

TPA3156D2EVM User's Guide

This user's guide describes operation of the TPA3156D2EVM (evaluation module). The user's guide also provides design information, such as a schematic, BOM, and PCB layout.

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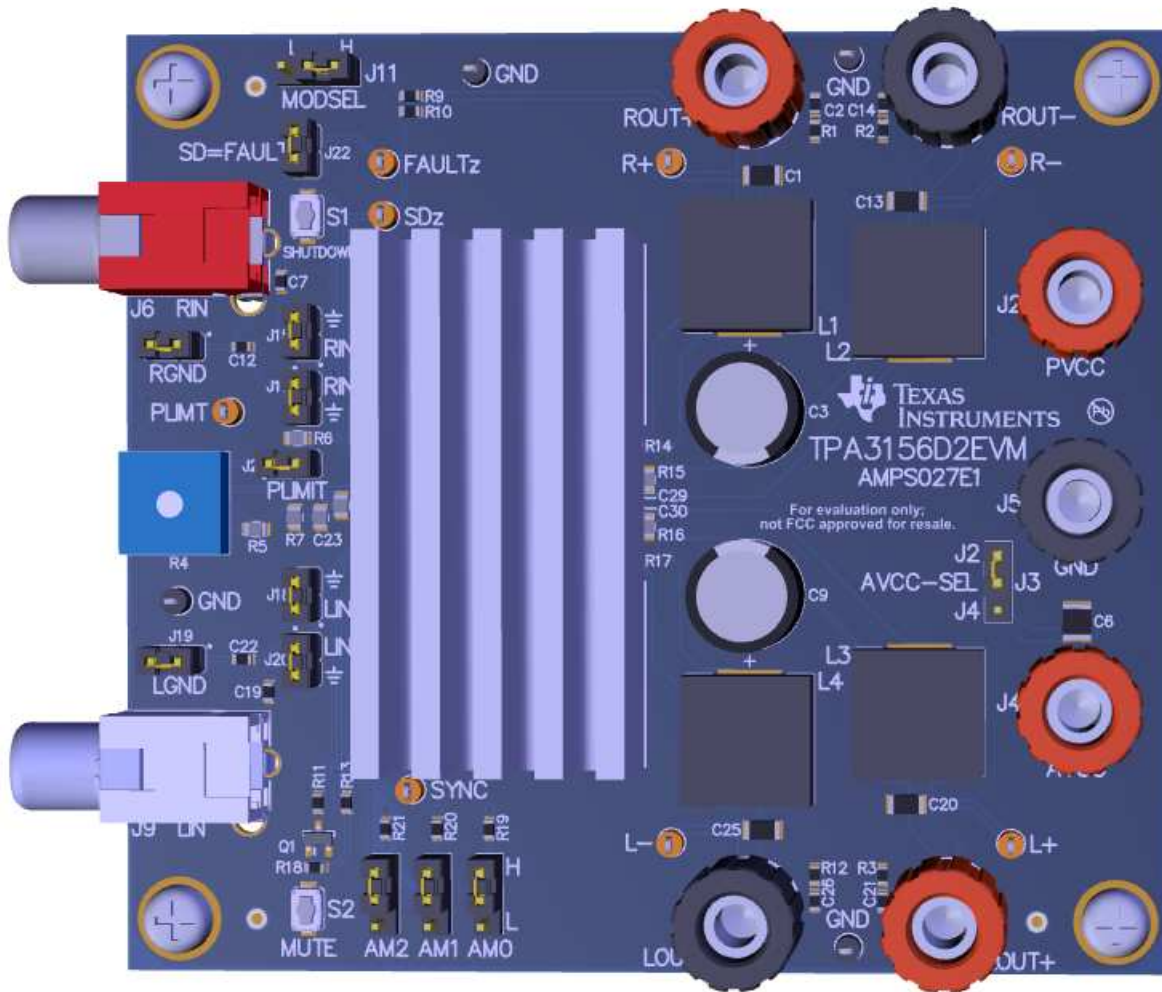
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1 Hardware Overview

The TPA3156D2EVM demonstrates the integrated circuit, TPA3156D2, from TI. The TPA3156D2 is an efficient, 70-W (per channel), stereo, digital-amplifier, power stage for driving two bridge-tied speakers or a single parallel bridge-tied load (PBTL). This document covers EVM specifications and design documentation.

