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Radiation Test Report for National TEXAS INSTRUMENTS TLC2262 (commercial devices)

Project STEREO

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Test Report Number	ESA_QCA0316T_I
Project	STEREO
SCC Component no.	
Component Designation	Advanced LinCMOS Rail-to-Rail Operational Amplifier (TLC2262)
Irradiation Spec. no.	
Family	Integrated Circuits
Group	Silicon Monolithic
Package	Plastic DIP/SO
Component Specification	
Test House Name	ESA / ESTEC
Irradiation Test Plan Number	
Manufacturer name	Texas Instruments
Application type of Acceptance	
Serial Number of samples	Five (5) samples serialised as Ref, 1, 2, 3 and 4
Manufacturing Date Code	
Irradiation Measurement Interval: Biased Unbiased: Circuit Reference: Supply Voltage: Temp ^{o}C: Duration:	 Yes No +8V Rom temperature 20 ± 3
Electrical Measurement Parameters	
Facility Source: Energy: Dose Rate: Absorbed Material: Thickness: Temperature ^{o}C:	 60Co 4.6 rad(Si)/min N/A N/A 20 ± 3
Dosimetry / Calibration method.	A calibrated NE2571, 0.66cc air ionisation chamber read by a calibrated Farmer 2670 dosimeter.
Anneal Test Biased Unbiased Bias Circuit Reference Supply Voltage Duration	 Yes No +8V 233 hours room temperature

1 INTRODUCTION

The following document contains the Radiation Test Report for TLC2262 Advanced LinCMOS Rail-to-Rail operational amplifier for the STEREO project.

2 APPLICABLE DOCUMENTS

AD1- ESA/SCC 22900 “Total Dose Steady-State Irradiation Test Method”

3 TEST DESCRIPTION

Five (5) TLC2262, Flight Lot, Texas Instruments devices were selected for TID irradiation testing at the ESTEC ^{60}Co facility. Irradiations were performed at a dose rate of 4.6 rad(Si)/min. Post irradiation room-temperature annealing measurements were also performed on the devices.

Of the selected devices, one was employed as a reference device while, four were serialised for radiation exposure. All devices were of the Small Outline (SO) type and for ease of measurements were soldered on special adapter boards. These adapter boards were mounted on the irradiation test-boards during exposure. After each exposure step the adapter boards were removed and mounted on the SZ-test system for parametric measurements. The irradiation test-board can accommodate and bias four adapter boards (four devices). Each op-amp was operated in a high gain configuration for real-time measurement of the output-offset voltage. The biasing scheme of the operational amplifiers is illustrated in figure 1. The irradiation test operating conditions were provided by the STEREO project. The device operating conditions, temperature conditions and applied dose rates are listed in table1.

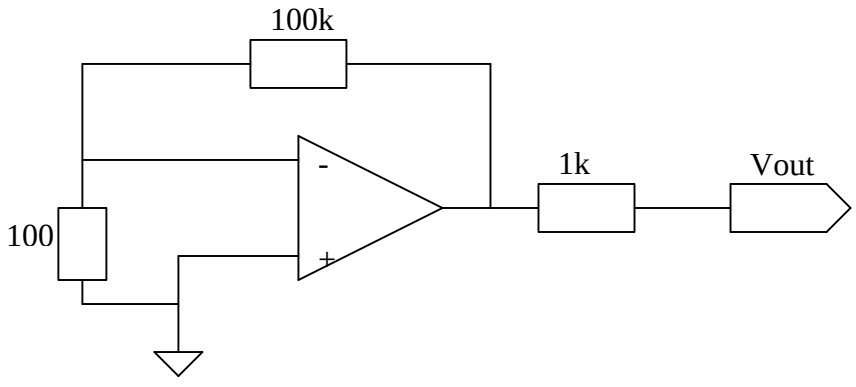

Figure 1 Schematic diagram of TLC2262 irradiation biasing scheme.

Parameter	Ref. Dev.	Dev1	Dev2	Dev3	Dev4
Bias During Irradiation	NA	+8V	+8V	+8V	+8V
Dose Rate	NA	4.6rad(Si)/min	4.6rad(Si)/min	4.6rad(Si)/min	4.6rad(Si)/min
Irradiation Temperature	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C

Table 1 Irradiation Test Conditions

3.1 Measurement set-up

Two sets of measurements were performed one set of continuous measurements during the irradiation runs and one set of parametric measurement at regular intervals between irradiation steps. Continuous measurements (performed during irradiation at 10 min intervals) were performed employing a HP-VEE system consisting of:

- HP 6626A System DC Power Supply
- HP 34970A Data Acquisition / Switch Unit

Measurement number	Devices 1,2,3 and 4
1	Device Output Offset Voltage

Table 2 Continuous measurements for each device during irradiation.

Parametric measurements were performed employing a SZ parametric tests system:

- SZ M3000 Test Station Sm02B
- M3000 TA09B Test Adapter
- Software UTS-Version 2.3.3

Table 3 list all parametric measurements performed and their limit values.

Test Parameter	Limit
Vos	Upper 2.5mV
Ios	Upper 1nA
Ib	Upper 1nA
Is+	Lower 0, Upper 1mA
CMRR	Lower 75dB
+PSRR	Lower 80dB
+Vom @ 20µA	Lower 4.85V
+Vom @ 100µA	Lower 4.85V
+Vom @ 400µA	Lower 4.7V
-Vom @ 50µA	Upper -4.99V

-Vom @ 500µA	Upper -4.85V
-Vom @ 4mA	Upper -4V
SR+	Lower 0.35 V/us

Table 3 Parameters measured by the SZ parametric Test System

The time between irradiation stop, performing parametric measurements and starting irradiation for all irradiation steps were less than 60min. 4 irradiation steps were performed and parametric measurements performed after each step (parametric also performed for the reference device). Pre-irradiation measurements were performed on all devices. Table 4 illustrates the irradiation and measurement history.

