

TRF1305x2-D2D Evaluation Module



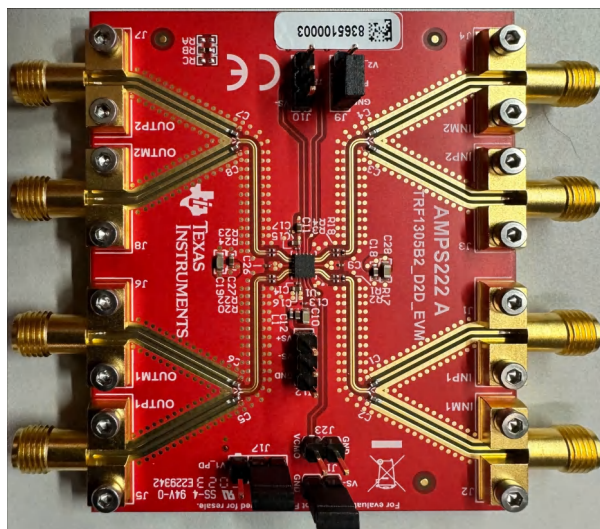
Description

The TRF1305EVM is designed to provide a quick setup to evaluate the TRF1305 series of fixed gain fully differential amplifiers (FDA) that have high linearity and 3dB bandwidth of the order of 6.5GHz. The TRF1305 are available in both single-channel and dual-channel packaging with three different fixed gains in each packaging. These amplifiers work with two flexible supply rails and can be dc-coupled and support a wide range of common-mode voltage.

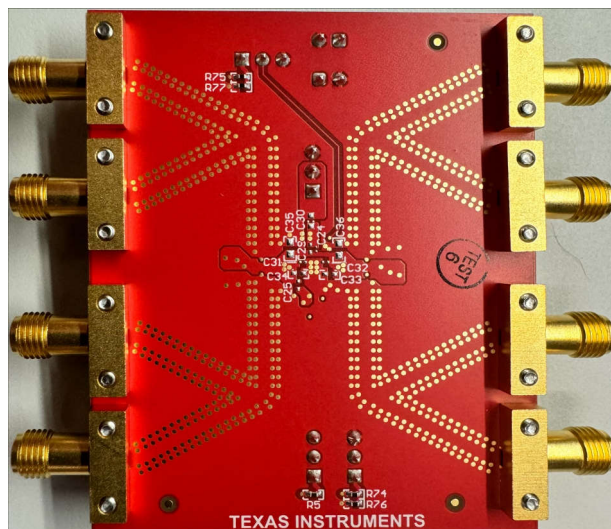
There are four types of EVMs that cover all device variants in the configurations.

Features

- Configured for split-supply operation and easily modified for single supply
- Single-ended or differential input signals
- Designed for easy connection to standard 50Ω input and output impedance test equipment
- Power down option available onboard using a jumper connector



TRF1305X2-D2D-EVM Board (Top View)



TRF1305X2-D2D-EVM Board (Bottom View)

1 Evaluation Module Overview

1.1 Introduction

This document is the user's guide for the evaluation boards (EVMs) meant for testing dual channel TRF1305 series of amplifiers in D2D configuration. There are four types of TRF1305 EVMs that are meant to test all device variants in different I/O configuration as shown in [Table 1-1](#) below.

Table 1-1. TRF1305 EVMs

| EVM | Devices | I/O Configurations | Comment |
|---------------|-------------------------------------|-----------------------|---|
| TRF1305x2-D2D | TRF1305A2 TRF1305B2 TRF1305C2 | D2D, S2D ¹ | Dual-channel amplifier - D2D (differential in, differential out) EVM. |
| TRF1305x1-D2D | TRF1305A1 TRF1305B1 TRF1305C1 | D2D, S2D | Single-channel amplifier - D2D (differential in, differential out) EVM. |
| TRF1305x2-S2D | TRF1305A2 TRF1305B2 TRF1305C2 | S2D | Dual-channel amplifier - S2D (single-ended in, differential out) EVM. |
| TRF1305x1-S2D | TRF1305A1 TRF1305B1 TRF1305C1 | S2D | Single-channel amplifier - S2D (differential in, differential out) EVM. |

This document also includes schematic diagrams, a bill of materials (BOM), printed-circuit board (PCB) layouts, and test block diagrams. Throughout this document, the abbreviations *EVM*, *EVM* or the term *evaluation module* means any one of the four EVMs listed above. This user's guide describes the basic steps and functions that are required for the proper operation and quick setup of the -EVM. Many sections in this user's guide are common to all TRF1305EVMs.

