

Evaluating the **ADRF5545A** Dual-Channel, 2.4 GHz to 4.2 GHz Receive Front End

FEATURES

- Full featured evaluation board for the **ADRF5545A**
- Easy connection to test equipment
- Matching network for 2.6 GHz and 3.6 GHz
- Thru line for calibration

EQUIPMENT NEEDED

- DC power supply
- Signal generator
- Spectrum analyzer
- Network analyzer

GENERAL DESCRIPTION

The **ADRF5545A** is an integrated, dual-channel receiver front end, ideally suited for time division duplexing (TDD) wireless infrastructure applications. The **ADRF5545A** consists of a high power switch and a two-stage low noise amplifier on each channel.

This user guide describes the ADRF5545A-EVALZ evaluation board, designed to easily evaluate the features and performance of the **ADRF5545A**. A photograph of the evaluation board is shown in Figure 1.

The **ADRF5545A** data sheet, available at www.analog.com, provides full specifications for the **ADRF5545A**. Consult the **ADRF5545A** data sheet in conjunction with this user guide when using the evaluation board.

ADRF5545A-EVALZ EVALUATION BOARD PHOTOGRAPH

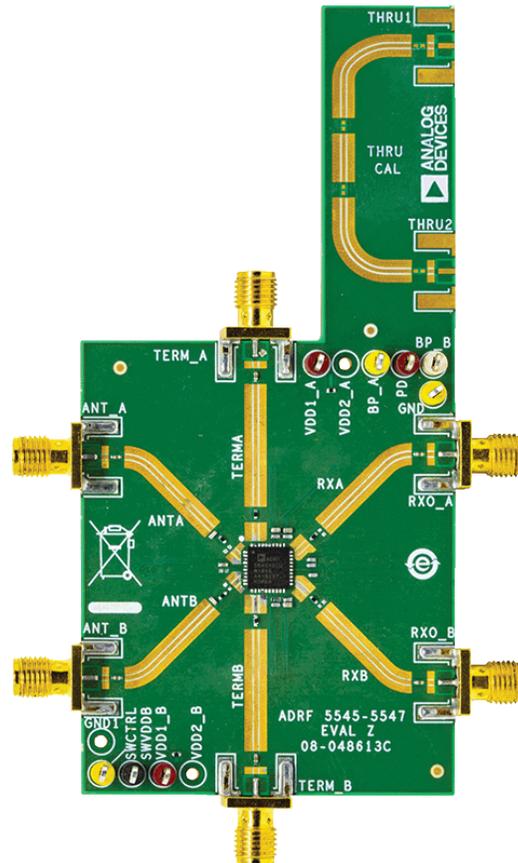


Figure 1.

20833-001

TABLE OF CONTENTS

Features	1	Power Supply Inputs	3
Equipment Needed.....	1	Control Inputs.....	3
General Description	1	RF Inputs and Outputs	4
ADRF5545A-EVALZ Evaluation Board Photograph	1	Test Procedure.....	5
Revision History	2	Evaluation Board Schematic and Artwork.....	7
Evaluation Board Hardware	3	Ordering Information.....	9
Overview.....	3	Bill of Materials.....	9
Board Layout.....	3		

REVISION HISTORY

5/2019—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

OVERVIEW

The ADRF5545A-EVALZ evaluation board is a connectorized board, assembled with the [ADRF5545A](#) and its application circuitry. All components are placed on the primary side of evaluation board. An assembly drawing for the evaluation board is shown in Figure 5. An evaluation board schematic is provided in Figure 4. Table 5 provides the bill of materials (BOM) list for evaluation board components.

BOARD LAYOUT

The ADRF5545A-EVALZ is designed using RF circuit design techniques on an 8-layer printed circuit board (PCB). The PCB stack-up is shown in Figure 2.

