TPA3200D1 Audio Power Amplifier Evaluation Module

The TPA3200D1 evaluation module consists of a single 20-W digital input mono audio power amplifier complete with a small number of external components mounted on a circuit board that can be used to directly drive a speaker with an external I^2S audio source as the input.

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1 Introduction

This section provides a top and bottom view of the EVM and the EVM board specifications.

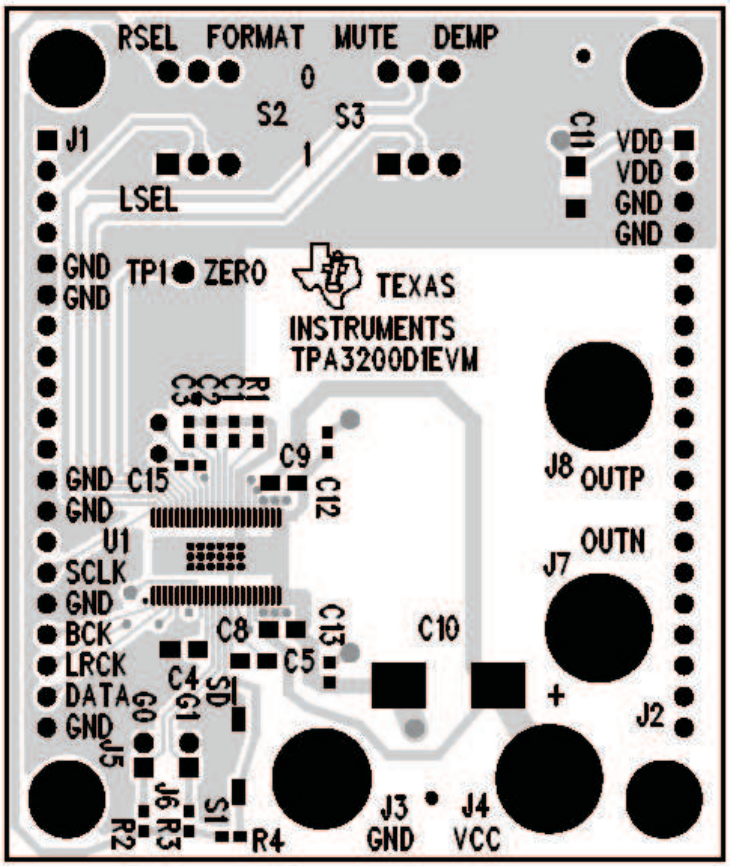

Figure 1. The TI TPA3200D1 Audio Power Amplifier EVM – Top View

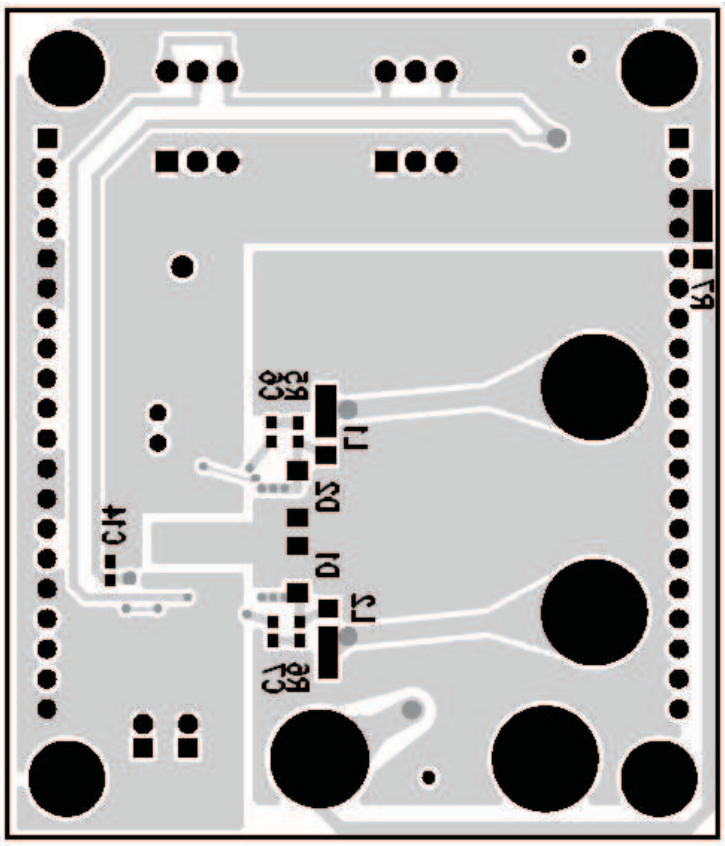

Figure 2. The TI TPA3200D1 Audio Power Amplifier EVM – Bottom View

Table 1. TPA3200D1 EVM Specifications

		TPA3200D1
V_{CC}	Supply voltage range	8 V to 18 V
V_{DD}		4.5 V to 5.5 V
I_{CC}	Supply current	3 A max
I_{DD}		40 mA max
	Continuous output power per channel, PO: 8 Ω, V_{CC} = 18 V, THD+N = 10%	20 W
R_L	Minimum load impedance	4 Ω

2 Operation

2.1 Quick Start List for Stand-Alone Operation

To use the TPA3200D1EVM stand-alone or when connecting it into existing circuits or equipment, follow these steps. Connections to the EVM module can be made by inserting stripped wire into the plated through holes on the J1, J2 headers and using banana plugs for the other connectors on the PCB.

2.1.1 Power Supply (Step 1)

1. Ensure that all external power sources are set to OFF.
2. Connect an additional external regulated power supply set to 5 V to the module VDD and GND pins on the top side of the **J2** header.

Note:

This supply should be turned ON before the VCC supply is turned ON.

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3. Connect an external regulated power supply adjusted from 8 V–18 V to the module VCC (**J4**) and GND (**J3**) banana jacks taking care to observe marked polarity.

2.1.2 Evaluation Module Preparations (Step 2)

Inputs and Outputs

1. Ensure that all connections are made to the I^2S inputs (SCLK, BCK, LRCK, DATA, and GND) on the **J1** header.
2. Connect a speaker across OUTP (**J8**) and OUTN (**J7**)
3. Install both gain jumpers GAIN0 (**J5**) and GAIN1 (**J6**). This sets the gain of the amplifier to the lowest level, 12 dB.

