esa DOCUMENT

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Radiation Test Report for Enhanced Low Dose Rate Sensitivity (ELDRS) Testing

OP484

OP484FP

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CHANGE RECORD

Issue: 1 Revision: 1

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Test Report Number	ESA_QCA0503T_I
Project	
SCC Component no.	
Component Designation	Precision, rail-to-rail input and output, quad op-amp OP484
Irradiation Spec. no.	
Family	Operational amplifiers
Group	Silicon Monolithic
Package	CERDIP-14, Flat Pack-14
Component Specification	
Test House Name	ESA / ESTEC
Irradiation Test Plan Number	
Manufacturer name	Analog Devices
Application type of Acceptance	
Serial Number of samples	Five (5) samples serialised for each package type as Ref, 1, 2, 3 and 4
Manufacturing Date Code	0239 (DIP version), 0247 (FP version)
Irradiation Measurement Interval: Biased Unbiased: Circuit Reference: Supply Voltage: Temp ^{o}C: Duration:	 Yes (3 parts) Yes (1 part) ±5V Room temperature 20 ± 3 29 days
Electrical Measurement Parameters	IOS, IB, IS, AV0, 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	 No Yes 29 days and 3 months at room temperature followed by 6 days at 100°C

1 INTRODUCTION

The following document contains the TID Radiation Test Report for OP484 (DIL and FP packages) precision, rail-to-rail input and output, quad operational amplifier.

2 APPLICABLE DOCUMENTS

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

3 TEST DESCRIPTION

Five (5) OP484 CERDIP and 5 OP484 FP (Analog 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.

For each package type, of the selected devices, one was assigned as a reference device while, four were serialised for radiation exposure (three 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 one OP484 and one OP484 FP. A small adaptor board (DIL→FP) was made so as to hold the OP484 FP and to plug it into the radiation and SZ header board. The biasing scheme of the operational amplifiers is illustrated in Figure 1. The device operating conditions, temperature conditions and applied dose rates are listed in Table 1.

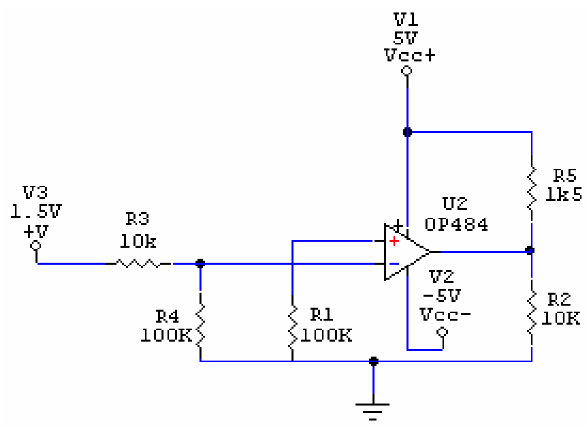

Figure 1: OP484 (DIL and FP) biasing conditions for irradiation

Table 1: Irradiation Test Conditions

Parameter	Dev 425	Dev 426 Biased	Dev 429 Biased	Dev 431 Biased	Dev 427 Unbiased
Bias During Irradiation	NA	+1.5V	+1.5V	+1.5V	NO
Dose Rate	NA	0.5rad(Si)/min	0.5rad(Si)/min	0.5rad(Si)/min	0.5rad(Si)/min
Irradiation Temperature	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C	20 ± 3 ^{o}C

3.1 Measurement set-up

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

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

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 and Table 3 list all parametric measurements performed and their limit values for both package types.

Table 2 : OP484 parameters measured by the SZ parametric Test System

Test Parameter	Limit
Input offset voltage VOS	Upper 0.25mV
Input offset current IOS	Upper 50nA
Input bias current IB	Upper 350nA
Supply Current IS	Lower 0mA Upper 8mA
Large signal voltage gain AV0	Lower 62dB

Table 3: OP484 FP parameters measured by the SZ parametric Test System

Test Parameter	Limit
Input offset voltage VOS	Upper 0.25mV
Input offset current IOS	Upper 50nA
Input bias current IB	Upper 350nA
Supply Current IS	Lower 0mA Upper 8mA
Large signal voltage gain AV0	Lower 62dB

The time between irradiation stop, performing parametric measurements and starting irradiation for all irradiation steps were less than 30min. 21 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.

Table 4: Irradiation and measurement history

Irradiation steps	Dev 425	Dev 426 Biased	Dev 429 Biased	Dev 431 Biased	Dev 427 Unbiased
Pre-rad. Par. measurements	Yes	Yes	Yes	Yes	Yes
0.72 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
1.34 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
2.02 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
3.94 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
4.6 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
5.27 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
5.94 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
6.59 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
8.66 krad(Si)					

Par. Measurements	Yes	Yes	Yes	Yes	Yes
9.34 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
10.03 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
11.03 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
11.78 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
13.77 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
14.42 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
15.21 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
15.95 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
16.68 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
18.86 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
19.56 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
20.02 krad(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

Results for each component type (figures 2 to 8 for the OP484 and 9 to 15 for the OP484FP) are presented for all measured parameters: the curves show the variation of the parameters as a function of dose. For ease of visualization the average of the three biased parts are illustrated. This is also the case for the unbiased part (the average of the quad op-amp).

