

# **TPA2031D1 Audio Power Amplifier Evaluation Module**

## **Contents**

1	Introduction .....	2
1.1	Related Documentation From Texas Instruments .....	2
1.2	Feature Highlights .....	2
1.3	Description .....	3
1.4	TPA2031D1EVM Specifications .....	3
2	Operation .....	4
2.1	Precautions .....	4
2.2	Quick Start List for Platforms .....	6
2.3	Quick Start List for Stand-Alone Operation .....	7
2.4	References .....	8

## **List of Figures**

1	Quick Start Platform Map .....	5
2	TPA2031D1 EVM Connected for Stereo BTL Output .....	8
3	TPA2031D1 EVM Schematic Diagram .....	9
4	TPA2031D1 EVM Top Layer .....	10
5	TPA2031D1 EVM Bottom Layer .....	10

## **List of Tables**

1	Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA2031D1 EVM .....	4
2	Platform Jumper and Switch Settings for the TPA2031D1 EVM .....	6
3	TPA2031D1 EVM Parts List .....	9

## 1 Introduction

This chapter provides an overview of the Texas Instruments (TI) TPA2031D1 NanoFree™ WCSP audio-amplifier evaluation module (TPA2031D1YZF EVM). It includes a list of EVM features, a brief illustrated description of the module, and a list of EVM specifications.

### 1.1 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.
- **TPA2031D1 2.5-W Mono Filter-Free Class-D Audio Power Amplifier** (literature number [SLOS417](#)) This is the data sheet for the TPA2031D1 audio amplifier integrated circuit.

### 1.2 Feature Highlights

The TI TPA2031D1 audio amplifier evaluation module and the TI Plug-N-Play audio amplifier evaluation platform include the following features:

- TPA2031D1 Low-Voltage Audio Power Amplifier Evaluation Module
  - 1,45 mm × 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
- 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 inputs
  - 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

### 1.3 Description

The TPA2031D1 audio power amplifier evaluation module is a complete, low-power single-channel audio power amplifier. It consists of the TI TPA2031D1 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 1.25-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 TPA2031D1 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 connect.

### 1.4 TPA2031D1EVM Specifications

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

## 2 Operation

Follow the steps in this chapter to prepare the TPA2031D1 audio-amplifier EVM for use. Using the TPA2031D1 EVM with the TI Plug-N-Play audio-amplifier evaluation platform is a quick, 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 1](#) are typical for the TPA2031D1 EVM. In this configuration, inserting a plug into the platform headphone jack (J10) shuts down the TPA2031D1 amplifier IC on the EVM.

**Table 1. Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA2031D1 EVM**

EVM	JP6	JP7	JP8	S2	S37
TPA2031D1	Mute	X <sup>(1)</sup>	Lo	See <sup>(2)</sup>	X

<sup>(1)</sup> X = Don't care

<sup>(2)</sup> Set S2 to On when signal conditioning board is installed in U1; set S2 to Off when no signal conditioning board is installed.

### 2.1 Precautions

#### CAUTION

##### Power Supply Input Polarity and Maximum Voltage

Always ensure that the polarity and voltage of the external power connected to VCC power input connector J1, J2, and/or VDD 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.

