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MAX9768 Evaluation Kit/Evaluation System

Evaluate: MAX9768

General Description

The MAX9768 evaluation kit (EV kit) is a fully assembled and tested printed-circuit board (PCB) that demonstrates the capabilities of the MAX9768 mono 10W Class D speaker amplifier with volume control. The MAX9768 EV kit also includes Windows® 98SE/2000/XP-compatible software that provides a simple graphical user interface (GUI) for exercising the features of the MAX9768.

The MAX9768 evaluation system (EV system) consists of the MAX9768 EV kit and a companion CMAXQUSB serial-interface board. The CMAXQUSB interface board allows a PC to control an I²C interface using its USB port. Order the MAX9768 EV system (MAX9768EVCMAXQU+) for a complete PC-based evaluation of the MAX9768. Order the MAX9768 EV kit (MAX9768EVKIT+) if you already have a MAX9768-compatible serial interface.

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Dual Mode is a trademark of Maxim Integrated Products, Inc.

Component Lists
MAX9768 EV System

PART	QTY	DESCRIPTION
MAX9768EVKIT+	1	MAX9768 EV kit
CMAXQUSB+	1	Serial-interface board

MAX9768 EV Kit

DESIGNATION	QTY	DESCRIPTION
MINIMAL COMPONENTS FOR CUSTOMER DESIGN		
C1, C2	2	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K
C3, C5	2	1µF ±10%, 10V X7R ceramic capacitors (0603) Murata GRM188R61A105K
C4	1	0.47µF ±10%, 16V X7R ceramic capacitor (0805) Murata GRM21BR71C474K
C6, C8	2	1µF ±10%, 16V X7R ceramic capacitors (0805) Murata GRM21BR71C105K
C7, C21	2	22µF ±20%, 16V aluminum electrolytic capacitor (C case) Panasonic EEEFC1C220R
R2, R3	2	20kΩ ±1% resistors (0603)
U1	1	Maxim 10W mono speaker amplifier with volume control MAX9768ETG+ (24-pin, 4mm x 4mm x 0.8mm, TQFN-EP*)

*EP = Exposed paddle.

Features

♦ **Fully Tested PCB**
♦ **10W Output into 8Ω Load at 13V Power Supply**
♦ **Bridge-Tied Load (BTL) Output and Click-and-Pop Suppression**
♦ **Dual Mode™ Volume Control: Analog or I²C**
♦ **Dual Modulation Schemes: Fixed Frequency and Spread Spectrum**
♦ **Shut-Down Mode and Speaker Mute Mode**
♦ **On-Board LDO for Low-Voltage Analog Power Supply**
♦ **Windows 98SE/2000/XP-Compatible Evaluation Software**
♦ **EV System Includes USB Connectivity**

Ordering Information

PART	TYPE
MAX9768EVKIT+	EV Kit
MAX9768EVCMAXQU+	EV System

+Denotes lead-free and RoHS-compliant.

Note: *The MAX9768 EV kit software is designed for use with the complete EV system. The EV system includes both the Maxim CMAXQUSB interface board and the EV kit. If the Windows software will not be used, the EV kit board can be purchased without the Maxim CMAXQUSB board.*

MAX9768 EV Kit (continued)

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION		
C9, C10	0	Not installed, ceramic capacitors (0603)
C11, C12	2	0.01µF ±10%, 50V X7R ceramic capacitors (0805) Murata GRM216R71H103K
C13, C15	2	0.22µF ±10%, 25V X7R ceramic capacitors (1206) Panasonic ECJ-3VB1E224K
C14, C16, C20	3	0.01µF ±10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C103K
C17	1	1µF ±10%, 16V X7R ceramic capacitor (0805) Murata GRM21BR71C105K
C18	1	1µF ±10%, 10V X7R ceramic capacitor (0603) Murata GRM188R61A105K

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.