OP484:

Ios (biased device) out of specification between 2.1 and 3.9 krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

-Ib (biased device) out of specification between 4.6 and 5.2 krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

+Ib (biased device) out of specification between 8.6 and 9.3 krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

Ios (unbiased device) out of specification between 11.7 and 13.7 krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

-Ib (unbiased device) out of specification between 4.6 and 5.2krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

+Ib (unbiased device) out of specification between 4.6 and 5.2krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

Remaining parameters within specification up to 20krad(Si)

OP484FP:

Ios (biased device) out of specification between 3.9 and 4.6krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

-Ib (biased device) out of specification between 11.7 and 13.7 krad(Si). Slight improvement after room temperature anneal. Significant improvement after +100^{o}C anneal.

Vos (biased devices) out of specification after +100^{o}C anneal.

Remaining parameters within specification up to 20krad(Si)

3.4.1 OP484

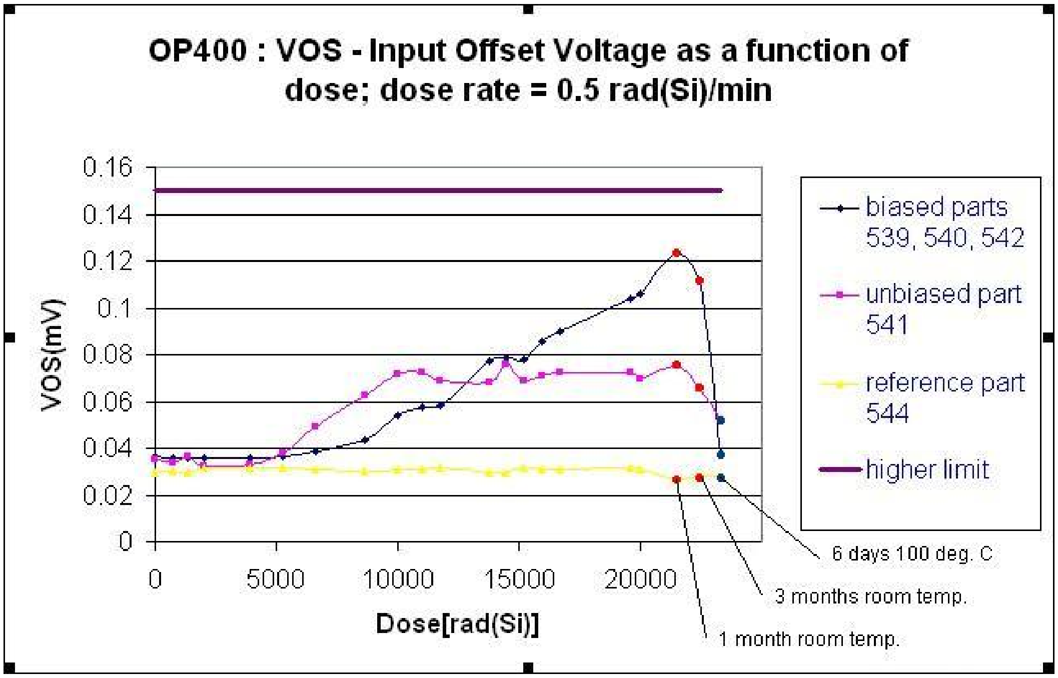

Figure 2: OP484 input offset voltage as a function of dose; gamma 0.5 rad(Si)/min

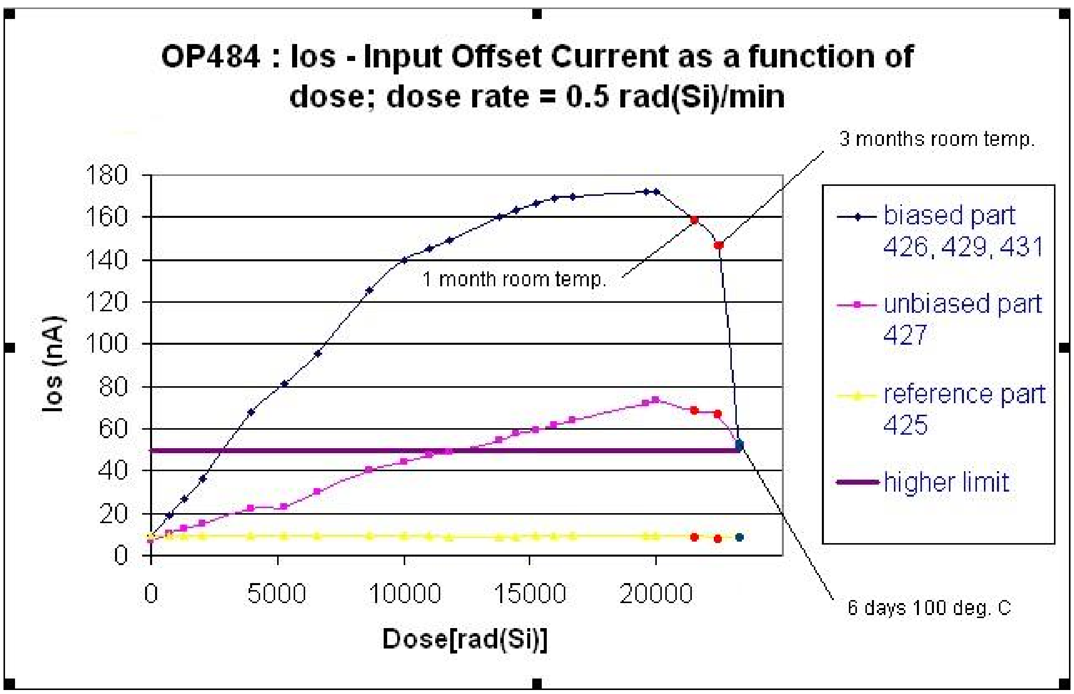

Figure 3: OP484 input offset current as a function of dose; gamma 0.5 rad(Si)/min

