19-0662; Rev 0; 11/06

MAX9723D Evaluation Kit/Evaluation System

General Description

The MAX9723D evaluation kit (EV kit) is a fully assembled and tested PCB that evaluates the MAX9723 stereo DirectDrive™ headphone amplifier with BassMax, volume control, and I²C. The MAX9723D EV kit operates from a single 1.8V to 3.6V power supply, and is capable of delivering 60mW into a 16Ω load.

The MAX9723D evaluation system (EV system) includes a MAX9723D EV kit, Windows 98SE/2000/XP-compatible software, and a Maxim system command module. The software's graphical user interface (GUI) allows easy control of the MAX9723D's I²C interface, adjusting settings such as BassMax and volume.

Order the complete EV system (MAX9723DEVCMODU+ or MAX9723DEVCMOD2+) for a comprehensive evaluation of the MAX9723A/MAX9723B/MAX9723C/MAX9723D using a PC. Order the EV kit (MAX9723DEVKIT+) if the CMODUSB+ or CMOD232+ system command module has already been purchased with a previous Maxim EV system, or for custom use in other microcontroller-based (µC) systems.

The EV kit comes with the MAX9723DETE+ installed. Contact the factory for free samples of the pin-compatible MAX9723A/MAX9723B/MAX9723C to evaluate these parts.

Windows is a registered trademark of Microsoft Corp.

Features

- **Single 1.8V to 3.6V Power-Supply Operation**
- **60mW Stereo DirectDrive Headphone Outputs (16Ω, V_{DD} = 3V)**
- **System Command Module: USB Interface (CMODUSB+) or Serial Interface (CMOD232+)**
- **Windows® 98SE/2000/XP-Compatible Evaluation Software**
- **Evaluates the MAX9723A/MAX9723B/MAX9723C (with IC replacement)**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE	INTERFACE
MAX9723DEVKIT+	EV kit	User-supplied I²C interface
MAX9723DEVCMODU+	EV system	CMODUSB+ USB interface board
MAX9723DEVCMOD2+	EV system	CMOD232+ RS-232 serial-interface board

+Denotes a lead-free and RoHS-compliant EV kit.

Note: *The MAX9723D EV kit software is included with the MAX9723D EV kit, but is designed for use with the complete EV system. The EV system includes a Maxim system command module (CMODUSB+ or CMOD232+) and the EV kit. If the Windows software will not be used, the EV kit board can be purchased without the Maxim system command module.*

Component List

MAX9723DEVCMODU+

PART	QTY	DESCRIPTION
MAX9723DEVKIT+	1	MAX9723D EV kit
CMODUSB+	1	System command module (USB serial interface)

MAX9723DEVCMOD2+

PART	QTY	DESCRIPTION
MAX9723DEVKIT+	1	MAX9723D EV kit
CMOD232+	1	System command module (RS-232 serial interface)

MAX9723DEVKIT+

DESIGNATION	QTY	DESCRIPTION
C1, C9, C10	3	0.1µF ±10%, 16V X7R ceramic capacitors (0603) TDK C1608X7R1C104K Murata GRM188R71C104K
C2, C3, C6	3	1µF ±10%, 10V X7R ceramic capacitors (0603) TDK C1608X7R1A105K TDK C1608X7R1C105K Murata GRM188R61A105K
C4, C5	2	0.47µF ±10%, X7R ceramic capacitors (0603) TDK C1608X7R1A474K (10V) Murata GRM188R71E474KA12D (25V) Murata GRM188R71C747KA88 (16V) Kemet C0603C474K9RAC7867 (6.3V)

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

MAX9723D Evaluation Kit/Evaluation System

Component List (continued)

MAX9723DEVKIT+

DESIGNATION	QTY	DESCRIPTION
J1	1	2 x 10 right-angle receptacle
JU1, JU2, JU3	3	3-pin headers
PJ1	1	3.5mm stereo jack (SMT, lead free, and RoHS) CUI Inc. SJ-3523-SMT
R1, R2	2	10kΩ ±1% resistors (0603) lead free
R3, R6	2	22.1kΩ ±1% resistors (0603) lead free
R4, R5	2	47.5kΩ ±1% resistors (0603) lead free
U1	1	MAX9723DETE+ (16-pin TQFN) Stereo DirectDrive headphone amplifier
—	3	Shunts
—	1	MAX9723D EV kit PCB

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Keystone	800-221-5510	www.keyelco.com
Murata	770-436-1300	www.murata.com
TDK	847-703-6100	www.component.tdk.com

Note: *Indicate that you are using the MAX9723D when contacting these component suppliers.*

MAX9723D EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX9723V03.EXE	Application program
TROUBLESHOOTING_USB.PDF	USB driver installation help file
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstall the EV kit software

Quick Start

Recommended Equipment

- DC power supply (3.3V @ 0.5A)
- Stereo audio source (e.g., CD player, MP3 player, etc.)
- 32Ω or 16Ω headphones
- MAX9723D EV system
  - MAX9723D EV kit
  - Maxim CMODUSB+ or CMOD232+ system command module
- A user-supplied Windows 98SE/2000/XP PC

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 98SE/2000/XP operating system.

