National Aeronautics and Space Administration

RH1021BMH-10 Precision 10 V Reference Total Ionizing Dose Test Report

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1. INTRODUCTION

The purpose of this test was to validate the Analog Devices (ADI) RH1021BMH-10 flight lot for use in the fabrication of Europa Clipper Propulsion subsystem flight hardware. This test shall serve as the radiation lot acceptance test (RLAT) for this flight lot with wafer lot number 769658.1 and lot date code (LDC) 1430A. Low dose rate (LDR) irradiations were performed in this test so that the device susceptibility to enhanced low dose rate sensitivity (ELDRS) could be determined.

2. DEVICES TESTED

2.1. Part Background

The RH1021 is a precision 10 V reference with ultralow drift and noise, extremely good long-term stability and almost total immunity to input voltage variations. The reference output will source and sink up to 10mA.

2.2. Device Under Test (DUT) Information

Twenty-five (25) parts from the flight lot of RH1021s were provided by the Europa Clipper Propulsion system to Code 561 for TID testing. Two of the twenty-five were used as controls. All specifications and descriptions are according to the datasheet (revision F). More information can be found in Table 1.

Table 1. Part Identification Information

Part Number	RH1021BMH-10
REAG ID#	19-008
Manufacturer	Analog Devices
Lot Date Code	1430A
Wafer Lot	769658.1
Quantity Tested	25
Part Function	Voltage Reference
Part Technology	Bipolar
Package	8-Lead TO-5 Metal Can

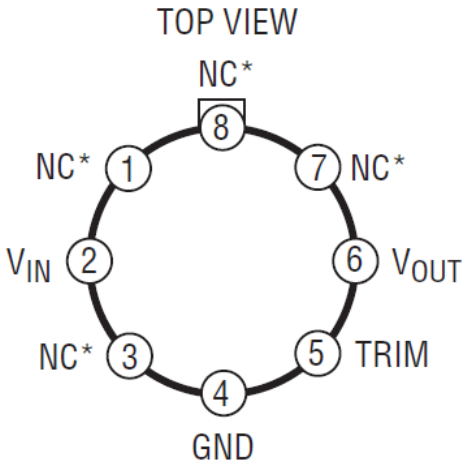

Fig. 1. Picture of pinout of device

Fig. 2. Picture of RH1021 in custom socket

3. TEST SETUP

The RH1021 TO-5 can package was soldered to a custom 8 pin DIP socket. Two Keithley 2425s and one HP 34401A voltmeter were used to characterize the RH1021's parameters.

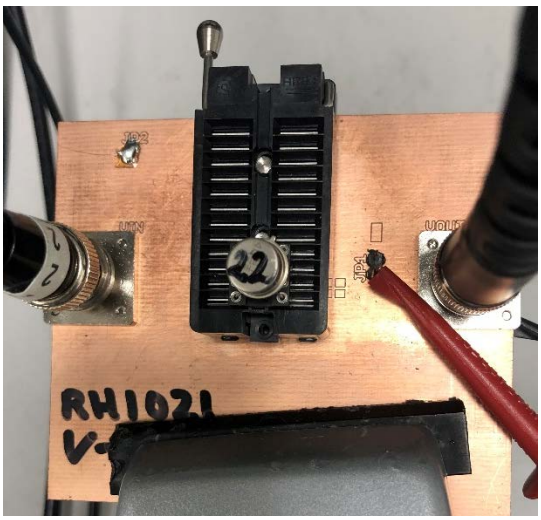

Fig. 3. Picture of RH1021 on test board

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.

4. TEST DESCRIPTION

4.1 Irradiation Conditions

Radiation testing was done by exposing the parts to gamma radiation at a low dose rate. Twenty-four (24) parts were tested, twenty-two (22) exposed to radiation and one as a control. Prior to the first radiation dose, all twenty-four parts were electrically tested. After each exposure level, the parts were tested again and returned to radiation within the time limits defined by MIL-STD-883, Method 1019. Eleven (11) parts were biased and eleven (11) were unbiased during the irradiation steps. See Table 2 for more information.

