

TPA6030A4 ***Audio Power Amplifier*** ***Evaluation Module***

User's Guide

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of 7 V to 15 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 85°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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Texas Instruments
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Dallas, Texas 75265

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Read This First

How to Use This Manual

This document contains the following chapters:

- Chapter 1—Introduction
- Chapter 2—Quick Start
- Chapter 3—Reference

Information About Cautions and Warnings

This book may contain cautions and warnings.

This is an example of a caution statement.

A caution statement describes a situation that could potentially damage your software or equipment.

This is an example of a warning statement.

A warning statement describes a situation that could potentially cause harm to you.

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.

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.

- **TPA6030A4 3-W Stereo Audio Power Amplifier With Advanced DC Volume Control** (literature number SLOS395). This is the data sheet for the TPA6030A4 audio amplifier integrated circuit.

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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Introduction

This chapter provides an overview of the Texas Instruments (TI) TPA6030A4 audio amplifier evaluation module (SLOP365). It includes a list of EVM features, a brief illustrated description of the module, and a list of EVM specifications.

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1.1 Feature Highlights

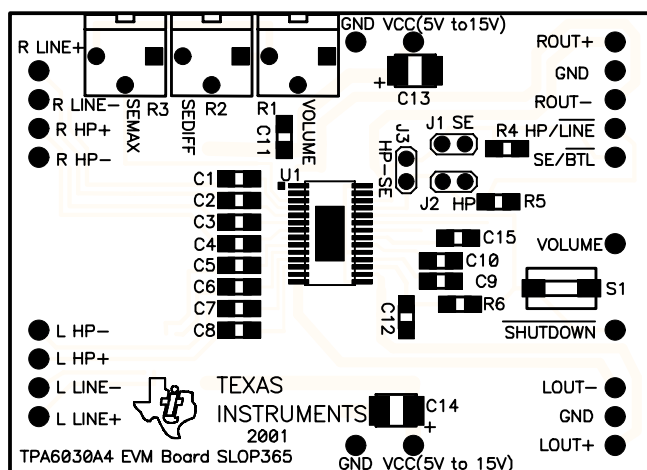
The TI TPA6030A4 audio amplifier evaluation module and the TI Plug-N-Play audio amplifier evaluation platform include the following features:

- TPA6030A4 3-W stereo audio power amplifier evaluation module
 - Fully differential operation and internal depop circuitry to minimize transients in outputs
 - 3 W per channel output power into 16 Ω , BTL, at $V_{CC} = 12$ V
 - Low current consumption in shutdown mode (1 μ A)
 - Internal input mux selects among two sets of stereo inputs
 - Stereo, bridge-tied load (BTL) or single-ended (SE) operation
 - DC voltage volume control from 36 dB to -40 dB, and a -80 dB mute
 - SE gain adjustable from 30 dB to -46 dB, and a -86 dB mute
- 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 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 to 15-V dc V_{CC} supply inputs
 - External regulated V_{DD} supply input
 - Socket for onboard 5 V/3.3 V V_{DD} voltage regulator EVM
 - Onboard 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 TPA6030A4 stereo 3-W audio power amplifier evaluation module is designed to demonstrate all of the different features and benefits of the TPA6030A4 amplifier. It consists of the TI TPA6030A4 stereo 3-W audio power amplifier IC along with a small number of other parts mounted on a circuit board that measures approximately 2 1/4 inches by 1 1/2 inches (Figure 1–1).

Figure 1–1. The TI TPA6030A4 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 TPA6030A4 evaluation module and is a convenient vehicle for demonstrating TI's audio power amplifier and related evaluation modules. The EVM simply plugs 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 TPA6030A4EVM Specifications

Supply voltage range, V_{CC}	7 V to 15 V
Supply current, I_{DD}	2 A max
Continuous output power per channel, P_O : 16- Ω BTL, $V_{CC}=12$ V	3 W
Audio input voltage, V_{I_i} :	
HP input	$V_{CC} + 0.3$ V
LINE input	$V_{CC} + 0.3$ V
Minimum load impedance, R_L	8 Ω †

† $V_{CC} = 7$ V is recommended for this load.

