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.
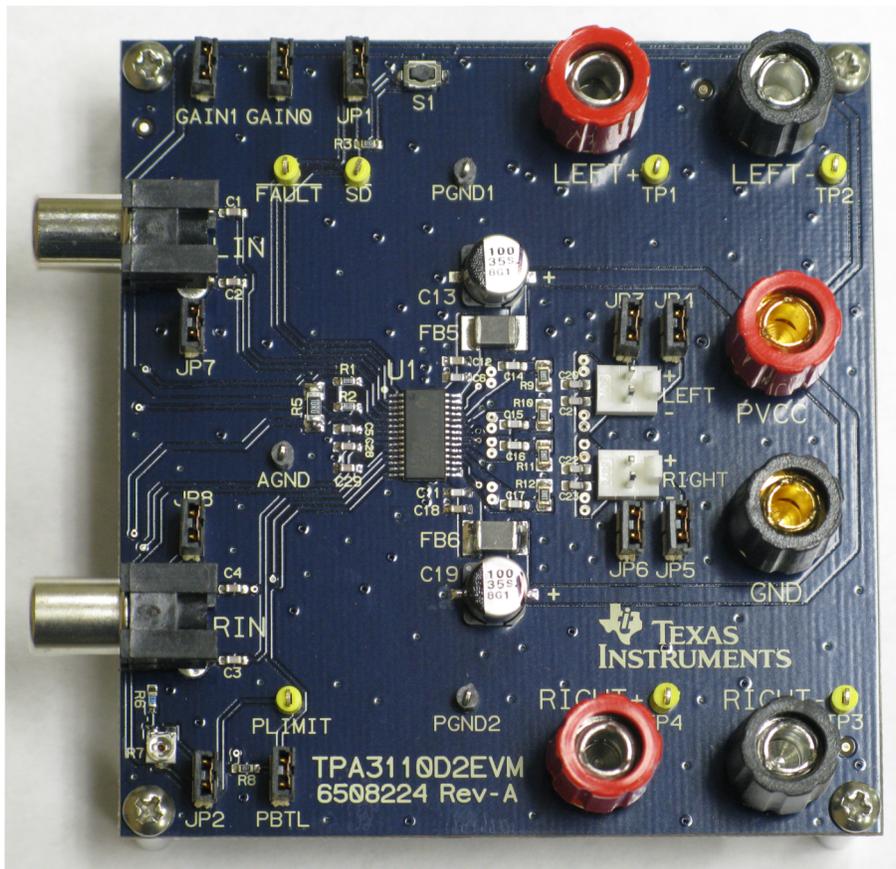
Figure 1. The TI TPA3110D2 EVM Audio Power Amplifier – Top View
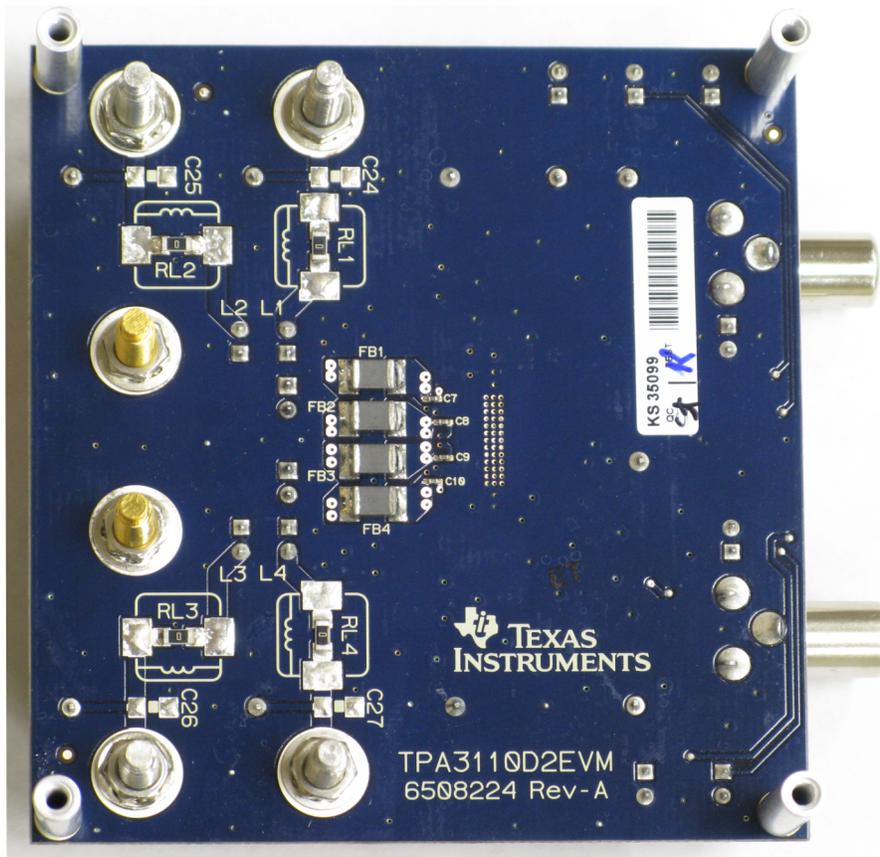
Figure 2. The TI TPA3110D2 EVM Audio Power Amplifier – Bottom View

