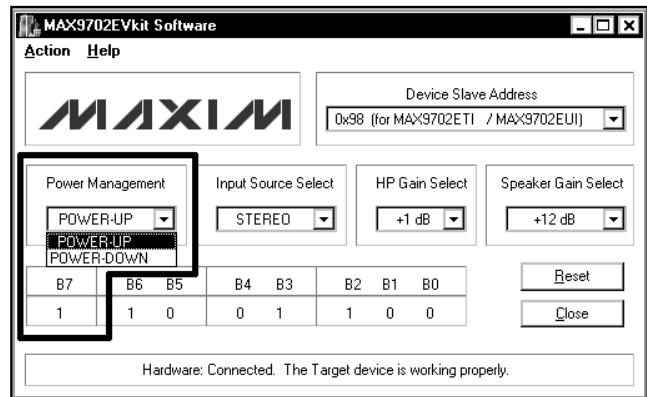


Figure 3. Power Management Combo Box

The **Input Source Select** combo box shown in Figure 4 allows the user to configure the MAX9702 multiplexer, which acts as a mixer to independently enable or disable both the stereo and mono inputs. The default setting is **STEREO**. This combo box controls B5 and B6 of the MAX9702 command register.

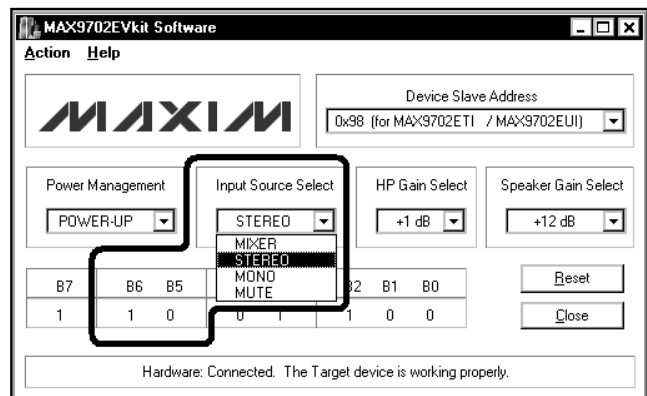


Figure 4. Input Source Select Combo Box

# MAX9702 Evaluation System/Evaluation Kit

The MAX9702 offers four headphone amplifier gain settings controlled through the I<sup>2</sup>C interface. Headphone amplifier gains of -2dB, +1dB, +4dB, and +7dB are set by command register B3 and B4. Figure 5 shows how to use the **HP Gain Select** combo box to pick one out of four headphone gain settings. The default setting is **+1dB**.

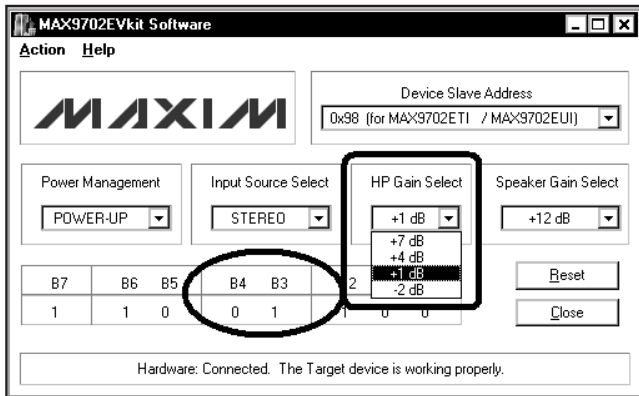


Figure 5. HP Gain Select Combo Box

In Figure 6, the **Speaker Gain Select** combo box gives the user the choices of eight different speaker gain settings through B2 to B0. The default setting is **+12dB**.

