

TPA3110D2 EVM Audio Amplifier Evaluation Board

This user's guide provides the TPA3110D2 evaluation board specifications and a quick start list for stand-alone operation. Also included are the schematic, printed-circuit board layout, and bill of materials.

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1 Introduction

The TPA3110D2 EVM customer evaluation module demonstrates the integrated circuit TPA3110D2 from Texas Instruments.

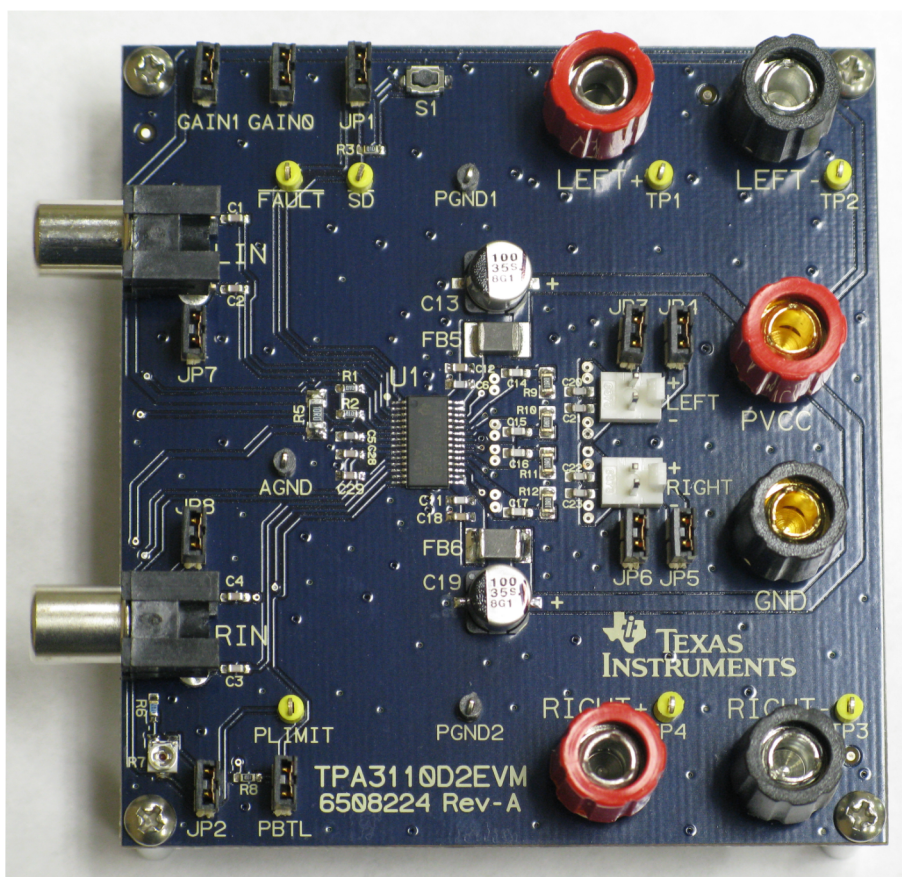


Figure 1. The TI TPA3110D2 EVM Audio Power Amplifier – Top View

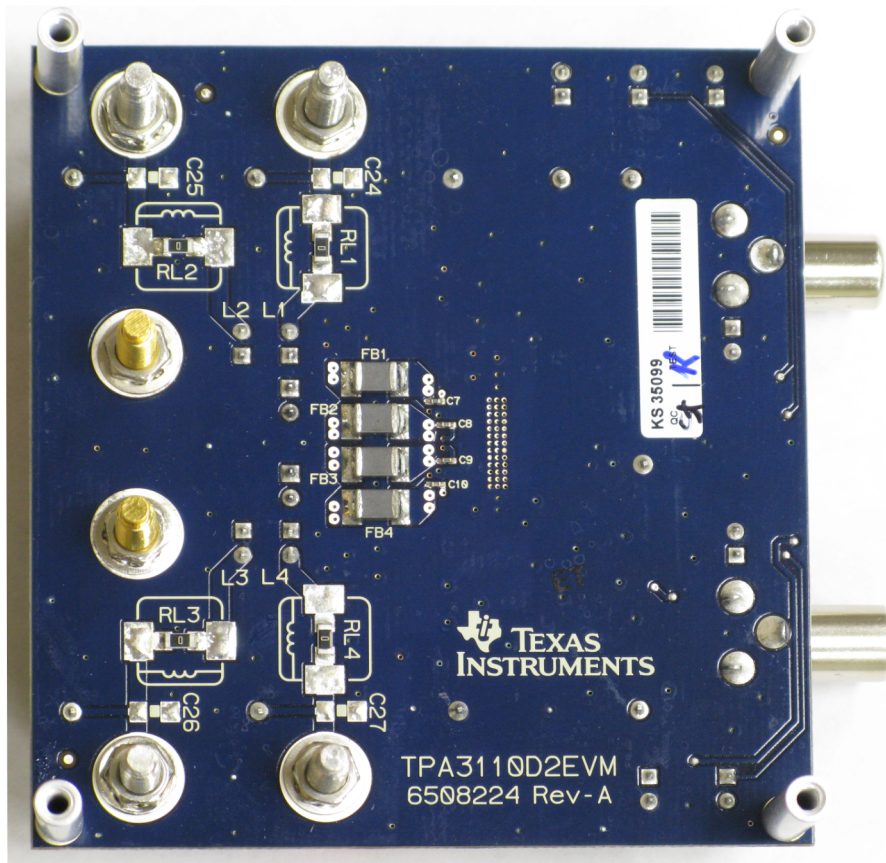


Figure 2. The TI TPA3110D2 EVM Audio Power Amplifier – Bottom View

1.1 TPA3110D2 EVM Specifications

Table 1. Key Parameters

| Key Parameters | |
|---------------------------|---|
| Power Supply Voltage | 8 to 26 Volts |
| Number of Channels | 2 Bridge Tied Load (BTL) Stereo |
| Load Impedance Stereo BTL | 4 to 8 Ω (connect 33- μ H series inductor for 4 Ω or 68- μ H inductor for 8 Ω if using the ferrite bead filters) |
| Load Impedance Mono PBTL | 2 to 8 Ω (connect series inductors if using with ferrite bead filters) |
| Output Power BTL | 15 W per channel |
| Output Power PBTL | 30 W |

2 Operation

2.1 Quick Start List for Stand-Alone Operation

Follow these steps to use the TPA3110D2 EVM stand-alone or when connecting it into existing circuits or equipment. Connections to the EVM module can be made by inserting stripped wire or banana plugs for the power supply and output connections. The input connectors are RCA phono jacks.

Power Supply

