AHEAD OF WHAT'S POSSIBLE™

SINGLE EVENT EFFECTS TEST REPORT ADRF5050-CSL

September 2025

Radiation Test Report	
Product:	ADRF5050-CSL
Effective LET:	≤ 58.0 MeV-cm^2/mg
Fluence:	1E7 Ions/cm^2
Facilities:	LBNL, TAMU
Tested:	April 2024, May 2025

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SEE Test Report for the ADRF5050-CSL – Non-Reflective SP4T Switch

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Test Dates:
LBNL: April 9th-11th, 2024
TAMU: May 22nd-27th, 2025

I. Introduction

The purpose of this test is to determine the Single-Event Effects (SEE) susceptibility of the ADRF5050-CSL, a nonreflective SP4T switch rated for 100MHz to 20GHz operation. Single Event Latch-up (SEL) and Single Event Transient (SET) were verified on April 9th – 11th 2024 at the LBNL heavy ion facility, and May 22nd – 27th at the TAMU heavy ion facility.

II. Device Under Test (DUT)

The ADRF5050-CSL is a non-reflective SP4T switch operating in the range of 100MHz to 20GHz. The EVAL-ADRF5050 was used to characterize the device.

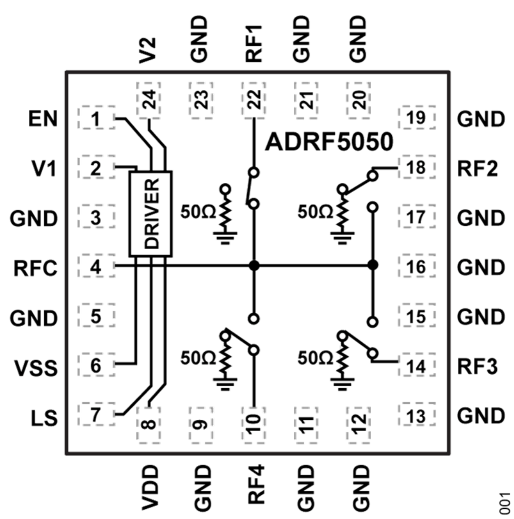


Figure 1. Functional block diagram.

Table 1
Part and test information.

Generic Part Number:	ADRF5050-CSL
Date of Test:	April 9th – 11th, 2024; May 22nd – May 27th, 2025
Manufacturer:	Analog Devices, Inc.
Die Rev:	ADRF5050_CS
Part Function:	Nonreflective SP4T Switch
Part Technology:	CMOS
Package Style:	24-terminal, 3 mm x 3 mm LGA
Interconnect:	Flip Chip
Die Thickness:	Thinned to 50µm

III. Test Facilities

The heavy-ion beam testing was carried out at the Lawrence Berkeley National Laboratory 88” Cyclotron Facility (LBNL) and Texas A&M K500 (TAMU). The test setup was in an open-air environment.

Facility: LBNL and TAMU
Cocktail: 16 MeV/nuc; 24.8 MeV/nuc
Fluence: 1×10^7 cm^{-2} (per run)
Ions: Shown in Table 2

Table 2.
Heavy-ion species, effective linear energy transfer (LET), and location tested.

Ion	Effective LET (MeV·cm^2/mg)	Location
Xe	81.6	LBNL
Ag	58.0	TAMU

IV. Test Method

A. Test Setup

The DUTs were de-processed to thin the die to a total thickness of 50µm. The ADRF5050-CSL was configured as shown in Figure 2. The LTC5596 was attached to the output of the ADRF5050-CSL to convert to a readable DC voltage on the PXIe-5172 oscilloscope. With the setup, the LTC5596 output voltage should be between 0.8V to 1.1V as shown in Figure 3, accounting for the 2.5dB cable loss. The supply current was monitored through the PXIe-4163 SMU. The DUT input currents, input voltages and RF output were recorded through a LabVIEW program. For SEL testing the supply voltages were set to nominal plus ten percent as shown in Table 3 and the DUT was heated to high temperature (~125°C). For SET testing the supply voltages were set to nominal values as shown in Table 3 at room temperature.

