The THS4551RUNEVM is an evaluation module for the single THS4551 amplifier in the RUN (VQFN-16) package. This evaluation module is designed to quickly and easily demonstrate the functionality and versatility of the amplifier. The EVM is ready to connect to power, signal source, and test instruments through the use of onboard connectors. The EVM comes configured for easy connection with common 50-Ω laboratory equipment on its inputs and outputs. The amplifier is configured for single-ended or differential input with gain of 1 V/V to differential output at the device pins, which is converted to single-ended via a transformer to the output. It can be easily configured for other functions, gains, and single- or split-supply operation.

The THS4551RUNEVM has an onboard load for the amplifier of 1 kΩ. The output transformer and resistor network converts this to a 50-Ω single-ended output.

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Trademarks

All trademarks are the property of their respective owners.
1 Features
This EVM supports the following features:
- Configured for split-supply operation and easily modified for single supply
- Default gain of 1 configuration is easily reconfigured for other gains
- Designed for easy connection to standard 50-Ω input and output impedance test equipment
- Inputs and outputs include SMA connectors

2 EVM Specifications
Table 1 lists the EVM specifications:

<table>
<thead>
<tr>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-supply voltage range (V– = ground)</td>
<td>2.7 to 5.4 V</td>
</tr>
<tr>
<td>V± Split-supply voltage range</td>
<td>±1.35 to ±2.7 V</td>
</tr>
<tr>
<td>IS± Supply current (no load)</td>
<td>1.35 mA</td>
</tr>
<tr>
<td>Input voltage V±, Max</td>
<td></td>
</tr>
<tr>
<td>IOUT Output drive ±80 mA</td>
<td></td>
</tr>
</tbody>
</table>

3 Power Connections
The THS4551RUNEVM is equipped with test point connectors for easy connection of power. The positive supply input is red and is labeled V+. The negative supply input is yellow and is labeled V–. The Ground is black and is labeled GND.

3.1 Split-Supply Operation
To operate as split supply, apply the positive supply voltage to V+, negative supply voltage to V–, and the ground reference from supply to GND.

3.2 Single-Supply Operation
To operate as single supply, connect both the V– connector and the GND connector to ground, and apply the positive supply voltage to V+. Inputs and outputs must be biased per data-sheet specifications for proper operation. The THS4551 output common-mode voltage defaults to mid supply if the Vcm connector is left floating.
4 Input and Output Connections

The THS4551RUNEVM is equipped with SMA connectors for easy connection of signal generators and analysis equipment. As shipped, the EVM is configured for a gain of 1, split supply, single-ended or differential input and single-ended output with 50-Ω termination. For best results, signals must be routed to and from the EVM with cables having 50-Ω characteristic impedance. Either IN+ (J2) or IN– (J1) can be used for single-ended input. The unused connector should be terminated with a 50-Ω resistive SMA load. If no SMA load is available the spaces marked C1 or C2 can be loaded with a 0-Ω resistor to terminate the unused input. Use both IN+ (J2) and IN– (J1) for differential input. OUT+ (J8) is the output connector for single-ended output signals. The amplifier converts the single-ended or differential input to a differential signal at its output pins. A resistor network (R8, R9, R10) and transformer on the output of the amplifier convert the differential output signal to single-ended, and provides a 1-kΩ load to the amplifier when terminated in 50 Ω. A 50-Ω line-impedance match at OUT+ should be preserved. This results in an output measurement loss, and the overall gain is approximately –30 dB. See the THS4551 data sheet applications section (SBOS778), schematics, and layouts for more detail and how to reconfigure the EVM.

4.1 VOCM Input Connections

The Vcm input (J3) is optional and the SMA connector is not loaded in default configuration. This input sets the common mode of the output pins. The THS4551 will automatically self-bias the output common-mode voltage to the mid-supply voltage if the Vocm pin is not connected. This is the optimal voltage for maximum output swing and best linearity.

The valid range of the VOCM is 0.55 V above the negative supply to 1.5 V below the positive supply. For example, on a ±2.5-V split supply, the Vocm pin can be set anywhere from –1.95 V to 1.0 V. With a single 5-V supply the valid range would be 0.55 V to 3.5 V. Remember, the outputs of the THS4551 can swing from rail to rail; however, the maximum output swing available is reduced when the VOCM pin is set to a voltage other than mid supply.

If providing 50-Ω termination for the Vcm input signal source is desired, C6 can be replaced with a 0-Ω resistor. The board is shipped with C6 populated with 0.22 µF and VOCM input is set to mid-supply voltage with C6 populated.

4.2 PD Input Connections

The PD jumper (J5) allows the THS4551 to be disabled. An SMA connector can also be loaded at J4 and a signal for the power down function can be applied for high-speed testing. Normally the J5 jumper is used to enable or disable (power down) the amplifier. When jumper J5 is open, the amplifier is not powered down, so it is enabled. When the shorting block is connected and J5 is closed, the amplifier is powered down.

For high-speed testing, the C4 can be replaced with 0 Ω to terminate the PD SMA input. The shorting block should be removed from J5 during high-speed testing. Because 0 Ω at C4 terminates to the ground and not to the supplies, the state of the amplifier will be undefined when the signal source is disconnected. For this reason, 0 Ω at C4 should only be used when driving the SMA connector with a high speed, controlled impedance source.