1.4 Special Notes Regarding the Data Sheet

The TPA6036A4EVM may have markings not consistent with the data sheet. Some EVMs have an incorrect supply voltage marked on them. The correct supply range is 7 V to 15 V, not 5 V to 15 V.

The EVM and this user's guide refer to the two input pins as HP and LINE, and refer to the control pin as HP/LINE. The data sheet refers to the two inputs as IN2 and IN1, respectively, and the control pin as IN2/IN1.

See the data sheet for the correct voltages and pin names.

Quick Start

The steps in this chapter can be followed to quickly prepare the TPA6030A4 audio amplifier EVM for use. Using the TPA6030A4 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 TI Plug-N-Play platform supplies a 5-V regulated voltage that is designed to allow devices with an $\overline{\text{SE/BTL}}$ pin to automatically switch to SE output mode when a headphone is inserted into the headphone jack. The $\overline{\text{SE/BTL}}$ pin on the TPA6030A4 is designed to switch high when the voltage applied to the pin meets or exceeds $0.8 V_{CC}$, requiring a minimum of 5.6 V when the power supply is at 7 V. This is more than the platform can supply, and consequently, the automatic $\overline{\text{SE/BTL}}$ toggle feature of the TI Plug-N-Play platform is not fully compatible with the TPA6030A4EVM. However, the output mode can be manually changed with the use of J1 on the TPA6030A4EVM (see Table 2–2).

Refer to the application section of the TPA6030A4 data sheet for more information about building a circuit that automatically switches output modes when a headphone is inserted.

The jumper and switch settings on the TI Plug-N-Play platform do not change with different V_{CC} levels.

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Table 2–1. Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA6030A4

EVM	JP5	JP6	JP7	JP8	S2	S3
P-N-P Platform	OFF	Mode	X	X	Note 4	X

- Notes:**
- 1) X = Don't care
 - 2) ON = Shunt installed
 - 3) OFF = Open
 - 4) 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 TPA6030A4EVM Jumper Settings

EVM	Mode	J1	J2	J3
TPA6030A4	BTL	OFF	X	OFF
	SE	ON	X	OFF

- Notes:**
- 1) ON = Shunt installed
 - 2) OFF = Open
 - 3) X = Don't care

2.1 Precautions

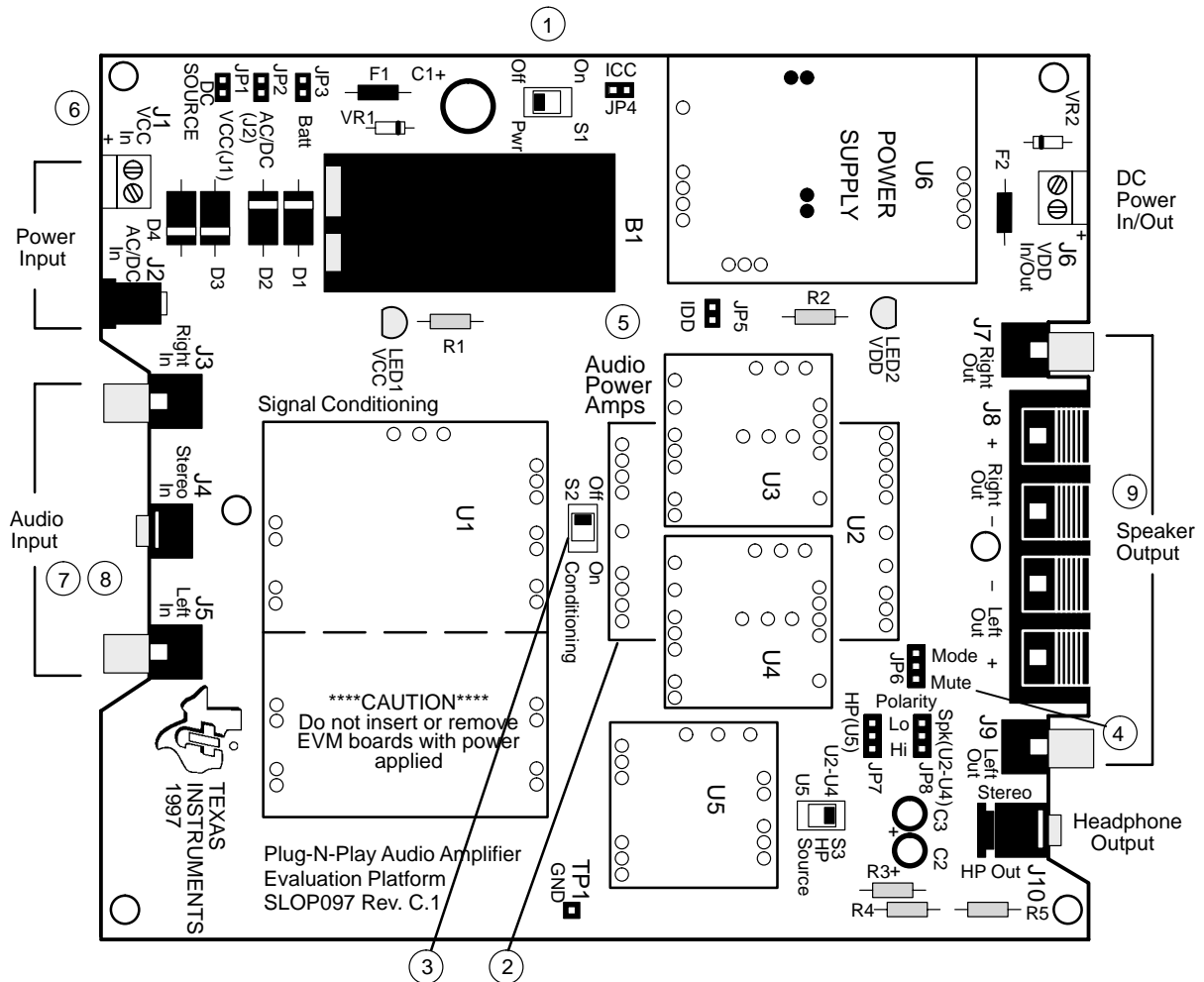
Power Supply Input Polarity and Maximum Voltage

