

TPA0202

Audio Power Amplifier

Evaluation Module

User's Guide

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Preface

Related Documentation From Texas Instruments

- ***TI Plug-N-Play Audio Amplifier Evaluation Platform*** (literature number SLOU011) provides detailed information on the evaluation platform and its use with TI audio evaluation modules.
- ***TPA0202 STEREO 2-W AUDIO POWER AMPLIFIER*** (literature number SLOS205) This is the data sheet for the TPA0202 audio amplifier integrated circuit.

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Introduction

This chapter provides an overview of the Texas Instruments (TI™) TPA0202 Audio Amplifier Evaluation Module (SLOP202). It includes a list of EVM features, a brief description of the module illustrated with a pictorial diagram, and a list of EVM specifications.

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1.1 Feature Highlights

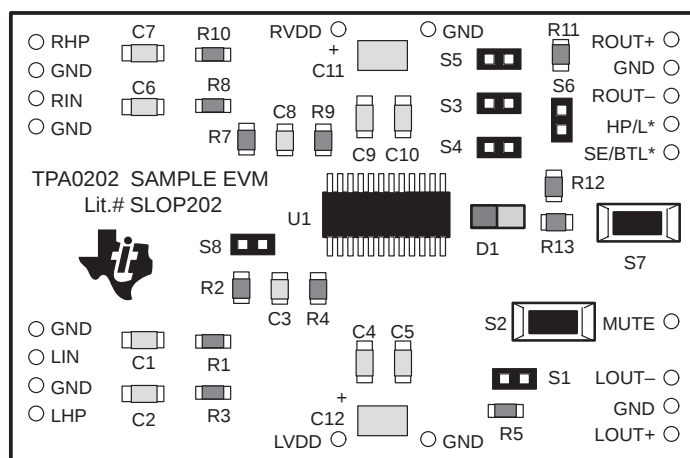
The TI TPA0202 Audio Amplifier Evaluation Module and the TI Plug-N-Play Audio Amplifier Evaluation Platform include the following features:

- ❑ TPA0202 Stereo 2-W Audio Power Amplifier Evaluation Module
 - Internal depop circuitry to eliminate turn-on transients in outputs
 - Dual channel, bridge-tied load (BTL) or single-ended operation
 - 3.3-V and 5-V operation
 - 2 W per channel output power into 3 Ω at 5 V, BTL
 - 850 mW per channel output power into 3 Ω at 3.3 V, BTL
 - Ultra-low current consumption in shutdown/mute mode (5 μ A)
 - Internal input MUX selects among two sets of stereo inputs
 - Module gain adjustable between approximately 2 and 22
- ❑ Quick and Easy Configuration with The TI Plug-N-Play Audio Amplifier Evaluation Platform
 - Evaluation module is designed to simply plug into the platform, automatically making all signal, control, and power connections
 - Platform provides flexible power options
 - Jumpers on the platform select power and module control options
 - Switches on the platform route signals
 - Platform provides quick and easy audio input and output connections
- ❑ Platform Power Options
 - External 5-V – 15-V DC V_{CC} supply inputs
 - External regulated V_{DD} supply input
 - Socket for on-board 5 V/3.3 V V_{DD} voltage regulator EVM
 - On-board overvoltage and reverse polarity power protection
- ❑ Platform Audio Input and Output Connections
 - Left and right RCA phono jack inputs
 - Miniature stereo phone jack input
 - Left and right RCA phono jack outputs
 - Left and right compression speaker terminal outputs
 - Miniature stereo headphone jack output

1.2 Description

The TPA0202 Stereo 2-W Audio Power Amplifier Evaluation Module is a complete, 2-Watt per channel stereo audio power amplifier. It consists of the TI TPA0202 Stereo 2-W Audio Power Amplifier IC along with a small number of other parts mounted on a circuit board that measures approximately 2¼ inches by 1½ inches (Figure 1–1).

Figure 1–1. The TI TPA0202 Audio Amplifier Evaluation Module



Single in-line header pins extend from the underside of the module circuit board to allow the EVM to be plugged into the TI Plug-N-Play Audio Amplifier Evaluation Platform, or to be wired directly into existing circuits and equipment when used stand-alone.

The platform has room for a single TPA0202 evaluation module and is a convenient vehicle for demonstrating TI's audio power amplifier and related evaluation modules. The EVMs simply plug into the platform, which automatically provides power to the modules, interconnects them correctly, and connects them to a versatile array of standard audio input and output jacks and connectors. Easy-to-use configuration controls allow the platform and EVMs to quickly model many possible end-equipment configurations.

There is nothing to build, nothing to solder, and nothing but the speakers included with the platform to "hook up."

1.3 TPA0202 EVM Specifications

Supply voltage range, V_{DD}	3 V to 5.5 V
Supply current, I_{DD}	2 A max
Continuous output power per channel, P_O :	
4- Ω BTL, $V_{DD}=5$ V	2 W
4- Ω BTL, $V_{DD}=3.3$ V	800 mW
Audio input voltage, V_I :	
SE	4 Vpp max
BTL	0.75 Vpp max
Minimum load impedance, R_L	3 Ω

Quick Start

The steps in this chapter can be followed to quickly prepare the TPA0202 audio amplifier EVM for use. Using the TPA0202 with the TI Plug-N-Play Audio Amplifier Evaluation Platform is a quick and easy way to connect power, signal and control inputs, and signal outputs to the EVM using standard connectors. However, the audio amplifier evaluation module can be used stand-alone by making connections directly to the module pins, and can be wired directly into existing circuits or equipment.

The platform switch and jumper settings shown in Table 2–1 are typical for the TPA0202 EVM and will cause the TPA0202 to switch to single-ended output mode when a plug is inserted into platform headphone jack J10.

Table 2–1. Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA0202

EVM	JP6	JP7	JP8	S2	S3
P-N-P Platform	Mode	X	Hi	Note 2	X

Notes: 1) X = Don't care
 2) Set S2 to ON when signal conditioning board is installed in U1; set S2 to OFF when no signal conditioning board is installed.

Table 2–2. Typical TPA0202 EVM Jumper Settings

EVM	S1	S3	S4	S5	S6	S8
TPA0202	ON	OFF	OFF	ON	ON	OFF

Note: S8 should remain OFF at all times.
 ON = shunt installed
 OFF = open

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2.1 Precautions

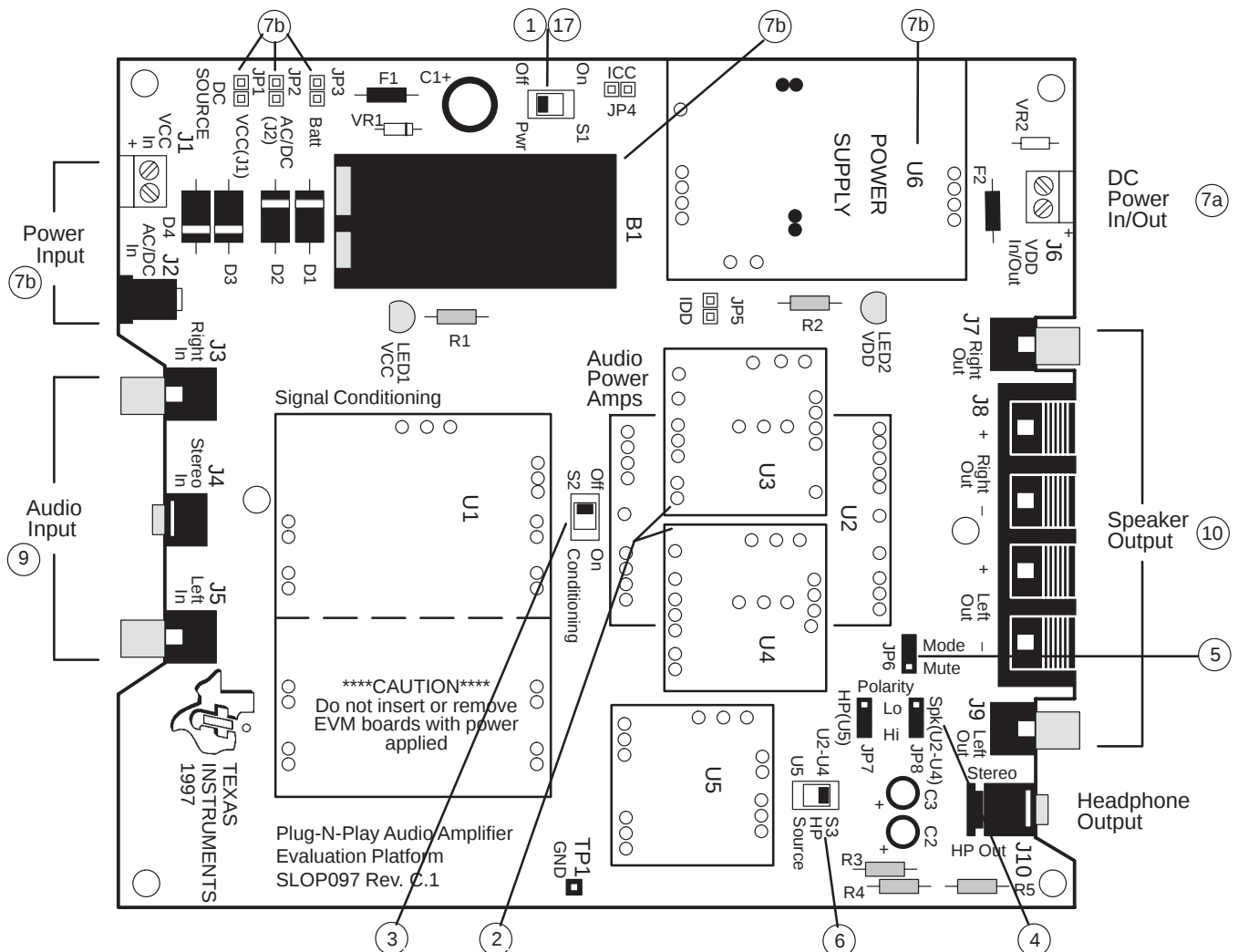
Power Supply Input Polarity and Maximum Voltage

