National Aeronautics and Space Administration

MIC4427 MOSFET Driver
Total Ionizing Dose Test Report

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1. INTRODUCTION

The purpose of this test was to characterize Microchip's MIC4427 parameter degradation for total dose response. In the test, the device was exposed to low dose rate (LDR*)* irradiations using gamma radiation. Device parameters such as supply currents, output voltages, and switching times were investigated.

2. DEVICES TESTED

2.1. Part Background

The MIC4427 is a dual MOSFET driver fabricated on a BiCMOS/DMOS process. It can withstand 500 mA of reverse current. The MIC4427 was designed for driving power MOSFETs that need low-impendance, high peak current, and fast switching time.

2.2. Device Under Test (DUT) Information

Ten (10) parts were tested for TID, eight were irradiated while two were used as control parts. All specifications and descriptions are according to the datasheet (DS20006202A rev. A). More information can be found in Table 1.

Table 1. Part Identification Information

Part Number	MIC4427
Flight Part Number	5962-8850308PA
Manufacturer	Microchip
Lot Date Code	4A1436
Quantity Tested	8
Part Function	MOSFET Driver
Part Technology	BiCMOS/DMOS
Package	PDIP-8

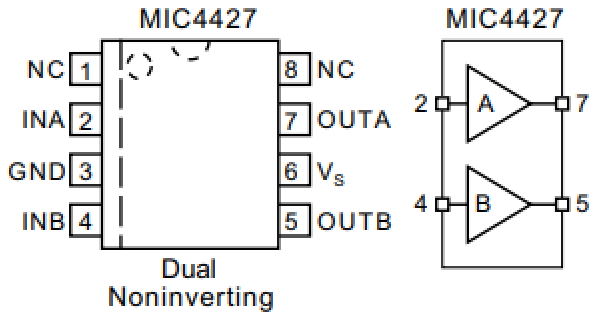

Fig. 1. Picture of pinout of device

3. TEST SETUP

General test procedures were in accordance with MIL-STD-883, Method 1019, Condition D. Parts were serialized randomly. ESD procedures were followed during test and transfer of the devices between irradiation chamber and characterization. Exposures were performed at ambient laboratory temperature.

Fig. 2. Picture of DUT on test board

4. TEST DESCRIPTION

4.1 Irradiation Conditions

Radiation testing was done by exposing the parts to gamma radiation at a low dose rate. Ten parts were tested, 8 exposed to radiation and two as controls. Prior to the first radiation dose, all ten parts were electrically tested and programmed. After each exposure level, the parts were tested again and returned to radiation within the time limits defined by MIL-STD-883, Method 1019. Four parts were biased and four were unbiased during the irradiation steps. See Table 2 for more information.

Due to a planned power shutdown in the REF, the parts were taken out of the radiation chamber and measured at 12 krad(Si). They were then placed in a freezer for 91 hours to avoid annealing and measured again before resuming the next irradiation step.

Table 2. Device Grouping

Group	Qty	Bias	Dose Rate	Exposure Level Steps (krad(Si))
1	4	Unbiased	9.65 mrad(Si)/s	0, 0.954, 4.89, 9.93, 12, 14.1, 19.9, 30.6
2	4	Biased	9.65 mrad(Si)/s	0, 0.954, 4.89, 9.93, 12, 14.1, 19.9, 30.6
3	2	Control	-	-

The biased parts were placed in DIP-8 socket adapters on a wire wrapped board. During irradiation, DUTs were powered as follows: Vs = 18V, Vin = 5V. Figure 3 is a picture of the bias board.