Procedure

Follow the steps below to verify board operation. **Caution:** Do not turn on the power supply until all connections are complete.

1) Visit the Maxim website (www.maxim-ic.com/evkit-software) to download the most recent version of the EV kit software, 9723RXX.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.
2) Install the MAX9723D 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) Carefully connect the system command module to the EV kit by aligning the 20-pin connector of the MAX9723D EV kit with the 20-pin header of the Maxim system command module interface board.
4) Enable the pullup resistors on the system command module by making sure the SDA switch and SCL switch (both on SW1) are thrown on.
5) If using Maxim's serial-interface board (CMOD232+), connect a 9-pin male-to-female cable from the computer's serial port to CMOD232+. CMOD232+ requires a 9V power supply to P1 (DC IN). For regulated 3.3V output voltage, install a shunt across pins 1-2 of J1 on the CMOD232+. If using Maxim's USB interface board (CMODUSB+), connect the A-to-B USB cable from the computer's USB port to CMODUSB+. CMODUSB+ requires no external power as it is powered from the PC USB port. For regulated 3.3V output, install a shunt across pins 2-3 of J1 on the CMODUSB+.
6) Ensure that a shunt is placed across pins 1-2 of JU3 on the MAX9723D EV kit board.

7) Connect a 3.3V power supply between the pads labeled V_{DD} and GND on the MAX9723D EV kit board.
8) Ensure that the input audio source is turned off.
9) Connect the stereo audio source to the pads labeled RIN, LIN, and GND on the MAX9723D EV kit board.
10) Plug the headphones into the 3.5mm headphone jack on the MAX9723D EV kit board.
11) Turn on the DC power supply.
12) Enable the audio source.
13) Start the MAX9723 program by opening its icon in the Windows **Start** menu. Select the device slave address from the device pulldown menu. See Table 1.

Detailed Description of Software

Device Selection and Slave Address

The MAX9723 has an I²C-compatible interface that allows serial communication between the MAX9723 and a microcontroller. The MAX9723 is available with one of two preset slave addresses (see Table 1). The MAX9723D EV kit ships with the MAX9723D. Change IC U1 to evaluate other devices. Samples of other MAX9723 devices are available through Maxim's website at www.maxim-ic.com.

The **Device** pulldown menu allows the user to select the device slave address. Select the slave address of the device being evaluated at startup. See Figure 2 for details.

Table 1. MAX9723 Slave Address

VERSION	MAX9723 SLAVE ADDRESS							
	A6	A5	A4	A3	A2	A1	A0	R/$\overline{W}$
MAX9723A	1	0	0	1	1	0	0	X
MAX9723B	1	0	0	1	1	0	1	X
MAX9723C	1	0	0	1	1	0	0	X
MAX9723D*	1	0	0	1	1	0	1	X