Always ensure that the polarity and voltage of the external power connected to V_{CC} power input connector J1, J2, and/or V_{DD} power input connector J6 are correct. Overvoltage or reverse-polarity power applied to these terminals can open on-board soldered-in fuses and cause other damage to the platform, installed evaluation modules, and/or the power source.

Inserting or Removing EVM Boards

Do not insert or remove EVM boards with power applied — damage to the EVM board, the platform, or both may result.

Figure 2–1. Quick Start Platform Map



2.2 Quick Start List for Platform

Follow these steps when using the TPA0202 EVM with the TI Plug-N-Play Audio Amplifier Evaluation Platform (see the platform user's guide, SLOU011, for additional details). Numbered callouts for selected steps are shown in Figure 2–1 and Figure 2–2, and details appear in Chapter 3.

☐ Platform preparations

- 1) Ensure that all external power sources are set to **OFF** and that the platform power switch **S1** is set to **OFF**.
- 2) Install a TPA0202 module in platform socket **U2**, taking care to align the module pins correctly.
- 3) Use switch **S2** to select or bypass the signal conditioning EVM (**U1**).
- 4) Set control signal **Polarity** jumper **JP8** to **Hi**.
- 5) Set jumper **JP6** to select the **Mode** control input (causes the TPA0202 to switch to the single-ended output mode if a plug is inserted into platform headphone jack **J10**).
- 6) If the headphone Jack (**J10**) output will be used, set Hp source switch **S3** to **U2–U4**.

Table 2–3. Platform Jumper and Switch Settings for the TPA0202

EVM	JP6	JP7	JP8	S2	S3
P-N-P Platform	Mode	X	Hi	Note 2	X

Notes:

- 1) X = Don't care
- 2) Set **S2** to **ON** when signal conditioning board is installed in **U1**; set **S2** to **OFF** when no signal conditioning board is installed.

☐ Power supply

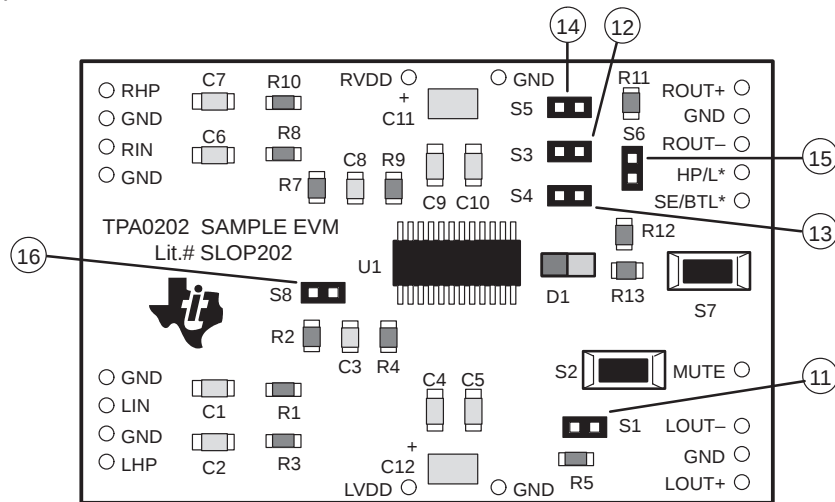
- 7) Select and connect the power supply (ensure power supply is set to **OFF**):
 - a) Connect an external regulated power supply set to 5 V to platform V_{DD} power input connector **J6** taking care to observe marked polarity, or
 - b) Install a voltage regulator EVM (SLVP097 or equiv.) in platform socket **U6**. Connect a 7 V – 12 V power source to a platform V_{CC} power input **J1** or **J2** and jumper the appropriate power input (see platform user's guide).

☐ Inputs and outputs

- 8) Ensure that the audio signal source level is set to minimum.
- 9) Connect the audio source to left and right RCA phono jacks **J3** and **J5** or stereo miniature phone jack **J4**.
- 10) Connect 3- Ω – 8- Ω speakers to left and right RCA jacks **J7** and **J9** or to stripped wire speaker connectors **J8**.

□ Evaluation Module Preparations

Figure 2–2. Module Preparation



- 11) To have the module amplifier IC enter the shutdown mode when the module mute control input is activated, set shutdown jumper **S1** to **ON**. To have the amplifier IC only mute when the module mute control input is activated, set shutdown jumper **S1** to **OFF**.
- 12) To select the line inputs, set input select jumper **S3** to **OFF**. To select the headphone inputs, set input select jumper **S3** to **ON**.
- 13) To allow the module $\overline{\text{SE/BTL}}$ control input to switch the amplifier IC between single ended (SE) and bridge-tied load (BTL) output modes, set output mode jumper **S4** to **OFF**. To keep the module amplifier IC in the single-ended output mode regardless of the control input state, set jumper **S4** to **ON**.
- 14) Set V_{DD} bridge jumper **S5** to either **ON** or **OFF** for normal operation.
- 15) To automatically select the headphone inputs when the single-ended output mode is selected by the module $\overline{\text{SE/BTL}}$ control input, set autosense control jumper **S6** to **ON**. To isolate the amplifier IC input select pin from the module output mode select control input, set autosense control jumper **S6** to **OFF**.
- 16) Set junction temperature measurement jumper **S8** to **OFF** for normal operation.

Table 2–4. Typical TPA0202 EVM Jumper Settings

EVM	S1	S3	S4	S5	S6	S8
TPA0202	ON	OFF	OFF	ON	ON	OFF

Note: S8 should remain open at all times, ON = shunt installed, OFF = open

□ Power Up

- 17) Verify correct voltage and input polarity and set the external power supply to **ON**. If V_{CC} and an on-board regulator EVM are used to provide V_{DD} , set platform power switch **S1** to **ON**.

