TEXAS INSTRUMENTS

TPA3003D2EVM

3-W Stereo Class-D Audio Power Amplifier With DC Volume Control

User's Guide

March 2003 HPL

SLOU159

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range specified in this user's guide. The supply voltage range should be 8.5 V to 14 V, and supply current (I_{CC}) should be no greater than 1.6 A maximum.

Operating outside the specified supply voltage range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the supply voltage and current range, please contact a TI field representative prior to applying power to the device.

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 60°C. The EVM is designed to operate properly with certain components above 60°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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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.

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.

Electrostatic Sensitive Devices



This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in its supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, refer to SSYA008.

Related Documentation From Texas Instruments

- TPA3003D2 data sheet (SLOS406)

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Chapter 1

Introduction

This chapter provides a brief description of the TPA3003D2EVM.

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1.1 Description

The TPA3003D2 audio power amplifier evaluation module is a 3-watt-per-channel class-D stereo audio power amplifier complete with a small number of external components mounted on a circuit board that measures approximately 2-1/4 inches by 1-3/4 inches (Figure 1–1 and Figure 1–2).

Figure 1–1. The TI TPA3003D2 Audio Power Amplifier EVM (Top View)

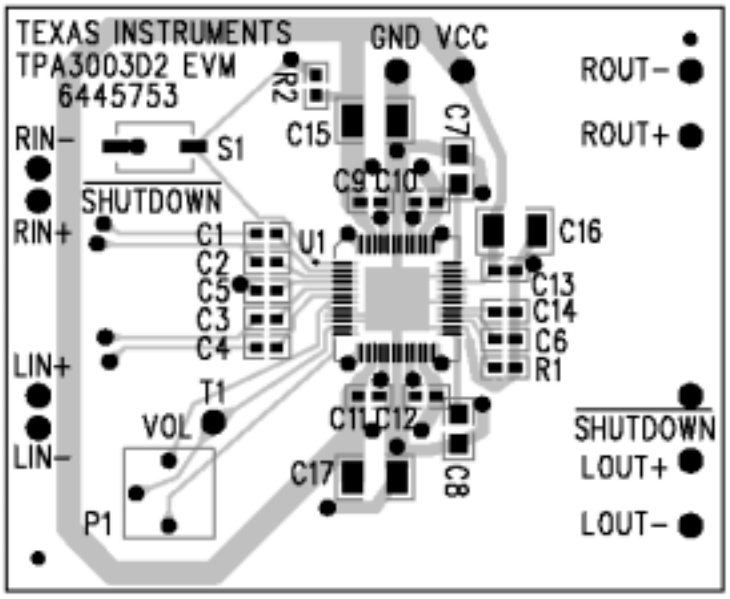
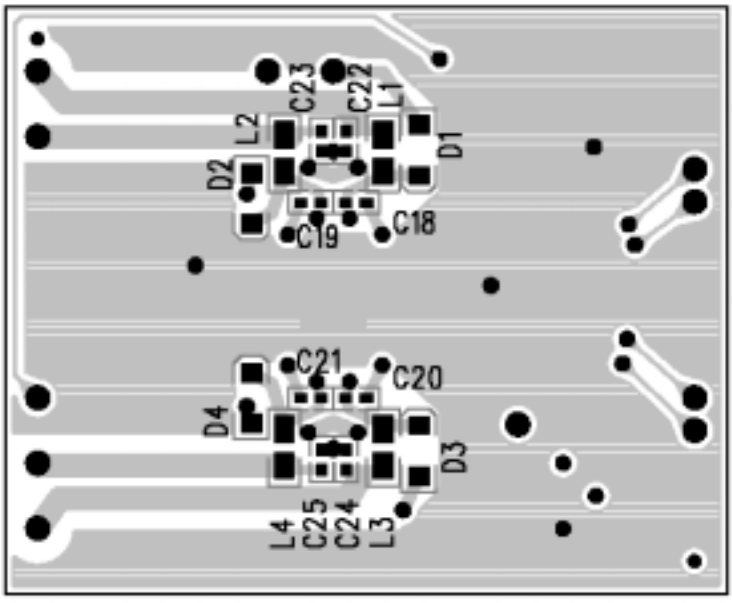