Irradiation steps	Ref. Dev.	Dev1	Dev2	Dev3	Dev4
Pre-rad. Par. measurements	Yes	Yes	Yes	Yes	Yes
1.8 krad(Si)	NA	Yes	Yes	Yes	Yes
par. measurements	Yes	Yes	Yes	Yes	Yes
6.5 krad(Si)	NA	Yes	Yes	Yes	Yes
par. measurements	Yes	Yes	Yes	Yes	Yes
13 krad(Si)	NA	Yes	Yes	Yes	Yes
par. measurements	Yes	Yes	Yes	Yes	Yes
14.9 krad(Si)	NA	Yes	Yes	Yes	Yes
Par. measurements	Yes	Yes	Yes	Yes	Yes

Table 4 Irradiation and measurement history

3.2 Thermal conditions

All irradiations and measurements were performed at room temperature (20 ± 3 ^{o}C).

3.3 Dosimetry

A calibrated NE2571, 0.66cc air ionisation chamber read by a calibrated Farmer 2670 dosimeter was used to measure the Total Ionising Dose.

3.4 Test Results

Figure2 illustrates the real-time measurements of the output voltage during irradiation. Figures 2 to 15 illustrate the parametric results. The graphs illustrate results for two devices on each chip. The

limit for which a parameter is considered out of specification is provided in the vertical axis legend of all graphs except graph1.

Following figure15, a discussion of the results is presented.

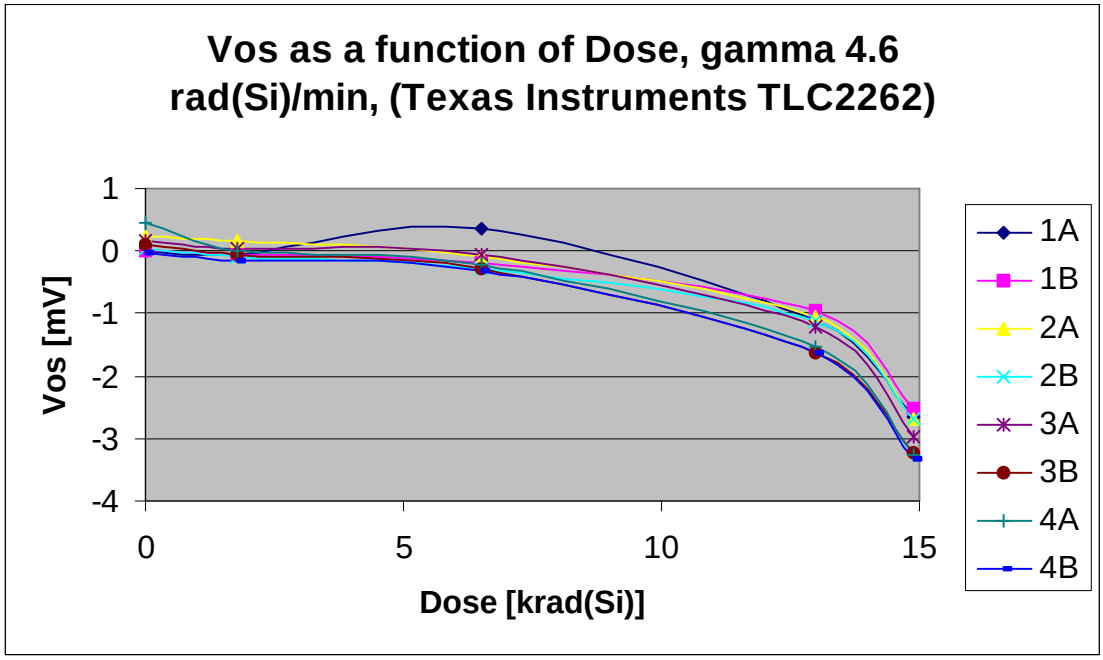

Figure 2 Voffs as a function of Dose, gamma 4.6 rad(Si)/min.

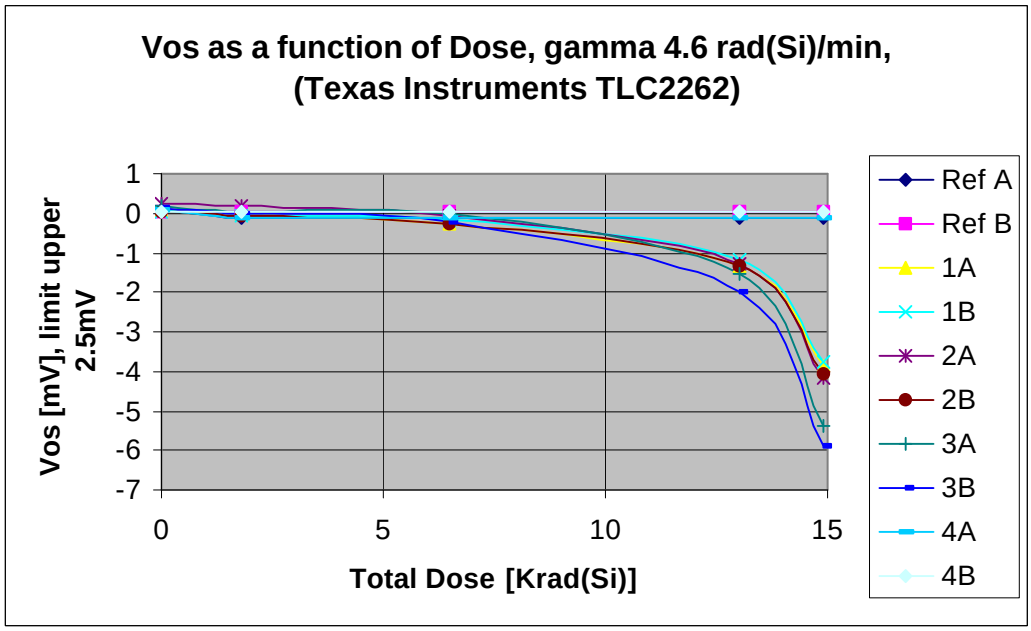

Figure 3 Vos as a function of Dose, gamma 4.6 rad(Si)/min.

