

TPA2050D4EVM Evaluation Module

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1 Introduction

1.1 Description

The TPA2050D4 is a stereo Class-D power amplifier along with a stereo DirectPath™ headphone amplifier. Both input channels have 32-step volume control and the DirectPath™ headphone amplifier has a 4-step level gain control with power limiter. The volume is controlled through an I²C™ interface. All amplifiers have output short-circuit and thermal-overload protection.

The TPA2050D4 evaluation module(EVM) is a complete, stand-alone audio board. It contains the TPA2050D4 WCSP(YZK) Class-D audio subsystem.

All components and the EVM are Pb free.

DirectPath is a trademark of Texas Instruments.
 Windows is a trademark of Microsoft Corporation.
 I²C is a trademark of Philips Electronics.

1.2 TPA2050D4EVM Specifications

VDD	Supply voltage range	-0.3 V to 6 V
IDD	Supply current	1.5 A Maximum
PO	Speaker Continuous output power per channel, 8 Ω , Vdd = 5 V, THD + N = 1%	1.25 W
	Headphone Continuous output power per channel, 16 Ω , Vdd = 5 V, THD + N = 1%	145 mW
RL	Minimum load impedance (Speaker)	8 Ω
	Minimum load impedance (Headphone)	16 Ω

2 Operation

The TPA2050D4EVM can be evaluated in a stand-alone mode or when connected to existing circuits with I²C controls.

2.1 Quick Start for Stand-Alone Operation

A desktop or laptop with Windows™ XP installed is required in the stand-alone operation. Connect the EVM to a computer with a USB cable. A jumper allows the TPA2050D4 to receive power from either the USB or an external supply via banana plugs. The inputs accept standard RCA plugs. The speaker output connection accepts banana plugs. The headphone output connection accepts standard 3.5-mm headphone plugs.

2.1.1 Software Installation Sequence

1. Insert the CD provided.
2. Unzip the files to a temporary folder.
3. Install TPA2050D4 software by executing setup.exe located in *TPA2050D4 Setup*.

Accept license agreement and defaults, and complete installation. Note: you can uninstall later with Add/Remove Programs. It is unnecessary to repeat the preceding steps, once the software is installed.

2.1.2 Evaluation Module Setup

1. Configure the jumpers as the following table for a default setting:

Table 1. Jumpers Default Setting

Jumper	Default Setting
JP1 (DVDD)	Shunt
JP2, JP3	Shunt across each other
JP4	Shunt
JP5, JP6, JP7, JP8	As shown in Figure 2
JP9 (USB PWR)	Remove

2. There are different modes of input operation in for TPA2050D4, configure the input according to the follow:

- a. Stereo Differential Mode (MODE[2:0] = 011):

Install shunts and connect RCA plugs as shown in [Figure 1](#).

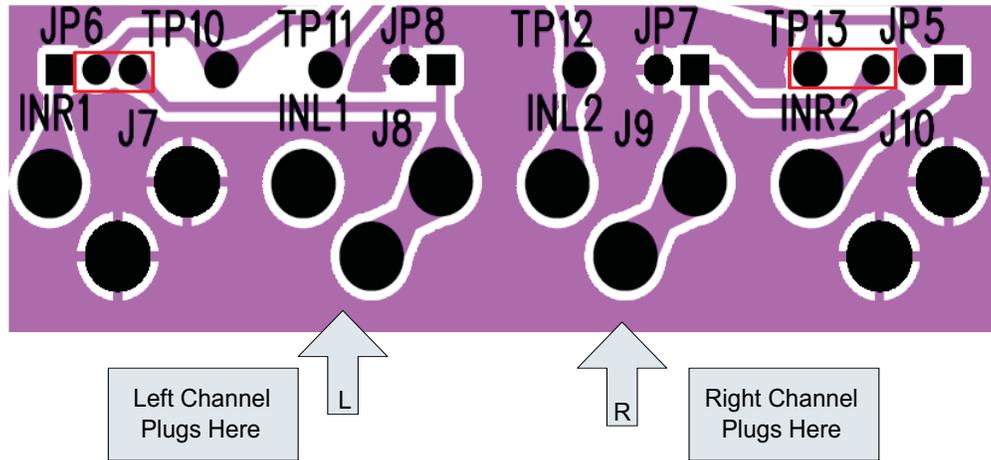


Figure 1. Stereo Differential Mode Input Configuration

- b. For all other modes, install shunts and connect RCA plugs as shown in [Figure 2](#).

