

TPA3001D1EVM

20-W Mono Class-D Audio Power Amplifier

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.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

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 8 V to 18 V.

Exceeding the specified supply voltage range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the supply voltage range, please contact a TI field representative prior to applying power to the device under test (DUT).

Applying loads outside of the specified load impedance 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 65°C. The EVM is designed to operate properly with certain components above 65°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

About This Manual

This user's guide describes the characteristics, operation, and use of the TPA3001D1EVM. The user's guide includes a schematic diagram, bill of materials (BOM), and board layout diagrams.

How to Use This Manual

This document contains the following chapters:

- ☐ Chapter 1—Introduction
- ☐ Chapter 2—Quick Start
- ☐ Chapter 3—Bill of Materials, Schematic, and PCB Layers

Trademarks

PowerPAD is a trademark of Texas Instruments.

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.

Contents

1	Introduction	1-1
1.1	Description	1-2
1.2	TPA3001D1EVM Specifications	1-3
2	Quick Start	2-1
2.1	Configuration	2-2
2.2	Precautions	2-2
2.3	Quick Start List for the Platform	2-4
2.4	Quick Start List for Stand-Alone Operation	2-5
3	Bill of Materials, Schematic, and PCB Layers	3-1
3.1	TPA3001D1EVM Bill of Materials	3-2
3.2	TPA3001D1EVM Schematic	3-3
3.3	TPA3001D1EVM PCB Layers	3-4

Figures

1–1	The TI TPA3001D1 Audio Power Amplifier EVM—Top View	1-2
1–2	The TI TPA3001D1 Audio Power Amplifier EVM—Bottom View	1-2
2–1	Quick Start Platform Map	2-3
3–1	TPA3001D1EVM Schematic Diagram	3-3
3–2	TPA3001D1EVM Top Layer	3-4
3–3	TPA3001D1EVM Bottom Layer	3-4

Tables

2–1	Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA3001D1	2-2
2–2	Typical TPA3001D1EVM Jumper Settings	2-2
2–3	Platform Jumper and Switch Settings for the TPA3001D1	2-4
2–4	Typical TPA3001D1EVM Jumper Settings	2-5
2–5	TPA3001D1EVM Gain Settings	2-7
3–1	TPA3001D1EVM Bill of Materials	3-2

Introduction

This chapter provides an overview of the Texas Instruments (TI) TPA3001D1EVM class-D audio amplifier evaluation module. It includes a list of EVM features, a brief illustrated description of the module, and a list of EVM specifications.

Topic	Page
1.1 Description	1-2
1.2 TPA3001D1EVM Specifications	1-3

1.1 Description

The TPA3001D1 evaluation module (EVM) is a 20-W class-D mono audio power amplifier complete with a small number of external components mounted on a circuit board measuring approximately 2 1/4 inches by 1 1/2 inches (Figure 1–1 and Figure 1–2).

