

TPA2010D1 ***Audio Power Amplifier*** ***Evaluation Module***

User's Guide

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2004, Texas Instruments Incorporated

EVM IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation kit being sold by TI is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not considered by TI to be fit for commercial use. As such, the goods being provided may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety measures typically found in the end product incorporating the goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may not meet the technical requirements of the directive.

Should this evaluation kit not meet the specifications indicated in the EVM User's Guide, the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Please be aware that the products received may not be regulatory compliant or agency certified (FCC, UL, CE, etc.). Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein**.

Please read the EVM User's Guide and, specifically, the EVM Warnings and Restrictions notice in the EVM User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact the TI application engineer.

Persons handling the product must have electronics training and observe good laboratory practice standards.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of 2.5 V to 5.5 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.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Read This First

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.
- **TPA2010D1 2.5-W Mono Filter-Free Class-D Audio Power Amplifier** (literature number SLOS417) This is the data sheet for the TPA2010D1 audio amplifier integrated circuit.

Trademark

NanoFree™ is a trademark of Texas Instruments Incorporated.

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.

Contents

1	Introduction	1-1
1.1	Feature Highlights	1-2
1.2	Description	1-3
1.3	TPA2010D1 EVM Specifications	1-3
2	Operation	2-1
2.1	Precautions	2-2
2.2	Quick Start List for Platform	2-3
2.3	Quick Start List for Stand-Alone	2-4
2.4	References	2-5
2.4.1	TPA2010D1 EVM Connected for Stereo BTL Output	2-5
2.4.2	TPA2010D1 EVM Schematic Diagram	2-6
2.4.3	TPA2010D1 Audio Power Amplifier Evaluation Module Parts List	2-6
2.4.4	TPA2010D1 EVM PCB Layers	2-7

Figures

2-1	Quick Start Platform Map	2-2
2-2	TPA2010D1 EVM Connected for Stereo BTL Output	2-5
2-3	TPA2010D1 EVM Schematic Diagram	2-6
2-4	TPA2010D1 EVM Top Layer	2-7
2-5	TPA2010D1 EVM Bottom Layer	2-7

Tables

2-1	Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA2010D1 EVM .	2-1
2-2	Platform Jumper and Switch Settings for the TPA2010D1 EVM	2-3
2-3	TPA2010D1 EVM Parts List	2-6

Introduction

This chapter provides an overview of the Texas Instruments (TI) TPA2010D1 NanoFree™ WCSF audio amplifier evaluation module (TPA2010D1YZF EVM). It includes a list of EVM features, a brief illustrated description of the module, and a list of EVM specifications.

The TPA2010D1 EVM is completely Pb-free. The device, all the components, and the printed-circuit board are all Pb-free. In addition, no lead is used in the manufacture or assembly of the module.

Topic	Page
1.1 Feature Highlights	1-2
1.2 Description	1-3
1.3 TPA2010D1 EVM Specifications	1-3

1.1 Feature Highlights

The TI TPA2010D1 audio amplifier evaluation module and the TI Plug-N-Play audio amplifier evaluation platform include the following features:

- TPA2010D1 Low-Voltage Audio Power Amplifier Evaluation Module
 - 1.45 mm x 1.45 mm NanoFree™ WCSP
 - Fully-differential filter-free Class-D amplifier
 - Single channel, bridge-tied load (BTL)
 - 2.5-V to 5.5-V operation
 - 2.5-W output power into 4 Ω at 5 V, BTL
 - Internal depop and quick start-up circuitry
 - Internal thermal and short-circuit protection
 - Module gain is set at 2 V/V
 - Completely Pb-free
- 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
 - Onboard 9-V battery
 - External 5-V to 15-V (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 TPA2010D1 audio power amplifier evaluation module is a complete, low-power single-channel audio power amplifier. It consists of the TI TPA2010D1 2.5-W low-voltage Class-D audio power amplifier IC in a very small NanoFree™ WCSP package, along with a small number of other parts mounted on a circuit board that is approximately one and a quarter inches square.

Single in-line header pins are mounted to the underside of the module circuit board. These pins 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, which has room for a pair of TPA2010D1 evaluation modules, 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 TPA2010D1 EVM Specifications

Supply voltage range, V_{DD}	2.5 V to 5.5 V
Power supply current rating required	1 A
Continuous output power, P_O : 4- Ω BTL, $V_{DD} = 5$ V	2.5 W
Audio input voltage, V_I	0 V to V_{DD} , max
Minimum load impedance, Z_L	4 Ω



Operation

Follow the steps in this chapter to prepare the TPA2010D1 audio amplifier EVM for use. Using the TPA2010D1 EVM 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 it can be wired directly into existing circuits or equipment.