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-μH series inductor for 4 Ω or 68-μH 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 molex 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
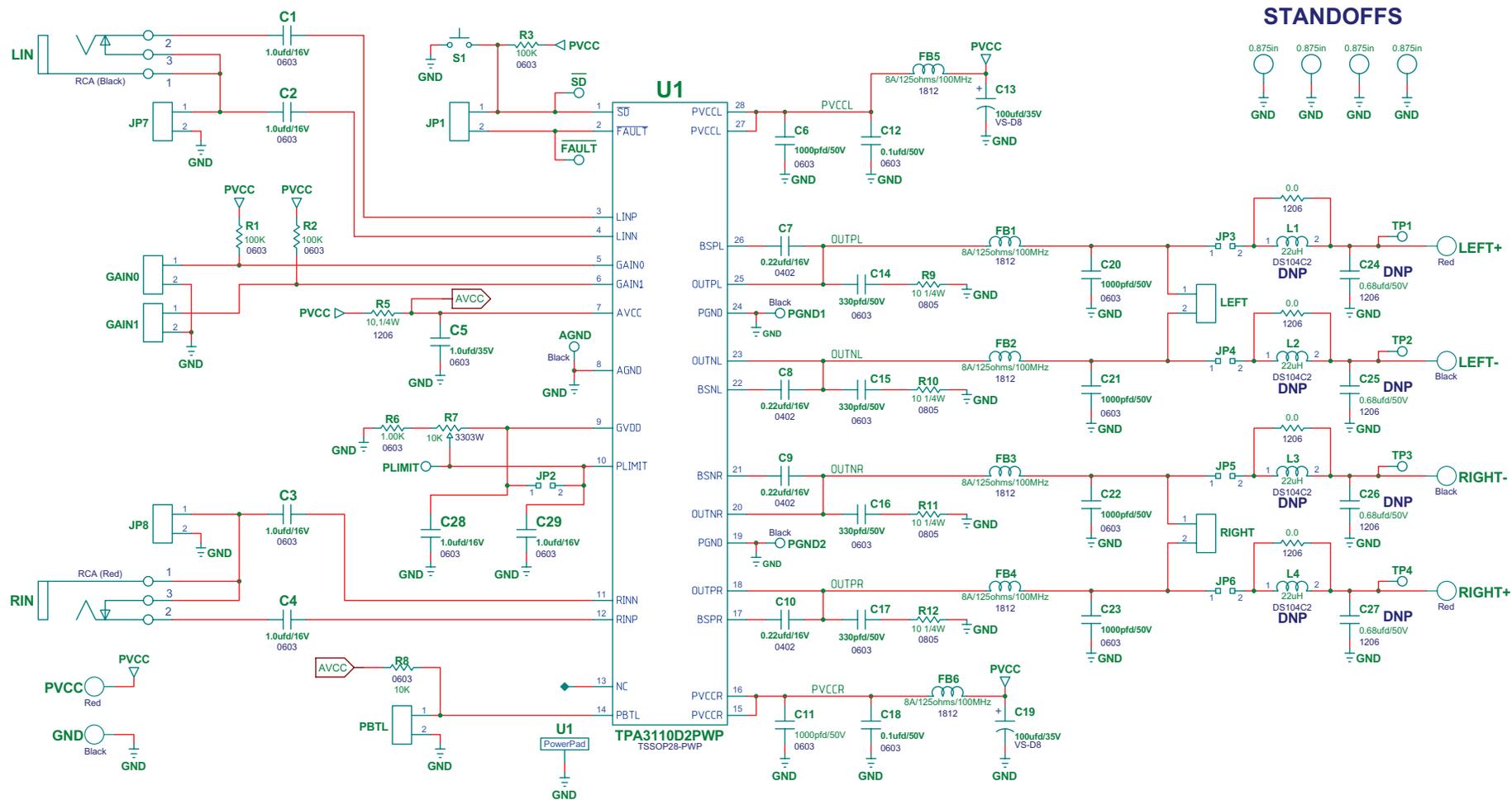
Figure 3. TPA311D2 EVM Schematic

