

Evaluating the ADRF5702 Silicon Digital Attenuator, 0.125dB LSB, 8-Bit, 50MHz to 20GHz

FEATURES

- ▶ Full featured evaluation board for the [ADRF5702](#)
- ▶ Easy connection to test equipment
- ▶ Additional through line for calibration

EQUIPMENT NEEDED

- ▶ DC power supplies
- ▶ Network analyzer

GENERAL DESCRIPTION

The ADRF5702 is a 8-bit digital attenuator with 31.875dB attenuation range manufactured in the silicon on insulator (SOI) process.

This user guide describes the ADRF5702-EVALZ evaluation board, which is designed to simply evaluate the features and performance of the ADRF5702. A photograph of the evaluation board is shown in [Figure 1](#).

ADRF5702-EVALZ EVALUATION BOARD PHOTOGRAPH

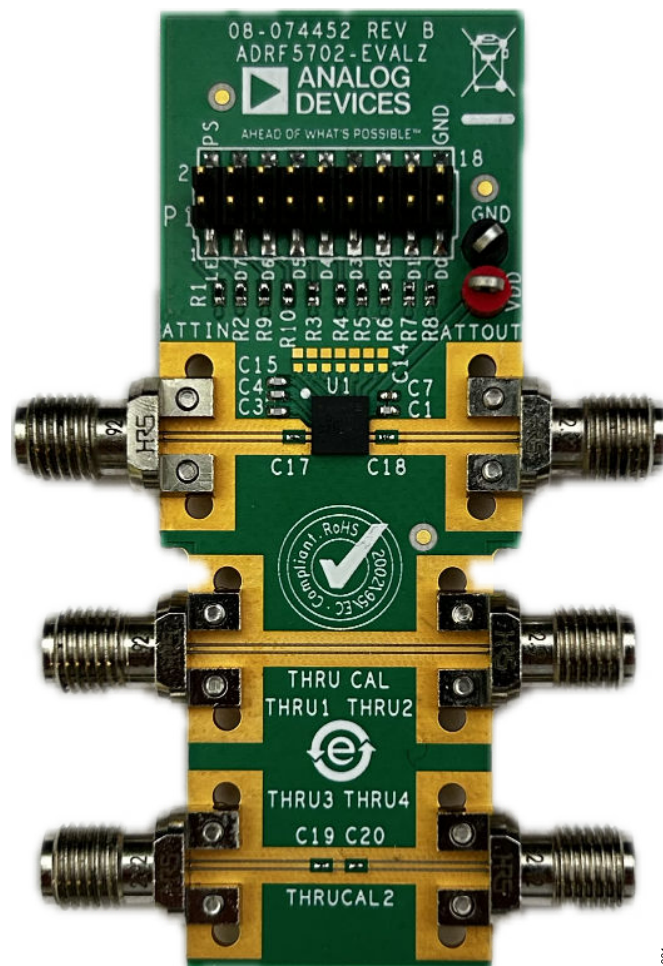


Figure 1. ADRF5702-EVALZ Evaluation Board Photograph

TABLE OF CONTENTS

Features.....	1	RF Inputs and Outputs	3
Equipment Needed.....	1	Test Procedure.....	4
General Description.....	1	Biasing Sequence.....	4
ADRF5702-EVALZ Evaluation Board Photograph	1	Expected Results.....	5
Evaluation Board Hardware.....	3	Evaluation Board Schematic and Artwork.....	6
Overview.....	3	Ordering Information.....	7
Board Layout.....	3	Evaluation Boards.....	7
Power Supply and Control Inputs.....	3	Bill of Materials.....	7

REVISION HISTORY

6/2025—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

OVERVIEW

The ADRF5702-EVALZ is a connectorized board, assembled with the ADRF5702 and its application circuitry. All components are placed on the primary side of ADRF5702-EVALZ. An assembly drawing for the ADRF5702-EVALZ is shown in Figure 8, and an evaluation board schematic is shown in Figure 7.