A single power supply is required to power up the EVM. Since most of the pins are PVCC compliant, the PVCC supply can also be used to power the analog supply (AV_{CC}) and can be used to pull up the logic pins for shutdown (SD) control, fault detection (FAULT), gain (GAIN0 and GAIN1), and PBTL as long as the voltage slew rate is limited to 10 V/ms. GVDD is an internally generated supply for the output FETs and is also used to power the PLIMIT voltage divider circuit on the EVM. PLIMIT is GVDD compliant, but not PVCC compliant. PLIMIT can also be powered by an external supply connected to the PLIMIT pin. Take care not to power the PLIMIT pin (or connect power to the GVDD pin inadvertently through the PLIMIT network) when the PVCC supply is turned off. This can cause damage to the IC.

Table 2. Power Supply Requirements

| Description | Voltage Range | Current Requirements | Minimum Wire Size |
|-------------|---------------|----------------------|-------------------|
| PVCC | 8 to 26 V | 3 A | 24 AWG |

Evaluation Module Preparations

1. Ensure that the external power source is set to OFF.
2. Connect the external regulated power supply adjusted from 8V to 26V to the module PVCC and GND banana jacks taking care to observe marked polarity.

Inputs and Outputs

1. For a BTL Configuration, connect a Load(s) across the outputs (LEFT+ and LEFT-) and (RIGHT+ and RIGHT-). For PBTL configuration, 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. Connect audio inputs, either differential or single-ended, to the LIN and RIN RCA phono plugs for BTL operation. For PBTL operation, apply a single input, differential or single-ended, to the RIN RCA phono plug.

