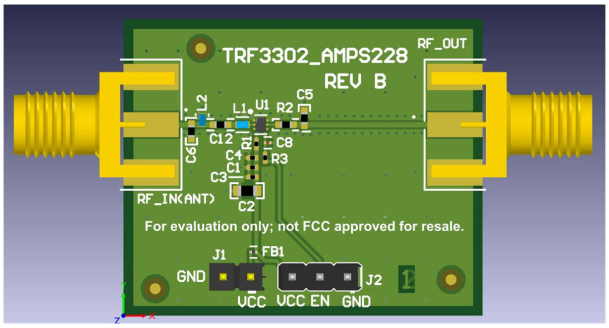
EVM User's Guide for TRF3302EVM

Description

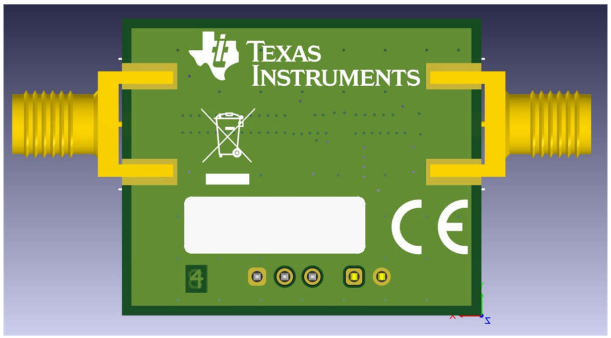
The TRF3302EVM (EVM) is designed to provide a quick way to evaluate the TRF3302 low-noise amplifiers. The EVM is default tuned 1300MHz to 1630MHz (L1 band) operation, with a single inductor change, the EVM can be optimized for 1165MHz to 1320MHz (L2/L5 bands). With four component changes, the EVM can operate wideband simultaneously covering 1165MHz to 1630MHz (all GPS/GNSS bands).

Features

- Reconfigurable input matching
- On-chip broadband output match supporting 1165MHz to 1630GHz



TRF3302EVM top view



TRF3302EVM bottom view

1 Evaluation Module Overview

1.1 Introduction

This EVM user's guide is for evaluating the TRF3302. This EVM users guide includes: the schematic diagram, bill of materials (BOM), printed-circuit board (PCB) layouts, and test setup diagrams. The EVM is compatible with both the industrial version (TRF3302) as well as Automotive AEC-Q100 (TRF3302-Q1).

1.2 Kit Contents

Table 1-1 lists the contents of the EVM kit. The EVM default is tuned to 1300MHz to 1630MHz (L1 band) and includes parts to reconfigure the EVM to 1165MHz to 1320MHz (L2/L5 band). Contact the Texas Instruments Customer support center if any components are missing.

Table 1-1. EVM Contents

Item	Description	Quantity
TRF3302EVM	Evaluation board	1
0402DC-11NXGRW	11nH inductor	3

1.3 Specification

Connector	Parameter	Value
RF_IN(ANT)	RF input port from antenna	Max 10dBm
RF_OUT	Output RF port	
J1	J1.1 VCC J1.2 GND	Voltage supply range from 1.8V to 3.3V
J2	J2.1 GND J2.2 ENABLE J2.3 VCC	Connect J2.2 to J2.3 for operation mode and connect J2.2 to J2.1 for shutdown mode. A potential must be forced on J2.2, and non-operational if left open.

1.4 Device Information

See the *TRF3302 1165MHz to 1630MHz, Multiband, GPS and GNSS Low-Noise Amplifier* data sheet for detailed device information.

2 Hardware

This section provides general usage information for the EVM.

1. Power up procedure:
   a. Set the current limit of the DC power supply to 50mA.
   b. Set the voltage of the DC power supply between 1.8V and 3.3V.
   c. Verify that the supply is turned off.
   d. Connect the power supply cables to the J1 connector of the EVM.
      i. The positive supply rail from the DC power supply is connected to pin 1 of J1.
      ii. Ground of DC output power supply is connected to pin 2 of J1.
   e. Connect a jumper between pins 2 and 3 of J2 to enable the TRF3302.
   f. Now turn on the DC power supply.
      i. The supply current (I_{CC}) drawn from the power supply is approximately 4mA to 5mA.
   g. If the supply current is below 1mA, then verify that the device is not disabled with jumper at J2 connected between pins 1 and 2.
2. Power-down procedure:
   a. Turn off the DC power supply.

See Figure 2-1 for a general single tone test setup diagram instruction. Note some components, such as supply bypass capacitors, are omitted for clarity.