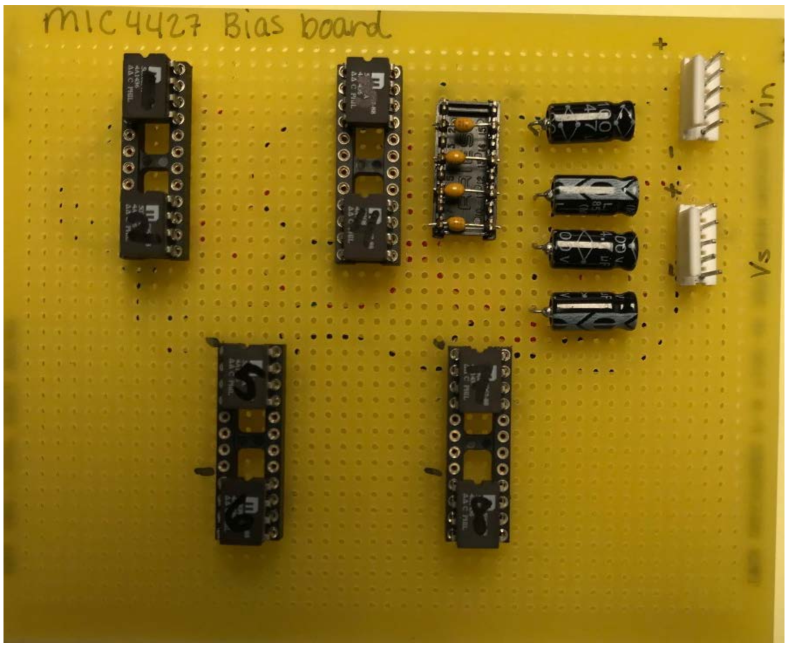

Fig. 3. Picture of bias board.

4.2 Electrical Tests

Specification thresholds were set in accordance with the MIC4427 datasheet.

All data from the electrical tests in Table 4 were logged in excel spreadsheet files.

Table 4. List of Electrical Tests Performed

Parameter	Sym-bol	Conditions -55 °C ≤ TA ≤ +125°C 4.5 V ≤ V_s ≤ 18 V	Specifications			
			Min	Typical	Max	Unit
Input Current	I_{IN}	0 V ≤ V_{IN} ≤ V_S			± 10	uA
		-5 V ≤ V_{IN} ≤ 0			± 10	mA
High output voltage	V_{OH}	$R_L = \infty$	Vs – 25mV			V
Low output voltage	V_{OL}	$R_L = \infty$			25	mV
Power supply current	I_{S1}	V_{IN} = 3V (both inputs)			12	mA
	I_{S2}	V_{IN} = 0V (both inputs)			0.6	mA
Rise Time	t_R	Vs = 18V, Fig. 4			30	ns
Fall Time	t_F	Vs = 18V, Fig. 4			40	ns
Delay time	t_{D1}	Vs = 18V, Fig. 4			30	ns
	t_{D2}	Vs = 18V, Fig. 4			50	ns

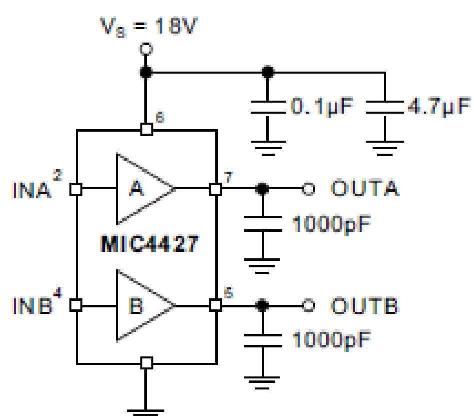

Fig. 4. Non-Inverting Driver Switching Time.

5. Failure Criteria

The parameter limits are defined as those listed in the MIC4427 datasheet. DC parameters thresholds were not exceeded during any of the irradiation steps. If functional failure was observed for any of the AC Test steps, those results were noted and compared relative to the dosing step and the individual device's previous dose step measurements.

6. Source Requirements

The total dose source is in a room air source gamma ray facility, which is compliant with MIL-STD-883, Method 1019. Dosimetry is NIST traceable.