Table 2. Device Grouping

Group	Qty	Bias	Dose Rate	Exposure Level Steps (krad(Si))
1	11	Unbiased	10 mrad(Si)/s	0, 25, 50, 75, 100, 125
2	11	Biased	10 mrad(Si)/s	0, 25, 50, 75, 100, 125
3	2	Control	N/A	N/A

The biased parts were placed in ZIF sockets to DIP-8 socket adapters on a wire wrapped board. During irradiation, biased DUTs were powered to +15 V. Table 3 describes the exact pinout of a biased part.

Table 3. Biased DUT pinout

Pin Name	Symbol	Pin Number	Connection
No Connect	NC	1	Internally connected to pins 3, 7, and 8
Input Voltage	V_{IN}	2	+15 V and through a capacitor to Ground (0 V)
No Connect	NC	3	Internally connected to pins 1, 7, and 8
Ground	GND	4	0 V and through a capacitor to V_{IN} (+15 V)
Trim	TRIM	5	
Output Voltage	V_{OUT}	6	5 kΩ to Ground
No Connect	NC	7	Internally connected to pins 1, 3, and 8
No Connect	NC	8	Internally connected to pins 1, 3, and 7

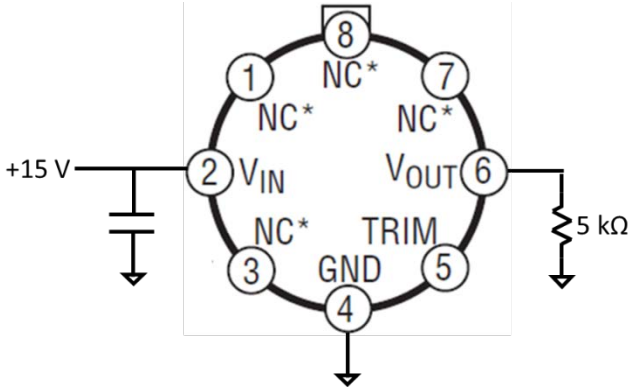

Fig. 4. Schematic of bias circuit for RH1021BMH-10 voltage reference.

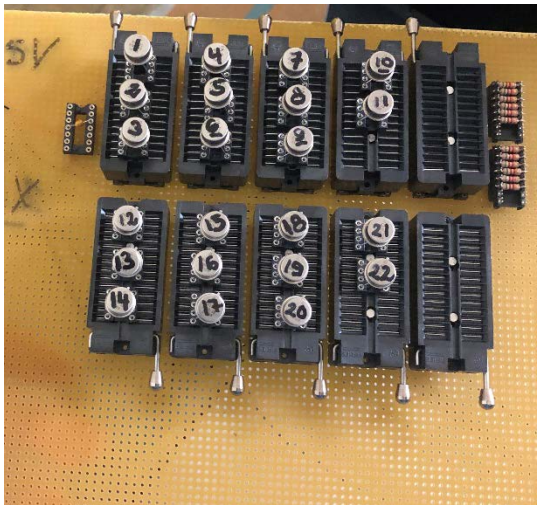
Fig. 5. RH1021 bias board

4.2 Electrical Tests

Specification thresholds were set in accordance with the Analog Devices datasheet I.D. No. 66-10-0179 Rev. E 0508 rh102110fe.

All data from the DC electrical tests in Table 4 were logged in excel spreadsheet files. Data for all parts were measured and logged.

Table 4. List of Electrical Tests Performed

Test	Symbol	Conditions T_A = +25°C V_{IN} = 15 V I_{OUT} = 0 A	Specifications		
			Min	Typ	Max
Output Voltage	V_{OUT}		9.935 V		10.065 V
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	11.5 V ≤ V_{IN} ≤ 14.5 V			6 ppm/V
		14.5 V ≤ V_{IN} ≤ 40 V			3 ppm/V
Load Regulation (Sourcing Current)	$\Delta V_{OUT}/\Delta I_{OUT}$	0 ≤ I_{OUT} ≤ 10 mA			25 ppm/mA
Supply Current (Series Mode)	I_S				1.7 mA

5. FAILURE CRITERIA

The parameter limits are defined as those listed in the RH1021 datasheet. No parameter thresholds were exceeded during any of the irradiation steps.

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

No parameters went out of specification through the entire irradiation to 125 krad(Si). All results, in graphical and raw table form, are shown below.

