This user's guide describes the characteristics, operation, and use of the TPA6120A2RGY evaluation module (EVM). This user's guide includes EVM description, performance specifications, board layout, bill of materials (BOM), and schematic diagram.

Contents
1 Introduction .......................................................................................................................... 2
   1.1 Related Documentation from Texas Instruments .......................................................... 2
   1.2 Description .................................................................................................................... 2
   1.3 Performance Specifications .......................................................................................... 2
2 Getting Started .................................................................................................................... 2
3 Customizing the EVM .......................................................................................................... 4
   3.1 Single-Ended Inverting Configuration .......................................................................... 4
   3.2 Single-Ended Noninverting Configuration .................................................................. 4
   3.3 Special Note on Filtering and Capacitors C7 and C8 .................................................. 4
   3.4 Special Note on Gain and Input Configurations ........................................................... 4
   3.5 Single Power Supply Configuration ............................................................................ 4
4 EVM Circuit and Layout ....................................................................................................... 5
   4.1 Layout Guidelines ......................................................................................................... 5
   4.2 TPA6120A2RGY EVM PCB Layouts ......................................................................... 5
   4.3 Schematic ..................................................................................................................... 7
   4.4 Bill of Materials ........................................................................................................... 7

List of Figures
1 TPA6120A2RGY EVM Top Layer ..................................................................................... 3
2 TPA6120A2RGY EVM Top Copper Layer ....................................................................... 5
3 TPA6120A2RGY EVM Middle Layer 1 ........................................................................... 5
4 TPA6120A2RGY EVM Middle Layer 2 ........................................................................... 5
5 TPA6120A2RGY EVM Bottom Layer ............................................................................. 5
6 TPA6120A2RGY EVM Schematic ..................................................................................... 7

List of Tables
1 TPA6120A2RGY EVM Specifications ................................................................................. 2
2 TPA6120A2RGY EVM Bill of Materials ........................................................................... 7
1 Introduction

The TPA6120A2RGY is a high-fidelity audio amplifier. The amplifier can operate from a split power supply, and is designed for low noise, high dynamic range performance.

1.1 Related Documentation from Texas Instruments

TPA6120A2 data sheet (literature number SLOS431)

1.2 Description

The TPA6120A2RGY EVM is designed to operate specifically with a split power supply and is configured with differential inputs with a gain of 1 V/V. The output signal is routed into a 3.5-mm headphone jack J4. The EVM is approximately 1.5 x 1.25 in.

1.3 Performance Specifications

Table 1. TPA6120A2RGY EVM Specifications

<table>
<thead>
<tr>
<th></th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$ Supply voltage range</td>
<td>±5</td>
<td>±15</td>
<td>V</td>
</tr>
<tr>
<td>Power supply current rating required</td>
<td>1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Continuous output power, $P_o$: 32-Ω stereo, $V_{CC} = \pm 12$ V</td>
<td>2</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>$V_i$ Audio input voltage</td>
<td>$-V_{CC}$</td>
<td>$V_{CC}$</td>
<td></td>
</tr>
<tr>
<td>$Z_{in}$ Minimum load impedance</td>
<td>8</td>
<td>Ω</td>
<td></td>
</tr>
</tbody>
</table>

CAUTION

1. Accidental swapping of supply polarities causes damage to the device and can cause damage to the other components on the board.
2. Do not short the outputs of the TPA6120A2RGY to either the positive or negative supply when operating with a split power supply. When operating with a single power supply, do not short the outputs to the positive supply. This damages the device.

2 Getting Started

Follow these steps to use the TPA6120A2RGY EVM in its original configuration:

Power Supply

1. Make sure all external power supplies are turned off.
2. Connect an external power supply with the positive voltage set between 5 V and 15 V to the terminal marked V+ (J1) on the EVM.
3. Connect the negative voltage to the terminal marked V– (J2), making sure the negative voltage is set to the same magnitude as that of the positive (that is, ±5 V, ±12 V, ±15 V).
4. Connect the left signal sources to the screw terminal labeled LIN (J3), and the right signal source to the screw terminal labeled RIN (J5).

NOTE: This EVM is configured for differential mode. To operate in single-ended mode, see Single-Ended Inverting Configuration.
Inputs and Outputs
1. Ensure the signal source is turned off or set to a minimum.
2. Connect the left signal source to the RCA jack labeled LIN+ (J5), and the right signal source to the RCA jack labeled RIN+ (J6).
3. Insert headphones into 3.5 mm headphone jack (J4).

Power Up
1. Verify correct voltage polarity on the supplies.
2. Turn on the power supply.
3. Turn on the signal source.
4. Adjust signal source level as needed.

