TPA6133A2 EVM

This user's guide describes the operation of the TPA6133A2 evaluation module (EVM) for the evaluation of the Texas Instruments TPA6133A2 amplifier and includes the EVM schematic, board art, and bill of materials.

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1 Introduction

This section provides an overview of the Texas Instruments (TI) TPA6133A2 DirectPath™ stereo headphone amplifier evaluation module (EVM). It includes a brief description of the module and a list of EVM specifications.

1.1 Description

The TPA6133A2 is a DirectPath™ stereo headphone amplifier capable of delivering 138 mW/Ch into 16 Ω and requires no output DC blocking capacitors. It has a fixed gain of +4 dB.

The TPA6133A2 EVM is a complete, stand-alone audio board. It contains the TPA6133A2QFN (RTJ) DirectPath™ stereo headphone amplifier. The device has 20 pins and the pin spacing is 0.5 mm. All components are Pb-free.

1.2 EVM Specifications

The following table lists the EVM specifications:

Supply voltage range, V_{BAT} (With JP_VBAT_SEL in the Pin 1 to Pin 2 position)	2.5 V to 5.5 V
Supply voltage range, V_{BAT} (With JP_VBAT_SEL in the Pin 2 to Pin 3 position)	+5.0 V (from computer's USB port)
Supply current, I_{DD}	0.50 A, maximum
Continuous output power, P_O, V_{DD} = 5 V, 16 Ω, THD + N = 1%	138 mW

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2 Operation

This section describes how to operate the TPA6133A2EVM.

2.1 Quick-Start List for Stand-Alone Operation

Use the following steps when operating the TPA6133A2EVM stand alone or when connecting the EVM into an existing circuit.

2.1.1 Power and Ground

1. Verify that the external power sources are set to OFF.
2. Set the power supply voltage between 2.5 V and 5.5 V. When connecting the power supply to the EVM, first connect the ground connection to the GND connector, and then connect the positive supply to the RED PWR_IN banana connector. Verify that the connections are made to the correct pin connector.
3. Install JP_VBAT_SEL between pins 1 and 2 to power the EVM from a variable power supply from 2.5 V to 5.5 V. Alternately, JP-VBAT_SEL can be placed in the pin 2 to pin 3 position to use the mini-USB connector (USB PWR) for +5-V power from a computer. This EVM does not contain a USB Controller and only uses the USB connector to draw power from a computer.
4. Ensure that the JP_Iq jumper is installed. This jumper can be removed and a current meter placed between pins 1 and 2 for device current measurements.
5. Ensure that JP3 and JP4 are for normal operation and removed for current testing. The LED is simply a power indicator and shows that the amplifier is active.

2.1.2 Inputs and Outputs

2.1.2.1 Audio

1. Verify that the audio source is set to the minimum level.
2. Connect the audio source (audio output should not exceed 1 vrms) to the RCA Connectors, L_IN1 and R_IN1.
3. There are four jumpers, JP5, JP6, JP7, and JP8, which should be left in place during testing when using the input RCA connectors. They can be removed and wired connections placed from pin 2 of each of the jumpers to an audio source, such as a codec EVM.
4. Connect JP_SE_R and JP_SE_L to ground for single-ended input, if necessary, by installing JP SE L and JP SE R. Generally, the single-ended ground is connected at the audio source in the system, like a codec, for example.
5. Using a 3.5-mm mini-phone plug (J1), connect a headset or other load, from 16 Ω to 32 Ω, to the headphone jack. (There are also positions on the EVM, LOAD_R and LOAD_L, where load resistors can be installed to facilitate testing.) The device will also drive higher impedance loads, 150 Ω, for example.

2.1.2.2 Enable (EN) Control

1. Shutdown is controlled by pushbutton S1. Press and hold S1 to place the TPA6133A2 in shutdown. Release S1 to reactivate the TPA6133A2.
2. The JP1 jumper can be installed to hold the TPA6133A2 in shutdown for current measurements, and so forth.

