Evaluation of the ADRF5347 High Linearity, Silicon SP4T Switch, 1.8 GHz to 3.8 GHz

FEATURES

- Full featured evaluation board for the ADRF5347
- Easy connection to test equipment
- Thru line for calibration

EQUIPMENT NEEDED

- DC power supplies
- Network analyzer

GENERAL DESCRIPTION

The ADRF5347 is a high linearity, single-pole, four-throw (SP4T) switch manufactured in the silicon process.

This user guide describes the ADRF5347-EVALZ evaluation board, designed to evaluate the features and performance of the ADRF5347. Figure 1 shows a photograph of the evaluation board.

The ADRF5347 data sheet provides full specifications for the ADRF5347. Consult the ADRF5347 data sheet in conjunction with this user guide when using the ADRF5347-EVALZ.

ADRF5347-EVALZ EVALUATION BOARD PHOTOGRAPH

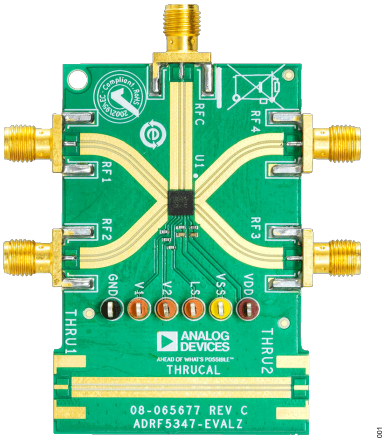

Figure 1. Evaluation Board Photograph

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REVISION HISTORY

6/2023—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

OVERVIEW

The ADRF5347-EVALZ is a connectorized board, assembled with the ADRF5347 and its application circuitry. All components are placed on the primary side of ADRF5347-EVALZ. Figure 10 shows an assembly drawing for the ADRF5347-EVALZ and Figure 9 shows an evaluation board schematic.

BOARD LAYOUT

The ADRF5347-EVALZ is designed using RF circuit design techniques on an 8-layer printed circuit board (PCB). Figure 2 shows the PCB stack-up.

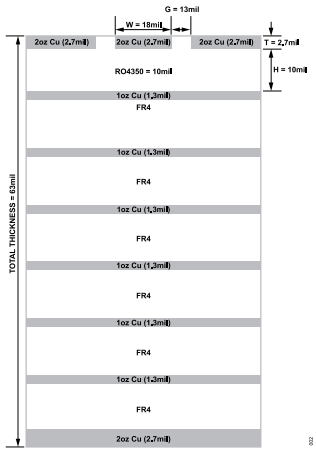

Figure 2. Evaluation Board Stack-Up

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 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 six 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 63 mil for mechanical strength.

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 ADRF5347, 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 ADRF5347-EVALZ requires two power supply inputs, three control inputs, and a ground, as shown in Table 1. The DC test points are populated on V_{DD}, V_{SS}, V1, V2, LS, and GND. 5 V supply is connected to the DC test point V_{DD} and −3.4 V supply is connected to the DC test point on V_{SS}. Ground reference can be connected to GND. Connect the control inputs, V1, V2, and LS to 3.3 V or 0 V. The typical total current consumption for the ADRF5347 is 2.4 mA from V_{DD} and 0.4mA from V_{SS}, with typical power dissipation of 13.36 mW.

The V_{DD} supply pin of the ADRF5347 is decoupled with 100 pF and 4.7 µF capacitors, and the control pins of the ADRF5347 are decoupled with a 100 pF capacitor.

Table 1. Power Supply and Control Inputs

Test Points	Description
VDD	Positive supply voltage
VSS	Negative supply voltage
V1	Control input 1
V2	Control input 2
LS	Logic select
GND	Ground

EVALUATION BOARD HARDWARE

RF INPUTS AND OUTPUTS

The ADRF5347-EVALZ has seven edge-mounted, subminiature A (SMA) connectors for the RF inputs and outputs, as shown in Table 2.

Table 2. RF Inputs and Outputs

SMA Connectors	Description
RFC	RF common port
RF1	RF throw port 1
RF2	RF throw port 2
RF3	RF throw port 3
RF4	RF throw port 4
THRU1	Thru line input and output
THRU2	Thru line input and output

The through calibration line, connecting the THRU1 and THRU2 RF connectors, calibrates out the board loss effects from the measurements of the ADRF5347-EVALZ to determine the device performance at the pins of the IC. Figure 3 shows the typical board loss for the ADRF5347-EVALZ at room temperature, as well as the embedded and de-embedded insertion loss for the ADRF5347.