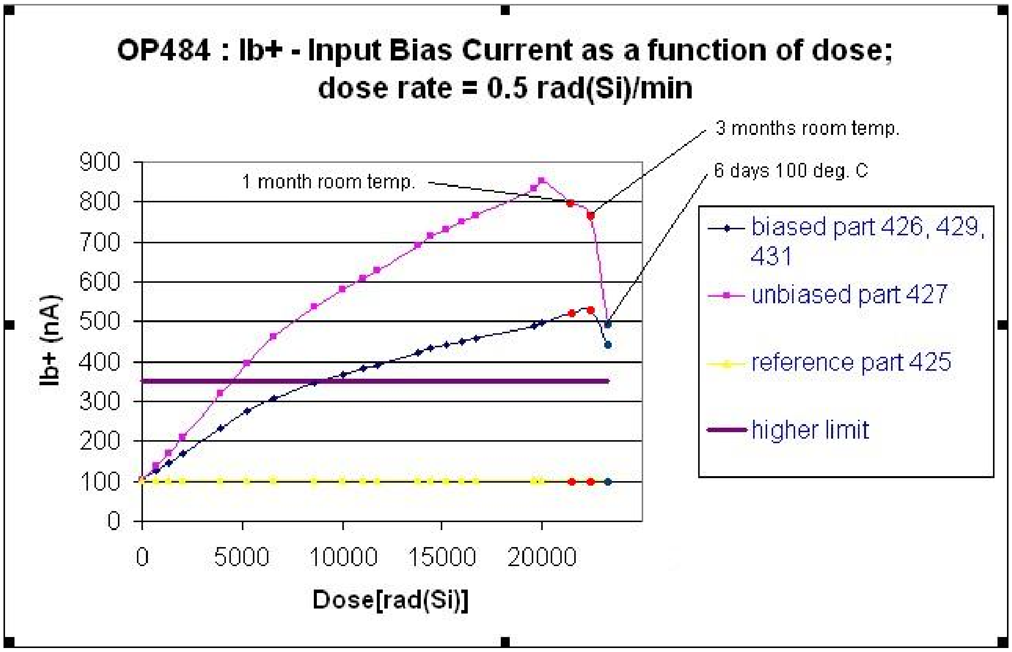

Figure 4: OP484 positive input bias current as a function of dose; gamma 0.5 rad(Si)/min

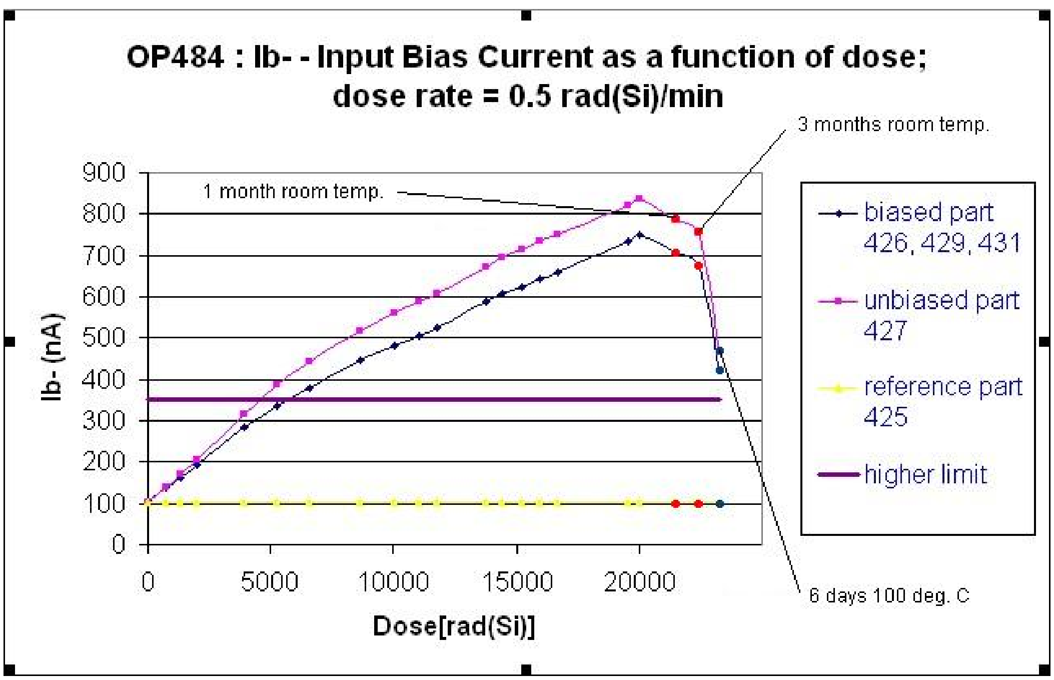

Figure 5: OP484 negative input bias current as a function of dose; gamma 0.5 rad(Si)/min