Control Inputs

1. Ensure the mode jumpers, PBTL, GAIN0, GAIN1, are set correctly depending on the desired operating state. Also, make sure to connect the left outputs together and the right outputs together at the LEFT and RIGHT mox connectors if PBTL operation is desired.

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 and enjoy!

Table 3. TPA3110D2 Control Guide

| Control | Function | Options | Notes |
|------------------------|--|--|--|
| JP1 | Allow amp to self reset after short-circuit protection event | Insert jumper for self reset. Leave off for latched SC fault | For latched SC fault, cycle power to reset the fault latch. |
| GAIN1/GAIN0 | Controls amp gain | Insert jumper for zero state (low), Leave off for one state (high) | 00 = 20 dB (GAIN1, GAIN0) 01 = 26 dB 10 = 32 dB 11 = 36 dB |
| JP2 | Defeats PLIMIT function and allows amp to run at full power. | Insert jumper for PLIMIT defeat | JP2 connects PLIMIT directly to GVDD |
| R7 | Adjust PLIMIT (an external voltage can also be applied to the PLIMIT test point) | | The output voltage rails will be limited to approximately 4X the voltage at the PLIMIT pin. Take care not to apply power to PLIMIT when the PVCC source is off. |
| PBTL | Sets the amplifier in PBTL mode | Insert jumper to defeat PBTL mode and run in normal stereo BTL mode. | If PBTL jumper is removed (PBTL mode), the Left outputs (OUTPL and OUTNL) as well as the Right outputs (OUTPR and OUTNR) are synchronized and in phase. This allows them to be connected together before the reconstruction filter for PBTL operations. For PBTL operation, connect the OUTPL and OUTNL to each other and connect the OUTPR and OUTNR to each other. This can be done by shorting the two pins of the molex connectors labeled LEFT and RIGHT. |
| JP3, JP4, JP5, and JP6 | Connects LC filters to outputs. | | The LC filters are not installed in this version of the EVM. However, the inductors are shipped with the EVM package. They can be installed and used as normal reconstruction filters or to smooth the audio waveforms for measurement. They can also be used when driving resistive loads to simulate a speaker load. This EVM is meant to demonstrate filter-free operation with just a ferrite bead and small capacitor for good EMI performance. |