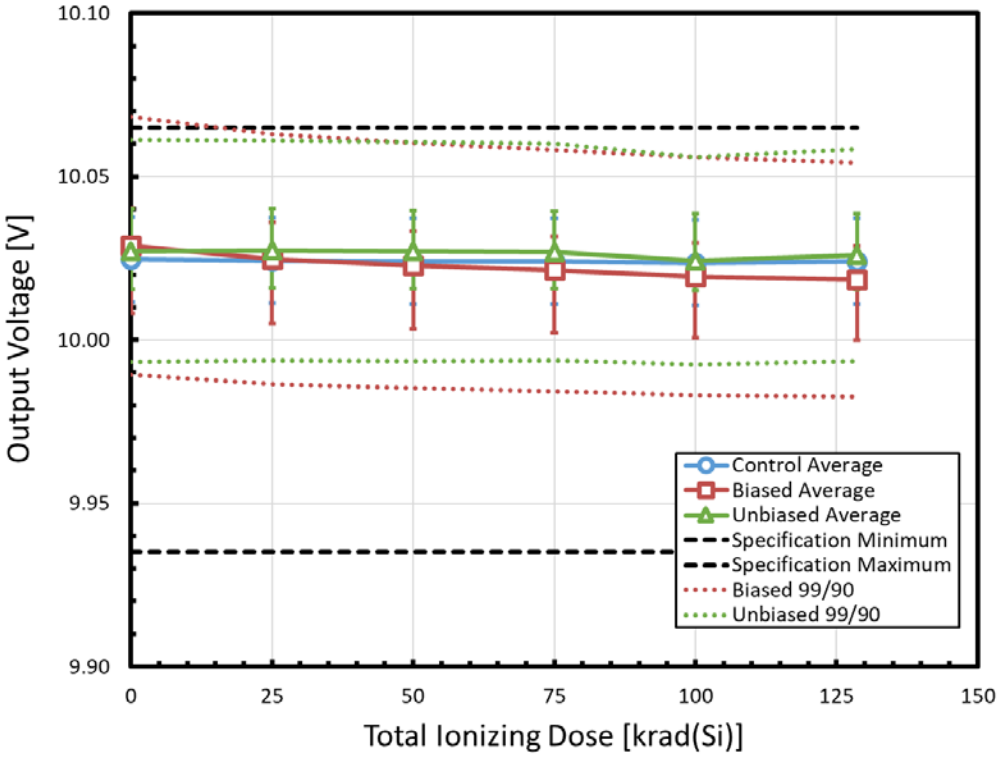

Fig. 6. Output Voltage over dose.

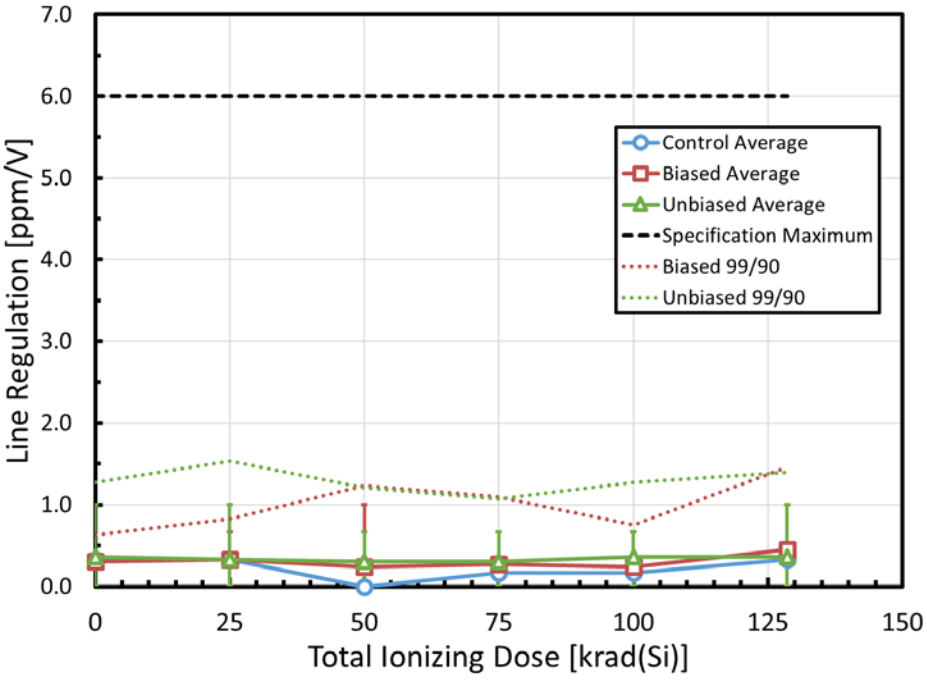

Fig. 7. Line Regulation with 11.5 V ≤ V_{IN} ≤ 14.5 V over dose.

