PROTONS TEST REPORT

ESA study: “Survey of Critical Components for 150 kRad Power Systems”

ESTEC Contract N° 22831/09/NL/AF refers

Part Type : IS2-1009RH

Package : TO-206AB

Description : Rad Hard 2.5V Reference

Manufacturer: Intersil

Alter Technology Group Spain Purchase Order N° ATGSP-TL-09-JC-CO-9 dated 11/27/2009

Alter Technology Group Spain Project Manager: David NUNEZ

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CHANGE RECORD

ISSUE	DATE	PAGE	DESCRIPTION OF CHANGES
01	June 7th, 2011	All	Original Issue

PROTONS TEST REPORT
on
IS2-1009RH
Rad Hard 2.5V Reference

From Intersil

TABLE OF CONTENTS

List of figures:

List of Tables:

1 Introduction

In the scope of the ESA study: “Survey of Critical Components for 150 kRad Power Systems”, a protons test of the Intersil IS2-1009RH, Rad Hard 2.5V Reference has been performed up to a total fluence of about 2E11 p/cm^2, in response to Alter Technology Group Spain purchase order reference ATGSP-TL-09-JC-CO-9 that refers to ESTEC contract N° 22831/09/NL/AF.

Displacement damage effects were investigated using 60 MeV protons energy. Devices were irradiated at UCL in Louvain - Belgium.

The purpose of this test was to characterize degradation due to proton displacement damage so a further mission analysis could determine their suitability for flight use. This test was conducted on samples provided by Alter Technology Group Spain.
Test has been performed in accordance with Hirex Engineering Radiation Test Plan HRX/SPE/0235 issue 3 dated 09/21/2010.

A complete set of electrical measurements together with graphical representation of measured parameters with respect to Equivalent Fluence levels received is also provided.

2 Applicable and Reference Documents

2.1 Applicable Documents

- Hirex Engineering Radiation Test Plan: HRX/SPE/0235 issue 3 dated 09/21/2010
- Alter Technology Group Proposal: ATGSP-OF-648/2009 Issue 1
- Minutes of Meeting: MM-SRP-ATG-0001 dated 29/10/2009
- Hirex specification: Total Ionizing dose test general procedure.
- SMD detail specification: 5962-00523

2.2 Reference Documents

- Intersil datasheet: ID FN4780.4 dated January 27, 2006

3 Test Samples

7 samples of the IS2-1009RH devices were tested (6 + 1 control sample).
Allocation of samples used for testing is provided in the following table. Serial numbers were arbitrarily defined by Hirex.

Number serialized by Hirex	Samples Allocation
1	Control sample
2	Biased OFF
3	Biased OFF
4	Biased OFF
5	Biased OFF
6	Biased OFF
7	Biased OFF

Identification of the IS2-1009RH is given below:

Part Number: IS2-1009RH/PROTO

Top Marking: logo IS2-1009RH /PROTO

Bottom Marking: -

Date Code: -

4 Experimental Conditions

4.1 Radiation Source Description

The protons exposures were performed at the UCL facility in Louvain-la-Neuve - Belgium.
The Proton Irradiation facility (Light Ion irradiation Facility or LIF) was used for this experiment. The corresponding experimental set-up is shown in Figure 1.