3 Schematic, Layout, and Bill of Materials

3.1 TPA311D2 EVM Schematic

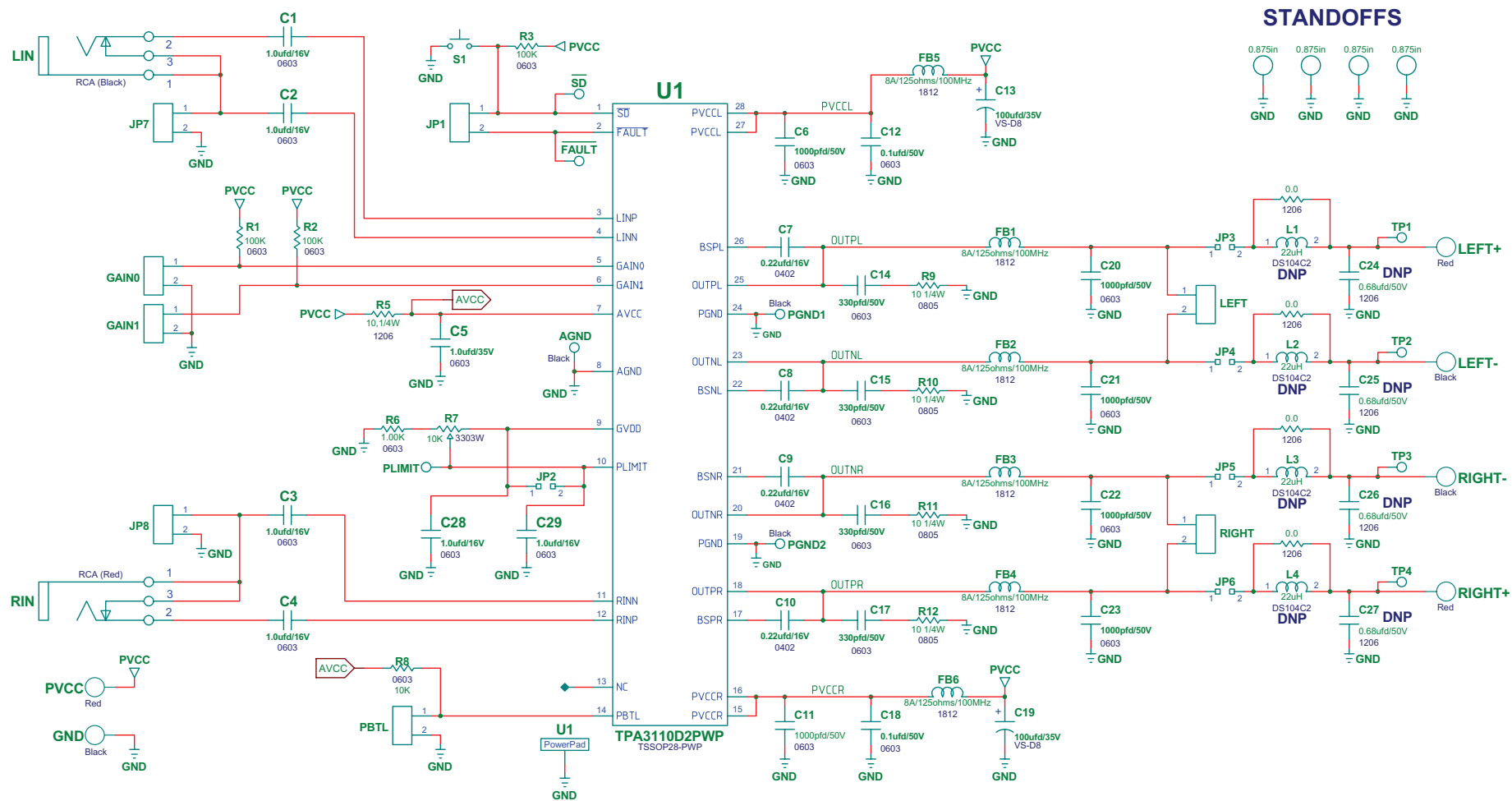


Figure 3. TPA311D2 EVM Schematic

3.2 TPA3110D2 EVM PCB Layers

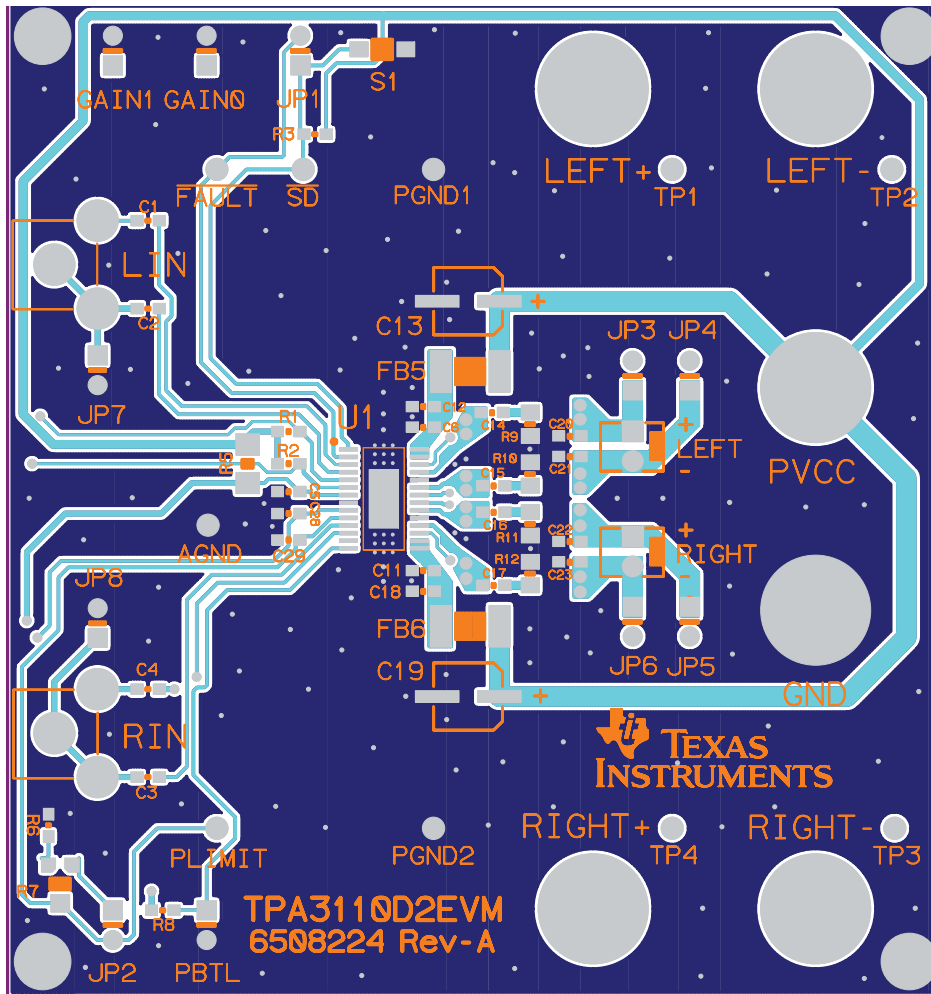


Figure 4. TPA3110D2 EVM – Top Side Layout

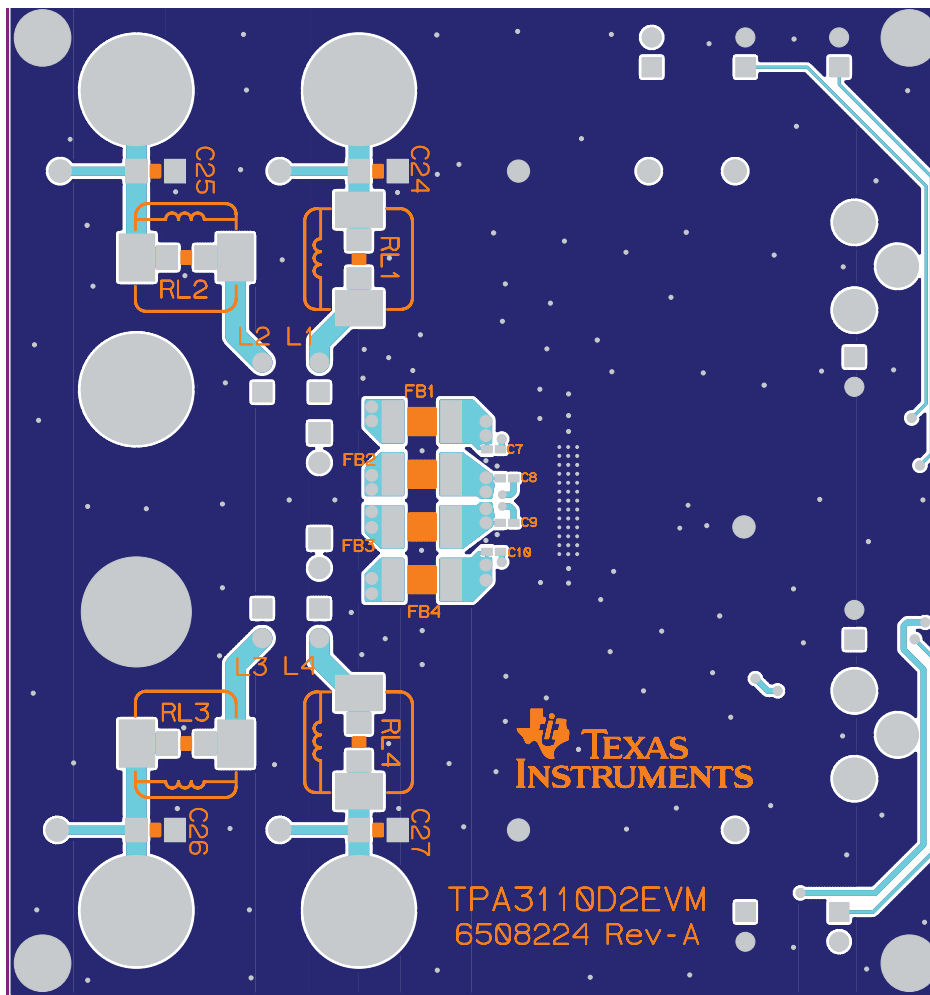


Figure 5. TPA3110D2 EVM – Bottom Side Layout

3.3 TPA3110D2 Bill of Materials

Table 4. Bill of Materials for TPA3110D2EVM

| Item | MANU Part no. | QTY | REF DESIGNATORS | Vendor Part No | Description | Vendor | MANU |
|--------------------------|------------------|-----|--|----------------|---|-------------------|-------------------|
| TI-SEMICONDUCTORS | | | | | | | |
| 1 | TPA3110D2PWP | 1 | U1 | TPA3110D2PWP | 15-W STEREO CLASS-D AUDIO POWER AMP, TSSOP28-PWP ROHS | TEXAS INSTRUMENTS | TEXAS INSTRUMENTS |
| CAPACITORS | | | | | | | |
| 2 | ECJ-1VC1H331J | 4 | C14, C15, C16, C17 | PCC331ACVCT | CAP SMD0603 CERM 330PFD 50V 5% COG ROHS | DIGI-KEY | PANASONIC |