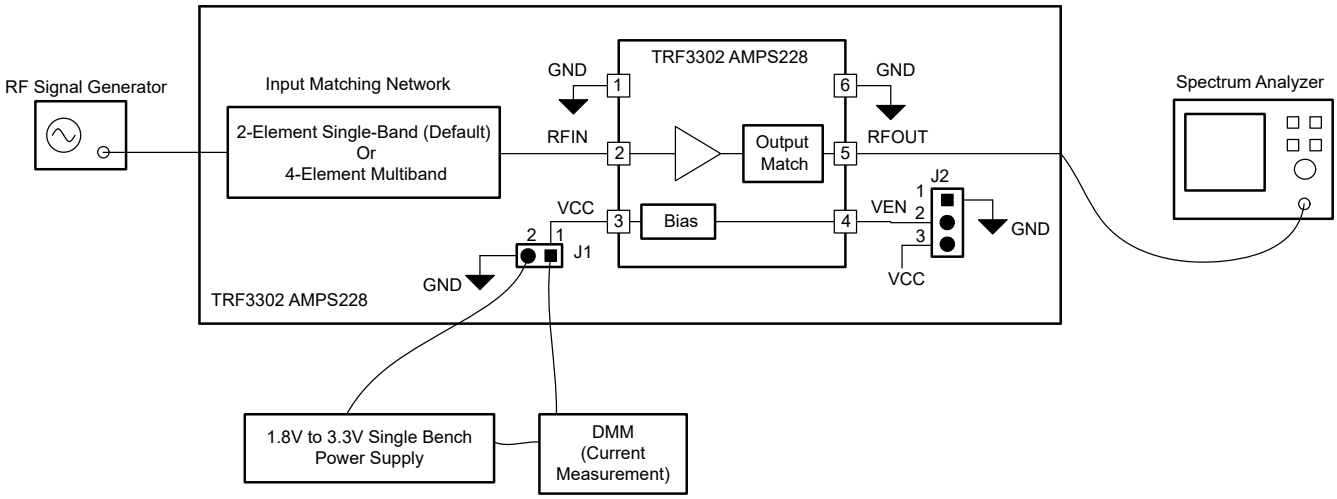


Figure 2-1. Single Tone Setup for TRF3302EVM for Gain and Output P1dB

1. Single tone measurement setup recommendation:
   a. RF signal generator signal connected to the RF_IN(ANT) SMA connector of the EVM. Also, connect spectrum analyzer or RF power meter to RF_OUT SMA connector of the EVM.
   b. The RF signal generator used must support up to 1.6GHz signal frequency for testing out the EVM.
   c. The maximum input power to the TRF3302 is 10dBm at the RF_IN (ANT) SMA connector reference plane.
   d. Properly characterize and account for the insertion loss of RF coaxial (coax) cables to accurately measure the device's gain, NF, and linearity performance.

3 Hardware Design Files

3.1 Schematics

Figure 3-1 shows the EVM schematic.

1. FB1, C2 and C3 are optional in the BOM. FB1 can be replaced by 0ohm 0201 resistor is sufficient for the DC operation of the TRF3302.
2. The EVM has input capacitor C12 installed for DC blocking and RF signal coupling while L1 inductor is tuned to support 1300 to 1630MHz (L1 band) by default.
3. Additional three L1 = 11nH inductors are provided with the EVM kit to replace L1 and optimize the TRF3302 to support 1165 to 1320MHz (L2/L5 band) as shown in Figure 3-2.
4. Replace C6, C12, L1, and L2 with 3.6pF, 12pF, 7.8nH and 2.8nH to optimize performance across 1165 to 1630MHz (all GPS/GNSS bands) as shown in Figure 3-3. R2 has to be replaced with capacitor value 4.7pF and C5 has to be replaced with inductor value 8.5nH to achieve gain flatness and a slight improvement in output matching.