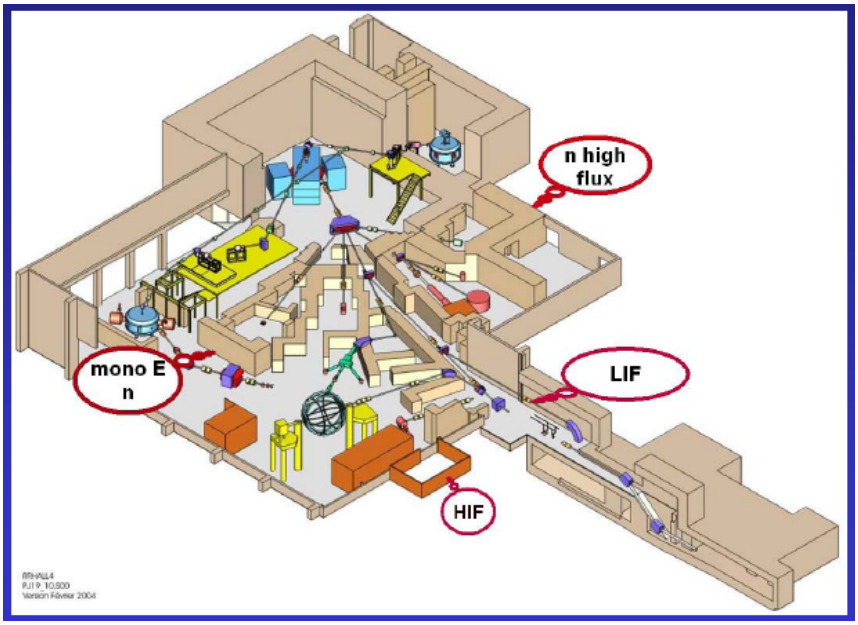


Figure 1 : LIF layout and typical experimental set-up

Light Ion irradiation Facility is characterized by the following beam parameters:
• Initial Proton Energies: 65 MeV;
• Energy Range: 9.3 – 62 MeV using energy degraders (See figure 2)
• Beam Flux at 62 MeV is between 10p/cm2/sec to 5E8 p/cm2/sec
• Irradiation Area: 8 cm diameter maximum

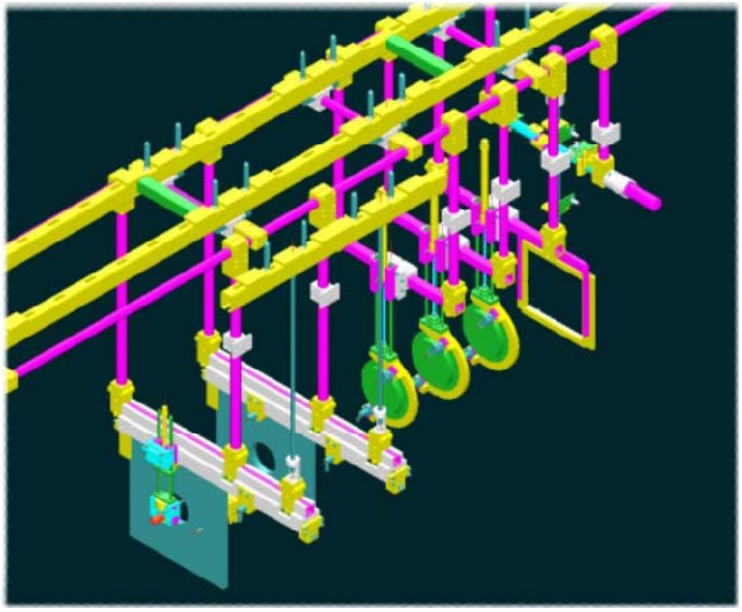


Figure 2: LIF Energy degraders

The irradiation conditions used for this test are provided in the following tables:

Fluence Steps	Total Fluence	Flux	Equivalent Total Dose	T
p/cm² @60MeV	p/cm² @60MeV	p/cm²/s	Rad (Si)	°C
0	0		0	
2E+11	2E+11	5.00E+08	27.5E+3	25

4.2 Bias during Dose Exposures and Measurements conditions

4.2.1 Bias conditions

During exposures all samples were biased OFF with all pins connected to ground.

4.2.2 Electrical Measurements

Electrical parameters test program principle for IS2-1009RH is provided in Figure 3.

A HP4142 DC tester and a HP3458A multimeter were used to perform required measurements.

A dedicated test fixture and a test board were designed to ensure proper measurement conditions.