| 3 | C1608C0G1H102J | 6 | C6, C11, C20, C21, C22, C23 | 445-1293-1 | CAP SMD0603 CERM 1000PFD 50V 5%COG ROHS | DIGI-KEY | TDK CORP. |
| 4 | C1608X7R1H104K | 2 | C12,C18 | 445-1314-1 | CAP SMD0603 CERM 0.1UFD 50V X7R ROHS | DIGI-KEY | TDK |
| 5 | EMK105BJ224KV-F | 4 | C7,C8,C9,C10 | 587-1452-1 | CAP SMD0402 CERM 0.22ufd 16V X5R ROHS | DIGI-KEY | TAIYO YUDEN |
| 6 | C0603C105K4PACTU | 6 | C1,C2,C3,C4,C28,C29 | 399-5090-1 | CAP SMD0603 CERM 1.0ufd 16V 10% X5R ROHS | DIGI-KEY | KEMET |
| 7 | GMK107BJ105KA-T | 1 | C5 | 587-1437-1 | CAP SMD0603 CERM 1.0ufd 35V 10% X5R ROHS | DIGI-KEY | TAIYO YUDEN |
| 8 | EEE-1VA101XP | 2 | C13,C19 | PCE3951CT | CAP SMD ELECT 100ufd 35V 20% VS-D8 ROHS | DIGI-KEY | PANASONIC |
| RESISTORS | | | | | | | |
| 9 | ERJ-8GEY0R00V | 4 | RL1, RL2, RL3, RL4 | P0.0ECT | RESISTOR SMD1206 0.0 OHM 5% 1/4W ROHS | DIGI-KEY | PANASONIC |
| 10 | ESR10EZPJ100 | 4 | R9,R10,R11,R12 | RHM10KCT | RESISTOR SMD0805 10 OHM 1% 1/4W ROHS | DIGI-KEY | ROHM |