Figure 1–1. The TI TPA3001D1 Audio Power Amplifier EVM—Top View

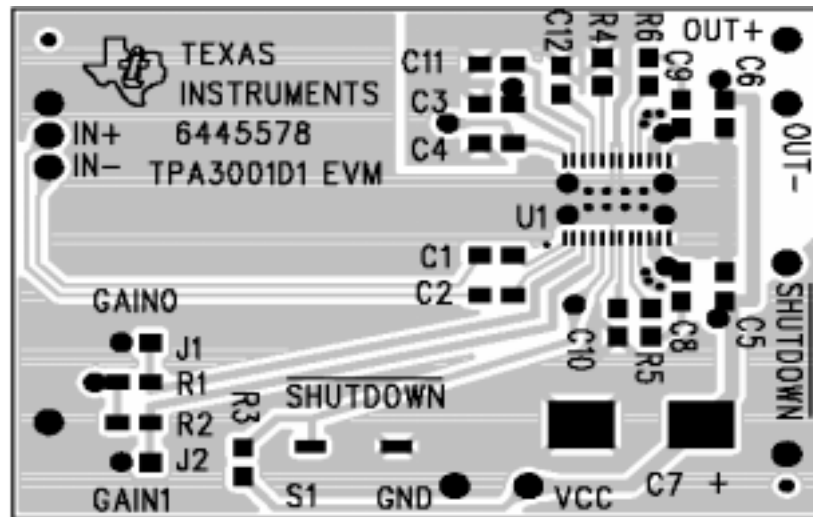
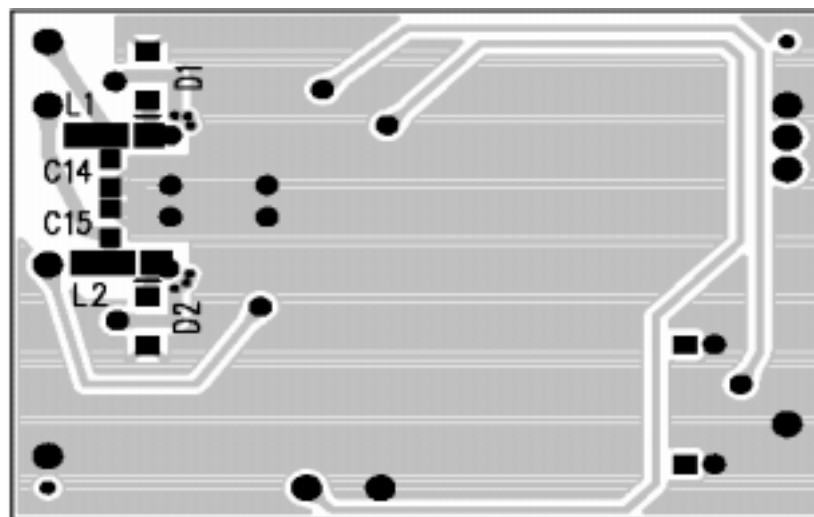


Figure 1–2. The TI TPA3001D1 Audio Power Amplifier EVM—Bottom View

**Note:**

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 operation.

The platform, which has room for a single TPA3001D1EVM, 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.

1.2 TPA3001D1EVM Specifications

Supply voltage range, V_{CC} 8 V to 18 V
Supply current, I_{CC} 2 A max
Continuous output power, $R_L = 8\ \Omega$, $V_{DD} = 18\text{ V}$, THD+N =10%, P_O . 20 W
Minimum load impedance, R_L $4\ \Omega^\dagger$

[†] Refer to the TPA3001D1 data sheet for recommendations on the maximum output power when driving a 4- Ω load.

Quick Start

Follow the steps in this chapter to quickly prepare the TPA3001D1EVM for use. Using the TPA3001D1EVM 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 in stand-alone operation by making connections directly to the module pins, and it can be wired directly into existing circuits or equipment.

Topic	Page
2.1 Configuration	2-2
2.2 Precautions	2-2
2.3 Quick Start List for the Platform	2-4
2.4 Quick Start List for Stand-Alone Operation	2-5

2.1 Configuration

The platform switch and jumper settings shown in Table 2–1 are typical for the TPA3001D1EVM and cause the TPA3001D1 to shut down when a plug is inserted into platform headphone jack J10 (see Note 3 in Table 2–1).

Table 2–1. Typical TI Plug-N-Play Platform Jumper and Switch Settings for the TPA3001D1

Power Type	JP1	JP2	JP3	JP4	JP5	JP6	JP7	JP8	S1	S2 (Note 2)	S3
VCC (J1)	ON	OFF	OFF	ON	X	Mode	X	X	ON	OFF	U5
AC/DC (J2)	OFF	ON	OFF	ON	X	Mode	X	X	ON	OFF	U5

Notes:

- 1) ON = Jumper installed, OFF = Jumper **NOT** Installed, X = Don't care
- 2) Set to ON when tone control board SLOP109 is installed in U1, otherwise set to OFF.
- 3) R3 must be removed from the TPA3001D1EVM to allow the headphone jack to control the shutdown of the TPA3001D1.