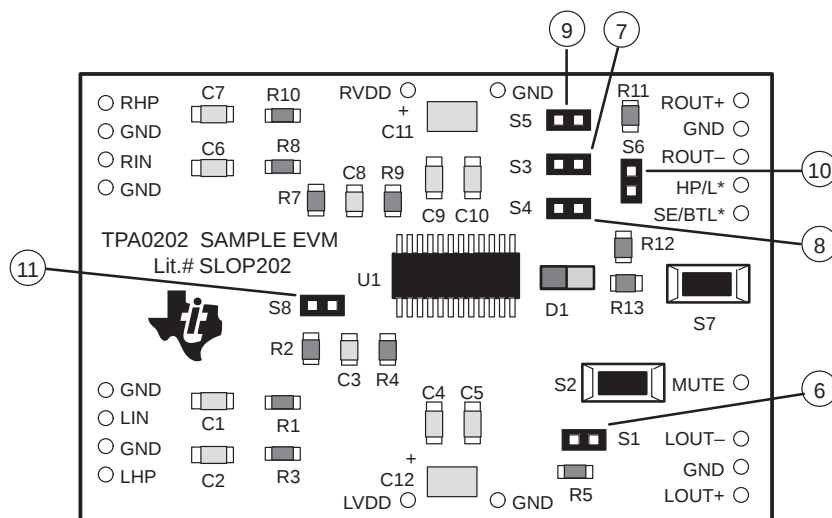
Platform LED2 should light indicating the presence of V_{DD} , and the evaluation modules installed on the platform should begin operation.

- 18) Adjust the signal source level as needed.

2.3 Quick Start List for Stand-Alone

Follow these steps to use the TPA0202 EVM stand-alone or when connecting it into existing circuits or equipment. Connections to the TPA0202 module header pins can be made via individual sockets, wire-wrapping, or soldering to the pins, either on the top or the bottom of the module circuit board. Numbered callouts for selected steps are shown in Figure 2–3 and details appear in Chapter 3.

Figure 2–3. Quick Start Module Map



□ Power supply

- 1) Ensure that all external power sources are set to **OFF**.
- 2) Connect an external regulated power supply set to 5 V to the module **VDD** and **GND** pins taking care to observe marked polarity. Separate right channel and left channel VDD supplies can be connected, or a single supply can be used for both.

□ Inputs and outputs

- 3) Ensure that audio signal source level adjustments are set to minimum.
- 4) Connect the audio source to the module **RIN/LIN** and **GND** or **RHP/LHP** and **GND** pins of each channel taking care to observe marked polarity.
- 5) Select output mode:
 - a) For BTL output, connect an 3-Ω – 8-Ω speaker to the module **OUT+** **OUT-** pins of each channel,
or
 - b) For single-ended output, connect a headphone or an 3-Ω – 8-Ω speaker to the module **OUT+** and **GND** pins of each channel through a 33 μF to 1000 μF output-coupling capacitor (Figure 3–10).

☐ Evaluation Module Preparations

- 6) To have the module amplifier IC enter the shutdown mode when the module mute control input is activated, set shutdown jumper **S1** to **ON**. To have the amplifier IC only mute when the module mute control input is activated, set shutdown jumper **S1** to **OFF**.
- 7) To select the line inputs, set input select jumper **S3** to **OFF**. To select the headphone inputs, set input select jumper **S3** to **ON**.
- 8) To allow the module $\overline{\text{SE/BTL}}$ control input to switch the amplifier IC between single ended (SE) and bridge-tied load (BTL) output modes, set output mode jumper **S4** to **OFF**. To keep the module amplifier IC in the single-ended output mode regardless of the control input state, set jumper **S4** to **ON**.
- 9) Set V_{DD} bridge jumper **S5** to **ON** to connect the **RVDD** and **LVDD** module power input pins together, or to **OFF** to keep the two power inputs isolated on board
- 10) To automatically select the headphone inputs when the single-ended output mode is selected by the module $\overline{\text{SE/BTL}}$ control input, set autosense control jumper **S6** to **ON**. To isolate the amplifier IC input select pin from the module output mode select control input, set autosense control jumper **S6** to **OFF**.
- 11) Set junction temperature measurement jumper **S8** to **OFF** for normal operation

☐ Control Inputs

- 12) Connect control lines to the various module control input pins as needed:
 - a) **HP/L***: A high selects the headphone input pins; a low or float selects the line input pins.
 - b) **SE/BTL***: A high selects the single-ended output mode; a low or float selects the bridge-tied load output mode.
 - c) **MUTE**: A high mutes the amplifier IC on the module; a low or float allows normal operation.

☐ Power-up

- 13) Verify correct voltage and input polarity and set the external power supply to **ON**.

The EVM should begin operation.

- 14) Adjust the signal source level as needed.

Details

This chapter provides details on the TPA0202 IC, the evaluation module, and the steps in the Quick-Start List, additional application information, and a parts list for the TPA0202 evaluation module.

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3.1 Precautions

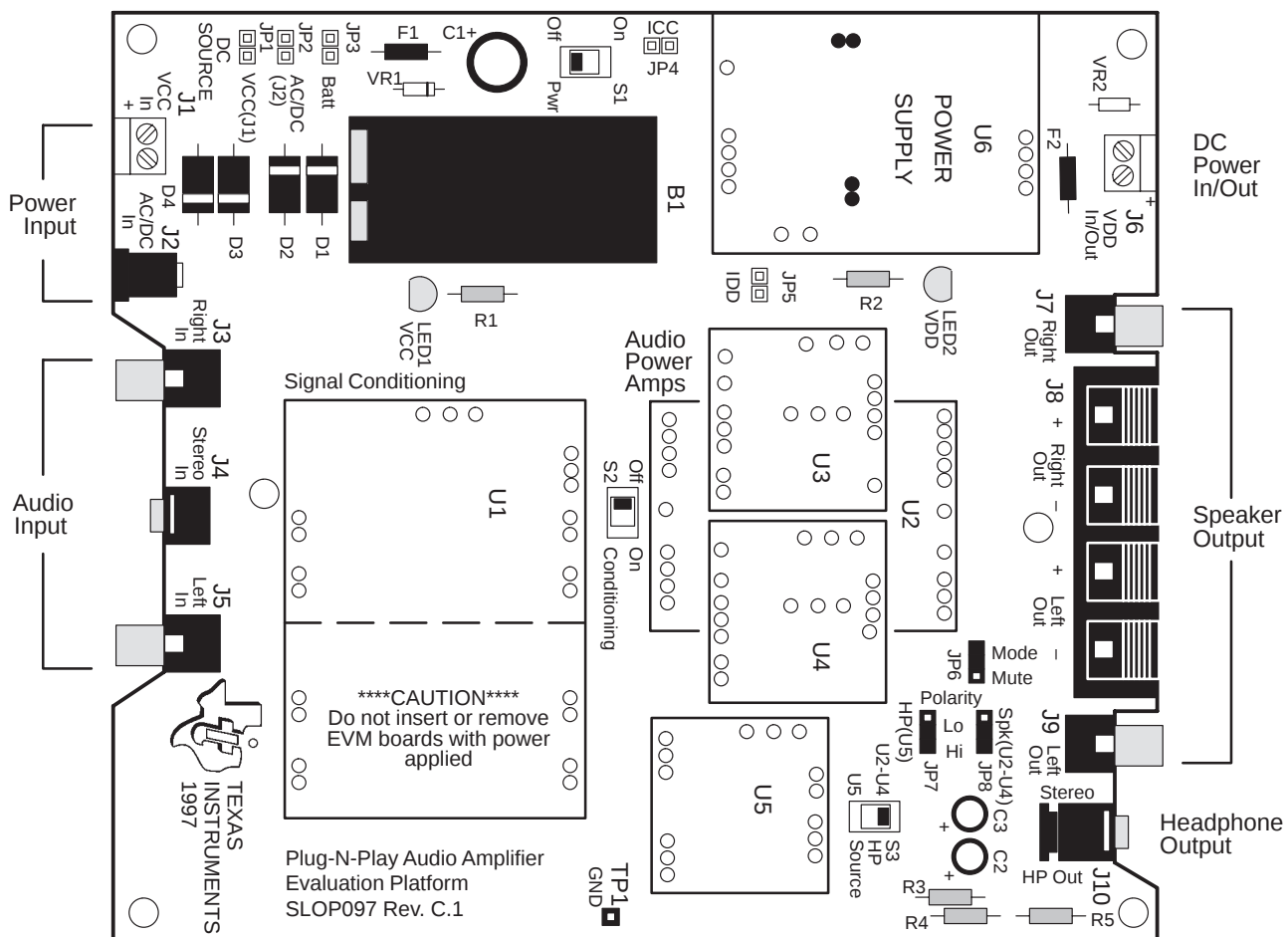
Power Supply Input Polarity and Maximum Voltage

Always ensure that the polarity and voltage of the external power connected to V_{CC} power input connector J1, J2, and/or V_{DD} power input connector J6 are correct. Overvoltage or reverse-polarity power applied to these terminals can open on-board soldered-in fuses and cause other damage to the platform, installed evaluation modules, and/or the power source.