Control Inputs

1. $\overline{\textbf{SHUTDOWN}}$: This terminal is active *low*. A *low* on the device terminal (< 0.8 V) shuts down the amplifier; a *high* (> 2 V) on the device terminal places the amplifier in the active state. Holding down switch **S1** places the amplifier in the SHUTDOWN state. Releasing **S1** returns the amplifier to the active state.
2. **MUTE**: This terminal is active *high*. A *high* on this terminal immediately terminates audio playback through the speakers. However, the outputs are still active (they are switching). The outputs are *not* disabled like the SHUTDOWN case. **S3** on the EVM controls the state of the MUTE terminal. Switching the left side of **S3** to 1 turns Mute *on*. Switching **S3** to the 0 position turns Mute *off*.
3. **FORMAT**: This terminal selects between two possible digital data input formats. **S2** on the EVM controls the data format. Switching the right side of **S2** to 0 selects the 16-24 bit, I^2S format. Switching the right side of S2 to 1 selects the 16-bit right-justified format.
4. **LSEL/RSEL**: A typical digital input data stream consists of 2 channels of data. However, this amplifier is a mono, bridged-tied amplifier. Therefore, it is necessary to select which channel of data is sent to the mono output. This terminal is used to select between the 2 channels, typically left/right data. Switching the left side of **S2** to the *RSEL* position selects right-channel data. Switching the left side of **S2** to the *LSEL* position selects left-channel data.
5. **DEMP**: This terminal is used to enable/disable the internal 44.1-kHz de-emphasis filter. **S3** on the EVM controls the functionality of this terminal. Switching the right side of **S3** to the 0 position *disables* the 44.1-kHz de-emphasis. Switching the right side of **S3** to the 1 position *enables* the 44.1-kHz de-emphasis.
6. **GAIN0/GAIN1**: Together, these terminals control the back-end gain of the amplifier. Jumpers **J5** and **J6** control these terminals. The position of these jumpers and resulting gain is shown in Table 2.

