esa DOCUMENT

document title/ titre du document

Radiation Test Report

OP200

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reference/*réference*
issue/*édition* 1
revision/*révision* 0
date of issue/*date d'édition* 25 octobre 2006
status/*état* Draft
Document type/*type de document* Radiation Test Report
Distribution/*distribution*

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APPROVAL

author *auteur*		date *date*

approved by *approuvé by*	date *date*

CHANGE LOG

reason for change */raison du changement*	issue/*issue*	revision/*revision*	date/*date*

CHANGE RECORD

Issue: 1 Revision: 1

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*

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Test Report Number	ESA_QCA0502T_I
Project	
SCC Component no.	
Component Designation	Dual low offset low power op-amp OP200
Irradiation Spec. no.	
Family	Operational amplifiers
Group	Silicon Monolithic
Package	CERDIP-14
Component Specification	
Test House Name	ESA / ESTEC
Irradiation Test Plan Number	
Manufacturer name	Analog Devices
Application type of Acceptance	
Serial Number of samples	Four (4) samples serialised as Ref, 1, 2, 3 and 4
Manufacturing Date Code	0304
Irradiation Measurement Interval: Biased Unbiased: Circuit Reference: Supply Voltage: Temp ^{o}C: Duration:	 Yes (2 parts) Yes (1 part) ±15V Room temperature 20 ± 3
Electrical Measurement Parameters	IOS, Ib, IS, AV0, Vo, SR, VOS
Facility Source: Energy: Dose Rate: Absorbed Material: Thickness: Temperature ^{o}C:	 60Co 0.5 rad(Si)/min N/A N/A 20 ± 3
Dosimetry / Calibration method.	A calibrated NE2571, 0.6cc air ionisation chamber read by a calibrated Farmer 2670 dosimeter.
Anneal Test Biased Unbiased Bias Circuit Reference Supply Voltage Duration	Yes 168h at 80^{o}C Yes No

1 INTRODUCTION

The following document contains the TID Radiation Test Report for OP200 dual low offset low power operational amplifier for the project.

2 APPLICABLE DOCUMENTS

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

3 TEST DESCRIPTION

Four (4) OP4200, AD devices were selected for TID irradiation testing at the ESTEC ^{60}Co facility. Irradiations were performed at a dose rate of 0.5rad(Si)/min. Post irradiation annealing measurements were also performed on the devices.

Of the selected devices, one was assigned as a reference device while, three were serialised for radiation exposure (two biased and one unbiased). After each exposure-step the components were removed and tested on the SZ-test system for parametric measurements. Each irradiation test-board accommodated and biased three OP200 devices. The biasing scheme of the operational amplifiers is illustrated in Figure 1, Figure 2 illustrates the device package. The operating conditions during irradiation were provided by the project. The device operating conditions, temperature conditions and applied dose rates are listed in Table 1. The pins of the unbiased devices were all shorted to ground.

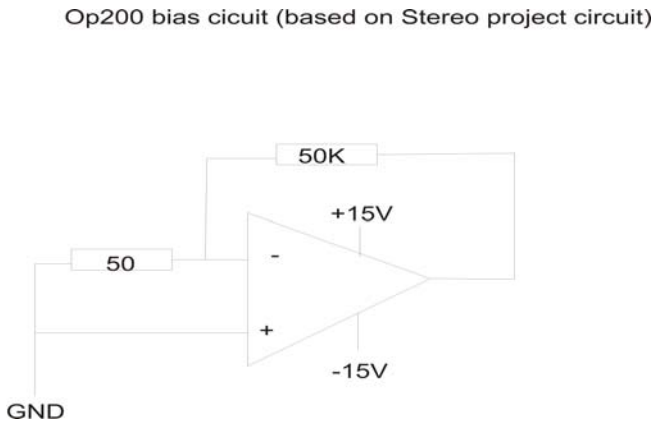

Figure 1: OP200 irradiation biasing conditions

Figure 2 OP200 package

Table 1: irradiation Test Conditions

Parameter	Ref	Dev1	Dev2	Dev3
Bias During Irradiation	NA	±15V	±15V	Unbiased
Dose Rate	NA	0.5rad(Si)/min	0.5rad(Si)/min	0.5rad(Si)/min
Irradiation Temperature	NA	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C

3.1 Measurement set-up

No in-situ measurements were performed during irradiation. Parametric measurements were performed with regular intervals as listed in Table 3. Parametric measurements were performed employing a SZ parametric tests system:

- SZ M3000 Test Station Sm02B
- M3000 TA09B Test Adapter
- Software UTS-Version 2.5.1

Table 2 lists all parametric measurements performed and their limit values.