Table 2–2. Typical TPA3001D1EVM Jumper Settings

EVM	GAIN0	GAIN1
TPA3001D1	ON	ON

Note: ON = Jumper installed, OFF = Jumper **NOT** Installed

2.2 Precautions

Power Supply Input Polarity and Maximum Voltage

Always ensure 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.

2.3 Quick Start List for the Platform

Follow these steps when using the TPA3001D1EVM with the TI plug-n-play audio amplifier evaluation platform (see the platform user's guide, SLOU011, for additional details).

Platform Preparations

- 1) Ensure all external power sources and platform power switch S1 are set to OFF.
- 2) Install a TPA3001D1 module in platform socket U2, taking care to align the module pins correctly (EVM power pins engage sockets U2 and U3).
- 3) Set switch S2 to OFF.
- 4) Set switch S3 to U5.
- 5) Set jumper JP6 to select the Mode control input.

Table 2–3. Platform Jumper and Switch Settings for the TPA3001D1EVM

Power Type	JP1	JP4	JP5	JP6	JP7	JP8	S1	S2 (Note 2)	S3
VCC (J1)	ON	ON	X	Mode	X	X	ON	OFF	U5

Notes: 1) ON = Jumper installed, OFF = Jumper **NOT** Installed, X = Don't care
 2) Set to ON when tone control board SLOP109 is installed in U1.

Power Supply

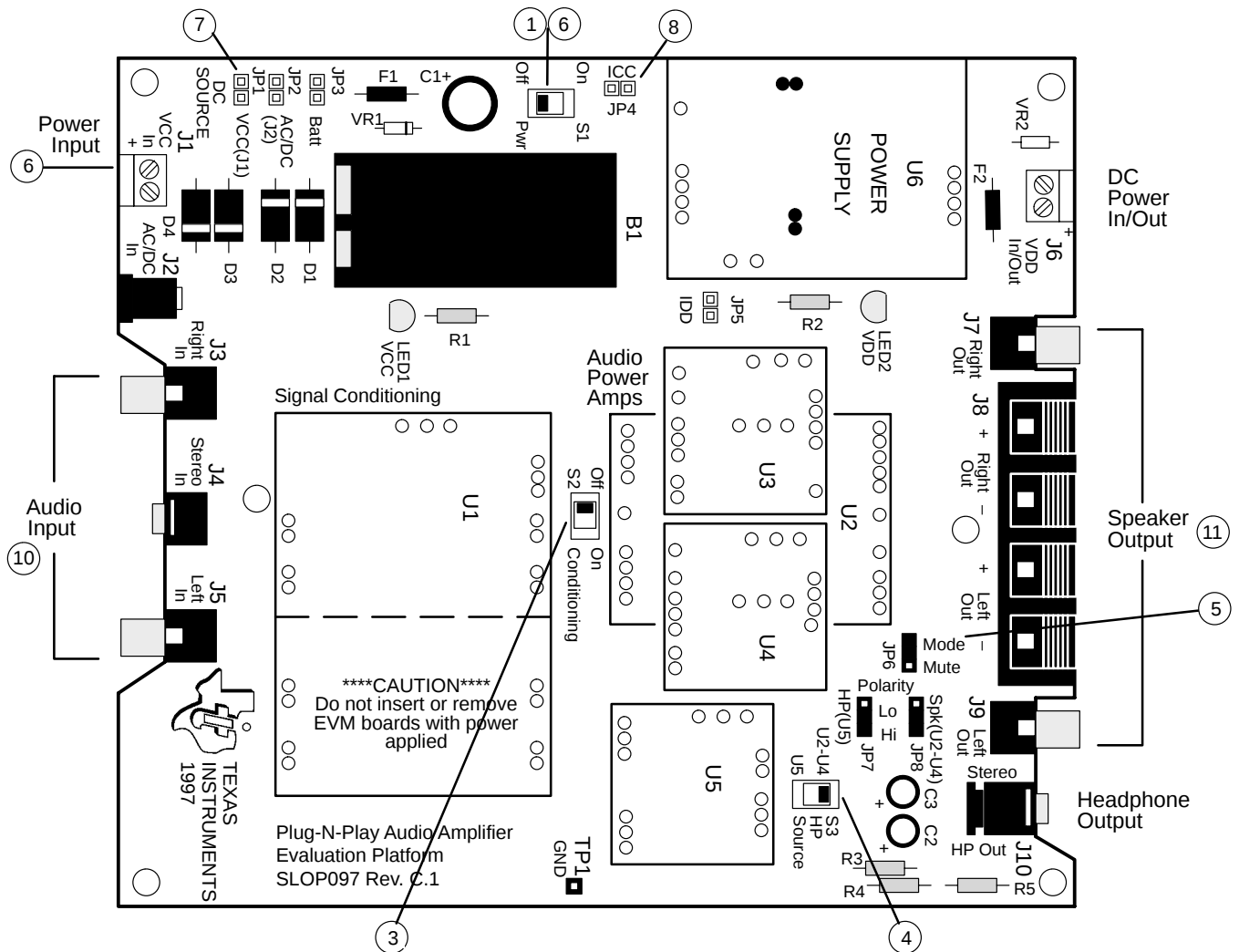
Do not exceed 15 V on the plug-n-play platform, or Zener diode VR1 may fail. If a power supply greater than 15 V is to be used, VR1 must be removed.