1.2 Kit Contents

[Table 1-2](#) lists the contents of the EVM kit. Contact the Texas Instruments Product Information Center nearest you if any components are missing. TI highly recommends that users check the [TI website](#) to verify that the latest versions of the related software is being used.

Table 1-2. Kit Contents

| Item | Quantity |
|-------------------|----------|
| TRF1305B2-D2D-EVM | 1 |

1.3 Specification

| Connector | Parameter | Value |
|-----------|-----------------|-----------|
| J1 | RF Input INP1 | Max 20dBm |
| J2 | RF Input INM1 | Max 20dBm |
| J3 | RF Input INP2 | Max 20dBm |
| J4 | RF Input INM2 | Max 20dBm |
| J5 | RF Output OUTP1 | |
| J6 | RF Output OUTM1 | |
| J7 | RF Output OUTP2 | |
| J8 | RF Output OUTM2 | |

¹ D2D EVMs can be configured in S2D by using a 50ohm SMA terminator on one of the inputs. For the best performance, S2D EVM is recommended.

| Connector | Parameter | Value |
|-----------|-------------------------------------|---|
| J9 | PD2 Select | Short 1,2 (V_PD) to disable Ch2. Short 2,3 (GND) to enable Ch2 |
| J10 | Mode Select | Open (default) See section 7.4.1 in data sheet for input common mode range extension |
| J11 | J11.1 VS- J11.2 GND | Open in split supply operation Short in single supply operation |
| J12 | J12.1 VS+ J12.2 VS- J12.3 GND | $VS+ \leq 5V$ $VS- \geq -2.5V$ $(VS+) + (VS-) = 5V$ |
| J17 | PD1 Select | Short 1,2 (V_PD) to disable Ch1. Short 2,3 (GND) to enable Ch1 |
| J23 | J23.1 VCMO J23.2 GND | Open (default) Apply external voltage to set desired output common mode |

1.4 Device Information

The TRF1305x2 is a very high performance, closed-loop, dual-channel RF amplifier that has an operational bandwidth from true-dc to > 6.5GHz. The device has excellent performance to drive high-speed, high-performance ADCs, such as the ADC12DJ5200RF and ADC32RF5x with a dc- or ac-coupled interface. The device is optimized for performance in the preset gain configuration. If a lower-than-preset gain is desired, then use external resistors. The TRF1305x2 features a VOVM pin that allows setting different output common-mode and input common-mode voltages (for example, for level-shifting or for most IQ down-converter ADC-interface applications that have differing dc common-mode voltages). The floating 2-rail split or single-supply option, and a MODE pin that allows extending the input common-mode range closer to the supplies. High channel-to-channel isolation allows the device to be used in a complex IQ transmit or receive signal chain without loss of signal integrity. The TRF1305x2 has a feature to power down each channel individually.