7. Results

Overall there was little to no degradation of any parameter during the entire irradiation to 30 krad(Si). One DUT at 20 krad(Si) showed a functional fault. It would not switch low during the low voltage sweep. This skewed the average for the unbiased parts. The other parameters to note change on are rise time (B side) and delay time. Rise time (B side), biased only mean, went out of specification on the last measurement at 30.6 krad(Si). The delay times (both A and B sides) had significant increases over irradiation with the biased DUTs. This parameter also seemed to be the only one affected by the annealing preventative period.

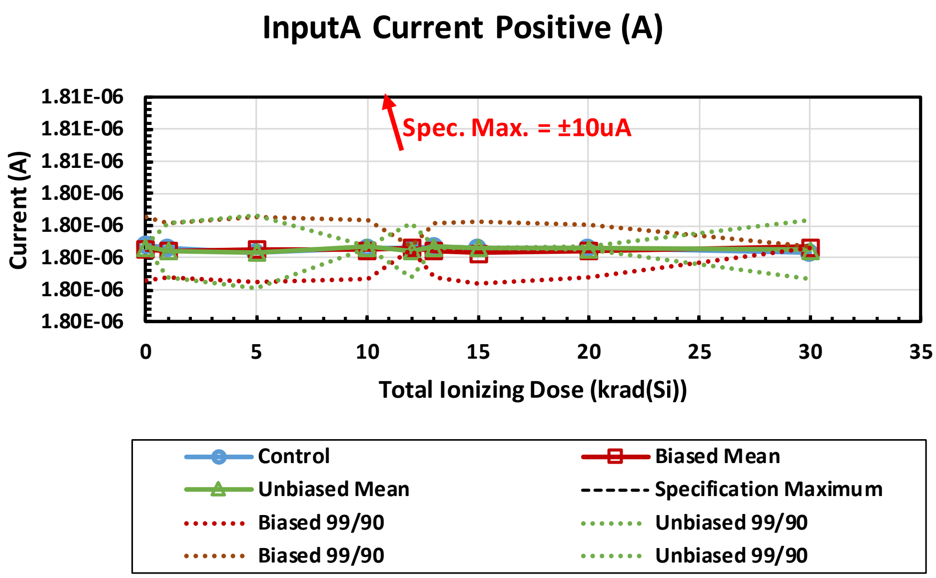

Fig. 5. Positive Input Current (A side) over irradiation (krad(Si)).

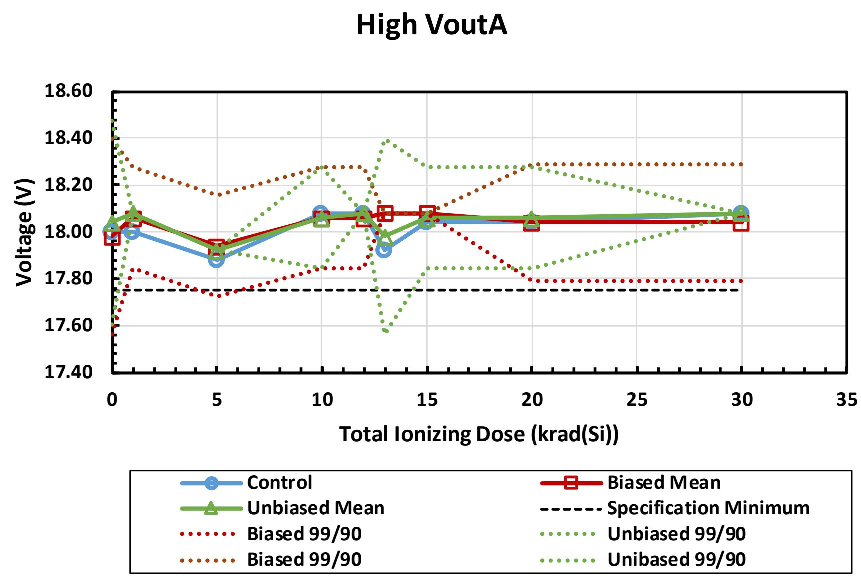

Fig. 6. High Output Voltage (A side) over irradiation (krad(Si)).

