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DOCUMENT

document title/ titre du document

RADIATION TEST REPORT

2N5154

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reference/*réference*
issue/*édition* 1
revision/*révision* 0
date of issue/*date d'édition* 27 February 2007
status/*état* Draft
Document type/*type de document* Radiation Test Report
Distribution/*distribution*

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Agence spatiale européenne

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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_QCA0703T_I
Project	
SCC Component no.	
Component Designation	NPN Transistor
Irradiation Spec. no.	
Family	Transistors
Group	Silicon
Package	T0-39
Component Specification	
Test House Name	ESA / ESTEC
Irradiation Test Plan Number	
Manufacturer name	Microsemi
Application type of Acceptance	
Serial Number of samples	Four (4) samples serialised as 0612, 0817, 0884 and 0577 (Ref)
Manufacturing Date Code	9927
Irradiation Measurement Interval: Biased Unbiased: Circuit Reference: Supply Voltage: Temp ^{o}C: Duration:	 Yes (2 parts – 0612 & 0817) Yes (1 part - 0884 +60V Room temperature 20 ± 3
Electrical Measurement Parameters	VCE (BR), ICB0, IEB0, VCE (sat), hfe1 (DC) & ICE0 Cut-off
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°C No Yes

1 INTRODUCTION

The following document contains the TID Radiation Test Report for 2N3810 dual pnp transistor for the project.

2 APPLICABLE DOCUMENTS

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

3 TEST DESCRIPTION

Four (4) 2N5154, 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 (0577) while, three were serialised for radiation exposure (0612 & 0817 biased and 0884 unbiased). After each exposure-step the components were removed and tested on the SZ-test system for parametric measurements. Each irradiation test-board accommodated the biased and unbiased 2N5154 devices. The biasing scheme of the transistors 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.

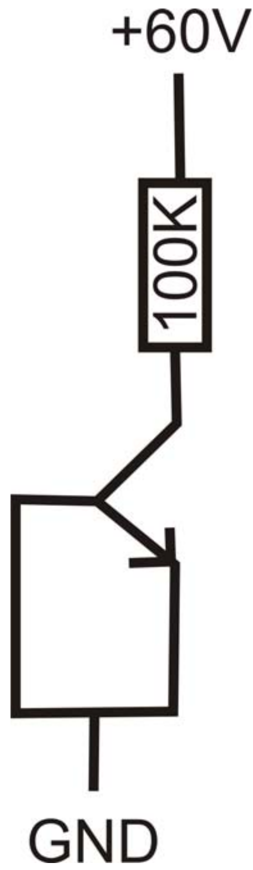

Figure 1: 2N5154 irradiation biasing conditions

Figure 2 2N5154 package

Table 1: irradiation Test Conditions

Parameter	Ref	Dev1	Dev2	Dev3
Bias During Irradiation	NA	+60V	+60V	0V
Dose Rate	NA	0.5rad(Si)/min	0.5rad(Si)/min	0.5rad(Si)/min
Irradiation Temperature	NA	20 ± 3 °C	20 ± 3 °C	20 ± 3 °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 TA07B Test Adapter
- Software UTS-Version 2.5.1

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

Parameter	Unit	LL	UL
VCE0 (BR)	V	80	200
IEB0	nA		1000
VCE (sat)	mV	0	750
hfe1 (DC)		7	1000
ICE0 - Coll. Cutoff Current	uA		50
VBE(sat) - B-E Saturation Volt	mV	0	1450

Table 2: 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 45min. 9 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
Pre-rad. Par. measurements	Yes	Yes	Yes	Yes
3.0 krad(Si)				
Par. measurements	Yes	Yes	Yes	Yes
5.8krad(Si)				
par. measurements	Yes	Yes	Yes	Yes
8.9krad(Si)				
par. measurements	Yes	Yes	Yes	Yes
13.3krads(Si)				
par. measurements	Yes	Yes	Yes	Yes
19.1krad(Si)				
Par. Measurements	Yes	Yes	Yes	Yes
26.7krad(Si)				
Par Measurements	Yes	Yes	Yes	Yes
44.5krad(Si)				
par. measurements	Yes	Yes	Yes	Yes
53.4krad(Si)				
par. measurements	Yes	Yes	Yes	Yes
62.3krad(Si)				
par. measurements	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 2N5154 are presented in **Error! Reference source not found.** to **Error! Reference source not found.**8