3.2   TPA3110D2 EVM PCB Layers
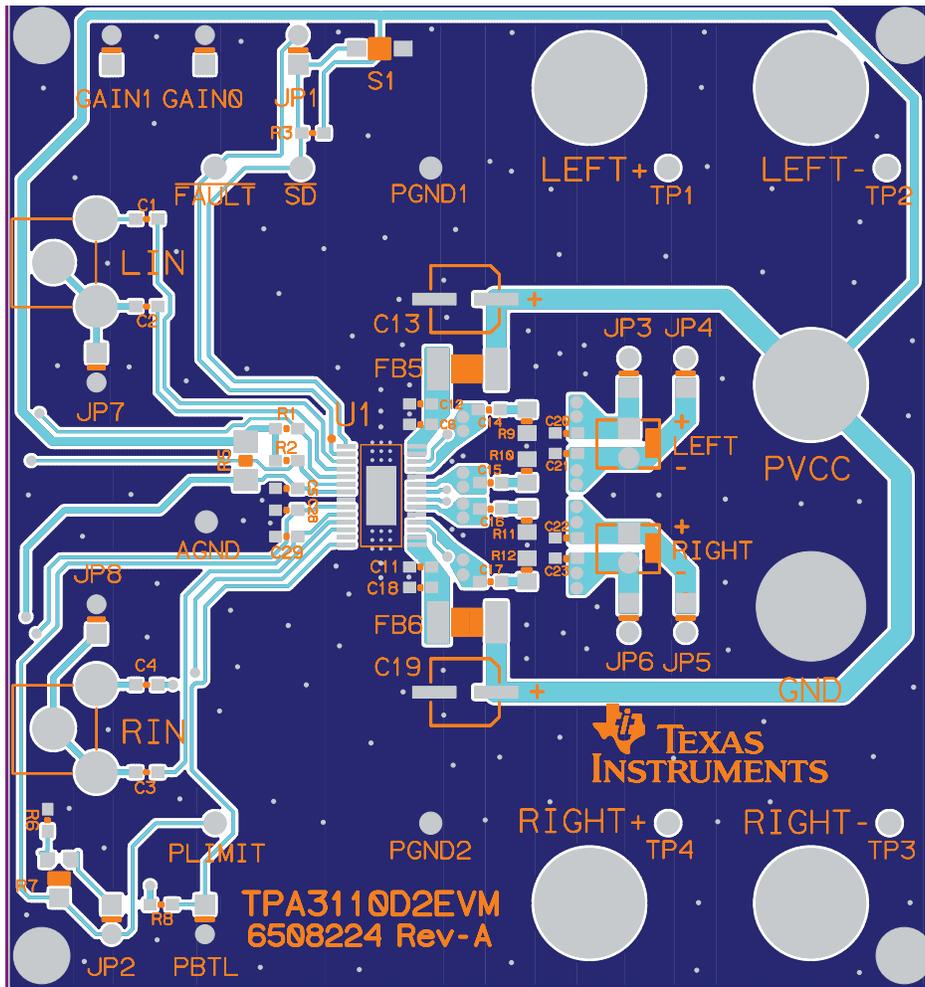
Figure 4. TPA3110D2 EVM – Top Side Layout
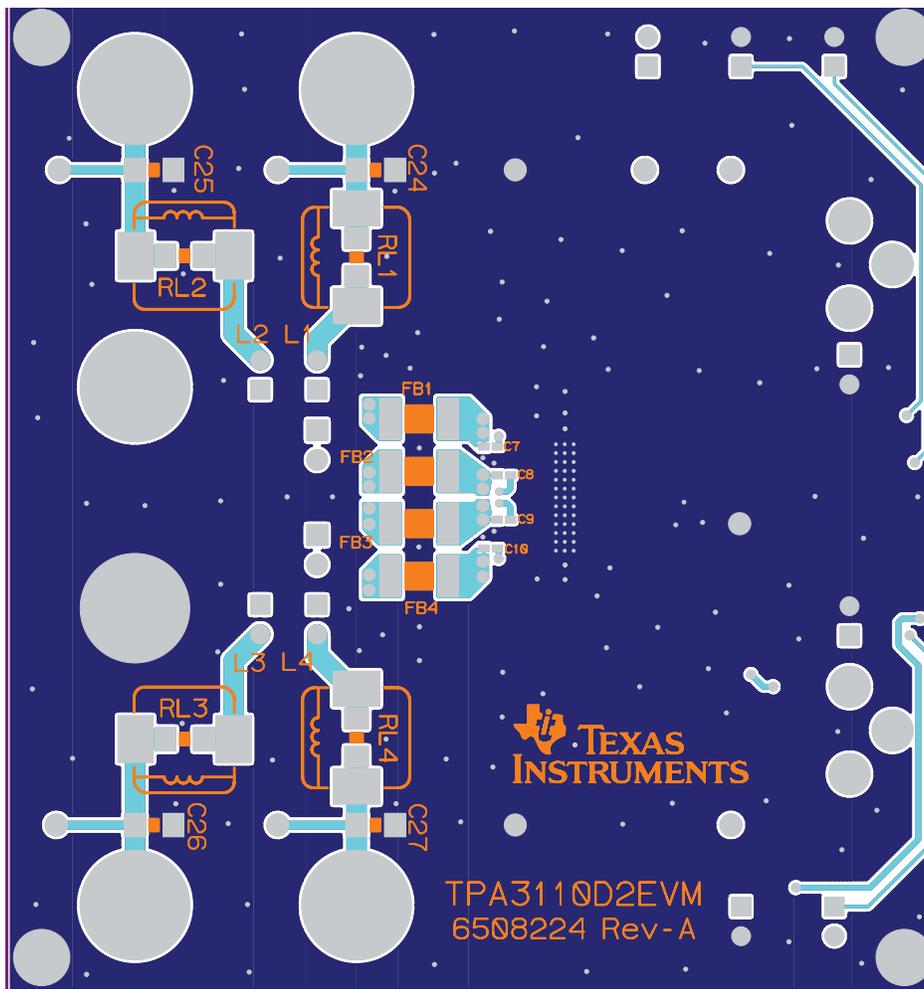
Figure 5. TPA3110D2 EVM − Bottom Side Layout

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 ROIHS	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	STEWARD
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	PJRAN1X1U01X	1	LIN	65K7770	JACK, RCA 3-PIN PCB-RA BLACK ROHS	NEWARK	SWITCHCRAFT
20	PJRAN1X1U03X	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**

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

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    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/lsds/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/lsds/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:*

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4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

IMPORTANT NOTICE

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