

EVM User's Guide: TRF1305x1-D2D-EVM

TRF1305x1-D2D Evaluation Module

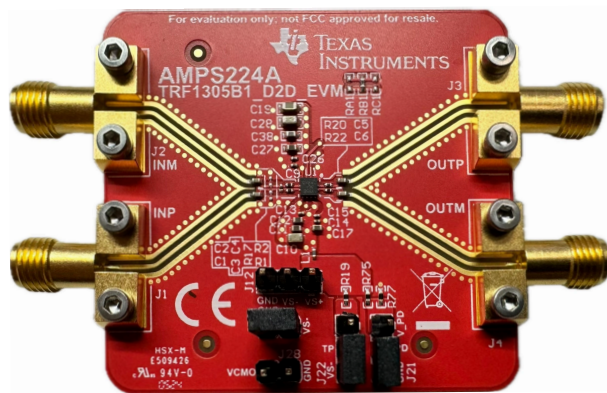


Description

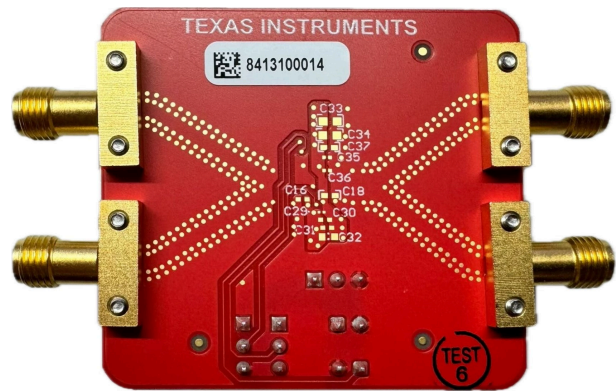
The TRF1305x1-D2D-EVM is designed to provide a quick setup to evaluate the TRF1305 series of fixed gain fully differential amplifiers (FDA) that have high linearity and operational bandwidth from true-dc to > 6.5GHz. The TRF1305 amplifiers are available in both single-channel and dual-channel packaging 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



TRF1305B1-D2D-EVM Board (Top View)



TRF1305B1-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 single-channel TRF1305 series of amplifiers in D2D configuration. [Table 1-1](#) lists the four types of TRF1305 EVMs that are meant to test all device variants in different I/O configuration.

Table 1-1. TRF1305 EVMs

EVM User's Guide	Device	Orderable Part No.	I/O Configurations	Comment
TRF1305x2-D2D	TRF1305A2	TRF1305A2-D2D-EVM	D2D, S2D ⁽¹⁾	Dual-channel amplifier - D2D (differential in, differential out) EVM
	TRF1305B2	TRF1305B2-D2D-EVM		
	TRF1305C2	TRF1305C2-D2D-EVM		
TRF1305x1-D2D	TRF1305A1	TRF1305A1-D2D-EVM	D2D, S2D	Single-channel amplifier - D2D (differential in, differential out) EVM
	TRF1305B1	TRF1305B1-D2D-EVM		
	TRF1305C1	TRF1305C1-D2D-EVM		
TRF1305x2-S2D	TRF1305A2	TRF1305A2-S2D-EVM	S2D	Dual-channel amplifier - S2D (single-ended in, differential out) EVM
	TRF1305B2	TRF1305B2-S2D-EVM		
	TRF1305C2	TRF1305C2-S2D-EVM		
TRF1305x1-S2D	TRF1305A1	TRF1305A1-S2D-EVM	S2D	Single-channel amplifier - S2D (differential in, differential out) EVM
	TRF1305B1	TRF1305B1-S2D-EVM		
	TRF1305C1	TRF1305C1-S2D-EVM		

(1) D2D EVMs can be configured in S2D by using a 50Ω SMA terminator on one of the inputs. For best performance, use an S2D 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*, *TRF1305x1-D2D-EVM* or the term *evaluation module* means any one of the four EVMs listed previously. This user's guide describes the basic steps and functions that are required for the proper operation and quick setup of the TRF1305x1-D2D-EVM. Many sections in this user's guide are common to all TRF1305EVMs. Throughout this document, TRF1305 or TRF1305x1 means TRF1305A1 or TRF1305B1 or TRF1305C1.