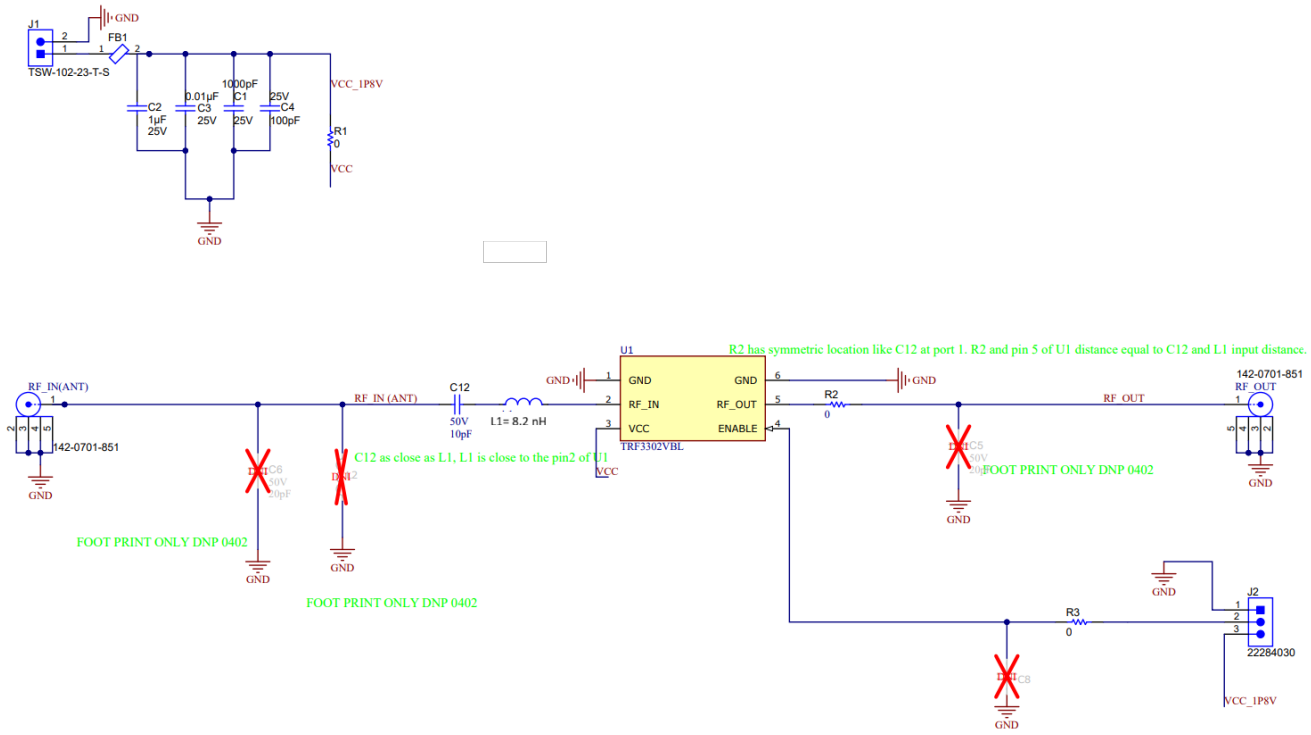


Figure 3-1. TRF3302EVM Schematic for L1 Band

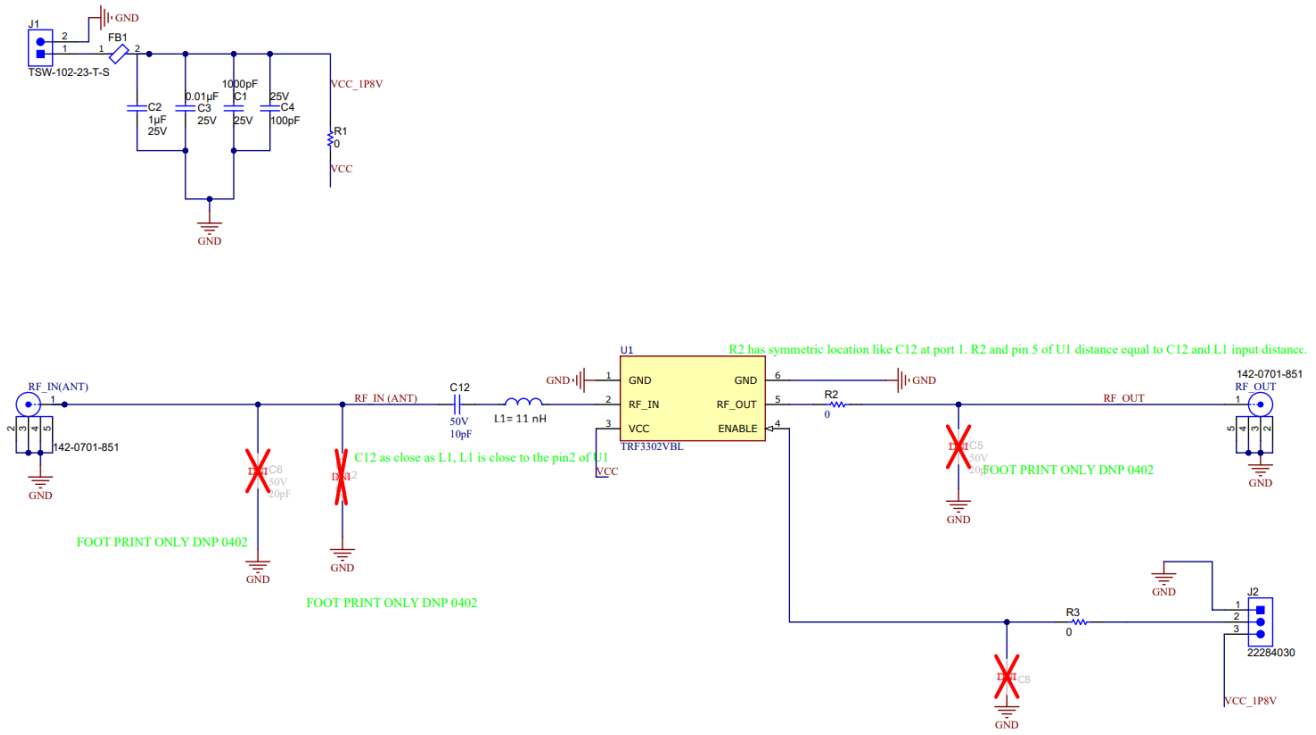


Figure 3-2. TRF3302EVM Schematic for L2/L5 Bands