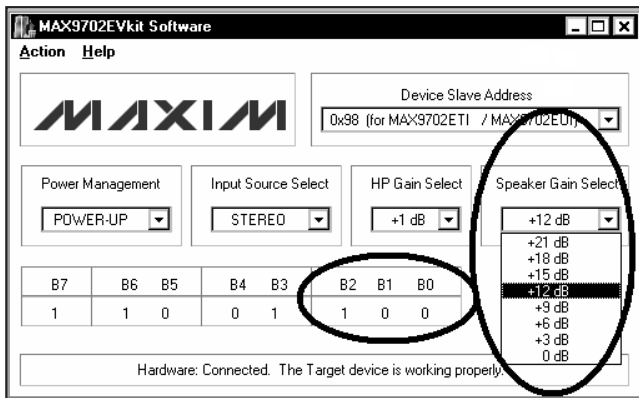


Figure 6. Speaker Gain Select Combo Box

## Detailed Description of Hardware

### MAX9702 Evaluation System

The MAX9702 evaluation system (MAX9702EVCMODU) is a complete high-efficiency, filterless class D stereo speaker power amplifier and a DirectDrive headphone amplifier system consisting of a MAX9702 evaluation kit (EV kit) and the Maxim CMODUSB command module.

### CMODUSB Command Module

The CMODUSB uses a proprietary design to provide SPI and I<sup>2</sup>C-compatible interfaces to demonstrate various Maxim devices. Maxim reserves the right to change the implementation of this module at any time with no advance notice.

### CMODUSB Power Supply

The CMODUSB board uses a MAX1658 linear regulator. Jumper J1 selects between the 5V DC voltage that comes from the USB connector or the MAX1658's regulated 3.3V output voltage. Set the CMODUSB jumper J1 at position 2-3 (3.3V) to evaluate the MAX9702 EV kit.

### MAX9702 EV Kit Stand-Alone Operation

The MAX9702 EV kit can be operated without the CMODUSB command module but the functions are limited to power-on reset default settings listed below:

- Input mode: STEREO
- Speaker gain: +12dB
- Headphone gain: +1dB

### MAX9702 EV Kit

The MAX9702 EV kit board can be obtained separately without the CMODUSB command module and provides a proven layout for evaluating the MAX9702/MAX9702B. The MAX9702ETI (U1) is powered from VDD. The user can change the power-supply VDD voltage level from 2.5V to 5.5V.

The MAX9702 features a shutdown mode to reduce power consumption and extend battery life. Shutdown can be either hardware-(hard-shutdown) or software-controlled (soft-shutdown). The soft-shutdown (**POWER-DOWN**) maintains the configuration set by the user. The hard-shutdown ( $\overline{\text{SHDN}} = 0$ ) resets the device configuration to default values. The user is given the flexibility to control the hard-shutdown using jumper JU1 as shown in Table 1.

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Evaluates: MAX9702/MAX9702B

**Table 1. Hardware Shutdown ( $\overline{\text{SHDN}}$ )**

JUMPER	SHUNT POSITION	$\overline{\text{SHDN}}$ HARDWARE INPUT PIN LOGIC LEVEL
JU1	1-2*	HIGH (Powered up)
	2-3	LOW (Enable hardware shutdown)
	Open	Controlled by $\overline{\text{SHDN}}$ pad

\*Default configuration

### Optional Class D Filter

The MAX9702 EV kit provides three sets of differential outputs. The first set of differential outputs (SR+/- and SL+/-) can be connected directly to a speaker load without any filtering. There are two optional filters that can be added to ease evaluation. The second set of differential outputs (FOUTR1+/- and FOURL1+/-) for the common-mode choke filter requires the following components: T1, T2, C2, C7, C16, and C21. The last set is the LCR filtered outputs (FOUTR2+/- and FOURL2+/-) require the following components: L1-L4, C1, C3, C4, C8, C9, C14, C17, C18, C22, C23, R1, R4, R6, and R8. See Table 2 for the suggested filtering component values for an 8 $\Omega$  load and 30kHz cutoff frequency.