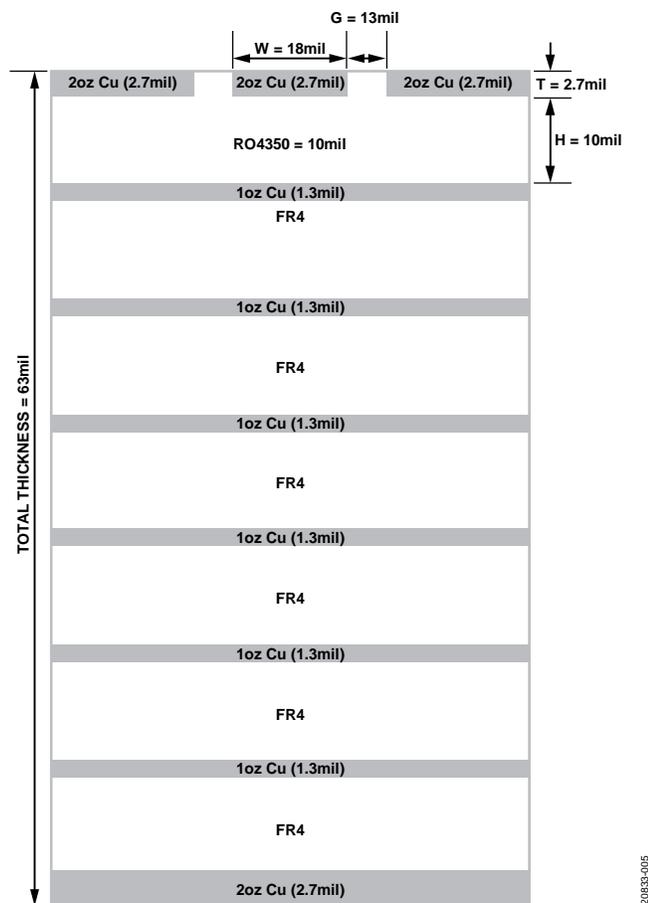


Figure 2. Evaluation Board Stack-Up

The outer copper layers are 2 oz (2.7 mil) thick and the inner layers are 1 oz (1.3 mil) thick.

The top dielectric material is 10 mil Rogers 4350B, which provides 50 Ω controlled impedance and optimizes high frequency performance. The remaining six dielectric layers are FR4 based filler layers that improve the mechanical strength of the board and meet the overall board thickness of approximately 63 mil.

All RF traces are routed on the top layer and the remaining seven layers are ground planes that provide a solid ground for RF transmission lines and help to manage thermal rise on the evaluation board during high power operations.

The RF transmission lines are designed using a coplanar waveguide (CPWG) model with a width of 18 mil and ground spacing of 13 mil to have a characteristic impedance of 50 Ω. Ground via fences are arranged on both sides of a coplanar waveguide to improve isolation between nearby RF lines and other signal lines.

The exposed ground pad of the [ADRF5545A](#), which is soldered on the PCB ground pad, is the main thermal conduit for heat dissipation. The PCB ground pad is densely populated with filled through vias to provide the lowest possible thermal resistance path from the top to the bottom of the PCB. The connections from the package ground leads to ground are kept as short as possible.

POWER SUPPLY INPUTS

The ADRF5545A-EVALZ evaluation board has five power supply inputs and one ground, as shown in Table 1. The dc test points are populated only on SWVDDB, VDD1_A, and VDD1_B, whereas VDD2_A and VDD2_B are shorted to VDD1_A and VDD1_B, respectively, via 0 Ω resistors. A single 5 V supply is connected to the dc test points on SWVDDB, VDD1_A, and VDD1_B. The typical total current consumption for the [ADRF5545A](#) is 180 mA.

Each supply pin for the low noise amplifiers (LNAs) of the [ADRF5545A](#) is decoupled with 1 nF and 10 μF capacitors. A 10 μF capacitor is used on the supply line for the switches of the [ADRF5545A](#).

Table 1. Power Supply Inputs and Ground

Test Points	Description
VDD1_A	Supply LNA Stage 1 on Channel A
VDD2_A	Supply LNA Stage 2 on Channel A, do not insert (DNI)
VDD1_B	Supply LNA Stage 1 on Channel B
VDD2_B	Supply LNA Stage 2 on Channel B, DNI
SWVDDB	Supply switches on Channel A and Channel B
GND1	Ground

CONTROL INPUTS

The ADRF5545A-EVALZ evaluation board has four control inputs as described in Table 2. Each control input is decoupled with a 100 pF capacitor.

Table 2. Control Inputs

Test Points	Description
BP_A	Bypass LNA Stage 2 on Channel A
BP_B	Bypass LNA Stage 2 on Channel B
PD	Power down all LNA stages on Channel A and Channel B
SWCTRL	Control switches on Channel A and Channel B

RF INPUTS AND OUTPUTS

The ADRF5545A-EVALZ evaluation board has eight edge mounted Subminiature Version A (SMA) connectors for the RF inputs and outputs, as shown in Table 3. Each RF input/output is ac-coupled using a series capacitor of 100 pF close to the SMA connector.

The evaluation board is assembled and shipped without SMA connectors and series components on the thru line by default. The user must connect these connectors and components to measure and calibrate out the board loss effects.