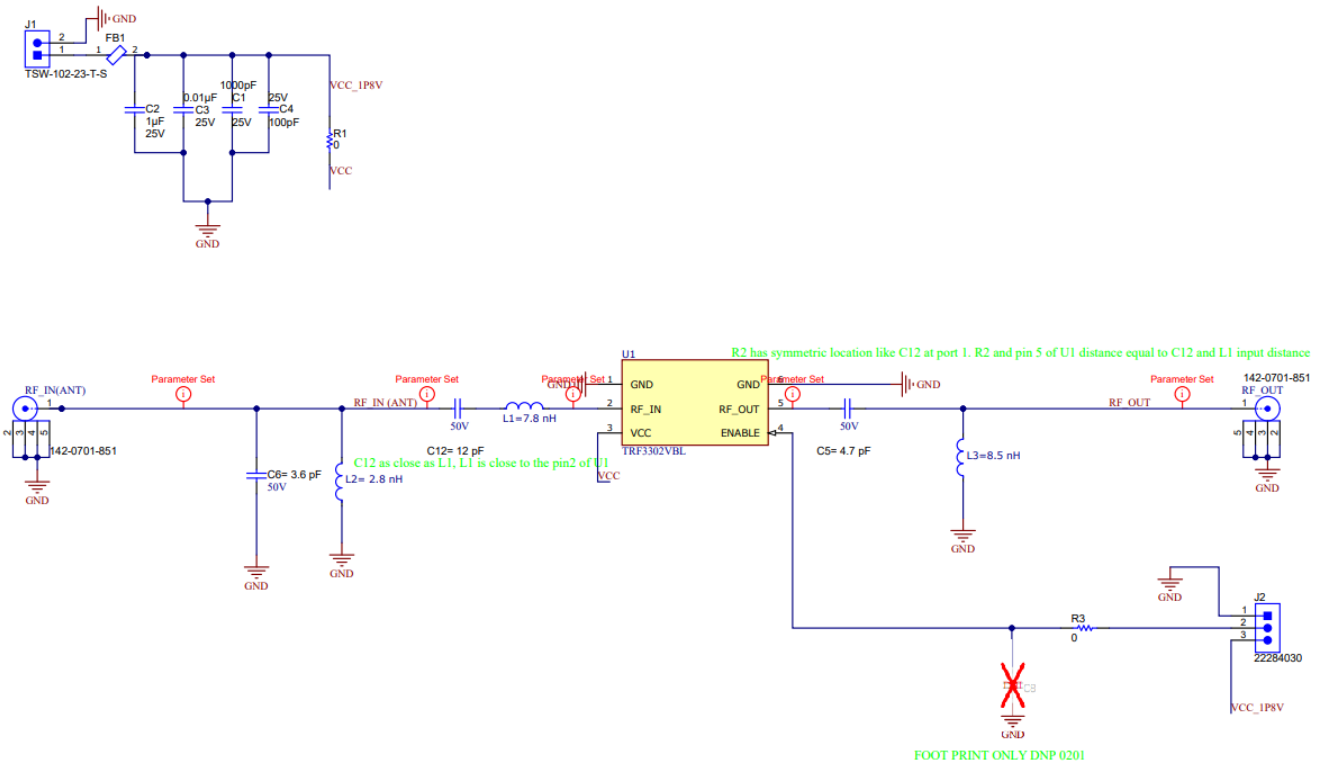


Figure 3-3. TRF3302EVM Schematic for All GPS/GNSS Bands

3.2 PCB Layouts

Figure 3-4 through Figure 3-7 illustrate the PCB layers for this EVM.