Inserting or Removing EVM Boards

Do not insert or remove EVM boards with power applied — damage to the EVM board, the platform, or both may result.

Figure 3–1. The TI Plug-N-Play Audio Amplifier Evaluation Platform



3.2 The TPA0202 Audio Power Amplifier Evaluation Module

The TPA0202 Audio Power Amplifier Evaluation Module is powered by a TPA0202 stereo power amplifier capable of delivering greater than 2 W of continuous power per channel into 3- Ω loads. The amplifier IC can be operated in either the BTL or single-ended output mode. The evaluation module includes control inputs for muting and shutdown, selection between two sets of stereo inputs, and switching between single ended and bridge-tied load output modes.

The module can be used with the TI Plug-N-Play Audio Amplifier Evaluation Platform (Figure 3–1) or wired directly into circuits or equipment. The module has single in-line header connector pins mounted to the under side of the board. These pins allow the module to be plugged into the TI platform, which automatically makes all the signal input and output, power, and control connections to the module.

The module connection pins are on 0.1-inch centers to allow easy use with standard perf board and plug board-based prototyping systems. Or, the EVM can be wired directly into existing circuits and equipment when used stand-alone.

The module appears in Figure 3–2 and its schematic is shown in Figure 3–3.

Figure 3–2. TPA0202 EVM

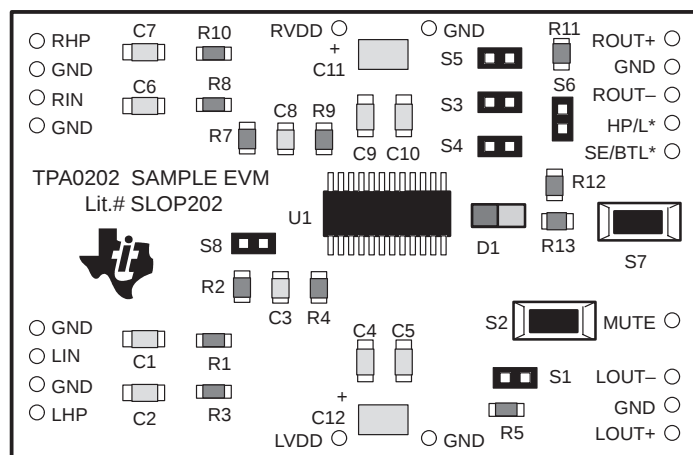
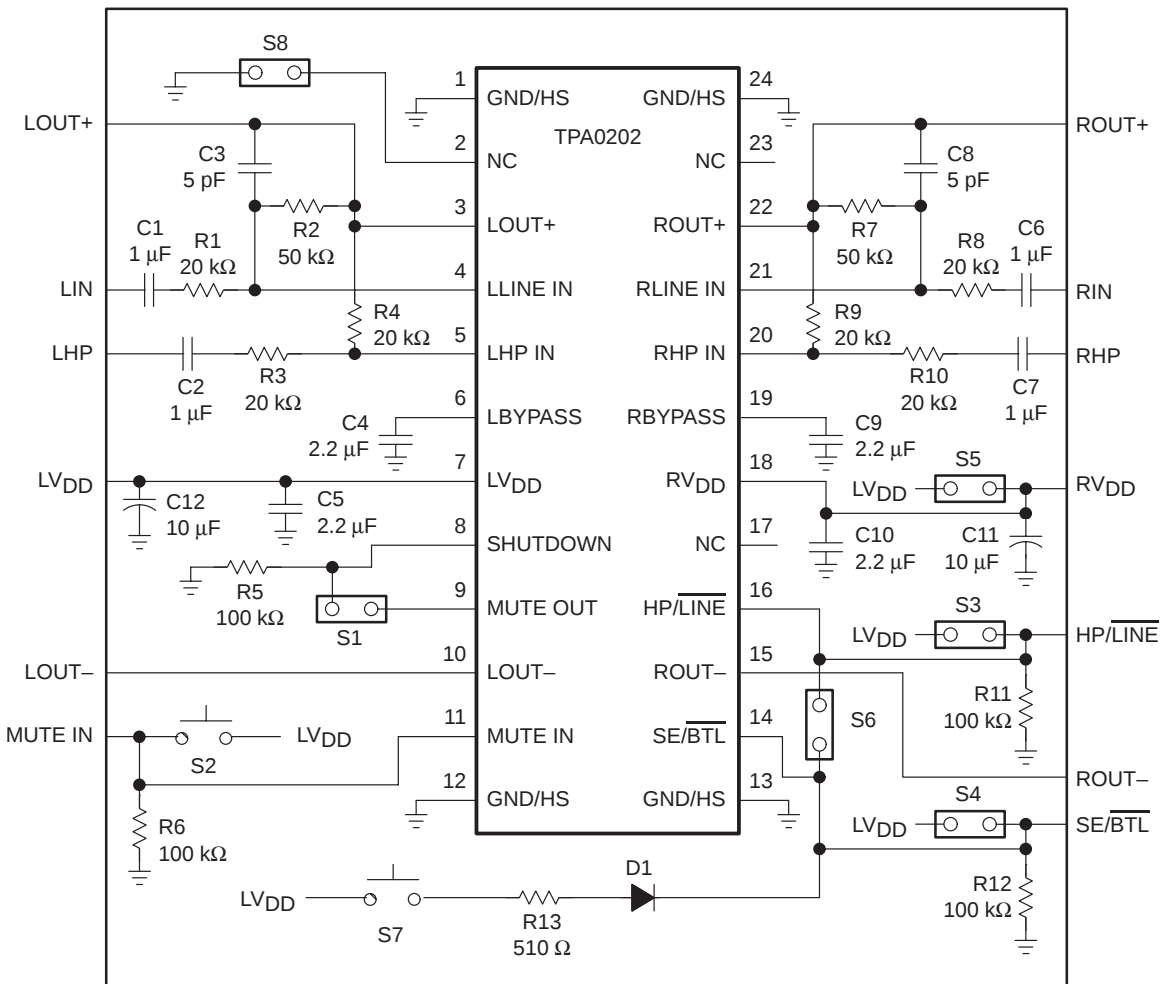


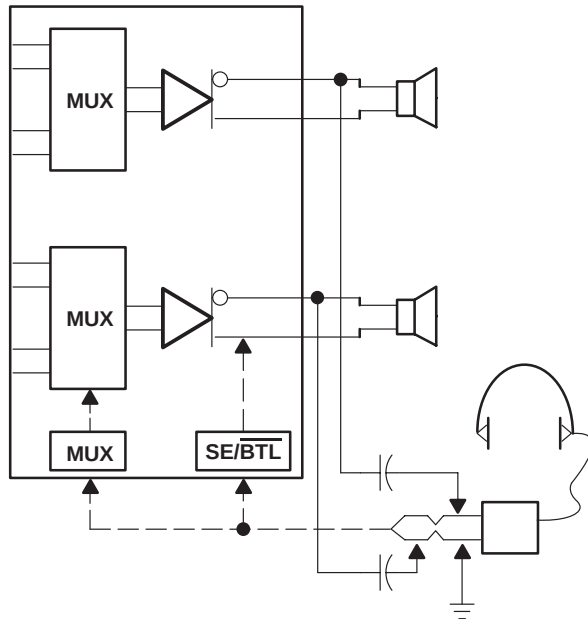
Figure 3–3. TPA0202 EVM Schematic Diagram



3.2.1 TPA0202 Audio Amplifier IC

The TPA0202 audio amplifier IC is a CMOS device intended primarily for bridge-tied load (BTL) operation in battery-powered applications. It is supplied in a very small 24-pin TSSOP thermal surface-mount package and has been designed to operate from low supply voltages (between approximately 3 V and 5.5 V) and deliver full power at distortion levels of less than 0.1% THD+N from a 5-V supply (Figure 3–4). Typical applications include portable computers and multimedia systems.