**Table 2. Suggested LCR Filter Components for an 8 $\Omega$  Load and 30kHz Cutoff**

COMPONENT	VALUE
L1-L4	15 $\mu$ H
C3, C9, C17, C22	0.033 $\mu$ F
C4, C18	0.15 $\mu$ F
C1, C8, C14, C23	0.068 $\mu$ F
R1, R4, R6, R8	22 $\Omega$

The MAX9702 is designed to pass FCC RF emissions without additional filtering when using 10cm of cable to connect the speaker. In applications where more margin and/or cable length is required, use the common-mode choke filter with capacitors C2, C7, C16, C21, and common-mode choke T1 and T2 to reduce the radiated emission. The value of these four capacitors is 100pF. Table 3 lists the cable length versus the required output filters.

**Table 3. Cable Length vs. Suggested Output Filters**

CABLE LENGTH X [in]	COMMON-MODE CHOKE FILTER	LCR FILTER
$X \leq 3$	—	—
$3 < X < 6$	Required	—
$X \geq 6$	—	Required

The MAX9702 features a total of four oscillator frequency operating modes that include two fixed-frequency modes, one spread-spectrum mode, and one external clock mode. Table 4 shows how to use jumper JU2 to configure these four operating modes.

**Table 4. Oscillator Frequency Operating Modes**

JUMPER	SHUNT POSITION	SYNC	MODE
JU2	1-2	GND	FFM with $f_S = 1100\text{kHz}$
	1-3	Unconnected	FFM with $f_S = 1340\text{kHz}$
	1-4*	V <sub>DD</sub>	SSM with $f_S = 1150\text{kHz} \pm 50\text{kHz}$
	1-5	Externally clocked	FFM with $f_S = \text{external clock frequency}$

\*Default configuration

The MAX9702 features a headphone sense input that monitors whether a headphone is present and automatically configures the device. Jumper JU3 gives the user a choice of how to handle the headphone sense as shown in Table 5.

**Table 5. Headphone Sense (HPS)**

JUMPER	SHUNT POSITION	HEADPHONE SENSE FUNCTION
JU3	Open	Disable speaker amplifier and enable headphone amplifier
	1-2*	Headphone jack automatically configures the MAX9702