MAX9768 Evaluation Kit/Evaluation System

DESIGNATION	QTY	DESCRIPTION
C19	1	100pF ±5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H101J
J1	1	2 x 10 right-angle female receptacle
J2	1	White RCA mono jack
J3–J6	4	Binding posts, uninsulated
JU1–JU5	5	Single-row 3-pin headers
JU6	1	3-way-pin header
JU7, JU8	2	2-pin headers
L1, L2	2	60Ω, 3A ferrite beads (0805) Murata BLM21PG600SN1
L3, L4	2	Shorted with 0Ω resistors (0603)
L5, L6	2	22µH, 1.9A inductors TDK SLF10145T-220M1R9PF
R1, R5	2	10kΩ ±5% resistors (0603)
R4	1	20Ω ±5% resistor (1206)
R6	1	10kΩ ±20% thumbwheel potentiometer Panasonic EVL-HFAA05B14

MAX9768 EV Kit (continued)

DESIGNATION	QTY	DESCRIPTION
U2	1	Maxim 12V low-dropout linear regulator MAX1726EUK33+ (5-pin SOT23)
—	8	Shunts
—	4	0.250in x 0.500in 4–40 round nylon spacers
—	4	4–40 x 0.375in nylon machine screws
—	1	PCB: MAX9768 Evaluation Kit+

MAX9768 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX9768.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
TROUBLESHOOTING_USB.PDF	USB driver installation help file

Quick Start

Recommended Equipment

Before proceeding, the following equipment is needed:

- 4.5V to 14V DC, 3A power supply

- Audio source (i.e., CD player, 1V$_{RMS}$ maximum output)

- 8Ω speaker

- MAX9768 EV system

    MAX9768 EV kit
    Maxim CMAXQUSB interface board
        (USB cable included)

- A user-supplied Windows 98SE/2000/XP 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 98SE/2000/XP operating system.

Procedure for Stand-Alone Operation

The MAX9768 EV kit is fully assembled and tested. Follow the steps below to verify board operation for analog volume control. **Do not turn on the power supply until all connections are completed.**

1) On the MAX9768 EV kit, make sure the shunts are in the default positions (see Table 1).

2) Connect the positive terminal of the 4.5V to 14V DC power supply to the PV$_{DD}$ binding post, and the power-supply ground terminal to the PGND binding post.

3) Connect the 8Ω speaker across the FOUT+ and FOUT- binding posts.

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 MAX9768 when contacting these component suppliers.*

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4) Plug the audio source to the RCA jack.

5) Turn on the audio source.

6) Turn on the 4.5V to 14V DC power supply.

7) Adjust the potentiometer R6 to change the speaker volume.

Procedure for I²C Interface Volume Control

The MAX9768 EV kit is fully assembled and tested. Follow the steps below to verify board operation for I²C volume control. **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, 9768Rxx.ZIP.

2) Install the MAX9768 evaluation software on your computer by running the INSTALL.EXE program. The program files are copied and icons are created in the Windows **Start** menu.

3) On the CMAXQUSB board, ensure that the shunt of JU1 is in the 3.3V position.

4) Carefully connect the boards by aligning the MAX9768 EV kit's 20-pin connector with the 20-pin connector of the CMAXQUSB board.

5) Ensure shunts on JU1, JU2, JU4, JU6, and JU7 are in their default positions (see Table 1).

6) Place the shunt on JU3 across pins 1-2.

7) Place the shunt on JU5 across pins 1-2.

8) Remove the shunt on JU8.

9) Connect the positive terminal of the 4.5V to 14V DC power supply to the PV_{DD} binding post, and the power-supply ground terminal to the PGND binding post.

10) Connect the 8Ω speaker across the FOUT+ and FOUT- binding posts.

11) Plug the audio source to the RCA jack.

12) Turn on the audio source.

13) Turn on the 4.5V to 14V DC power supply.