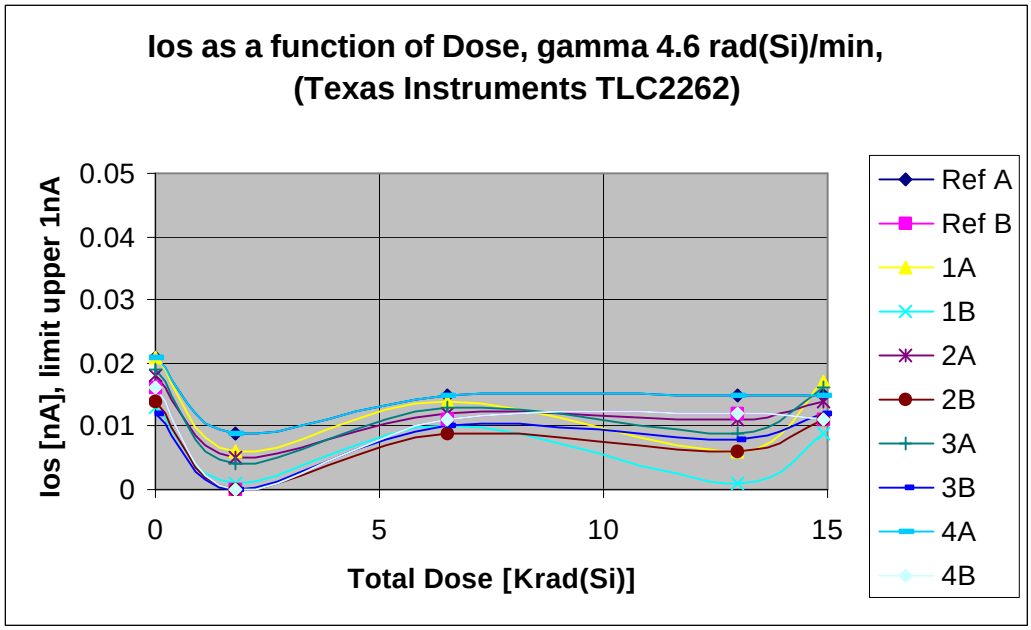

Figure 4 Ios as a function of Dose, gamma 4.6 rad(Si)/min.

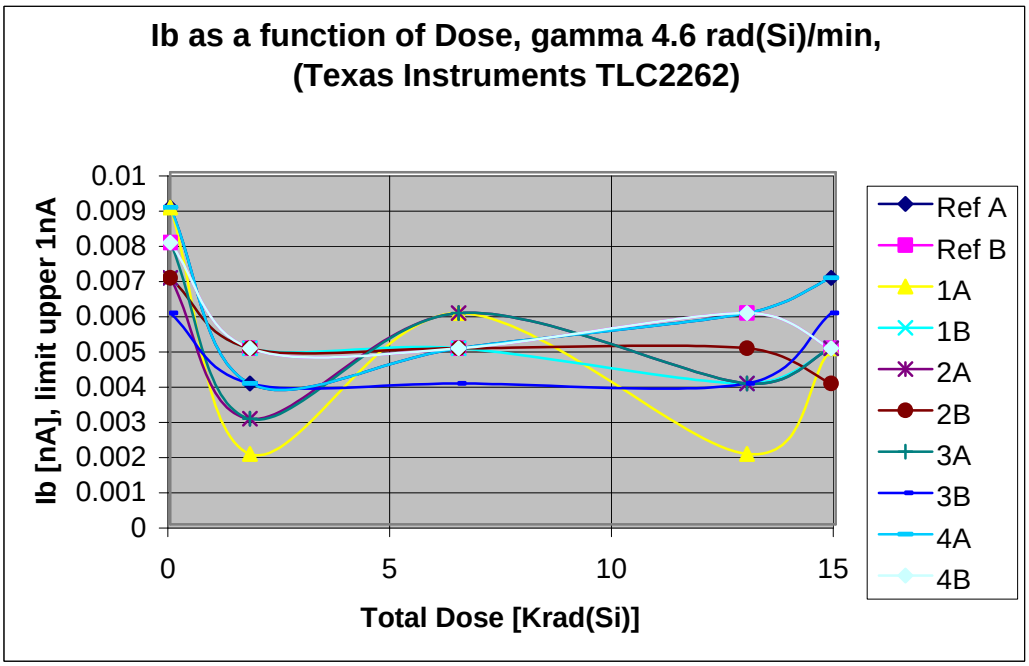

Figure 5 Ib as a function of Dose, gamma 4.6 rad(Si)/min.