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 onboard 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 TPA6030A4EVM 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:

Note:

The TI Plug-N-Play platform sends the input signal to both the HP and LINE inputs automatically, and only to the positive inputs. To fully take advantage of the TPA6030A4 differential input as well as the input mode selectable mux, the EVM should be used in a stand-alone fashion.

□ 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 TPA6030A4 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 jumper **JP6** to select the **Mode** control input.
- 5) Remove jumper **JP5**.

Table 2–3. Platform Jumper and Switch Settings for the TPA6030A4

EVM	JP5	JP6	JP7	JP8	S2	S3
P-N-P Platform	Off	Mode	X	Hi	Note 4	X

Notes:

- 1) X = Don't care
- 2) ON = Shunt installed
- 3) OFF = Open
- 4) 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

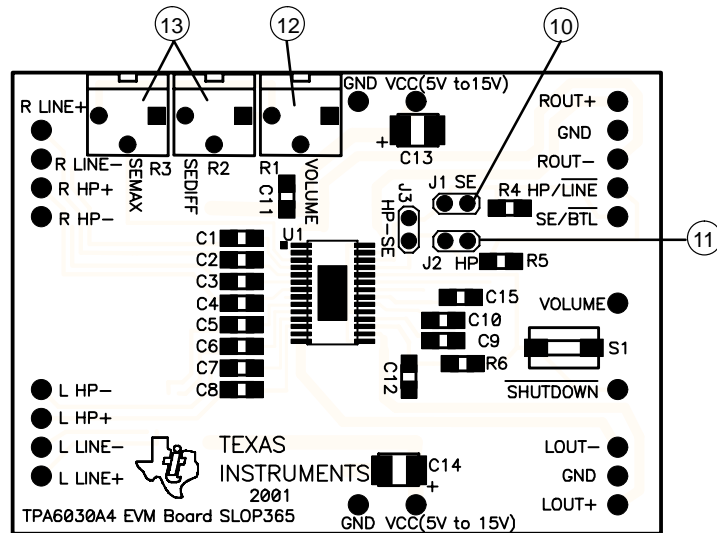
- 6) Select and connect an external regulated power supply (ensure power supply is turned **OFF**) set from 7 V to 15 V to platform V_{CC} power input connector **J1**, taking care to observe marked polarity. Jumper the appropriate power input.

