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

LM117

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Issue: 1 Revision: 1

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Table Of Contents

Test Report Number	ESA_QCA0504T_I
Project	
SCC Component no.	
Component Designation	Adjustable, positive voltage regulators LM117
Irradiation Spec. no.	
Family	Voltage regulators
Group	Silicon Monolithic
Package	TO39(LM117), [TO220(LM317) employed as reference device]
Component Specification	
Test House Name	ESA / ESTEC
Irradiation Test Plan Number	
Manufacturer name	National Semiconductor
Application type of Acceptance	
Serial Number of samples	Two (2) samples serialised as 1 and 2 for LM117; One sample of LM317 employed as a reference device
Manufacturing Date Code	
Irradiation Measurement Interval: Biased Unbiased: Circuit Reference: Supply Voltage: Temp ^{o}C: Duration:	 Yes LM117 No ±15V Room temperature 20 ± 3 29 days
Electrical Measurement Parameters	Vout, Vref, Iout, DOV, RegLine
Facility Source: Energy: Dose Rate: Absorbed Material: Thickness: Temperature ^{o}C:	 60Co 0.5rad(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 1 week and 1 month at room temperature, followed by 6 days at 100^{o}C

1 INTRODUCTION

The following document contains the TID Radiation Test Report for LM117 adjustable positive voltage regulators. As part of an ELDRS characterisation programme these devices were included in a low dose rate irradiation test campaign to identify their susceptibility to ELDRS. The LM137 was employed as a reference device due to the low number of available LM117 devices.

2 APPLICABLE DOCUMENTS

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

3 TEST DESCRIPTION

Two (2) LM117 National Semiconductor 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.

Two LM117 were serialised and irradiated biased while one LM137 was employed as a reference device. After each irradiation exposure-step the components were removed and parametric measurements performed on the SZ-test system. The irradiation test-board accommodated and biased two LM117 devices. The biasing scheme of the voltage regulators is illustrated in Figure 1. The device operating conditions, temperature conditions and applied dose rates are listed in Table 1.

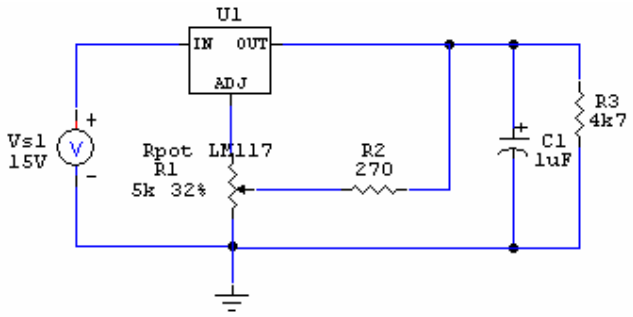

Figure 1: LM117 irradiation biasing conditions

Parameter	Ref. Dev.	Part A	Part B
Bias During Irradiation	NA	+15V	+15V
Dose Rate	NA	0.5rad(Si)/min	0.5rad(Si)/min
Irradiation Temperature	20 ± 3 °C	20 ± 3 °C	20 ± 3 °C

Table 1 Irradiation Test Conditions

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 TA03B Test Adapter
- Software UTS-Version 2.5.1

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

Table 2: LM117 parameters measured by the SZ parametric Test System

Test Parameter	Limit
Output voltage Vout	Lower 11.25V Upper 13V
Reference voltage Vref	Lower 1.2V Upper 1.3V
Output current Iout	Lower 4mA Upper 7mA
Output current Iout	Lower 4mA Upper 7mA
Dropout voltage DOV	Lower 1.5V Upper 2.3V
Line regulation RegLine	Lower –6.5mV Upper 6.5mV
Line regulation RegLine	Lower –0.625mV Upper 0.625mV
Line regulation RegLine	Lower –6mV Upper 6mV

The time between irradiation stop, performing parametric measurements and starting irradiation for all irradiation steps were less than 30min. 17 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 3 lists the irradiation and measurement history. Unfortunately, the current SZ set-up was incapable of measuring the device load regulation.