Figure 1. TPA6120A2RGY EVM Top Layer
3 Customizing the EVM

The TPA6120A2RGY EVM comes in a differential configuration with a gain of 1 V/V. However, the EVM is designed to be flexible, and can be converted to operate in single-ended inverting and noninverting configurations. The TPA6120A2RGY EVM can also be operated in a single power supply configuration.

3.1 Single-Ended Inverting Configuration

The TPA6120A2RGY EVM can operate in a single-ended inverting gain configuration without modification. To operate in single-ended mode with the unmodified EVM, simply put the signal line into the inverting terminal (–) and the ground line into the noninverting terminal (+). This yields an inverting configuration with a gain of –1 V/V.

The EVM can also be modified to operate in single-ended inverting only mode with a reduced BOM. To do this, short resistors R1, R2, R9 (for the left channel) and short R10, R11, and R12 (for the right channel). Put the signal line on the inverting terminal and the ground line on the noninverting terminal. This yields an inverting configuration with a gain of –1 V/V.

3.2 Single-Ended Noninverting Configuration

The EVM can operate in a single-ended noninverting gain configuration without modification by applying the signal line to the noninverting input and the ground line to the inverting input. This yields a gain of +1 V/V.

Another possible setup for noninverting configuration is to remove R9 (for the left channel) and R10 (for the right channel). Apply the signal line to the noninverting input and the ground line to the inverting input. This yields a gain of +2 V/V.

3.3 Special Note on Filtering and Capacitors C7 and C8

Capacitors C7 and C8 can be added into the EVM to form a low-pass filter into the amplifier. A typical application for this is to block out the band noise caused by the output of a DAC. When selecting capacitance values, the cut-off frequency of the filter becomes 1/(π × R × C) instead of 1/(2π × R × C) because the capacitor is connected differentially, which halves the required capacitance.

3.4 Special Note on Gain and Input Configurations

The TPA6120A2RGY high-fidelity audio power amplifier has two separate channels, left and right. It is not necessary to operate each channel in the same configuration. For test purposes, it may be desirable to operate the left channel with a noninverting configuration, and the right channel with an inverting configuration. One channel may be configured to operate with differential inputs while the other channel with single-ended inputs. The TPA6120A2RGY EVM allows for this flexibility. From a listening standpoint, the best audio performance is achieved when both channels are operated with the same configuration. In this case, there is no sound difference between the left and right channels for the human ear to detect.

3.5 Single Power Supply Configuration

The TPA6120A2RGY EVM was not optimized for single power supply operation. To operate in this mode, the V– terminal must be connected to GND. DC-blocking capacitors must be used at the outputs to prevent large amounts of dc current from flowing through the headphones due to the high midrail bias. Likewise, dc-blocking capacitors must be used at the input. R9 and R10 must be removed. The positive input nodes must be biased to midrail. Resistors R9 and R10 tie the positive node to ground.
4 EVM Circuit and Layout

The TPA6120A2RGY EVM layout was carefully planned to minimize the capacitance and inductance detected by the output and input pins of the amplifier.

This chapter includes the EVM layout, the TPA6120A2RGY EVM component selection, schematic, and BOM.

4.1 Layout Guidelines

Use the following guidelines during layout:

- Keep layout tight to minimize layout parasitics (that is, keep traces as short as possible and do not cross signal lines, if possible)
- Maintain symmetry in the layout to maximize common-mode rejection (CMR)
- Maximize copper area connection to the PowerPad for best heat dissipation performance (if cutting the ground plane, make cuts radially and not circularly)
- Remove ground plane from inputs to minimize stray capacitance

4.2 TPA6120A2RGY EVM PCB Layouts

Figure 2 shows the top copper layer of the TPA6120A2RGY EVM. The RCA jacks at the inputs are configured to short to ground when no plug is inserted. The noninverting configuration of the EVM requires that RIN and LIN be at ground. Rather than have the signal go through the long signal trace to get to the input jacks, 0-Ω resistors R11 and R12 are used to provide a connection to ground much closer to the device.

A star point for ground should be chosen. For the TPA6120A2RGY EVM, the ground terminal of the board is (J7). Current paths to the star ground should be as direct as possible.

Figure 3 through Figure 5 illustrate other TPA6120A2RGY EVM copper layers.
Figure 4. TPA6120A2RGY EVM Middle Layer 2

Figure 5. TPA6120A2RGY EVM Bottom Layer
4.3 Schematic

Figure 6 illustrates the TPA6120A2RGY EVM schematic.

![TPA6120A2RGY EVM Schematic](image)

4.4 Bill of Materials

Table 2 list the BOM for this EVM.