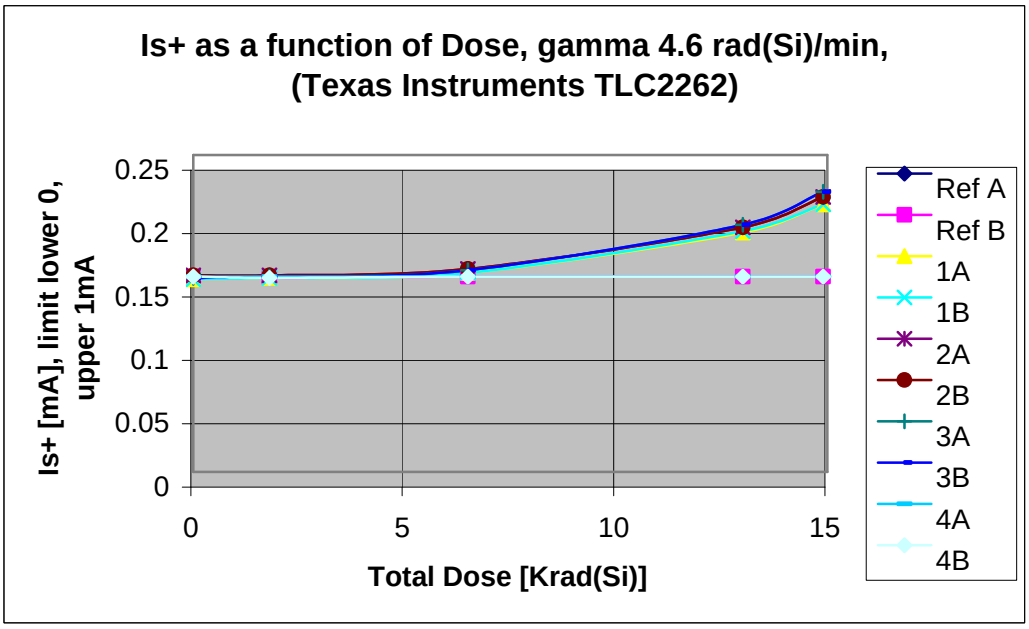

Figure 6 Is+ as a function of Dose, gamma 4.6 rad(Si)/min.

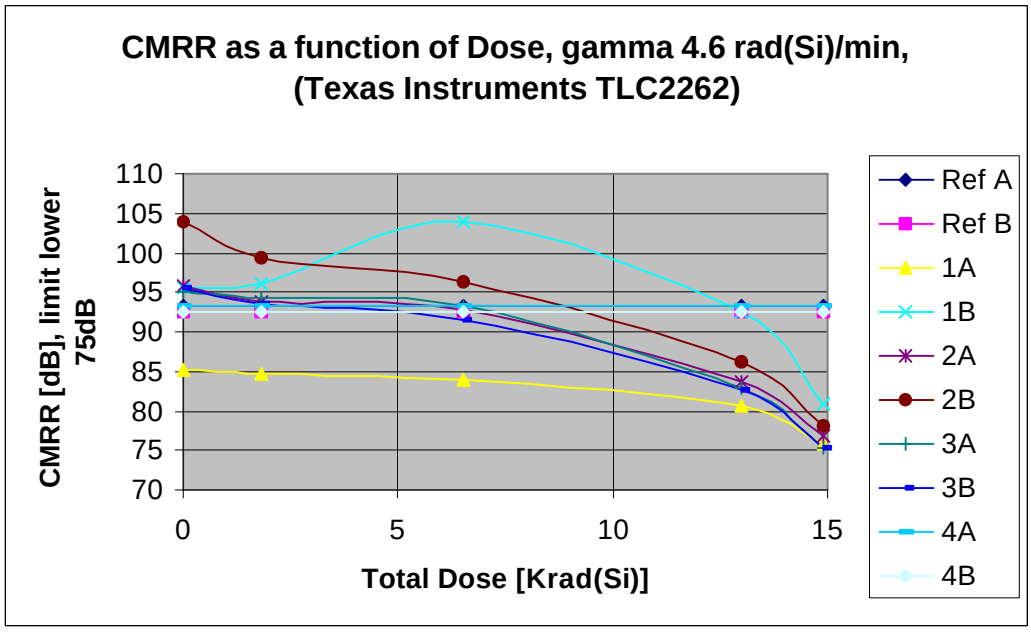

Figure 7 CMRR as a function of Dose, gamma 4.6 rad(Si)/min.

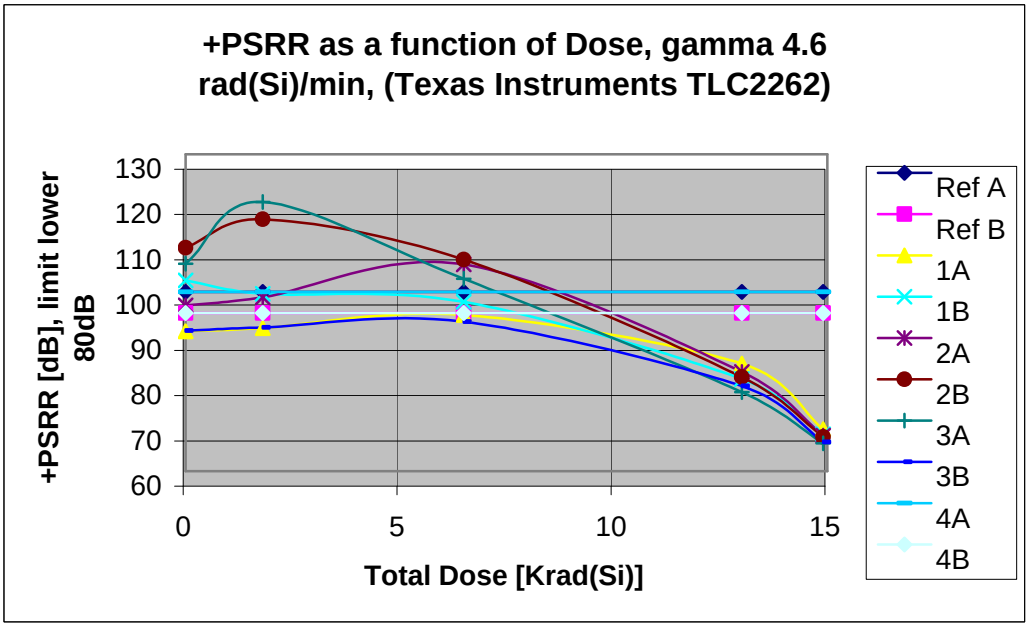

Figure 8 +PSRR as a function of Dose, gamma 4.6 rad(Si)/min.