14) Connect the USB cable from the PC to the CMAXQUSB board. A **Building Driver Database** window pops up in addition to a **New Hardware Found** message. If you do not see a window that is similar to the one described above after 30s, remove the USB cable from the CMAXQUSB and reconnect it. Administrator privileges are required to install the USB device driver on Windows 2000/XP. Refer to

Table 1. MAX9768 EV Kit Jumper Settings

JUMPER	SHUNT POSITION	DESCRIPTION
JU1	2-3*	Normal operation
	1-2	Speaker mute
JU2	1-2*	Normal operation
	2-3	Amplifier shutdown
JU3, JU4	2-3*	I²C Address: disabled, stand-alone operation
	1-2	I²C Address: 1001 011x
	1-2, 2-3	I²C Address: 1001 001x
	2-3, 1-2	I²C Address: 1001 010x
JU5	2-3*	Stand-alone operation
	1-2	I²C volume control mode
JU6	1-4*	SYNC connected to GND
	1-2	SYNC connected to V_{DD}
	1-3	SYNC unconnected
	Open	SYNC connected to external clock
JU7	1-2*	V_{DD} supplied by on-board LDO regulator
	Open	V_{DD} supplied by an external power supply
JU8	1-2*	In stand-alone operation: classic PWM modulation
	Open	In stand-alone operation: filterless modulation
	Open	I²C interface control mode

*Default position.

the TROUBLESHOOTING_USB.PDF document included with the software if you have any problems during this step.

15) 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\MAX9768** (or the directory chosen during installation) using the **Browse** button.

16) Start the MAX9768 EV kit software by opening its icon in the **Start** menu. The GUI main window appears, as shown in Figure 1.

17) Move the volume-control slider on the software window and verify that the speaker volume changes.

__Detailed Description of Hardware

The MAX9768 is a mono, switch-mode (Class D) audio power amplifier. The EV kit is designed to be driven by the lineout or headphone jack of a CD player, or directly connected to any audio source. A thumbwheel potentiometer mounted on-board is provided to control the volume. The volume can also be controlled by the I^2C interface.

The EV kit has an on-board LDO (MAX1726) to power the input buffers and the volume-control circuitry.

Preamplifier Gain Configuration

The preamplifier gain stage of the MAX9768 EV kit is configured to 0dB. To avoid clipping at the amplifier input stage, ensure input signals are ≤ $1V_{RMS}$. If input signals are ≥ $1V_{RMS}$, attenuate the input signal at the preamplifier gain stage to avoid clipping at the preamplifier output. The preamplifier gain stage is defined as:

$$A_{V\ (preamplifier)} = -R3\ /\ R2$$

where R2 is in the 10kΩ to 40kΩ range.

Define the preamplifier gain such that the output of the preamplifier is ≤ $1V_{RMS}$ (i.e., V_{IN} x $A_{V\ (preamplifier)}$ ≤ $1V_{RMS}$). Once the preamplifier gain is fixed, use the amplifier's volume-control block to set the clipping levels at the output of the Class D amplifier.

Power Supplies

The power supply is applied on PV_{DD} and PGND binding posts. V_{DD} is generated either by the on-board MAX1726 or by an external 3.3V power supply applied between the V_{DD} pad and PGND. See Table 2 for JU7 setting.

Table 2. JU7 Jumper Setting

JUMPER	SHUNT POSITION	DESCRIPTION
JU7	1-2*	On-board V_{DD} generated by MAX1726
	Open	User-provided 3.3V V_{DD} power supply

*Default position.

Volume Control

Jumpers JU3, JU4, JU5, and JU8 select which volume-control mode is used. See Table 3 for details.

Table 3. Control-Mode Setting

JUMPER	SHUNT POSITION	DESCRIPTION
JU3, JU4	2-3*	I^2C Address: disabled, stand-alone operation
	1-2	I^2C Address: 1001 011x
	1-2, 2-3	I^2C Address: 1001 001x
	2-3, 1-2	I^2C Address: 1001 010x
JU5	2-3*	Stand-alone operation
	1-2	I^2C volume control mode
JU8	1-2*	In stand-alone operation: classic PWM modulation
	Open	In stand-alone operation: filterless modulation
	Open	I^2C interface control mode

*Default position.