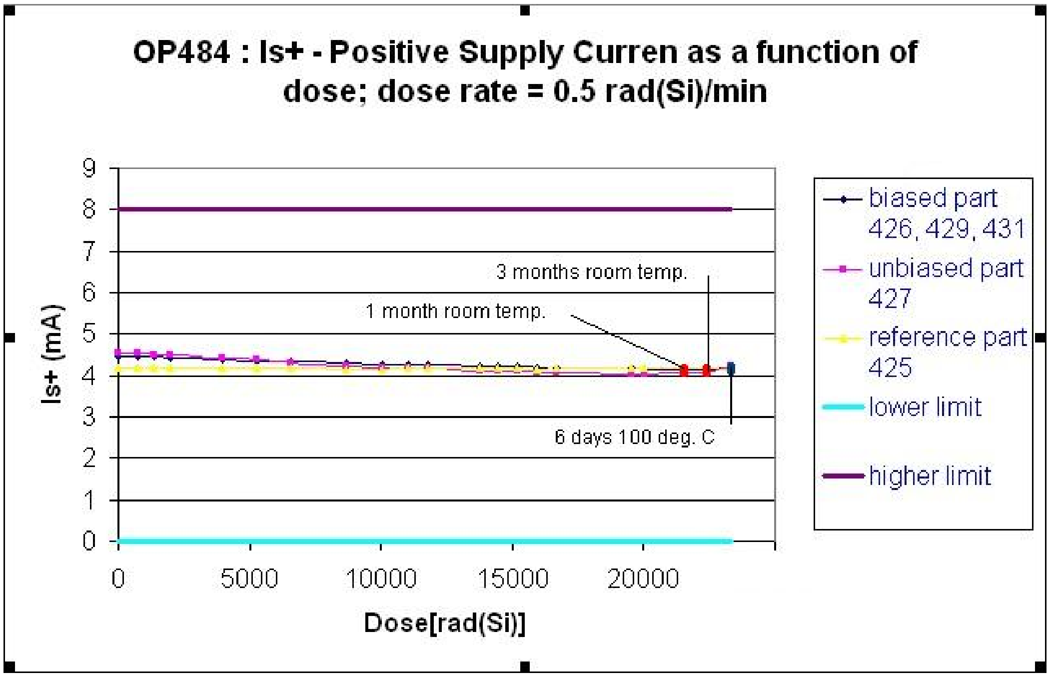

Figure 6: OP484 positive supply current as a function of dose; gamma 0.5 rad(Si)/min

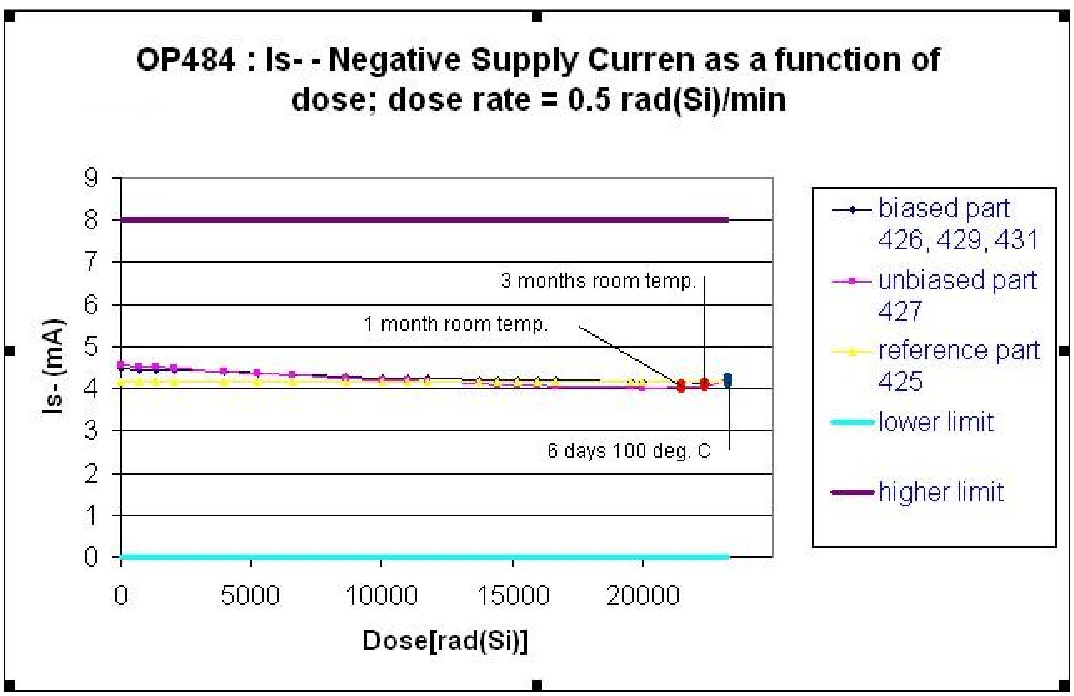

Figure 7: OP484 negative supply current as a function of dose; gamma 0.5 rad(Si)/min