Figure 1–2. The TI TPA3003D2 Audio Power Amplifier EVM (Bottom View)



1.2 TPA3003D2EVM Specifications

Supply voltage range, V_{CC} . . . . . 8.5 V to 14 V
Input voltage range, V_I (VOL, MUTE, $\overline{\text{FADE}}$) . . . . . 0 V to 5.5 V
V_I ($\overline{\text{SD}}$) . . . . . 0 V to V_{CC} + 0.3 V
V_I (RINN, RINP, LINN, LINP) . . . . . 0 V to 7 V
Supply current, I_{CC} . . . . . 1.6 A Max
Continuous output power per channel, P_O: 8 Ω, V_{CC} = 12 V, THD+N = 10% . . . . . 3 W
Minimum load impedance, R_L . . . . . 8 Ω

Chapter 2

Operation

This chapter describes how to operate the TPA3003D2EVM.

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2.1 Quick Start List for Stand-Alone Operation 2-2

2.1 Quick Start List for Stand-Alone Operation

Follow these steps to use the TPA3003D2EVM stand-alone or when connecting it into existing circuits or equipment. Connections to the EVM 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.

2.1.1 Power Supply

1) Ensure that all external power sources are set to OFF.
2) Connect an external regulated power supply, set between 8.5 V and 14 V, to the module VCC and GND pins, taking care to observe marked polarity.

2.1.2 Inputs and Outputs

1) Ensure that the audio signal source level adjustments are set to minimum.
2) Connect the right and left positive audio source to the module RIN+ and LIN+ pins, respectively. Connect the right and left negative audio source to the module RIN– and LIN– pins, respectively.
3) If using single ended inputs, ground the LIN+ and RIN+ pins and connect the signal source to RIN– and LIN–.

Note:

If RIN+ and LIN+ on the EVM are connected to ground, the RINP and LINP on TPA3003D2 IC are ac grounded through C2 and C3. For the best noise performance, directly connect the input side (left side) of C2 and C3 to the AGND side of C5 with a short trace or solder bridge.

2.1.3 Evaluation Module Preparations

Adjust the signal source level as needed.

2.1.4 Control Inputs

Note:

Refer to the TPA3003D2 data sheet for logic threshold voltage ratings.

1) **$\overline{\text{SHUTDOWN}}$**: This pin is active low. A low on this pin shuts down the amplifier; a high on this pin places the amplifier in the active state. Leaving this pin floating also allows normal amplifier operation. Holding down switch S1 places the amplifier in the shutdown state. Releasing S1 returns the amplifier to the active state. The absolute maximum voltage on this terminal is V_{CC} + 0.3 V.
2) **MUTE**: This pin controls the stereo class-D outputs of the amplifier (ROUT+, ROUT–, LOUT+, and LOUT–). This pin is active high. A *high* on this pin causes the outputs (OUT+ and OUT–) to instantaneously ramp down in volume, which mutes the device. A *low* on this pin causes the outputs (OUT+ and OUT–) to instantaneously ramp up to volume. The absolute maximum voltage on this pin is 5.5 V.

Note:

Do not leave the MUTE pin floating. The TPA3003D2EVM connects the MUTE pin to ground. If the MUTE function is to be utilized on the EVM, unsolder the pin and lift it off the module circuit board. Solder a wire to the pin and apply the necessary voltage for the desired function.

3) **$\overline{\text{FADE}}$**: This pin controls the stereo class–D outputs of the amplifier (ROUT+, ROUT – , LOUT+, and LOUT –) during the four states of the device (power on, power off, coming out of shutdown, and going into shutdown). This pin is active low. A low on this pin causes the outputs (OUT+, and OUT –) to slowly ramp up to volume, when the device is powered on or when the device comes out of the shutdown state. A low also causes the outputs to slowly ramp down in volume when the device goes into shutdown. A high on this pin causes the outputs (OUT+, and OUT –) to instantaneously ramp up to volume when the device is powered on or when the device comes out of the shutdown state. A high also causes the outputs to instantaneously ramp down in volume when the device goes into shutdown. The absolute maximum voltage on this terminal is 5.5 V.