Table 2. Gain Settings

GAIN1 (J6)[1]	GAIN0 (J5)[1]	AMPLIFIER GAIN (dB)
ON	ON	12
ON	OFF	18
OFF	ON	23.6
OFF	OFF	Reserved

(1) OFF = Jumper removed; ON = Jumper installed

Control Outputs

1. **ZERO**: This pin is a TTL output for monitoring the state of the digital input. If the data for L-channel and R-channel remains at a 0 level for 1024 sampling periods (or LRCK clock periods), ZERO is set to a logic 1 state. If an input is present, the ZERO output is set to a logic 0. If desired, the output of this terminal can be inverted with an external transistor and used to place the amplifier in a SHUTDOWN state when no input is detected (see the operation of the $\overline{\text{SHUTDOWN}}$ terminal in the *Control Input* section). A test point, **TP1**, is provided to monitor this output.

Power Up

1. Verify correct voltage and input polarity, and turn the external power supplies *on*. The supplies should be sequenced such that the 5-V supply comes up first before the 8-V – 18-V supply is turned *on*. The EVM should begin operation.
2. Adjust the control inputs to the desired settings.
3. If no sound is audible, check the state of the MUTE (**S3**) switch.
4. If the sound is distorted, check the status of the FORMAT (**S2**) switch to ensure that the format selected matches the incoming digital data stream.
5. Adjust the amplifier gain by installing/removing the gain jumpers, **J5** and **J6**.
6. Switch between the *left* and *right* digital data by moving the left side of switch **S2** between the two settings.

2.2 Quick Start List for DEM-DAI/DAC Platform Operation

To use the TPA3200D1EVM with a DEM-DAI/DAC platform, follow these steps. The DEM-DAI/DAC platform consists of a 96-kHz digital audio receiver that accepts S/PDIF and optical inputs for direct interface to a digital audio source such as an audio precision or component CD/DVD player. This platform can be used to evaluate the audio performance of the TPA3200D1EVM using a measurement system such as the Audio Precision system. Figure 3 is referenced throughout this section. See the DEM-DAI1742 document (SBAU034) for detailed information on the operation of this board.