\*Default configuration

# MAX9702 Evaluation System/Evaluation Kit

Evaluates: MAX9702/MAX9702B

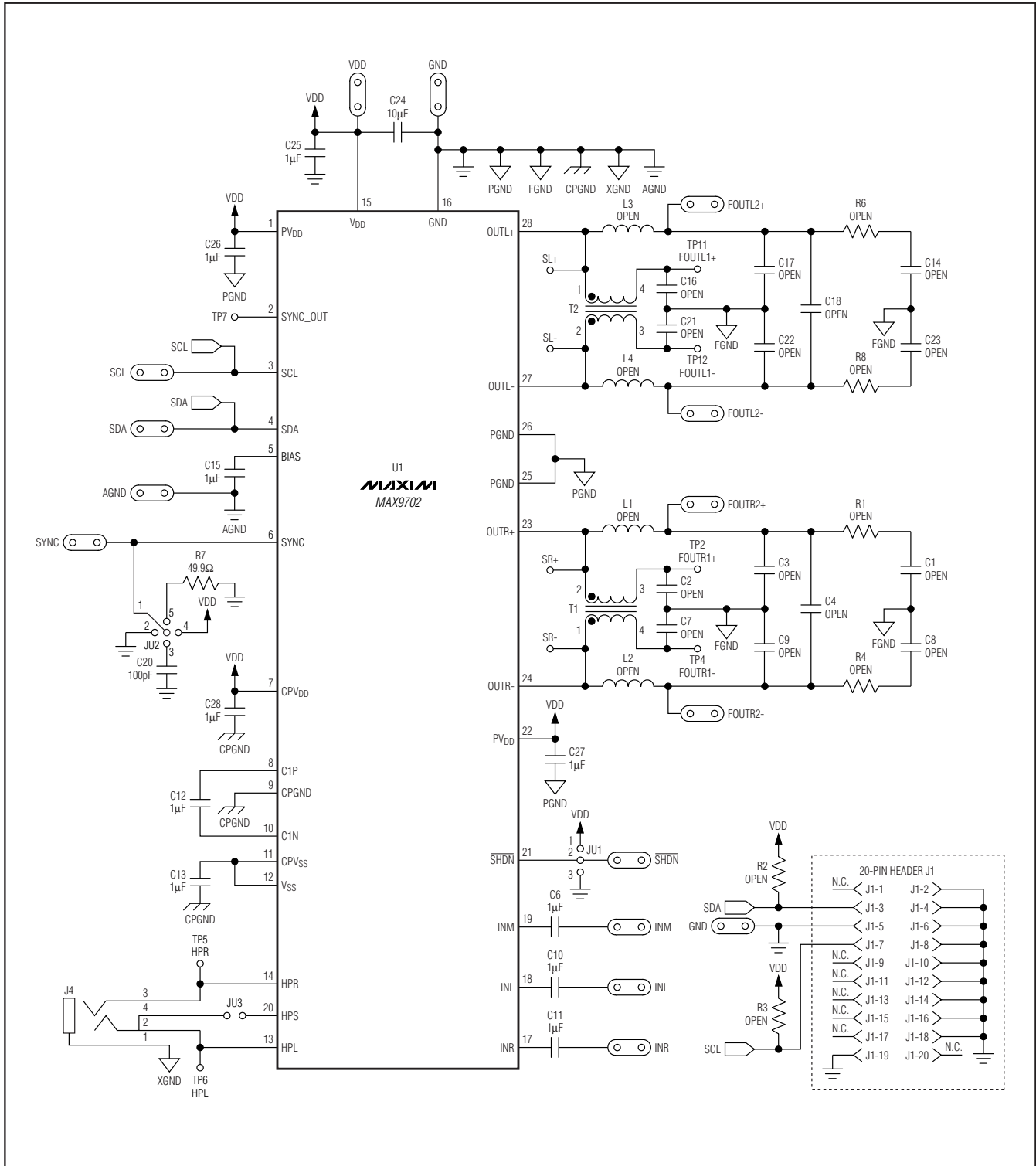


Figure 7. MAX9702 EV Kit Schematic

# MAX9702 Evaluation System/Evaluation Kit

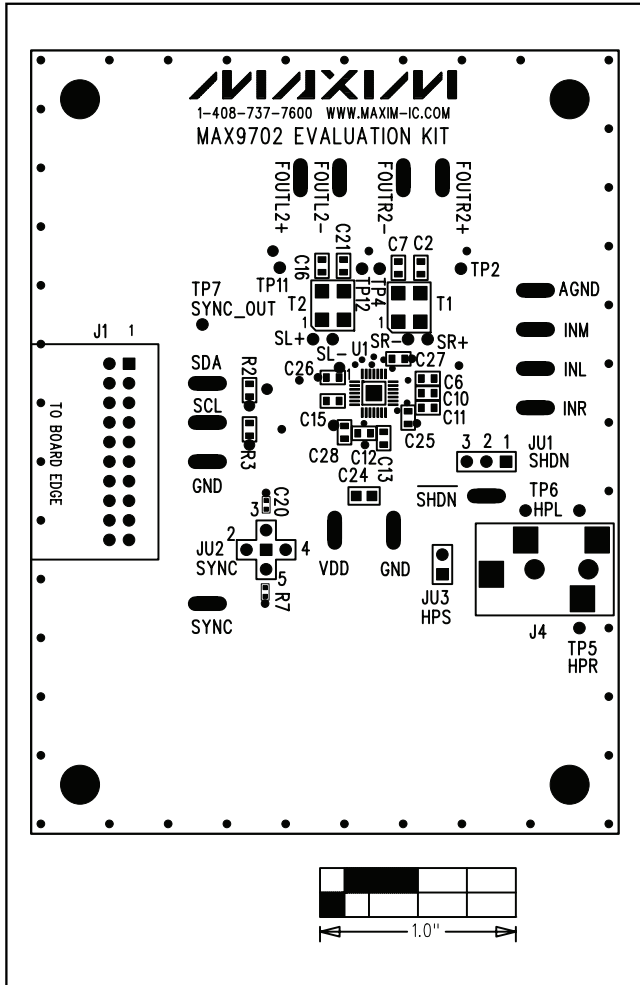