The platform switch and jumper settings shown in Table 2–1 are typical for the TPA2010D1 EVM. They cause the TPA2010D1 amplifier IC on the EVM to shut down 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 TPA2010D1 EVM

EVM	JP6	JP7	JP8	S2	S3
TPA2010D1	Mute	X	Lo	See 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.

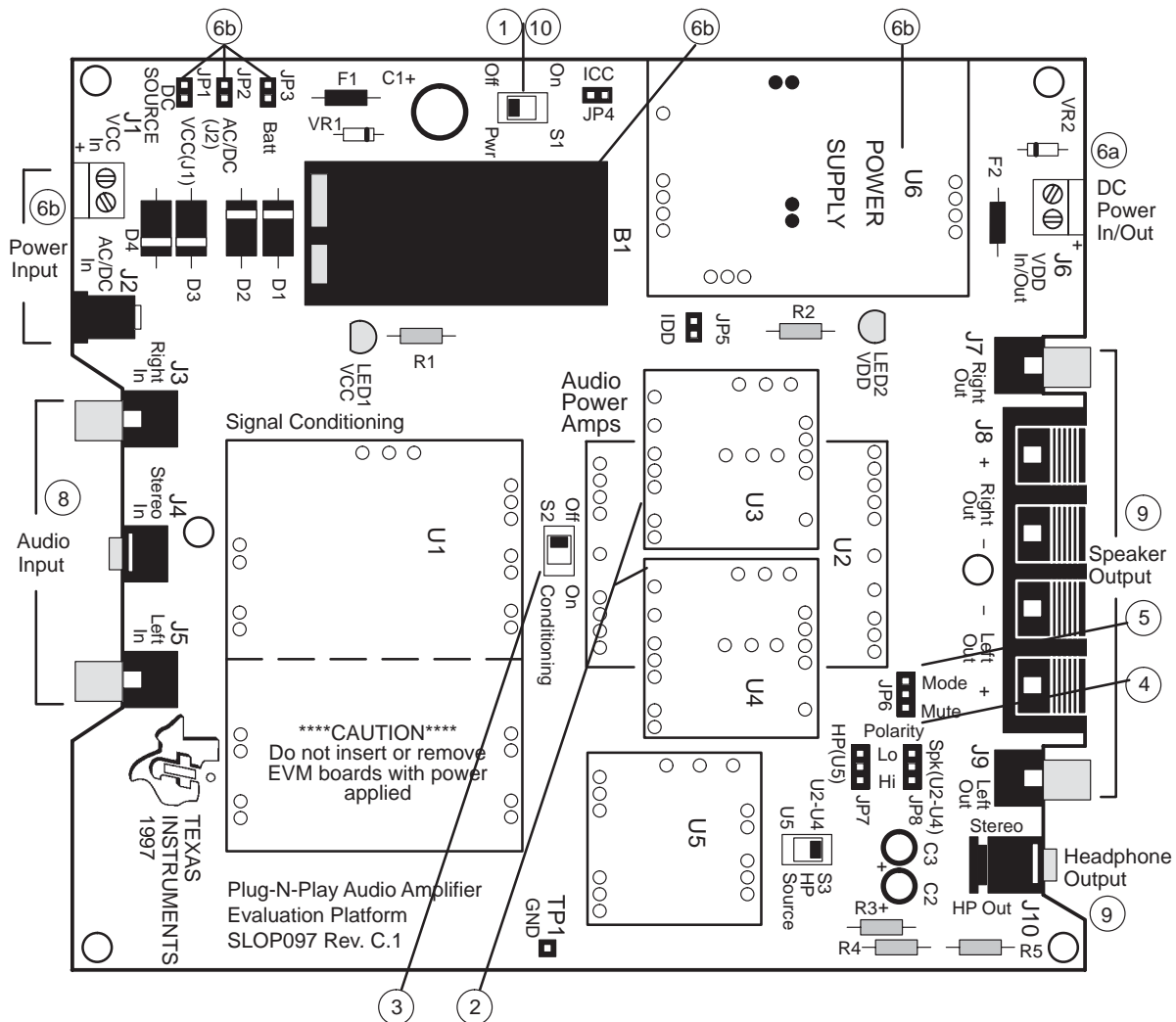
Topic	Page
2.1 Precautions	2–2
2.2 Quick Start List for Platform	2–3
2.3 Quick Start List for Stand-Alone	2–4
2.4 References	2–5

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 TPA2010D1 EVM with the TI Plug-N-Play audio amplifier evaluation platform (see the platform user's guide, SLOU011, for additional details).