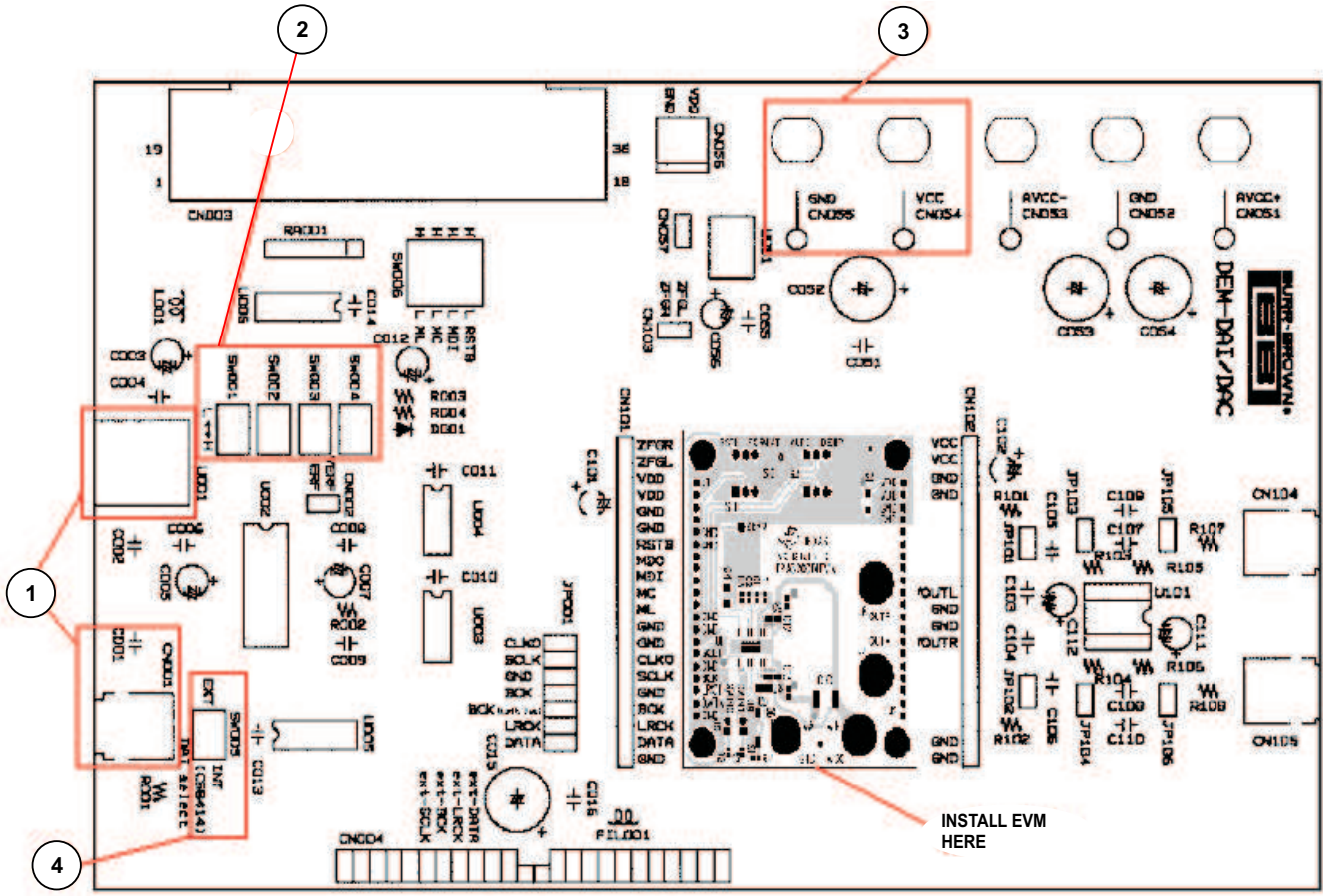

Figure 3. DEM-DAI/DAC Evaluation Platform

2.2.1 Evaluation Platform Preparations (Step 1)

Setup

1. Install the EVM into the DEM-DAI/DAC platform in the location at the center of the platform. The header labeled **J1** should be attached to **CN101** on the DEM platform. The header labeled **J2** should be attached to **CN102** on the DEM platform. See Figure 3 for proper alignment.
2. Connect a CD/DVD player or audio precision via a single RCA cable from the coaxial (digital) output to **CN001** or use an optical cable to connect from the optical (digital) output to **U001** on the DEM platform. See Note 1 in Figure 3.
3. Set switches **SW001–SW003** on the DEM platform according to Table 3. Settings of this switch need to match the FORMAT selection on the TPA3200D1EVM. Other settings of **SW001–SW003** are not supported by the TPA3200D1EVM. See Note 2 in Figure 3.