Table 2: parameters measured by the SZ parametric Test System

Test Parameter	Limit
Input offset voltage VOS	Upper 50mV
Input offset current IOS	Upper 1nA
Input bias current IB	Upper 50nA
Supply Current IS	Lower 0mA Upper 2.9mA
Large signal voltage gain AV0	Lower 73dB
Positive supply voltage V0+	Lower 12V

Negative supply voltage V0-	Upper -12V
Slew rate SR	Lower 0.05V/μs

The time between irradiation stop, performing parametric measurements and starting irradiation for all irradiation steps were less than 30min. 7 irradiation steps were performed and parametric measurements taken after each step (parametric also performed for the reference device). Pre-irradiation measurements were performed on all devices. Table 3 illustrates the irradiation and measurement history.

Table 3: irradiation and measurement history

Irradiation steps	Ref	Dev 1	Dev 2	Dev 3	Dev 541 Unbiased
Pre-rad. Par. measurements	Yes	Yes	Yes	Yes	Yes
3.1krad(Si)					
Par. measurements	Yes	Yes	Yes	Yes	Yes
5.8krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
8.9krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
13.4krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
18.7krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
26.7krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
44.5krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
53.4krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
62.3krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes

3.2 Thermal conditions

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

3.3 Dosimetry

A calibrated NE2571, 0.6cc air ionisation chamber read by a calibrated Farmer 2670 dosimeter was used to measure the Total Ionising Dose.

3.4 Test Results

The irradiation test results for OP200 are presented in Figure 3 to Figure 13. A description of the results is provided below:

- At 13.4krad(Si) the biased devices 1 and 2 are exceed the specified upper limit of Ios. However, recovery of Ios is observed at 18.7krad(Si) (devices 1b and 2b gradually increase and exceed specification again between 44.5 and 53.4krad(Si)). Nominal measurement of reference and unbiased devices indicate that the the observed anomaly at 13.4krad(Si) is real. At 13.4krad(Si) the following parameters also show a clear drift : Ib+, Ib-, Is+, Is-, Vout, SR+ and SR-. For SR+ and SR-, devices 1b and 2b initially increased in value at the 13.4krad(Si) measurement point for subsequently to drop below the lower specified limit at 18.7, 26.7 and 44.5krad(Si). For most parameters some recovery is observed after 168h 80^{o}C anneal.
- The unbiased device 3b illustrated anomalous behavior (out of specification) for the following parameters; Vout+, SR- and VOS at the 18.7krad(Si) measurement point. Device 3a is below specified limit for SR- at 62.3krad(Si) (recovers after anneal) and below spec for SR+ at 53.4 and 62.3krad(Si) (recovers after anneal).

