

# User's Guide

## RUN-FDA-4567-EVM



### ABSTRACT

The RUN-FDA-4567-EVM is an unassembled evaluation module for fully differential amplifiers with input common mode control such as the THS4567 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 can be configured for easy connection with common 50- $\Omega$  laboratory equipment on its inputs and outputs or optionally it can use a differential diode connection as the input. The EVM features multiple connection options for the input common mode, output common mode, and enable control signals. The output has an optional transformer connection to convert the differential output to a single ended signal for use with test equipment.

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### 1 Trademarks

All trademarks are the property of their respective owners.

## 2 Features

This EVM supports the following features:

- Can be used with split supply or single supply configuration
- Configurable gain and feedback network capacitors
- Designed for easy connection to standard 50-Ω input and output impedance test equipment
- Inputs, outputs, and control signals include SMA connectors for high speed operation

## 3 EVM Specifications

Refer to [SBOSA51](#) for specific EVM input, output, and supply voltage ratings.

## 4 Power Connections

The RUN-FDA-4567-EVM 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.

### 4.1 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.

### 4.2 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.

## 5 Input and Output Connections

The RUN-FDA-4567-EVM is equipped with SMA connectors for easy connection of signal generators and analysis equipment. For best results, voltage 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 or balanced with an equivalent resistive load to ground so that both input networks are the same impedance. Use both IN+ (J2) and IN- (J1) for differential voltage input or diode D1 for a differential diode input. OUT+ (J8) or OUT- (J9) can be used for single ended output in conjunction with transformer T1 by terminating the opposite output to ground using R8 or R18 respectively. A resistor network (R5, R6, R7, R15, and R16) provides a load matching network to the amplifier to allow for a larger amplifier load while maintaining a desired terminated characteristic output impedance. For single ended output measurements 50-Ω line-impedance match at the output should be preserved.

## 5.1 VOCM and VICM Input Connections

The output common mode control (Vocm) can be set by using the resistor divider created by R17 and R26, the test point TP1, or with the SMA connector J3. If providing 50-Ω termination for the Vcm input signal source is desired, C5 can be replaced with a 50-Ω resistor.

The input common mode (Vicm) can be set by using the resistor divider created by R27 and R28, the test point TP7, or with the SMA connector J10. If providing 50-Ω termination for the Vcm input signal source is desired, C20 can be replaced with a 50-Ω resistor.

The EVM also contains a ICM EN input connection to disable or enable the input common mode control functionality. It is set to V+ by default using resistor R21 and can be shorted to V- with jumper J6. For high-speed control, C15 can be replaced with 0 Ω to terminate the PD SMA input with a 50 ohm resistor in R20. The shorting block should be removed from J7 during high-speed testing. Because 0 Ω at C10 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.

## 5.2 Enable Input Connections

The AMP EN jumper (J4) controls the amplifiers disable function on pin 3 of the device. It is set to V+ by default using resistor R13 and can be shorted to V- with jumper J5.

For high-speed testing, C4 can be replaced with 0 Ω to terminate the PD SMA input with a 50 ohm resistor in R10. 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.

## 5.3 Example EVM Configuration Using the THS4567

The example component configuration shown in the [Figure 6-1](#) illustrates a default board setup for evaluating the THS4567 amplifier. In the configuration shown, the board is set for 50-Ω single ended voltage input on IN- (J1) and output on OUT+ (J8). The gain is set to approximately 7 V/V using the input and feedback resistors, and resistor R2 provides the 50-Ω input impedance match while R12 balances the impedance on the non-signal input. The output network created by R6, R7, and R16 form a total load of 1kΩ to the amplifier while still providing a 50-Ω output impedance match. In addition to the impedance matching, the output network also attenuates the total output an additional 32 dB.

The input common mode enable and amplifier enable functions are set by default for easy control using jumpers J7 and J5 respectively. The Vocm and Vicm voltage signals are set up for simple DC voltage control using the test points TP1 and TP7.

The power supply is set up for a split supply configuration with three decoupling capacitors on each supply to provide high speed decoupling performance.

## 6 RUN-FDA-4567-EVM Schematic, Layout, and Bill of Materials

Section 6 illustrates the EVM schematic with an example configuration for the THS4567 amplifier, the layout prints, and an example bill of materials.