Table 3: Irradiation and measurement history

Irradiation steps	Ref. Dev.	Dev1 Biased	Dev2 Biased	Dev3 Biased	Dev4 Unbiased
Pre-rad. Par. measurements	Yes	Yes	Yes	Yes	Yes
0.59 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
1.3 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
2 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
4.2 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
5.1 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
5.95 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
6.72 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
10.3 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
11 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
11.7 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
12.4 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
14.5 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
15.2 krad(Si)					
par. measurements	Yes	Yes	Yes	Yes	Yes
15.9 krad(Si)					
Par. Measurements	Yes	Yes	Yes	Yes	Yes
16.8 krad(Si)					
Par Measurements	Yes	Yes	Yes	Yes	Yes
17.6 krad(Si)					

par. measurements	Yes	Yes	Yes	Yes	Yes
19.8 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 LM117 Test Results

The irradiation test results for LM117 are illustrated in figures 2 to 9. Up to a total dose of 19.8 krad(Si) all parameters were within specification (except RegLine2vref that was out of spec already pre-irradiation). However, after the first room temperature annealing Vref drifted out of specification. Additional degradation was observed on Vref after the second room temperature annealing. Although not out of specification, the following parameters degraded during the two room temperature annealing periods: Vo, I_OutNormal and I_OutRef. An improvement in the parameters that drifted was observed after the high temperature anneal period.