Table 3. RF Inputs and Outputs

SMA Connectors	Description
ANT_A	Antenna input to Channel A
ANT_B	Antenna input to Channel B
TERM_A	Termination output from Channel A
TERM_B	Termination output from Channel B
RXO_A	Receiver output from Channel A
RXO_B	Receiver output from Channel B
THRU1	Thru line input/output, DNI
THRU2	Thru line input/output, DNI

The ADRF5545A covers the 2.4 GHz to 4.2 GHz wide frequency range and only requires a few external components to be tuned to a specific band within that wide range.

Table 4 lists the required matching components. The ADRF5545A-EVALZ evaluation board is assembled and shipped with 3.6 GHz matching components by default. The evaluation board can be tuned for 2.6 GHz application with minor changes on some matching components, as shown in Table 4.

Table 4. Matching Components

Matching Components	2.6 GHz (2.4 GHz to 2.8 GHz)	3.6 GHz (3.4 GHz to 3.8 GHz)
ANT_x Connectors Capacitors C1, C2	0.6 pF ¹	0.3 pF
RXO_x Connectors Capacitors C26, C27 Jumpers/Resistors R22, R23	0.8 pF ¹ 1.2 nH ²	Open 0 Ω

¹ KEMET HiQ-CBR series.

² TDK MLG1005S series.

TEST PROCEDURE

The ADRF5545A-EVALZ evaluation board is shipped fully assembled and tested. Figure 3 provides a basic test setup diagram. Perform the following steps to complete the test setup and verify the operation of the ADRF5545A-EVALZ evaluation board:

1. Connect the GND1 test point to the ground terminal of the power supply.
2. Connect the VDD1_A, VDD2_A, and SWVDDDB test points to the voltage output terminal of power supply.
3. Connect the BP_A, BP_B, PD, and SWCTRL test points to the ground terminal of the power supply for high gain receive operation.
4. Connect a signal generator to the ANT_A SMA connector. Set the signal generator to -30 dBm output power at 3.6 GHz.
5. Connect a spectrum analyzer to the RXO_A SMA connector. Set the spectrum analyzer to a 3.6 GHz center frequency and the reference power level at 10 dBm.
6. Connect $50\ \Omega$ loads to the TERM_A, ANT_B, RXO_B, TERM_B SMA connectors.
7. Turn on the 5 V supply that sources a current of approximately 180 mA.
8. Turn on the RF signal generator. The spectrum analyzer displays a tone of approximately 0 dBm at 3.6 GHz so that Channel A of the ADRF5545A-EVALZ evaluation board has a receive gain of 30 dB.
9. Turn off the RF signal generator and then the power supply.
10. To repeat the test on Channel B, connect the test equipment to the ANT_B and RXO_B SMA connectors in Step 4 and Step 5, and connect $50\ \Omega$ loads to the TERM_A, TERM_B, ANT_A, and RXO_A SMA connectors in Step 6.

Additional test equipment is needed to fully evaluate the device functions and performance.

The ADRF5545A can be configured in different modes by connecting the control test points to 5 V or ground. Use a separate power supply to evaluate control input functions.

Use a network analyzer to evaluate the receive gain, transmit insertion loss and isolation, RF input and output return losses, and channel to channel isolation.

For noise figure evaluation, use either a noise figure analyzer or a spectrum analyzer with a noise option. The use of a low excess noise ratio (ENR) noise source is recommended.

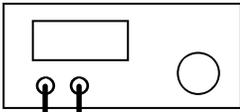
For third-order intercept point evaluation, use two signal generators and a spectrum analyzer. A high isolation power combiner is recommended.

For power compression and power handling evaluations, use a 2-channel power meter and a signal generator. A power amplifier with an output power rating of >200 W is recommended at the input. Test accessories such as couplers and attenuators must have sufficient power handling.

The ADRF5545A-EVALZ evaluation board comes with a support plate attached to the bottom side. To ensure maximum heat dissipation and to reduce thermal rise on the evaluation board during high power evaluations, this support plate must be attached to a heat sink using thermal grease.

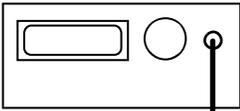
Note that the measurements performed at the SMA connectors of the evaluation board include the losses of the SMA connectors and the PCB. The thru line must be measured to calibrate out the board effects. The thru line is the summation of an RF input line and an RF output line that are connected to the device and equal in length.