1.2 Kit Contents

The following tables list the contents of each 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 for TRF1305A1-D2D-EVM

Item	Quantity
TRF1305A1-D2D-EVM	1

Table 1-3. Kit Contents for TRF1305B1-D2D-EVM

Item	Quantity
TRF1305B1-D2D-EVM	1

Table 1-4. Kit Contents for TRF1305C1-D2D-EVM

Item	Quantity
TRF1305C1-D2D-EVM	1

1.3 Specification

Table 1-5. Key System Specifications

Connector	Parameter	Value
J1	RF Input INP1	Max 20dBm
J2	RF Input INM1	Max 20dBm
J3	RF Output OUTP1	
J4	RF Output OUTM1	
J5	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+ ≤ 5V VS– ≥ –2.5V (VS+) – (VS–) = 5V
J21	PD1 Select	Short 1,2 (V_PD) to disable Ch1. Short 2,3 (GND) to enable Ch1
J22	Mode Select	Open (default) See section 7.4.1 in data sheet for input common mode range extension
J28	J23.1 VCMO J23.2 GND	Open (default) Apply external voltage to set desired output common mode

1.4 Device Information

The TRF1305 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 TRF1305 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.

2 Hardware

2.1 General Usage Information

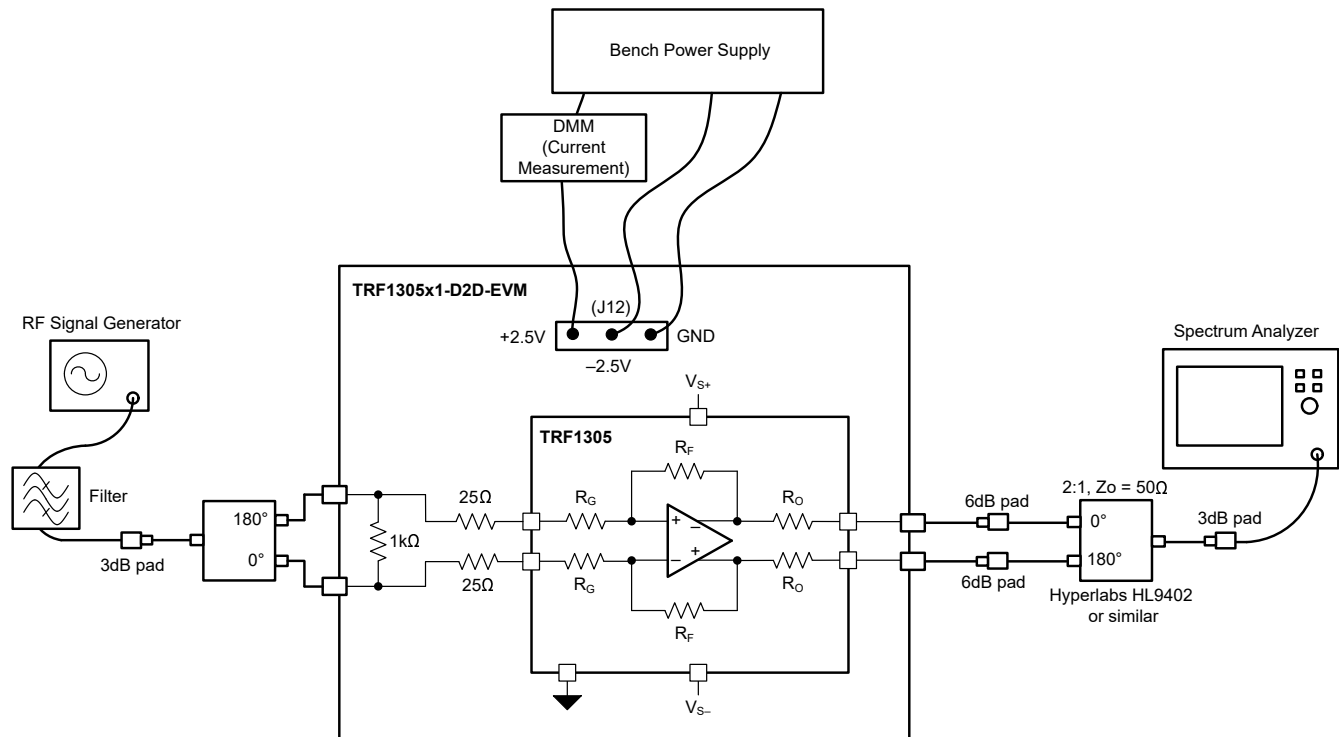


Figure 2-1. Single-Tone Setup for Gain and Output P1dB

This section provides general usage information for the TRF1305x1-D2D-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 200mA.
 - 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 100mA.
 - e. If the supply current is low, then verify that the device is not disabled by the PD pin (J21).
- Single-supply operation:
 - a. To operate as single supply, connect jumper $VS-$ to GND (J5), 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 1.8V (logic-1) on PD pin to power-down the chip (J21). Ground the PD pin to enable the chip.
- When the device is disabled, the supply current (I_Q) drawn from the power supply is approximately 25mA.

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 J28 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 TRF1305x1-D2D-EVM EVM.
 - c. The TRF1305x1-D2D-EVM device input is 50Ω in the pass-band. To minimize signal reflections due to impedance mismatch, use 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 J3 and J4 SMA connectors. The TRF1305x1-D2D-EVM 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](#). Use of an attenuator pad of approximately 3dB to 6dB is recommended at the three terminals of the passive balun to minimize reflections.
 - f. Lastly, 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 TRF1305x1-D2D-EVM EVM schematic.