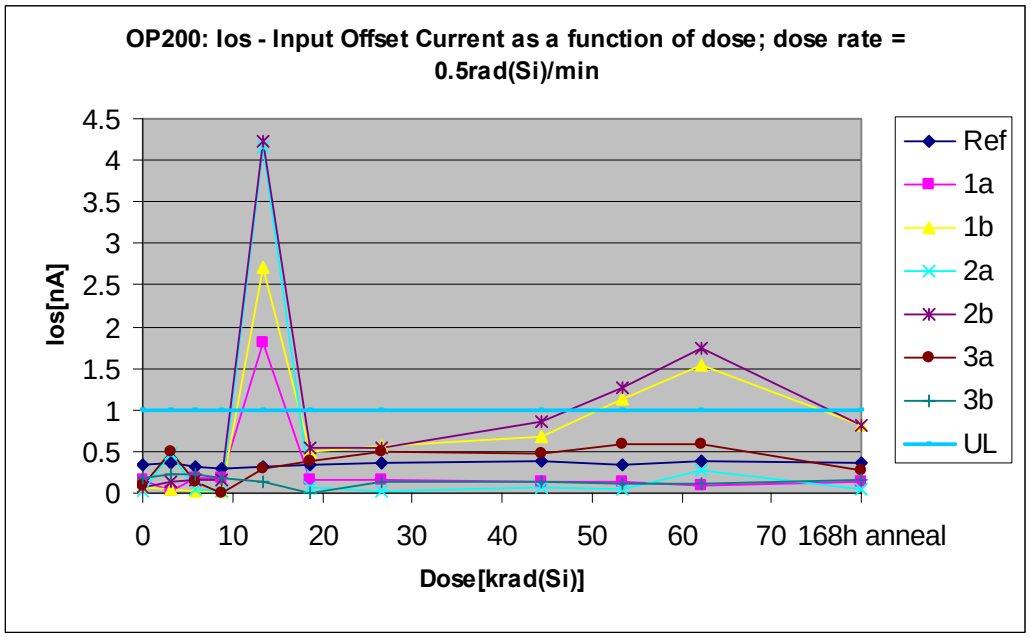

Figure 3: OP200 input offset current as a function of dose; gamma 0.5 rad(Si)/min

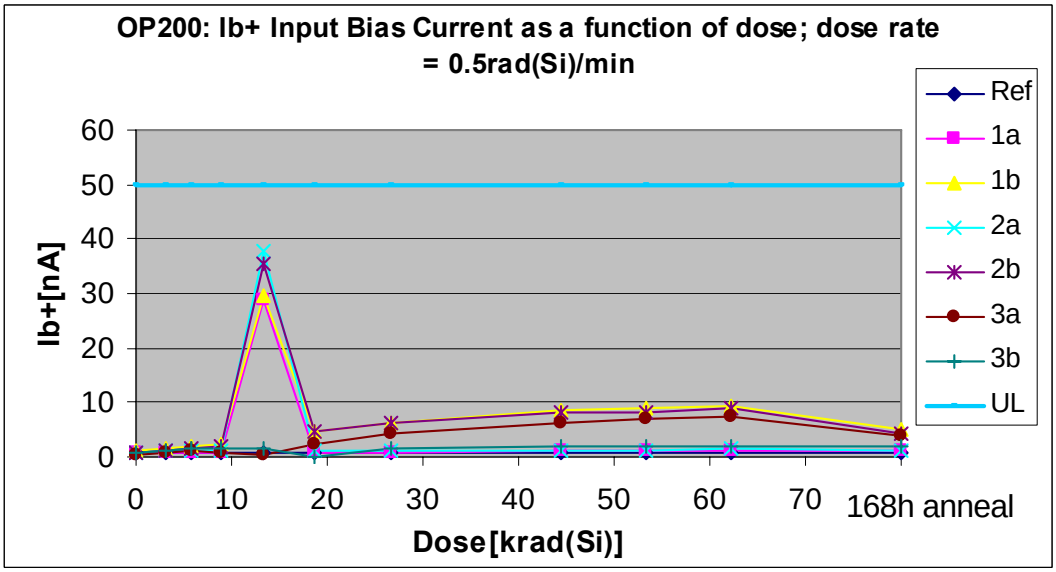

Figure 4: OP200 positive input bias current as a function of dose; gamma 0.5 rad(Si)/min