Note:

Do not leave the $\overline{\text{FADE}}$ pin floating. The TPA3003D2EVM connects the-$\overline{\text{FADE}}$ pin to ground. If the fade function is to be disabled, unsolder the pin and lift it off the module circuit board. Solder a wire to the pin and apply the necessary voltage for the desired function.

2.1.5 Power Up

1) Verify correct voltage and input polarity and set the external power supply to ON. The EVM begins operation.

2) Adjust the signal source level as needed.

Adjusting the Speaker Volume

3) Adjust the speaker (connected across OUT+ and OUT–) volume as needed by turning the P1 potentiometer in the clockwise direction to increase the volume. Conversely, turn P1 in the counterclockwise direction to decrease the volume. Refer to Table 3–2 in the Reference section for volume control settings.

Test Pins for Speaker Volume

❑ T1 – VOL – Speaker volume

Chapter 3

Reference

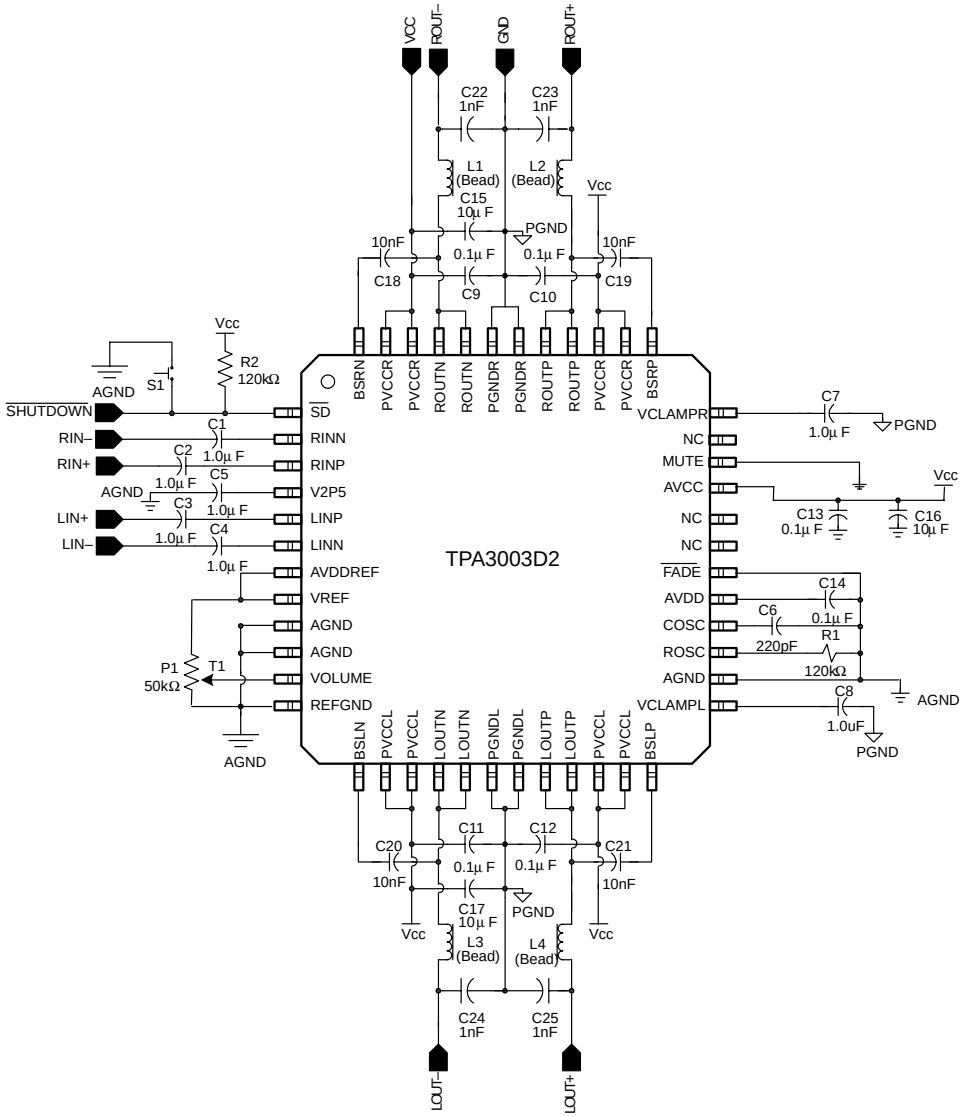
This chapter provides reference information for the TPA3003D2EVM.