Figure 8. MAX9702 EV Kit Component Placement Guide—Component Side

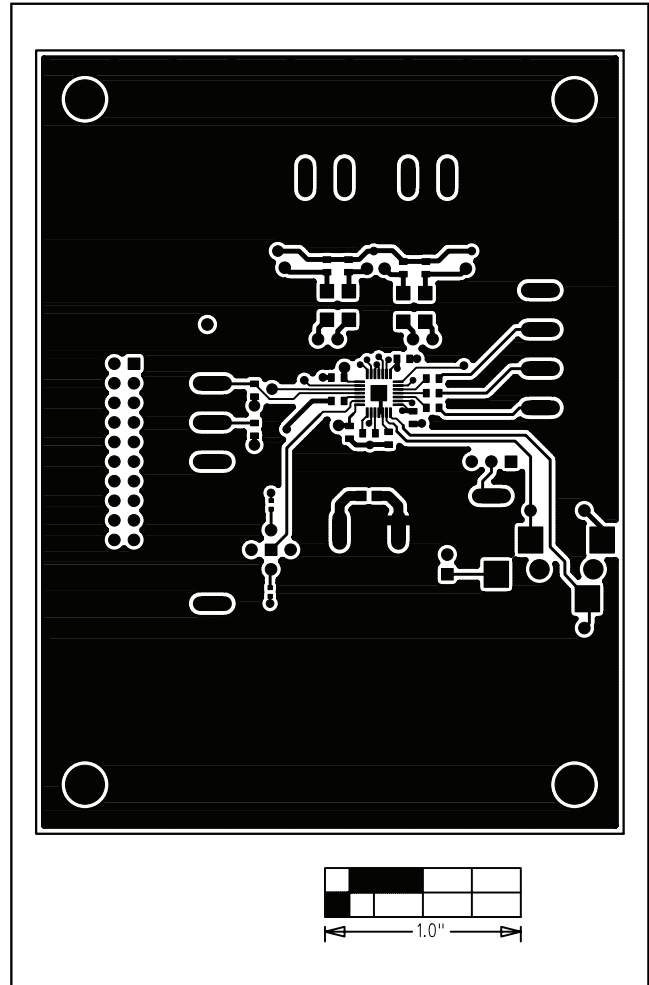


Figure 9. MAX9702 EV Kit PC Board Layout—Component Side

Evaluates: MAX9702/MAX9702B

# MAX9702 Evaluation System/Evaluation Kit

**Evaluates: MAX9702/MAX9702B**

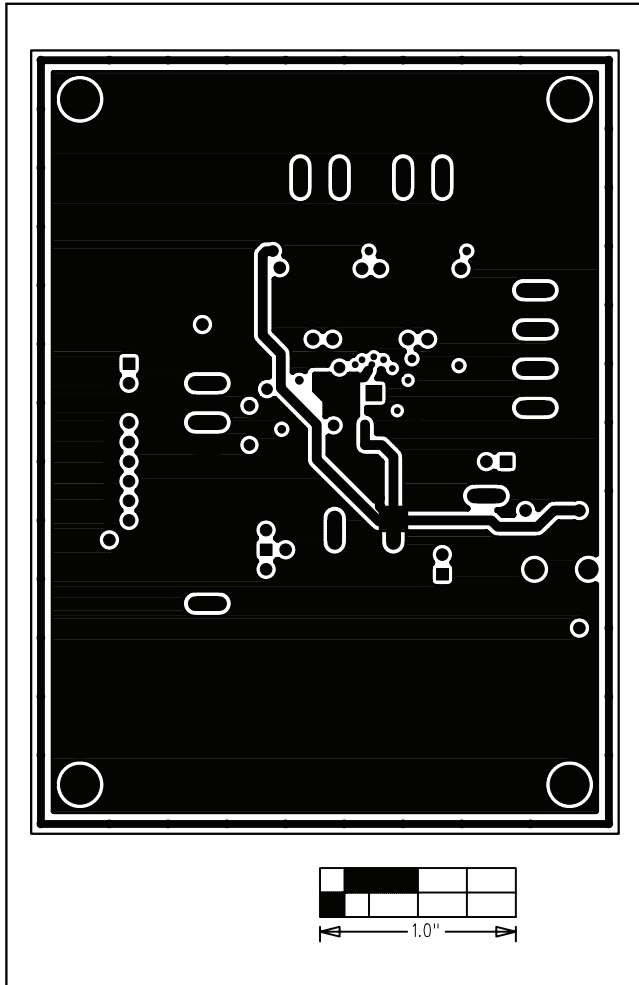