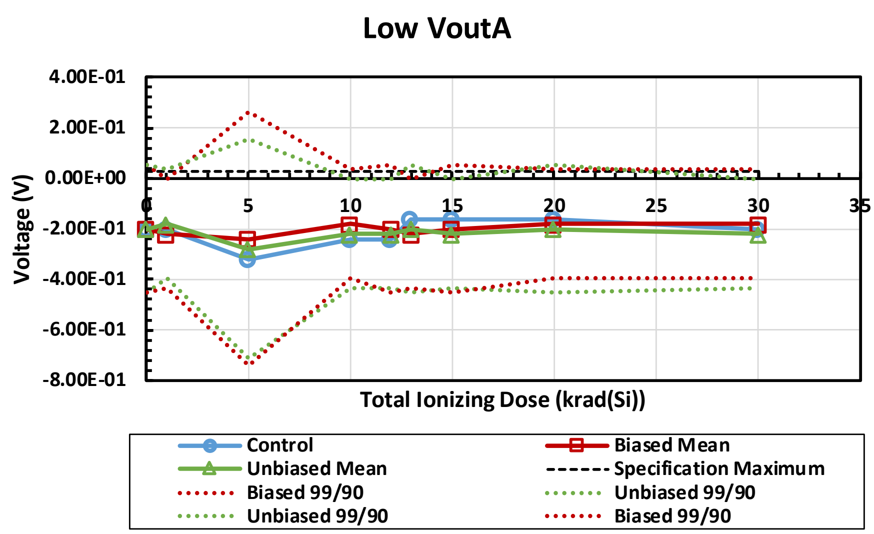

Fig. 7. Low Output Voltage (A side) over irradiation (krad(Si)).

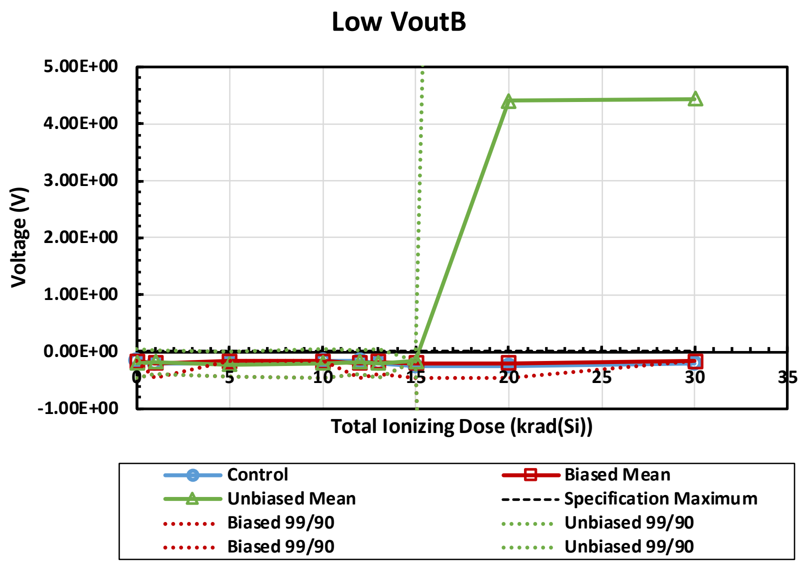

Fig. 8. Low Output Voltage (B side) over irradiation (krad(Si)).