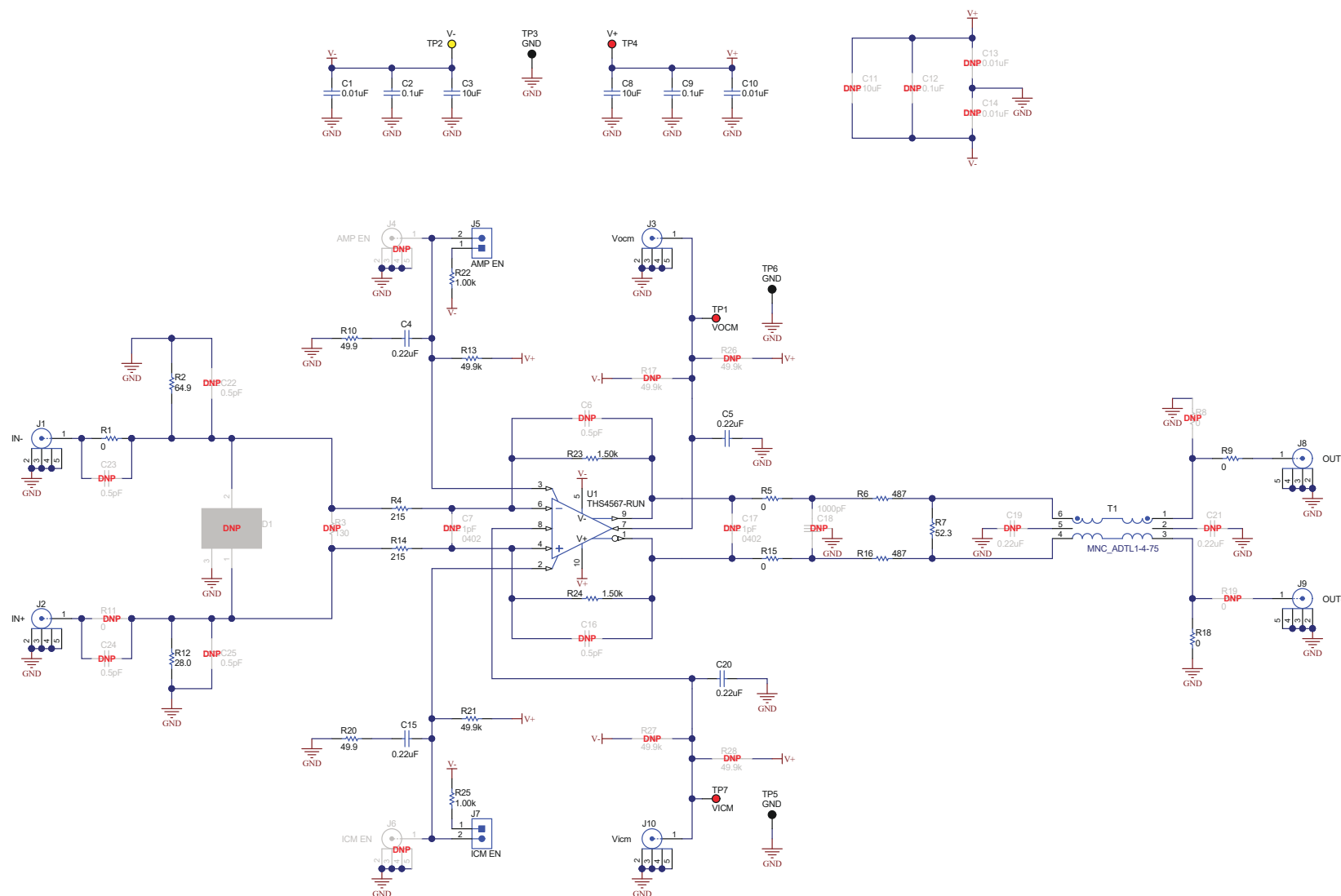


Figure 6-1. RUN-FDA-4567-EVM Schematic and Example Configuration

## 6.1 RUN-FDA-4567-EVM Layers

Figure 6-2 through Figure 6-9 shows the RUN-FDA-4567-EVMPCB layers.