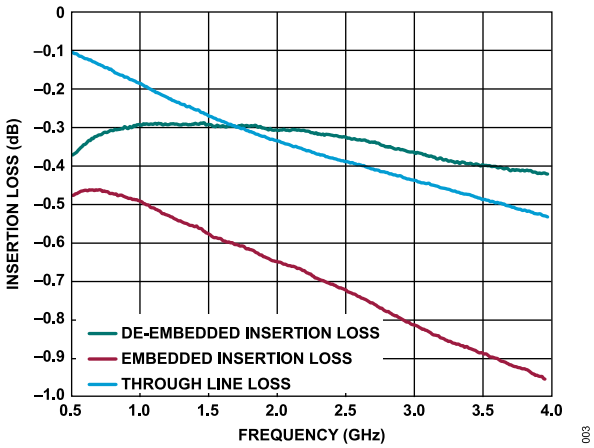

Figure 3. Insertion Loss vs. Frequency

TEST PROCEDURE

BIASING SEQUENCE

To bias up the ADRF5347-EVALZ, perform the following steps:

1. Ground the GND test point.
2. Bias up the V_{DD} test point.
3. Bias up the V_{SS} test point.
4. Bias up the V1, V2, and LS test points.
5. Apply an RF input signal.

The ADRF5347-EVALZ is shipped fully assembled and tested. Figure 4 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 verify the operation of the ADRF5347-EVALZ:

1. Connect the GND test point to the ground terminal of the power supply.
2. Connect the V_{DD} test point to the voltage output terminal of the 5 V supply and the V_{SS} test point to the voltage output terminal of the −3.4 V supply. Note that the current must be 2.4 mA and 0.4 mA, respectively.
3. Connect the V1, V2, and LS test points to the voltage output terminal of the 3.3 V supply. The ADRF5347 can be configured in different modes by connecting the control test points to 3.3 V or 0 V, as shown in Table 3.
4. Connect a calibrated network analyzer to the RFC, RF1, RF2, RF3, and RF4 SMA connectors. If network analyzer port count is not enough, terminate unused RF ports with 50 Ω. Sweep the frequency from 10 MHz to 4 GHz and set the power to –5 dBm.
5. The ADRF5347-EVALZ is expected to have an insertion loss of 0.42 dB at 3.8 GHz. See the expected results in Figure 5.

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.

The ADRF5347-EVALZ comes with a support plate attached to the bottom side. To ensure maximum heat dissipation and to reduce thermal rise on the 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 ADRF5347-EVALZ include the losses of the SMA connectors and the PCB. The thru line must be measured to calibrate out the effects on the ADRF5347-EVALZ. The thru line is the summation of an RF input line and an RF output line connected to the device and equal in length.

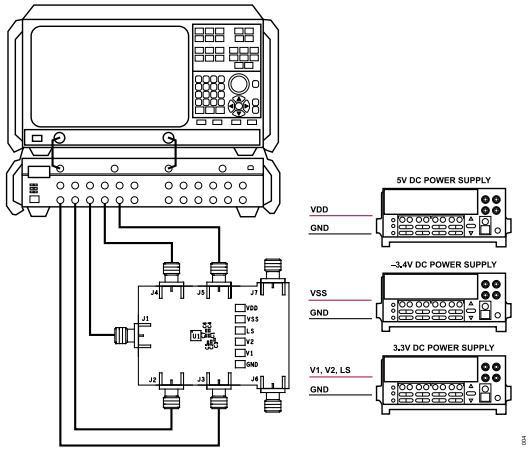

Figure 4. Test Setup Diagram

Table 3. Control Voltage Truth Table

Digital Control Inputs			RFx Paths			
LS	**V1**	**V2**	**RF1 to RFC**	**RF2 to RFC**	**RF3 to RFC**	**RF4 to RFC**
Low	Low	Low	Insertion loss (on)	Isolation (off)	Isolation (off)	Isolation (off)
Low	High	Low	Isolation (off)	Insertion loss (on)	Isolation (off)	Isolation (off)
Low	Low	High	Isolation (off)	Isolation (off)	Insertion loss (on)	Isolation (off)
Low	High	High	Isolation (off)	Isolation (off)	Isolation (off)	Insertion loss (on)
High	Low	Low	Isolation (off)	Isolation (off)	Isolation (off)	Insertion loss (on)
High	High	Low	Isolation (off)	Isolation (off)	Insertion loss (on)	Isolation (off)
High	Low	High	Isolation (off)	Insertion loss (on)	Isolation (off)	Isolation (off)
High	High	High	Insertion loss (on)	Isolation (off)	Isolation (off)	Isolation (off)