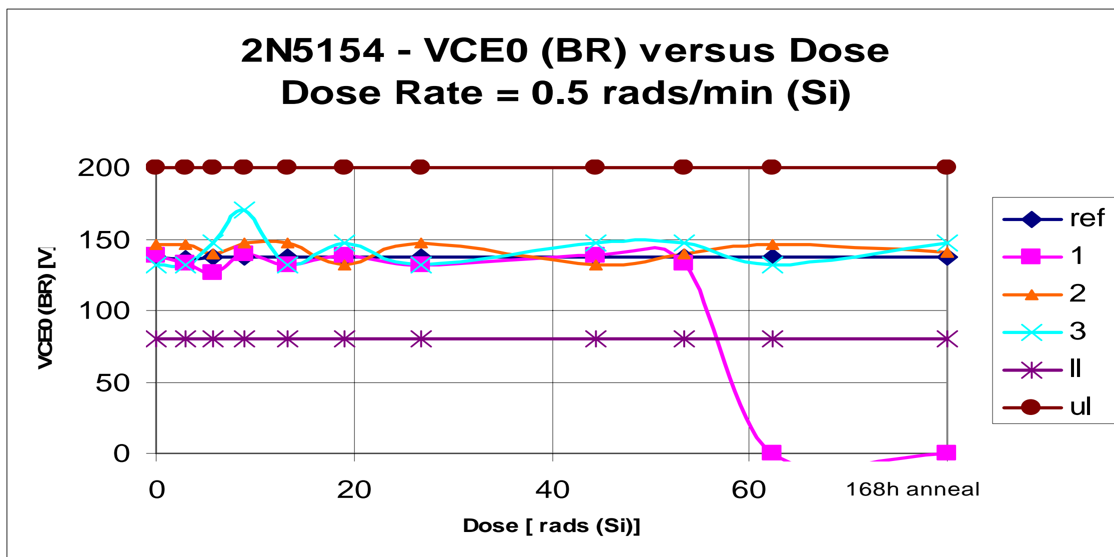

Fig 3. VCE0 (BR) versus Dose [Dose Rate=0.5 rads/min(Si)]

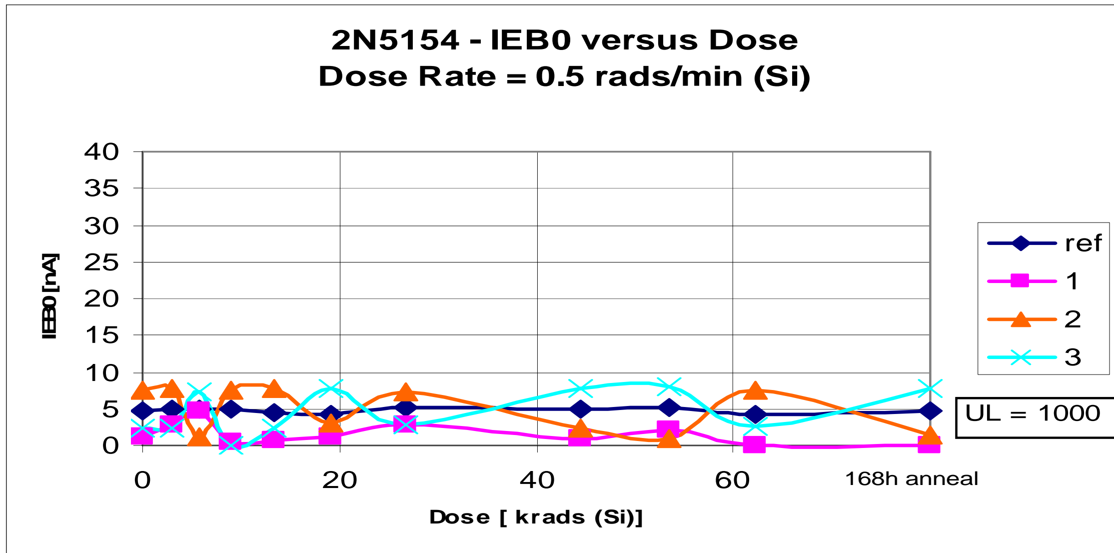

Fig 4. IEB0 versus Dose [Dose Rate=0.5 rads/min(Si)]

