



# MAX98304 Evaluation Kit

## General Description

The MAX98304 evaluation kit (EV kit) is a fully assembled and tested circuit board that uses the MAX98304 filterless Class D amplifier to drive a speaker in portable audio applications. The EV kit comes with a MAX98304EWL+ in a 9-bump, 0.3mm pitch wafer-level package (WLP). Designed to operate from a 2.5V to 5.5V DC power supply, the EV kit is capable of delivering 3.2W into a 4Ω load. The EV kit accepts differential or single-ended input signals.

## Features

- ◆ Filterless Operation Passes Radiated Emissions with 60cm of Speaker Cable
- ◆ 2.5V to 5.5V Single-Supply Operation
- ◆ 3.2W Mono Class D Output
- ◆ Selectable Gain Control
- ◆ Differential or Single-Ended Input
- ◆ Low-Power Shutdown Input
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX98304EVKIT+	EV Kit

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

## Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	10μF ±20%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J106M
C2	1	0.1μF ±10%, 16V X7R ceramic capacitor (0402) Murata GRM155R71C104K
C3, C4	2	0.47μF ±10%, 10V X5R ceramic capacitors (0402) Murata GRM155R61A474K
C5, C6	0	Not installed, ceramic capacitors (0603)
C7-C11	0	Not installed, ceramic capacitors (0603); provided with the EV kit: 0.22μF ±10%, 25V X7R ceramic capacitors (0603) Murata GRM188R71E224K
FB1, FB2	2	0Ω ±5% resistors (0603)
INPUT	1	Black RCA jack
JU1	1	2-pin header
JU2	1	3-pin header

DESIGNATION	QTY	DESCRIPTION
JU3	1	5-pin, 4-way header
L1, L2	0	Not installed, inductors—shorted with PCB trace; provided with the EV kit: 22μH ±20%, 1A inductors TOKO A916CY-220M
FOUT+, FOUT-, PVDD, PGND	4	Binding posts
OUT+, OUT-	2	1-pin headers
R1, R2	2	100kΩ ±5% resistors (0402)
R3, R4	0	Not installed, resistors (0603); provided with the EV kit: 22Ω ±5% resistors (0603)
U1	1	Mono Class D amplifier (9 WLP) Maxim MAX98304EWL+ (Top Mark: AIR)
—	3	Shunts
—	1	PCB: MAX98304 EVALUATION KIT+

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## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
TOKO America, Inc.	847-297-0070	www.tokoam.com

**Note:** Indicate that you are using the MAX98304EWL+ when contacting these component suppliers.

## Quick Start

### Recommended Equipment

- MAX98304 EV kit
- 5V, 2A DC supply
- 4Ω speaker
- Mono audio signal source

### Procedure

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

- 1) Verify that shunts are installed as follows:
  - JU1: Installed (single-ended input)
  - JU2: Pins 1-2 (device enabled)
  - JU3: Pins 1-5 (12dB gain)
- 2) Connect the power-supply positive and negative outputs to the PVDD and PGND pads or binding posts on the EV kit, respectively.
- 3) Verify that the audio source output is disabled.
- 4) Connect the mono audio source to the INPUT RCA jack or between the IN+ and IN- pads on the EV kit.
- 5) Connect the speaker across the FOUT+ and FOUT- test points.
- 6) Set the power-supply output to 5V.
- 7) Enable the power-supply output.
- 8) Enable the audio source.
- 9) Verify that the speaker is playing the audio source signal.

## Detailed Description of Hardware

The MAX98304 EV kit features the MAX98304 filterless Class D amplifier, designed to drive a mono speaker in portable audio applications. The EV kit comes with a MAX98304EWL+ in a 9-bump, 0.3mm pitch WLP. The EV kit operates from a DC power supply that provides 2.5V to 5.5V and 2A of current. The EV kit accepts a differential or single-ended audio input. The audio input source is amplified to drive 3.2W into a 4Ω speaker.

JU1 configures the EV kit inputs for single-ended or differential operation. JU2 enables or disables the speaker amplifier. The amplifier overall gain can be set between 0dB and +12dB using JU3. The EV kit provides a set of differential outputs. The device outputs (FOUT+, FOUT-) can be connected directly to a speaker load without any filtering with 60cm of cable. However, filter components can be added to ease evaluation. See the *Filtered Output* section for additional information.

### Input Mode

JU1 provides the option to select between a differential or single-ended input mode for the EV kit. See Table 1 for JU1 configuration.

**Table 1. Input Mode (JU1)**

SHUNT POSITION	IN- PCB PAD	INPUT MODE
Installed*	Connected to PGND	Single-ended input
Not installed	Connected to a user-supplied negative differential input	Differential input

\*Default position.

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## Shutdown

JU2 enables or disables the audio speaker amplifier. See Table 2 for JU2 configuration.

## Gain Setting

The EV kit maximum signal gain can be configured to five different settings. JU3 selects the overall gain for the EV kit. See Table 3 for JU3 configuration.