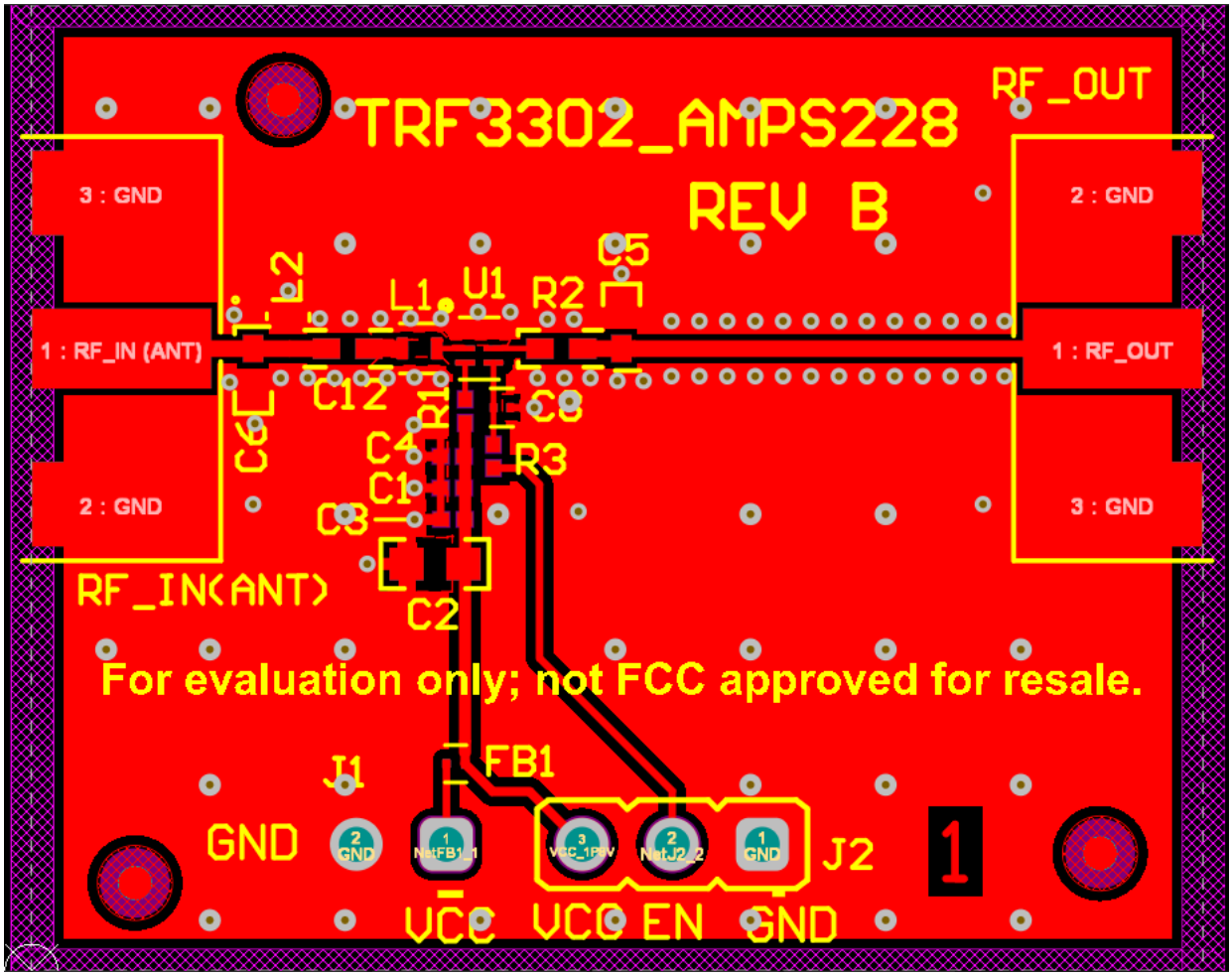


Figure 3-4. Top Layer

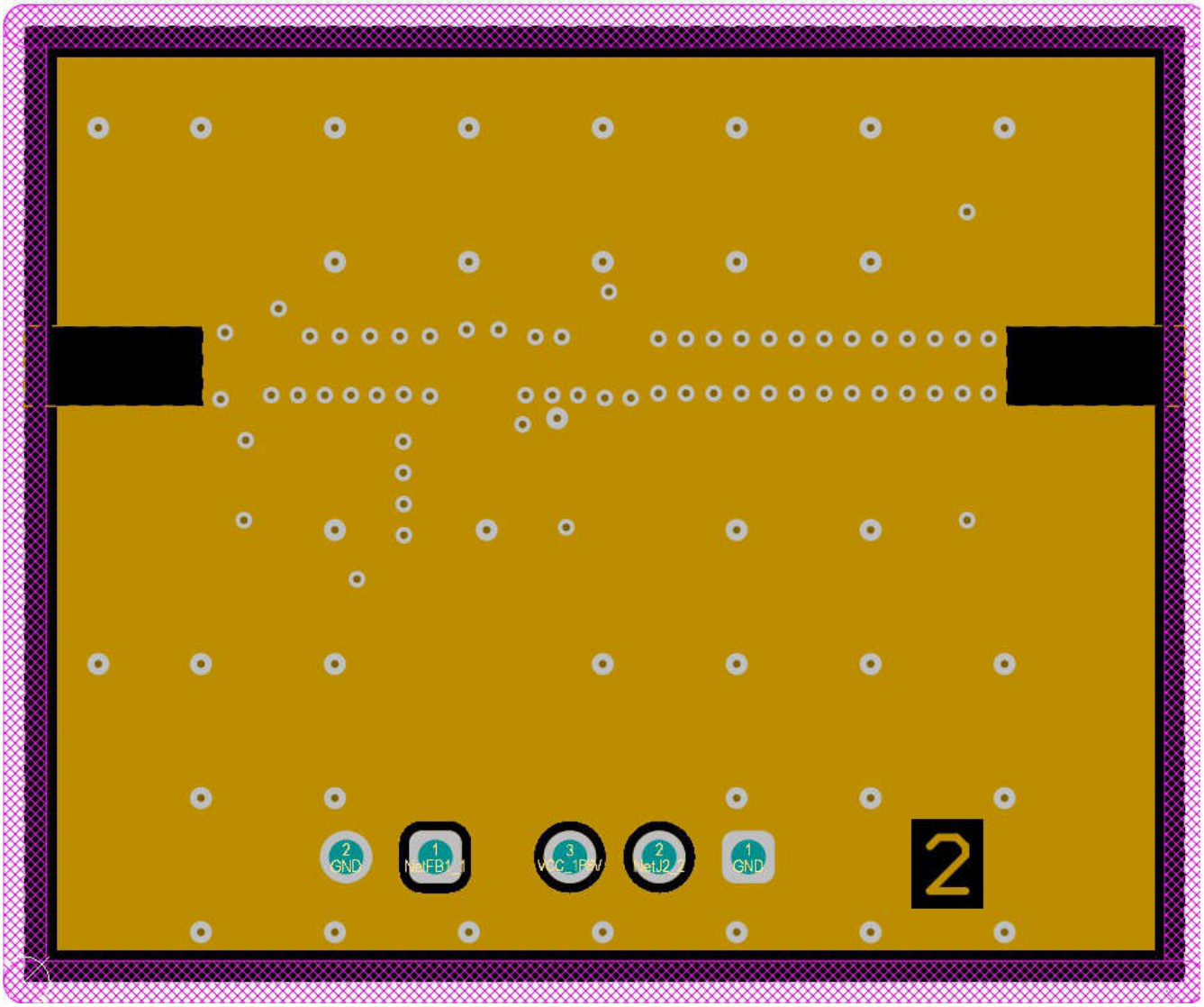


Figure 3-5. Layer 2

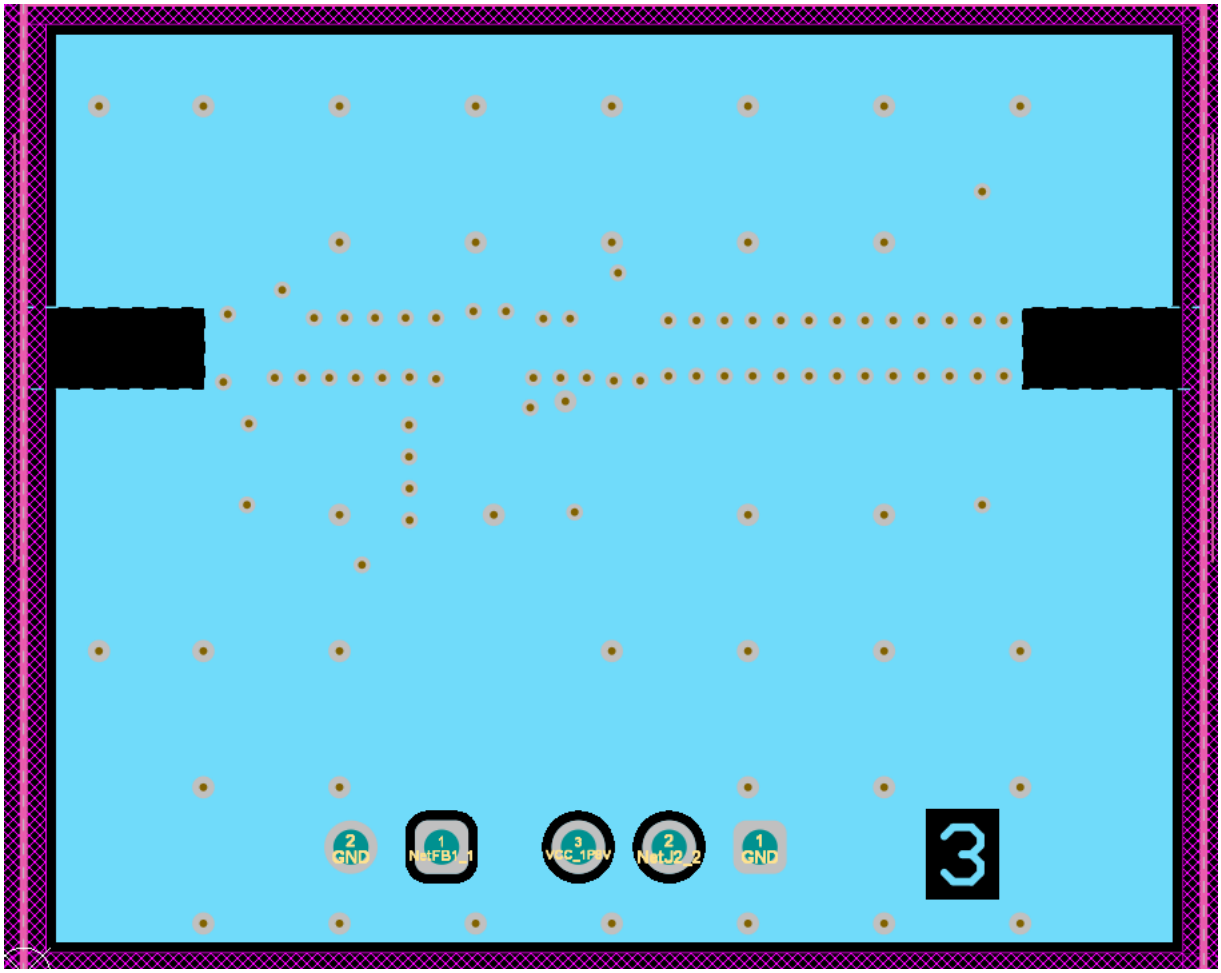


Figure 3-6. Layer 3