2 Hardware

2.1 General Usage Information

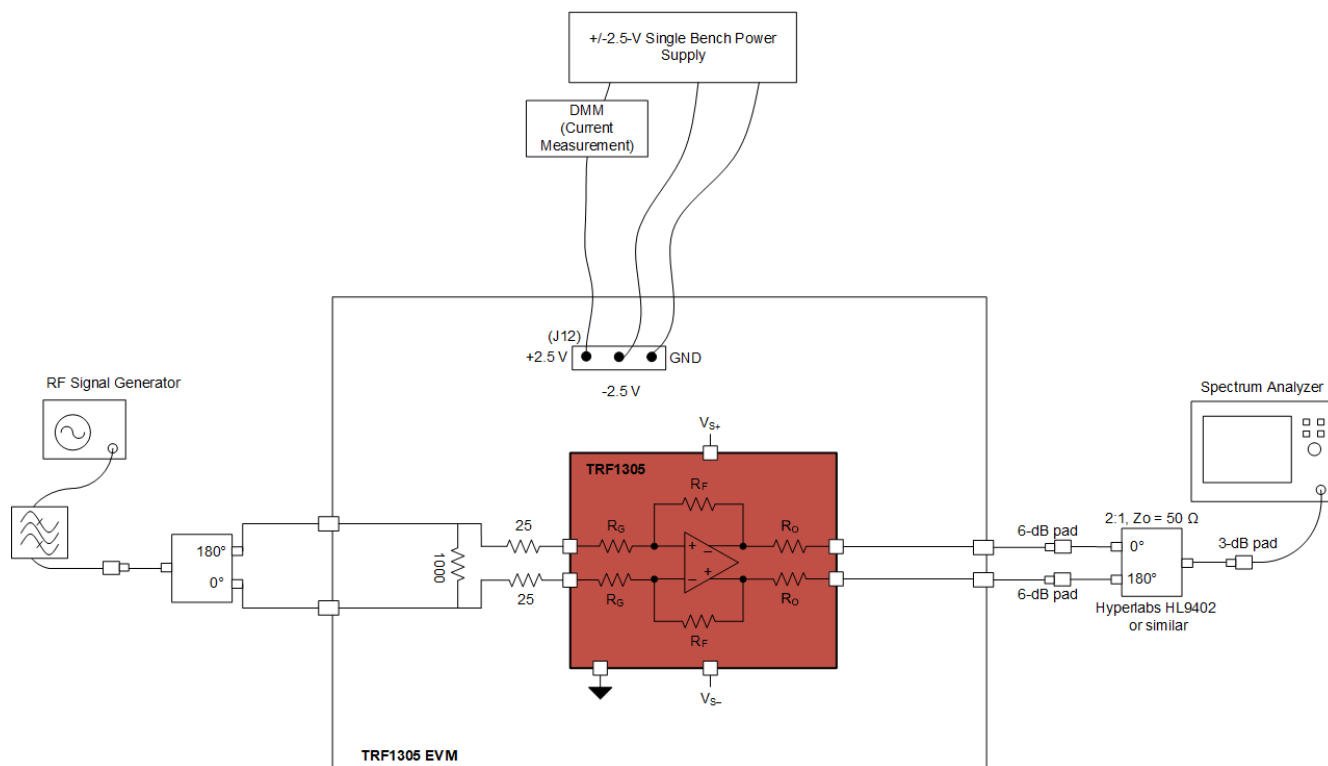


Figure 2-1. Single Tone Setup for Gain and Output P1dB

This section provides general usage information for the EVM. See [Figure 2-1](#) for a general single tone setup diagram as a reference point for the following instructions (some components, such as supply bypass capacitors, are omitted for clarity):

1. Recommended power up sequence:
 - Split-supply operation:
 - a. To operate as split supply, apply the positive supply voltage to $VS+$, negative supply voltage to $VS-$, and the ground reference from supply to GND (J12). The supply voltages do not need to be symmetrical, provided that the total supply voltage is 5V, any combination of positive and negative supply voltages is acceptable. This feature is often used when the output common mode voltage must be set to a particular value. For best performance, the power supply voltages must be symmetrical around the desired output common-mode voltage.
 - b. Set the current limit of the DC output power supply at 250mA.
 - c. Making sure the supply is turned off, connect the power supply cables to the J12 connector of the EVM.
 - d. Now turn on the DC power supply of $VS+ = 2.5V$ and $VS- = -2.5V$. The supply current (I_Q) drawn from the power supply is approximately 180mA.
 - e. If the supply current is low, then verify that the device is not disabled by the PD pin (J17, J9).
 - Single-supply operation:
 - a. To operate as single supply, connect jumper $VS-$ to GND (J11), and apply the positive supply voltage to $VS+$ (J12). Inputs and outputs must be biased as in the [TRF1305 data sheet](#) specifications for proper operation.
2. Power-down option:
 - Connect +1.8 V (logic-1) on PD pin to power-down the chip (J9, J17). Ground the PD pin to enable the chip.