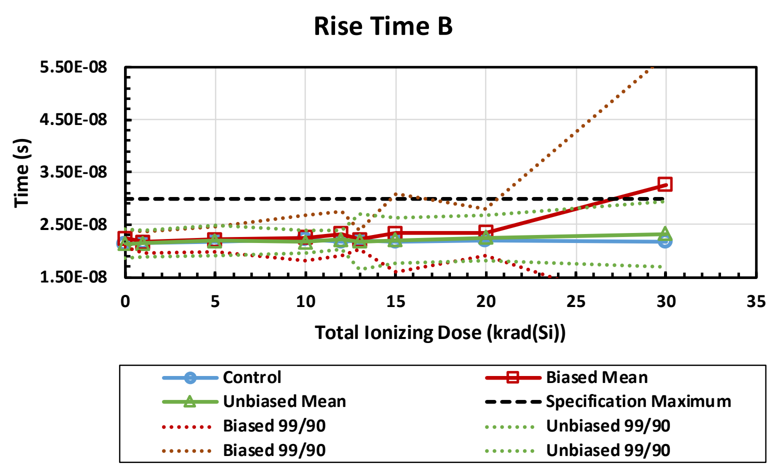

Fig. 9. Rise Time (B side) over irradiation (krad(Si)).

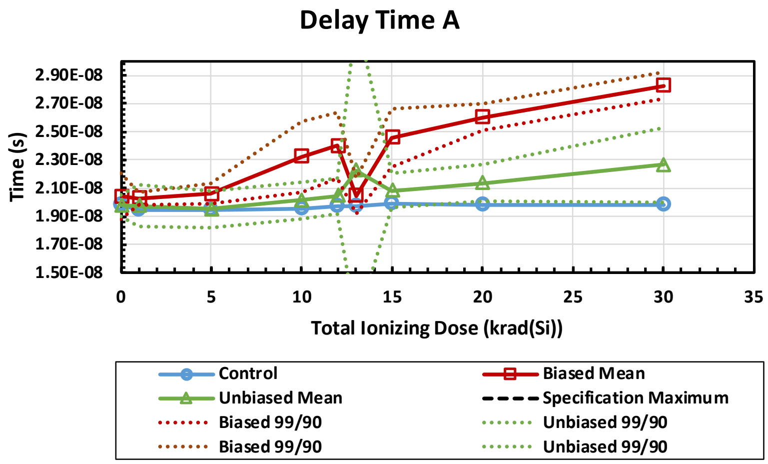

Fig. 10. Delay Time (A side) over irradiation (krad(Si)).

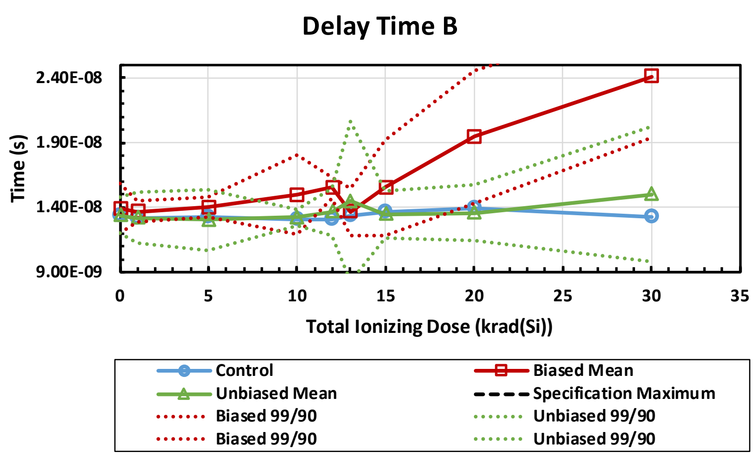

Fig. 11. Delay Time (B side) over irradiation (krad(Si)).

8. SUMMARY

The MIC4427 dual MOSFET driver showed insignificant degradation up to 30 krad(Si) at a low dose rate.

9. REFERENCES

1) Department of Defense “Test Method Standard Microcircuits,” MIL-STD-883 Test Method 1019.9 Ionizing radiation (total dose) test procedure, June 7, 2013, https://landandmaritimeapps.dla.mil/Downloads/MilSpec/Docs/MIL-STD-883/std883.pdf.
2) MIC4426/7/8 Datasheet, rev. A, May 2019.
3) 5962-88503 Datasheet, rev. K, Oct. 2015.