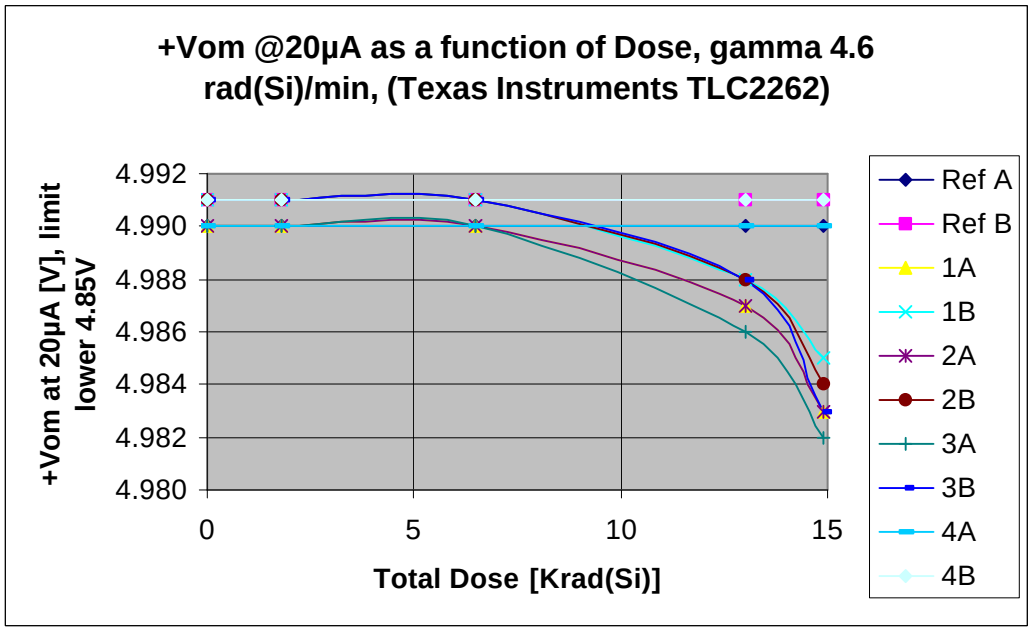

Figure 9 +Vom (at 20µA) as a function of Dose, gamma 4.6 rad(Si)/min.

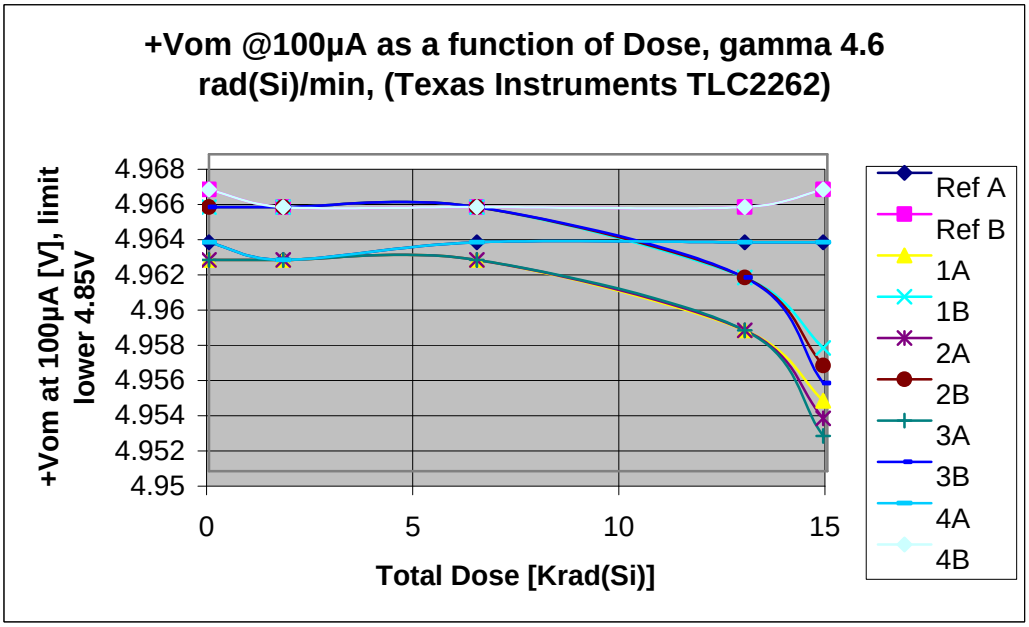

Figure 10 +Vom (at 100µA) as a function of Dose, gamma 4.6 rad(Si)/min.