Table 3. Digital Audio Receiver Data Format

SW001	SW002	SW003	Receiver Output Data Format
L	H	L	16-24 bit I^2S
H	L	H	16-bit Right Justified

4. Set switch **SW005** to **INT** (**CS8414**). See Note 4 in Figure 3.

Power Supply

1. Ensure that all external power sources are set to *off*
2. Connect a 5-V supply to **CN054** and **CN055** on the DEM-DAI/DAC platform. See Note 3 in the Figure 3. **CN054** should be connected to the positive and **CN055** connected to the negative side of the supply.
3. Connect an external regulated power supply adjusted from 8 V–18 V to the module VCC (**J4**) and GND (**J3**) banana jacks taking care to observe marked polarity. Be careful when inserting the banana plugs to ensure that they are not inserted too far and short out vias on the DEM-DAI/DAC platform below.

2.2.2 Evaluation Module Preparations (Step 2)

Inputs and Outputs

1. Ensure that a CD/DVD player or audio precision is connected via a single RCA cable from the coaxial (digital) output to **CN001** or use an optical cable to connect from the optical (digital) output to **U001** on the DEM–DAI/DAC platform.
2. Connect a speaker across OUTP (**J8**) and OUTN (**J7**) on the TPA3200D1EVM.
3. Install both gain jumpers GAIN0 (**J5**) and GAIN1 (**J6**) on the TPA3200D1EVM. This sets the gain of the amplifier to the lowest level, 12 dB.

Control Inputs

1. **$\overline{\text{SHUTDOWN}}$**: This terminal is active *low*. A *low* on the device terminal (< 0.8 V) shuts down the amplifier; a *high* (> 2 V) on the device terminal places the amplifier in the active state. Holding down switch **S1** places the amplifier in the SHUTDOWN state. Releasing **S1** returns the amplifier to the active state.
2. **MUTE**: This terminal is active *high*. A *high* on this terminal immediately terminates audio playback through the speakers. However, the outputs are still active (they are switching). The outputs are *not* disabled like the SHUTDOWN case above. **S3** on the EVM controls the state of the MUTE terminal. Switching the left side of **S3** to 1 turns Mute *on*. Switching **S3** to the 0 position turns Mute *off*.
3. **FORMAT**: This terminal selects between two possible digital data input formats. **S2** on the EVM controls the data format. Switching the right side of **S2** to 0 selects the 16–24 bit, I^2S format. Switching the right side of **S2** to 1 selects the 16-bit right-justified format. Switches **SW001–SW003** should be set on the DEM platform to match the settings on the EVM.
4. **LSEL/RSEL**: A typical digital input data stream consists of 2 channels of data. However, this amplifier is a mono, bridged-tied amplifier. Therefore, it is necessary to select which channel of data is sent to the mono output. This terminal is used to select between the 2 channels, typically left/right data. Switching the left side of **S2** to the *RSEL* position selects right-channel data. Switching the left side of **S2** to the *LSEL* position selects left-channel data.
5. **DEMP**: This terminal is used to enable/disable the internal 44.1-kHz de-emphasis filter. **S3** on the EVM controls the functionality of this terminal. Switching the right side of **S3** to the 0 position *disables* the 44.1-kHz de-emphasis. Switching the right side of **S3** to the 1 position *enables* the 44.1-kHz de-emphasis.
6. **GAIN0/GAIN1**: Together, these terminals control the back-end gain of the amplifier. Jumpers **J5** and **J6** control these terminals. The position of these jumpers and resulting gain is shown in Table 4.

Table 4. Gain Settings

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(1) OFF = Jumper removed; ON = Jumper installed

Control Outputs

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Power Up

1. Verify correct voltage and input polarity and turn the external power supplies *on*. The supplies should be sequenced such that the 5-V supply comes up first before the 8-V – 18-V supply is turned *on*. The EVM should begin operation.
2. Adjust the control inputs to the desired settings.
3. If no sound is audible, check the state of the MUTE (**S3**) switch.
4. If the sound is distorted, check the status of the FORMAT (**S2**) switch to ensure the format selected matches the incoming digital data stream selected by **SW001–SW003** on the DEM-DAI/DAC platform.
5. Adjust the amplifier gain by installing/removing the gain jumpers, **J5** and **J6**.
6. Switch between the LEFT and RIGHT digital data by moving the left side of switch **S2** between the two settings.