TEST PROCEDURE

EXPECTED RESULTS

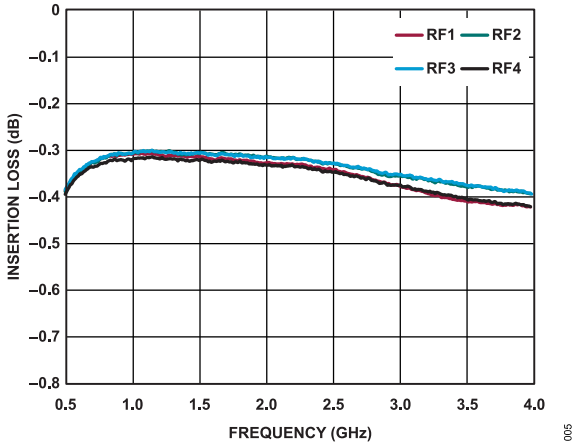

Figure 5. Insertion Loss for RFC to RFx Selected vs. Frequency

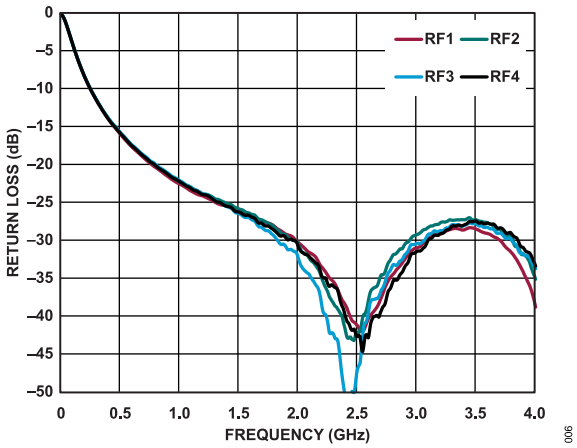

Figure 6. Return Loss for RFC when RFx Selected vs. Frequency

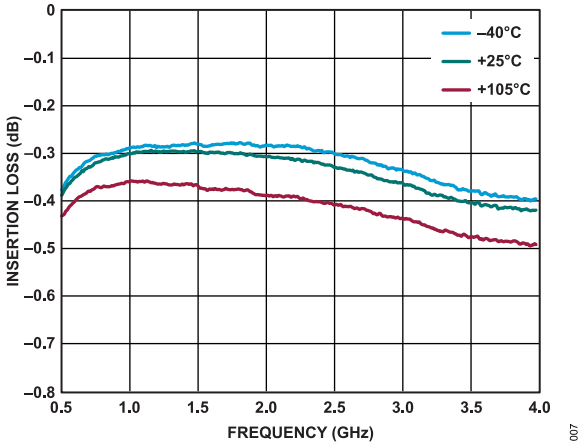

Figure 7. Insertion Loss for RFC to RF1 Selected vs. Frequency over Various Temperatures