## Filtered Output

Audio analyzers typically cannot accept pulse-width-modulated (PWM) signals at their inputs. Therefore, the EV kit features the option to install a lowpass filter at its outputs to ease evaluation. OUT+ and OUT- are shorted to FOUT+ and FOUT-. The trace must be broken at L1 and L2 before installing inductors L1 and L2 (provided with the EV kit). The filter components (C7–C11, R3, and R4) are provided with the EV kit and must be installed prior to operation. Use FOUT+ and FOUT- to connect the filtered PWM outputs to an audio analyzer. The default lowpass filter at the EV kit outputs is optimized for an 8Ω speaker. Contact the factory for the 4Ω speaker filter.

**Table 2. Shutdown (JU2)**

SHUNT POSITION	SHDN PIN	AMPLIFIER
1-2*	Connected to PVDD	Enabled
2-3	Connected to PGND	Disabled

\*Default position.

The IC can pass CE EN55022B regulations with 60cm of speaker cable and no filtering. However, ferrite-bead filters can be used to achieve further attenuation of radiated emissions. To install the ferrite-bead filters, replace shorting resistors FB1 and FB2 with 0603 or smaller ferrite beads and install filter capacitors on the C5 and C6 pads. The speaker wire should be connected to the FOUT+ and FOUT- pads.

## Filterless Output

The EV kit's filterless outputs (OUT+ and OUT-) can be connected directly to a speaker load without any filtering. Use the OUT+ and OUT- test points or the FOUT+ and FOUT- pads to connect a speaker directly to the IC outputs. Inductors L1 and L2 are not installed for maximum efficiency.

**Table 3. Gain Setting (JU3)**

SHUNT POSITION	GAIN PIN	MAXIMUM GAIN (dB)
Open	Not connected	0
1-2	Connected to PVDD through R1	+3
1-3	Connected to PVDD	+6
1-4	Connected to PGND through R2	+9
1-5*	Connected to PGND	+12

\*Default position.

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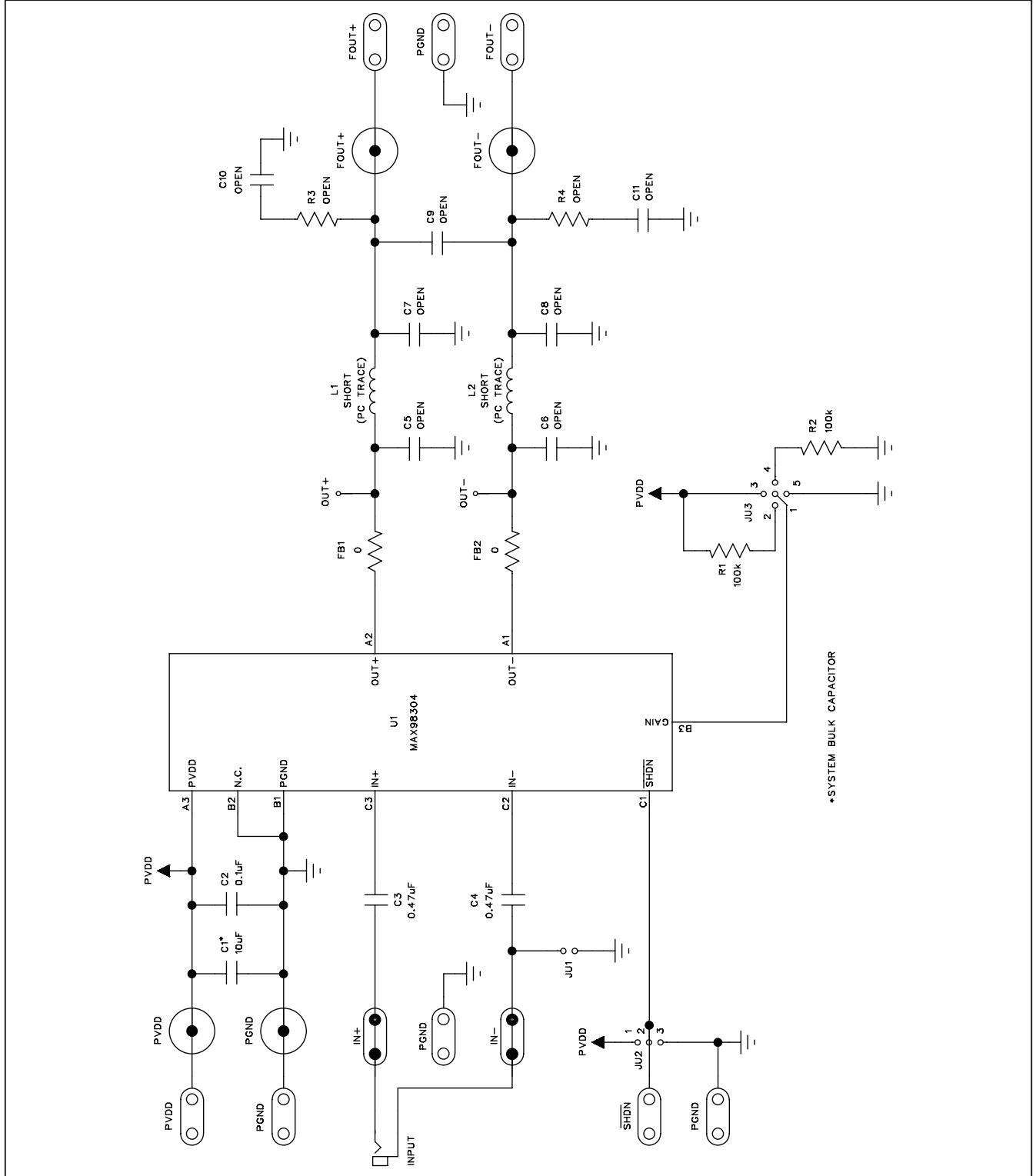