3 Schematic, PCB Layers and Parts List

This section contains the EVM schematic, board layout, and bill of materials.

3.1 TPA3200D1 EVM Schematic

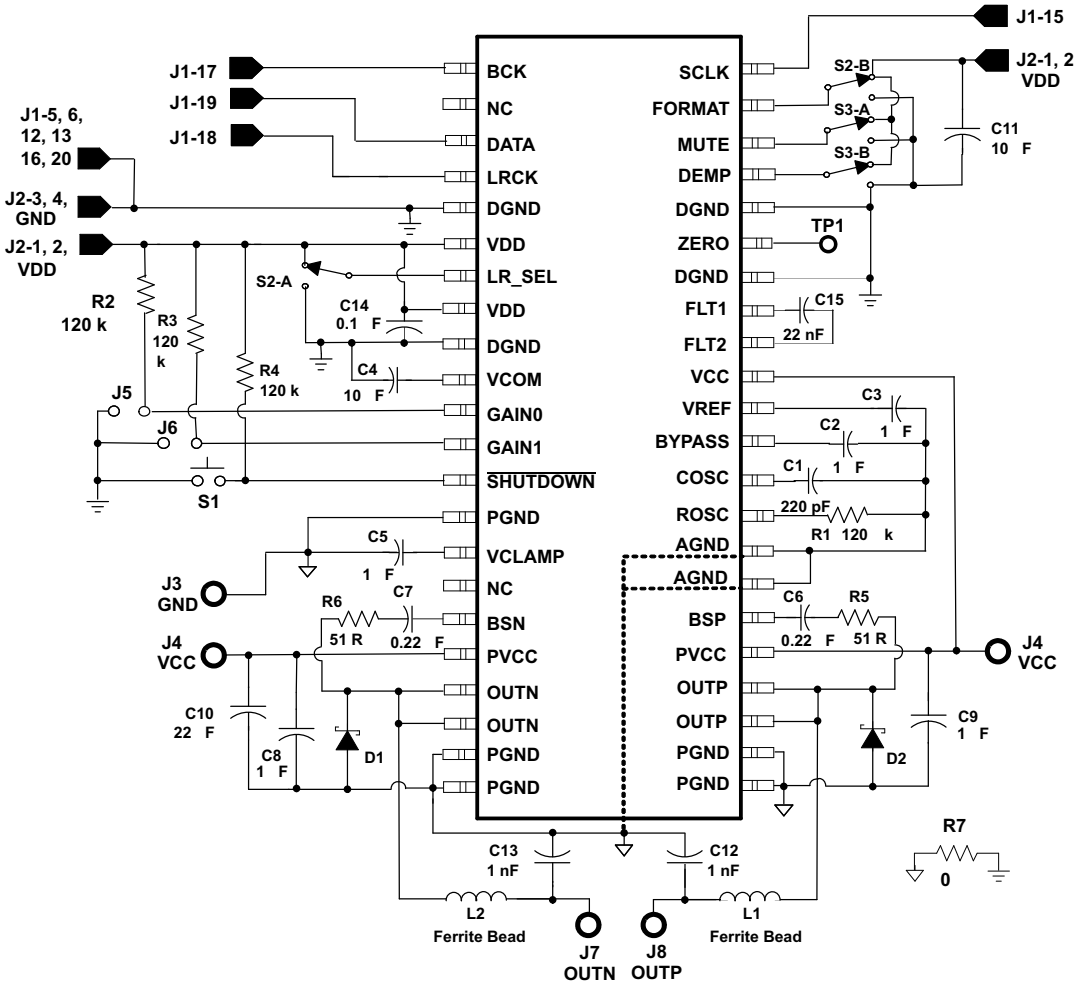

Figure 4. TPA3200D1 EVM Schematic

3.2 TPA3200D1 EVM PCB Layers

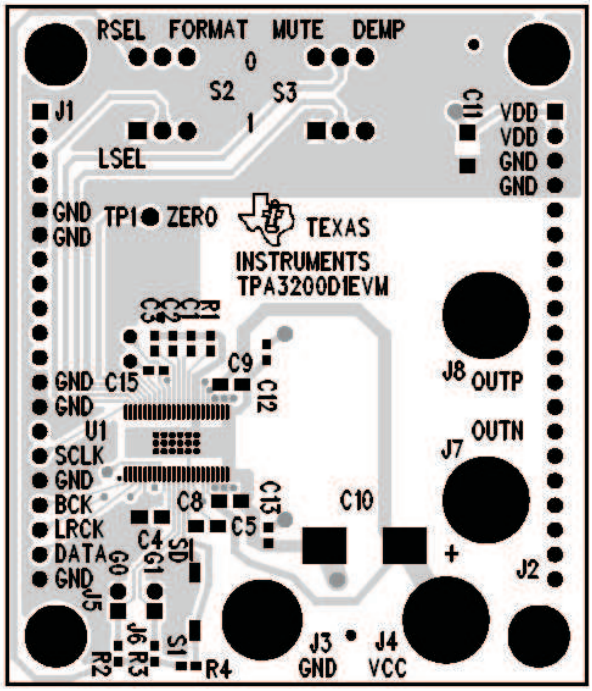

Figure 5. TPA3200D1 EVM – Top Layer

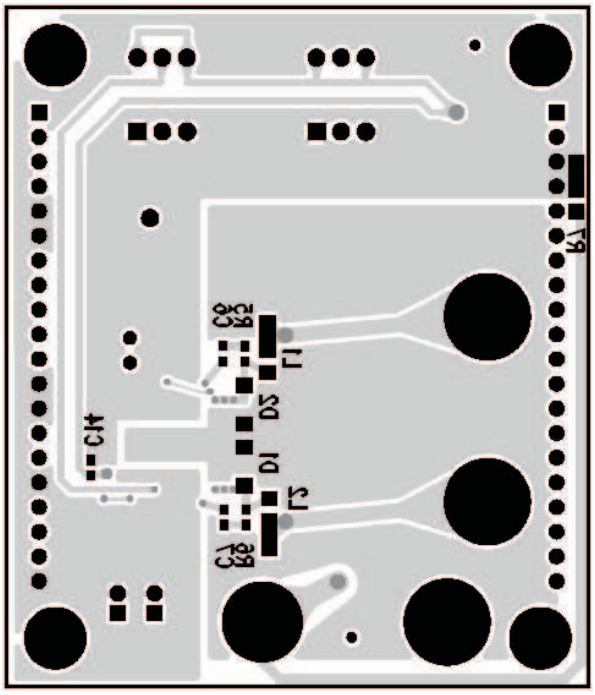

Figure 6. TPA3200D1 EVM – Bottom Layer

4 TPA3200D1 EVM Parts List

Table 5. TPA3200D1 EVM Parts List

Reference	Description	Size	Qty	Mfg.	Manufacturer Part #	Vendor/#
C1	Capacitor, ceramic, 220pF, +/-5%, 50V	0603	1	Panasonic	ECJ-1VC1H221J	Digi-Key/ PCC221ACVCT-ND
C2-C3	Capacitor, ceramic, 1.0uF, +80%/-20%, Y5V, 10V	0603	2	Panasonic	ECJ-1VF1A105Z	Digi-Key/ PCC1787CT-ND
C4	Capacitor, ceramic, 10uF, +80%/-20%, Y5V, 10V	0805	1	TDK	C2012Y5V1A106ZT	Digi-Key/ 445-1371-2
C5, C8-C9	Capacitor, Ceramic, 1.0uF, +80%/-20%, Y5V, 50V	0805	3	Tayio Yuden	UMK212F105ZG-T	Tecal
C6, C7	Capacitor, ceramic, 0.22uF, +80%/-20%, Y5V, 16V	0603	2	Panasonic	ECJ-1VF1C224Z	Digi-Key/ PCC1790CT-ND