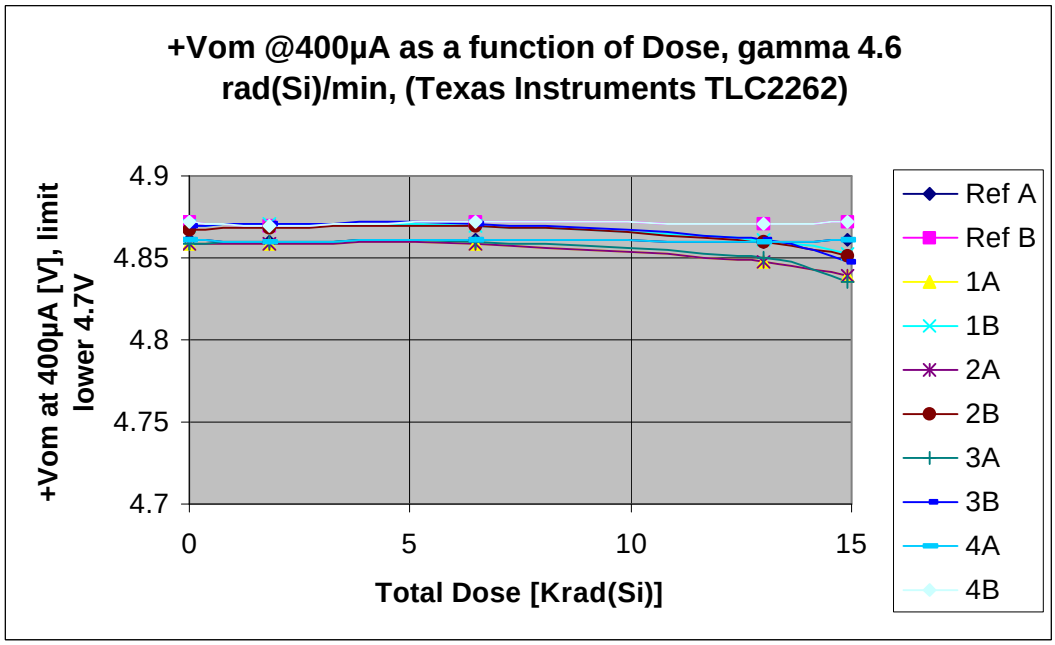

Figure 11 +Vom (at 400µA) as a function of Dose, gamma 4.6 rad(Si)/min.

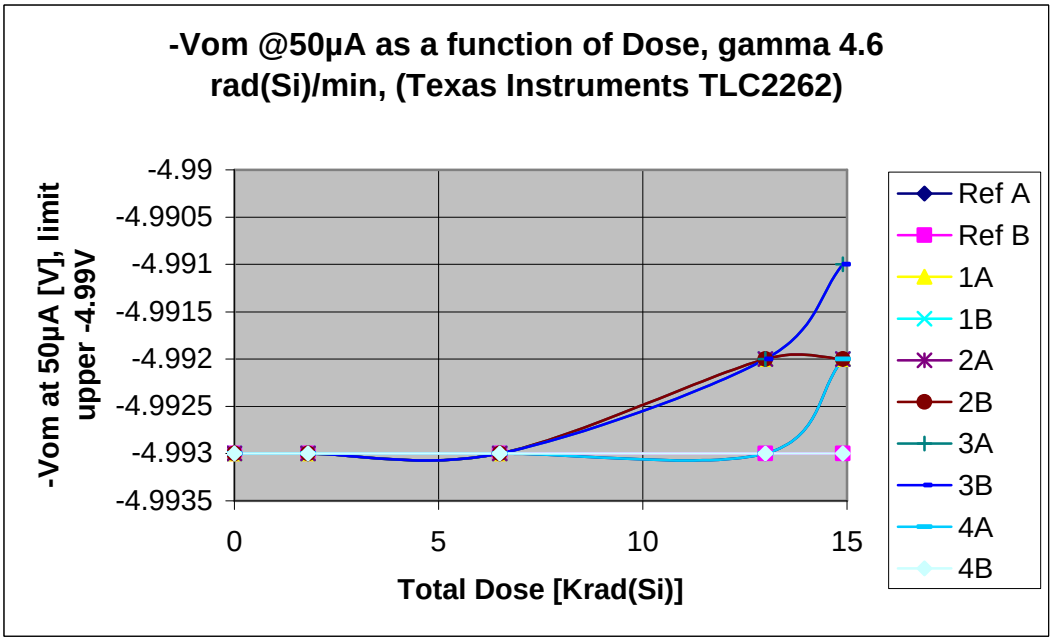

Figure 12 -Vom (at 50µA) as a function of Dose, gamma 4.6 rad(Si)/min.

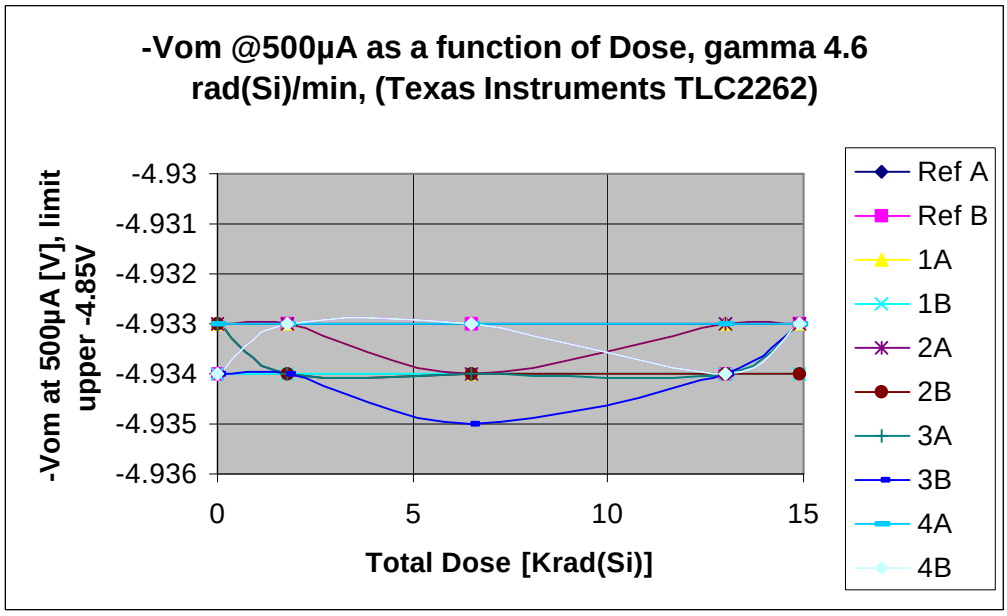

Figure 13 -Vom (at 500µA) as a function of Dose, gamma 4.6 rad(Si)/min.