Figure 10. MAX9702 EV Kit PC Board Layout—Second (Ground) Layer

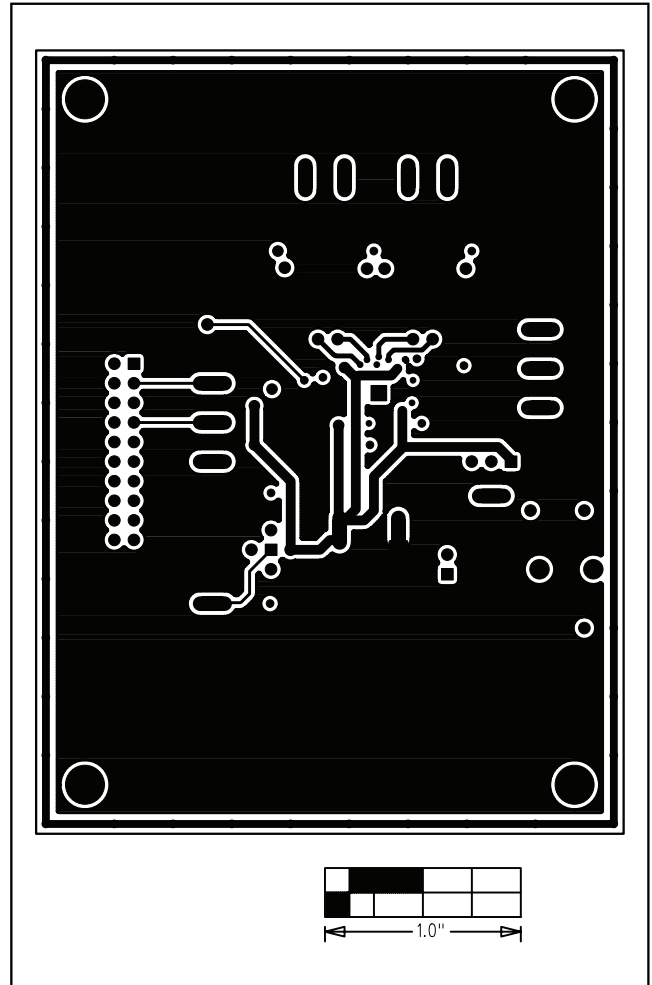


Figure 11. MAX9702 EV Kit PC Board Layout—Third (Power) Layer



# MAX9702 Evaluation System/Evaluation Kit

Evaluates: MAX9702/MAX9702B