#### CAUTION

##### 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.

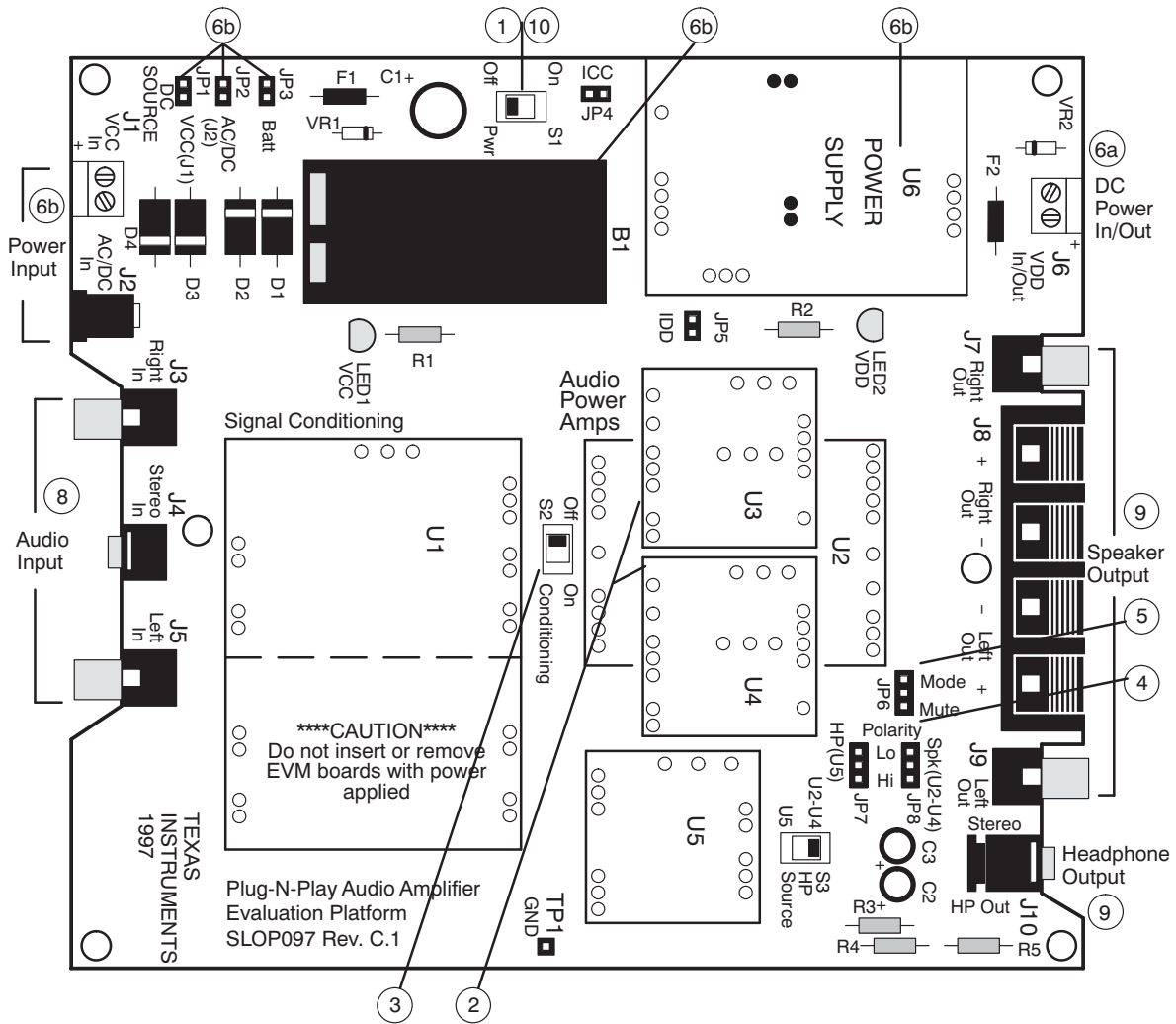


Figure 1. Quick Start Platform Map

## 2.2 Quick Start List for Platforms

Follow these steps when using the TPA2031D1 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 TPA2031D1 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 TPA2031D1 EVM must be open to allow the TPA2031D1 to shut down if a plug is inserted into platform headphone jack J10.

**Table 2. Platform Jumper and Switch Settings for the TPA2031D1 EVM**

EVM	JP6	JP7	JP8	S2	S37
TPA2031D1	Mute	X <sup>(1)</sup>	Lo	See <sup>(2)</sup>	X

<sup>(1)</sup> X = Don't care

<sup>(2)</sup> 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 TPA2031D1 modules, or to stereo miniature phone jack (J4).
- 9) Connect 4- $\Omega$  to 32- $\Omega$  speakers to left (J9) or right (J7) RCA jacks, or both if using two TPA2031D1 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 Operation

Follow these steps to use the TPA2031D1 EVM stand-alone or when connecting it into existing circuits or equipment. Connections to the TPA2031D1 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**