**EV kit IC version.*

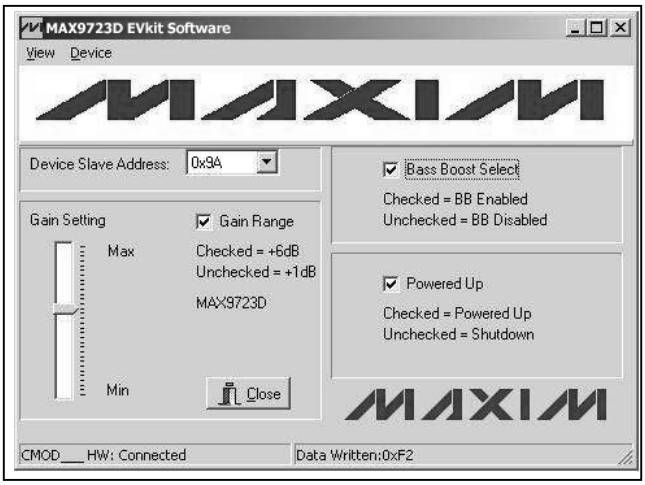


Figure 1. MAX9723D EV Kit Software GUI Window

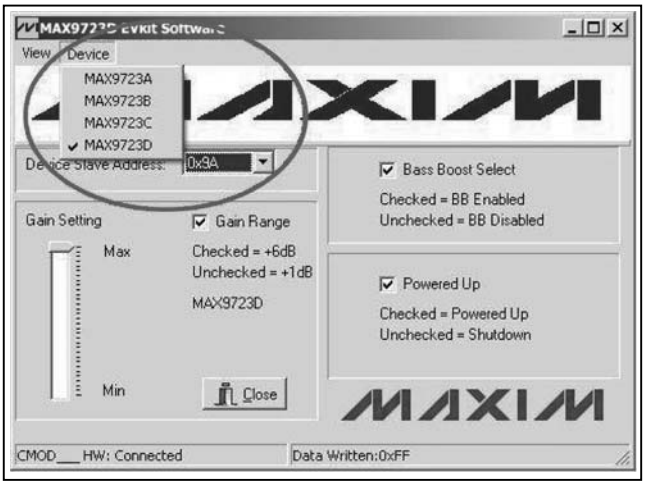


Figure 2. Device Selection and Slave Address

Gain Range and Gain Settings

The MAX9723 offers two options for the maximum volume setting (A_{V_VOL}). The MAX9723A/MAX9723B have selectable maximum gains of -5dB or 0dB, while the MAX9723C and MAX9723D have selectable maximum gains of +1dB or +6dB.

The **Gain Range** checkbox (Figure 3) allows the user to select between the two maximum gain ranges. See Table 2 for the corresponding gain range of each IC version.

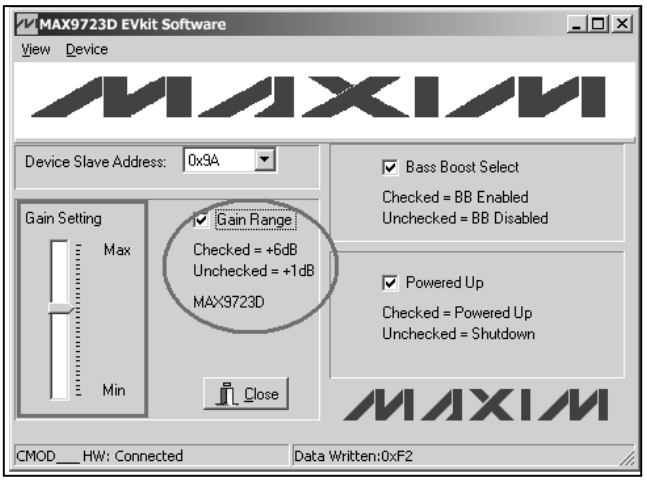


Figure 3. Gain Range Checkbox and Gain Setting Slide Bar for MAX9723 Gain Adjustments

Table 2. MAX9723 Gain Range

VERSION	GAIN RANGE (dB)
MAX9723A	-5 or 0
MAX9723B	-5 or 0
MAX9723C	+1 or +6
MAX9723D*	+1 or +6

**EV kit IC version.*

The MAX9723 also includes a 32-level volume control that adjusts the overall gain (A_{V_VOL}) of the output amplifiers.

Use the **Gain Setting** slide bar to adjust A_{V_VOL}.

Bass Boost Select

The MAX9723 includes a bass-boost feature that compensates for the headphone's poor bass response by increasing the amplifier gain at low frequencies (A_{V_BOOST}). The bass-boost setting is customized by adjusting R5, R6, and C9 for the left channel and R4, R6, and C10 for the right channel. See the *Detailed Description of Hardware* section.

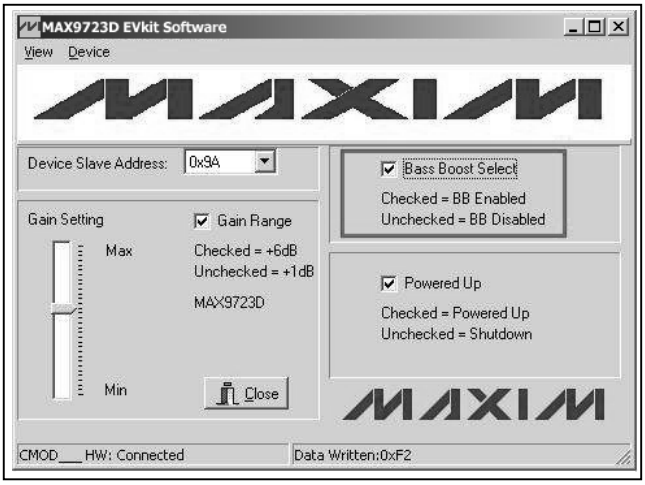


Figure 4. MAX9723 Bass-Boost Feature

Checking the **Bass Boost Select** checkbox (Figure 4) enables bass boost. The output has additional gain (A_{V_BOOST}) on top of the overall gain (A_{V_VOL}). The default A_{V_BOOST} is +8.8dB for bass frequencies. The absolute gain at low frequencies is equal to:

$$A_{V_TOTAL} = A_{V_VOL} + A_{V_BOOST}$$

Powered Up Checkbox and Close Button

Uncheck the **Powered Up** checkbox (Figure 5), while $\overline{SHDN}$ is pulled high, to shut down the MAX9723. The EV kit software powers up in the state shown in Figure 5. Clearing the **Powered Up** checkbox does not reset the internal registers.

Press the **Close** button (Figure 5) to quit the MAX9723D EV kit software.

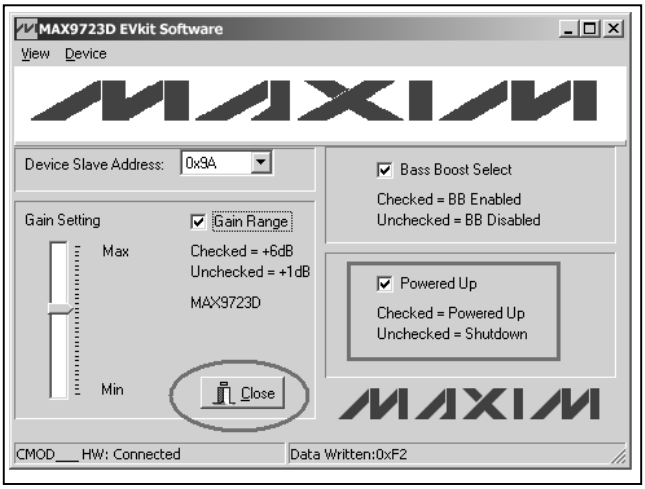


Figure 5. Powered Up Checkbox and Close Button

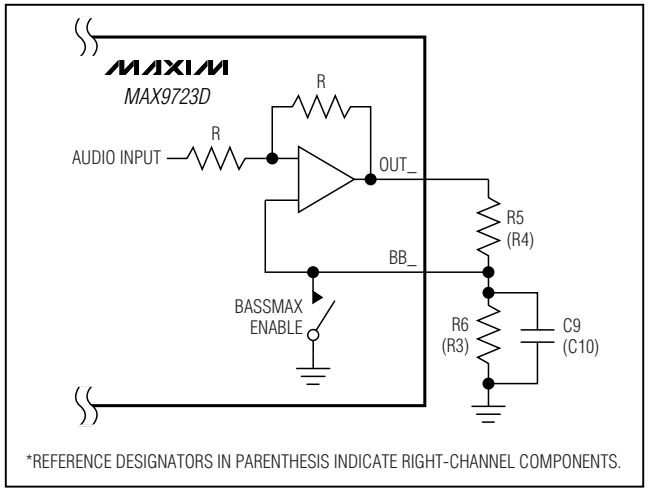


Figure 6. Bass Boost External Components for Left Channel

Detailed Description of Hardware

BassMax Component Selection

PCB components R5, R6, and C9 set the bass boost for the left channel, while components R4, R3, and C10 set the bass boost for the right channel (see Figure 6). The default bass boost is +8.8dB. Changing the components listed above modifies the bass-boost gain and frequency response. For example, when bass boost is enabled, the ratio of R5 and R6 sets the left-channel bass boost gain ($A_{V_BOOST_}$) that is calculated using the following equation. Adjust resistors R4 and R3 to set the right-channel bass boost.

$$A_{V_BOOSTL} = 20 \times \log\left(\frac{R5 + R6}{R5 - R6}\right)$$

To maintain circuit stability, the ratio:

$$\frac{R6}{R5 + R6}$$

must not exceed 1/2 (a ratio of 1/3 is recommended). The switch that shorts BB_ to SGND, when BassMax is disabled, can have an on-resistance as high as 300Ω. Choose a value for R5 (R3) greater than 40kΩ to ensure that positive feedback is negligible when BassMax is disabled. Table 3 contains a list of R6 (R3) values, with R5 (R4) = 47kΩ, and the corresponding low-frequency gain.