Figure 1 shows the EVM board.



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Figure 1. TPA3156D2EVM

Table 1 lists the EVM specifications.

Table 1. TPA3156D2EVM Specifications

Key Parameters	Value
Power supply voltage	4.5 V to 26 V
Number of channels	Two bridge-tied load (BTL) stereos
Load impedance	3.2 Ω to 8 Ω
Output power BTL	70 W per channel
Output power PBTL	140 W

2 Operation

This chapter describes the power supply and system interfaces of the TPA3156D2EVM board. Information regarding handling and unpacking, absolute operating conditions, and a description of the factory default switch and jumper configurations are also provided. The following is a step-by-step guide to configuring the TPA3156D2EVM for device evaluation.

2.1 Electrostatic Discharge Warning

Many components on the TPA3156D2EVM are susceptible to damage by electrostatic discharge.

CAUTION

Failure to observe ESD handling procedures may result in damage to EVM components.

2.2 Unpacking the EVM

When opening the TPA3156D2EVM package, ensure there is one TPA3156D2EVM board using one TPA3156D2. If the EVM is missing, contact the TI Product Information Center nearest you to inquire about a replacement.

2.3 Power Supply Setup

A single power supply or separate PVCC/AVCC is required to power up the EVM (see [Table 2](#)). Because most of the pins are PVCC compliant, the PVCC supply can also be used to power the analog supply (AVCC) and to pull up the logic pins for shutdown (SD) control, and fault detection (FAULT).

Table 2. Power Requirements

Description	Voltage Range	Current Requirement	Minimum Wire Size
PVCC/AVCC	4.5 to 26 V	8 A	24 AWG

CAUTION

Applying voltages above the limitations given in [Table 2](#) may permanently damage the hardware.

2.4 Evaluation Module Preparations

- Ensure that the external power source is set to OFF.
- Connect the external regulated power supply, adjusted from 4.5 V to 26 V, to the module PVCC and GND banana jacks, taking care to observe marked polarity.

2.5 Inputs and Outputs

Make the following input and output connections:

For BTL configuration:

1. Connect audio inputs, either differential or single-ended, to the LIN and RIN RCA phono plugs. To enable the individual channel shutdown feature, tie RINP and RINN directly to ground (without capacitors), and OUTPL and OUTNL should work normally.
2. Connect a load (or loads) across the outputs (OUTL+ and OUTL-) and (OUTR+ and OUTR-).

For PBTL configuration:

1. Apply a single input, differential or single ended, to the RIN RCA phono plug and tie LINP and LINN directly to Ground (without capacitors).
2. Connect a single load from one of the left speaker jacks to one of the right speaker jacks depending on how the filters are loaded.

2.6 Power Up

1. Verify correct voltage and input polarity and turn the external power supplies ON. The EVM should begin operation.
2. Adjust the audio source for the correct volume.

2.7 Recommended Settings

This section contains the recommended settings for stereo, single-channel, and mono output.

[Table 3](#) lists the settings for a single-ended input with auto recovery, PLIMIT, and BTL (stereo output).

Table 3. TPA3156D2EVM Setting 1 (Stereo Output)

Setting	Description
J6 (RIN)	R channel audio input
J9 (LIN)	L channel audio input
JP1 (GNDR+) and JP3(GNDR-) set to OUT	R channel on
JP4 (GNDL+) and JP6(GNDL-) set to OUT	L channel on
JP2 (RGND) set to IN	Single-ended input (R channel)
JP5 (LGND) set to IN	Single-ended input (L channel)
JP7 sets IN	Set PLIMIT
R4	Change PLIMIT voltage value
JP8 (/SD=/FAULT) set to IN	Auto-recovery mode
J11 (MODESEL=L)	Low idle-loss mode

Table 4 lists the settings for a single-ended input with auto recovery, PLIMIT, and BTL (single-channel output).