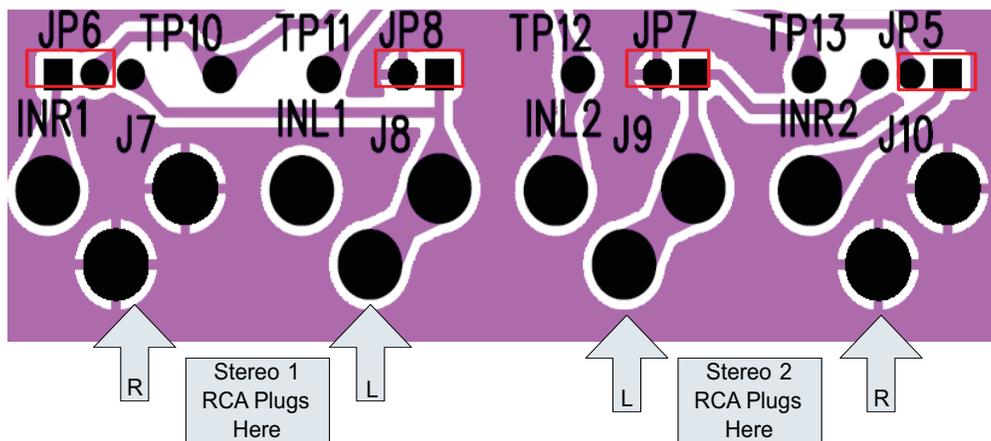


Figure 2. Non-Differential Mode Input Configuration

3. Install shunts in JP2 and JP3 as shown in [Figure 3](#). This sets the TPA2050D4 to accept I²C inputs from the EVM itself.

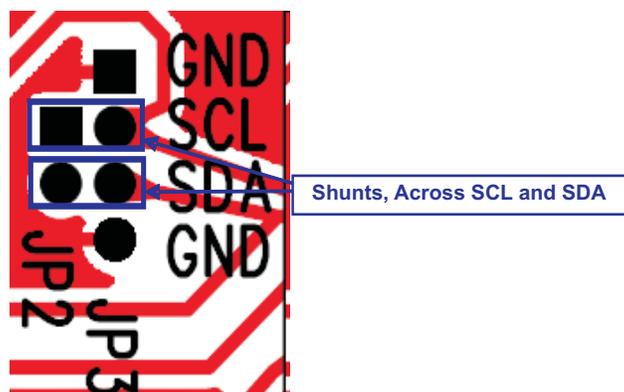


Figure 3. Place Shunts Horizontally Across SCL and SDA

4. Ensure that all external power sources are set to OFF.
5. Connect an external regulated power supply adjusted from 2.5 V to 5.5 V to the module VDD (J5) and GND (J6) banana jacks, taking care to observe the marked polarity.
6. Install shunt in JP1 if DVDD is powered by the 1.8 V regulated supply from the EVM itself. If DVDD is powered by another supply (between 1.8 V and 3.3 V), remove shunt in JP1 and connect the supply at header 1 of JP1.
7. HPVDD is set to VDD by default. If HPVDD is powered by another supply (between 2.5 V and 5.5 V), remove R17 and connect the supply at TP24.
8. Connect audio source as mentioned in step 2.
9. Connect headphones to J4.
10. Connect speakers (8 Ω to 32 Ω) to the output (J11, J12 for LOUT and J13, J14 for ROUT). The speakers can also be connected to J2 and J3 if header connection is available in the speakers.
11. Plug in the USB.
12. Turn on power sources.
13. The TPA2050D4 can also be powered by USB cable if the audio amplifier output power is less than 100mW. Shunt JP9 and remove the power supply at J5 and J6 for USB power option.
14. The following table provides the test points information on the EVM:

Table 2. Test Points Information

Test Point	Description
TP1, TP2, TP3, TP4	OUTR+, OUTR-, OUTL-, OUTL+
TP5, TP6, TP7, TP8	Filtered OUTR+, OUTR-, OUTL-, OUTL+
TP9	HPVSS
TP10	INR_1
TP11	INL_1
TP12	INL_2
TP13	INR_2
T14	HPRIGHT
T15	HPLEFT
TP18	DVDD
TP20	SCL
TP23	SDA
TP24	HPVDD
TP27	VREF
TP19, TP21, TP22, TP25, TP26	GND

2.1.3 Using the Software

1. Start the TPA2050D4 Interface by clicking the *Start* menu and clicking on the *Texas Instruments Inc -> TPA20050D4* icon.