| 11 | ERJ-8ENF10R0 | 1 | R5 | P10.0FCT | RESISTOR SMD1206 10.0 OHM 1% 1/4W ROHS | DIGI-KEY | PANASONIC |
| 12 | RC0603FR-071KL | 1 | R6 | 311-1.00KHRCT | RESISTOR SMD0603 1.00K OHM 1% 1/10W ROHS | DIGI-KEY | YAGEO |
| 13 | ERJ-3GEYJ103V | 1 | R8 | P10KGCT | RESISTOR SMD0603 10K 5% 1/10W ROHS | DIGI-KEY | PANASONIC |
| 14 | 3303W-3-103E | 1 | R7 | 3303W-103ECT | POT 10K SMD SINGLE TURN CERMET ROHS | DIGI-KEY | BOURNS |
| 15 | ERJ-3EKF1003V | 3 | R1,R2,R3 | P100KHCT | RESISTOR SM0603 100K OHM 1% 1/16W ROHS | DIGI-KEY | PANASONIC |
| FERRITE BEADS | | | | | | | |
| 16 | HI1812V101R-10 | 6 | FB1, FB2, FB3, FB4, FB5, FB6 | 240-2543-1 | FERRITE BEAD SMD1812 125 OHM@100MHz 8A ROHS | DIGI-KEY | STEWART |
| HEADERS AND JACKS | | | | | | | |
| 17 | PBC02SAAN | 11 | JP1, JP2, JP3, JP4, JP5, JP6, JP7, JP8, PBTL, GAIN0, GAIN1 | S1011E-02 | HEADER 2 PIN MALE, PCB STRAIGHT GOLD ROHS | DIGI-KEY | SULLINS |