5V POWER SUPPLY UNIT



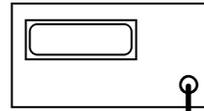
CONNECT TO SUPPLY,
CONTROL AND GROUND
TEST POINTS

SIGNAL GENERATOR



FREQUENCY = 3.6GHz
POWER = -30dBm

SPECTRUM ANALYZER



CENTER = 3.6GHz
SPAN = 1MHz
ATTENUATION = 20dB
REFERENCE LEVEL = +10dBm
RESOLUTION BANDWIDTH = 30kHz

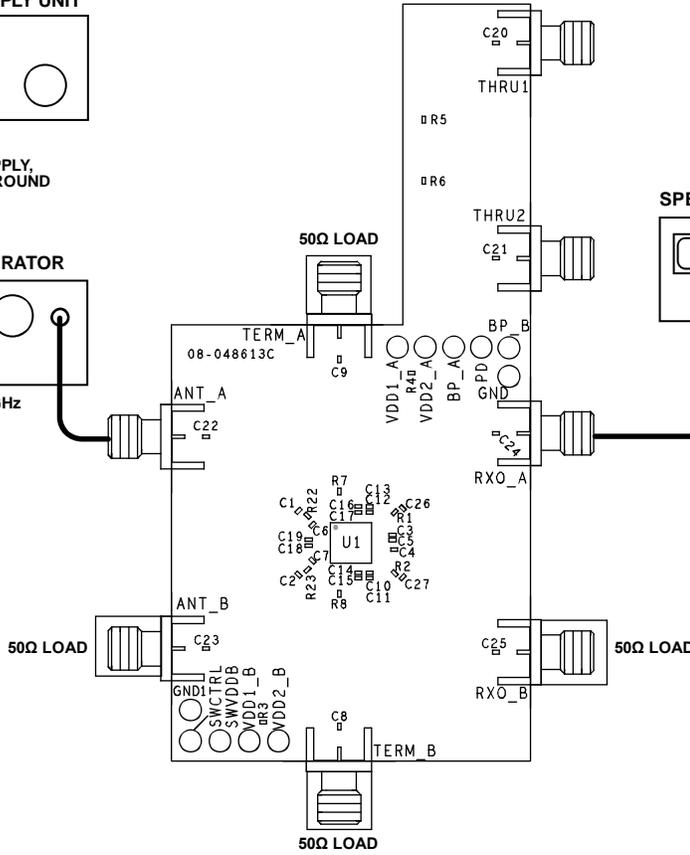


Figure 3. Test Setup Diagram

20893-002

EVALUATION BOARD SCHEMATIC AND ARTWORK

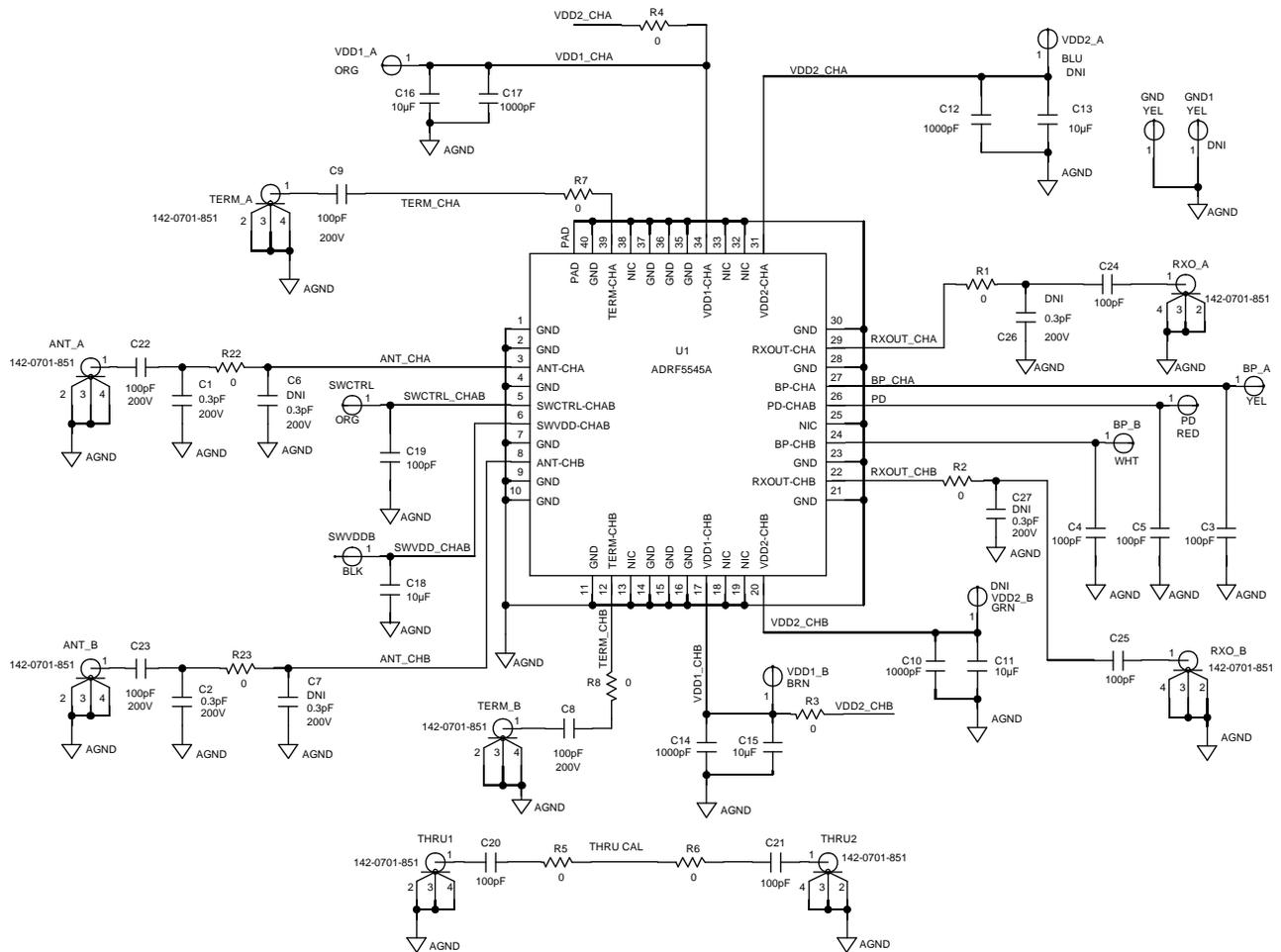
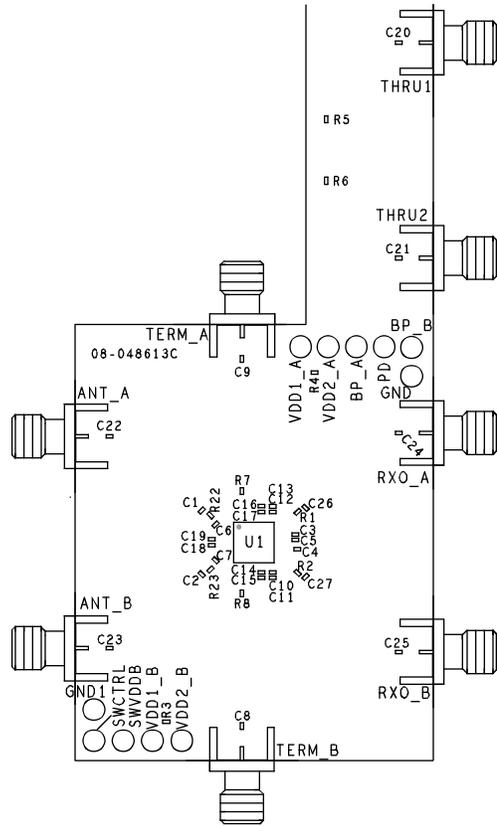


Figure 4. Evaluation Board Schematic

20033-004



20853-003

Figure 5. Evaluation Board Assembly Diagram

ORDERING INFORMATION

BILL OF MATERIALS

Table 5. Bill of Materials for ADRF5545A-EVALZ Evaluation Board

Reference Designator	Description	Value	Manufacturer	Part Number
J1 to J8	PCB mount SMA connector	Not applicable	Johnson/Cinch Connectivity Solutions	142-0701-851
C1, C2	Capacitor, 200 V, 0402 package	0.3 pF	American Technical Ceramics (ATC)	600L0R3AT200T
C3, C4, C5	Capacitor, 50 V, 0402 package	100 pF	Murata Electronics	GCM1555C1H101JA16D
C10, C12, C14, C17	Capacitor, 25 V, 0402 package	1 nF	TDK	CGJ2B2X7R1E102K050BA
C11, C13, C15, C16, C18	Capacitor, 10 V, 0402 package	10 μF	Samsung Electro-Mechanics	CL05A106MP5NUNC
C8, C9, C19, C20, C21, C22, C23, C24, C25	Capacitor, 200 V, 0402 package	100 pF	KEMET	C0402C101J2GACTU
R1 to R8, R22, R23	Resistor, 0402 package	0 Ω	Panasonic Electronic Components	ERJ-2GE0R00X
U1	RF front-end IC	Not applicable	Analog Devices, Inc.	ADRF5545A
PCB	PCB	Not applicable	Analog Devices, Inc.	08_048613c



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

©2019 Analog Devices, Inc. All rights reserved. Trademarks and registered trademarks are the property of their respective owners. UG20833-0-5/19(0)



www.analog.com