Shutdown Mode

Jumper JU2 sets the amplifier in normal operation or shutdown mode. See Table 4 for details.

Table 4. JU2 Setting

JUMPER	SHUNT POSITION	DESCRIPTION
JU2	1-2*	Normal operation
	2-3	Shutdown mode

*Default position.

Mute Control

Jumper JU1 controls the MUTE pin state. See Table 5 for details.

Table 5. JU1 Setting

JUMPER	SHUNT POSITION	DESCRIPTION
JU1	2-3*	Normal operation
	1-2	Speaker muted

*Default position.

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Modulation Schemes

Jumper JU6 sets the output modulation scheme. See Table 6 for details.

Table 6. JU6 Setting

JUMPER	SHUNT POSITION	DESCRIPTION
JU6	1-4*	Fixed-frequency mode with f_{SW} = 300kHz
	1-2	Spread-spectrum mode with f_S = 300kHz ±7.5kHz
	1-3	Fixed-frequency mode with f_S = 360kHz
	Open	Fixed-frequency mode with f_S = 1/4 external clock frequency

Default position.

__Detailed Description of Software

To start the MAX9768 EV kit software, double-click the MAX9768 EV kit icon created during installation. The GUI main window appears, as shown in Figure 1. Wait approximately 2s while the MAX9768 EV kit software connects to the CMAXQUSB board and automatically detects the I2C address of the device.

On the left side of the window, the scrollbar is used to increment/decrement the speaker volume by one step.

On the right side of the window, a user can manually change the device I2C address, set volume directly by programming the volume register, and set the modulation mode.
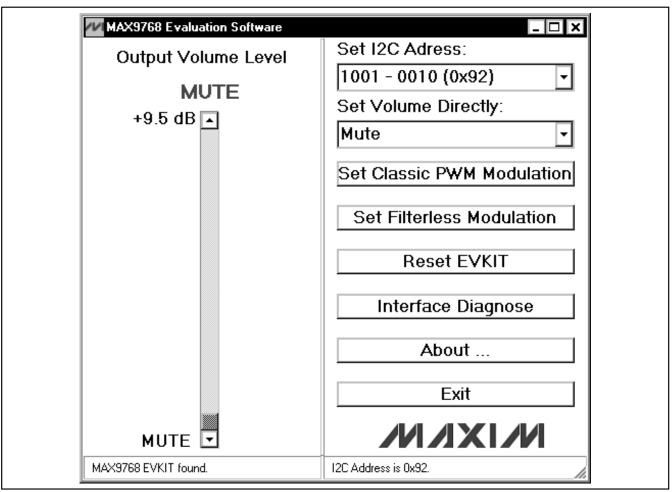