BOARD LAYOUT

The ADRF5702-EVALZ is designed using RF circuit design techniques on a 4-layer printed circuit board (PCB). The PCB stack-up is shown in Figure 2.

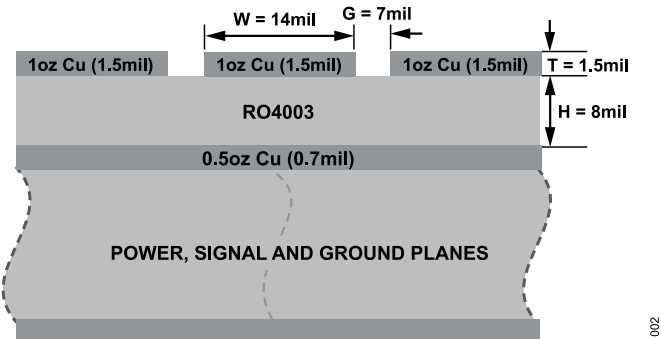


Figure 2. Evaluation Board Stack-Up

The outer copper layers are 1oz (1.5mil) thick and the inner layers are 0.5oz (0.7mil) thick.

The top dielectric material is 8mil Rogers 4003, which provides 50Ω controlled impedance and optimizes the high frequency performance. All RF traces are routed on the top layer, and the second layer is used as the ground plane for RF transmission lines. The remaining two layers are also ground planes filled with FR4 material to manage the thermal rise during high power operations and are supported with dense and filled vias to the PCB bottom for thermal relief. The overall board thickness is approximately 62mil for mechanical strength.

The RF transmission lines are designed using a coplanar waveguide (CPWG) model with a width of 14mil and ground spacing of 7mil to have a characteristic impedance of 50Ω. Ground via fences are arranged on both sides of the CPWG to improve isolation between nearby RF lines and other signal lines.

The exposed ground pad of the ADRF5702, 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 AND CONTROL INPUTS

The ADRF5702-EVALZ has one power-supply input, ten control inputs, and a ground, as shown in Table 1. The DC test points are populated on VDD, D0 to D7, LE, PS, and GND. A 5V or 3.3V supply is connected to the DC test points on VDD. Ground reference can be connected to GND. Connect D0 to D7, LE, and PS to 3.3V or 0V. The typical total current consumption for the ADRF5702 is 3.50mA for 5V VDD or 1.75mA for 3.3V VDD.

The VDD supply pin of the ADRF5702 is decoupled with 100pF capacitor.

Table 1. Power Supply and Control Inputs

Test Point	Description
VDD	5V or 3.3V supply voltage
D0 to D7	Control Input 0 to Control Input 7
PS	Parallel serial control
LE	Latch enable
GND	Ground

RF INPUTS AND OUTPUTS

The ADRF5702-EVALZ has four edge-mounted, 2.92mm connectors for the RF inputs and outputs, as shown in Table 2.

Table 2. RF Inputs and Outputs

SMA Connector	Description
ATTIN	Attenuator input
ATTOUT	Attenuator output
THRU1	Thru line input and output
THRU2	Thru line input and output

The ADRF5702-EVALZ is shipped together with a thru line that calibrates out the board loss effects from the measurements determining the device performance at the pins of the IC.

TEST PROCEDURE

BIASING SEQUENCE

To bias up the ADRF5702-EVALZ, perform the following steps:

1. Ground the GND test point.
2. Bias up the VDD test point.
3. Bias up the D0 to D7, PS, and LE test points.
4. Apply an RF input signal.