Table 3
Test Instrumentation

Name	Configured Values	Equipment
V_{DD}	3.6V (SEL); 3.3V (SET)	PXIe-4163
V_{SS}	-3.6V (SEL); -3.3V (SET)	PXIe-4163
V_{CTRL}	0 V	PXIe-4163
V_{EN}	0 V	PXIe-4163
RFIN	1GHz, 2GHz; -5dBm, -10dBm	HMC-T2240
RFOUT	Measured	LTC5596 + PXIe-5172

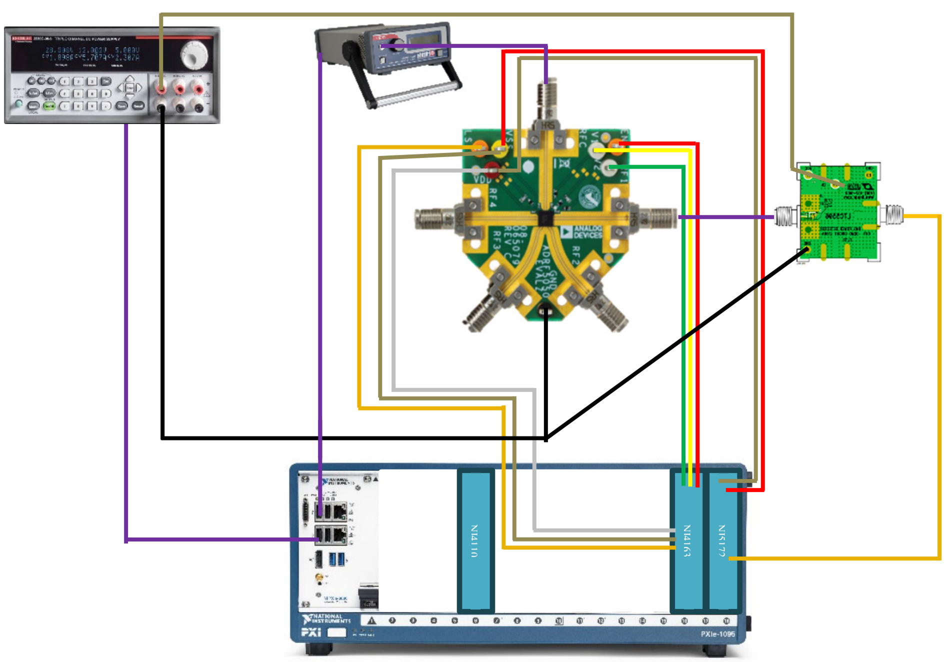


Figure 2. ADRF5050-CSL test setup.

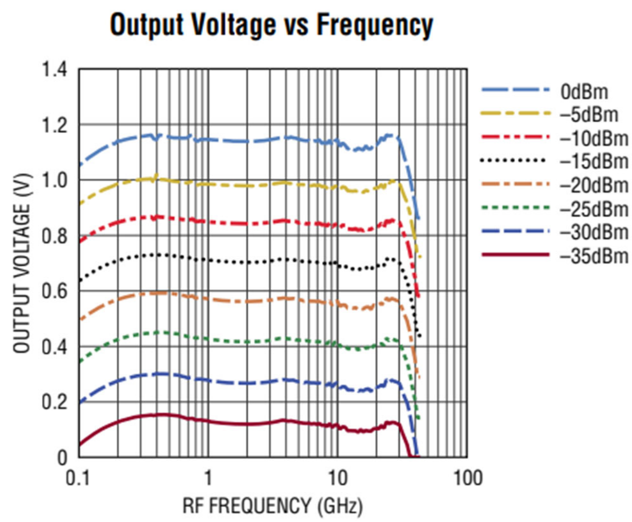


Figure 3. LTC5596 Frequency-Voltage Curve.

B. *Irradiation procedure*

SEL:

1. The device was power on and brought up to ~125°C.
2. The software to monitor the I/O voltages and currents was turned on.
3. The ion beam was turned on.
4. Once the 1e+07 fluence was reached, the beam was turned off and the software to monitor the I/O voltages and currents was terminated.

SET:

1. The device was powered on at room temperature.
2. The software to monitor the I/O voltages was turned on.
3. The ion beam was turned on.
4. Once the 1e+07 fluence was reached, the beam was turned off and the software to monitor the I/O voltages and currents was terminated.

V. Results

SEL – No destructive events were observed on the ADRF5050-CSL to the highest effective LET tested at 81.6 MeV·cm^2/mg at LBNL and 58.0 MeV·cm^2/mg at TAMU. The SEL plots are shown in the Appendix.