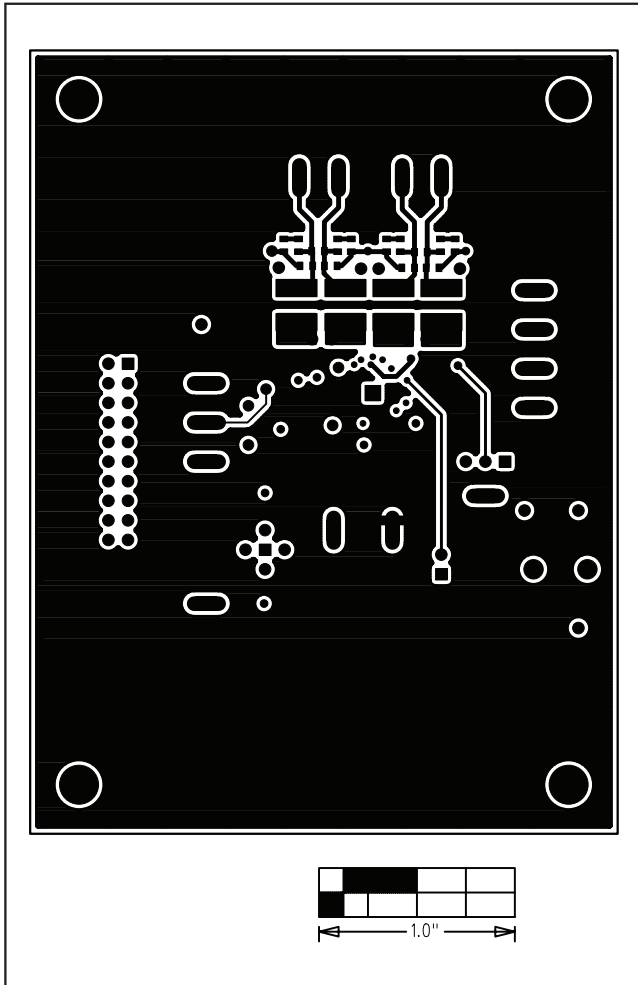


Figure 12. MAX9702 EV Kit PC Board Layout—Solder Side

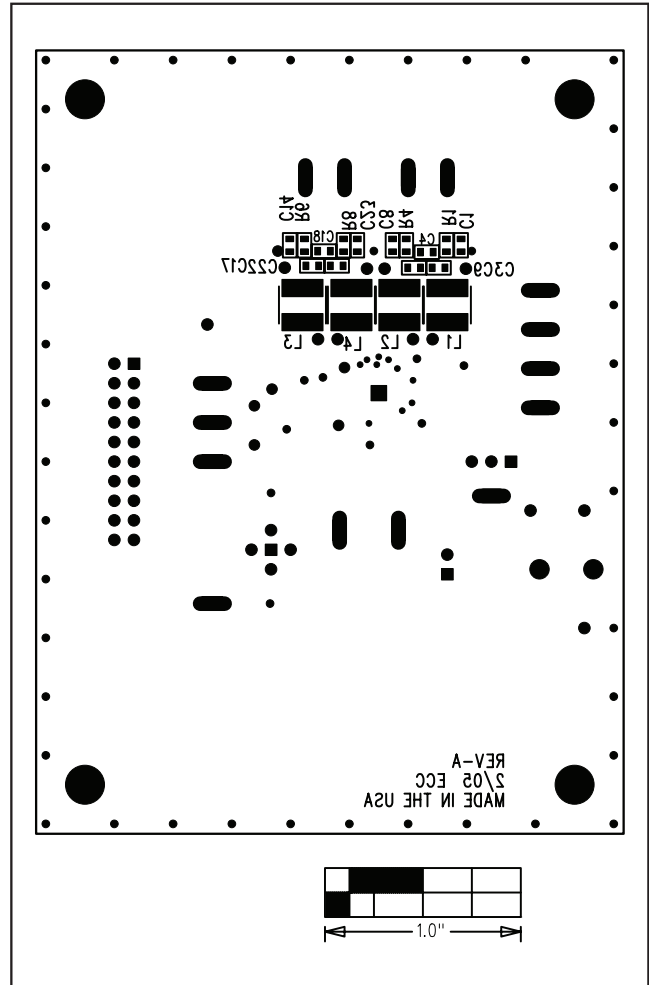


Figure 13. MAX9702 EV Kit Component Placement Guide—Solder Side

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