2.1.3 Gain Setting

The gain of the TPA6133A2 is fixed at +4 dB

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2.1.4 Power Up

1. Verify the correct connections as described in Power and Ground and Inputs and Outputs.
2. Verify the correct voltage setting of the power supply and turn ON the power supply. Proper operation of the EVM should begin.
3. Adjust the audio signal source, as needed.
4. There may be a small *pop* present at power on and power off, if S1 is not pressed before turning on or turning off power. In a system application, the amplifier should be held in shutdown until power and devices in the signal chain ahead of it stabilize.

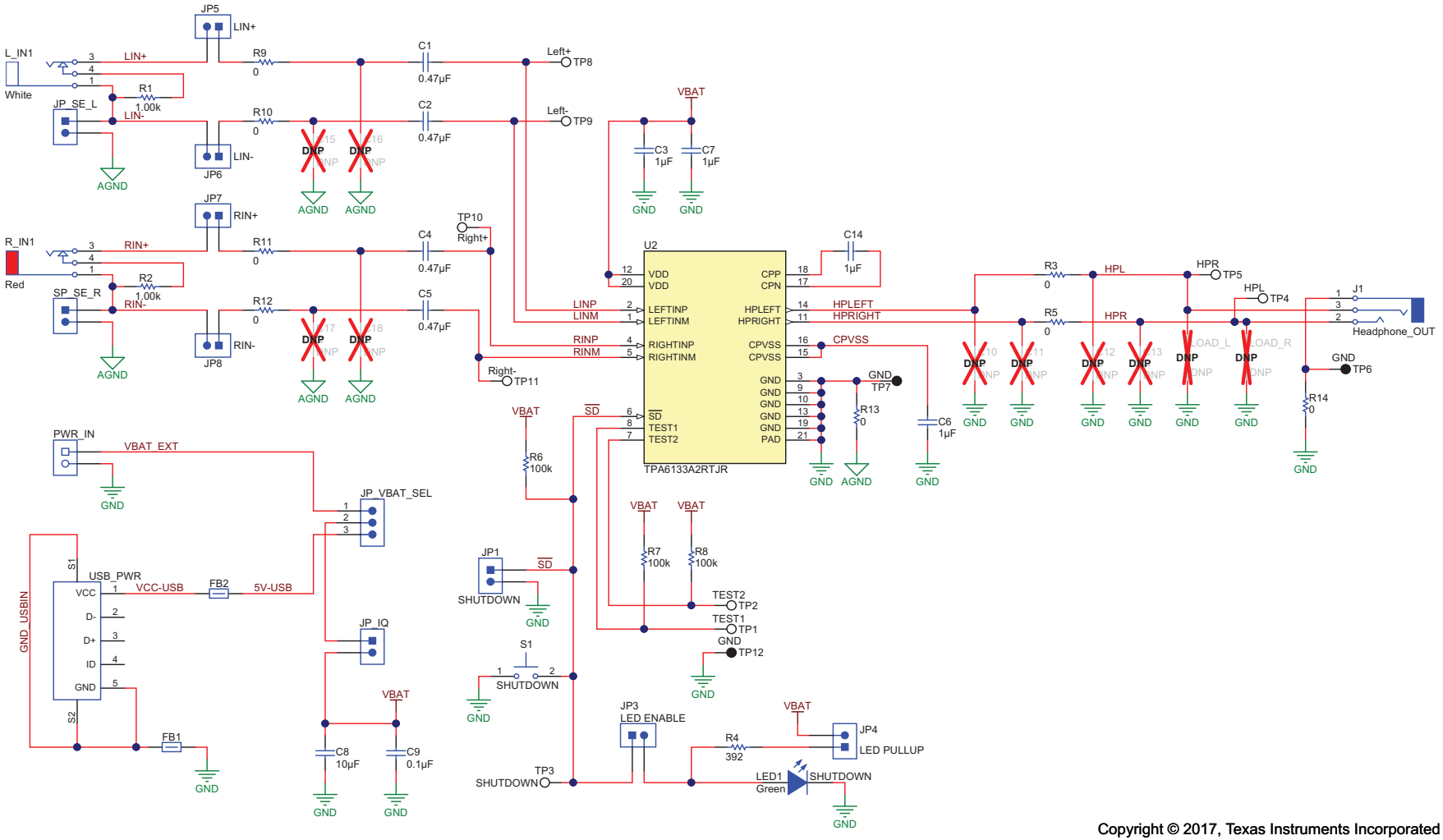
3 Reference

This section includes the EVM schematic, board layout reference, and parts list. This EVM contains PCB stuffing options for other devices and they are labeled as DNP on the schematic. Also, the outputs, OUTL and OUTR contain unpopulated stuffing options for output-filter circuitry and are also DNP, except for R3 and R5 which are populated as 0-Ω resistors. The resistors can be removed and ferrite beads installed, if desired. There are also PCB pads for TVS diodes which can be populated for IEC ESD testing.