3. CM (output common mode voltage) input:
 - The TRF1305 device has an output common-mode control pin that sets the output common mode voltage. The output common-mode voltage at the output pins, OUTPx and OUTMx, defaults to the LDO output voltage of $V_{S-} + 2.5V$ when VOXM pin is floated.
 - If a different output common-mode voltage is specified, then the J23 jumper can be used to connect an external low-impedance voltage source. See the TRF1305 data sheet for performance curves that show how performance is impacted by an output common mode voltage that is not at the mid-supply voltage.
4. Single tone measurement setup recommendation:
 - a. Single ended signal from RF signal generator is converted to a differential signal using an external passive balun as shown in [Figure 2-1](#). Differential signal is fed to input SMA connectors, J1, J2. When measuring single tone distortion, use an RF band pass filter as shown in [Figure 2-1](#).
 - b. The RF signal generator used must support up to 10GHz signal frequency for testing out the EVM.
 - c. The device input is 50Ω in the pass-band.
To minimize signal reflections due to impedance mismatch, TI recommends using an attenuator pad of approximately 3dB to 6dB between the source and J4 SMA input.
 - d. The EVM outputs are fully differential (or 180° out-of-phase) at J5 and J6 SMA connectors. The device has low output impedance at dc and low frequencies.
 - e. When connecting to a spectrum analyzer, the differential signal out of the EVM must be converted to a single-ended signal using an external passive balun as shown in [Figure 2-1](#). Usage of an attenuator pad of approximately 3dB to 6dB is recommended at the three terminals of the passive balun to minimize reflections.
 - f. Lastly, TI recommends to properly characterize and account for the insertion loss of RF coaxial (coax) cables, attenuator pads, and passive baluns to measure accurate gain and power levels for the device.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the EVM schematic.