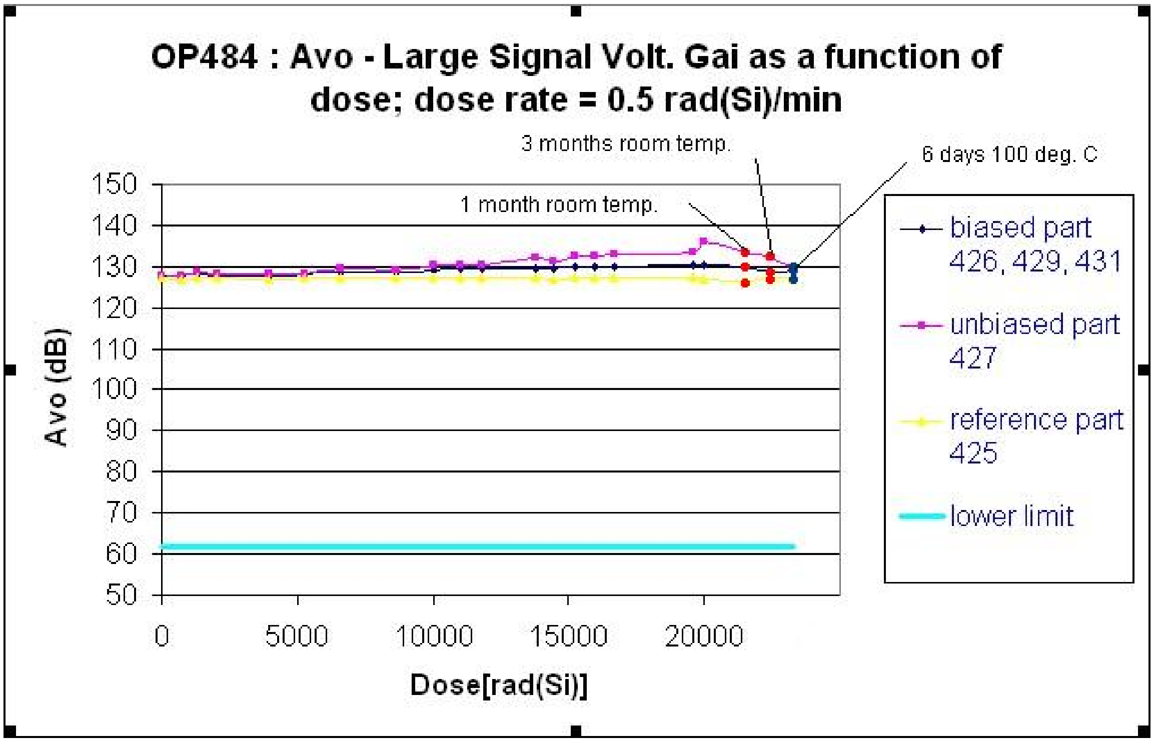

Figure 8: OP484 large signal voltage gain as a function of dose; gamma 0.5 rad(Si)/min

3.4.2 OP484FP

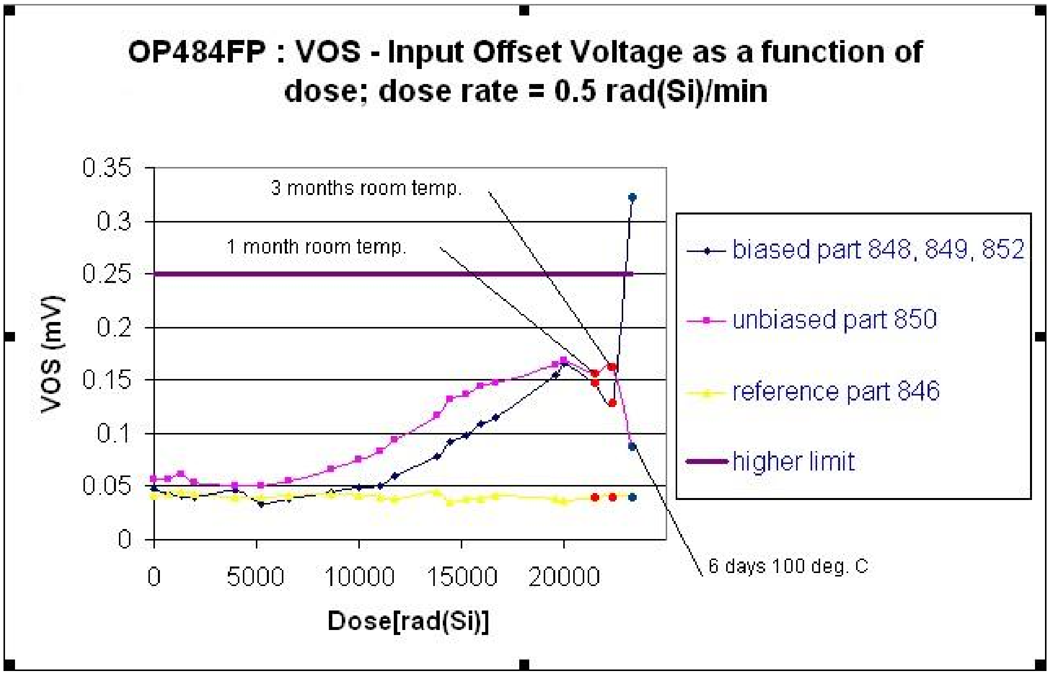

Figure 9: OP484 FP input offset voltage as a function of dose; gamma 0.5 rad(Si)/min