Table 4
SEL Test Runs

Run	Board Serial Number	Ion	Supply Voltage (V_{DD},V_{SS})	Effective LET	Angle	Flux	Fluence	SEL
#			*V*	*MeV·cm^2/mg*	*Degrees*	*Ions/s*	*Total Ions*	
43	3	Xe	3.6, -3.6	81.6	45	5.618E+04	1.000E+07	0
188	8	Ag	3.6, -3.6	58.0	0	9.234E+04	9.988E+06	0
189	15	Ag	3.6, -3.6	58.0	0	9.338E+04	1.005E+07	0

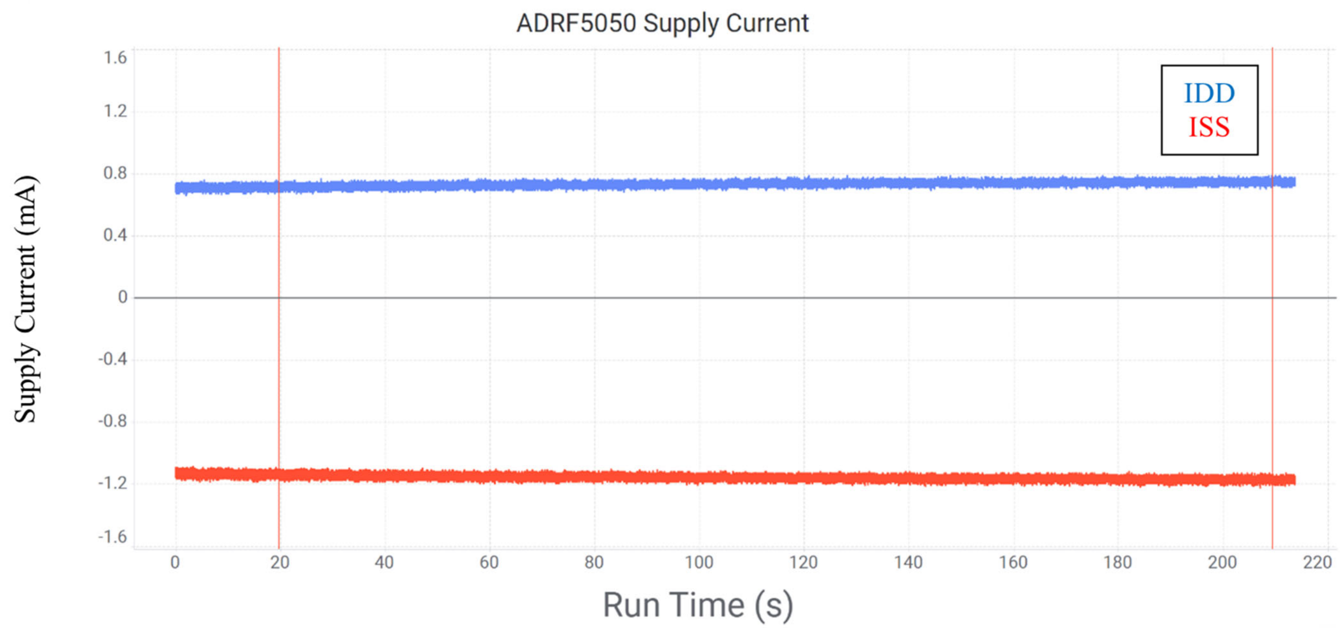
SET – No transients were observed in the ADRF5050-CSL to the highest effective LET tested at 81.6 MeV·cm^2/mg. Two devices were tested. The SET plots are shown in the Appendix.

Table 5
SET Test Runs

Run	Board Serial Number	Ion	Supply Voltage (V_{DD},V_{SS})	Effective LET	Angle	Flux	Fluence	SET
#			*V*	*MeV·cm^2/mg*	*Degrees*	*Ions/s*	*Total Ions*	
39	1	Xe	3.3, -3.3	81.6	45	5.814E+04	1.000E+7	0
41	3	Xe	3.3, -3.3	81.6	45	2.336E+04	1.000E+7	0