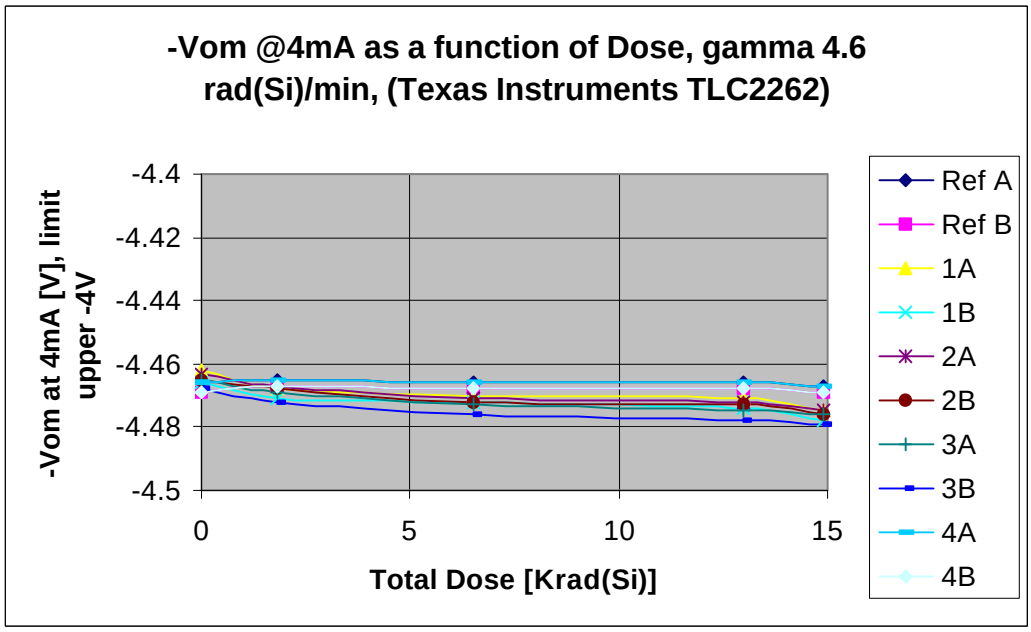

Figure 144 -Vom (at 4mA) as a function of Dose, gamma 4.6 rad(Si)/min.

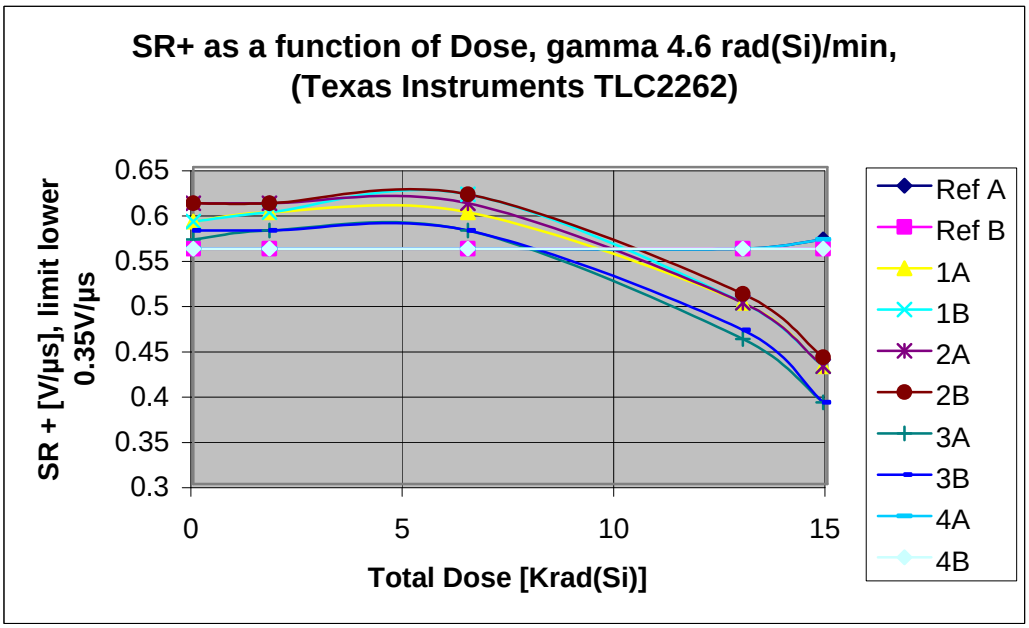

Figure 15 SR+ as a function of Dose, gamma 4.6 rad(Si)/min.

Figure 2 illustrates the real-time measurement data during the irradiation run. The figure illustrates some spread in the results, which is common for COTS devices.

Figures 3 to 15 illustrate that all parameters were within specified values after exposure to a total dose of 14.9 krad(Si) expect Vos and PSRR+, illustrated in figures 3 and 8 respectively. Both parameters were out of spec between 13 and 14.9 krad(Si).

3.5 Annealing Test Results

All devices were subjected to 233 hour room temperature biased annealing (no high temperature anneal as per AD1 was performed due to time constraints). Only anneal results for post-irradiation failed parameters are discussed below.