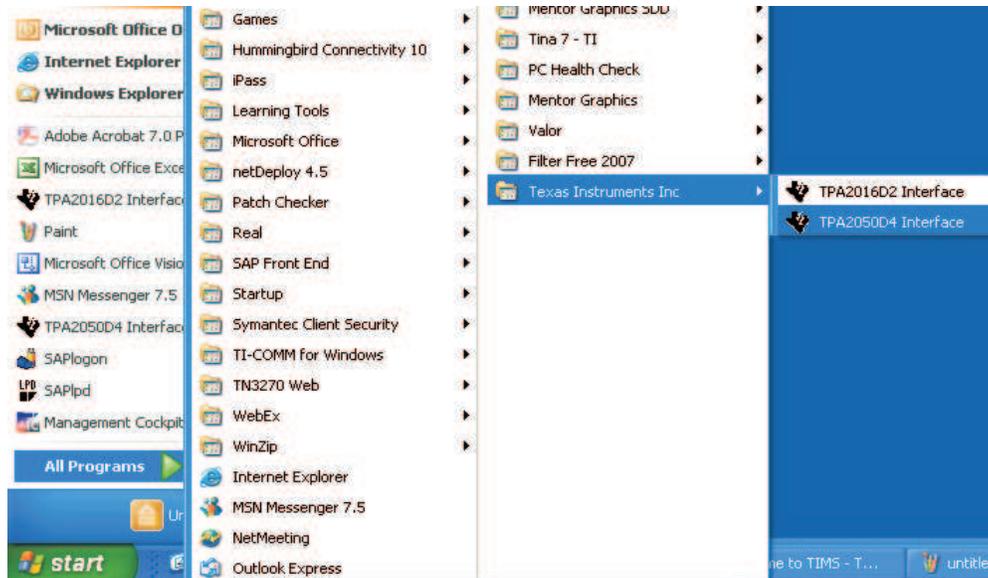


Figure 4. Starting the Software

- The TPA2050D4 software interface is as shown in Figure 5.

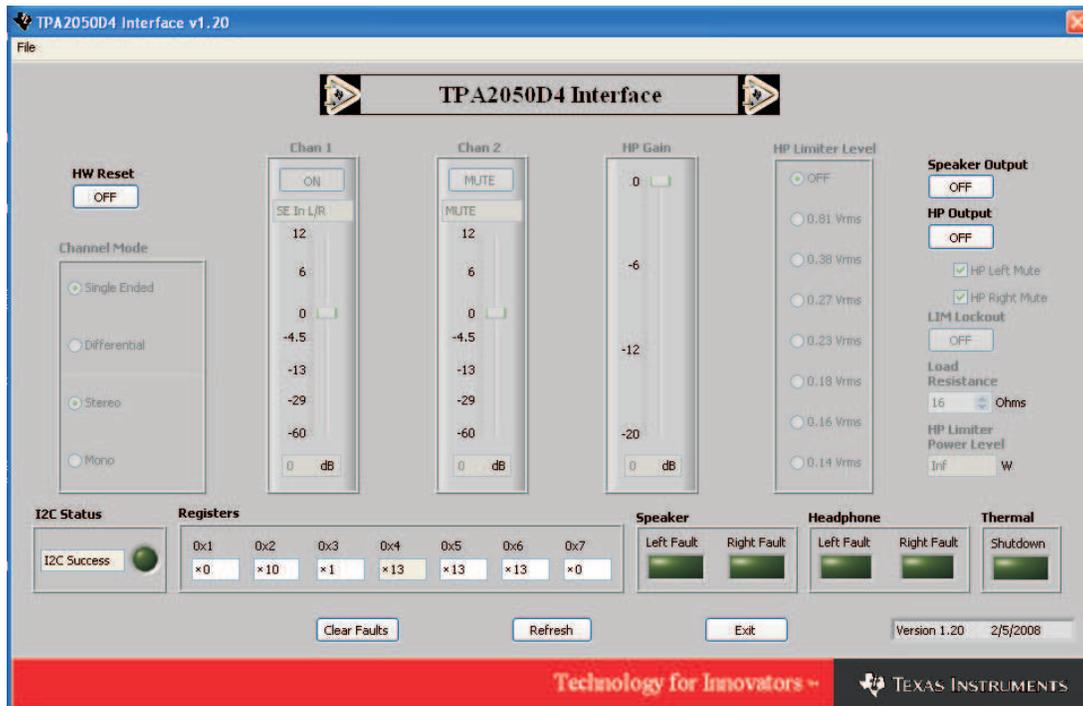


Figure 5. Software Interface

Note: The TPA2050D4 powers up with the amplifiers disabled, muted, and the gain set to the minimum. To hear an output, enable and unmute each channel, and set the gain to a higher level.

- Follow these steps only if using a PC is both the music source and the computer on which the TPA2050D4 GUI is run.

When using WinXP, if after initially installing the software, the PC does not play music out of the headphone jack:

- Open the Control Panel.
 - Click on Sounds, Speech, and Audio Device Link under the Control Panel.
 - Click on Sounds and Audio Device Properties link.
 - Click on the Audio tab.
 - Verify that the Default device under Sound playback is the audio driver of the PC HW, not the USBMODEVM TPA2050D4 GUI driver.
 - Change the driver in the menu to the PC Audio HW driver.
 - Click on OK.
- Click the button in *SW Shutdown* to activate/deactivate software shutdown.
 - Click the button in *Speaker Output* to enable/disable speaker output.
 - Click the button in HP Output to enable/disable headphone output.
 - Check/uncheck HP Left Mute to place headphone left output in/out of mute.
 - Check/uncheck HP Right Mute to place headphone right output in/out of mute.
 - Select input mode in the *Channel Mode*.
 - Adjust the volume for both channels of the speaker amplifier by sliding the bar in *Chan 1* and *Chan 2*.
 - Adjust the headphone gain in *HP Gain* by sliding the bar.
 - Select the headphone limiter level by clicking the voltage limit.
 - Select the headphone impedance in *Load Resistance*, the *Headphone Limiter Power Level* will be

displayed.