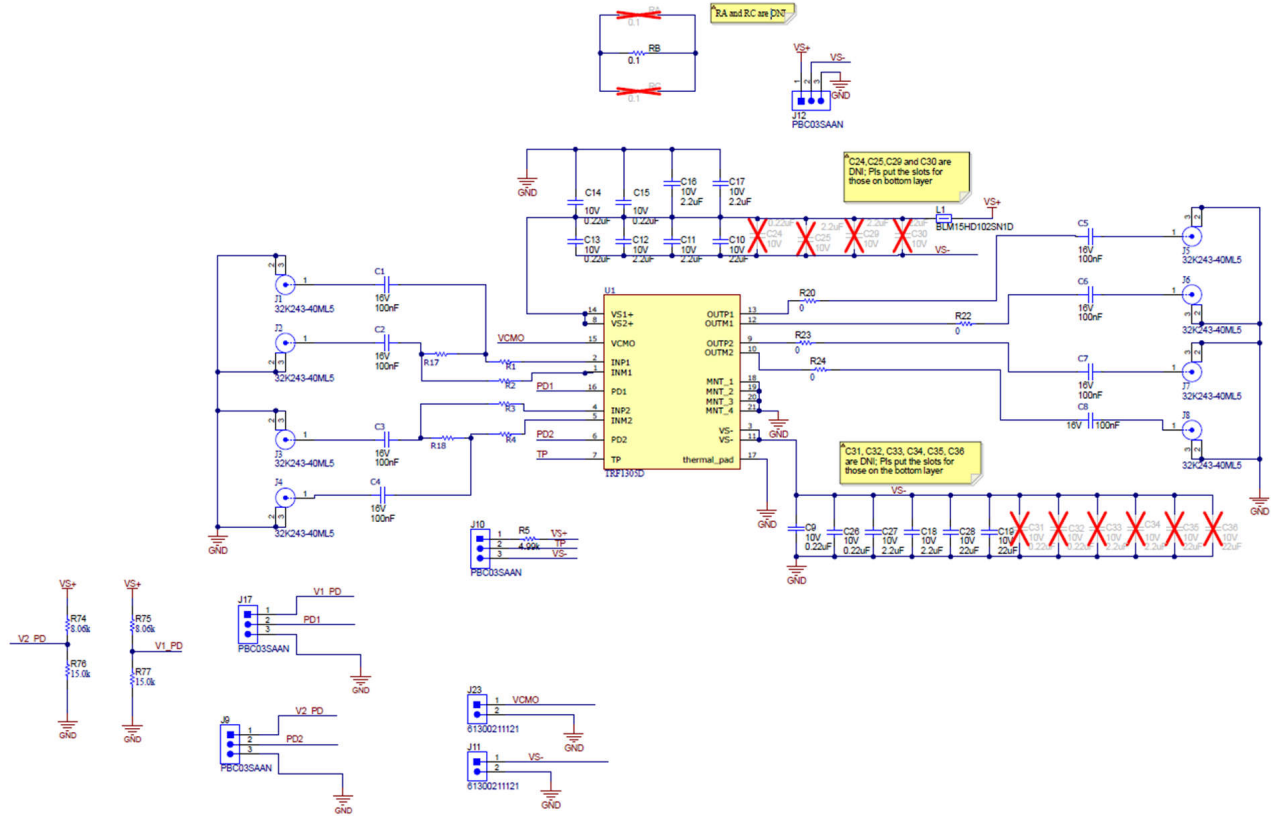


Figure 3-1. EVM Schematic

3.2 PCB Layout

Figure 3-2 through Figure 3-5 illustrate the PCB layers for this EVM.