Table 4. TPA3156D2EVM Setting 1 (Single-Channel Output)

Setting	Description
J6 (RIN)	No audio input
J9 (LIN)	L channel audio input
JP1 (GNDR+) and JP3 (GNDR-) set to IN	R channel off
JP4 (GNDL+) and JP6 (GNDL-) set to OUT	L channel on
JP5 (LGND) set to IN	Single-ended input (L channel)
JP7 set to IN	Set PLIMIT
R4	Change PLIMIT voltage value
JP8 (/SD=/FAULT) set to IN	Auto-recovery mode
J11 (MODESEL=L)	Low idle-loss mode

Table 5 lists the settings for a single-ended input with auto recovery, PLIMIT, and PBTL (mono output).

Table 5. TPA3156D2EVM Setting 2 (Mono Output)

Setting	Description
J6 (RIN)	R channel audio input
J9 (LIN)	No audio input
JP1 (GNDR+) and JP3 (GNDR-), set to OUT	R channel on
JP4 (GNDL+) and JP6 (GNDL-), set to IN	L channel off, PBTL mode
JP2, set to IN	Single-ended input (R channel)
JP7, set to IN	Set PLIMIT
R4	Change PLIMIT voltage value
JP8 (/SD=/FAULT) set to IN	Auto-recovery mode
J11 (MODESEL=L)	Low idle-loss mode

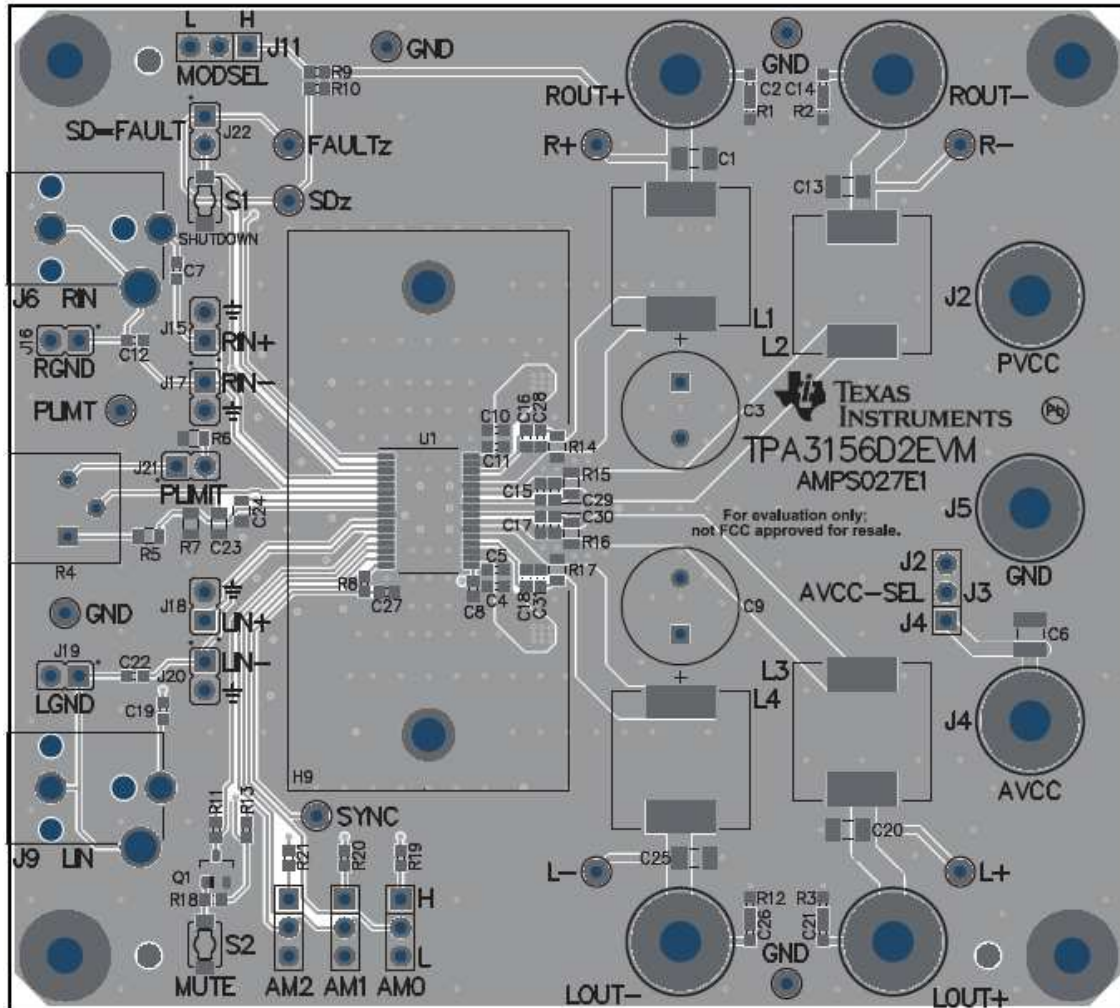
2.8 Separate PVCC and AVCC Supply Support