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3.1 TPA6133A2EVM Schematic

Figure 1 illustrates the TPA6133A2EVM schematic.



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Figure 1. TPA6133A2EVM Schematic

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3.2 TPA6133A2EVM PCB Layers

Figure 2 through Figure 6 illustrate the TPA6133A2EVM PCB layout images.

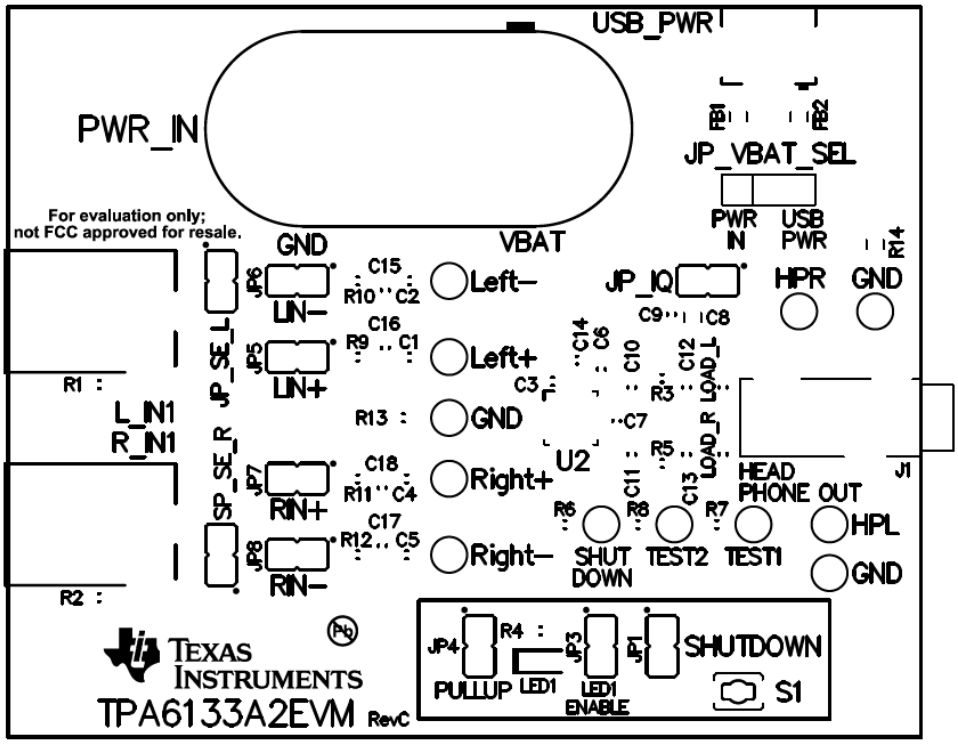


Figure 2. Top View with Silk Screen

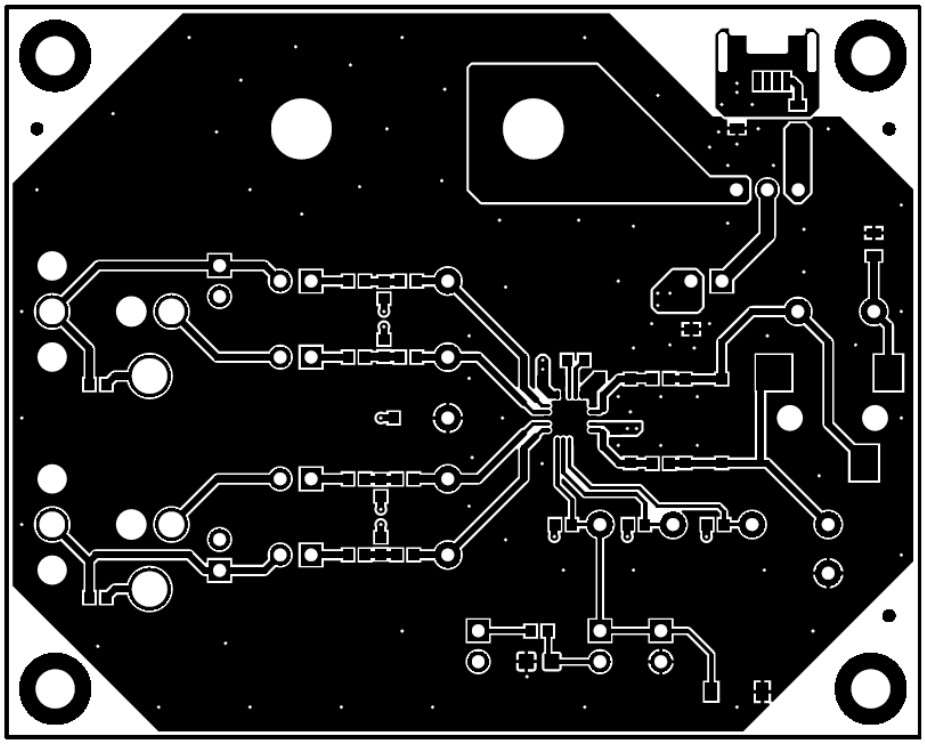


Figure 3. Top Layer

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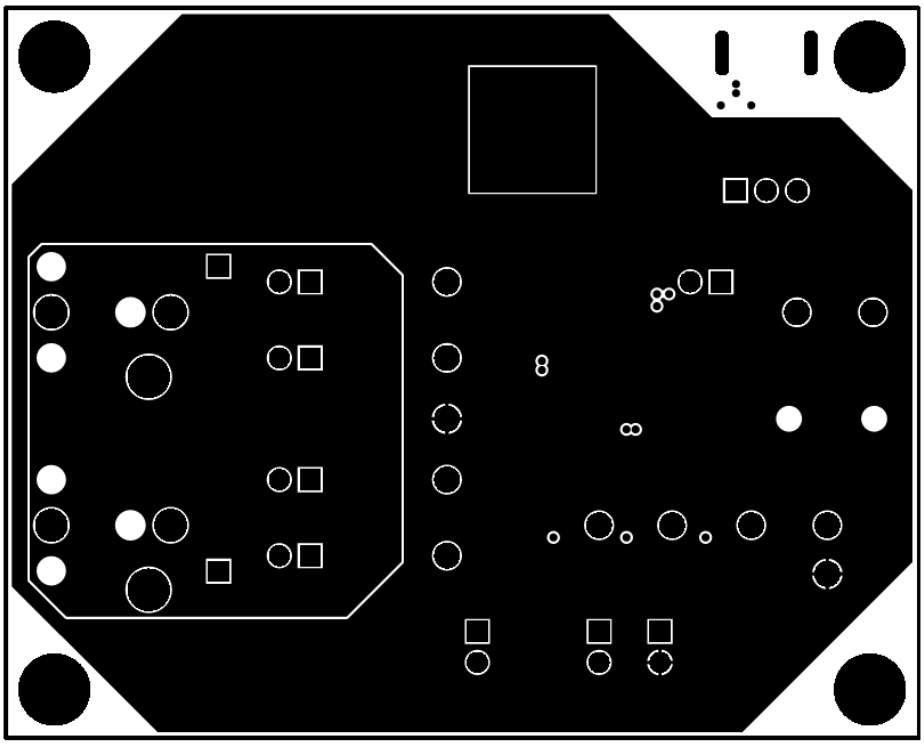