- 6) Ensure power switch S1 is set to OFF. Connect a regulated power supply with an output of 8 V to 15 V to J1, taking care to observe marked polarity.
- 7) Set jumper JP1 for DC source to be from input J1.
- 8) Set jumper JP4 for VCC power to EVMs.

Inputs and Outputs

- 9) Ensure that the audio signal source level is set to minimum.
- 10) Connect the audio source to the right RCA phono jack J3 or the mono miniature phone jack J4.
- 11) Connect speakers to the right RCA jack J7 or to the stripped wire speaker connectors J8.

Figure 2–1. Quick Start Platform Map



Evaluation Module Preparations

- 12) Use jumpers GAIN0 and GAIN1 to set the gain (Table 2–4).

Table 2–4. Typical TPA3001D1EVM Jumper Settings

GAIN1	GAIN0	GAIN (dB)
ON	ON	12
ON	OFF	18
OFF	ON	23.6
OFF	OFF	36

Note: ON = Jumper installed, OFF = Jumper REMOVED

Power Up

- 13) Verify correct voltage and input polarity and set the external power supply and platform power switch S1 to ON.

Note:

Platform LED1 should light indicating the presence of VCC, and the evaluation module(s) installed on the platform should begin operation.

- 14) Set switch S2 to ON if tone control board SLOP109 is installed in U1.
15) Adjust the signal source level as needed.

2.4 Quick Start List for Stand-Alone Operation

Follow these steps to use the TPA3001D1EVM as a stand-alone unit, or when connecting it into existing circuits or equipment. Connections to the TPA3001D1 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 from 8 V to 18 V to the module VCC and GND pins taking care to observe marked polarity. It is only necessary to use the ground pins adjacent to the module power pins.

Inputs and Outputs

- 3) Ensure that audio signal source level adjustments are set to minimum.
- 4) Connect the audio source across the module IN+ and IN– pins, taking care to observe marked polarity. For single-ended input, the negative input pin (IN–) should be connected to the ground of the audio signal source.
- 5) Connect a speaker to the module OUT+ and OUT– pins, taking care to observe marked polarity.

Evaluation Module Preparations

- 6) Adjust the source signal level as needed.
- 7) Use jumpers GAIN0 and GAIN1 to set the gain as shown in Table 2–5.

Table 2–5. TPA3001D1EVM Gain Settings

GAIN1	GAIN0	GAIN (dB)
ON	ON	12
ON	OFF	18
OFF	ON	23.6
OFF	OFF	36

Note: ON = Jumper installed, OFF = Jumper NOT installed

Control Inputs

Note:

The control signals applied to the EVM shutdown inputs must have sufficient current capability to overcome the 120-k Ω pullup resistor on each input.

Holding down S1 places the amplifier in the shutdown state. Releasing S1 returns the amplifier to the active state.