□ Inputs and Outputs

- 7) Ensure that the audio signal source level is set to minimum.
- 8) Connect the audio source to left and right RCA phono jacks **J3** and **J5** or stereo miniature phone jack **J4**.
- 9) Connect 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



- 10) The SE jumper, **J1**, is used to select between the two output modes, SE and BTL. To allow the module SE/BTL control input to force the amplifier IC into a BTL output mode, set output mode jumper **J1** to **OFF**. To keep the module amplifier IC in the single-ended output mode regardless of the control input state, set jumper **J1** to **ON**.
- 11) The HP jumper, **J2**, is used to select between the two input modes, HP and LINE. To keep the amplifier IC in LINE input mode, set **J2** to **OFF**. To keep the amplifier IC in the HP input mode, set jumper **J2** to **ON**.

□ Power Up

Platform LED1 should light indicating the presence of V_{CC} , and the evaluation modules installed on the platform should begin operation.

□ Volume Control

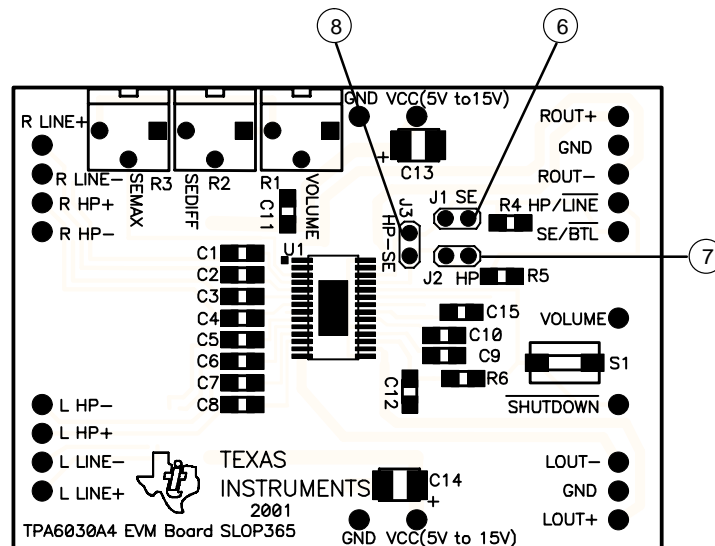
- 12) Potentiometer R1 (VOLUME) sets the BTL volume, which can range from -40 dB to $+36$ dB using 2.53 dB steps. Turning the potentiometer clockwise increases the gain; turning counterclockwise decreases the gain. To mute the volume (-80 dB), turn the potentiometer, R1, as far as it will go in a counterclockwise direction. Refer to Table 3–2 in the Reference chapter for a list of the volume levels.
- 13) The SE volume may be set independently using potentiometers R2 (SEDIFF) and R3 (SEMAX). SEDIFF set the difference between the BTL volume and the SE volume, while SEMAX sets the maximum volume in SE mode.
- 14) Turning potentiometer R2 (SEDIFF) clockwise decreases the difference between SE and BTL volumes; counterclockwise increases the difference.
- 15) Turning potentiometer R3 (SEMAX) clockwise increases the maximum SE volume; counterclockwise decreases the maximum SE volume.

For more information on volume control operation, see the TPA6030A4 data sheet.

2.3 Quick Start List for Stand-Alone

Follow these steps to use the TPA6030A4EVM stand-alone or when connecting it to existing circuits or equipment. Connections to the TPA6030A4 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.

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 from 7 V to 15 V to the module V_{CC} and GND pins taking care to observe marked polarity.

Inputs and Outputs

- 3) Ensure that audio signal source level adjustments are set to minimum.
- 4) Connect the right (or left) positive lead of the audio source to the module R LINE+ (or L LINE+) pins and the negative lead to the R LINE– (or L LINE–) pins. If using the headphone inputs, connect the positive audio source to the module R HP+ (L HP+) and the negative lead to R HP– (L HP–). The inputs can be used with a differential or single-ended audio source. If stereo use is desired, connect both right and left inputs to the appropriate sources.
- 5) Select output mode:
 - a) For BTL output, connect a speaker to the module OUT+ and OUT– pins of each channel, (see Figure 2–4)
or
 - b) For single-ended output, connect a headphone or a speaker to the module OUT+ and GND pins of each channel through a 33 μF to 1000 μF output-coupling capacitor (Figure 2–5).