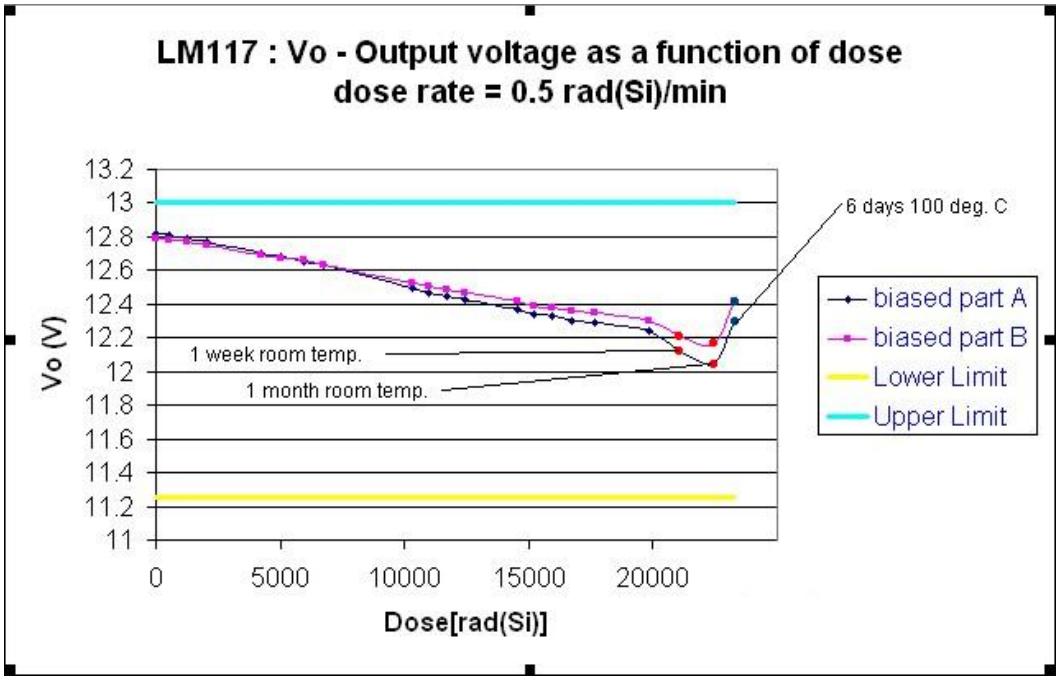

Figure 2: LM117 output voltage as a function of dose; gamma 0.5 rad(Si)/min

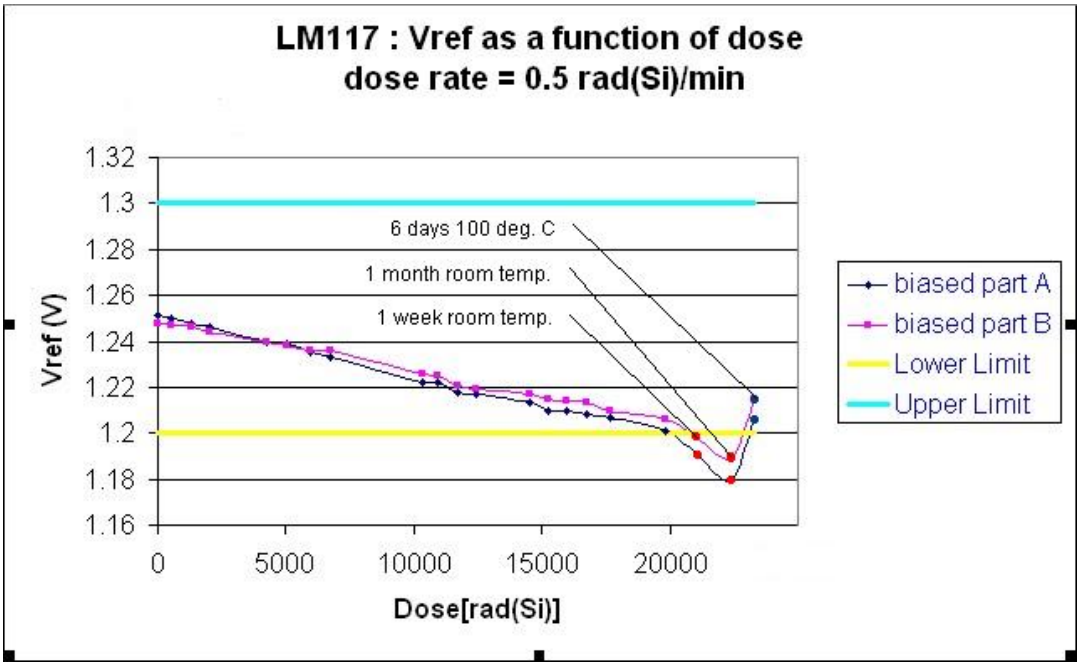

Figure 3: LM117 reference voltage as a function of dose; gamma 0.5 rad(Si)/min

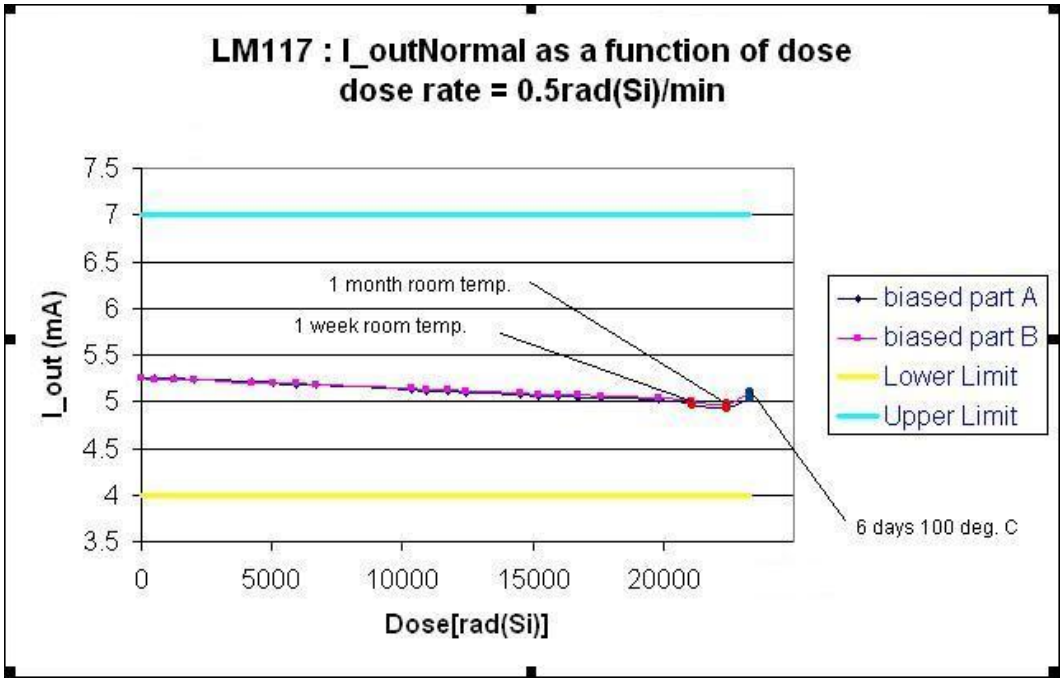

Figure 4: LM117 output current as a function of TID; gamma 0.5 rad(Si)/min

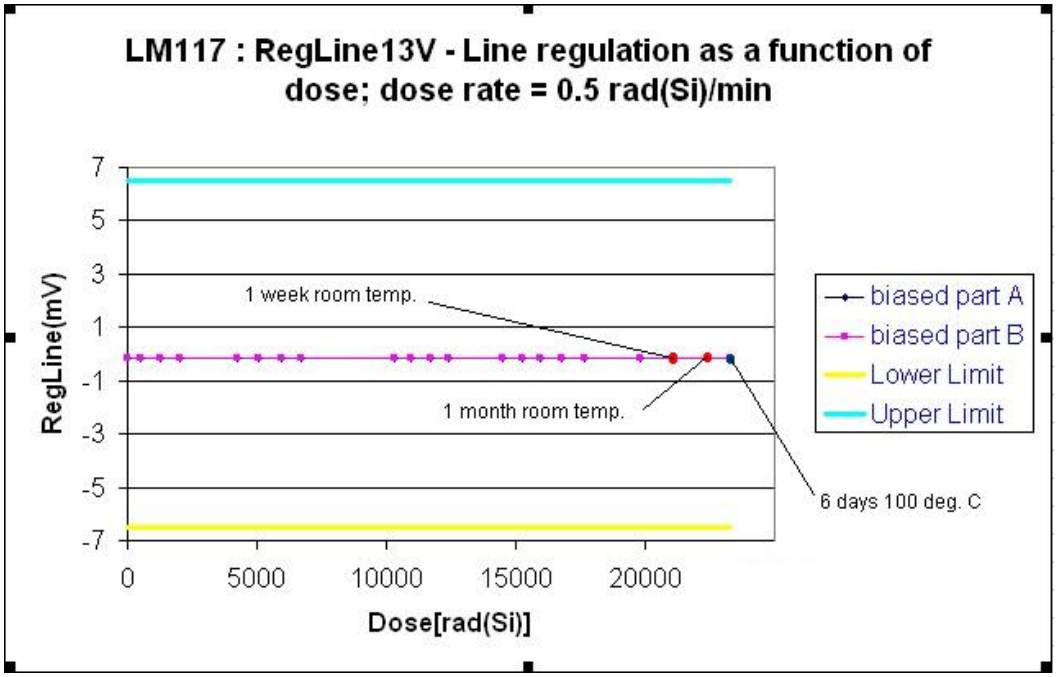

Figure 5: LM117 Line regulation as a function of dose; gamma 0.5rad(Si)/min