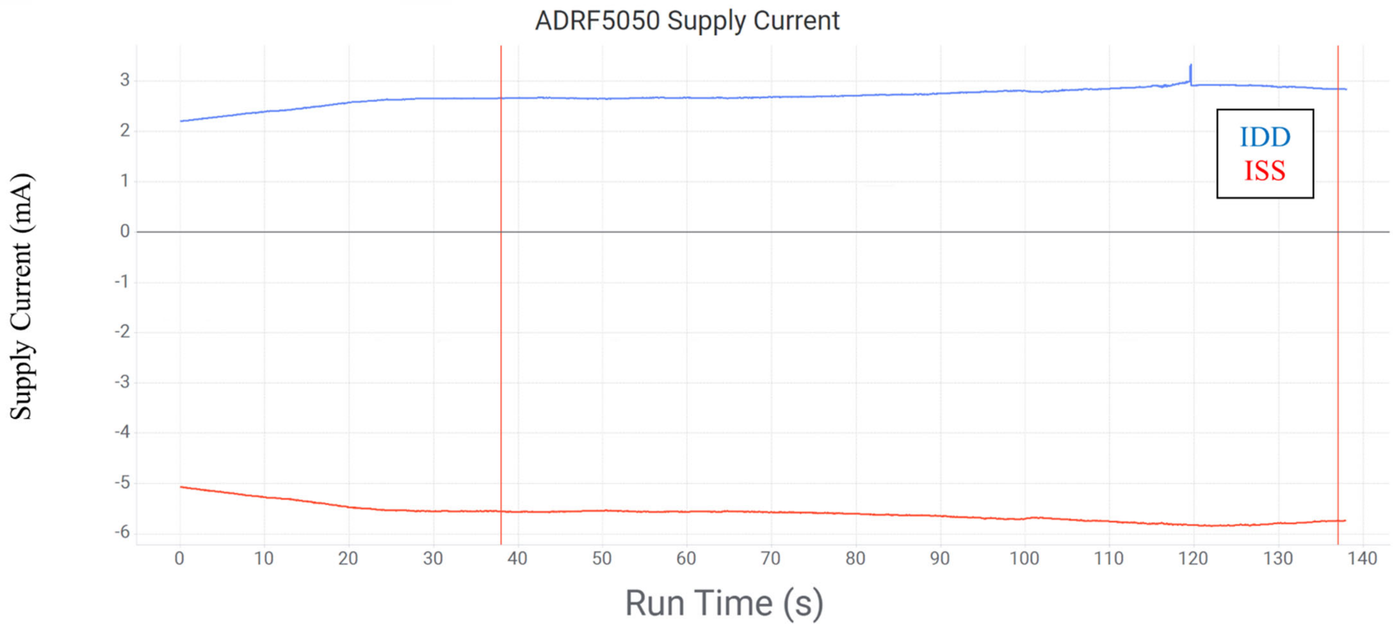
Appendix:

Latch-up



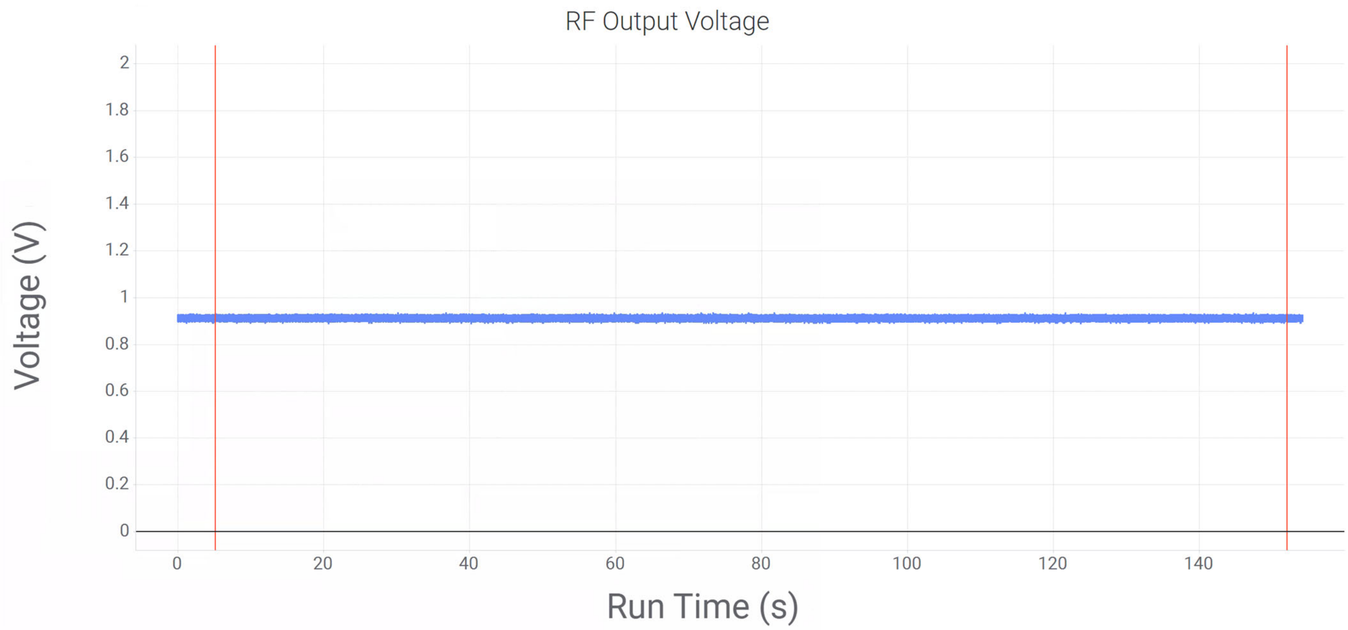
Run 43, Board 2, LET: 81.6 MeV·cm²/mg, RFin: -5.0dBm @ 1GHz