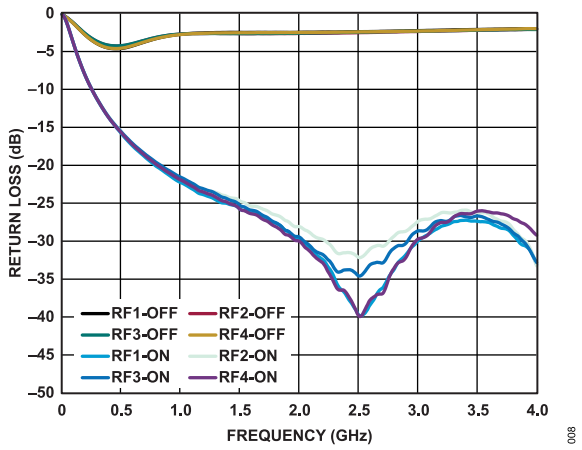

Figure 8. Return Loss for RFC when RFx Selected vs. Frequency

EVALUATION BOARD SCHEMATIC AND ARTWORK

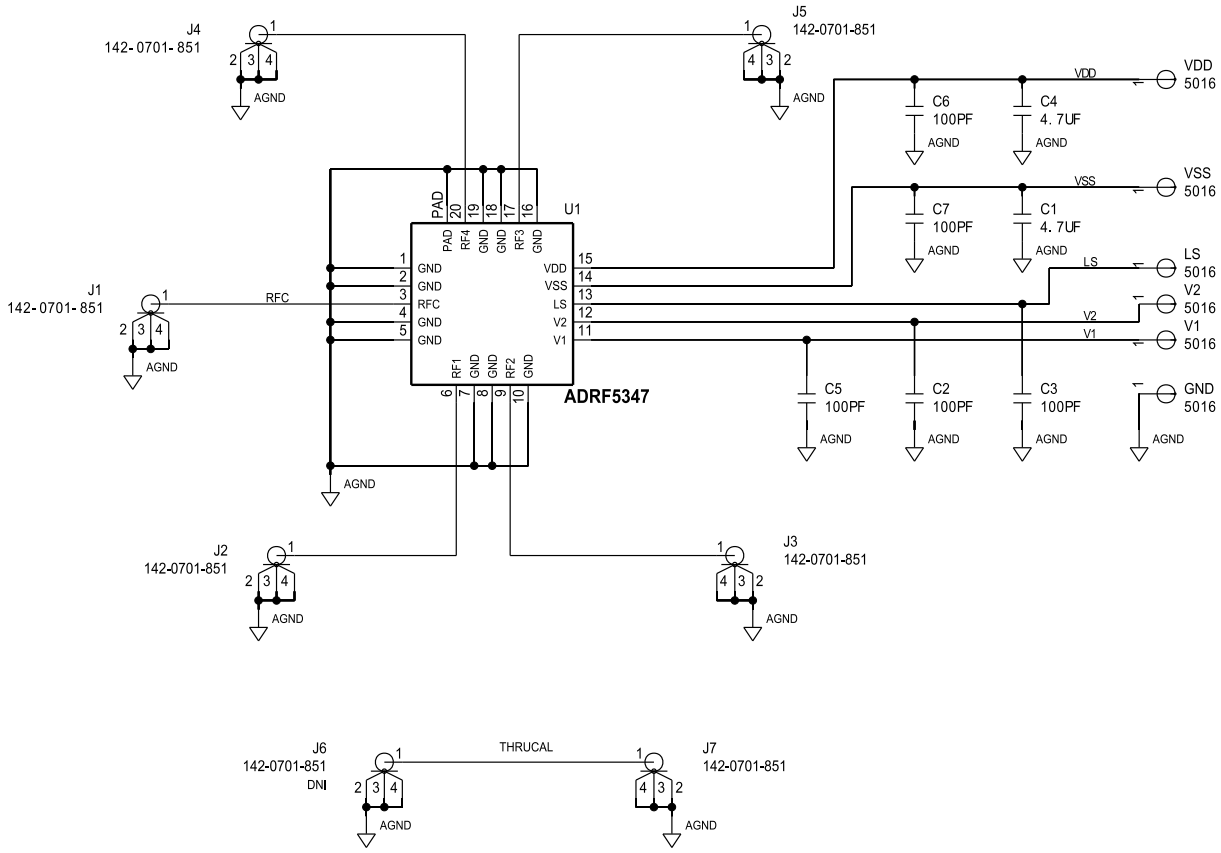

Figure 9. ADRF5347-EVALZ Evaluation Board Schematic

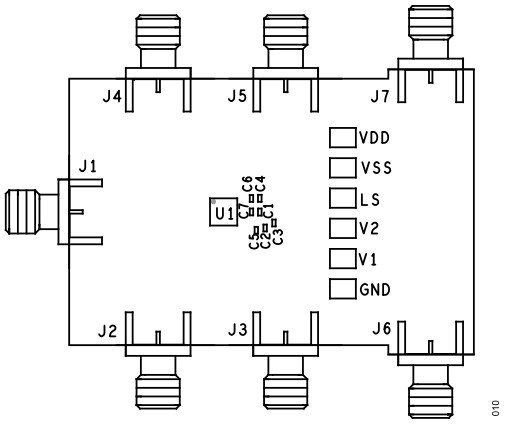

Figure 10. ADRF5347-EVALZ Evaluation Board Assembly Diagram