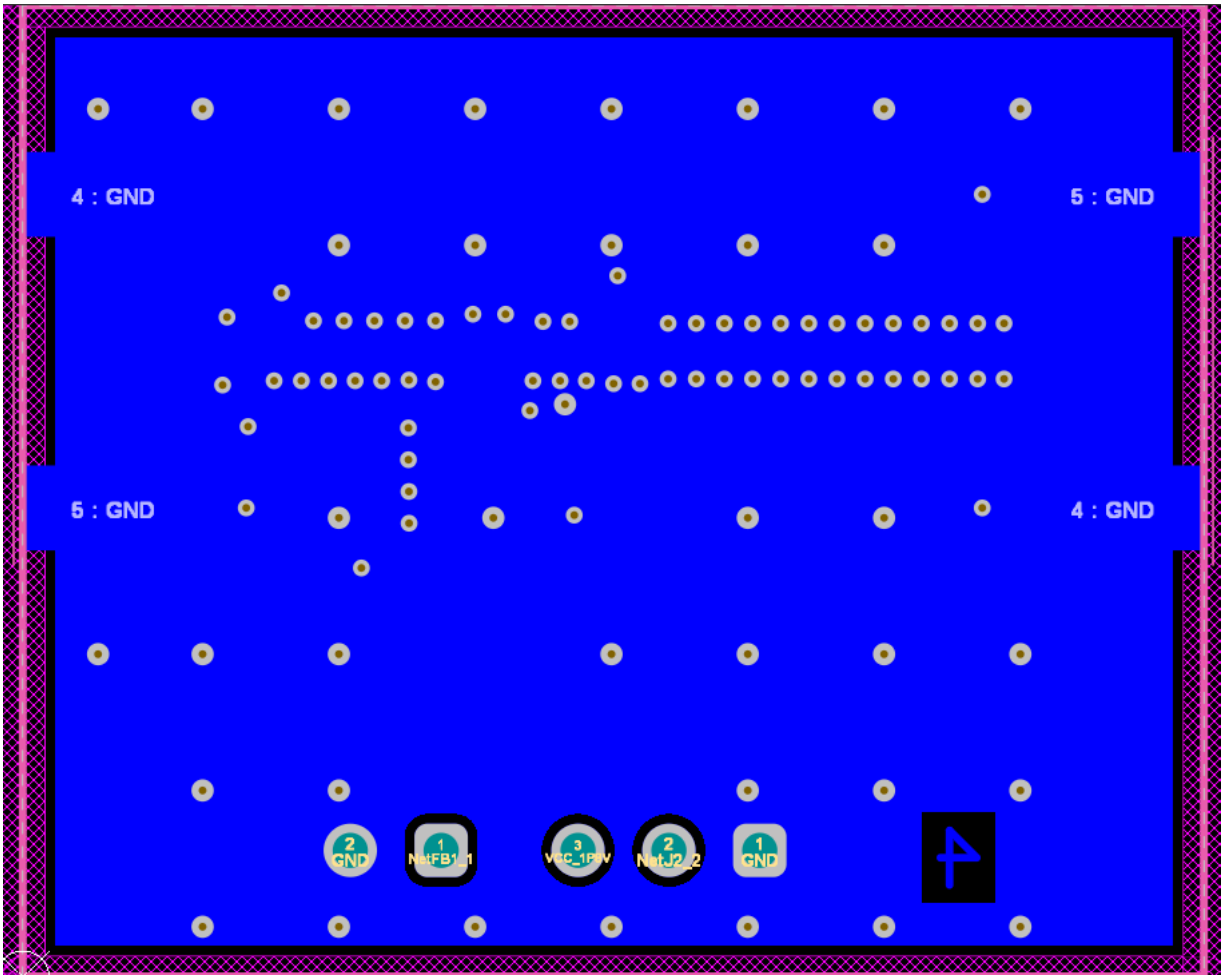


Figure 3-7. Bottom Layer

3.2.1 PCB Stack-Up and Material

The EVM board dimensions are 1300 mil by 1070 mil, thickness is 60.5-mil, 4-layer board with material type Isola® 370HR as shown in Figure 3-8. 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 nominal 50Ω. The bottom three layers are ground layers.