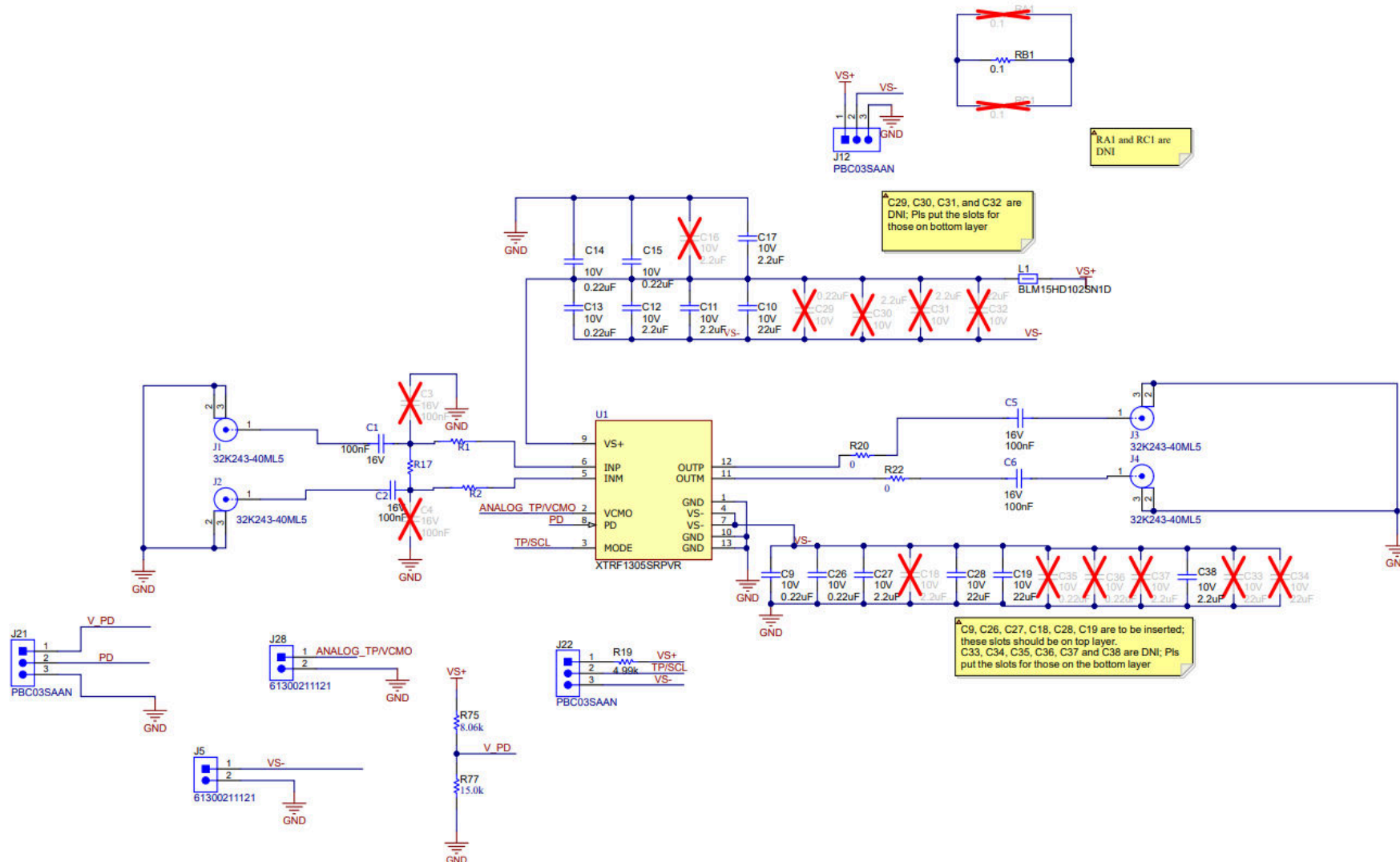


Figure 3-1. TRF1305x1-D2D-EVM Schematic

3.2 PCB Layout

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

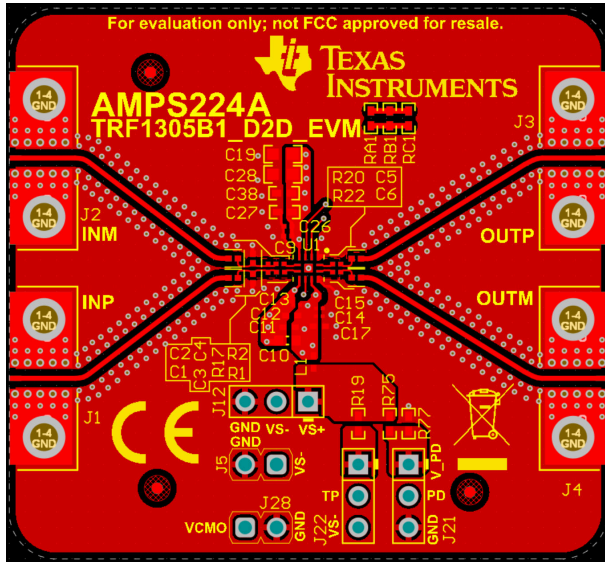


Figure 3-2. Top Layer

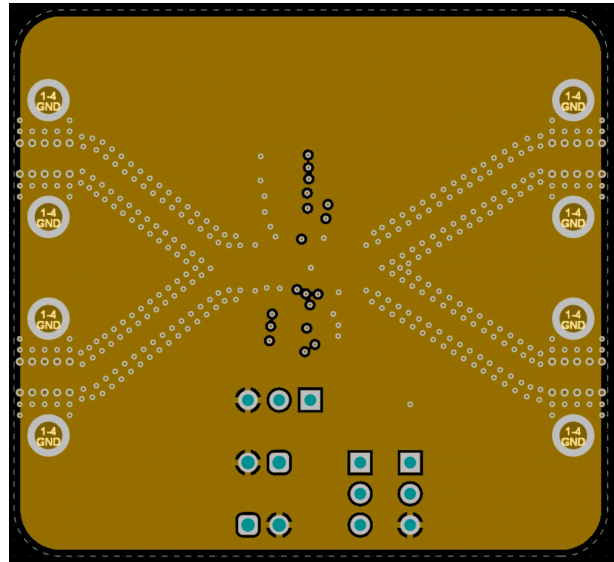


Figure 3-3. Layer 2

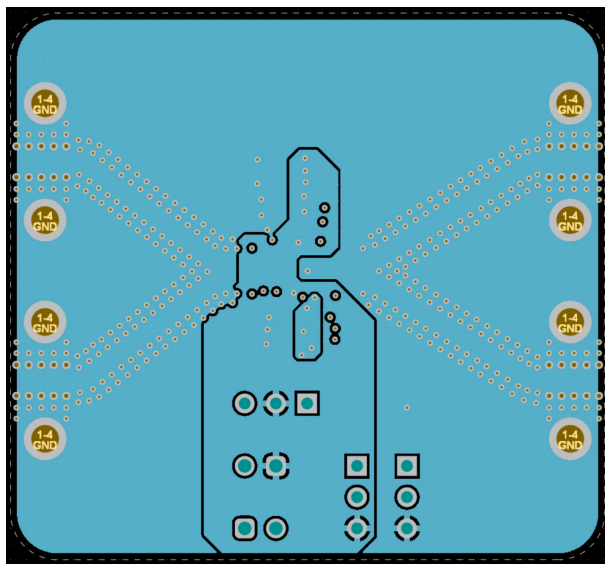


Figure 3-4. Layer 3

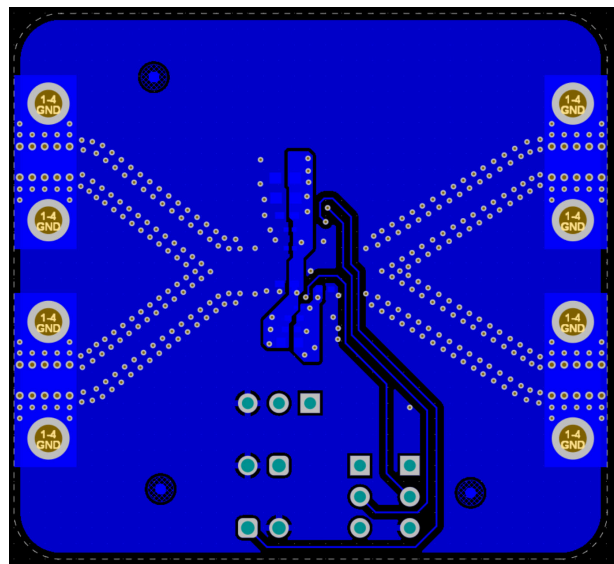


Figure 3-5. Bottom Layer

3.2.1 Stack-Up and Material

The TRF1305x1-D2D-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. The second layer is the reference RF ground layer. The signal trace impedance is targeted at 50Ω. The bottom three layers are ground layers.

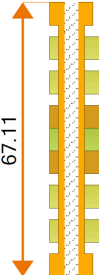
Layer	Stack up	Supplier	Supplier Description	Description	Base Thickness	Processed Thickness	ϵ_r	
1		GOULD	COPPER FOIL	12+35 m	1.850	2.559		
		ISOLA	185HR	#2116	5.000	4.966	4.320	
		ISOLA	185HR	#2116	5.000	4.966	4.320	
2						1.378	1.378	