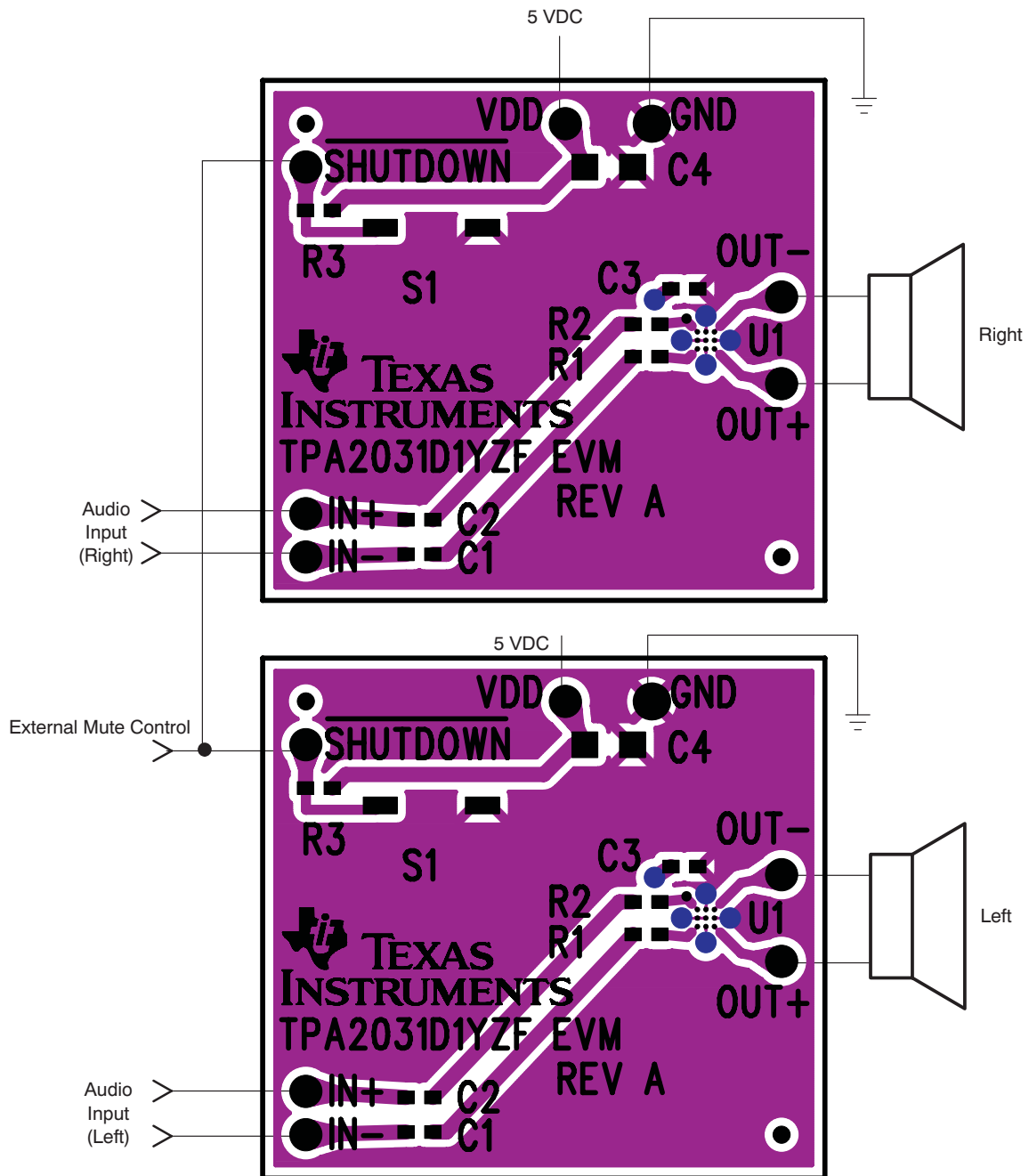
- 3) Ensure that the signal source level is set to minimum.
- 4) Connect the positive lead from the audio source to the module IN+ pin and the negative lead to the IN- pin.
- 5)  $\overline{\text{SHUTDOWN}}$  can be enabled by either depressing switch S1, or by driving the  $\overline{\text{SHUTDOWN}}$  EVM pin with TTL level logic.
- 6) Connect a 4- $\Omega$  to 32- $\Omega$  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 TPA2031D1 EVM Connected for Stereo BTL Output