□ 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 TPA2010D1 module in platform sockets U3 and U4 for stereo operation (or a module in either U3 or U4 for single channel operation), 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 Lo.
- 5) Set jumper JP6 to select the mute control input. Jumper, J1, on the TPA2010D1 EVM must be open to allow the TPA2010D1 to shutdown if a plug is inserted into platform headphone jack J10.

Table 2–2. Platform Jumper and Switch Settings for the TPA2010D1 EVM

EVM	JP6	JP7	JP8	S2	S3
TPA2010D1	Mute	X	Lo	See 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

- 6) Select and connect the power supply:
 - a) Connect an external regulated power supply set to a voltage between 2.5 V and 5.5 V to platform V_{DD} power input connector J6, taking care to observe marked polarity,
or
 - b) Install a voltage regulator EVM (SLVP097 or equivalent.) in platform socket U6. Install a 9-V battery in B1 or 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

- 7) Ensure that signal source level is set to minimum.
- 8) Connect the audio source to left (J5) or right (J3) RCA phono jacks, or both if using two TPA2010D1 modules, or to stereo miniature phone jack (J4).
- 9) Connect 4- Ω to 32- Ω speakers to left (J9) or right (J7) RCA jacks, or both if using two TPA2010D1 modules, or to stripped wire connector (J8).

□ Power Up

- 10) 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 lights, indicating the presence of V_{DD} , and the evaluation modules installed on the platform begin operation.

- 11) Adjust the signal source level as needed.

2.3 Quick Start List for Stand-Alone

Follow these steps to use the TPA2010D1 EVM stand-alone or when connecting it into existing circuits or equipment. Connections to the TPA2010D1 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.

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 V_{DD} and GND pins, taking care to observe marked polarity.

Inputs and outputs

- 3) Ensure that the signal source level is set to minimum.
- 4) Connect the positive lead from the audio source to the module IN+ pin and the negative lead to the IN– pin.
- 5) $\overline{\text{SHUTDOWN}}$ can be enabled by either depressing switch S1, or by driving the $\overline{\text{SHUTDOWN}}$ EVM pin with TTL level logic.
- 6) Connect a 4- Ω to 32- Ω speaker to the module OUT+ and OUT– pins.