Figure 3–4. TPA0202 Amplifier IC



The IC includes two separate amplifier channels, each of which can operate in either the bridged-tied load (BTL) mode or the single-ended mode as selected by the $\overline{\text{SE/BTL}}$ pin. In the BTL mode, the two output lines of each channel operate 180° out-of-phase with each other for increased power. The speaker load is connected directly across OUT+ and OUT- , and neither line is connected to ground. BTL operation provides many benefits, including quadruple the output power of single-ended operation and no need for bulky output coupling capacitors. In the single-ended mode, the speaker load is connected between the OUT+ terminal, through an output coupling capacitor, to system ground. For more information, see the TPA0202 amplifier IC data sheet, TI Literature Number SLOS205.

3.2.2 Depop Circuitry

The TPA0202 amplifier IC contains internal circuitry to minimize the various turn-on transients that might appear at the output during the transition from power off, shutdown, or mute to normal operation. Output turn-on transients can be virtually eliminated by sequencing the control inputs to the IC such that the TPA0202 amplifier is held in the single-ended output mode for a short time after the mute control pin is released (see paragraph 3.3.2.7).

3.2.3 BTL Operation

To operate in the bridge-tied load output mode, the module $\overline{\text{SE/BTL}}$ control input terminal must be held low. The module output signal from OUT+ must go through the speaker load and be returned directly to OUT- , and **NOT** to system ground. This requires that the OUT- line be isolated not only from system ground, but also from the OUT- lines of any other amplifiers in the system. The platform provides such isolated output lines from the amplifier EVM sockets directly to separate left and right speaker connectors.

3.2.4 Single-Ended Operation

For single-ended operation, the module SE/BTL control input pin must be held high. The speaker (or headphone) load is connected to the module OUT+ output pin through a coupling capacitor, and to platform/system ground. A 470- μ F electrolytic coupling capacitor is provided on the platform in the signal path to the headphone output jack for this purpose, and a control signal from the platform headphone jack can be routed to the module control input pin to switch the TPA0202 IC to the single-ended mode.

In the single-ended mode, the amplifiers inside the TPA0202 IC that drive the OUT– lines do not operate and do not dissipate any power. The OUT– pins go into a high-impedance state and can be left connected or allowed to float.

3.2.5 Inputs and Gain

Each channel has two separate signal inputs that are pin-selectable. They are called *line* (L) and *headphone* (HP). The line inputs are fixed at a gain of 10 and the headphone inputs are fixed at a gain of –1. In the typical application in which the TPA0202 powers small speakers until headphones are plugged in, the difference in the gain selected for the two inputs provides approximately the same perceived listening level in the headphones as from the speakers. An input multiplexor in the amplifier IC selects between the two inputs according to the state of the HP/LINE IC pin.

Gain for each input is determined by the ratio of the input resistor to the feedback resistor on the module PCB. And, although the input gains are fixed at the factory, they can be adjusted by changing the resistor values on the module PCB. However, care must be taken because the surface-mount solder pads on the PCB are somewhat fragile and will not survive many soldering/desoldering operations. In addition, the values selected for the gain-setting resistors affect the performance of the internal depop circuitry (see the TPA0202 data sheet).

The TPA0202 amplifier IC, as most other amplifiers, exhibits its best distortion and noise performance at lower gain levels (see the TPA0202 data sheet). Even so, the TPA0202 at its highest gain setting has significantly less distortion than most low-cost speakers.

Gain versus total harmonic distortion (THD) should be considered in each application. Both the module input signal level and the TPA0202 module gain should be adjusted to obtain the lowest overall distortion level for a particular overall gain. A quick rule of thumb (everything else being equal): the module input signal level should be as high as possible without clipping or overloading the TPA0202 input, and the TPA0202 gain should be kept as low as possible.

3.3 Using The TPA0202 EVM With the Plug-N-Play Evaluation Platform

The TPA0202 Audio Amplifier Evaluation Module was designed to be used with the TI Plug-N-Play Audio Amplifier Evaluation Platform. It simply plugs into socket U2.

The following paragraphs provide additional details for using the TPA0202 EVM with the platform.

3.3.1 Installing and Removing EVM Boards

TI Plug-N-Play evaluation modules use single-in-line header pins installed on the underside of the module circuit board to plug into sockets on the platform. The EVM pins and the platform sockets are keyed such that only the correct type of EVM can be installed in a particular socket, and then only with the proper orientation.

Evaluation modules are easily removed from the platform by simply prying them up and lifting them out of their sockets. Care must be taken, however, to prevent bending the pins.

3.3.1.1 EVM Insertion

- 1) Remove all power from the evaluation platform.
- 2) Locate socket U2 on the platform.
- 3) Orient the module correctly.
- 4) Carefully align the pins of the module with the socket pin receptacles.
- 5) Gently press the module into place.
- 6) Check to be sure that all pins are seated properly and that none are bent over.

3.3.1.2 EVM Removal

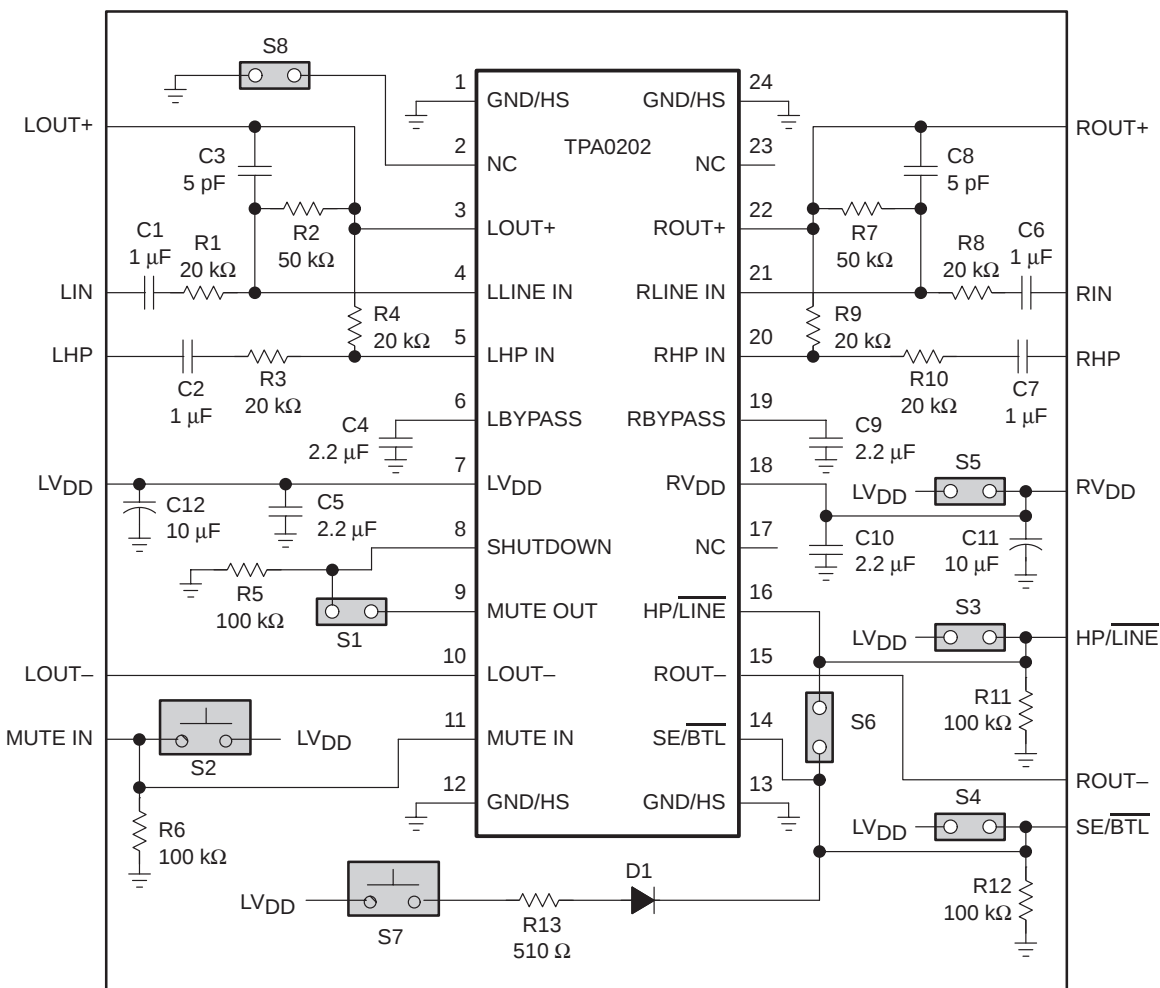
- 1) Remove all power from the evaluation platform.
- 2) Using an appropriate tool as a lever, gently pry up one side of the module a small amount.
- 3) Change to the opposite side of the module and use the tool to pry that side up a small amount.
- 4) Alternate between sides, prying the module up a little more each time to avoid bending the pins, until it comes loose from the socket.
- 5) Lift the EVM off of the platform.