Table 3. BassMax Gain Examples—R5 (R4) = 47kΩ

R6 (R3) (kΩ)	AV GAIN (dB)
39	20.6
33	15.1
27	11.3
22	8.8
15	5.7
10	3.7

Note: *Reference designators in parenthesis indicate right-channel components.*

The low-frequency boost attained by the BassMax circuit is added to the gain realized by the volume setting. Select the BassMax gain so that the output signal remains within the dynamic range of the MAX9723. Output signal clipping occurs at low frequencies if the BassMax gain boost is excessively large (refer to the *Output Dynamic Range* section in the MAX9723 data sheet).

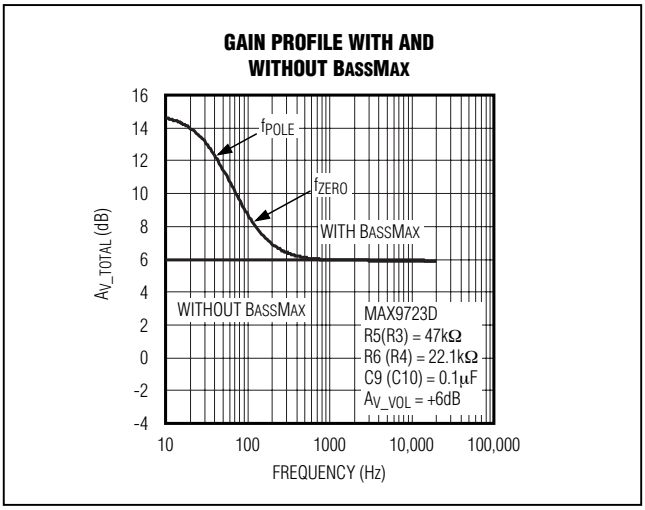


Figure 7. BassMax, Gain Profile Example for A_{V_VOL} = +6dB

For the left channel, capacitor C9 creates a pole and a zero according to the following equations:

$$f_{POLE} = \frac{R5 - R6}{2\pi \times C9 \times R5 \times R6}$$

$$f_{ZERO} = \frac{R5 + R6}{2\pi \times C9 \times R5 \times R6}$$

f_{POLE} is the frequency that the gain boost begins to roll off. f_{ZERO} is the frequency that the bass-boost gain no longer affects the transfer function and the volume-control gain dominates. Table 4 lists capacitor values and the corresponding poles and zeros for a given DC gain. See Figure 7 for an example of a gain profile using BassMax. Set the right-channel frequency response by adjusting R4, R3, and C10.

Table 4. BassMax Pole and Zero Examples for a Gain Boost of 8.8dB—R5 (R4) = 47kΩ and R6 (R3) = 22kΩ

C9 (C10) (nF)	f_{POLE} (Hz)	f_{ZERO} (Hz)
100	38	106
82	47	130
68	56	156
56	68	190
47	81	230
22	174	490
10	384	1060

Note: *Reference designators in parenthesis indicate right-channel components. Simply substitute R4 for R5, R3 for R6, and C10 for C9 for right-channel equations.*

MAX9723D EV System

The MAX9723D EV system (MAX9723DEVCMODU+ or MAX9723DEVCMOD2+) is a complete stereo DirectDrive headphone amplifier system consisting of the MAX9723D EV kit and Maxim's system command module (CMODUSB+ or CMOD232+).

The MAX9723D EV kit provides a proven layout for evaluating the MAX9723 and comes with the MAX9723DETE+ installed.

CMODUSB+ and CMOD232+ Command Module

The CMODUSB+ and CMOD232+ use a proprietary design to provide SPI- and I²C-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 5VDC voltage that comes from the USB connector and the MAX1658's regulated 3.3V output voltage. Set the CMODUSB+ jumper J1 at position 2-3 to have 3.3V output voltage to evaluate the MAX9723D EV kit.

CMOD232+ Power Supply

The CMOD232+ board uses a MAX1659 linear regulator. Jumper J1 selects either the MAX1659's 5V default output voltage or 3.3V output voltage. Set the CMOD232+ jumper J1 at position 1-2 to have 3.3V output voltage to evaluate the MAX9723D EV kit.

MAX9723D EV Kit Stand-Alone Operation

The MAX9723D EV kit operates without the system command module, but the functions are limited to power-on reset-default settings listed below:

- BassMax enabled
- Maximum gain range:
  0dB for MAX9723A/MAX9723B or +6dB for MAX9723C/MAX9723D
- Maximum gain setting
- Device enabled

Input Mode

The audio input terminals on the MAX9723D EV kit accept stereo single-ended inputs (INR and INL).