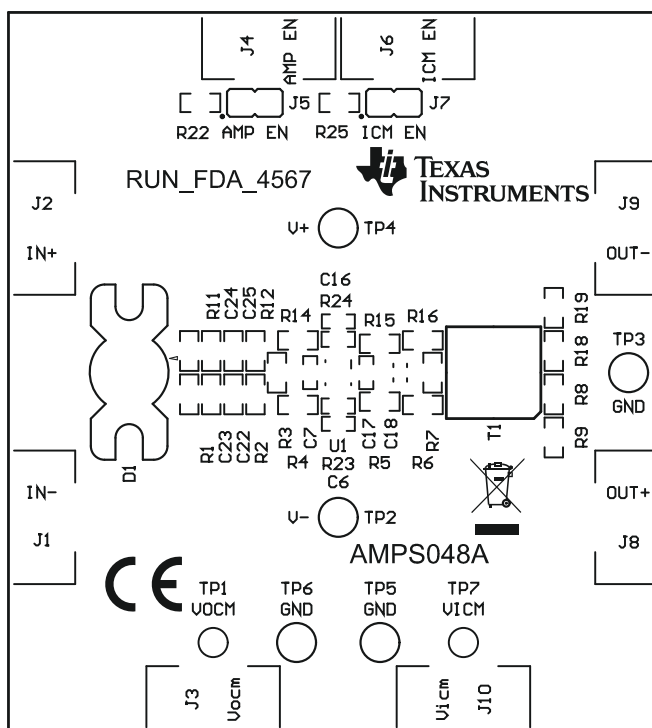


Figure 6-2. Top Layer Overlay

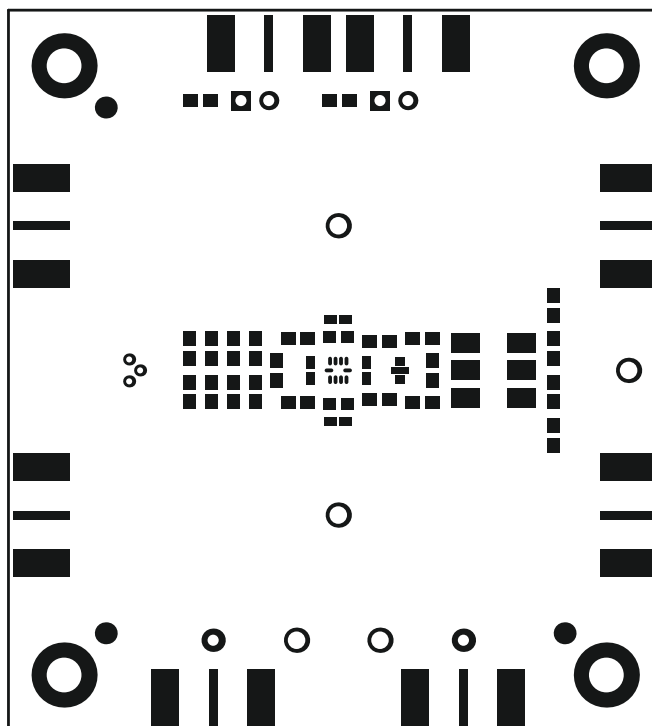


Figure 6-3. Top Layer Solder Mask

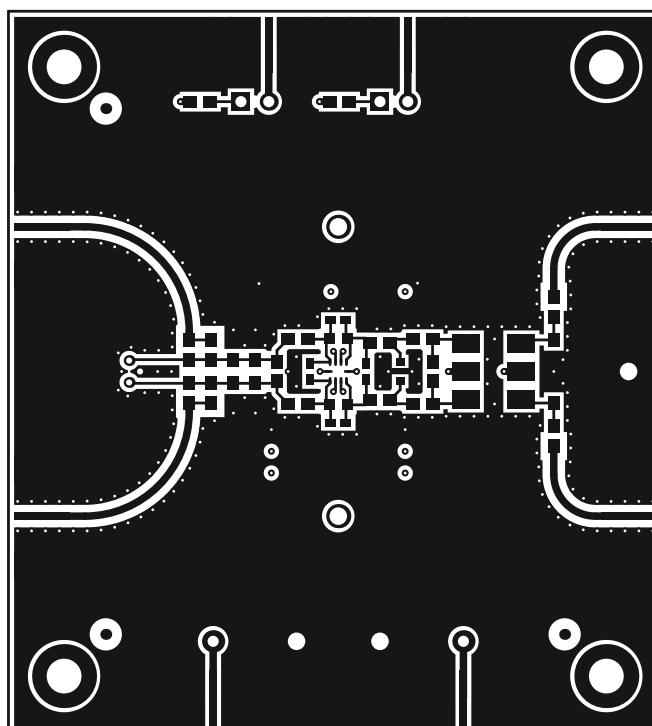


Figure 6-4. Top Layer