4.3 Using the Optional Differential Outputs (J6, J7)

The THS4551RUNEVM can be reconfigured for fully-differential outputs. By removing resistors R19 and R20, the balun circuit is disconnected from the amplifier output. If 50-Ω resistors are loaded in the R26 and R27 resistor positions, and SMA connectors are loaded in the J6 and J7 connector positions, J6 and J7 can be used for fully-differential output signals. If 50-Ω test equipment is connected to J6 and J7, the total load to the amplifier is 200 Ω. The data-sheet specifications were produced with a 1-kΩ load. In order to match a 1-kΩ load, load R26 and R27 with 475-Ω resistors, and then load R25 and R28 with 56.2-Ω resistors.
5 THS4551RUNEVM Schematic, Layout, and Bill of Materials

5.1 Schematic

Figure 1 illustrates the EVM schematic.
5.2 THS4551RUNEVM Layers

Figure 2 through Figure 5 show the THS4551RUNEVM layers.
Figure 3. THS4551RUNEVM Layer 2
Figure 4. THS4551RUNEVM Layer 3
Figure 5. THS4551RUNEVM Bottom Layer
### 5.3 Bill of Materials

Table 2 lists the EVM bill of materials.

#### Table 2. THS4551RUNEVM Bill of Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Reference</th>
<th>Quantity</th>
<th>Part Number</th>
<th>Manufacturer</th>
<th>Description</th>
<th>Note</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>C3, C12</td>
<td>2</td>
<td>GRM188R71C103KA01D</td>
<td>Murata</td>
<td>CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0603</td>
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</tr>
<tr>
<td>2</td>
<td>C4, C6</td>
<td>2</td>
<td>GRM188R61A224KA01D</td>
<td>Murata</td>
<td>CAP, CERM, 0.22 µF, 10 V, +/-10%, X5R, 0603</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>C5, C11</td>
<td>2</td>
<td>0603YC104JA72A</td>
<td>AVX</td>
<td>CAP, CERM, 0.1 µF, 16 V, +/-5%, X7R, 0603</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>C7</td>
<td>1</td>
<td>GRM1555C1H1R0CA01D</td>
<td>Murata</td>
<td>CAP, CERM, 1 pF, 50 V, +/-5%, C0G/NP0, 0402</td>
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</tr>
<tr>
<td>5</td>
<td>C8, C10</td>
<td>2</td>
<td>GRM21BR61C106KE1SL</td>
<td>Murata</td>
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<tr>
<td>6</td>
<td>J1, J2, J8</td>
<td>3</td>
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<td>Emerson Network Power</td>
<td>Connector, End launch SMA, 50 ohm, SMT</td>
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<tr>
<td>7</td>
<td>J5</td>
<td>1</td>
<td>FBG02SAAAN</td>
<td>Sullins Connector Solutions</td>
<td>Header, 100mil, 2x1, Gold, TH</td>
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<td>8</td>
<td>R1, R4, R5, R6, R16</td>
<td>5</td>
<td>CRCW060349R9FKEA</td>
<td>Vishay-Dale</td>
<td>RES, 49.9, 1%, 0.1 W, 0603</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>R2, R3</td>
<td>2</td>
<td>MCR10E2P000</td>
<td>Rohm</td>
<td>RES, 0, 5%, 0.125 W, 0805</td>
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</tr>
<tr>
<td>10</td>
<td>R8, R10</td>
<td>2</td>
<td>CRCW0603487RFKEA</td>
<td>Vishay-Dale</td>
<td>RES, 487, 1%, 0.1 W, 0603</td>
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<tr>
<td>11</td>
<td>R9, R30, R31</td>
<td>3</td>
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<td>RES, 100, 1%, 0.1 W, 0603</td>
<td></td>
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<tr>
<td>15</td>
<td>R29</td>
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<td>CRCW06031000RFKEA</td>
<td>Vishay-Dale</td>
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<tr>
<td>16</td>
<td>SH-J5_1-OPEN</td>
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<td>382811-6</td>
<td>AMP</td>
<td>Shunt, 100mil, Gold plated, Black</td>
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<tr>
<td>17</td>
<td>T2</td>
<td>1</td>
<td>ADTL1-4-75+</td>
<td>Minicircuits</td>
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<td>5000</td>
<td>Keystone</td>
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<tr>
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<td>1</td>
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<td>20</td>
<td>TP3, TP5, TP6</td>
<td>3</td>
<td>5011</td>
<td>Keystone Electronics</td>
<td>Test Point, TH, Multipurpose, Black</td>
<td></td>
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<tr>
<td>21</td>
<td>TP4</td>
<td>1</td>
<td>5010</td>
<td>Keystone Electronics</td>
<td>Test Point, TH, Multipurpose, Red</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>U1</td>
<td>1</td>
<td>THS4551RUNT</td>
<td>Texas Instruments</td>
<td>Low Power, Precision, 150MHz, Fully Differential Amplifier</td>
<td></td>
</tr>
</tbody>
</table>
STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. **Delivery:** TI delivers TI evaluation boards, kits, or modules, including 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 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 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 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/lods/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/lods/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.
【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】開発キットの中には技術基準適合証明を受けていないものがあります。技術基準適合証明を受けていないも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取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」を譲渡先、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

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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5. Accuracy of Information: To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
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