Figure 1. MAX9768 Evaluation Software Main Window

Figure 2. MAX9768 EV Kit Schematic

MAX9768 Evaluation Kit/Evaluation System
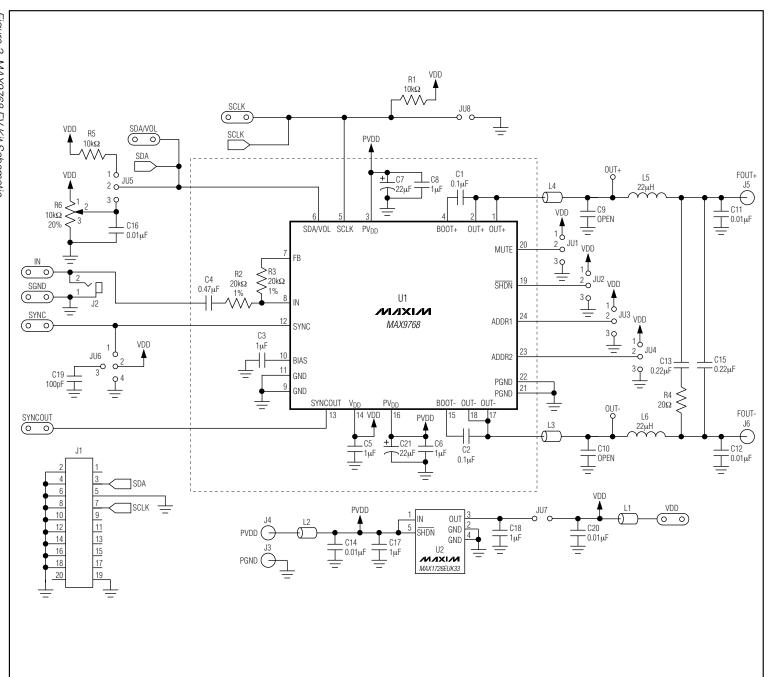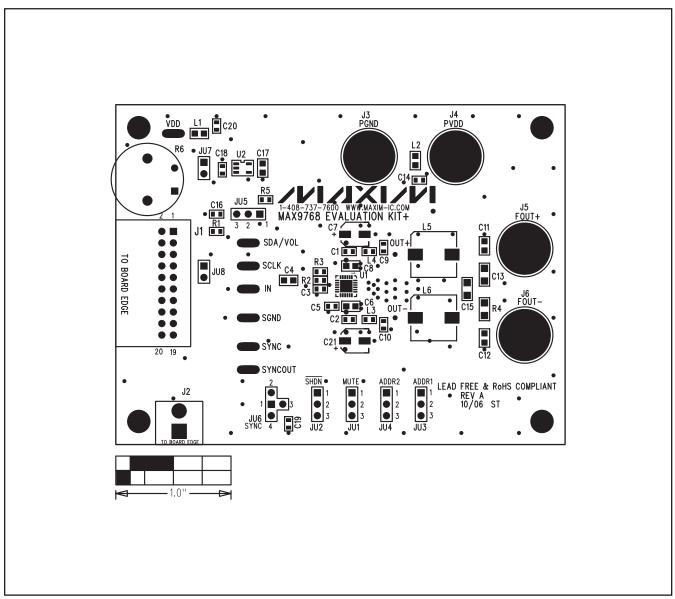
Figure 3. MAX9768 EV Kit Component Placement Guide—Component Side

Figure 4. MAX9768 EV Kit PCB Layout—Component Side
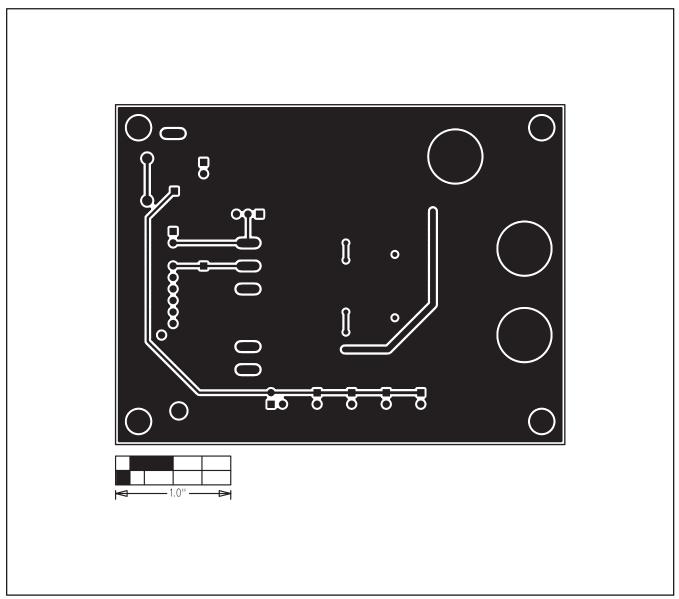
Figure 5. MAX9768 EV Kit PCB Layout—Solder Side