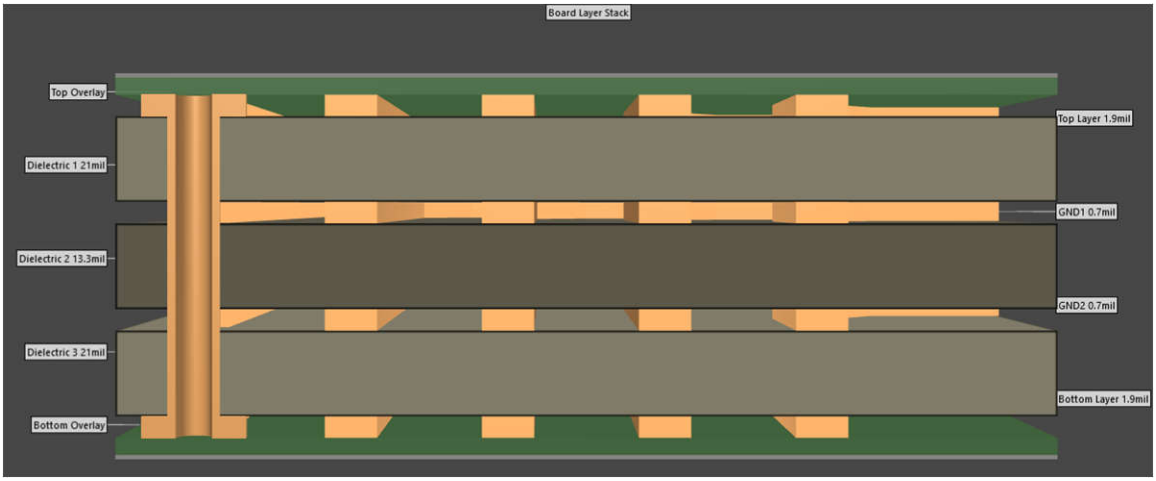


Figure 3-8. EVM Stack-Up (Units in Mils)

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		AMPS228	Any
C1	1	1000pF	CAP, CERM, 1000pF, 25V, +/- 10%, X7R, 0201	0201	GRM033R71E102KA01D	MuRata
C2	1	1uF	CAP, CERM, 1uF, 25V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71E105KA64D	MuRata
C3	1	0.01uF	CAP, CERM, 0.01 µF, 25V,+/- 10%, X7R, 0201	0201	GRM033R71E103KE14D	MuRata
C4	1	100pF	CAP, CERM, 100pF, 25V, +/- 10%, X7R, 0201	0201	GRM033R71E101KA01D	MuRata
C12	1	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/NP0, 0402	0402	GJM1555C1H100JB01	MuRata
FB1	1		Ferrite Bead, 0201, 120Ω @ 100MHz, 25%, 0.23Ω, 450mA	0201	BLM03AX121SN1D	Murata
J1	1		Header, 2.54mm, 2x1, Tin, TH	Header, 2.54mm, 2x1, TH	TSW-102-23T-S	Samtec
J2	1		Header, 2.54mm, 3x1, Tin, TH	Header, 2.54mm, 3x1, Tin, TH	22284030	Molex
L1	1	8.2nH	8.2nH Unshielded Wirewound Inductor 1.6A 70mOhm Max 0402 (1005 Metric)	0402	0402DC-8N2XGRW	Coilcraft
R1, R3	2	0	RES, 0, 5%, 0.05W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
R2	1	0	RES, 0, 5%, 0.063W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
RF_IN(ANT), RF_OUT	2		Connector, End launch SMA, 50ohm, SMT	SMA End Launch	142-0701-851	Cinch Connectivity
U1	1		TRF3302	WSON-FCRLF-6	TRF3302VBLR	Texas Instruments
C5, C6	0	20pF	CAP, CERM, 20pF, 50V, +/- 5%, C0G/NP0, 0402	0402	C0402C200J5GACTU	Kemet
C8	0	1nF	Chip Multilayer Ceramic Capacitors for General Purpose, 0201, 1000pF, C0G, 30ppm/°C, 5%, 25V	0201	GRM0335C1E102JA01D	Murata
L2	0	7.2nH	Chip Inductors 7.2nH 1500mA 0.055 Ohm	0402	0402HP-6N8XGLW	Coilcraft

4 Additional Information

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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

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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 DEGREDATION 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/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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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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.

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.

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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