<table>
<thead>
<tr>
<th>Designator</th>
<th>Qty</th>
<th>Value</th>
<th>Description</th>
<th>Package Reference</th>
<th>Part Number</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>!PCB</td>
<td>1</td>
<td></td>
<td>Printed Circuit Board</td>
<td></td>
<td>AIP022</td>
<td>Any</td>
</tr>
<tr>
<td>C1</td>
<td>1</td>
<td>10uF</td>
<td>CAP, CERM, 10uF, 25V, +/-20%, X5R, 0603</td>
<td>0603</td>
<td>C1608X5R1E106M080AC</td>
<td>TDK Corporation</td>
</tr>
<tr>
<td>C2, C3, C4, C5</td>
<td>4</td>
<td>0.1uF</td>
<td>CAP, CERM, 0.1uF, 25V, +/-10%, X7R, 0603</td>
<td>0603</td>
<td>GRM188R71E104KA01D</td>
<td>Murata</td>
</tr>
<tr>
<td>C6</td>
<td>1</td>
<td>10uF</td>
<td>CAP, CERM, 10uF, 25V, +/-20%, X5R, 0603</td>
<td>0603</td>
<td>GRM188R61E106MA73</td>
<td>Murata</td>
</tr>
<tr>
<td>H1, H2, H3, H4</td>
<td>4</td>
<td></td>
<td>Bumpon, Hemisphere, 0.25 X 0.075, Clear</td>
<td>75x250 mil</td>
<td>SJ5382</td>
<td>3M</td>
</tr>
<tr>
<td>J1, J2, J3, J5</td>
<td>4</td>
<td></td>
<td>Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH</td>
<td>7.0x8.2x6.5mm</td>
<td>ED555/2DS</td>
<td>On-Shore Technology</td>
</tr>
<tr>
<td>J4</td>
<td>1</td>
<td></td>
<td>Connector, Audio Jack, 3.5mm, Stereo, SMD</td>
<td>Audio Jack SMD</td>
<td>SJ-3523-SMT</td>
<td>CUI Inc</td>
</tr>
<tr>
<td>R1, R2, R5, R6, R7, R8, R11, R12</td>
<td>8</td>
<td>402</td>
<td>RES, 402 ohm, 1%, 0.1W, 0603</td>
<td>0603</td>
<td>RC0603FR-07402RL</td>
<td>Yageo America</td>
</tr>
<tr>
<td>R3, R4</td>
<td>2</td>
<td>39.2</td>
<td>RES, 39.2 ohm, 1%, 0.125W, 0805</td>
<td>0805</td>
<td>CRCW080539R2FKEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>R9, R10, R13, R14</td>
<td>4</td>
<td>806</td>
<td>RES, 806 ohm, 1%, 0.1W, 0603</td>
<td>0603</td>
<td>CRCW0603806RFKEA</td>
<td>Vishay-Dale</td>
</tr>
<tr>
<td>U1</td>
<td>1</td>
<td></td>
<td>HIGH FIDELITY HEADPHONE AMPLIFIER, RGY0014A</td>
<td>RGY0014A</td>
<td>TPA6120A2RGY</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>C7, C8</td>
<td>0</td>
<td>1000pF</td>
<td>CAP, CERM, 1000pF, 25V, +/-5%, COG/NP0, 0803</td>
<td>0603</td>
<td>GRM188SC1E102JA01D</td>
<td>Murata</td>
</tr>
<tr>
<td>FID1, FID2, FID3</td>
<td>0</td>
<td></td>
<td>Fiducial mark. There is nothing to buy or mount.</td>
<td>Fiducial</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

(1) Unless otherwise noted, all parts may be substituted with equivalents.
Texas Instruments Incorporated (TI) markets, sells, and loans all evaluation boards, kits, and/or modules (EVMs) pursuant to, and user expressly acknowledges, represents, and agrees, and takes sole responsibility and risk with respect to, the following:

1. User agrees and acknowledges that EVMs are intended to be handled and used for feasibility evaluation only in laboratory and/or development environments. Notwithstanding the foregoing, in certain instances, TI makes certain EVMs available to users that do not handle and use EVMs solely for feasibility evaluation only in laboratory and/or development environments, but may use EVMs in a hobbyist environment. All EVMs made available to hobbyist users are FCC certified, as applicable. Hobbyist users acknowledge, agree, and shall comply with all applicable terms, conditions, warnings, and restrictions in this document and are subject to the disclaimer and indemnity provisions included in this document.

2. Unless otherwise indicated, EVMs are not finished products and not intended for consumer use. EVMs are intended solely for use by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

3. User agrees that EVMs shall not be used as, or incorporated into, all or any part of a finished product.

4. User agrees and acknowledges that certain EVMs may not be designed or manufactured by TI.

5. User must read the user's guide and all other documentation accompanying EVMs, including without limitation any warning or restriction notices, prior to handling and/or using EVMs. Such notices contain important safety information related to, for example, temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

6. User assumes all responsibility, obligation, and any corresponding liability for proper and safe handling and use of EVMs.