Supplying a voltage of AVCC that is lower than PVCC (for example PVCC = 24 V and AVCC = 12 V), reduces the power dissipation on the internal LDO. This gives customers the flexibility to choose between the extreme, low-idle current mode (J3: 1 and 2 set to IN, with separate AVCC) and single power supply mode (J3: 2 and 3 set to IN, without AVCC).

3 Board Layout, Bill of Materials, and Schematic

3.1 TPA3156D2EVM Board Layouts

Figure 2 and Figure 3 show the board layouts for the EVM.



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Figure 2. TPA3156D2EVM Top Overlay

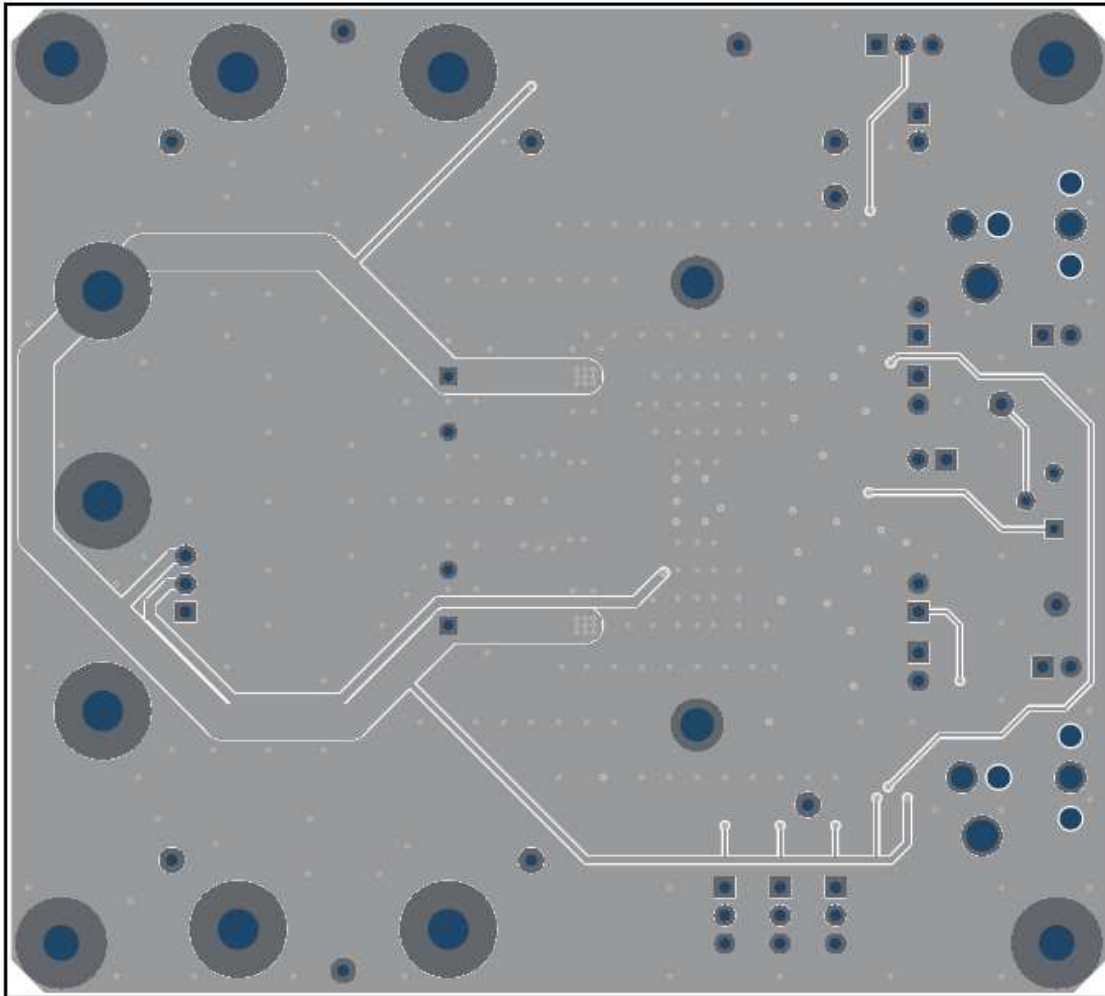


Figure 3. TPA3156D2EVM Bottom Overlay

3.2 Bill of Materials (BOM)

Table 6 lists the BOM for this EVM.

Table 6. TPA3156D2EVM BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed-circuit board		AMPS027	Any		
C1, C13, C20, C25	4	0.68 μ F	Capacitor, ceramic, 0.68 μ F, 50 V, \pm 10%, X7R, 1206	1206	GRM31MR71H684KA88L	MuRata		
C2, C14, C21, C26	4	0.01 μ F	Capacitor, ceramic, 0.01 μ F, 50 V, \pm 10%, X7R, 0603	0603	GRM188R71H103KA01D	MuRata		
C3, C9	2	220 μ F	Capacitor, AL, 220 μ F, 35 V, \pm 20%, 0.09 Ω , TH	10 x 12.5 mm	EEU-FC1V221	Panasonic		
C4, C10	2	0.1 μ F	Capacitor, ceramic, 0.1 μ F, 50 V, \pm 10%, X7R, 0603	0603	GCM188R71H104KA57D	MuRata		