3.3.2 TPA0202 Module Jumper Settings and Switches

The TPA0202 EVM is equipped with several pushbutton SPST switches and jumpers that act as SPST switches to allow module operation to be modified to suit various requirements. In the following discussion, setting a jumper to **ON** means that a shunt is installed across the two pins of the jumper. Setting a jumper to **OFF** means that no shunt is installed on the jumper. See Figure 3.5.

In typical applications, some or all of the jumper functions are controlled by the system microcontroller or external logic.

Figure 3–5. TPA0202 EVM Jumpers and Switches



3.3.2.1 S1 — Shutdown Jumper

To have the module amplifier IC enter the shutdown mode when the module mute control input is activated, set shutdown jumper S1 to ON.

The mute control output pin on the TPA0202 amplifier IC follows the mute control input pin and is buffered. Jumper S1 connects the mute output pin to the shutdown control input pin of the IC so that when S1 is ON, the IC is forced into shutdown mode instead of mute mode when the mute control input goes high. When S1 is OFF, a pulldown resistor on the module holds the IC shutdown control input pin low, keeping the IC out of the shutdown mode.

The shutdown mode reduces IC current consumption to approximately 5 μ A compared to approximately 1.5 mA in the mute mode. It takes longer, however, to resume normal operation from the shutdown mode (approx. 1 s to 2 s) than it takes to resume normal operation from the mute mode (approx. 100 ms to 500 ms).

3.3.2.2 S2 — Mute Switch

Pushbutton switch S2 on the TPA0202 EVM allows manual muting of the amplifier IC.

3.3.2.3 S3 — Input Select Jumper

To select the line inputs, set input select jumper S3 to OFF. To select the headphone inputs, set input select jumper S3 to ON.

The TPA0202 amplifier IC has two separate inputs for each channel. An internal multiplexor selects which input will be connected to the amplifier based on the state of the HP/ $\overline{\text{LINE}}$ pin on the IC. However, the EVM HP/L* control input pin is not directly controlled by anything on the platform — the platform socket for that module pin is N/C. The amplifier IC HP/ $\overline{\text{LINE}}$ control pin can be tied high manually via jumper S3 or connected to the amplifier IC SE/ $\overline{\text{BTL}}$ control pin via jumper S6 so that it follows that control signal.

For manual control, jumper S3 connects the HP/L* module control input pin to V_{DD} , so that when S3 is ON, the headphone inputs are selected. When S3 is OFF, a pulldown resistor on the module holds the IC shutdown control input pin low, selecting the line inputs.

3.3.2.4 S4 — Output Mode Jumper

To keep the module amplifier IC in the single-ended output mode regardless of the module control input state, set jumper S4 to ON.

Jumper S4 connects the SE/ $\overline{\text{BTL}}$ output mode control input pin on the amplifier IC directly to V_{DD} , so that when S4 is ON, the IC is held in the single-ended output mode regardless of the state of the SE/BTL* module control input. When S4 is OFF, a pulldown resistor on the module holds the IC output mode control input pin low, keeping the IC in the BTL output mode.

3.3.2.5 S5 — VDD Bridge Jumper

Jumper S5 connects the module LV_{DD} power supply line to the RV_{DD} power supply line. When the TPA0202 EVM is plugged into the platform, both VDD supplies are sourced from the same platform power bus, so the state of jumper S5 is irrelevant.

If the EVM is used stand-alone, jumper S5 can be set to ON to simplify connection of the module to external power, or set to OFF to allow each amplifier channel to be powered from a separate supply.

3.3.2.6 S6 — Autosense Jumper

To automatically select the headphone inputs when the single-ended output mode is selected by the module SE/BTL* control input, set autosense control jumper S6 to ON.

Jumper S6 connects the SE/ $\overline{\text{BTL}}$ output mode select pin of the amplifier IC to the HP/ $\overline{\text{LINE}}$ input select pin of the amplifier IC so that the HP input is selected automatically when the single-ended output mode is selected by the mode signal applied to the module SE/BTL* control input pin.

Note that when autosense jumper S6 is set to ON, the headphone input **and** the single-ended output mode are selected, and the SE/BTL* control signal will have no effect, if **either** jumper S3 or jumper S4 are set to ON.

3.3.2.7 S7 — SE Output Mode Switch

Pushbutton switch S7 on the TPA0202 EVM allows the manual selection of the single-ended output mode.

When used in conjunction with mute switch S2, output thumps and pops that might occur when returning to normal operation from the mute mode can be eliminated by releasing mute switch S2 half a second before releasing the SE output mode switch S7 (see the TPA0202 data sheet for more information).

In a typical application, this sequencing can be controlled by the system micro-controller or external logic.

3.3.2.8 S8 — Junction Temperature Measurement Jumper

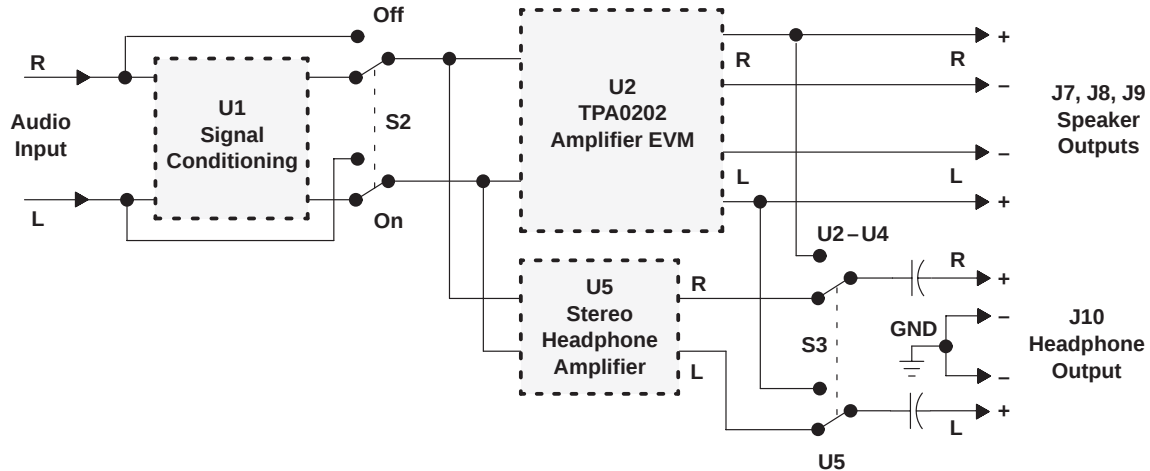
Set junction temperature measurement jumper S8 to OFF for normal operation.

The TPA0202 amplifier IC sources a current proportional to the device junction temperature that can be measured at the terminals of jumper S8 with an ammeter. This is not intended as a real-time measurement, but as an aid to the design and characterization of the PCB on which the IC is mounted. See the TPA0202 IC data sheet for additional information.

3.3.3 Signal Routing

Signal flow on the platform is controlled by two signal routing switches, as shown in Figure 3–5.

Figure 3–6. Platform Signal Routing and Outputs



3.3.3.1 Signal Conditioning

The audio signal from the input jacks can be applied to the signal conditioning socket (U1) if an EVM is installed there, or socket U1 can be bypassed and the audio input signal applied directly to the inputs of the TPA0202.

- ❑ Switch **S2** selects signal conditioning or bypasses it

3.3.3.2 Headphone Output Jack

Switch S3 is the source select for the stereo headphone output jack, J10. The headphone jack is capacitively coupled (via 470 μ F electrolytics) and can output either the signal from the headphone amplifier in socket U5, or the signal from the TPA0202 power amplifier installed in socket U2, as determined by the setting of headphone source select switch S3.

When S3 is set to the power amplifier position (U2 – U4), the headphone jack is connected to the TPA0202 power amplifier OUT+ output lines. When a plug is inserted into the jack, signals output through J10 are returned to platform ground, requiring single-ended power amplifier operation. A switch inside the headphone jack produces a control signal that can be routed to the power amplifier socket to shut down the TPA0202 EVM or switch it to single-ended output mode when a plug is inserted.