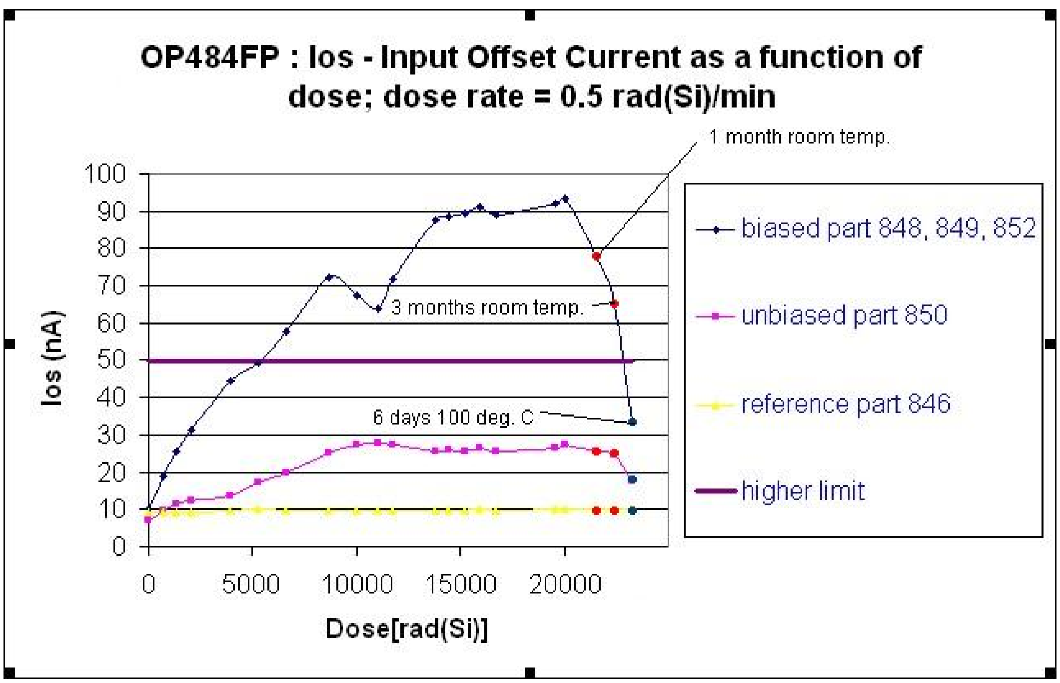

Figure 10: OP484 FP input offset current as a function of dose; gamma 0.5 rad(Si)/min

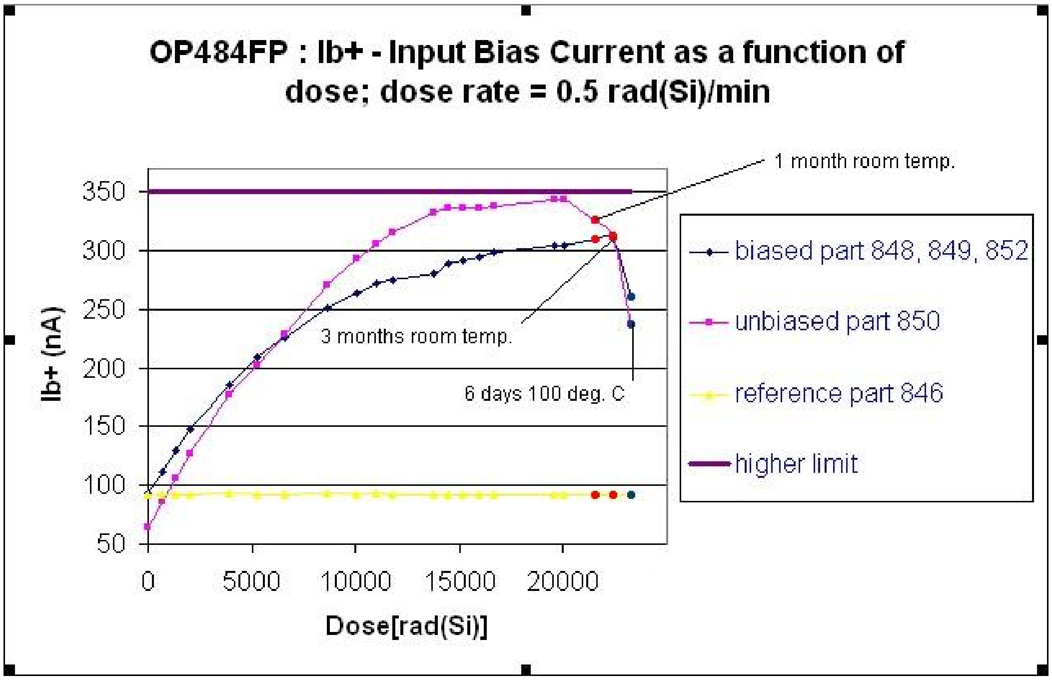

Figure 11: OP484 FP input bias current as a function of dose; gamma 0.5 rad(Si)/min