C5, C11	2	1000 pF	Capacitor, ceramic, 1000 pF, 50 V, \pm 5%, C0G/NP0, 0603	0603	GRM1885C1H102JA01D	MuRata		
C6	1	10 μ F	Capacitor, ceramic, 10 μ F, 35 V, \pm 10%, X7R, 1210	1210	GRM32ER7YA106KA12L	MuRata		
C7, C12, C19, C22	4	1 μ F	Capacitor, ceramic, 1 μ F, 16 V, \pm 10%, X7R, 0603	0603	GRM188R71C105KA12D	MuRata		
C8	1	1 μ F	Capacitor, ceramic, 1 μ F, 30 V, \pm 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK		
C15, C16, C17, C18	4	0.22 μ F	Capacitor, ceramic, 0.22 μ F, 25 V, \pm 10%, X7R, 0603	0603	GRM188R71E224KA88D	MuRata		
C23, C24	2	1 μ F	Capacitor, ceramic, 1 μ F, 16 V, \pm 10%, X7R, 0805	0805	C0805C105K4RACTU	Kemet		
C27	1	47 pF	Capacitor, ceramic, 47 pF, 50 V, \pm 5%, C0G/NP0, 0603	0603	GRM1885C1H470JA01D	MuRata		
H1, H2, H3, H4	4		Machine screw, round, #4 – 40 x 1/4, nylon, Phillips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply		
H5, H6, H7, H8	4		Standoff, hex, 0.5" L #4 – 40 Nylon	Standoff	1902C	Keystone		
H9	1		Heatsink, 25 x 50 x 25 mm	Heatsink, 25 x 50 x 25 mm	HEATSINK100W_25X50X25	Texas Instruments		
J1, J2, J4, J8	4		Binding Post, RED, TH	11.4 x 27.2 mm	7006	Keystone		
J3, J11, J12, J13, J14	5		Header, 100 mil, 3 x 1, gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J5, J7, J10	3		Binding post, black, TH	11.4 x 27.2 mm	7007	Keystone		
J6	1		RCA jack, red, R/A, TH	PC Mount Phono jack-red, TH	971	Keystone		