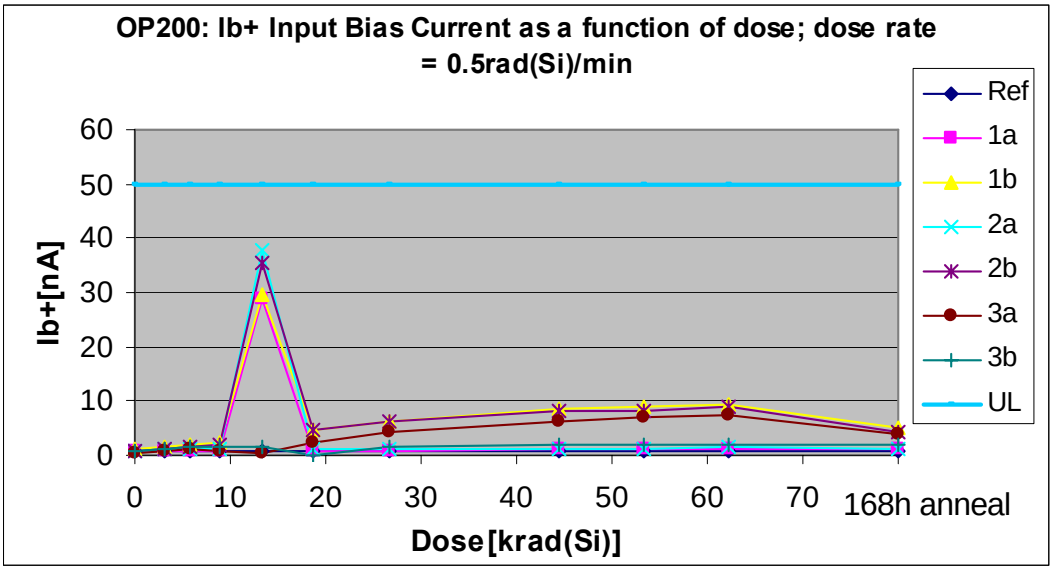

Figure 5: OP200 input bias current as a function of dose; gamma 0.5 rad(Si)/min

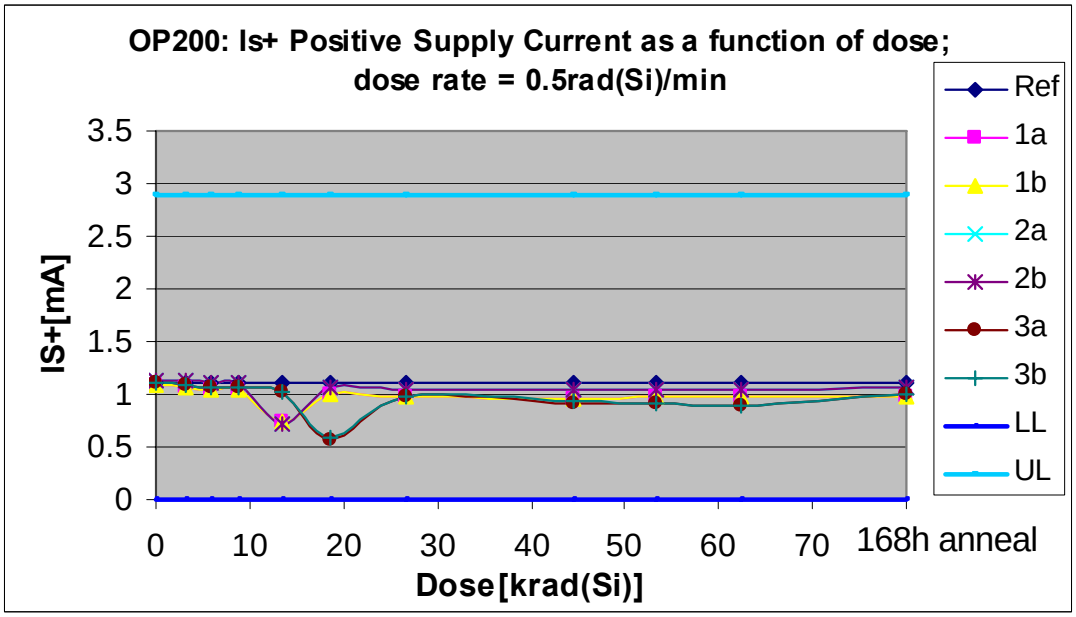

Figure 6: OP200 positive supply current as a function of dose; gamma 0.5 rad(Si)/min