Source select switch S3 connects the headphone jack to the output lines of either the headphone amplifier socket U5, or the power amplifier sockets (U2 – U4).

- To keep the TPA0202 amplifier outputs separated, set switch **S3** to the headphone amplifier position (**U5**) and use the speaker outputs (**J7**, **J8**, and **J9**)
- To route the TPA0202 amplifier outputs to the headphone output jack (**J10**), set switch **S3** to the power amplifier position (**U2 – U4**) — use this setting *only* if the TPA0202 EVM is to drive single-ended loads connected to **J10**

3.3.4 Mute/Mode

The TPA0202 EVM is equipped with a mute control input pin. When this input is tied to V_{DD} , the TPA0202 amplifier IC on the module enters the mute mode and dissipates very little power. When the EVM control input is tied to GND or allowed to float, amplifier operation resumes.

In typical applications, as often found in notebook computers, portable audio products, and such, the internal speakers mute when headphones are plugged into the headphone jack, or internal speakers mute when external speakers are connected. In applications using separate speaker and headphone amplifiers, the one not being used can be shut down (muted) to conserve power.

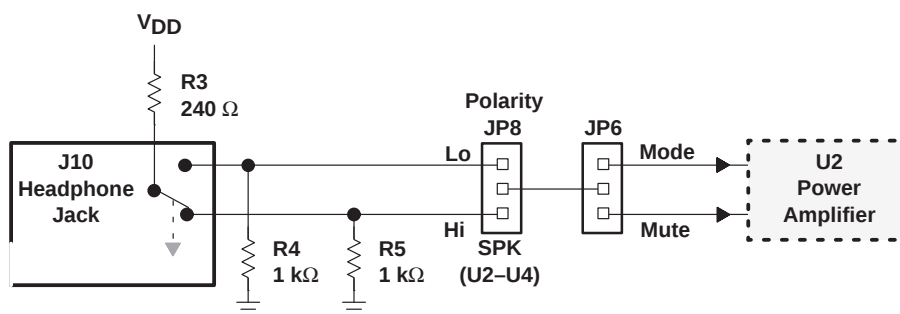
A mode control input pin on the EVM switches the TPA0202 amplifier IC between the bridge-tied load (BTL) output mode and the single-ended (SE) output mode. When the mode control input is tied to GND, the module operates in the BTL output mode. When this input is tied to V_{DD} , the module operates in the single-ended output mode.

In the typical application, output mode switching allows the TPA0202 to operate in the BTL output mode for increased power to internal speakers and then switch to single-ended mode to drive headphones when a plug is inserted into the headphone jack.

3.3.4.1 Headphone Jack Control Signals

The platform headphone output jack (J10) contains an internal switch that changes the state of a pair of control lines when a plug is inserted (Figure 3–6). Each control line is pulled down by a 1-k Ω resistor to ground (R4 and R5). The switch in the headphone jack pulls one line or the other up to V_{DD} through a 240- Ω resistor (R3) depending on whether a plug is inserted in J10 or not.

Figure 3–7. Mute/Mode and Polarity Control



3.3.4.2 Mute/Mode Select (JP6)

A 3-pin jumper header (JP6) on the platform, functioning as an SPDT switch, routes the control signal from the headphone jack to either the mute control input pin or the mode control input pin of the evaluation module.

- To mute the TPA0202 amplifier module using the control signal from the platform headphone jack, jumper **JP6** to **MUTE**
- To switch the output mode of the TPA0202 amplifier between BTL and single-ended using the control signal from the platform headphone jack, jumper **JP6** to **MODE**

3.3.4.3 Mute/Mode Polarity Select (JP8)

A second 3-pin jumper header (JP8) on the platform selects the control signal polarity by connecting either the active-high or the active-low line from the headphone jack to jumper JP6.

- ☐ When JP6 is set to Mute, use the following JP8 settings for the TPA0202:
 - To mute the TPA0202 amplifier module *when* a plug is inserted into the headphone jack, jumper **JP8** to **Hi** (this is the typical setting).
 - To mute the TPA0202 amplifier module *until* a plug is inserted into the headphone jack, jumper **JP8** to **Lo**.
- ☐ When JP6 is set to Mode, use the following JP8 settings for the TPA0202:
 - To switch the TPA0202 amplifier module to the *single-ended* output mode when a plug is inserted into the headphone jack, jumper **JP8** to **Hi** (this is the typical setting).
 - To switch the TPA0202 amplifier module to the *BTL* output mode when a plug is inserted into the headphone jack, jumper **JP8** to **Lo**.

3.3.5 Power Requirements

The TPA0202 Audio Power Amplifier Evaluation Module can operate from any voltage between approximately 3 V and 5.5 V; however, the TPA0202 amplifier IC on the module is characterized for operation at 3.3 V and 5 V. For best performance (highest output power with lowest distortion), the module should be operated at approximately 5 V unless there is a specific reason for operating it from a lower voltage.

The TI Plug-N-Play Audio Amplifier Evaluation Platform with a voltage regulator EVM installed on it can provide a regulated V_{DD} supply from a wide variety of unregulated V_{CC} voltage inputs between approximately 5.5 V and 12 V, including an on-board 9-V battery. Or, an external regulated power source can be used to supply V_{DD} voltage to the platform and the TPA0202 evaluation module installed on it.

Although the TPA0202 amplifier IC draws approximately 1.25 A from the power supply during continuous full power output, peak current draw can be as high as 2 A. Any power supply connected to the platform should be capable of providing 2 A of current to avoid clipping of the output signal during peaks. Current consumption driving speakers at normal listening levels is typically 0.5 A or less.

The platform is equipped with overvoltage and reverse-polarity supply voltage input protection in the form of fused crowbar circuits.

- ☐ V_{DD} voltage applied to platform screw terminals J6 *MUST NOT* exceed the absolute maximum rating for the TPA0202 amplifier IC installed on the evaluation module (6 V) or damage to the IC may result. In no case should V_{DD} voltage of the incorrect polarity or in excess of 6.1 V be applied to screw terminals J6 of the platform, or the power protection circuit on the V_{DD} line will trip.
- ☐ V_{CC} voltage applied to the platform *MUST NOT* exceed the maximum voltage input specified for the voltage regulator module installed in socket U6 (12 V for the SLVP097), or damage to the voltage regulator module may result. In no case should V_{CC} voltage applied to the platform exceed 15 V, or the overvoltage protection circuit on the V_{CC} bus will trip.

3.3.6 Inputs and Outputs

The TI Plug-N-Play Audio Amplifier Evaluation Platform is equipped with several standard connectors for audio inputs and outputs.

3.3.6.1 Inputs

In most cases, audio signals enter the platform through either a pair of RCA phono jacks (J3 and J5) or a miniature (1/8") stereo phone jack (J4). Certain signal conditioning and amplifier EVMs, however, may have additional signal input connectors mounted on the module circuit board.

The platform audio signal input jacks (J3, J4, and J5) are of the closed-circuit type, grounding the signal input lines when no plugs are inserted.

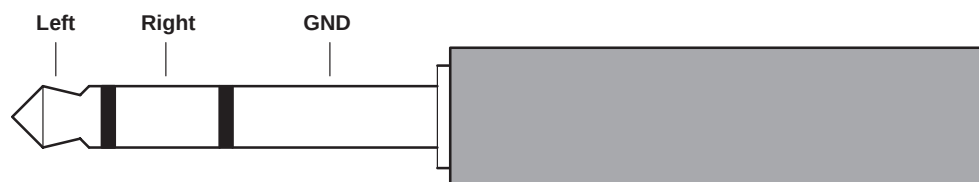
3.3.6.2 Outputs

Amplified audio output signals leave the platform through left and right RCA phono jacks (J7 and J9), left and right pairs of compression connectors for stripped speaker wires (J8), and optionally, through a miniature (1/8") stereo phone jack (J10), for headphones.

The audio output lines from the power amplifiers are separate all the way to the edge of the platform (output jacks J7, J8, and J9) — the OUT– lines from the power amplifier sockets are not tied to each other or to platform ground. This allows the TPA0202 power amplifier EVM to operate in the highly-efficient bridge-tied load configuration when driving speakers.