Table 6. TPA3156D2EVM BOM (continued)

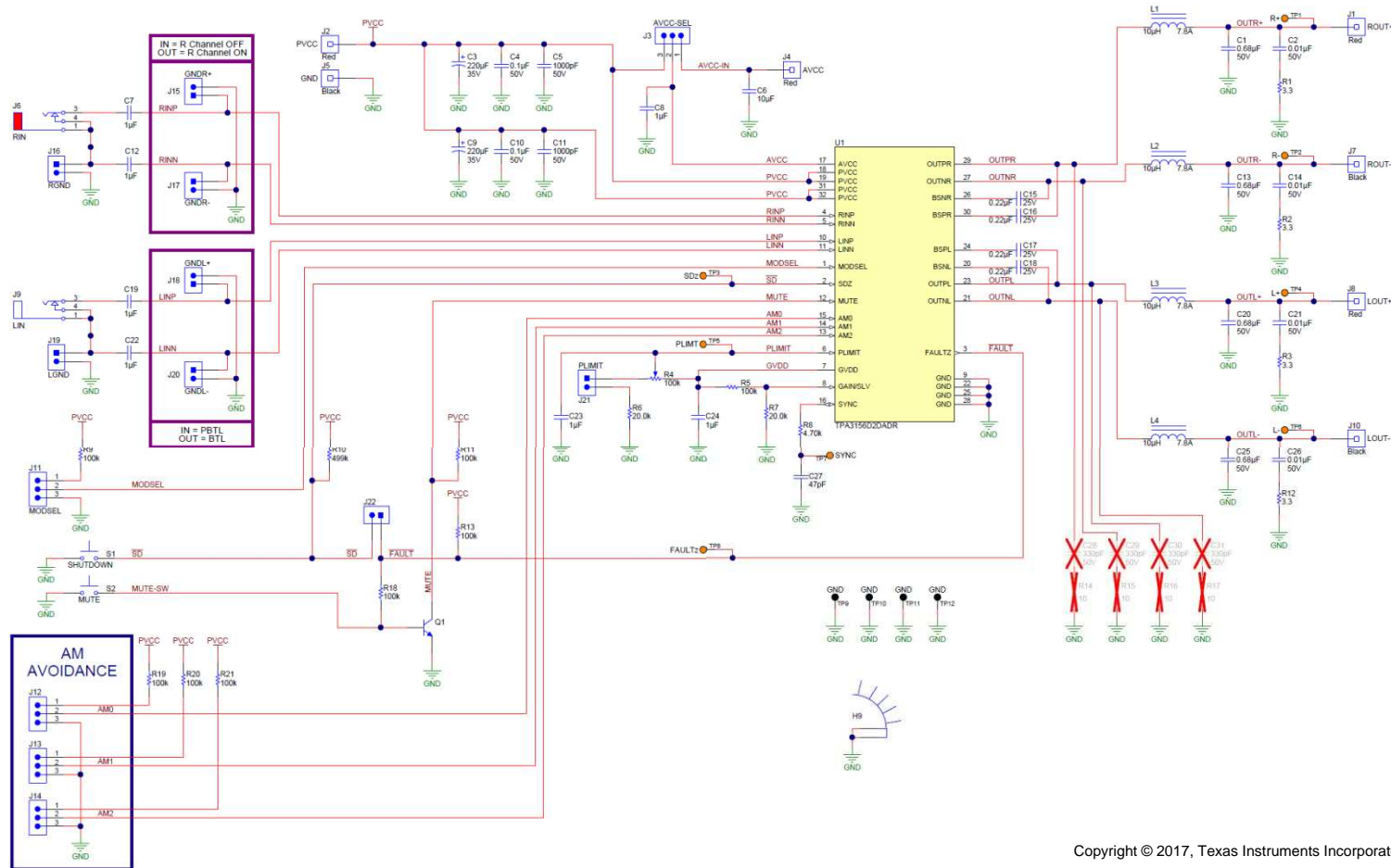
Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
J9	1		RCA jack, white, R/A, TH	PC Mount Phono jack-white, TH	970	Keystone		
J15, J16, J17, J18, J19, J20, J21, J22	8		Header, 100 mil, 2 × 1, gold, TH	Sullins 100 mil, 1 × 2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
L1, L2, L3, L4	4	10 µH	Inductor, Shielded, Ferrite, 10 µH, 7.8 A, 0.011 Ω, SMD	2-pin, 12.3 × 12.3 mm body, 8 mm height	931BS-100M	MuRata Toko		
Q1	1		40-V Transistor, NPN, 40 V, 0.6 A, SOT-23	SOT-23	MMBT2222ALT1G	ON Semiconductor		
R1, R2, R3, R12	4	3.3	Resistor, 3.3, 5%, 0.1 W, 0603	0603	CRCW06033R30JNEA	Vishay-Dale		
R4	1	100 k	Trimmer, 100-kΩ, 0.5 W, TH	375 × 190 × 375 mil	3386P-1-104LF	Bourns		
R5	1	100 k	Resistor, 100 k, 1%, 0.125 W, 0805	0805	CRCW0805100KFKEA	Vishay-Dale		
R6, R7	2	20.0 k	Resistor, 20.0 k, 1%, 0.125 W, 0805	0805	CRCW080520K0FKEA	Vishay-Dale		
R8	1	4.70 k	Resistor, 4.70 k, 0.1%, 0.1 W, 0603	0603	RG1608P-472-B-T5	Susumu Co Ltd		
R9, R11, R13, R18, R19, R20, R21	7	100 k	Resistor, 100-kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo America		
R10	1	499 k	Resistor, 499 k, 1%, 0.1 W, 0603	0603	RC0603FR-07499KL	Yageo America		
S1, S2	2		Switch, tactile, SPST-NO, 0.05 A, 12 V, SMT	Switch, 4.4 × 2 × 2.9 mm	TL1015AF160QG	E-Switch		
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11, SH12, SH13	13	1 × 2	Shunt, 100 mil, gold-plated, black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8		Test point, miniature, orange, TH	Orange miniature test point	5003	Keystone		
TP9, TP10, TP11, TP12	4		Test point, miniature, black, TH	Black miniature test point	5001	Keystone		

Table 6. TPA3156D2EVM BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
U1	1		Two 70-W, class-d amplifiers with low idle power dissipation, DAD0032A (TSSOP-32)	DAD0032A	TPA3156D2DADR	Texas Instruments	TPA3156D2DAD	Texas Instruments
C28, C29, C30, C31	0	330 pF	Capacitor, ceramic, 330 pF, 50 V, $\pm 5\%$, C0G/NP0, 0603	0603	GRM1885C1H331JA01D	MuRata		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
R14, R15, R16, R17	0	10	Resistor, 10, 5%, 0.125 W, 0805	0805	CRCW080510R0JNEA	Vishay-Dale		

3.3 TPA3156D2EVM Schematic

Figure 4 shows the schematics for the TPA3156D2EVM.



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Figure 4. TPA3156D2EVM Schematic

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 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
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 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
 - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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