Run 188, Board 6, LET: 58.0 MeV·cm²/mg, RFin: -10dBm @ 2GHz

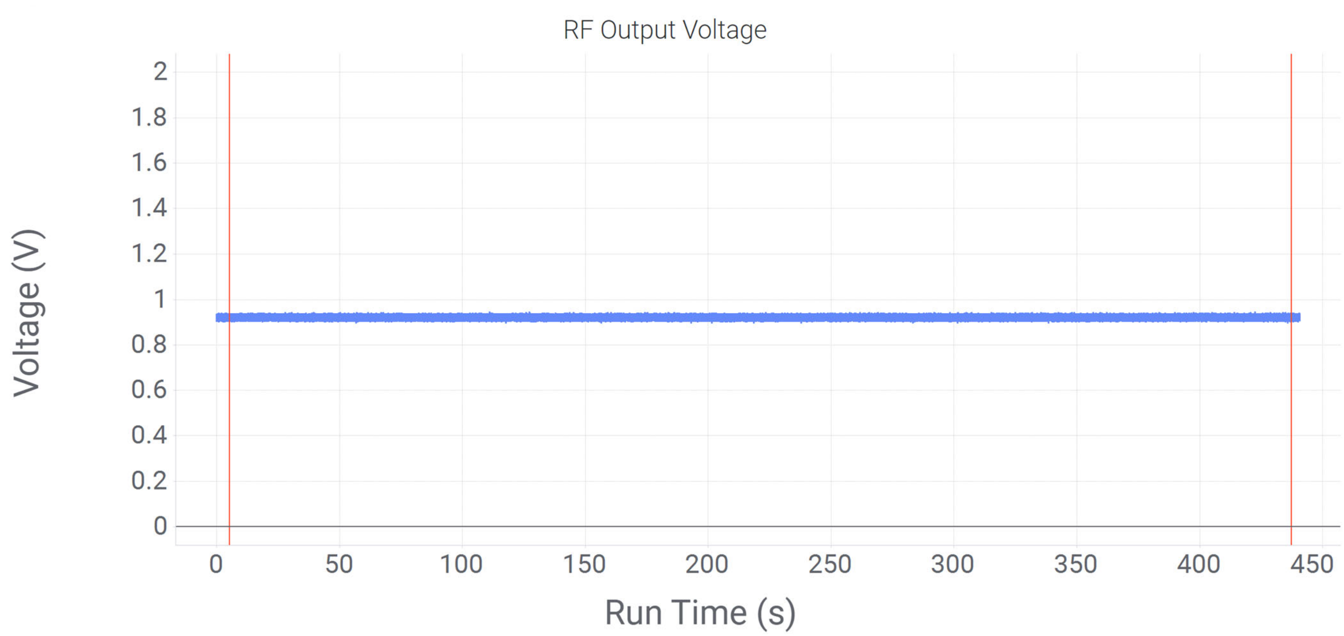


Run 189, Board 10, LET: 58.0 MeV·cm^2/mg, RFin: -10.0dBm @ 2GHz

Transient



Run 39 RF Output 1, Board 1, LET: 86.1 MeV·cm²/mg, RFin: -5.0dBm @ 1GHz



Run 41 RF Output 1, Board 3, LET: 86.1 MeV·cm²/mg, RFin: -5.0dBm @ 1GHz