		ISOLA	185HR	1.00 1.0/1.0	39.370	39.370	4.420	
3						1.378	1.378	
		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. TRF1305x1-D2D-EVM Stack-Up (Units in Mils)

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials for TRF1305A1D2D-EVM

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
1	!PCB	1		AMPS224	Any	Printed Circuit Board	
2	C1, C2, C5, C6	4	100nF	ATC530L104KT16T	American Technical Ceramics	0.1µF ±10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
3	C9, C13, C14, C15, C26	5	0.22µF	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22µF, 10V, ± 20%, X5R, 0201	0201
4	C10, C19, C28	3	22µF	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22µF, 10V, ± 20%, X5R, 0603	0603
5	C11, C12, C17, C27, C38	5	2.2µF	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2µF, 10V, ± 10%, X7S, 0402	0402
6	J1, J2, J3, J4	4		32K243-40ML5	Rosenberger	SMA JACK 50OHM, R/A, SMT	SMA JACK, R/A, SMT
7	J5, J28	2		61300211121	Würth Elektronik	Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH
8	J12, J21, J22	3		PBC03SAAN	Sullins Connector Solutions	Header, 100mil, 3x1, Gold, TH	PBC03SAAN
9	L1	1	1000ohm	BLM15HD102SN1D	MuRata	Ferrite Bead, 1000ohm @ 100MHz, 0.25A, 0402	0402
10	R1, R2	2	24.9	ERJ-1GNF24R9C	Panasonic Electronic Components	24.9Ohms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Thick Film	0201
11	R17	1	1k	ERJ-1GNF1001C	Panasonic Electronic Components	1kOhms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Automotive AEC-Q200Thick Film	0201
12	R19	1	4.99k	RC0402FR-074K99L	Yageo America	RES, 4.99k, 1%, 0.063W, 0402	0402
13	R20, R22	2	0	ERJ-1GN0R00C	Panasonic	RES, 0, 5%, .05W, AEC-Q200Grade 0, 0201	0201
14	R75	1	8.06k	CRCW04028K06FKED	Vishay-Dale	RES, 8.06k, 1%, 0.063W, AEC-Q200Grade 0, 0402	0402
15	R77	1	15.0k	CRCW040215K0FKED	Vishay-Dale	RES, 15.0k, 1%, 0.063W, 0402	0402
16	RB1	1	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	0402