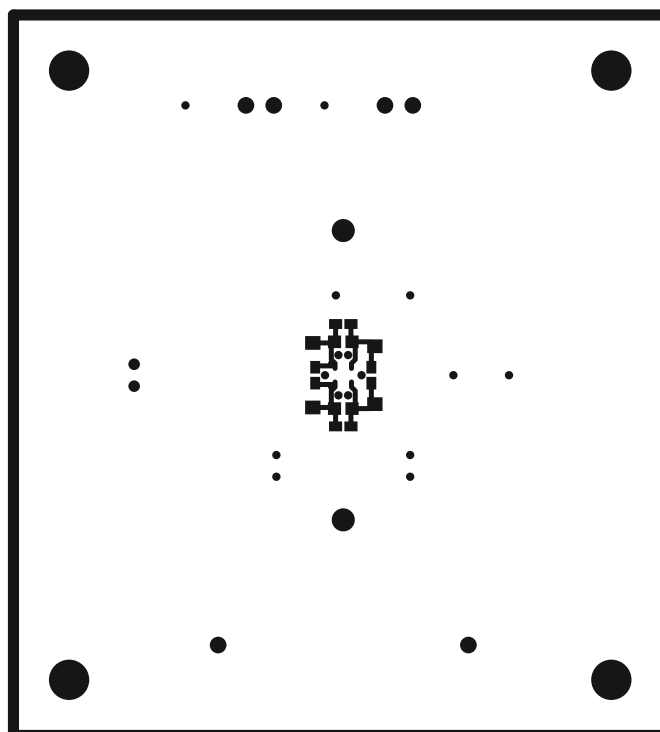


Figure 6-5. Layer 2, Ground

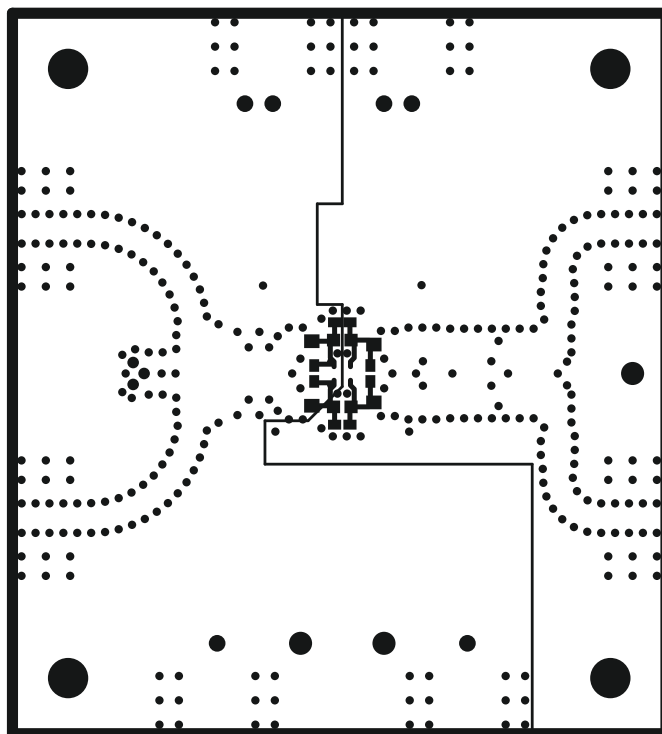


Figure 6-6. Layer 3, Power

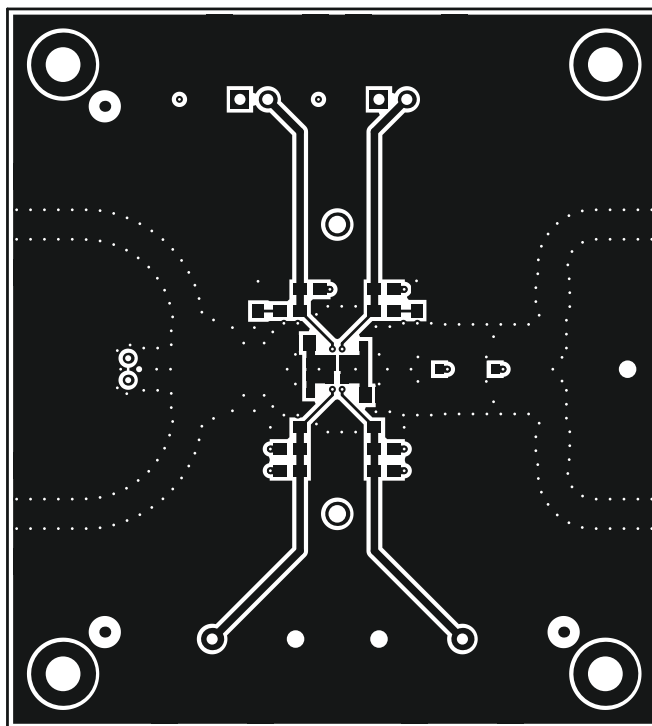


Figure 6-7. Bottom Layer