Figure 1. MAX98304 EV Kit Schematic

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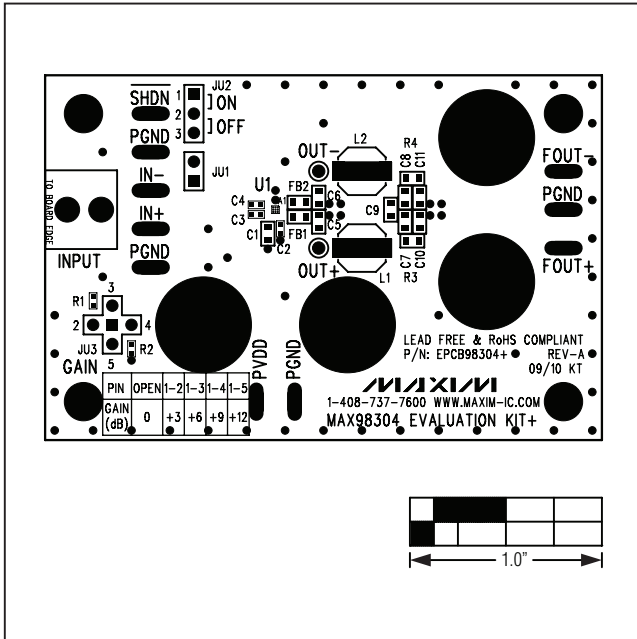


Figure 2. MAX98304 EV Kit Component Placement Guide—Component Side

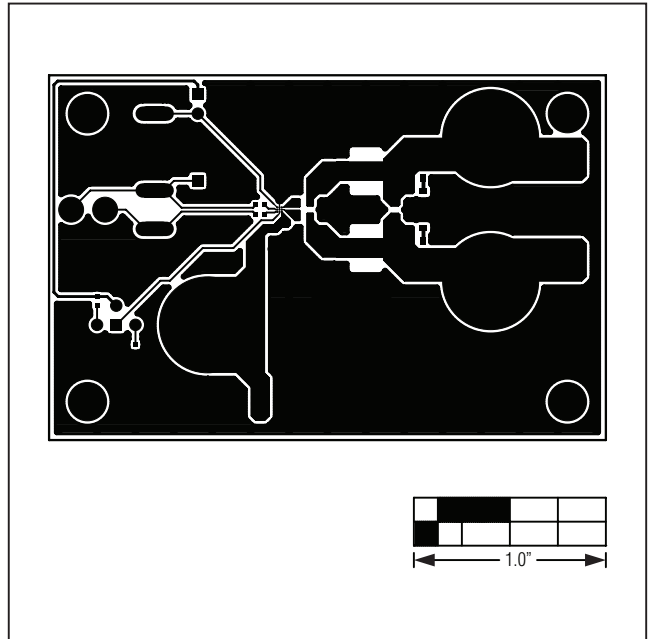


Figure 3. MAX98304 EV Kit PCB Layout—Component Side

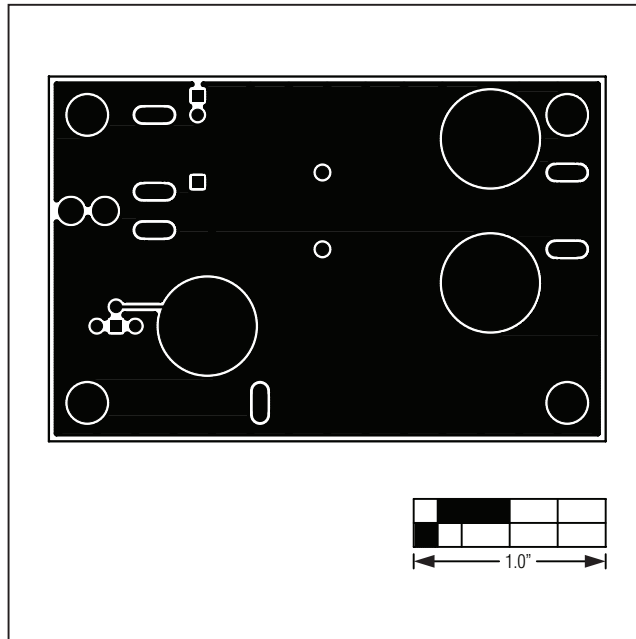


Figure 4. MAX98304 EV Kit PCB Layout—Solder Side

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## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/10	Initial release	—

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