Table 3-1. Bill of Materials for TRF1305A1D2D-EVM (continued)

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
17	U1	1		TRF1305A1RPVR	Texas Instruments	TRF1305A1RPVR	WQFN-FCRLF12
18	C3, C4	0	100nF	ATC530L104KT16T	American Technical Ceramics	0.1 μ F \pm 10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
19	C16, C18, C30, C31, C37	0	2.2 μ F	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2 μ F, 10V, \pm 10%, X7S, 0402	0402
20	C29, C35, C36	0	0.22 μ F	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22 μ F, 10V, \pm 20%, X5R, 0201	0201
21	C32, C33, C34	0	22 μ F	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22 μ F, 10V, \pm 20%, X5R, 0603	0603
22	FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
23	RA1, RC1	0	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	0402

Table 3-2. Bill of Materials for TRF1305B1D2D-EVM

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
1	!PCB	1		AMPS224	Any	Printed Circuit Board	
2	C1, C2, C5, C6	4	100nF	ATC530L104KT16T	American Technical Ceramics	0.1µF ±10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
3	C9, C13, C14, C15, C26	5	0.22µF	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22µF, 10V, ± 20%, X5R, 0201	0201
4	C10, C19, C28	3	22µF	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22µF, 10V, ± 20%, X5R, 0603	0603
5	C11, C12, C17, C27, C38	5	2.2µF	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2µF, 10V, ± 10%, X7S, 0402	0402
6	J1, J2, J3, J4	4		32K243-40ML5	Rosenberger	SMA JACK 50OHM, R/A, SMT	SMA JACK, R/A, SMT
7	J5, J28	2		61300211121	Würth Elektronik	Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH
8	J12, J21, J22	3		PBC03SAAN	Sullins Connector Solutions	Header, 100mil, 3x1, Gold, TH	PBC03SAAN
9	L1	1	1000ohm	BLM15HD102SN1D	MuRata	Ferrite Bead, 1000ohm @ 100MHz, 0.25A, 0402	0402
10	R1, R2	2	24.9	ERJ-1GNF24R9C	Panasonic Electronic Components	24.9Ohms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Thick Film	0201
11	R17	1	1k	ERJ-1GNF1001C	Panasonic Electronic Components	1kOhms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Automotive AEC-Q200Thick Film	0201
12	R19	1	4.99k	RC0402FR-074K99L	Yageo America	RES, 4.99k, 1%, 0.063W, 0402	0402
13	R20, R22	2	0	ERJ-1GN0R00C	Panasonic	RES, 0, 5%, .05W, AEC-Q200Grade 0, 0201	0201
14	R75	1	8.06k	CRCW04028K06FKED	Vishay-Dale	RES, 8.06k, 1%, 0.063W, AEC-Q200Grade 0, 0402	0402
15	R77	1	15.0k	CRCW040215K0FKED	Vishay-Dale	RES, 15.0k, 1%, 0.063W, 0402	0402
16	RB1	1	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	0402
17	U1	1		TRF1305B1RPVR	Texas Instruments	PTRF1305B1RPVR	WQFN-FCRLF12

Table 3-2. Bill of Materials for TRF1305B1D2D-EVM (continued)