Table 4. Bill of Materials for TPA3110D2EVM (continued)

| Item | MANU Part no. | QTY | REF DESIGNATORS | Vendor Part No | Description | Vendor | MANU |
|---|-----------------|-----|---|----------------|---|----------|-------------------------|
| 18 | 22-23-2021 | 2 | LEFT, RIGHT | WM4200 | HEADER MALE 2PIN 100LS W/ FRICTION LOCK ROHS | DIGI-KEY | MOLEX |
| 19 | PJРАН1X1U01X | 1 | LIN | 65K7770 | JACK, RCA 3-PIN PCB-RA BLACK ROHS | NEWARK | SWITCHCRAFT |
| 20 | PJРАН1X1U03X | 1 | RIN | 89K7617 | JACK, RCA 3-PIN PCB-RA RED ROHS | NEWARK | SWITCHCRAFT |
| TESTPOINTS AND SWITCHES | | | | | | | |
| 21 | 5004 | 7 | SD, TP1, TP2, TP3, TP4, FAULT, PLIMIT | 5004K | PC TESTPOINT, YELLOW, ROHS | DIGI-KEY | KEYSTONE ELECTRONICS |
| 22 | 5001 | 3 | AGND, PGND1, PGND2 | 5001K | PC TESTPOINT, BLACK, ROHS | DIGI-KEY | KEYSTONE ELECTRONICS |
| 23 | TL1015AF160QG | 1 | S1 | EG4344CT | SWITCH, MOM, 160G SMT 4X3MM ROHS | DIGI-KEY | E-SWITCH |
| BINDING POSTS | | | | | | | |
| 24 | 3760-2 | 2 | LEFT+, RIGHT+ | 565-3760-2 | BINDING POST, RED 60V/15A TIN ROHS | MOUSER | POMONA |
| 25 | 3760-0 | 2 | LEFT-, RIGHT- | 565-3760-0 | BINDING POST, BLACK 60V/15A TIN ROHS | MOUSER | POMONA |
| 26 | 3750-2 | 1 | PVCC | 565-3750-2 | BINDING POST, RED 60V/15A GOLD ROHS | MOUSER | POMONA |
| 27 | 3750-0 | 1 | GND | 565-3750-0 | BINDING POST, BLACK 60V/15A GOLD ROHS | MOUSER | POMONA |
| SHUNTS | | | | | | | |
| 28 | SPC02SYAN | 11 | JP1, JP2, JP3, JP4, JP5, JP6, JP7, JP8, PBTL, GAIN0, GAIN1 | S9001 | SHUNT, BLACK AU FLASH 0.100LS | DIGI-KEY | SULLINS |
| STANDOFFS AND HARDWARE | | | | | | | |
| 29 | PMS 440 0025 PH | 4 | SO1-S04 | H342 | 4-40 SCREW, STEEL 0.250 IN | DIGI-KEY | BUILDING FASTENERS |
| 30 | 2030 | 4 | SO1-S04 | 2030K | STANDOFF, 4- 40, 0.875INx3/16IN, ALUM RND F-F | DIGI-KEY | KEYSTONE ELECTRONICS |
| COMPONENTS NOT ASSEMBLED | | | | | | | |
| C24, C25, C26, C27, L1, L2, L3, L4 | | | | | | | |

Revision History

| Changes from A Revision (July 2010) to B Revision | Page |
|--|-------------|
| • Replaced Figure 3 | 6 |
| • Replaced Figure 4 | 7 |
| • Replaced Figure 5 | 8 |

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
 - 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

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