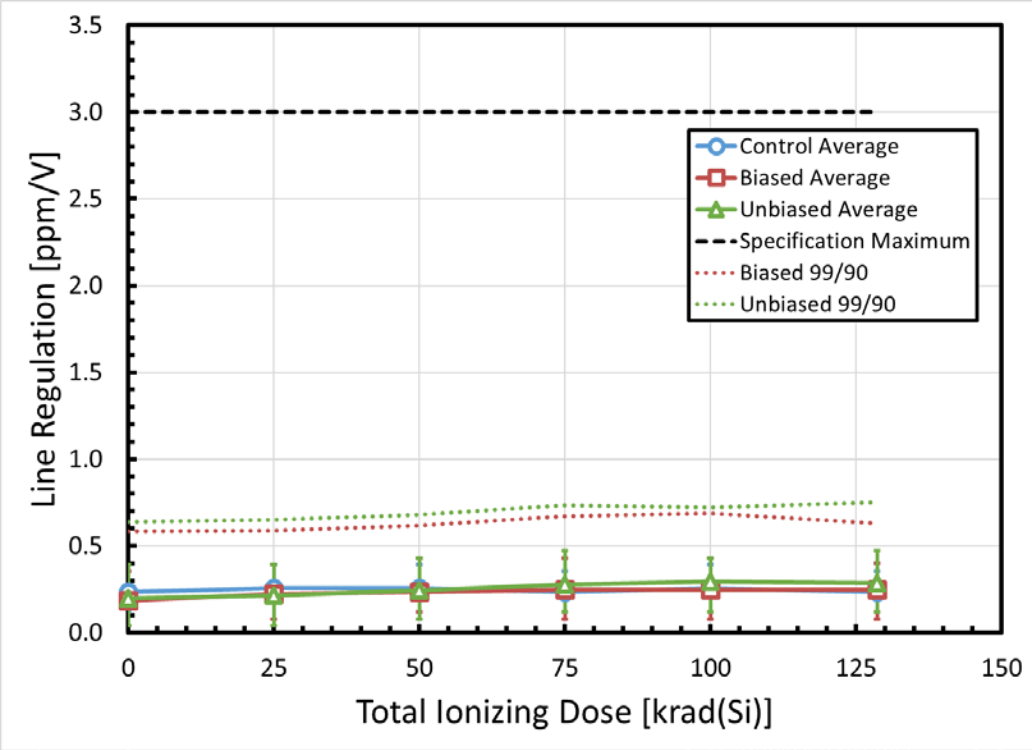

Fig. 8. Line Regulation with 14.5 V ≤ V_{IN} ≤ 40 V over dose.