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3.1 TPA3003D2EVM Schematic

Figure 3–1. TPA3003D2EVM Schematic



3.2 EVM PCB Layers

Figure 3–2. TPA3003D2EVM (Top Layer)

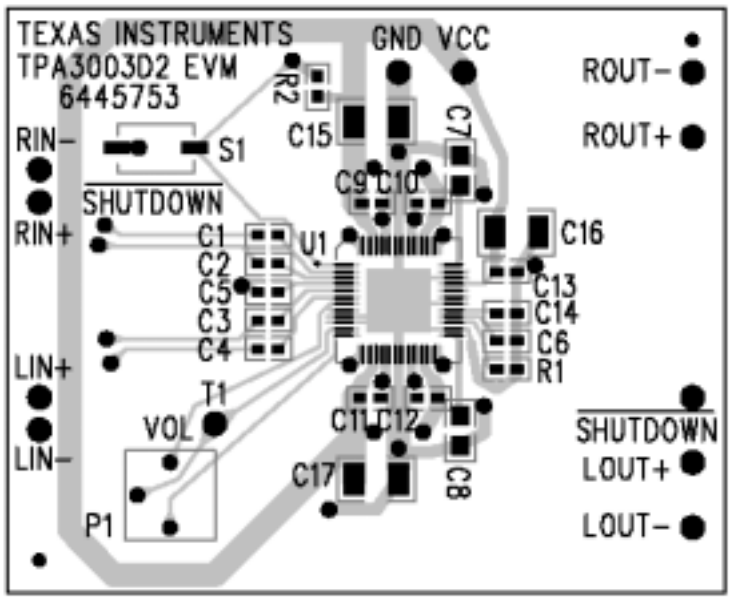
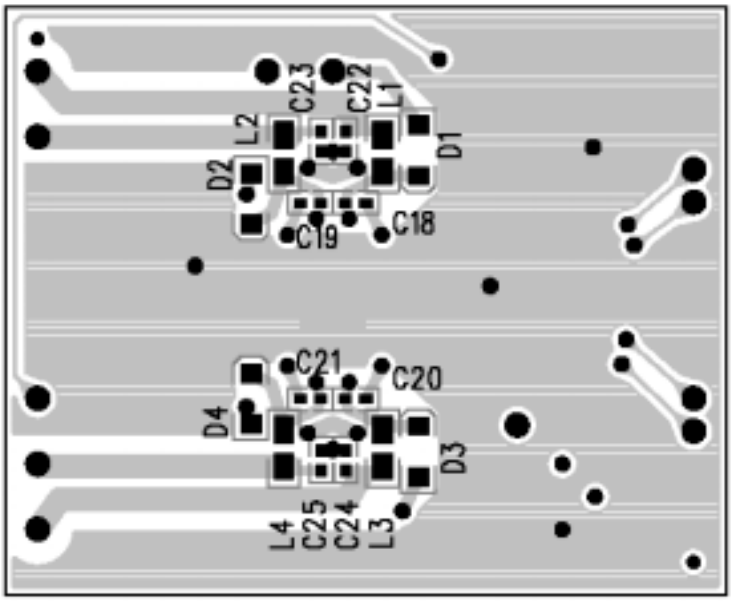


Figure 3–3. TPA3003D2EVM (Bottom Layer)