The headphone jack (J10) is capacitively coupled to source select switch S3, which connects J10 to the output lines of either the headphone amplifier socket or the power amplifier sockets (Figure 3–5). When the TPA0202 output signal is routed to J10 by S3, signals output via J10 are returned to platform ground when a plug is inserted (Figure 3–7), requiring single-ended operation of the power amplifiers.

Figure 3–8. Typical Headphone Plug



3.4 Using The TPA0202 EVM Stand-Alone

Using the TPA0202 Audio Power Amplifier Evaluation Module stand-alone is much the same as using it with the platform. The same 3-V to 5.5-V power supply range and the isolated OUT+ and OUT– lines for BTL operation requirement exists.

Note that the mute signal applied to the EVM mute pin must be able to supply enough current to overcome the pulldown resistor on the module (100 k Ω).

3.4.1 TPA0202 EVM Connected for BTL Output

Figure 3–9. TPA0202 EVM Connected for Stereo BTL Output

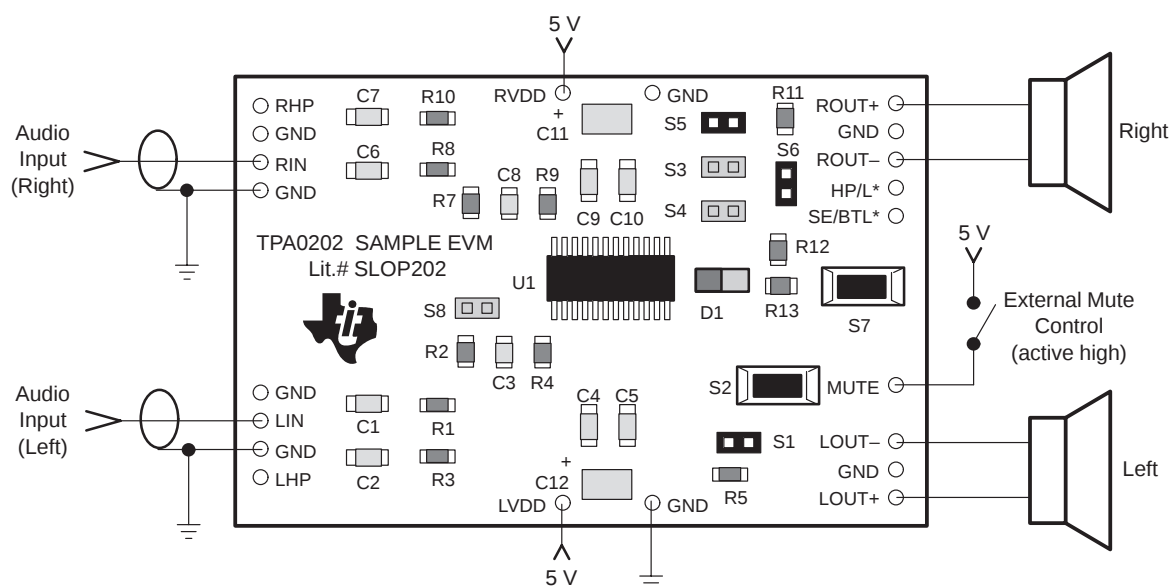


Table 3–1. Typical TPA0202 EVM Jumper Settings for BTL Stand-Alone

EVM	S1	S3	S4	S5	S6	S8
TPA0202	X	OFF	OFF	ON	X	OFF

Note: ON = shunt installed, OFF = open, X = don't care, S8 = always OFF

3.4.2 TPA0202 EVM Connected for Single-Ended Output

Figure 3–10. TPA0202 EVM Connected for Stereo Single-Ended Output

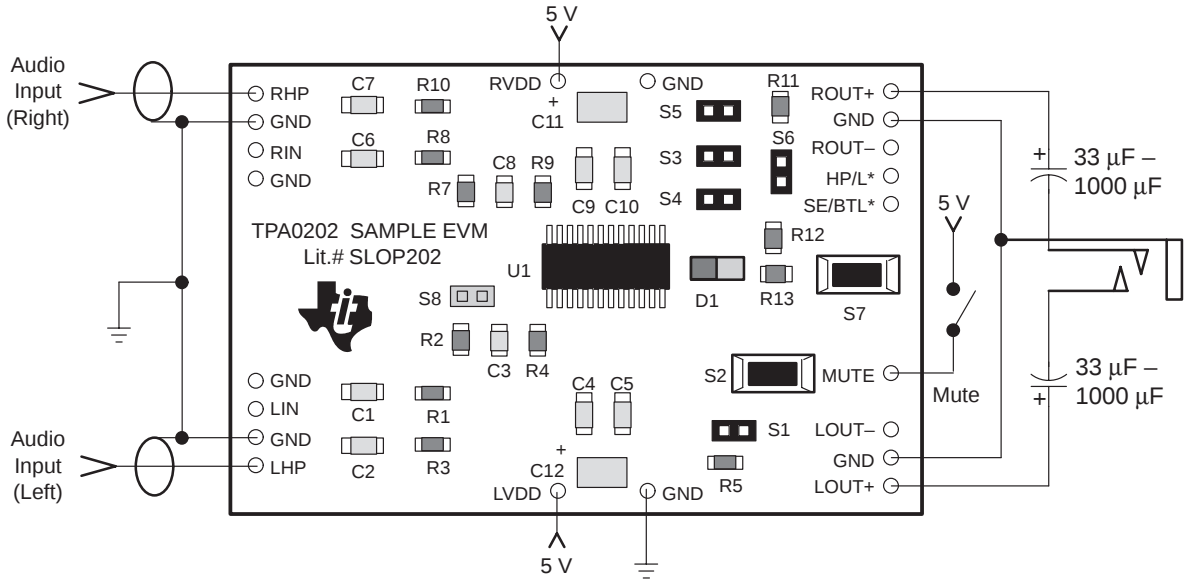


Table 3–2. Typical TPA0202 EVM Jumper Settings for Single-Ended Stand-Alone

EVM	S1	S3	S4	S5	S6	S8
TPA0202	X	ON	ON	ON	X	OFF

Note: ON = shunt installed, OFF = open, X = don't care, S8 = always OFF

3.5 TPA0202 Audio Power Amplifier Evaluation Module Parts List

Table 3–1. TPA0202 EVM Parts List

Ref.	Description	Size	EVM Qty.	Manufacturer/ Part Number	Digi-Key Number
C1, C2, C6, C7	Capacitor, 1 μ F, 80%–20%, nonpolarized	1206	4	Murata GRM42-6Y5V105Z16BL	Newark 93F2254
C4, C5, C9, C10	Capacitor, 2.2 μ F, 20%, nonpolarized	1206	4	TDK C3216X5R1A225	
C3, C8	Capacitor, 5 pF	0805	2	Panasonic ECU-V1H050CCN	Digi-Key PCC050CNCT-ND
C11, C12	Capacitor, 10 μ F, 6.3 V	A	2	Panasonic ECS-TOJY106R	Digi-Key PCS1106CT-ND
R1, R2, R4, R8, R9, R10	Resistor, 20 k Ω , 1/8 W, 5%	0805	6	Panasonic ERJ-8GEYJ203V	Digi-Key P20KKABK-ND
R2, R7	Resistor, 50 k Ω , 1/8 W, 5%	0805	2	Panasonic ERJ-8GEYJ503V	Digi-Key P50KKABK-ND
R5, R6, R11, R12	Resistor, 100 k Ω , 1/8 W, 5%	0805	6	Panasonic ERJ-6GEYJ104V	Digi-Key P100KABK-ND
R13	Resistor, 510 k Ω , 1/8 W, 5%	0805	1	Panasonic ERJ-6GEYJ510V	Digi-Key P510KABK-ND
D1	Diode	SMD	1		
S2, S7	Switch, momentary	SMD	2	Panasonic P8048SCT-ND	Digi-Key P8048SCT-ND
S1, S3–S6, S8	Header, 2 position	2 mm	6	Norcomp	Digi-Key 2163-02-ND
P1, P3, P4	Shunts	2 mm	3	3M	Digi-Key 953170-30-ND
U1	IC, TPA0202, audio amplifier, 2 W, 2 channel	24 pin TSSOP	1	TI TPA0202	
PCB1	PCB, TPA0202 EVM		1	TI SLOP202	