7. Should any EVM not meet the specifications indicated in the user's guide or other documentation accompanying such EVM, the EVM may be returned to TI within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY TI TO USER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. TI SHALL NOT BE LIABLE TO USER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RELATED TO THE HANDLING OR USE OF ANY EVM.

8. No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which EVMs might be or are used. TI currently deals with a variety of customers, and therefore TI's arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services with respect to the handling or use of EVMs.

9. User assumes sole responsibility to determine whether EVMs may be subject to any applicable federal, state, or local laws and regulatory requirements (including but not limited to U.S. Food and Drug Administration regulations, if applicable) related to its handling and use of EVMs and, if applicable, compliance in all respects with such laws and regulations.

10. User has sole responsibility to ensure the safety of any activities to be conducted by it and its employees, affiliates, contractors or designees, with respect to handling and using EVMs. Further, user is responsible to ensure that any interfaces (electronic and/or mechanical) between EVMs 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.

11. User shall employ reasonable safeguards to ensure that user's use of EVMs will not result in any property damage, injury or death, even if EVMs should fail to perform as described or expected.

12. User shall be solely responsible for proper disposal and recycling of EVMs consistent with all applicable federal, state, and local requirements.

Certain Instructions. User shall operate EVMs within TI's recommended specifications and environmental considerations per the user's guide, accompanying documentation, and any other applicable requirements. Exceeding the specified ratings (including but not limited to input and output voltage, current, power, and environmental ranges) for EVMs may cause property damage, personal injury or death. If there are questions concerning these ratings, 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the applicable EVM user's guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using EVMs' schematics located in the applicable EVM user's guide. When placing measurement probes near EVMs during normal operation, please be aware that EVMs may become very warm. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use EVMs.

Agreement to Defend, Indemnify and Hold Harmless. User agrees to defend, indemnify, and hold TI, its directors, officers, employees, agents, representatives, affiliates, 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 and/or use of EVMs. User's indemnity shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if EVMs fail to perform as described or expected.

Safety-Critical or Life-Critical Applications. If user intends to use EVMs in evaluations of safety critical applications (such as life support), and a failure of a TI product considered for purchase by user for use in user's product would reasonably be expected to cause severe personal injury or death such as devices which are classified as FDA Class III or similar classification, then user must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.
 rửa FREQUENCY REGULATORY COMPLIANCE INFORMATION FOR EVALUATION MODULES

Texas Instruments Incorporated (TI) evaluation boards, kits, and/or modules (EVMs) and/or accompanying hardware that is marketed, sold, or loaned to users may or may not be subject to radio frequency regulations in specific countries.

General Statement for EVMs Not Including a Radio

For EVMs not including a radio and not subject to the U.S. Federal Communications Commission (FCC) or Industry Canada (IC) regulations, TI intends EVMs to be used only for engineering development, demonstration, or evaluation purposes. EVMs are not finished products typically fit for general consumer use. EVMs may nonetheless generate, use, or radiate radio frequency energy, but have not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or the ICES-003 rules. Operation of such EVMs may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

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 could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

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 its own expense.

FCC Interference Statement for Class B EVM devices

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. 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.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003. Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-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.

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.
Important Notice for Users of EVMs Considered “Radio Frequency Products” in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in 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.

http://www.tij.co.jp

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】本開発キットは技術基準適合証明を受けておりません。本製品のご使用に際しては、電波法遵守のため、以下のいずれかの措置をとっていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を講ずう、移転先に通知しない限り、譲渡、移転できないものとします
上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿6丁目24番1号
西新宿三井ビル
http://www.tij.co.jp

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan
IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have not been so designated is solely at the Buyer’s risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

**Products**

- Audio: www.ti.com/audio
- Amplifiers: amplifier.ti.com
- Data Converters: dataconverter.ti.com
- DLP® Products: www.dlp.com
- DSP: dsp.ti.com
- Clocks and Timers: www.ti.com/clocks
- Interface: interface.ti.com
- Logic: logic.ti.com
- Power Mgmt: power.ti.com
- Microcontrollers: microcontroller.ti.com
- RFID: www.ti-rfid.com
- OMAP Applications Processors: www.ti.com/omap
- Wireless Connectivity: www.ti.com/wirelessconnectivity

**Applications**

- Automotive and Transportation: www.ti.com/automotive
- Communications and Telecom: www.ti.com/communications
- Computers and Peripherals: www.ti.com/computers
- Consumer Electronics: www.ti.com/consumer-apps
- Energy and Lighting: www.ti.com/energy
- Industrial: www.ti.com/industrial
- Medical: www.ti.com/medical
- Security: www.ti.com/security
- Space, Avionics and Defense: www.ti.com/space-avionics-defense
- Video and Imaging: www.ti.com/video

**TI E2E Community**

- e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2014, Texas Instruments Incorporated