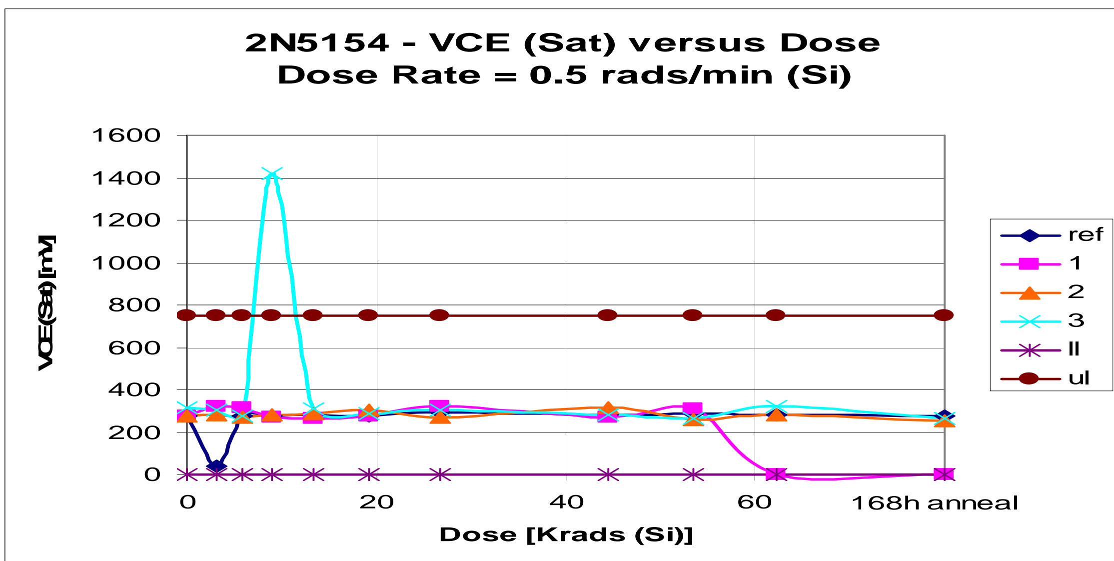

Fig 5. VCE (sat) versus Dose [Dose Rate=0.5 rads/min(Si)]

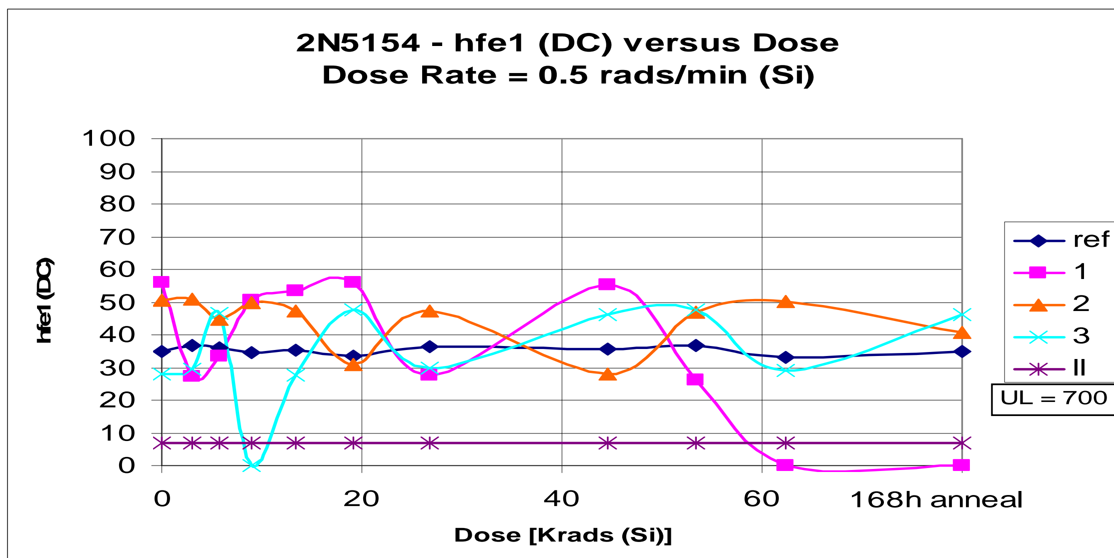

Fig 6.hfe1 (DC) versus Dose [Dose Rate=0.5 rads/min(Si)]