12. *I2C Status* box reports the status of I²C communications. An error or failure has occurred if it turns red.
13. *Thermal* box reports the status of thermal failure. A thermal fault has occurred if it turns red.
14. The GUI has a built-in I2C programming interface. It has a log feature to record the changes that was made in the GUI. Follow the steps below to use the I2C programming function.
 - At the top left corner of the GUI, click *File* to access the I2C programming interface.
 - *Save Script* can record the current register values. Select *Save Script* >> Click the folder icon to browse to the place where you want to save the script >> name the file in txt format then select OK to save.
 - *Load Script* can load the previously saved script to program the entire register file. Select *Load Script* >> Click the folder icon to browse to the place where the script is located >> Select the file then click OK >> Click Load.
 - *I2C interface* can program individual register value of TPA2050D4. Select *I2C Interface* >> I2C address is xE0, which is the address of TPA2050D4. Device address is from 1 to 7, which is the register address of TPA2050D4.
 - *Record Script* can record all the changes made in the GUI and store the changes in a text file. Select *Record Script* >> Click the folder icon to browse to the place where you want to record the script and then name the file in txt format >> Click *Record Off* to *Record On*, the green light will turn red to indicate that the recording is activated >> Click *Exit* >> Make changes in the GUI >> Select *Record Script* >> Click *Record On* to *Record Off*. The red light will turn green to indicate that the recording is deactivated. >> Click *exit*. All the changes will be recorded in the selected txt file.

2.2 Quick Start List When Connected to External I²C Controller

The TPA2050D4EVM can be easily connected to existing circuits with I²C controls. Connections to the EVM module can be made using banana plugs for the power supply. The inputs accept standard RCA plugs. The output connection accepts standard 3.5-mm headphone plugs.

2.2.1 Evaluation Module Setup

1. Install shunts in jumpers JP4. Remove shunts in JP2 and JP3 and connect I²C controls to JP3 as shown in [Figure 6](#).
2. There are 2 options to power DVDD.
 - a. Connect USB cable to supply 1.8V for DVDD and remove R17.
 - b. Disconnect USB cable. Remove JP1 and connect an external power supply(from 1.75 V to 1.95 V) at TP18 (to DVDD).