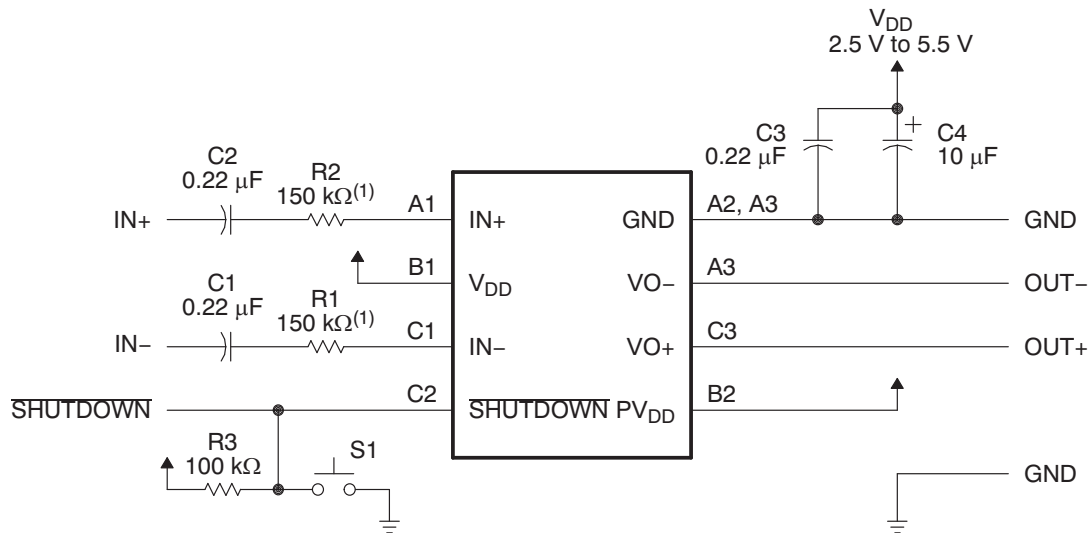


NOTE: Due to the very small size of the NanoFree™ WCSP IC package, the standard part number TPA2031D1 is replaced with the code AKO (Pb-free version).

Figure 2. TPA2031D1 EVM Connected for Stereo BTL Output



### 2.4.2 TPA2031D1 EVM Schematic Diagram



(1) Values shown are for EVM revision A only. For non-rev A EVMs,  $R_1 = R_2 = 60.4 \text{ k}\Omega$ ,  $A_V = 5 \text{ V/V}$ .

Figure 3. TPA2031D1 EVM Schematic Diagram

### 2.4.3 TPA2031D1 Audio Power Amplifier Evaluation Module Parts List

Table 3. TPA2031D1 EVM Parts List

Qty	Reference	Description	SMD <sup>(1)</sup> Size <sup>(2)</sup>	Manufacturer/ Part Number	Digi-Key <sup>(3)</sup> Number
3	C1, C2, C3	Capacitor, 0.22 $\mu\text{F}$ , 80%/–20%, nonpolarized	0603	Panasonic ECJ-1VF1C224Z	Digi-Key PCC1790TR-ND
1	C4	Capacitor, 10 $\mu\text{F}$ , 6.3 V	A	Panasonic ECS-TOJY106R	Digi-Key PCS1106CT-ND
2	R1, R2 <sup>(4)</sup>	Resistor, 150 k $\Omega$ , 1/16 W, 1%	0603	Panasonic ERJ-3EKF6042V	Digi-Key P60.4KHTR-ND
1	R3	Resistor, 100 k $\Omega$ , 1/16 W, 10%	0603	Panasonic ERJ-3EKF1003V	Digi-Key <sup>(2)</sup> 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, TPA2031D1, Mono Class-D audio amplifier	1,45 mm $\times$ 1,45 mm WCSP package	TI TPA2031D1YZF	
1	PCB1	Printed-circuit board, TPA2031D1 EVM			

<sup>(1)</sup> All items are SMD except terminal posts. All components are Pb free.

<sup>(2)</sup> Due to the very small size of the NanoFree™ WCSP IC package, the standard part number TPA2031D1 is replaced with the code AKO (Pb-free version).

<sup>(3)</sup> Call Digi-Key for Pb-free information.

<sup>(4)</sup> Values shown are for EVM revision A only. For non-rev A EVMs,  $R_1 = R_2 = 60.4 \text{ k}\Omega$ ,  $A_V = 5 \text{ V/V}$ .

The TPA2031D1 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.

### 2.4.4 TPA2031D1 EVM PCB Layers

The following illustrations depict the TPA2031D1 EVM PCB layers and silkscreen. These drawings are not to scale. Gerber plots can be obtained from any TI sales office.