C10	Capacitor, ceramic, 22uF, +/-20%, X5R, 25V	1812	1	TDK	C4532X5R1E226M	Digi-Key/ 445-114-1-ND
C11	Capacitor, ceramic, 10uF, +80%/-20%, Y5V, 10V	1206	1	Murata	GRM31MF51A106ZA01L	Digi-Key/ 490-1843-2-ND
C12-C13	Capacitor, ceramic, 1000pF, 10%, X7R, 50V	0603	2	Panasonic	ECJ-1VB1H102K	Digi-Key/ PCC1772TR-ND
C14	Capacitor, ceramic, 0.1uF, +80%/-20%, Y5V, 50V	0603	1	Panasonic	ECJ-1VF1H104Z	Digi-Key/ PCC2153CT-ND
C15	Capacitor, polyester film, 0.022 µF, 10%, 63V	Thru-hole	1	Wima	MKS02-0.022/63/10	Mouser/ MKS02.022/63/10
D1-D2	Schottky diode, Vfm=0.5V @ 1A, Vr=30V	SMA	4	Diode, Inc.	B130-13	Digi-Key/ B130DITR-ND
L1-L2	Ferrite Bead, 0.05 ohms DCR, 70 ohms at 100MHz, 3A	1206	2	Fair-rite	2512067007Y3	Mouser/ 623-2512067007Y3
R1-R4	Resistor, chip, 120 kohm, 1/16 W, 5%	0603	4	Panasonic	ERJ-3GEYJ124V	Digi-Key/ P120KGTR-ND
R5, R6	Resistor, chip, 51 ohm, 1/10 W, 5%	0603	2	Panasonic	ERJ-3GEYJ510V	Digi-key/ P51GTR-ND
R7	Resistor, chip, 0 ohm, 1/4W, 5%	1206	1	Panasonic	ERJ-8GEY0R00V	Digi-key/ P0.0ETR-ND
S1	SWITCH, MOMENTARY, SMD, LOW PROFILE	SMT	1	Panasonic	EVQ-PPBA25	Digi-Key/ P8086SCT-ND