3.3 TPA3003D2EVM Parts List

Table 3–1. TPA3003D2EVM Parts List

Reference	Description	Size	Qty	Mfg.	Part #	Vendor #
C1–C5	Capacitor, ceramic, 1.0 μF, +80%/–20%, Y5V, 10 V	0603	5	Panasonic	ECJ–1VF1A105Z	Digi–Key PCC1787CT–ND
C6	Capacitor, ceramic, 220 pF, ±5%, 50 V	0603	1	Panasonic	ECJ–1VC1H221J	Digi–Key PCC221ACVCT–ND
C7, C8	Capacitor, ceramic, 1.0 μF, +80%/–20%, Y5V, 50 V	0805	2	Taiyo Yuden	UMK212F105ZG–T	TeCal UMK212F10526–T
C9–C14	Capacitor, ceramic, 0.1 μF, +80%/–20%, Y5V, 50 V	0603	5	Panasonic	ECJ–1VF1H104Z	Digi–Key PCC2153CT–ND
C15, C16, C17	Capacitor, ceramic, 10 μF, +80%/–20%, Y5V, 25 V	1210	3	Panasonic	ECJ–4YF1E106Z	Digi–Key PCC2171CT–ND
C18–C21	Capacitor, ceramic, 0.01 μF, +80%/–20%, Y5V, 50 V	0603	4	Panasonic	ECJ–1VF1H103Z	Digi–Key PCC1801CT–ND
C22–C25	Capacitor, ceramic, 1000 pF, ±10%, X7R, 50 V	0603	4	Panasonic	ECJ–1VB1H102K	Digi–Key PCC1772TR–ND
L1–L4	Ferrite bead, 0.05 Ω DCR, 70 Ω at 100 MHz, 3A	1206	4	Fair–rite	2512067007Y3	Mouser 623–2512067007Y3
R1–R2	Resistor, chip, 120 kΩ, 1/16 W, 5%	0603	2	Panasonic	ERJ–3GEYJ124V	Digi–Key P120KGTR–ND
D1–D4	Do not install					
P1	Potentiometer, 50 kΩ, thru hole		1	Bourns	3362P–1–503	Digi–Key 3362P–503–ND
S1	Switch, momentary, SMD, low profile		1	Panasonic	EVQ–PPBA25	Digi–Key P8086SCT–ND
PnP pins	Headers, 0.1 in centers, 1/2 in long		11	Samtec	SW–19–8–G–S	
T1	Test points, 0.040” mounting hole		1	Farnell	240–345	
U1	TPA3003D2PFB	48-pin QFP	1	TI	TPA3003D2PFB	

3.4 DC Volume Control

Table 3–2. DC Volume Control for Class-D Outputs

VOLTAGE ON THE VOLUME PIN AS A PERCENTAGE OF VREF (INCREASING VOLUME OR FIXED GAIN)	VOLTAGE ON THE VOLUME PIN AS A PERCENTAGE OF VREF (DECREASING VOLUME)	GAIN OF CLASS-D AMPLIFIER
%	%	dB
0 – 4.5	0 – 2.9	–75
4.5 – 6.7	2.9 – 5.1	–40.0
6.7 – 8.91	5.1 – 7.2	–37.5
8.9 – 11.1	7.2 – 9.4	–35.0
11.1 – 13.3	9.4 – 11.6	–32.4
13.3 – 15.5	11.6 – 13.8	–29.9
15.5 – 17.7	13.8 – 16.0	–27.4
17.7 – 19.9	16.0 – 18.2	–24.8
19.9 – 22.1	18.2 – 20.4	–22.3
22.1 – 24.3	20.4 – 22.6	–19.8
24.3 – 26.5	22.6 – 24.8	–17.2
26.5 – 28.7	24.8 – 27.0	–14.7
28.7 – 30.9	27.0 – 29.1	–12.2
30.9 – 33.1	29.1 – 31.3	–9.6
33.1 – 35.3	31.3 – 33.5	–7.1
35.3 – 37.5	33.5 – 35.7	–4.6
37.5 – 39.7	35.7 – 37.9	–2.0
39.7 – 41.9	37.9 – 40.1	0.5
41.9 – 44.1	40.1 – 42.3	3.1
44.1 – 46.4	42.3 – 44.5	5.6
46.4 – 48.6	44.5 – 46.7	8.1
48.6 – 50.8	46.7 – 48.9	10.7
50.8 – 53.0	48.9 – 51.0	13.2
53.0 – 55.2	51.0 – 53.2	15.7
55.2 – 57.4	53.2 – 55.4	18.3
57.4 – 59.6	55.4 – 57.6	20.8
59.6 – 61.8	57.6 – 59.8	23.3
61.8 – 64.0	59.8 – 62.0	25.9
64.0 – 66.2	62.0 – 64.2	28.4
66.2 – 68.4	64.2 – 66.4	30.9
68.4 – 70.6	66.4 – 68.6	33.5
> 70.6	>68.6	36.0