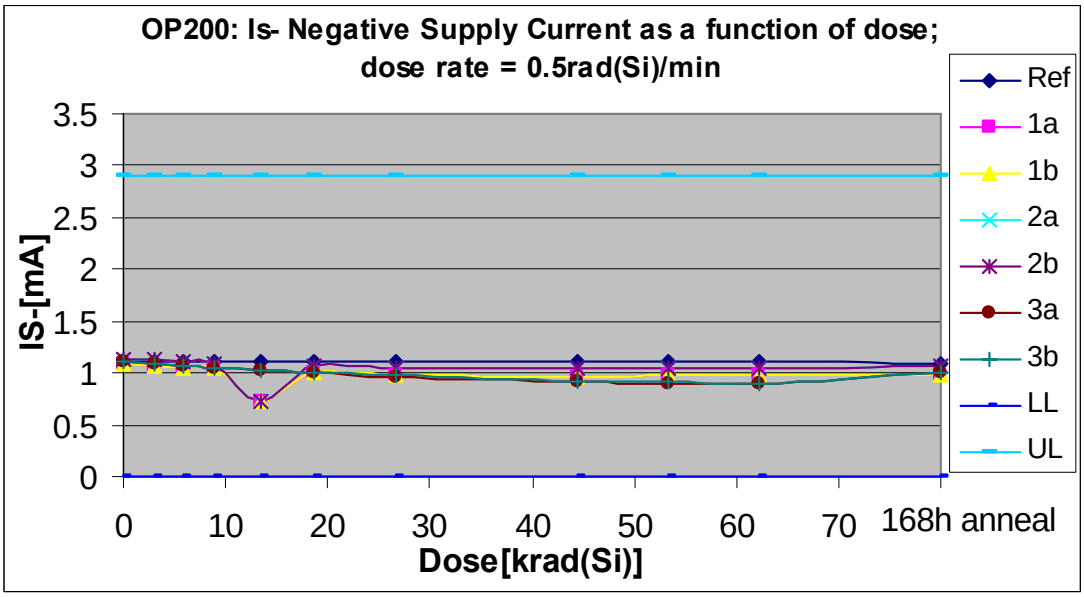

Figure 7: OP200 negative supply current as a function of dose; gamma 0.5 rad(Si)/min

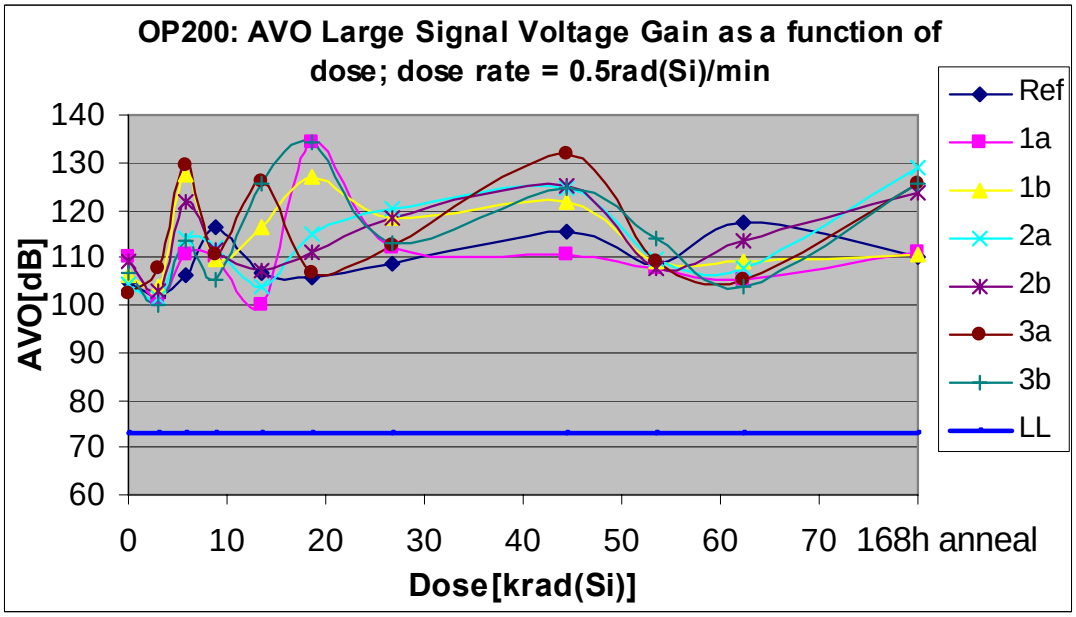

Figure 8: OP200 large signal voltage gain as a function of dose; gamma 0.5 rad(Si)/min