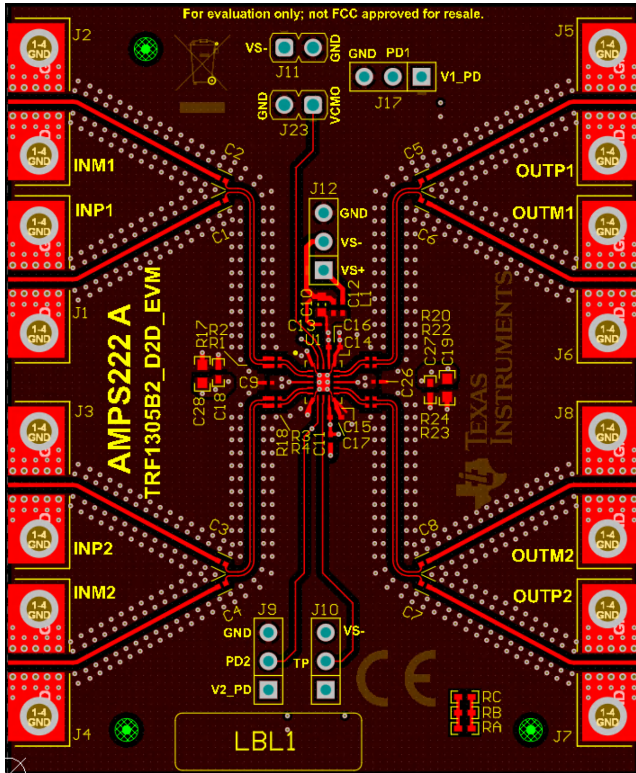


Figure 3-2. Top Layer

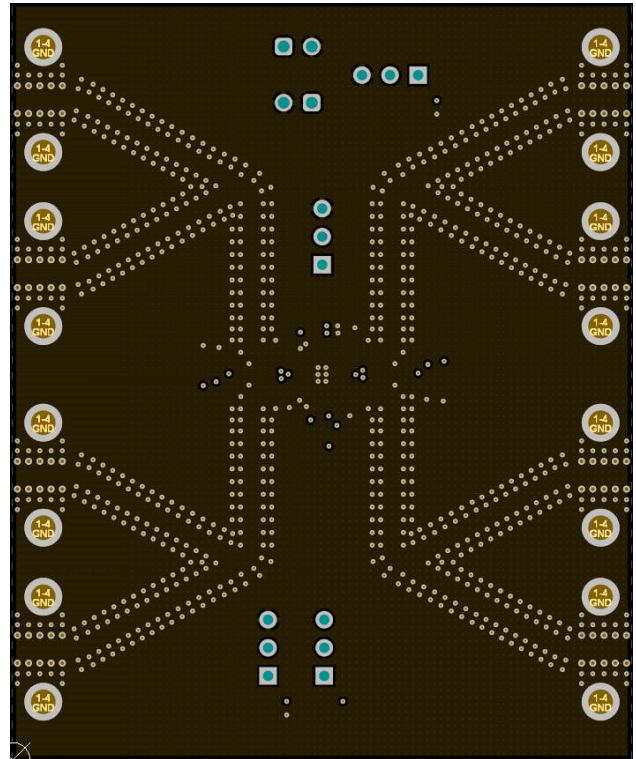


Figure 3-3. Layer 2

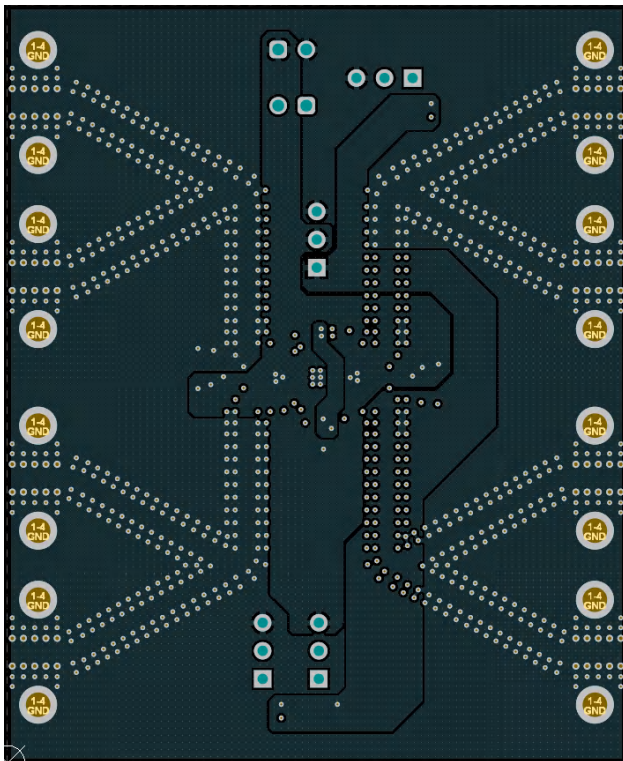


Figure 3-4. Layer 3

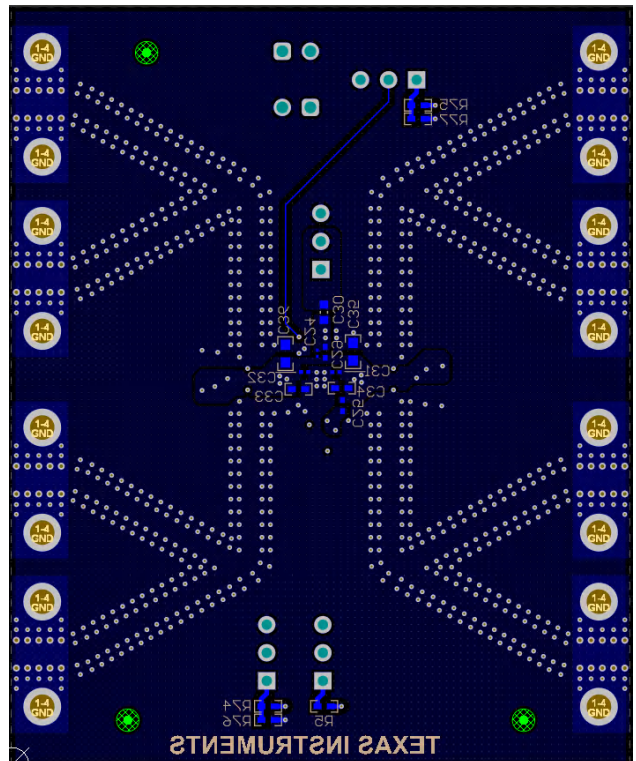
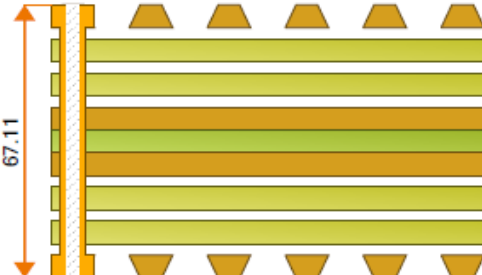