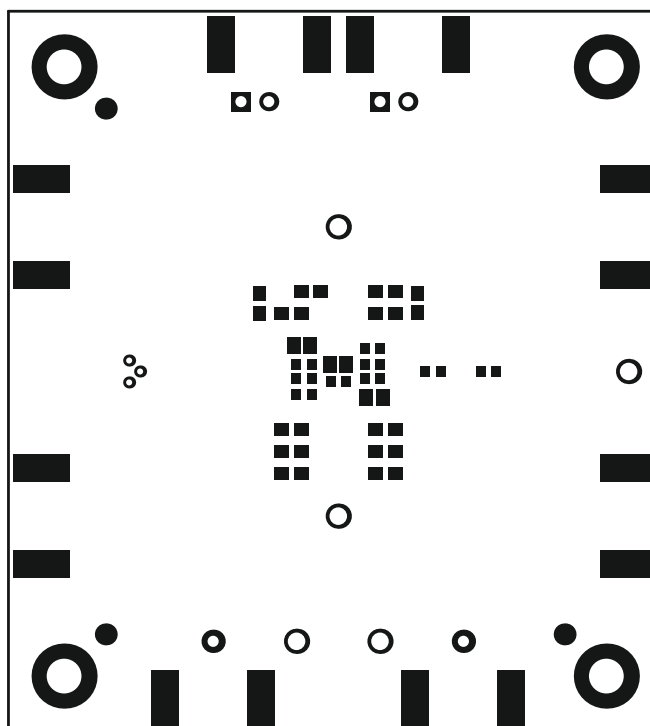


Figure 6-8. Bottom Layer Solder Mask

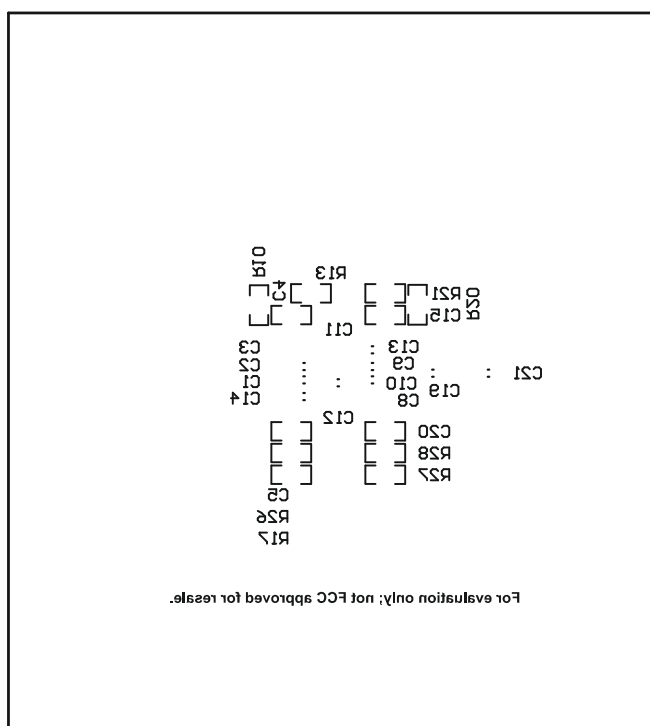


Figure 6-9. Bottom Layer Overlay



## 6.2 Bill of Materials

Table 6-1 lists the EVM bill of materials.