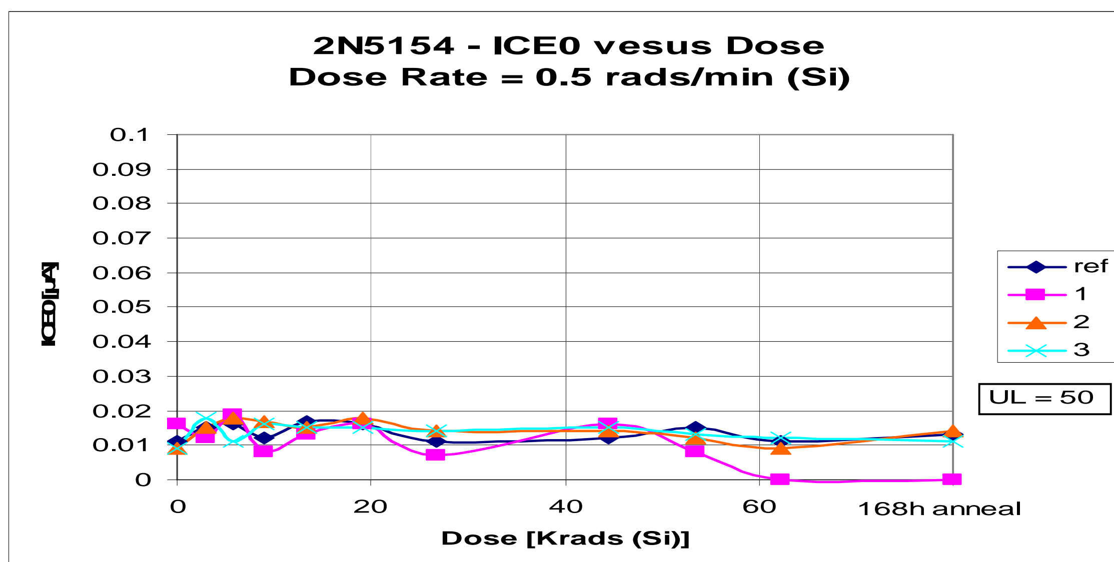

Fig 7. ICE0 Cut Off versus Dose [Dose Rate=0.5 rads/min(Si)]

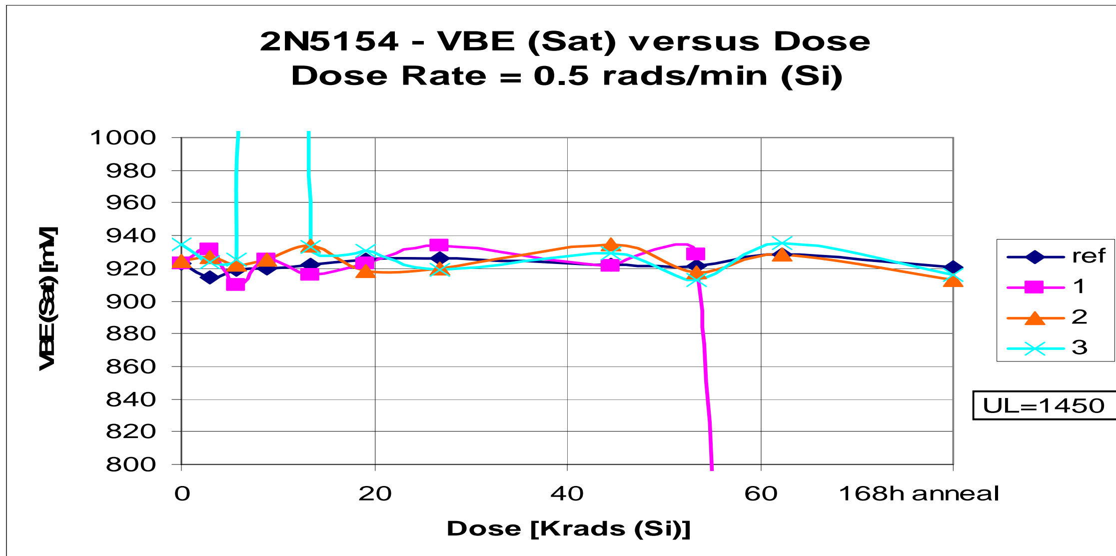

Fig 8.VBE (sat) versus Dose [Dose Rate=0.5 rads/min(Si)]

4 CONCLUSION

Irradiation tests of the 2N5154 devices were performed to investigate the component's suitability for flight.

Device 1 goes outside limits for VCE (sat) and VBE (sat) at 62Krads and dose not recover after annealing. As no other devices show this strange effect it is possible that it was due to a bad connection during the SZ measurement; especially as IEB0 registers only 0.013nA at 8.9Krads.

Device 3 shows anomalous behaviour at 8.9Krads for VCE (sat) , hfe1 (DC) and VBE (sat) but recovers by 13.3Krads.