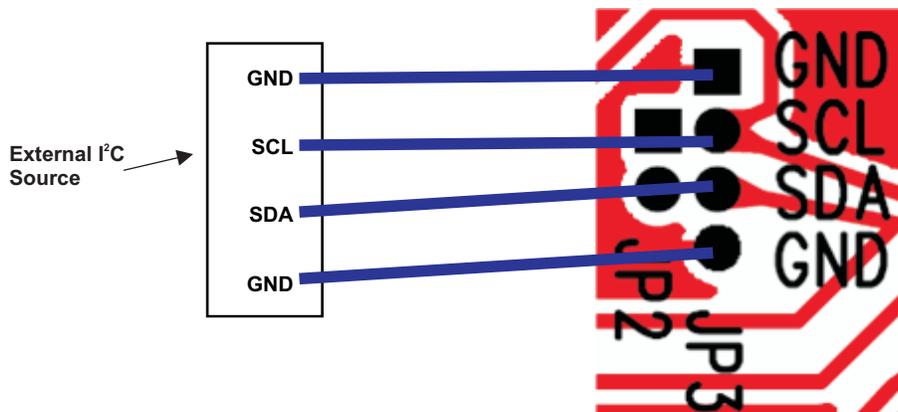


Figure 6. Connect I²C Controls to JP3

3. For all the other connections, follow the steps in section 2.1.2.

3 TPA2050D4EVM Schematic

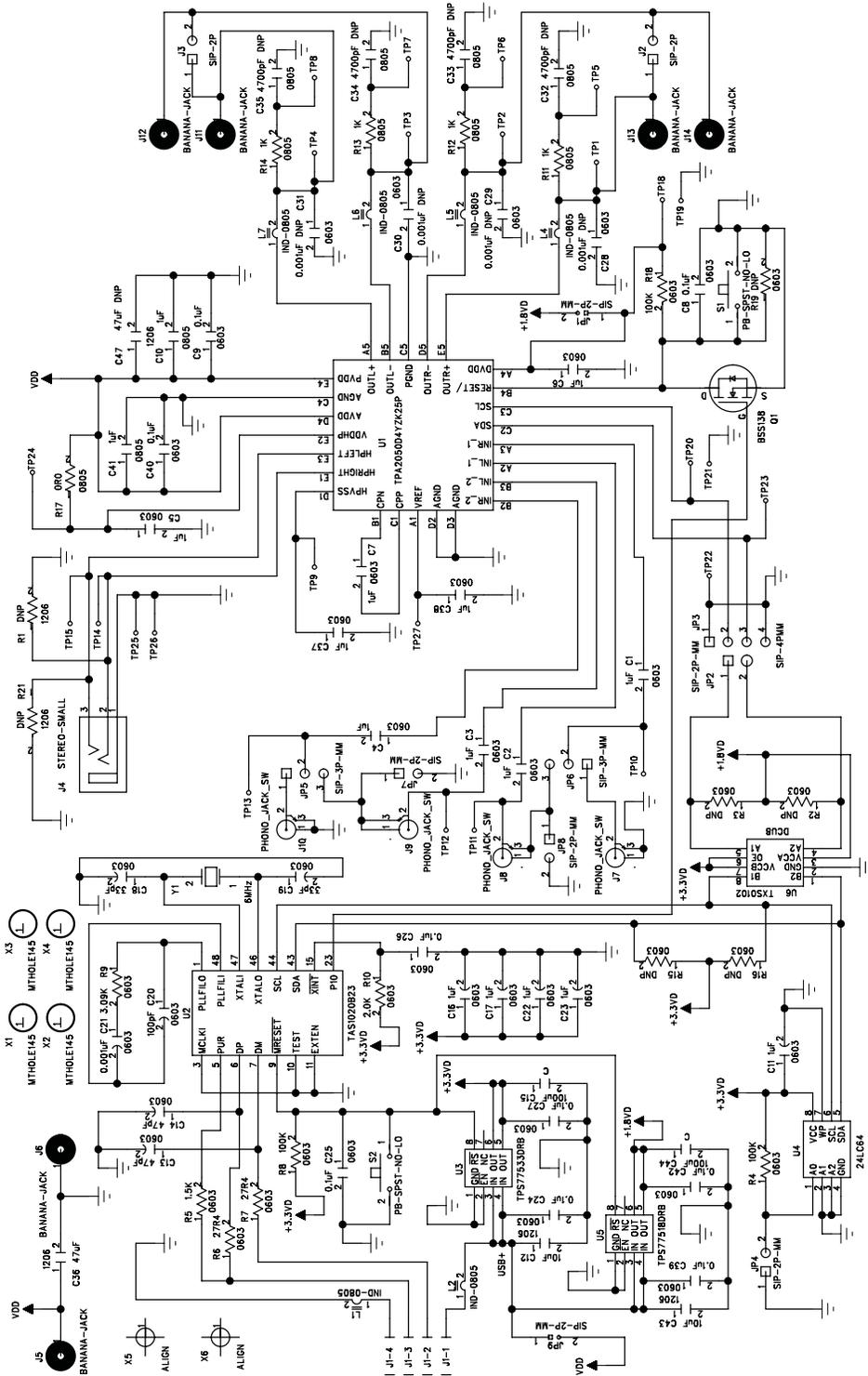


Figure 7. TPA2050D4EVM Schematic

4 TPA2050D4EVM PCB Layers

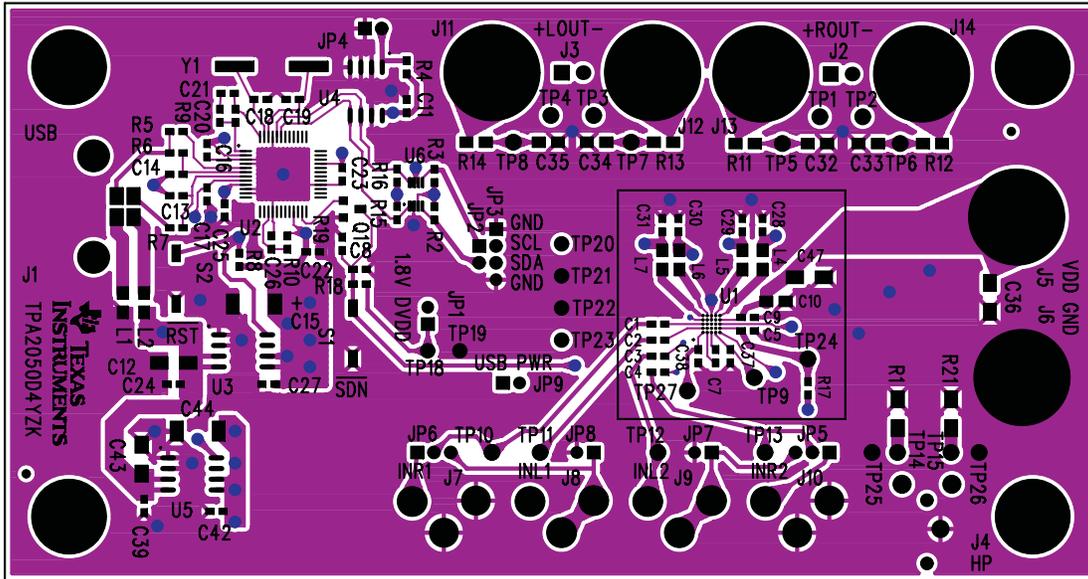


Figure 8. TPA2050D4EVM – Top Layer

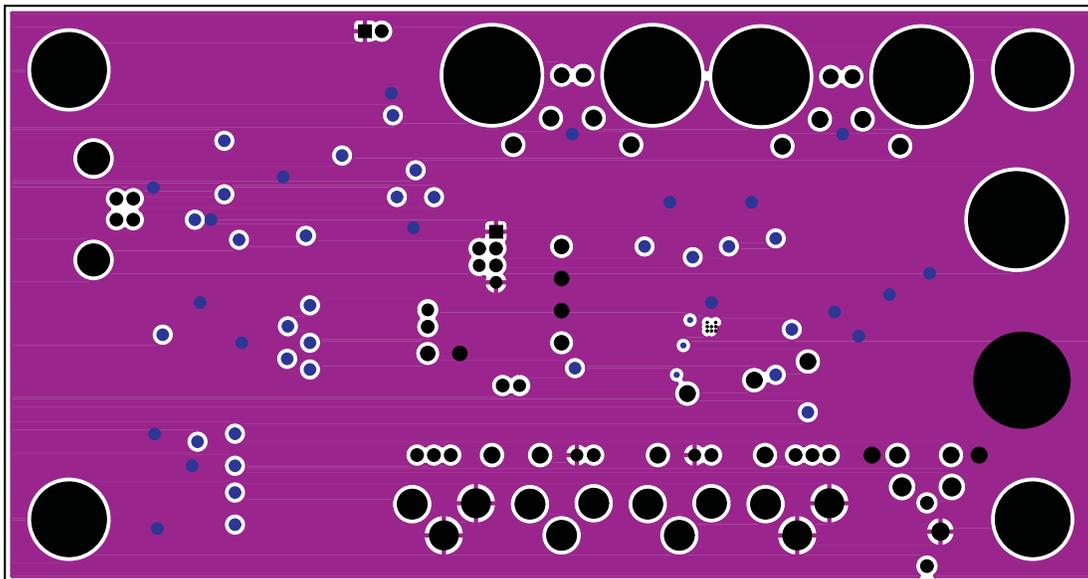


Figure 9. TPA2050D4EVM – Layer 2

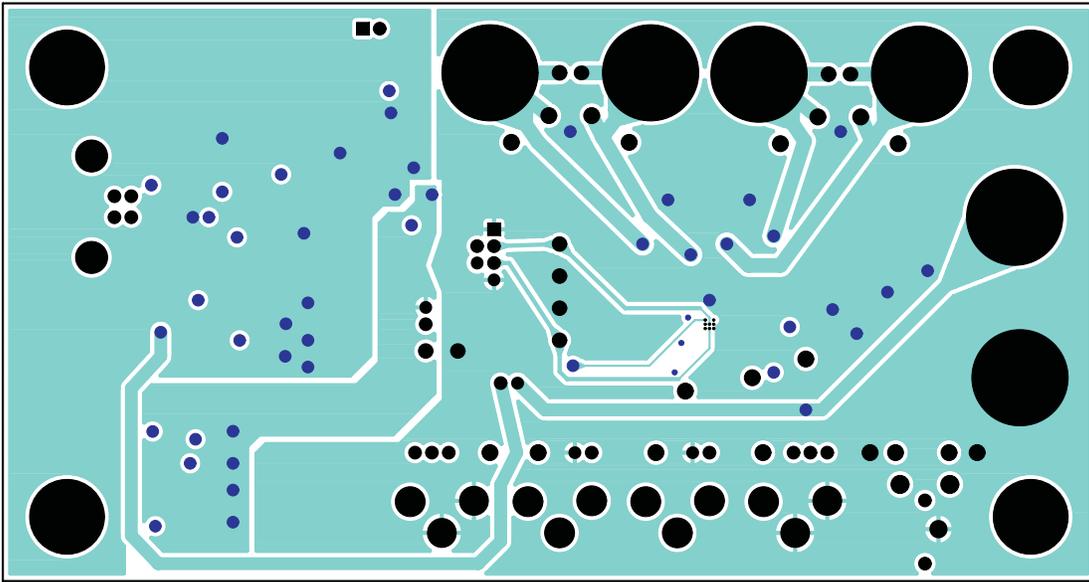


Figure 10. TPA2050D4EVM – Layer 3

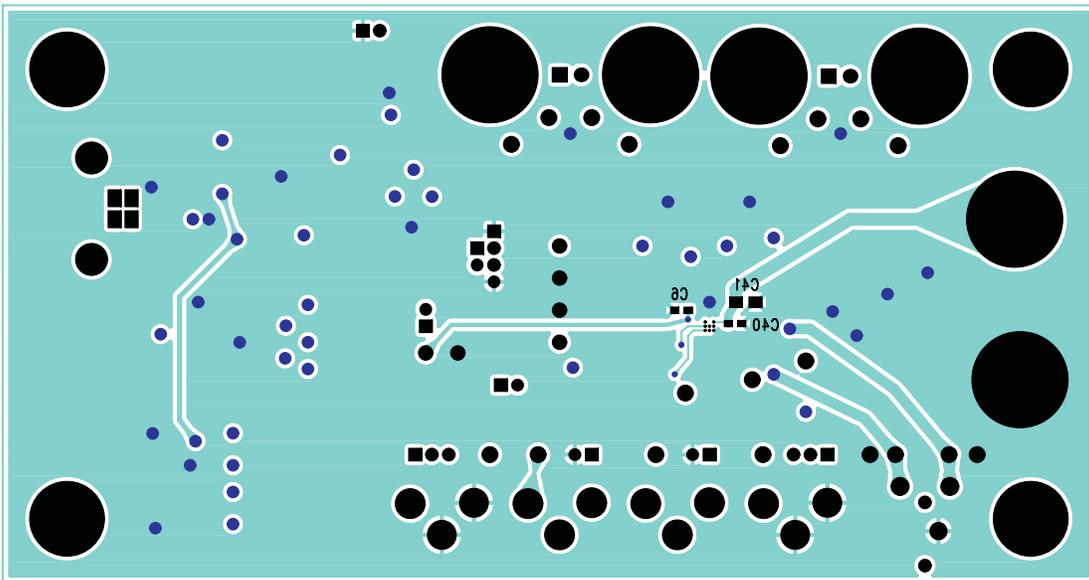


Figure 11. TPA2050D4EVM – Bottom Layer

5 TPA2050D4EVM Parts List

Table 3. TPA2050D4EVM Parts List

Item	Ref	Description	Size	Qty	MFR / Part No.	Vendor / Part No.
10	C15, C44	CAP, TANT, 100µF, 10V, 10%, LOESR SMD	C	2	EPCOS/B45197A2107K309	DigiKey/495-1528-2-ND
12	C1–C4	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	4	TDK/C1608X5R1A105K	Digikey/445-1321-2-ND
16	C6, C11 C16, C17, C22, C23	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	6	TDK/C1608X5R1A105KT	DigiKey/445-1321-2
17	C5	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	1	TDK/C1608X5R1A105KT	DigiKey/445-1321-2
	C6, C7	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	2	TDK/C1608X5R1A105KT	DigiKey/445-1321-2
19	C8, C9, C40	Capacitor, Ceramic, 0.1µF, ±10%, X5R, 25V	603	3	AVX/06033D104KAT2A	DigiKey/478-1244-2-ND
20	C10, C41	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	805	2	AVX/0805ZD105KAT2A	DigiKey/478-1412-1-ND
23	C12, C43	6.3V, 10µF, Ceramic Chip Capacitor, ±10%, X5R	1206	2	TDK/C3216X5R0J106K	DigiKey/445-1388-1