Evaluation Module Preparations

- 6) To force the EVM into a BTL output mode, set jumper **J1** to **OFF**. To force the EVM into a SE output mode, set jumper **J1** to **ON**.
- 7) To force the EVM into using the LINE inputs, set jumper **J2** to **OFF**. To force the EVM into using HP inputs, set jumper **J2** to **ON**.

 Control Inputs

- 8) To allow the amplifier IC to switch from the LINE inputs to the HP inputs when the output switches from BTL output mode to SE output mode and vice versa, set jumper **J3** to **ON**. To allow the inputs and output modes to switch independently, set jumper **J3** to **OFF**. Connect control lines to the various module control input pins as needed.
- 9) **SE/BTL**: A high voltage applied to this pin selects the SE output mode; a low voltage or float on this pin selects the BTL output mode. Refer to the TPA6030A4 data sheet for trip level information.
- 10) **SHUTDOWN**: A low voltage applied to this pin shuts down the amplifier IC on the module; a high voltage or float on this pin allows normal operation. Refer to the TPA6030A4 data sheet for trip level information.

 Power-Up

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

The EVM should begin operation.

 Volume Control

- 12) Potentiometer R1 (VOLUME) sets the BTL volume, which can range from -40 dB to $+36$ dB using 2.53 dB steps. Turning the potentiometer clockwise increases the volume; turning counterclockwise decreases the volume. To mute the volume (-80 dB), turn the potentiometer, R1, as far as it will go in a counterclockwise direction. Refer to Table 3–2 in the Reference chapter for a list of the volume levels.
- 13) The SE volume may be set independently using potentiometers R2 (SEDIFF) and R3 (SEMAX). SEDIFF sets the difference between the BTL volume and the SE volume, while SEMAX sets the maximum volume in SE mode.
- 14) Turning potentiometer R2 (SEDIFF) clockwise decreases the difference between the volumes; counterclockwise increases the difference.
- 15) Turning potentiometer R3 (SEMAX) clockwise increases the maximum SE volume; counterclockwise decreases the maximum SE volume.

For more information on volume control operation, see the TPA6030A4 data sheet.