The ADRF5702-EVALZ is shipped fully assembled and tested. [Figure 3](#) provides a basic test setup diagram to evaluate the s-parameters using a network analyzer. Perform the following steps to complete the test setup and to verify the operation of the ADRF5702-EVALZ:

1. Connect the GND test point to the ground terminal of the power supply.
2. Connect the VDD test point to the voltage output terminal of the 5V or 3.3V supply. Note that the current from VDD test point is around 3.50mA for 5V VDD or 1.75mA for 3.3V VDD.
3. Connect the D0 to D7, EN, and LS test points to the voltage output terminal of the 3.3V supply. The ADRF5702 can be configured in different modes by connecting the control test points to 3.3V or 0V.
4. Connect a calibrated network analyzer to the ATTIN and ATT-OUT 2.92 mm connectors. If the network analyzer port count is not enough, terminate unused RF ports with 50Ω. Sweep the frequency from 100MHz to 20GHz and set the power to 10dBm.
5. The ADRF5702-EVALZ is expected to have an insertion loss of 2.6dB at 20GHz. See the expected results in [Figure 4](#).

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

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

For power compression and power handling evaluations, use a 2-channel power meter and a signal generator. A high enough power amplifier is also recommended at the input. Test accessories, such as couplers and attenuators, must have enough power handling.

Note that the measurements performed at the 2.92mm connectors of the ADRF5702-EVALZ include the losses of the 2.92mm connectors and the PCB. The thru line must be measured to calibrate out the effects on the ADRF5702-EVALZ. 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.

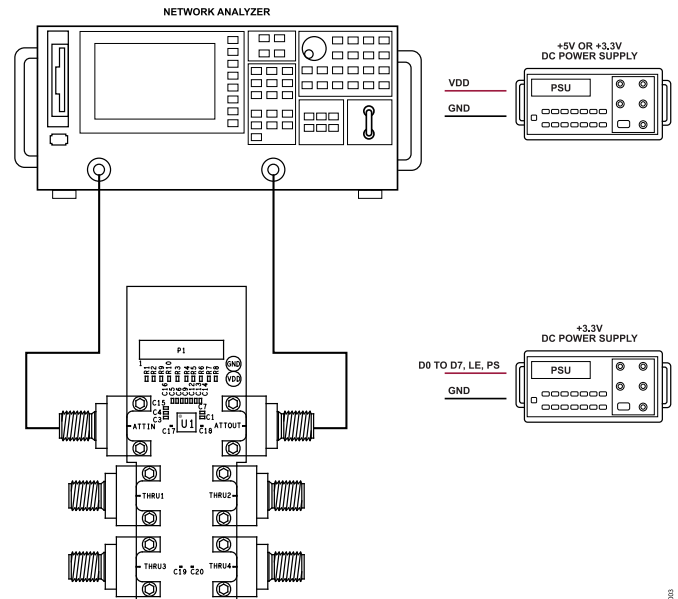


Figure 3. Test Setup Diagram

Table 3. Truth Table

Digital Control Input ¹								Attenuation State (dB)
D7	D6	D5	D4	D3	D2	D1	D0	
Low	Low	Low	Low	Low	Low	Low	Low	0 (reference)
Low	Low	Low	Low	Low	Low	Low	High	0.125
Low	Low	Low	Low	Low	Low	High	Low	0.25
Low	Low	Low	Low	Low	High	Low	Low	0.5
Low	Low	Low	Low	High	Low	Low	Low	1.0
Low	Low	Low	High	Low	Low	Low	Low	2.0
Low	Low	High	Low	Low	Low	Low	Low	4.0
Low	High	Low	Low	Low	Low	Low	Low	8.0
High	Low	Low	Low	Low	Low	Low	Low	16.0
High	High	High	High	High	High	High	High	31.875

¹ Any combination of the states within this table provides an attenuation equal to the sum of the bits selected.