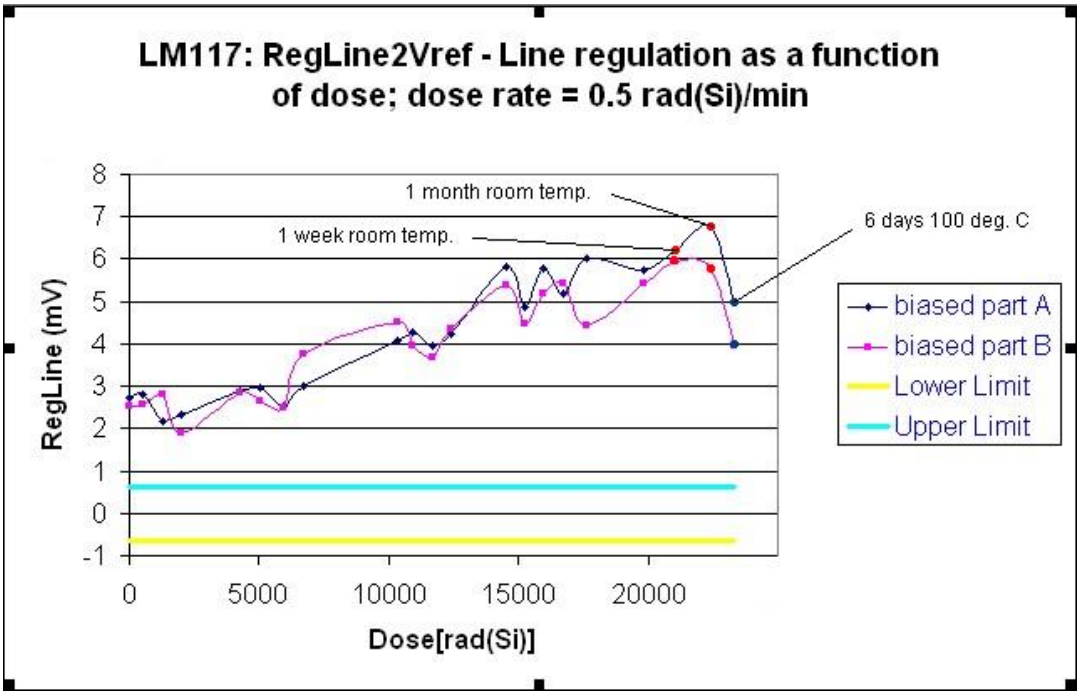

Figure 6: LM117 Line regulation as a function of dose; gamma 0.5rad(water)/min

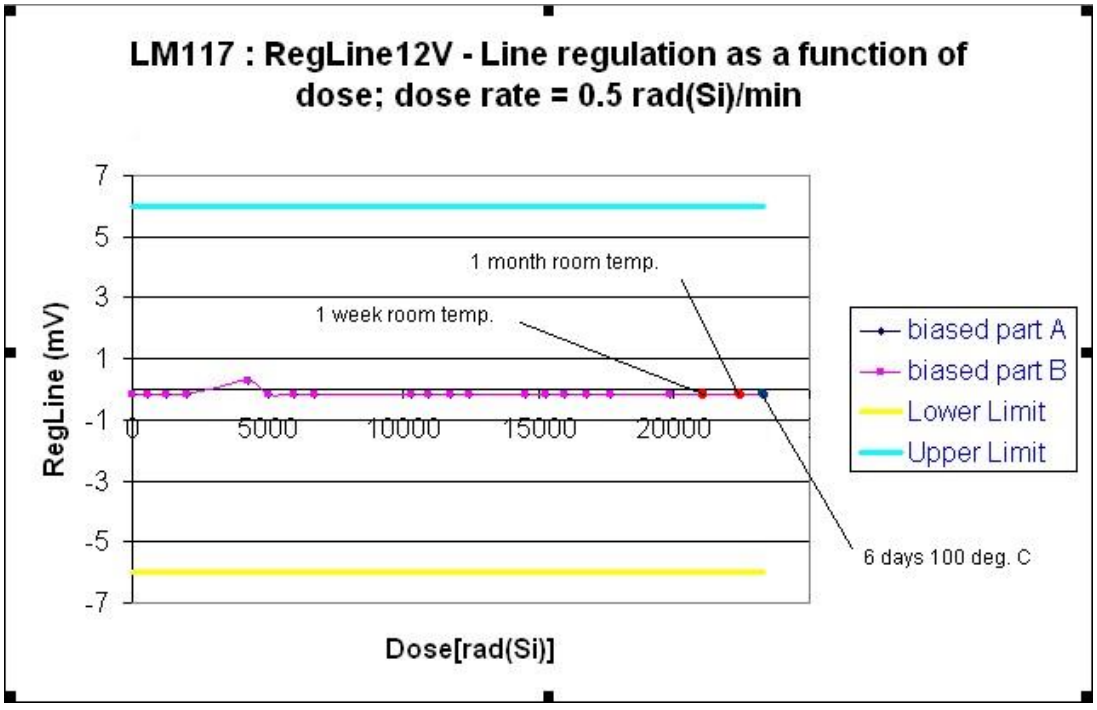

Figure 7: LM117 Line regulation as a function of dose; gamma 0.5rad(Si)/min

4 CONCLUSION

Irradiation tests on the 100krad radiation tolerant National Semiconductors LM117 were performed to investigate the component's susceptibility to ELDRS. Most device parameters were within specification up to a level of 19.8krad(Si) even though many parameters degraded. One parameter, RegLine2Vref, was outside specification pre-irradiation and illustrated increased degradation after each irradiation step. Vref was out of specification after the first room temperature annealing period and degraded further after the second room temperature annealing period. All drifted parameters illustrated improved after the +100^{o}C annealing period.

Unfortunately, the SZ test system was incapable of measuring the Load Regulation parameter.