S2, S3	SWITCH, 2-Position, toggle, DIP	DIP	2	Grayhill	76STC02	
J3	1/16" Spacer (3 per plug), BLACK	1/16"	3	Volt Plastics	WF-0312-0187-0050	www.voltplastics.com
J4	1/16" Spacer (3 per plug), RED	1/16"	3	Volt Plastics	WF-0312-0187-0050	www.voltplastics.com
J7	1/16" Spacer (3 per plug), BLUE	1/16"	3	Volt Plastics	WF-0312-0187-0050	www.voltplastics.com
J8	1/16" Spacer (3 per plug), YELLOW	1/16"	3	Volt Plastics	WF-0312-0187-0050	www.voltplastics.com
J3, J4, J7-J8	Banana Eyelets		4		SE-68-Hot Solder Dipped	
J5, J6	Header, 2 position, Male	2mm	2	Norcomp	2163-36-01-P2	Digi-Key/ 2163S-36-ND
J5, J6 (shunts)	SHUNT, 2MM	2mm	2	Specialty	2JM-G	
TP1	Test Points, 0.040" mounting hole		1	Farnell	240-345	
U1	TPA3200D1, 20W, digital input, audio amplifier	44-pin TSSOP	1	TI	TPA3200D1DCP	

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It is important to operate this EVM within the input voltage range of 8 V to 18 V for VCC and 4.5 V to 5.5 V for VDD and the output voltage range of 8 V to 18 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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