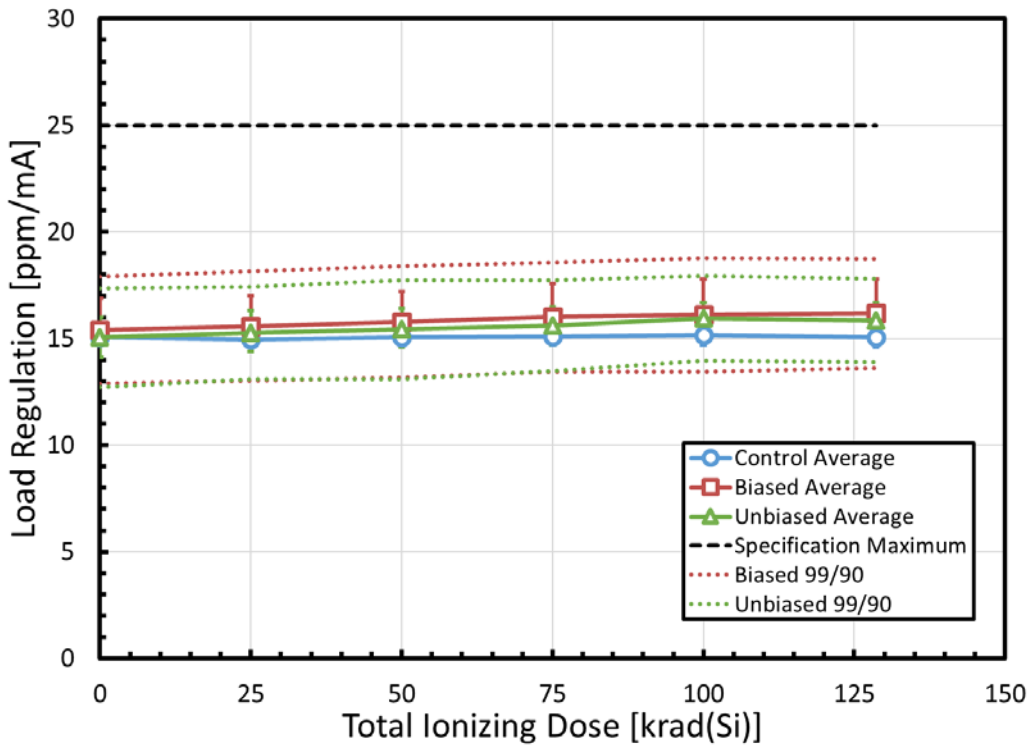

Fig. 9. Load Regulation over dose.

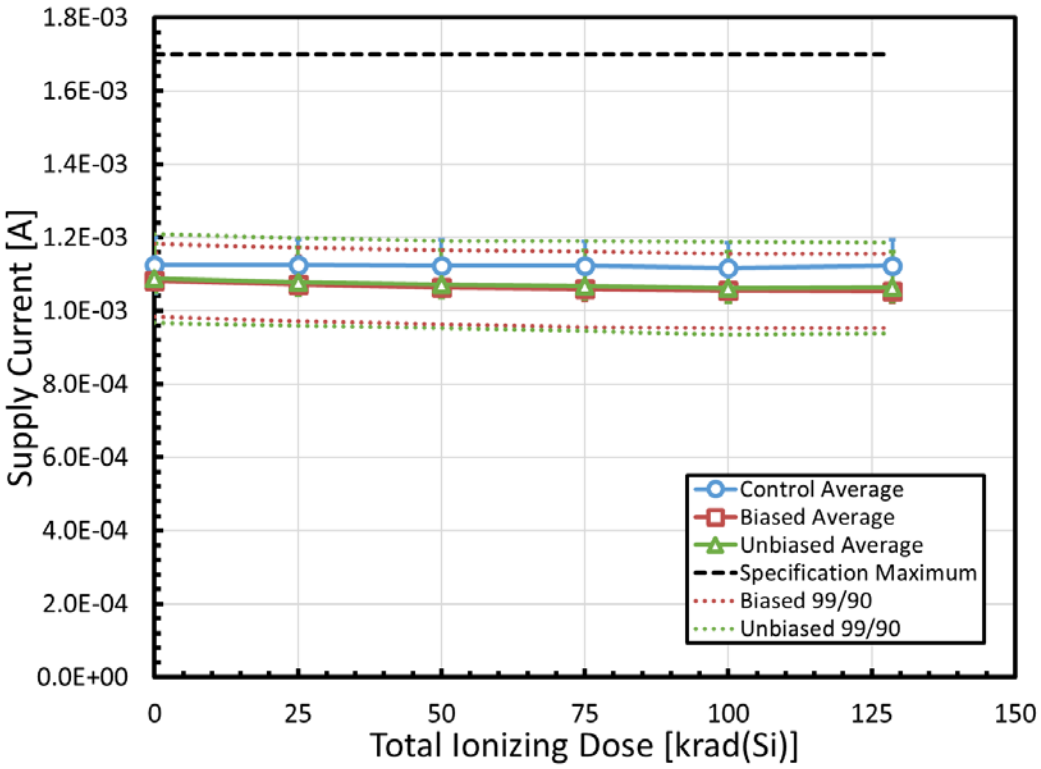

Fig. 10. Supply Current over dose.

8. SUMMARY

No parameters went out of specification during the entire irradiation up to 128.6 krad(Si)

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) Analog Devices datasheet I.D. No. 66-10-0179 Rev. E 0508 rh102110fe