Figure 4. GND Layer

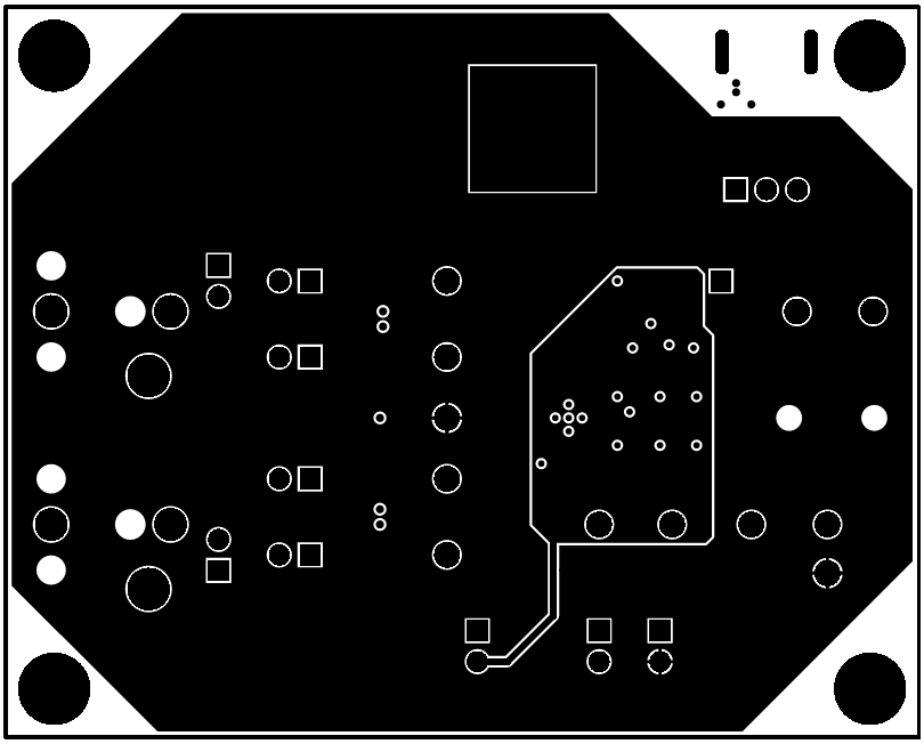


Figure 5. Power and GND Layer

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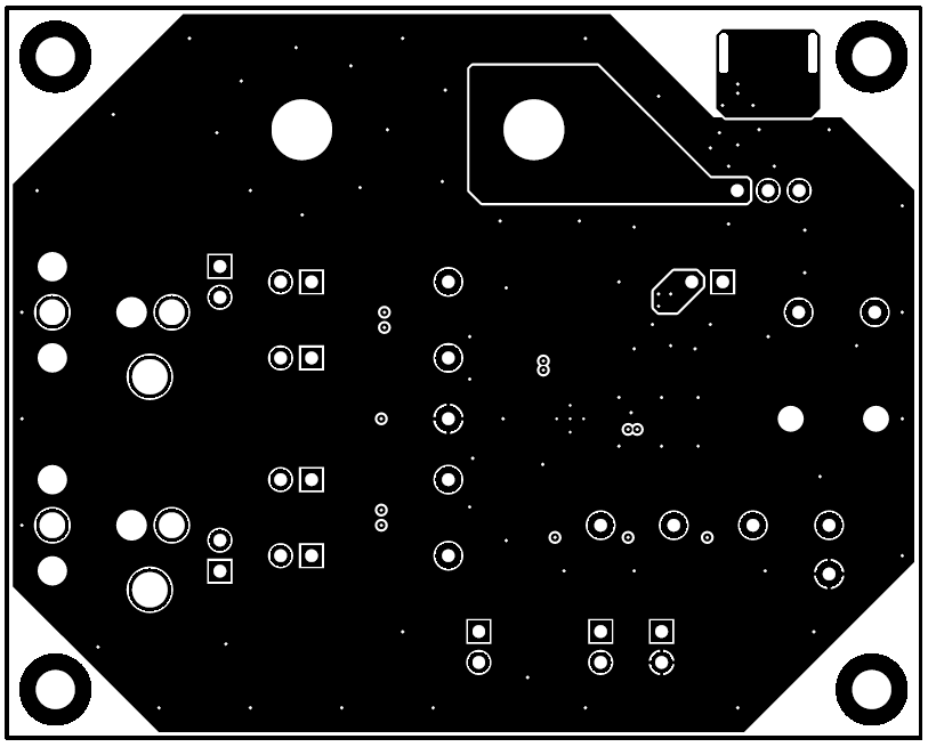


Figure 6. Bottom Layer

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3.3 TPA6133A2EVM Bill of Materials

Table 1 lists the TPA6133A2EVM bill of materials.