24	C13, C14	Capacitor, ceramic, 47pF 50V C0G 5%	603	2	TDK/C1608C0G1H470J	DigiKey/445-1277-2
28	C18, C19	50V, 33pF, Ceramic Chip Capacitor, ±5%, NPO	603	2	TDK/C1608C0G1H330J	Digikey/445-1275-1-ND
30	C20	50V, 100pF, Ceramic Chip Capacitor, +/-5%, NPO	603	1	TDK/C1608C0G1H101J	DigiKey/445-1293-1
31	C21	50V, 1 nF, Ceramic Chip Capacitor, ±5%, NPO	603	1	TDK/C1608C0G1H102J	Mouser/810-C1608C0G1H102J
34	C24– C27, C39, C42	Capacitor, ceramic, 0.1 µF, ±10%, X5R, 25 V	603	6	AVX/06033D104KAT2A	DigiKey/478-1244-2-ND
38	C28–C31	Capacitor, Ceramic, 25V, X5R, 1nF, 10%	603	DNP	TDK/C0603X5R1E102K	DigiKey/445-1790-2-ND
42	C32– C35	Capacitor, Ceramic, 50V, 5%, X7R, 4700 pF	805	DNP	AVX/08055C472JAT2A	Digikey/478-3770-2-ND
46	C36	Capacitor, Ceramic, 47µF, ±20%, X5R	1206	DNP	Taiyo Yuden/LMK316BJ476ML-T	Digi-Key/587-1780-1-ND
47	C37	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	1	TDK/C1608X5R1A105KT	DigiKey/445-1321-2
16	C38	Capacitor, ceramic, 1.0µF, ±10%, X5R, 10 V	603	1	TDK/C1608X5R1A105KT	DigiKey/445-1321-2
56	C47	Capacitor, Ceramic, 47µF, ±20%, X5R	1206	1	Taiyo Yuden/ LMK316BJ476ML-T	Digi-Key/587-1780-1-ND
57	L1, L2	Inductor Bead, 600-Ω, 2A	805	2	TDK/MPZ2012S601A	Digi-Key/445-2206-1-ND
59	L4–L7	Inductor Bead, 100 Ω, 4A	805	4	TDK/MPZ2012S101A	DigiKey/445-1567-1-ND
59	L4–L7	Resistor, thick film, 0 Ω, 1/8 W, 5%	805	DNP	Panasonic/ERJ-6GEY0R00V	DigiKey/P0.0ATR-ND
65	JP1(DVDD)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP2	DigiKey/2663S-36-ND
66	JP2(I2C)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP3	DigiKey/2663S-36-ND
67	JP4(EEPROM)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP4	DigiKey/2663S-36-ND