Figure 3-5. Bottom Layer

3.2.1 Stack-Up and Material

The EVM is a 67-mil, 4-layer board with material type Isola® 370HR. The top layer routes the power, ground, and signals between SMA connectors and the device. Second layer is the reference RF ground layer. The signal trace impedance is targeted at 50Ω. The bottom three layers are ground layers.



| Layer | Stack up | Supplier | Supplier Description | Description | Base Thickness | Processed Thickness | εr |
|-------|----------|----------|----------------------|--------------|----------------|---------------------|-------|
| 1 | | GOULD | COPPER FOIL | 12+35 m | 1.850 | 2.559 | |
| 2 | | ISOLA | 185HR | #2116 | 5.000 | 4.966 | 4.320 |
| | | ISOLA | 185HR | #2116 | 5.000 | 4.966 | 4.320 |
| 3 | | | | | 1.378 | 1.378 | |
| | | ISOLA | 185HR | 1.00 1.0/1.0 | 39.370 | 39.370 | 4.420 |
| 4 | | | | | 1.378 | 1.378 | |
| | | ISOLA | 185HR | #2116 | 5.000 | 4.966 | 4.320 |
| | | ISOLA | 185HR | #2116 | 5.000 | 4.966 | 4.320 |
| 4 | | GOULD | COPPER FOIL | 12+35 m | 1.850 | 2.559 | |

Figure 3-6. EVM Stack-Up (Units in Mils)