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
18	C3, C4	0	100nF	ATC530L104KT16T	American Technical Ceramics	0.1 μ F \pm 10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
19	C16, C18, C30, C31, C37	0	2.2 μ F	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2 μ F, 10V, \pm 10%, X7S, 0402	0402
20	C29, C35, C36	0	0.22 μ F	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22 μ F, 10V, \pm 20%, X5R, 0201	0201
21	C32, C33, C34	0	22 μ F	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22 μ F, 10V, \pm 20%, X5R, 0603	0603
22	FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
23	RA1, RC1	0	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	0402

Table 3-3. Bill of Materials for TRF1305C1D2D-EVM

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
1	!PCB	1		AMPS224	Any	Printed Circuit Board	
2	C1, C2, C5, C6	4	100nF	ATC530L104KT16T	American Technical Ceramics	0.1µF ±10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
3	C9, C13, C14, C15, C26	5	0.22µF	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22µF, 10V, ± 20%, X5R, 0201	0201
4	C10, C19, C28	3	22µF	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22µF, 10V, ± 20%, X5R, 0603	0603
5	C11, C12, C17, C27, C38	5	2.2µF	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2µF, 10V, ± 10%, X7S, 0402	0402
6	J1, J2, J3, J4	4		32K243-40ML5	Rosenberger	SMA JACK 50OHM, R/A, SMT	SMA JACK, R/A, SMT
7	J5, J28	2		61300211121	Würth Elektronik	Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH
8	J12, J21, J22	3		PBC03SAAN	Sullins Connector Solutions	Header, 100mil, 3x1, Gold, TH	PBC03SAAN
9	L1	1	1000ohm	BLM15HD102SN1D	MuRata	Ferrite Bead, 1000ohm @ 100MHz, 0.25A, 0402	0402
10	R1, R2	2	24.9	ERJ-1GNF24R9C	Panasonic Electronic Components	24.9Ohms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Thick Film	0201
11	R17	1	1k	ERJ-1GNF1001C	Panasonic Electronic Components	1kOhms ±1% 0.05W, 1/20W Chip Resistor 0201(0603Metric) Automotive AEC-Q200Thick Film	0201
12	R19	1	4.99k	RC0402FR-074K99L	Yageo America	RES, 4.99k, 1%, 0.063W, 0402	0402
13	R20, R22	2	0	ERJ-1GN0R00C	Panasonic	RES, 0, 5%, .05W, AEC-Q200Grade 0, 0201	0201
14	R75	1	8.06k	CRCW04028K06FKED	Vishay-Dale	RES, 8.06k, 1%, 0.063W, AEC-Q200Grade 0, 0402	0402
15	R77	1	15.0k	CRCW040215K0FKED	Vishay-Dale	RES, 15.0k, 1%, 0.063W, 0402	0402
16	RB1	1	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	0402
17	U1	1		TRF1305C1RPVR	Texas Instruments	TRF1305C1RPVR	WQFN-FCRLF12

Table 3-3. Bill of Materials for TRF1305C1D2D-EVM (continued)

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
18	C3, C4	0	100nF	ATC530L104KT16T	American Technical Ceramics	0.1 μ F \pm 10% 16V Ceramic Capacitor X7R 0402(1005Metric)	0402
19	C16, C18, C30, C31, C37	0	2.2 μ F	C1005X7S1A225K050BC	TDK	CAP, CERM, 2.2 μ F, 10V, \pm 10%, X7S, 0402	0402
20	C29, C35, C36	0	0.22 μ F	LMK063BJ224MP-F	Taiyo Yuden	CAP, CERM, 0.22 μ F, 10V, \pm 20%, X5R, 0201	0201
21	C32, C33, C34	0	22 μ F	CL10A226MP8NUNE	Samsung Electro-Mechanics	CAP, CERM, 22 μ F, 10V, \pm 20%, X5R, 0603	0603
22	FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
23	RA1, RC1	0	0.1	ERJ2BWFR100X	Panasonic	RES, 0.1, 1%, 0.25W, 0402	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, [TRF1305B1 Single-Channel, DC to > 6.5GHz 3dB BW, Fully Differential Amplifier](#) data sheet

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (March 2025) to Revision B (July 2025)	Page
• Updated schematic.....	6

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 semiconductor 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/lstds/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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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。

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/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.
 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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 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
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