68	JP7(INL_2)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP5	DigiKey/2663S-36-ND
69	JP8(INL_1)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP6	DigiKey/2663S-36-ND
70	JP9 (USB PWR)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP7	DigiKey/2663S-36-ND
71	JP10(MONO-)	Header, 2 position, male, 2mm		1	Norcomp/26633601RP8	DigiKey/2663S-36-ND
73	JP5 (INR_2)	Header, 3 position, male, 2mm		1	Norcomp/26633601RP10	DigiKey/2663S-36-ND
74	JP6 (INR_1)	Header, 3 position, male, 2mm		1	Norcomp/26633601RP11	DigiKey/2663S-36-ND
75	JP3(I2C)	Header, 4 position, male, 2mm		1	Norcomp/26633601RP2	DigiKey/2663S-36-ND
	R1, R21		1206	DNP		
108	R18	resistor chip, 100 kΩ, 0.1W, 1%	603	1	Panasonic/ERJ-3EKF1003V	DigiKey/P100KHCT-ND
109	R2, R3, R15, R16	DNP	603	DNP		
111	R4, R8	Resistor, chip, 100 kΩ, 1/16W, 5%	603	2	Panasonic/ERJ-3GEYJ104V	DigiKey/P100KGCT-ND
112	R5	Resistor, chip, 1.5 kΩ, 1/10W, 5%	603	1	Panasonic/ERJ-3GEYJ152V	DigiKey/P1.5KGTR-NDT
113	R6, R7	Resistor, chip, 27.4 Ω, 1/16W 1%	603	2	Panasonic/ERJ-3EKF27R4V	DigiKey/P27.4HCT-ND
116	R9	Resistor, chip, 3.09 kΩ, 1/16W 1%	603	1	Panasonic/ERJ-3EKF3091V	DigiKey/P3.09KHCT-ND
117	R10	Resistor, chip, 2 kΩ, 1/10W, 5%	603	1	Panasonic/ERJ-3GEYJ202V	DigiKey/P2.0KGCT-ND
118	R11– R14	Resistor, chip, 1 kΩ, 1/8W, 5%	805	4	Panasonic/ERJ-6GEYJ102V	DigiKey/P1.0KACT-ND
	R17 (VDDHP)	Resistor, thick film, 0 Ω, 1/8 W, 5%	805	1	Panasonic/ERJ-6GEY0R00V	DigiKey/P0.0ATR-ND
	R19		603	DNP		
134	Y1	6MHz Crystal SMD, 32 pF cap loading		1	ECS/ECS-60-32-5PXDN-TR	DigiKey/XC1259CT-ND
133	J1	USB Type B Slave Connector Thru-Hole	USB-B	1	Mill-Max/897-30-004-90-000000	DigiKey/ED90003-ND