3.3 EVM Bill of Material

Table 3-1. Bill of Materials

| Item # | Designator | Quantity | Value | Description | Part Number | Manufacturer | Package Reference |
|--------|--------------------------------|----------|--------------|---|---------------------|---------------------------------|------------------------------|
| 1 | !PCB | 1 | | Printed Circuit Board | AMPS222 | Any | |
| 2 | C1, C2, C3, C4, C5, C6, C7, C8 | 8 | 100nF | 0.1 μ F \pm 10% 16V Ceramic Capacitor X7R 0402 (1005 Metric) | ATC530L104KT16T | American Technical Ceramics | 0402 |
| 3 | C9, C13, C14, C15, C26 | 5 | 0.22 μ F | CAP, CERM, 0.22 μ F, 10V, +/- 20%, X5R, 0201 | LMK063BJ224MP-F | Taiyo Yuden | 0201 |
| 4 | C10, C19, C28 | 3 | 22 μ F | CAP, CERM, 22 μ F, 10V, +/- 20%, X5R, 0603 | CL10A226MP8NUNE | Samsung Electro-Mechanics | 0603 |
| 5 | C11, C12, C16, C17, C18, C27 | 6 | 2.2 μ F | CAP, CERM, 2.2 μ F, 10V, +/- 10%, X7S, 0402 | C1005X7S1A225K050BC | TDK | 0402 |
| 6 | J1, J2, J3, J4, J5, J6, J7, J8 | 8 | | SMA JACK 50 OHM, R/A, SMT | 32K243-40ML5 | Rosenberger | SMA JACK, R/A, SMT |
| 7 | J9, J10, J12, J17 | 4 | | Header, 100mil, 3x1, Gold, TH | PBC03SAAN | Sullins Connector Solutions | PBC03SAAN |
| 8 | J11, J23 | 2 | | Header, 2.54mm, 2x1, Gold, TH | 61300211121 | Würth Elektronik | Header, 2.54mm, 2x1, TH |
| 9 | L1 | 1 | 1000 ohm | Ferrite Bead, 1000 ohm @ 100MHz, 0.25A, 0402 | BLM15HD102SN1D | MuRata | 0402 |
| 10 | LBL1 | 1 | | Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll | THT-14-423-10 | Brady | PCB Label 0.650 x 0.200 inch |
| 11 | R1, R2, R3, R4 | 4 | 24.9 | 24.9 Ohms \pm 1% 0.05W, 1/20W Chip Resistor 0201 (0603 Metric) Thick Film | ERJ-1GNF24R9C | Panasonic Electronic Components | 0201 |
| 12 | R5 | 1 | 4.99k | RES, 4.99 k, 1%, 0.063 W, 0402 | RC0402FR-074K99L | Yageo America | 0402 |
| 13 | R17, R18 | 2 | 1k | 1 kOhms \pm 1% 0.05W, 1/20W Chip Resistor 0201 (0603 Metric) Automotive AEC-Q200 Thick Film | ERJ-1GNF1001C | Panasonic Electronic Components | 0201 |
| 14 | R20, R22, R23, R24 | 4 | 0 | RES, 0, 5%, .05 W, AEC-Q200 Grade 0, 0201 | ERJ-1GN0R00C | Panasonic | 0201 |
| 15 | R74, R75 | 2 | 8.06k | RES, 8.06 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402 | CRCW04028K06FKED | Vishay-Dale | 0402 |
| 16 | R76, R77 | 2 | 15.0k | RES, 15.0 k, 1%, 0.063 W, 0402 | CRCW040215K0FKED | Vishay-Dale | 0402 |
| 17 | RB | 1 | 0.1 | RES, 0.1, 1%, 0.25 W, 0402 | ERJ2BWFR100X | Panasonic | 0402 |

Table 3-1. Bill of Materials (continued)

| Item # | Designator | Quantity | Value | Description | Part Number | Manufacturer | Package Reference |
|--------|------------------------------------|----------|--------|--|---------------------|---------------------------|-------------------|
| 18 | U1 | 1 | | TRF1305D | TRF1305D | Texas Instruments | WQFN16 |
| 19 | C24, C31, C32 | 0 | 0.22uF | CAP, CERM, 0.22uF, 10V, +/- 20%, X5R, 0201 | LMK063BJ224MP-F | Taiyo Yuden | 0201 |
| 20 | C25, C29, C33, C34 | 0 | 2.2uF | CAP, CERM, 2.2uF, 10V, +/- 10%, X7S, 0402 | C1005X7S1A225K050BC | TDK | 0402 |
| 21 | C30, C35, C36 | 0 | 22uF | CAP, CERM, 22uF, 10V, +/- 20%, X5R, 0603 | CL10A226MP8NUNE | Samsung Electro-Mechanics | 0603 |
| 22 | FID1, FID2, FID3, FID4, FID5, FID6 | 0 | | Fiducial mark. There is nothing to buy or mount. | N/A | N/A | N/A |
| 23 | RA, RC | 0 | 0.1 | RES, 0.1, 1%, 0.25 W, 0402 | ERJ2BWFR100X | Panasonic | 0402 |

4 Additional Information

4.1 Trademarks

Isola® is a registered trademark of Isola USA Corporation.
All trademarks are the property of their respective owners.

5 Related Documentation

For related documentation, see the following:

- Texas Instruments, [TRF1305B2 Dual-Channel, DC to > 6.5GHz 3dB BW, Fully Differential Amplifier](#) data sheet

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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.
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 - 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.
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 - 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/llds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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。

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 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/llds/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。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

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.

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4. *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 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.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
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