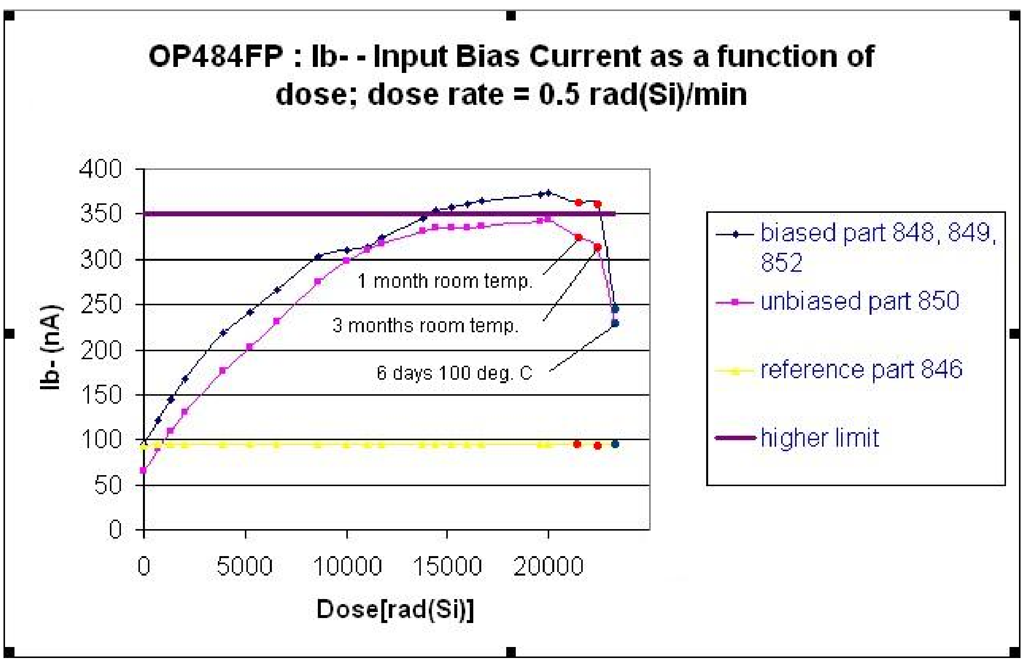

Figure 12: OP484 FP negative input bias current as a function of dose; gamma 0.5 rad(Si)/min

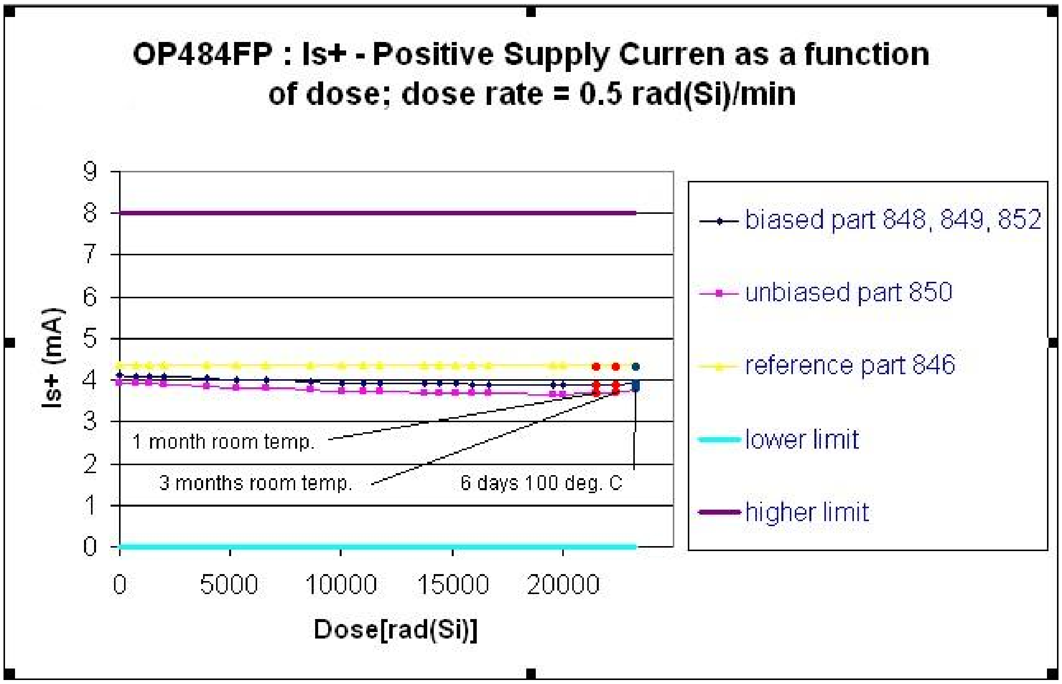

Figure 13: OP484 FP positive supply current as a function of dose; gamma 0.5 rad(Si)/min