TEST PROCEDURE

EXPECTED RESULTS

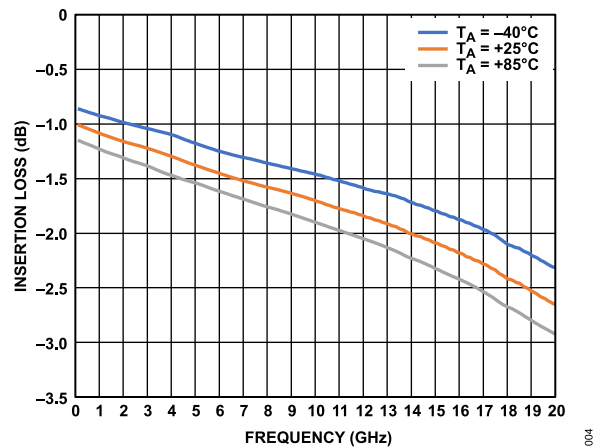


Figure 4. Insertion Loss for RFC to RFx On vs. Frequency

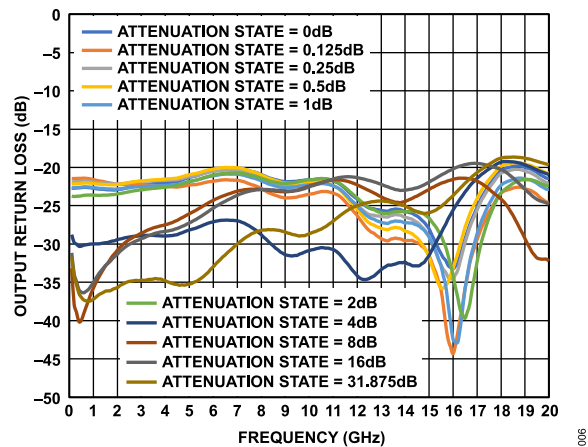


Figure 6. Output Return Loss vs. Frequency

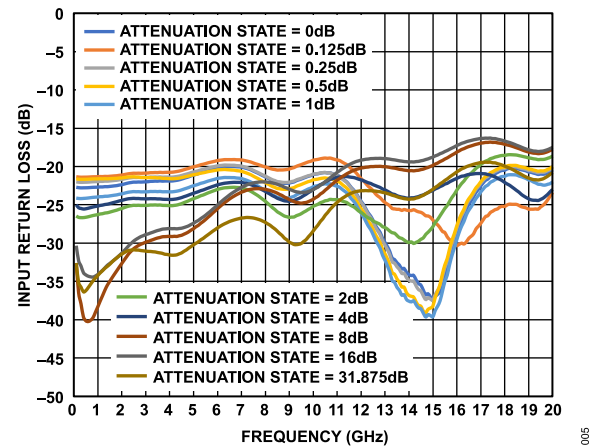


Figure 5. Input Return Loss vs. Frequency

[illegible]

analog.com

ORDERING INFORMATION

EVALUATION BOARDS

Table 4. Evaluation Boards

Model ¹	Description
ADRF5702-EVALZ	Evaluation Board

¹ Z = RoHS-Compliant Part.

BILL OF MATERIALS

Table 5. Bill of Materials for ADRF5702-EVALZ

Quantity	Reference Designator	Description	Manufacturer	Part Number
1	C1	Capacitors, 100pF, 50V, C0402 package	Murata	GCM1555C1H101JA16D
2	C17, C18	Capacitors, 100nF, 6.3V, C01005	Passive Plus Inc.	01005BB104-MW6R3
10	R1 to R10	Resistors, 0Ω, 1/16W, R0402 package	Yageo	RC0402JR-070RL
2	ATTIN and ATTOUT	Edge-mount 2.92mm connectors	Hirose Electronic Co.	HK-LR-SR2(12)
1	P1	18 position male header	Molex	87759-1850
5	VDD, GND	Surface-mount test points	Components Corporation	TP-104-01-0X
1	U1	Silicon digital attenuator, 0.125dB LSB, 8-bit, 100MHz to 20GHz	Analog Devices, Inc.	ADRF5702
1	PCB	ADRF5702 evaluation board	Analog Devices	ADRF5702-EVALZ

**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 Analog Way, Wilmington, MA 01887-2356, U.S.A. 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. All Analog Devices products contained herein are subject to release and availability.