Figure 2–4. TPA6030A4EVM Connected for Stereo Bridge-Tied Load (BTL) Output

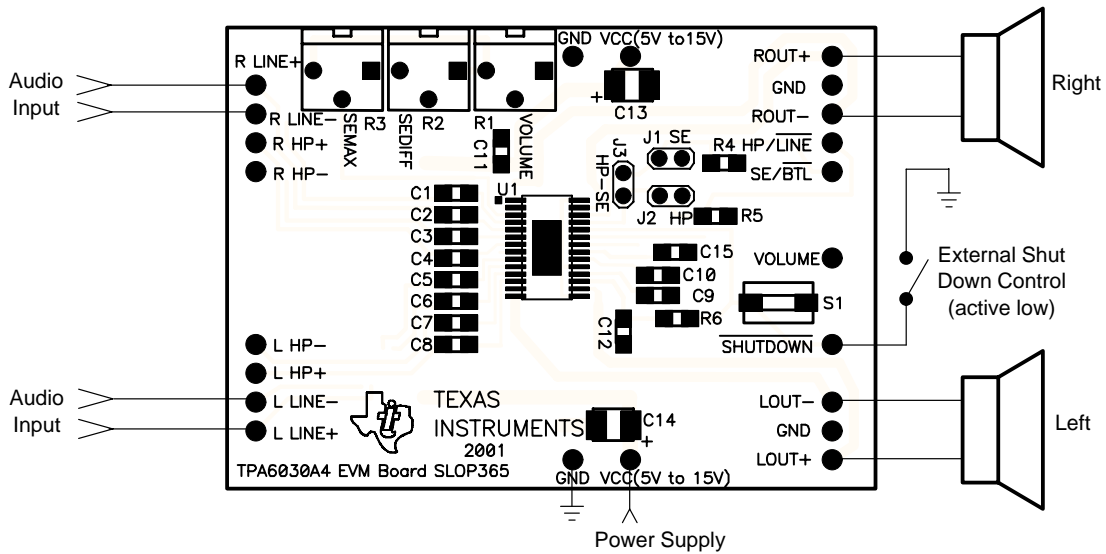


Table 2–4. Typical TPA6030A4EVM Jumper Settings for BTL Stand-Alone

EVM	J1	J2	J3
TPA6030A4	OFF	OFF	OFF

Note: ON = Shunt installed
OFF = Open

Figure 2–5. TPA6030A4EVM Connected for Stereo Single-Ended (SE) Output

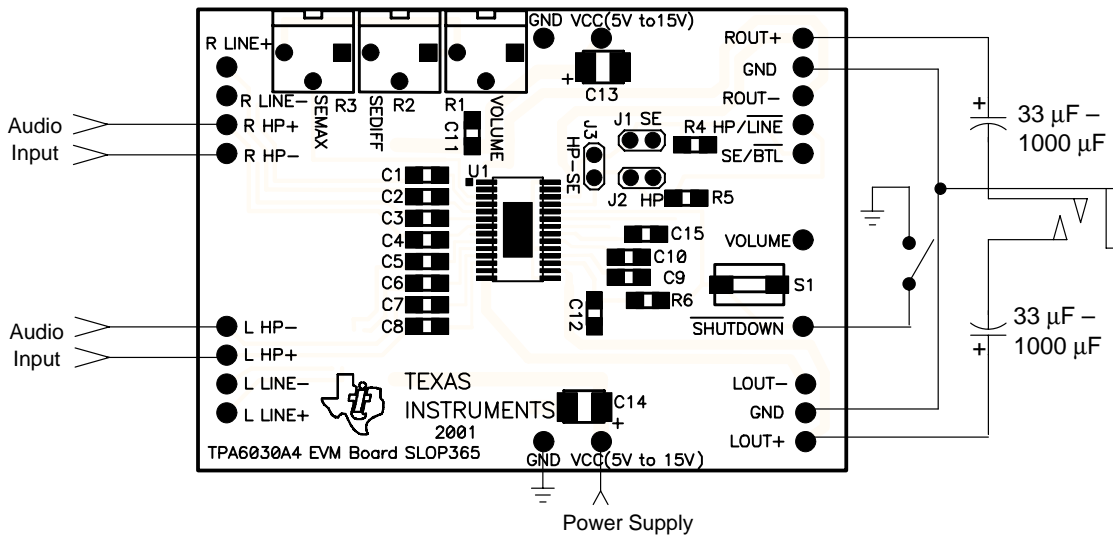


Table 2–5. Typical TPA6030A4EVM Jumper Settings for SE Stand-Alone

EVM	J1	J2	J3
TPA6030A4	ON	ON	OFF

Note: ON = Shunt installed
OFF = Open

Reference

This chapter contains reference information pertaining to the layout and schematic of the TPA6030A4EVM. Also included is the volume control table for the TPA6030A4.

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3.1 TPA6030A4EVM Layout and Schematic