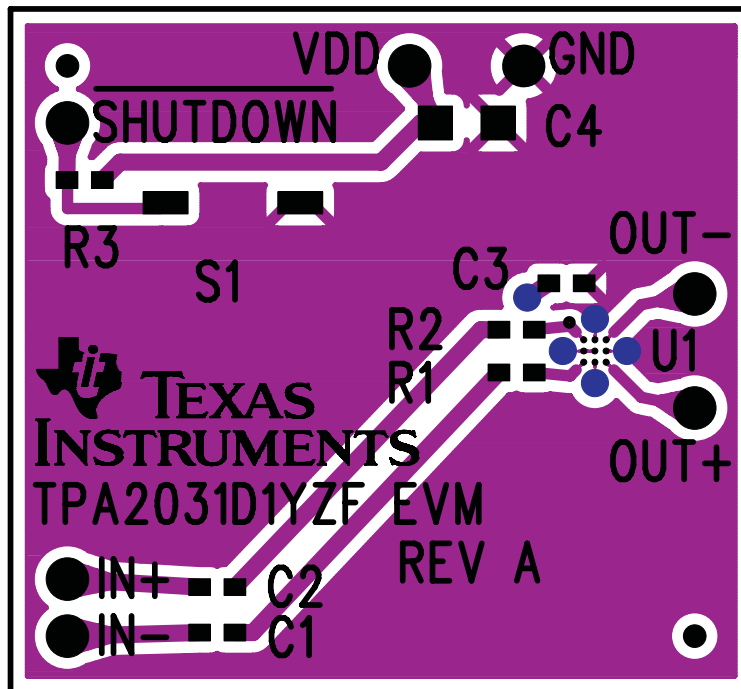


Figure 4. TPA2031D1 EVM Top Layer

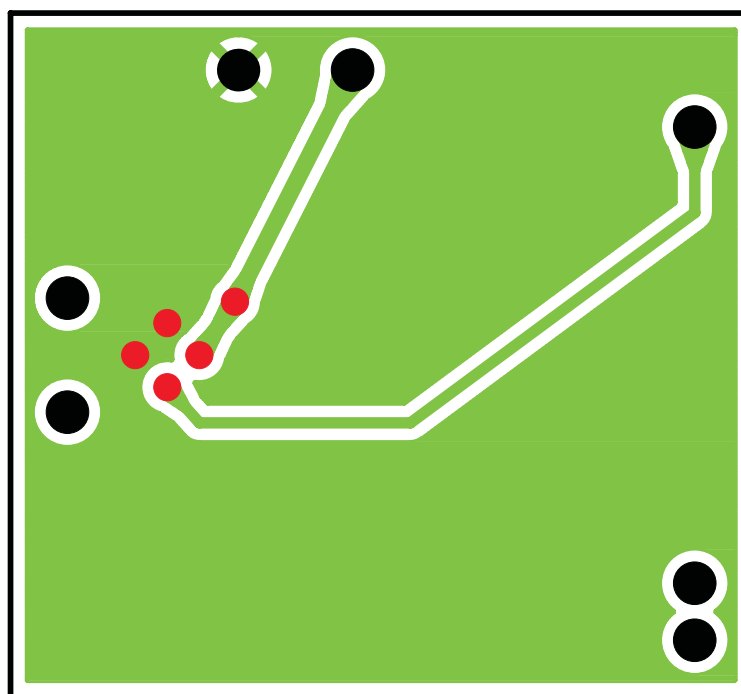


Figure 5. TPA2031D1 EVM Bottom Layer

## EVM IMPORTANT NOTICE (CATEGORY B)

### IMPORTANT: TI is providing the enclosed TPA2031D1 EVM evaluation module under the following conditions:

This evaluation module (EVM) being provided by Texas Instruments (TI) is intended for use for ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY and is not considered by Texas Instruments to be fit for commercial use. As such, this EVM may not be complete in terms of design and/or manufacturing related protective considerations including product safety measures typically found in the end-product incorporating the module. As a prototype, this product does not fall within the scope of the European Union Directive on electromagnetic compatibility and on low voltage and therefore may not meet the technical requirements of the directive. This EVM is not subject to the EU marking requirements.

- **Should this EVM not meet the specifications indicated in the User's Guide the EVM may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY TI 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 EVM. The user acknowledge that the use of the EVM could present serious hazards and that it is the user's responsibility to take all precautions for the handling and use of the EVMs in accordance with good laboratory practices. Please be aware that the products received may not be regulatory compliant or agency certified (FCC, UL, 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.
- **NEITHER PARTY WILL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**
- TI is currently dealing with various customers for products, and therefore our arrangement with the user **will not be exclusive.**
- **TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**
- Please read the User's Guide and specifically the section in the User's Guide pertaining to warnings and restrictions prior to handling the product. This section contains important information regarding high temperature and voltages which TI recommends to be read before handling the EVMs. In case of any doubt regarding safety, please contact the TI application engineer.
- Persons handling the product should 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 combination, machine, or process in which such TI products or services might be or are used.
- This Agreement is subject to the laws of the State of Texas, excluding the body of conflicts of laws and the United Nations Convention on the International Sale of Goods, and will be subject to the exclusive jurisdiction of the courts of the State of Texas.

### FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general customer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to 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.

### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage and the output voltage ranges as specified in the table below.

Input Range, $V_S$	2.5 V to 5.5 V
Input Range, $V_I$	-0.3 V to 6 V NOT TO EXCEED $V_{S+}$ or $V_{S-}$
Output Range, $V_O$	-0.3 V to $V_{DD} + 0.3$ NOT TO EXCEED $V_{S+}$ or $V_{S-}$

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  
Copyright © 2008, Texas Instruments Incorporated

## 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 TI 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. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2008, Texas Instruments Incorporated