MAX9723 I²C Address

The MAX9723 device is an I²C/SMBus™ slave and is write only. Versions A and C have a fixed slave address of 1001100X, and versions B and D have a fixed slave address of 1001101X. See Table 1 for details.

SMBus is a trademark of Intel Corp.

Power Supply

The MAX9723D EV kit board is powered from a user-supplied +1.8V to +3.6VDC power supply between the V_{DD} and GND pads.

Hardware- or Software-Shutdown Control

The MAX9723 features a shutdown mode to reduce power consumption and extend battery life. Shutdown can be either hardware- or software-controlled. The software-controlled shutdown maintains the configuration set by the user (see the *Powered Up Checkbox and Close Button* section). Jumper JU3 controls the hardware-shutdown function of the MAX9723D EV kit. Move jumper JU3 to position 2-3 to shut down the entire MAX9723 and reset all the registers to their power-on defaults. See Table 5 for shutdown shunt positions.

Table 5. Hardware Shutdown Selection

JU3	FUNCTION
1-2*	Normal operation
2-3	Power-down mode

**Default position.*

User-Supplied I²C Interface

Connect SDA, SCL, and GND lines from the user-supplied I²C interface to the corresponding pads on the MAX9723D EV kit board. Install shunts across pins 1-2 of JU1 and JU2 to pull up the SDA and SCL lines. Remove the jumpers if the bus is already pulled up.