Table 1. TPA6133A2EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		TPA6133A2EVM	Any	-	-
C1, C2, C4, C5	4	0.47uF	CAP, CERM, 0.47 µF, 16 V, +/- 10%, X7R, 0603	0603	C0603C474K4RACTU	Kemet		
C3, C6, C7, C14	4	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	Murata		
C8	1	10uF	CAP, CERM, 10 µF, 16 V, +/- 10%, X5R, 0805	0805	GRM21BR61C106KE15L	Murata		
C9	1	0.1uF	CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R, 0603	0603	GRM188R71C104KA01D	Murata		
FB1, FB2	2	30 ohm	Ferrite Bead, 30 ohm @ 100 MHz, 1.5 A, 0805	0805	MMZ2012R300A	TDK		
H1, H2, H3, H4	4		MACHINE SCREW PAN PHILLIPS 4-40	Machine Screw, 4-40, 1/4 inch	PMSSS 440 0025 PH	B&F Fastener Supply		
H5, H6, H7, H8	4		HEX STANDOFF 4-40 ALUMINUM 3/4"	HEX STANDOFF 4-40 ALUMINUM 3/4"	2204	Keystone		
J1	1		Audio Jack, 3.5mm, Stereo, R/A, SMT	Audio Jack SMD	SJ-3523-SMT	CUI Inc.		
JP1, JP3, JP4, JP5, JP6, JP7, JP8, JP_IQ, JP_SE_L, SP_SE_R	10		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
JP_VBAT_SEL	1		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
LED1	1	Green	LED, Green, SMD	0805	SML-LXT0805GW-TR	Lumex		
L_IN1	1		RCA Jack, White, R/A, TH	PC Mount Phono Jack-White, TH	970	Keystone		
PWR_IN	1		Dual Binding Posts with Base, 2x1, TH	Dual Binding Posts with Base, 2x1, TH	6883	Pomona Electronics		
R1, R2	2	1.00k	RES, 1.00 k, 0.1%, 0.1 W, 0603	0603	RT0603BRB071KL	Yageo America		
R3, R5, R9, R10, R11, R12, R13	7	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic		
R4	1	392	RES, 392, 1%, 0.1 W, 0603	0603	CRCW0603392RFKEA	Vishay-Dale		
R6, R7, R8	3	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEYJ104V	Panasonic		
R14	1	0	RES, 0, 5%, 0.125 W, 0805	0805	RC0805JR-070RL	Yageo America		
R_IN1	1		RCA Jack, Red, R/A, TH	PC Mount Phono Jack-Red, TH	971	Keystone		
S1	1		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	Switch, 4.4x2x2.9 mm	TL1015AF160QG	E-Switch		

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Table 1. TPA6133A2EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11	11	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP8, TP9, TP10, TP11	9		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone		
TP6, TP7, TP12	3		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone		
U2	1		138-mW DirectPath(TM)Stereo Headphone Amplifier with I2C Volume Control, RTJ0020D (WQFN-20)	RTJ0020D	TPA6133A2RTJR	Texas Instruments	TPA6130A2RTJT	Texas Instruments
USB_PWR	1		Connector, Receptacle, Mini-USB Type B, R/A, SMT	Connector, Receptacle, Mini-USB Type B, R/A, SMT	UX60SC-MB-5S8	Hirose Electric Co. Ltd.		
C10, C11, C12, C13, C15, C16, C17, C18	0	0.1uF	CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R, 0603	0603	GRM188R71C104KA01D	Murata		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
LOAD_L, LOAD_R	0	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic		
	Notes:	Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.						

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Revision History

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

Changes from Original (June 2013) to A Revision	Page
• Changed schematic image for board revision C.	5
• Changed PCB layout images for board revision C.	6
• Changed BOM for board revision C.	9

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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   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 semiconductors 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   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:*

   3.1 *United States*

      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/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 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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

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:*

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.

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.

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