Room temperature anneal measurements varying degree of improvement in all parameters. Figure 16 illustrates that the Vos values for all devices recover and return to their specified values between 65h and 233h room temperature biased anneal. This is also the case for the PSRR+ values illustrated in figure 17. It is observed that the device-to-device spread is prominent during annealing.

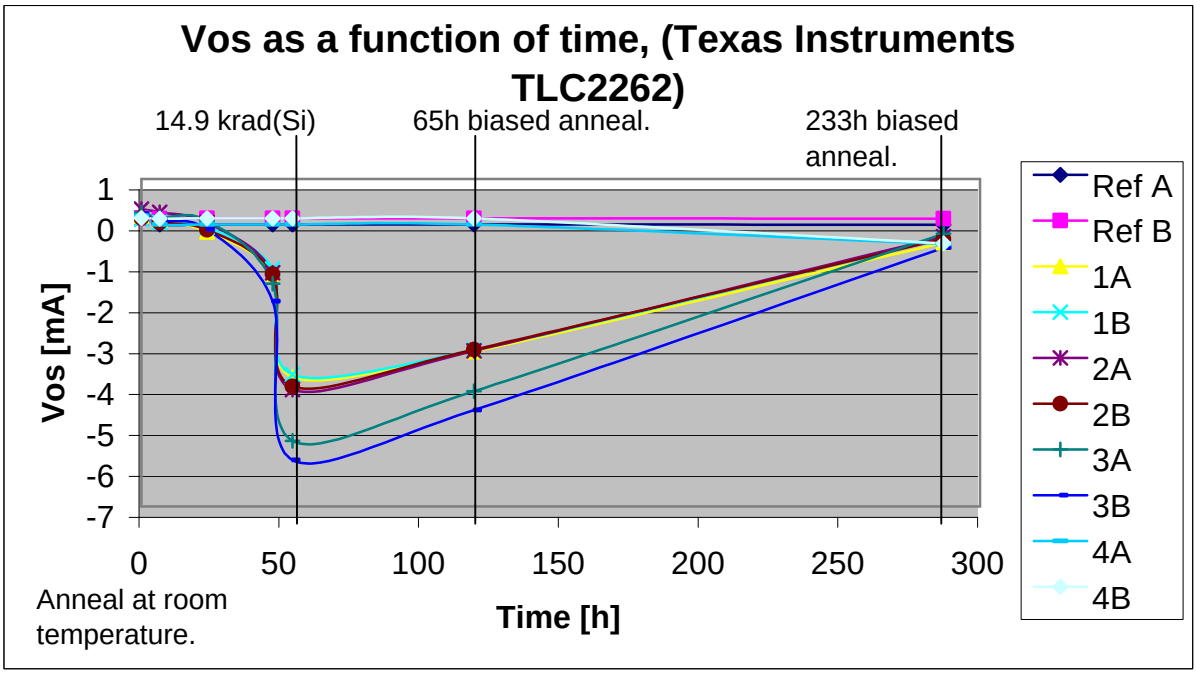

Figure 16 Vos as a function of time, gamma 4.6 rad(Si)/min.

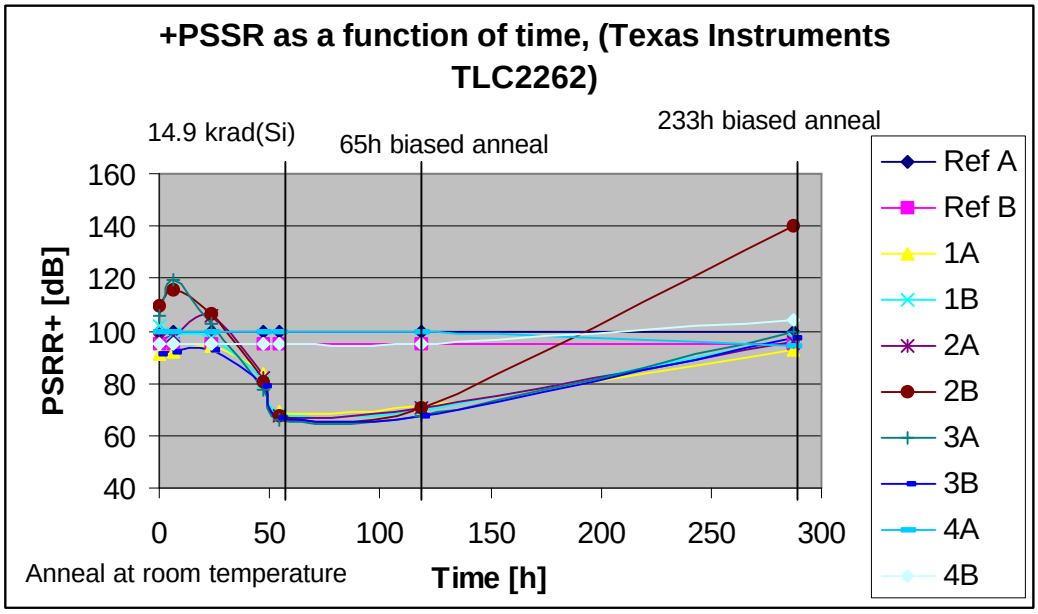

Figure 17 PSRR+ as a function of time.

3.6 Conclusion

The commercial TLC2262 operational amplifier irradiation tests show that two parameters failed between 13 and 14.9krad(Si) total ionising dose. The total ionising dose requirement set by the STEREO project is 15krad(Si) (including a margin of 2).

Annealing results illustrate that all parameters recovered and were within specified levels between 65h and 233h biased room temperature anneal.