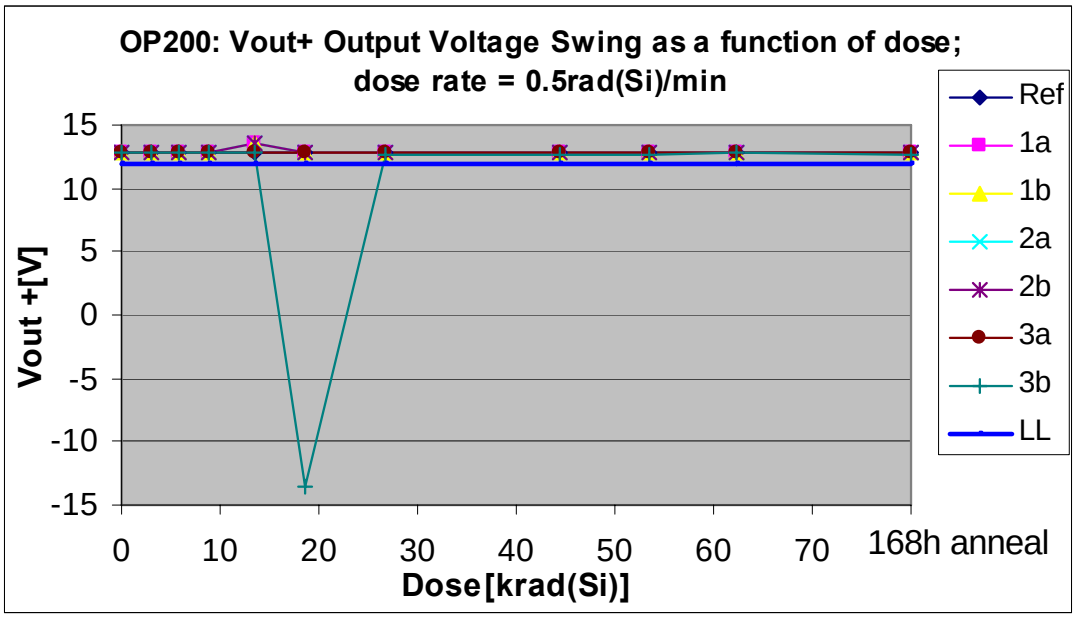

Figure 9: OP200 output voltage swing as a function of dose; gamma 0.5 rad(Si)/min

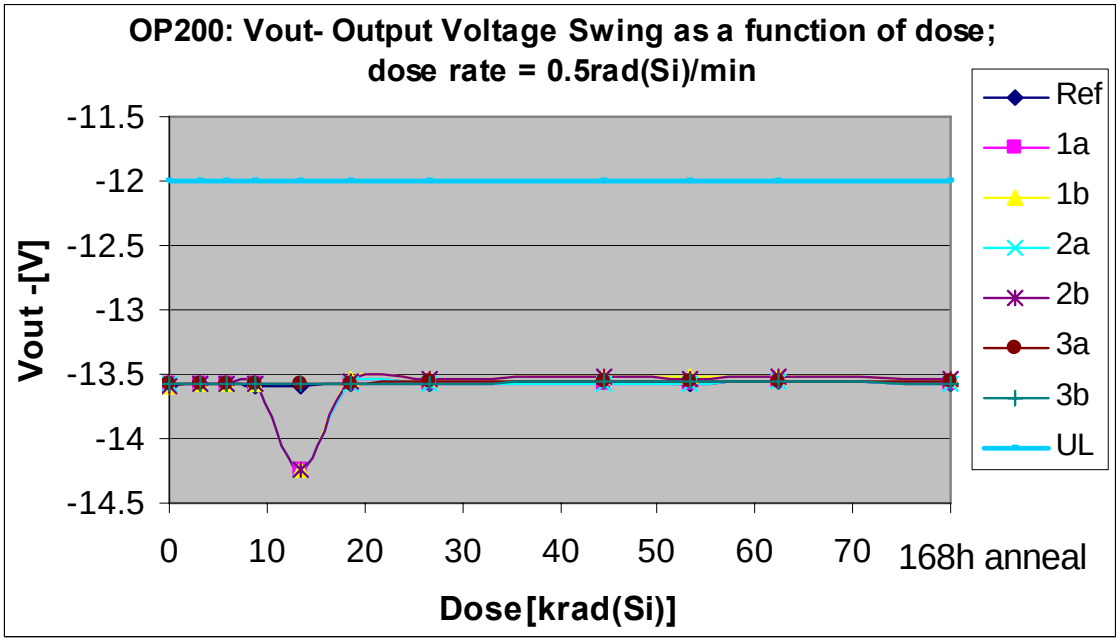

Figure 10: OP20 negative output voltage gain as a function of dose; gamma 0.5 rad(Si)/min