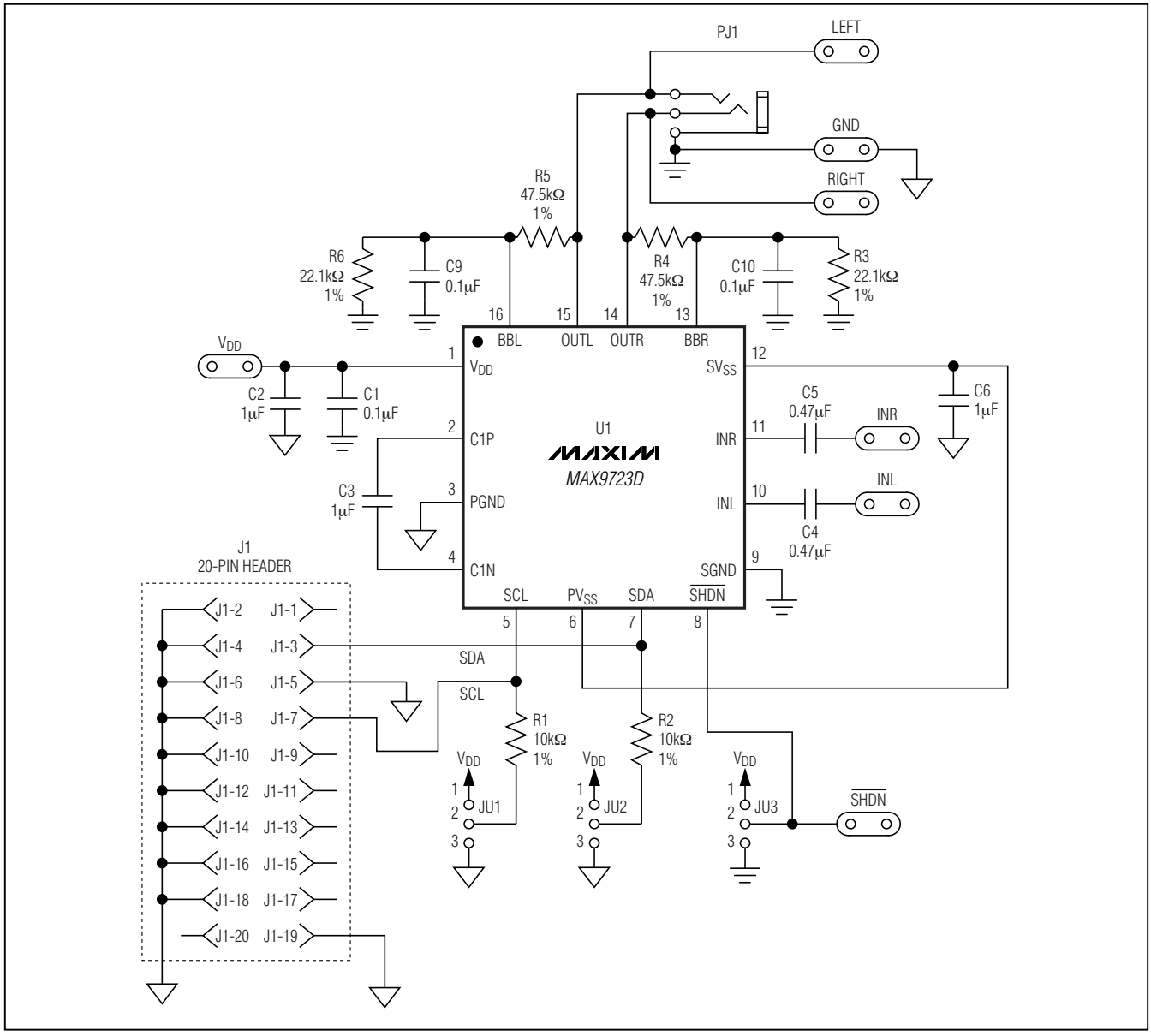


Figure 8. MAX9723D EV Kit Schematic

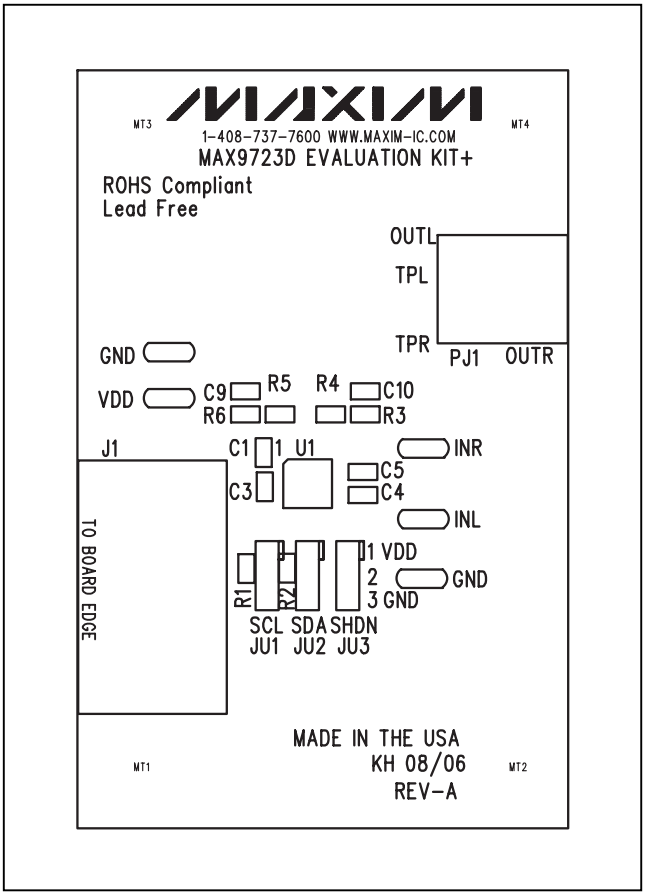


Figure 9. MAX9723D EV Kit Component Placement Guide—Component Side

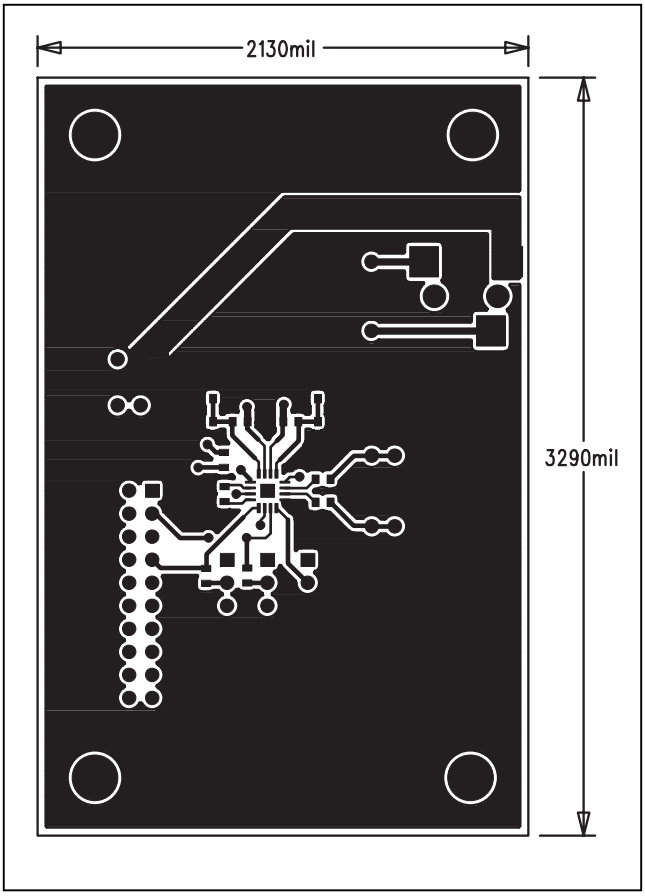


Figure 10. MAX9723D EV Kit PCB Layout—Component Side