Table 3. TPA2050D4EVM Parts List (continued)

Item	Ref	Description	Size	Qty	MFR / Part No.	Vendor / Part No.
	J2, J3	Header, 2 position, male, 2.54mm		2	Sullins/PBC36SAAN	DigiKey/S1011E-36-ND
103	J7–J10	Phono jack, PC mount, switched		4	Switchcraft/PJРАН1X1U03	Newark/16C1860
	J5, J6, J11–J14	Banana Jack w/knurled Thumbnut (nickel plate)		6	Emerson/111-2223-001	Digi-Key/J587
124	J4	Stereo headphone jack, 3.5mm	STEREO -SMALL	1	Kycon/STX-3000	Mouser/806-STX-3000
125	S1, S2	Switch, momentary, SMD, low profile		2	Panasonic/EVQ-PPBA25	DigiKey/P8086SCT-ND
129	U1	Audio amplifier subsystem	CSP25	1	TI/TPA2052D4 YZK	
128	U2	USB Streaming Controller	QFP48-5	1	TI/TAS1020BPFB	
131	U3	3.3V LDO Regulator with reset output	SOIC8	1	TI/TPS77533DGN	
	U4	64K 2-Wire Serial EEPROM I2C		1	Microchip/24LC64I/SN	DigiKey/24LC64-I/SN-ND
130	U5	1.8V LDO Regulator with reset output	SOIC8	1	TI/TPS77518DGN	
132	U6	Bi-directional level translator	DCU8	1	TI/XS0102DCU	
	Q1	MOSFET N-CH 50V 220MA	SOT-23		Fairchild/BSS138	Digikey/BSS138CT-ND
80	TP1(OUTL+), TP2(OUTL-), TP3(OUTR-), TP4(OUTR+)	white stand off	PAD	4		
84	TP5– TP8	white stand off	PAD	4		
88	TP9(HPVSS)	white stand off	PAD	1		
92	TP10–TP14 (HPRIGHT), TP15(HPLEFT), TP18(DVDD)	white stand off	PAD	7		
98	TP19, TP21,TP22, TP25, TP26 (ground)	black	PAD	4		
99	TP20(SCL), TP23(SDA), TP24 (HPVDD), TP27(VREF)	white	PAD	4		

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of -0.3 V to 6 V and the output voltage range of -0.3 V to VDD +0.3 .

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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