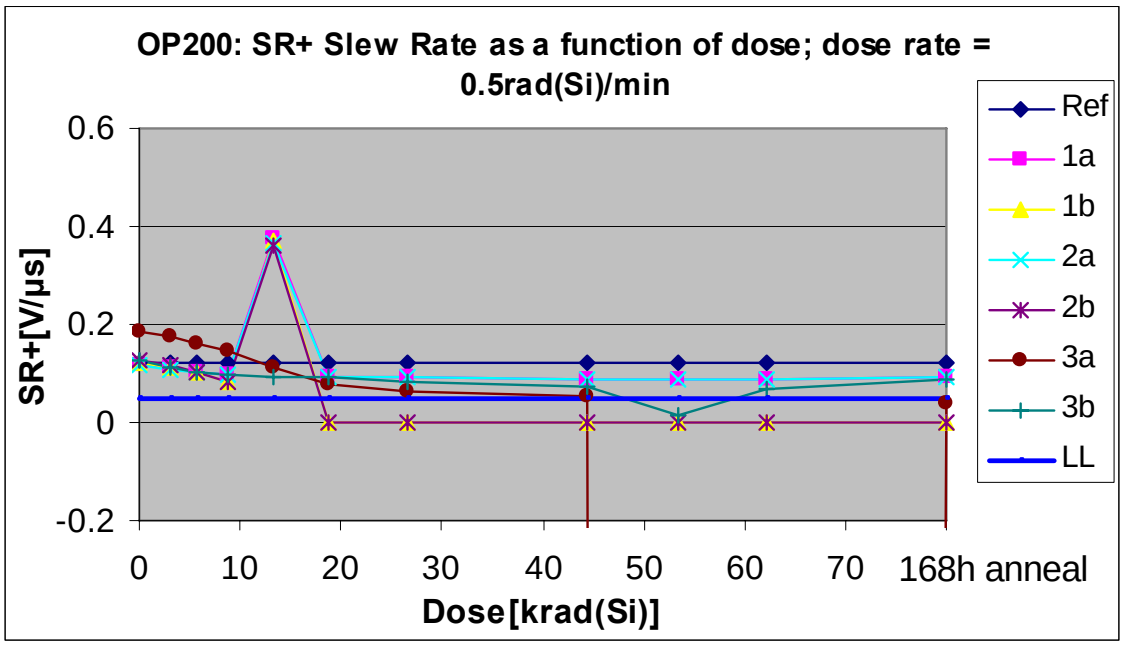

Figure 11: OP200 positive slew rate as a function of dose; gamma 0.5 rad(Si)/min

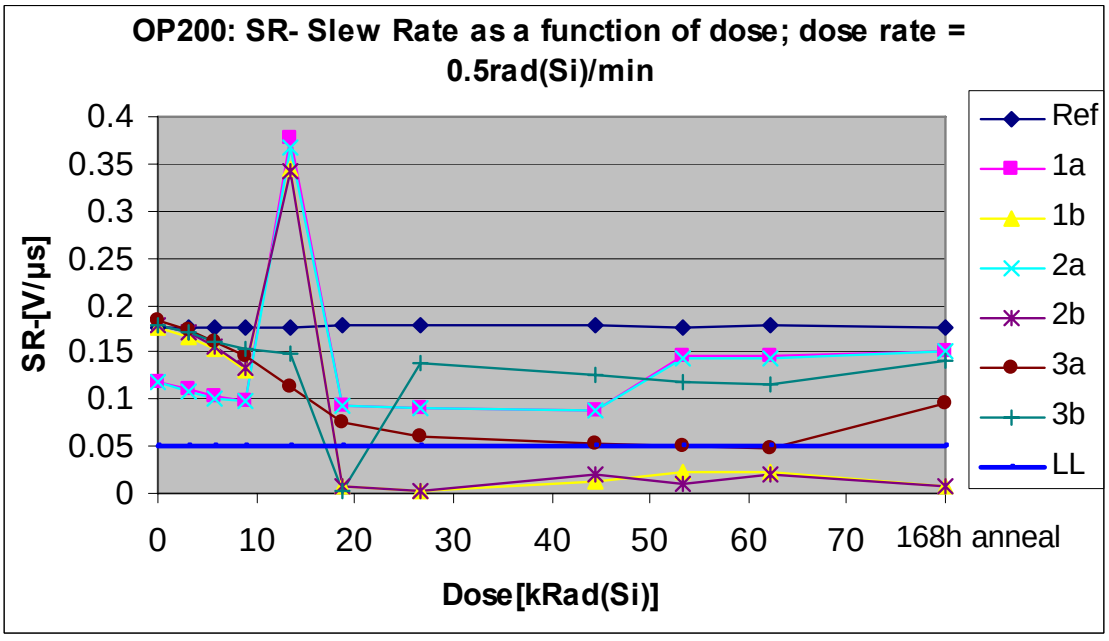

Figure 12: OP200 negative slew rate as a function of dose; gamma 0.5 rad(Si)/min

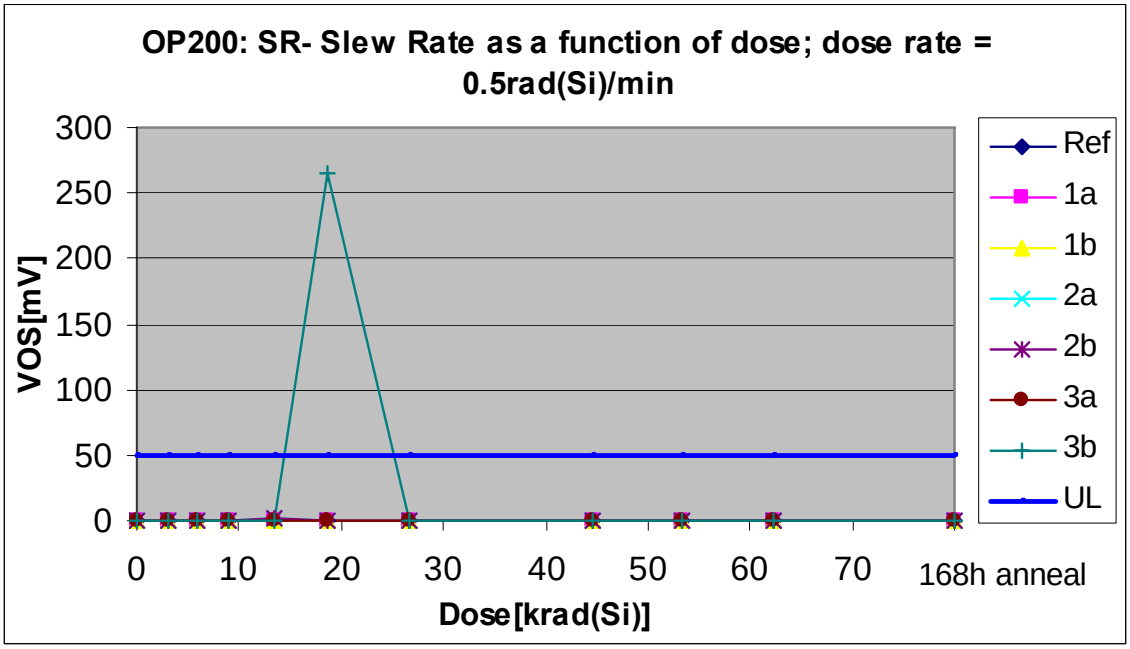

Figure 13: OP200 input offset voltage as a function of dose; gamma 0.5 rad(Si)/min

4 CONCLUSION

Irradiation tests of the OP200 devices were performed to investigate the component's suitability for flight. Biased devices illustrated an anomalous increase in Ios (and noticeable change in other parameters) at the 13.4krad(Si) measurement point. The reference and unbiased device results at the same irradiation step were nominal indicating correct operation of the measurement system. Interestingly, all parameters had recovered to nominal values from the 18.7krad(Si) measurement point except for SR+ and SR- for devices 1b and 2b that significantly below specified limits (impacting the AC performance of the device).

The unbiased device performed nominally up to 44.5krad(Si) with the exception of device 3b for which parameters Vout+, SR- and VOS were out of specification at 18.7krad(Si). Additionally, device 3a was below specified limit for SR- at 62.3krad(Si) (recovers after anneal) and device 3b below spec for SR+ at 53.4 and 62.3krad(Si) (recovers after anneal).

The test results indicate that the OP200 (DC0304), considering the biasing scheme employed, performs well up to a TID level of 10krad. However, between 8.9 and 13.4krad(Si) Ios is out of specification (recovery is observed between 13.4 and 18.7krad(Si)) and SR+ / SR- out of specification from 18.7krad(Si). Thus, above 8.9 to 13.4krad(Si) the suitability of the OP200 is questionable and needs to be critically assessed seen in view of application requirements. Unbiased devices performed well up to 44.5krad(Si).