Figure 3–1. TPA6030A4 EVM Top Layer

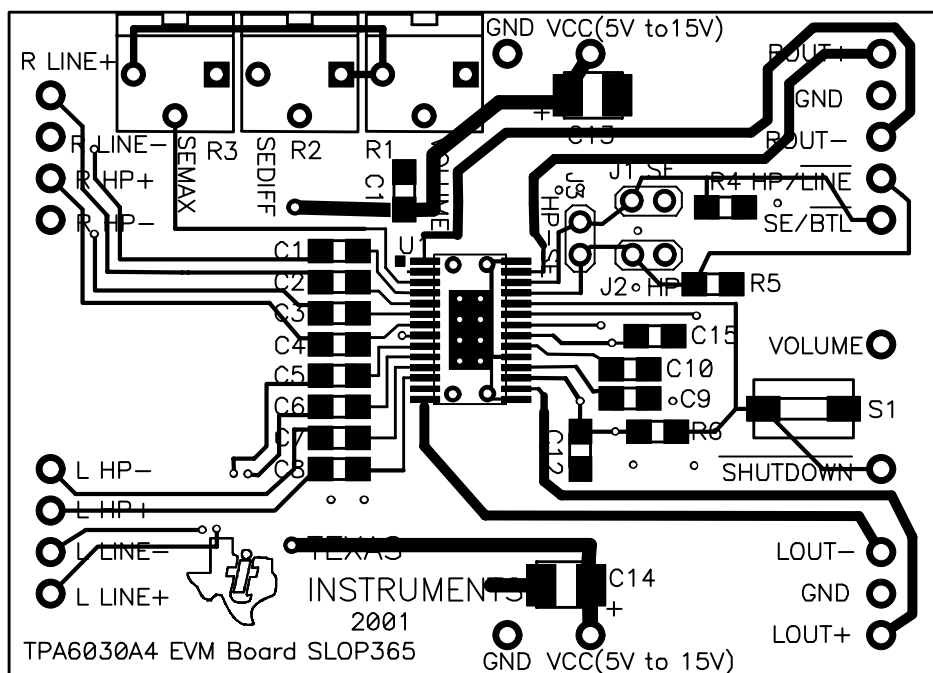


Figure 3–2. TPA6030A4EVM Bottom Layer

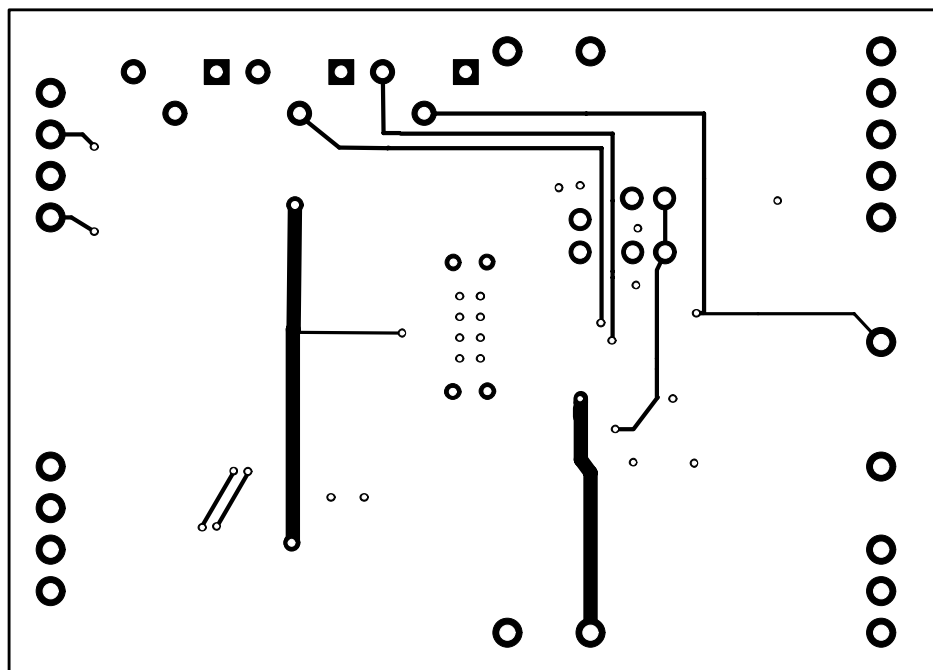
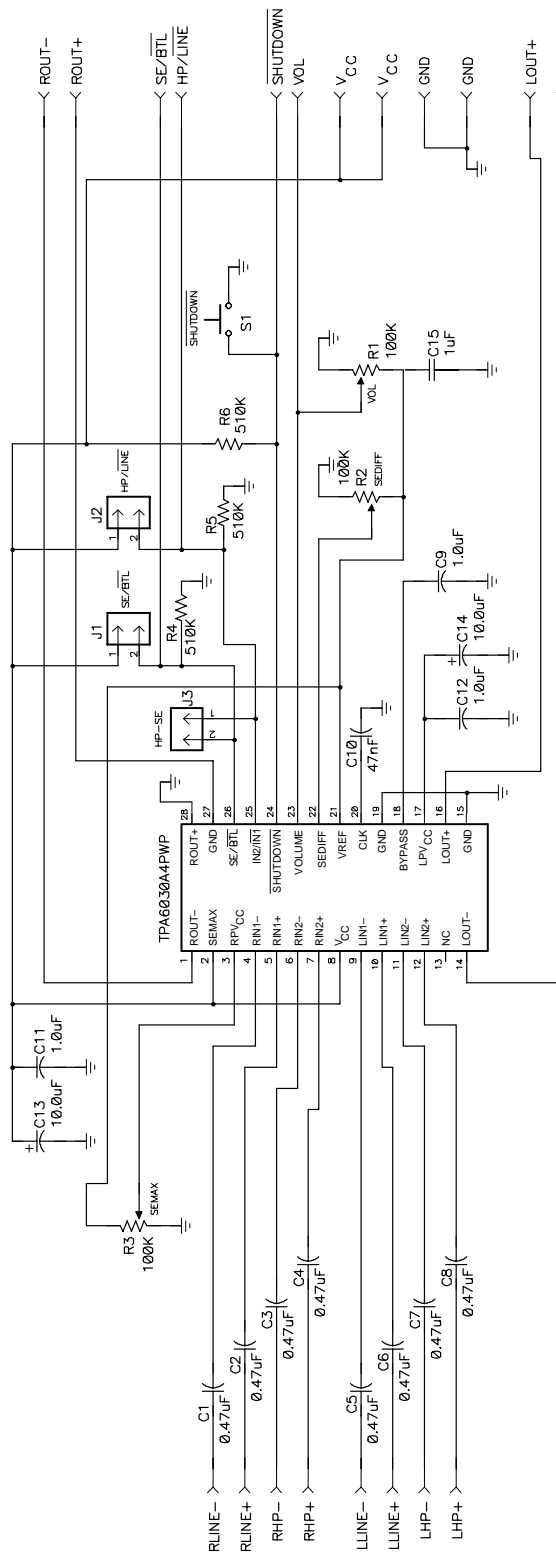