Power Up

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

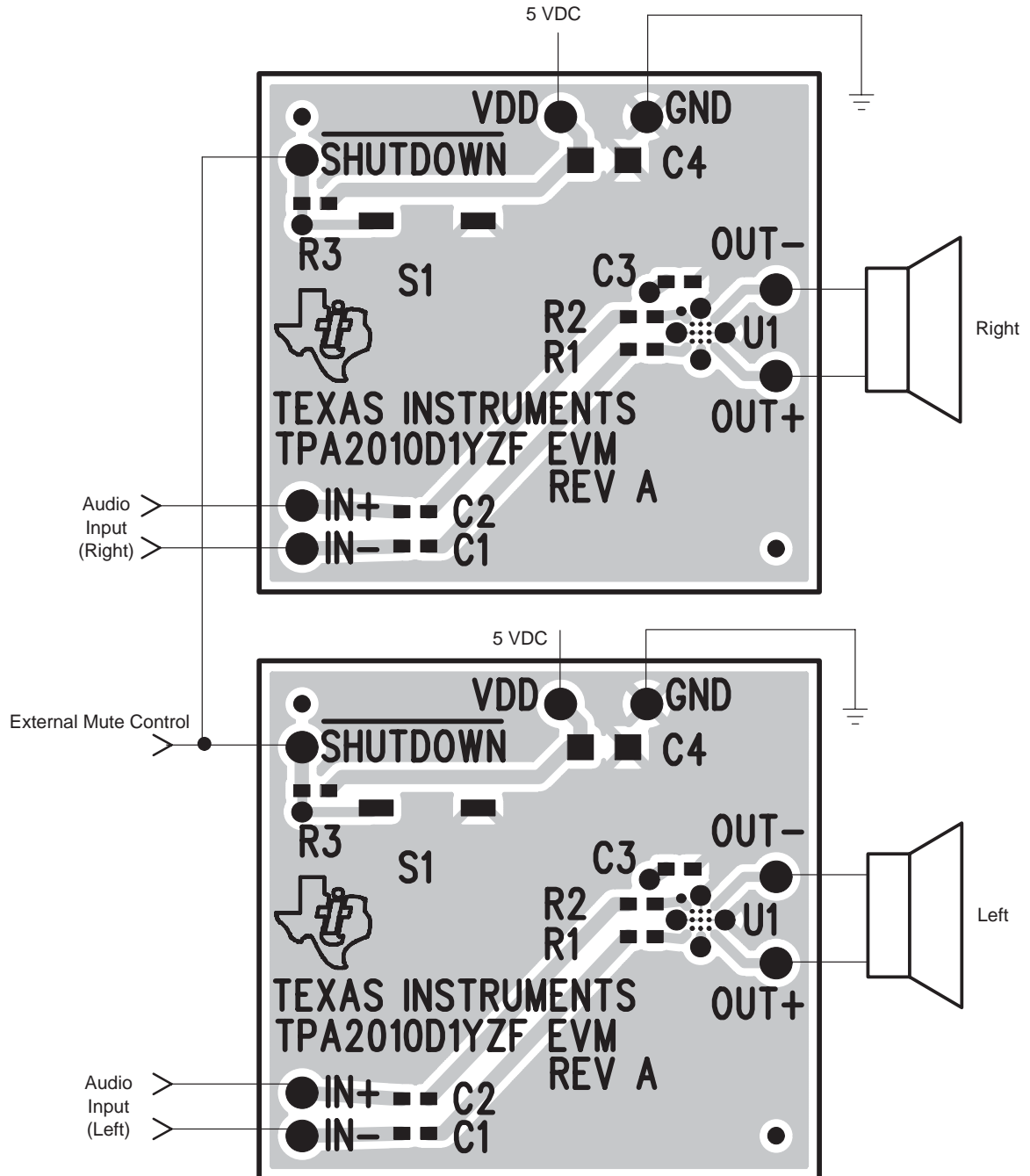
The EVM begins operation.

- 8) Adjust the signal source level as needed.

2.4 References

2.4.1 TPA2010D1 EVM Connected for Stereo BTL Output

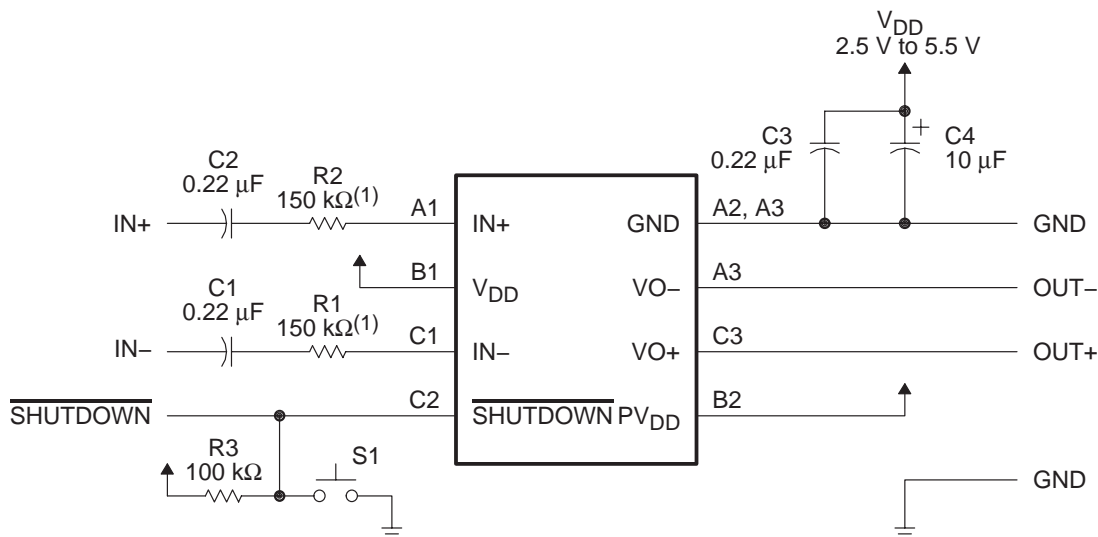
Figure 2–2. TPA2010D1 EVM Connected for Stereo BTL Output



Note: Due to the very small size of the NanoFree™ WSCP IC package, the standard part number TPA2010D1 is replaced with the code AKO (Pb-free version).