**Table 6-1. RUN-FDA-4567-EVM Example Bill of Materials**

Item	Part Reference	Quantity	Part Number	Manufacturer	Description	Note
1	C1, C10	2	C0603H103J3GACTU	Kemet	CAP, CERM, 0.01 $\mu$ F, 25 V, $\pm$ 5%, C0G/NP0, 0603	
2	C2, C9	2	0603YC104JAT2A	AVX	CAP, CERM, 0.1 $\mu$ F, 16 V, $\pm$ 5%, X7R, 0603	
3	C3, C8	2	GRM21BR61C106KE15L	MuRata	CAP, CERM, 10 $\mu$ F, 16 V, $\pm$ 10%, X5R, 0805	
4	C4, C5, C15, C20	4	GRM188R61A224KA01D	MuRata	CAP, CERM, 0.22 $\mu$ F, 10 V, $\pm$ 10%, X5R, 0603	
5	FID4, FID5, FID6	3	N/A	N/A	Fiducial mark. There is nothing to buy or mount.	
6	H1, H2, H3, H4	4	PMSSS 440 0025 PH	B&F Fastener Supply	MACHINE SCREW PAN PHILLIPS 4-40	
7	H5, H6, H7, H8	4	1891	Keystone	Hex Standoff, #4-40, Aluminum, 1/4 in	
8	J1, J2, J3, J8, J9, J10	6	142-0701-806	Cinch Connectivity	Connector, End launch SMA, 50 $\Omega$ , SMT	
9	J5, J7	2	PBC02SAAN	Sullins Connector Solutions	Header, 100 mil, 2x1, Gold, TH	
10	R1, R5, R9, R15, R18	5	MCT06030Z0000ZP500	Vishay/Beyschlag	RES, 0, 5%, 0.125 W, 0603	
11	R2	1	RC0603FR-0764R9L	Yageo America	RES, 64.9, 1%, 0.1 W, 0603	
12	R4, R14	2	RT0603BRD07215RL	Yageo America	RES, 215, 0.1%, 0.1 W, 0603	
13	R6, R16	2	CRCW0603487RFKEA	Vishay-Dale	RES, 487, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	
14	R7	1	RC0603FR-0752R3L	Yageo	RES, 52.3, 1%, 0.1 W, 0603	
15	R10, R20	2	CRCW060349R9FKEA	Vishay-Dale	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	
16	R12	1	RC0603FR-0728RL	Yageo America	RES, 28.0, 1%, 0.1 W, 0603	
17	R13, R21	2	RC0603FR-0749K9L	Yageo America	RES, 49.9 k, 1%, 0.1 W, 0603	
18	R22, R25	2	ERJ-3EKF1001V	Panasonic	RES, 1.00 k, 1%, 0.1 W, 0603	
19	R23, R24	2	RT0603BRD071K5L	Yageo America	RES, 1.50 k, 0.1%, 0.1 W, 0603	
20	SH-J1, SH-J2	2	382811-6	AMP	Shunt, 100 mil, Gold plated, Black	
21	T1	1	ADTL1-4-75+	Minicircuits	RF Transformer, 75 $\Omega$ , 0.5 to 1000 MHz, SMT	
22	TP1, TP7	2	5000	Keystone	Test Point, Miniature, Red, TH	
23	TP2	1	5014	Keystone	Test Point, Multipurpose, Yellow, TH	
24	TP3, TP5, TP6	3	5011	Keystone	Test Point, Multipurpose, Black, TH	
25	TP4	1	5010	Keystone	Test Point, Multipurpose, Red, TH	
26	U1	1	THS4567-RUN	Texas Instruments	High-Speed, Fully-Differential Transimpedance Amplifier, RUN0010A (WQFN-10)	

## 7 References

- Texas Instruments, [THS4567 220 MHz CMOS Input, Fully Differential Amplifier data sheet](#)

## 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.

### **WARNING**

**Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

### 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/lscs/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lscs/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/lscs/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lscs/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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lscs/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lscs/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/lscs/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_02.page)

#### 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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