Figure 3–3. TPA6030A4EVM Schematic



3.2 TPA6030A4 Audio Power Amplifier Evaluation Module Parts List

Table 3–1. TPA6030A4EVM Parts List

Reference	Description	Size	EVM Qty.	Manufacturer/ Part Number	Distributor's Number
C9, C11, C12, C15	Capacitor, 1 μ F, 80%/-20%, nonpolarized, 16 V	0805	4	Panasonic ECJ-2VF1C105Z	Digi-Key PCC1849TR-ND
C1, C2, C3, C4, C5, C6, C7, C8	Capacitor, 0.47 μ F, 80%/-20%, nonpolarized, 16 V	0805	8	Panasonic ECJ-2VF1C474Z	Digi-Key PCC1847TR-ND
C13, C14	Capacitor, 10 μ F, 16 V	B	2	Panasonic ECS-T1CX106R	Digi-Key PCS3106TR-ND
C10	Capacitor, 47 nF, 80%/-20%, nonpolarized, 25 V	0805	1	Murata GRM216F51E473ZA01D	
R4, R5, R6	Resistor, 510 k Ω , 1/10 W	0805	3	Panasonic ERJ-6GEYJ514	Digi-Key P510KATR-ND
R1, R2, R3	Potentiometer, 100 k Ω , Cermet ST SL, thru hole		3	Bourns 33362P-1-104	Digi-Key 3362P-104-ND
S1	Switch, momentary	SMD	1	Panasonic EVQ-PJX04M	Digi-Key P8050SCT-ND
J1, J2, J3	Header, 2 position	2 mm	3	Norcomp 2163-2-01-P2	Digi-Key 2163S-02-ND
	Shunts	2 mm	3	2JM-G	Digi-Key SPE1302-ND
U1	IC, TPA6030A4, audio amplifier	28 pin TSSOP	1	TI TPA6030A4PWP	

3.3 Volume Control

Table 3–2. Volume Control ($V_{CC} = 12\text{ V}$, No Load, $SEDIFF = 0\text{ V}$, $SEMAX = 5VREF$)

Voltage On VOLUME Pin as a Percentage of 5VREF	Speaker Volume (dB)	Headphone Volume (dB)
0–10	–80.00	–86.00
10–12.6	–40.00	–46.00
12.6–15.2	–37.47	–43.47
15.2–18	–34.93	–40.93
18–20.6	–32.40	–38.40
20.6–23.4	–29.87	–35.87
23.4–26	–27.33	–33.33
26–28.6	–24.80	–30.80
28.6–31.4	–22.27	–28.27
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