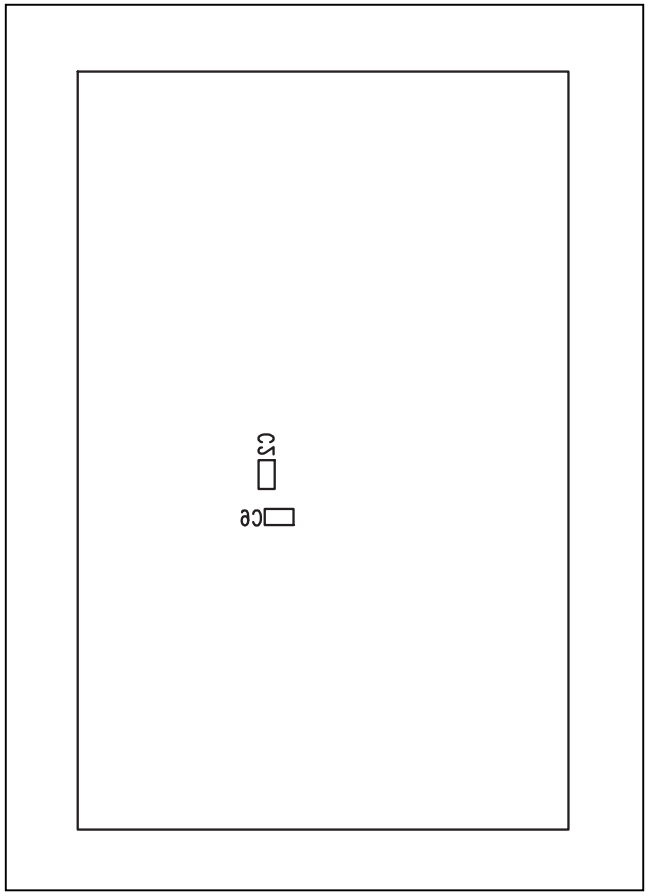


Figure 11. MAX9723D EV Kit Component Placement Guide—Solder Side

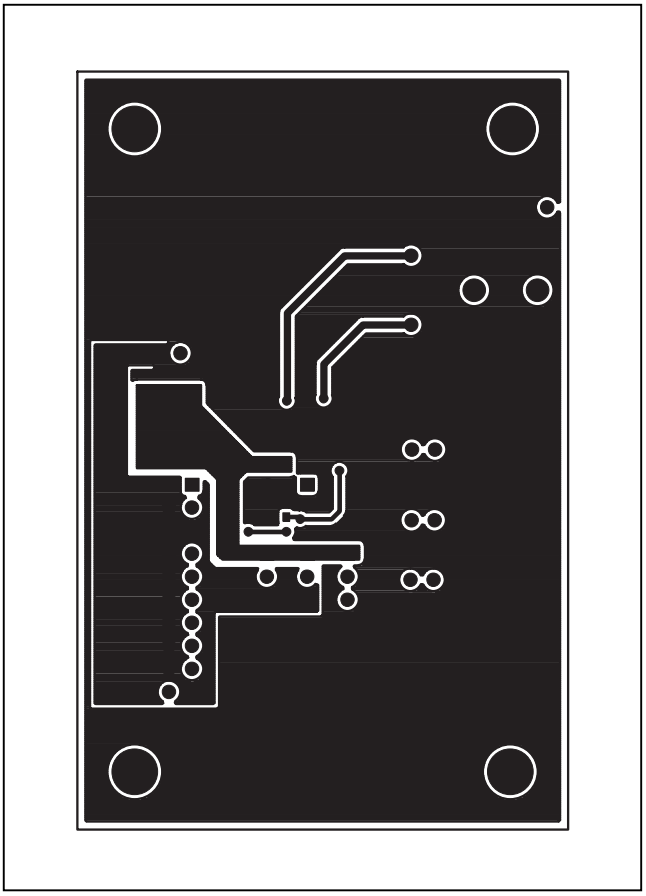


Figure 12. MAX9723D EV Kit PCB Layout—Solder Side

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