Refer to the TPA3001D1 data sheet (SLOS398) for logic threshold voltage ratings.

- 8) **SHUTDOWN:** This pin is active low. A low on this pin shuts down the amplifier; a high on this pin places the amplifier in an active state. Leaving this pin floating also allows normal amplifier operation.

Power Up

- 9) Verify correct voltage and input polarity and set the external power supply to ON. The EVM should begin operation.
- 10) Adjust the signal source level as needed.

Bill of Materials, Schematic, and PCB Layers

This chapter contains the bill of materials, schematic, and board layout for the TPS3001D1EVM.

Topic	Page
3.1 TPA3001D1EVM Bill of Materials	3-2
3.2 TPA3001D1EVM Schematic	3-3
3.3 TPA3001D1EVM PCB Layers	3-4

3.1 TPA3001D1EVM Bill of Materials

Table 3–1. TPA3001D1EVM Bill of Materials

Reference	Description	Size	Qty	MFG.	Part Number
C1, C2	Capacitor, ceramic, 0.47 μ F, 80%/–20%, Y5V, 16 V	0805	2	Panasonic	ECJ–2VF1C474Z
C3–C6, C10, C11	Capacitor, ceramic, 1 μ F, 80%/–20%, Y5V, 25 V	0805	7	Panasonic	ECJ–2FF1E105Z
C7	Capacitor, electrolytic, 10 μ F, 35 V, SMD	D	1	Panasonic	ECS–T1VD106R
C8,C9	Capacitor, ceramic, 0.22 μ F, 80%/–20%, Y5V, 16V	0805	2	Panasonic	ECJ–2VF1C224Z
C12	Capacitor, ceramic, 220 pF, $\pm$ 10%, X7R, 50 V	0805	1	Panasonic	ECU–V1H221KBN
C14,C15	Capacitor, ceramic, 1000 pF, $\pm$ 10%, X7R, 50 V	805	2	Panasonic	ECJ–2VB1H102K
L1, L2	Ferrite Bead, 0.05 Ω , DCR, 70 Ω at 100 MHz, 3 A	1206	2	Fair–Rite	2512067007Y3
R1, R2, R3, R4	Resistor, chip, 120 k Ω , 1/10 W, 5%	0805	4	Panasonic	ERJ–6GEYJ124V
R5	Resistor, chip, 0 Ω , 1/10W, 5%	805	1	Panasonic	ERJ–6GEY0R00V
R6, R7	Resistor, chip, 51 Ω , 1/10 W, 5%	0805	2	Panasonic	ERJ–6GEYJ510V
D1, D2	Schottky diode, Vfm = 0.5 V at 1 A, Vr = 30 V	SMA	2	Diodes, Inc.	B130–13
J1(GAIN0), J2(GAIN1)	Header, 2 position, male	2mm	2	Norcomp	2163–36–01–P2
	Shunts	2mm	2	Specialty Electronics	2JM–G
S1 (SHUTDOWN)	Switch, momentary pushbutton, 12 V, 50 mA		1	Panasonic	EVQ–PJS04K
PnP pins	Headers, 0.1 inch centers, 1/2 inch long		10	Sullins	PZC36SABN
U1	TPA3001D1PWP	24-pin TSSOP	1	TI	TPA3001D1PWP

The schematic diagram illustrates the TPA3001D1 audio amplifier circuit. The input stage consists of two input channels, IN- and IN+, each connected to the INN and INP pins of the TPA3001D1 through capacitors C1 and C2 (0.47 μF). The gain is controlled by the GAIN0 and GAIN1 pins, which are connected to a gain control input (J1) through capacitors C3 and C4 (1 μF). The shutdown pin is connected to a SHUTDOWN input through a 120 kΩ resistor (R3) and a 1 μF capacitor (C10). The power supply is connected to the VCC pin, and the shutdown pin is connected to the SHUTDOWN input through a 120 kΩ resistor (R3). The output stage includes a power pad, a ferrite bead (L1), and a diode (D1). The circuit is designed for a 100W output power.