2.4.2 TPA2010D1 EVM Schematic Diagram

Figure 2–3. TPA2010D1 EVM Schematic Diagram



(1) Values shown are for EVM revision A only. For non-rev A EVMs, $R1 = R2 = 60.4 \text{ k}\Omega$, $A_V = 5 \text{ V/V}$.

2.4.3 TPA2010D1 Audio Power Amplifier Evaluation Module Parts List

Table 2–3. TPA2010D1 EVM Parts List

Qty.	Reference	Description	SMD Size	Manufacturer/ Part Number	Digi-Key Number
3	C1, C2, C3	Capacitor, 0.22 μF , 80%/–20%, nonpolarized	0603	Panasonic ECJ–1VF1C224Z	Digi-Key ⁽²⁾ PCC1790TR–ND
1	C4	Capacitor, 10 μF , 6.3 V	A	Panasonic ECS–TOJY106R	Digi-Key PCS1106CT–ND
2	R1, R2 ⁽¹⁾	Resistor, 150 $\text{k}\Omega$, 1/16 W, 1%	0603	Panasonic ERJ–3EKF6042V	Digi-Key ⁽²⁾ P60.4KHTR–ND
1	R3	Resistor, 100 $\text{k}\Omega$, 1/16 W, 10%	0603	Panasonic ERJ–3EKF1003V	Digi-Key ⁽²⁾ P100KHTR–ND
1	S1	Momentary switch		Panasonic P8048SCT–ND	Digi-Key P8048SCT–ND
7		Terminal post headers		Sullins PTC36SABN or SAMTEC TSW–19–8–G–S	Digi-Key S1022–36–ND
1	U1	IC, TPA2010D1, Mono Class-D audio amplifier	1.45 mm x 1.45 mm WCSP package	TI TPA2010D1YZF	
1	PCB1	Printed-circuit board, TPA2010D1 EVM			

(1) Values shown are for EVM revision A only. For non-rev A EVMs, $R1 = R2 = 60.4 \text{ k}\Omega$, $A_V = 5 \text{ V/V}$.

(2) Call Digi-Key for Pb-free information.

Note: Due to the very small size of the NanoFree™ WCSP IC package, the standard part number TPA2010D1 is replaced with the code AKO (Pb-free version).

Note: All items are SMD except terminal posts. All components are Pb free.

2.4.4 TPA2010D1 EVM PCB Layers

The following illustrations depict the TPA2010D1 EVM PCB layers and silk-screen. These drawings are not to scale. Gerber plots can be obtained from any TI sales office.

Figure 2–4. TPA2010D1 EVM Top Layer

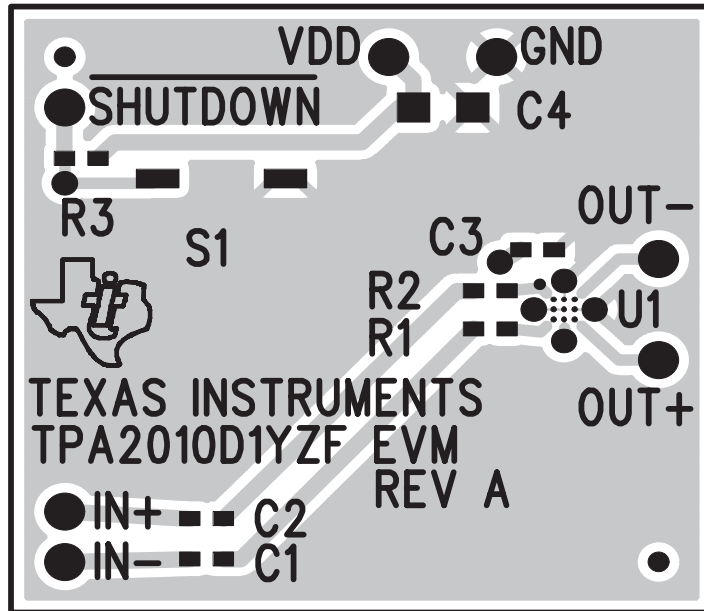


Figure 2–5. TPA2010D1 EVM Bottom Layer