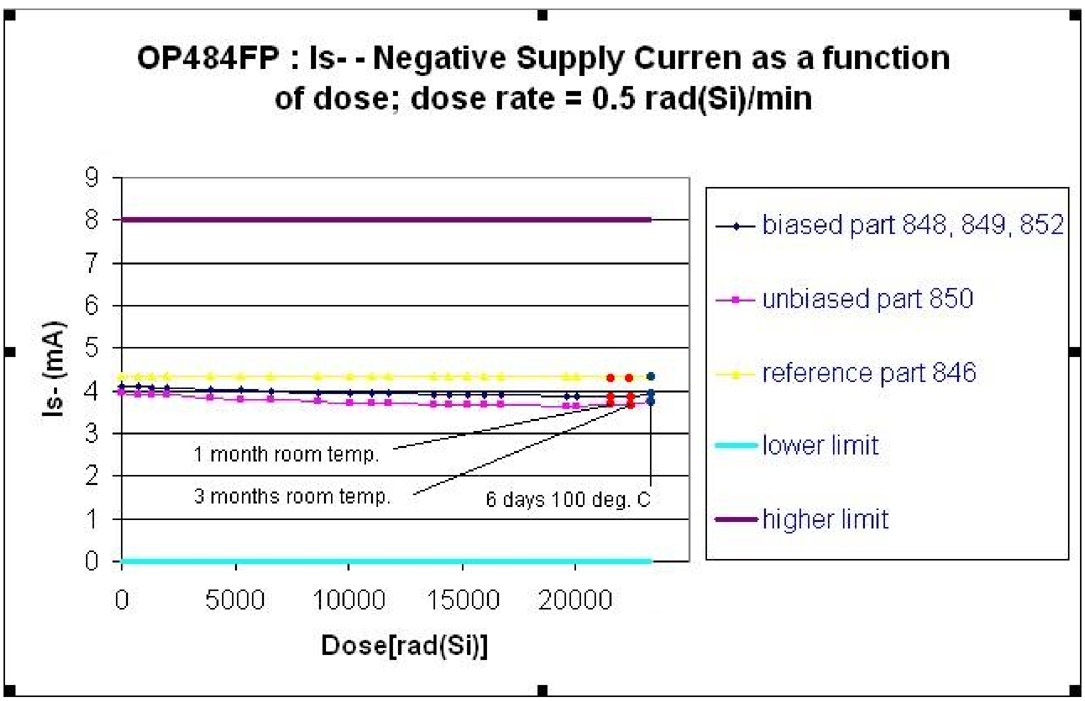

Figure 14: OP484 FP negative supply current as a function of dose; gamma 0.5 rad(Si)/min

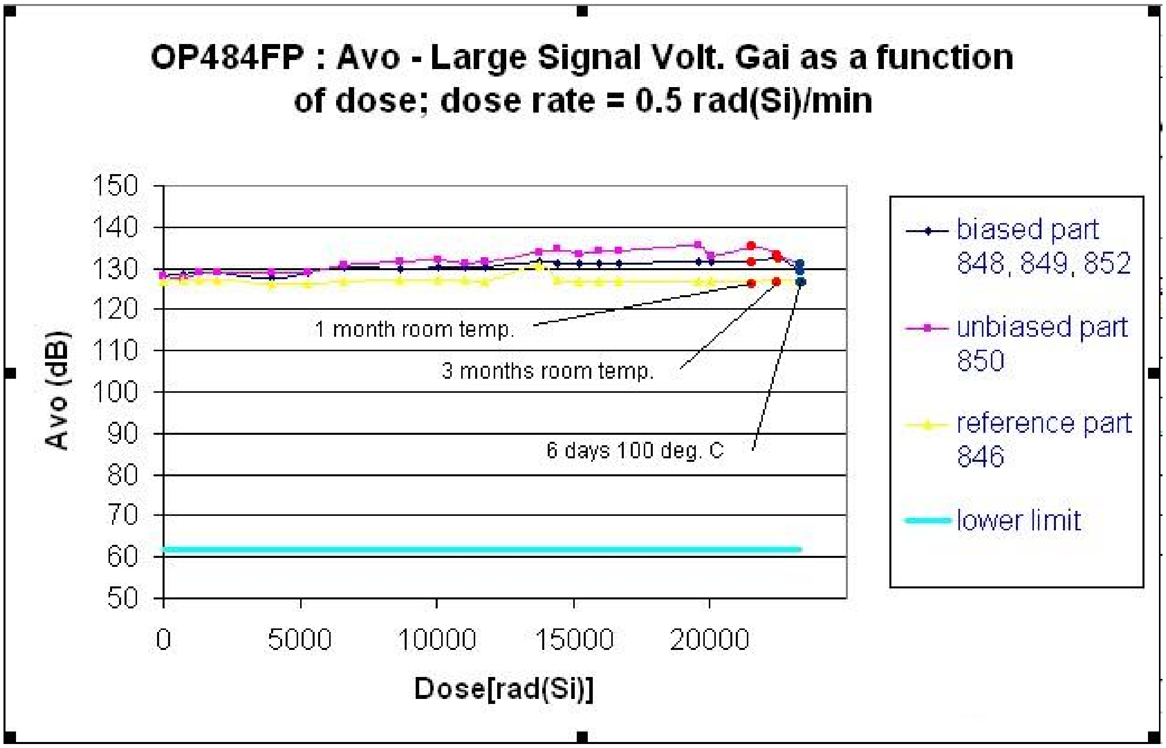

Figure 15: OP484 FP large signal voltage gain as a function of dose; gamma 0.5 rad(Si)/min

4 CONCLUSION

Irradiation tests on the 100krad radiation tolerant OP484 (both CERDIP and Flat Pack versions) were performed to investigate the component's susceptibility to ELDRS. Most device parameters were within specification up to a level of 20krad(Si) even though some degraded. The following parameters for the CERDIP package, biased devices were out of specification at relatively low TID values; Ios between 2.1 and 3.9 krad(Si); -Ib between 4.6 and 5.2krad(Si); +Ib between 8.6 and 9.3krad(Si). The following parameters for the Flat Pack biased devices were out of specification at relatively low TID values; Ios between 3.9 and 4.6 krad(Si); -Ib between 11.7 and 13.7krad(Si). The Flat Pack versions seem to suffer less from ELDRS than the CERDIP package version (it has to be emphasised that these have two different date codes).

The results indicate a bias dependency for some of the parameters. Most parameters remained unchanged or improved with room temperature annealing and most parameters improved after the +100°C annealing period.