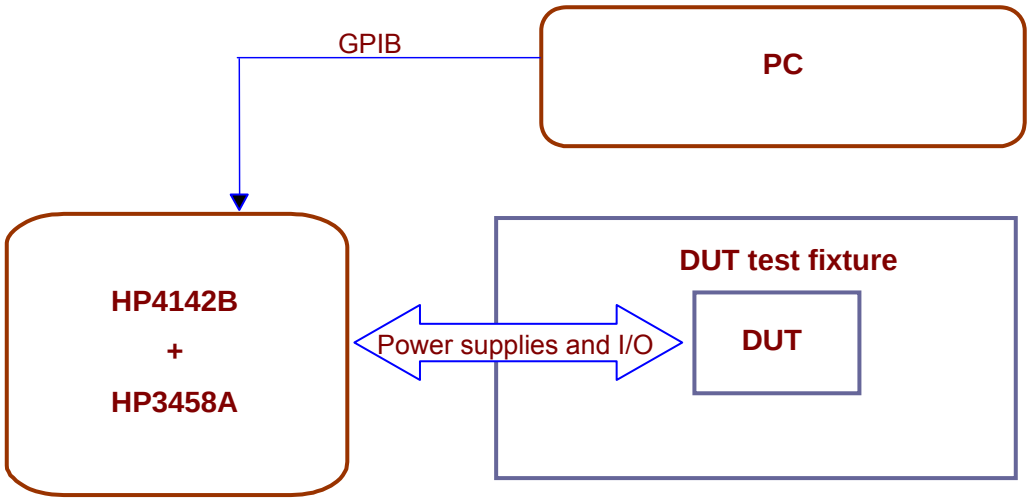


Figure 3 : IS2-1009RH test program principle

Electrical parameters test conditions and limits used for performing this test are given in Table 1.

Parameter	Description	Conditions Note 1	Spec			Unit
			Min	Typ	Max	
VREF	Reference voltage	IL = 1 mA	2.495	-	2.505	V
DVZ/DIZ	Zener voltage versus zener current	400µA≤IR≤8mA	-6	-	6	mV
Rz1	Shunt Resistance	IZ1 = 400µA, Note 1	-	-	-	Ω
Rz2	Shunt Resistance	IZ2 = 1mA, Note 2	0	-	0.6	Ω
Rz3	Shunt Resistance	IZ3 = 8mA, Note 3	-	-	-	Ω

Note 1: Rz1= |(Vz1-Vz3)/(Iz1-Iz3)|
Note 2: Rz2= |(Vz2-Vz1)/(Iz2-Iz1)|
Note 3: Rz3= |(Vz2-Vz3)/(Iz2-Iz3)|

Table 1 : Measured electrical parameters

5 Conclusion

A proton displacement damage test was carried out by Hirex Engineering under Alter Technology Group Spain contract on the Intersil IS2-1009RH Rad Hard 2.5V Reference in TO-206AB package.

Each device was exposed at room temperature to a protons flux of 60 MeV incident energy up to a total fluence of 2E+11p/cm².

A summary of failed parameters is provided in the following table.
Parameters not listed remained within specification limits all along testing.
Detail test results are presented in the following section.

Parameters	Failure Level between :	Comments
VREF	0 & 2E+11 kRad(Si)	

Table 2 : Summary of parameters failure levels

6 Test Results

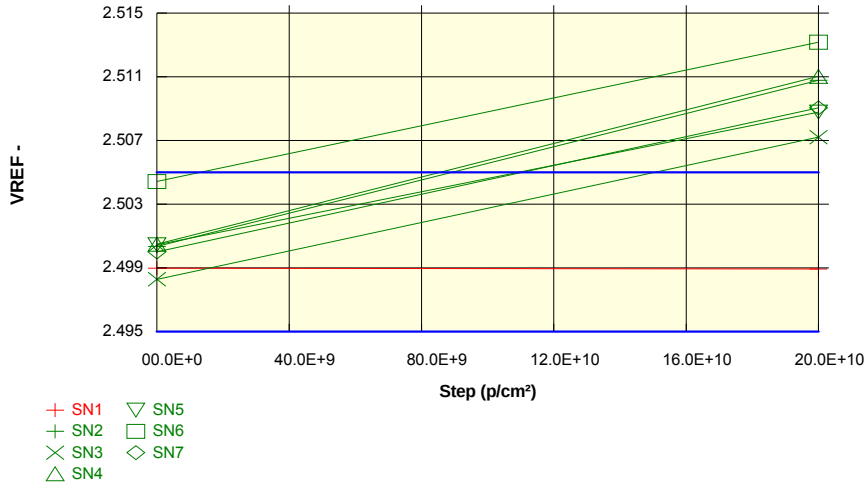
Test results including tables and graphics are provided in this section for each measured parameter.

Parameter measurements values are plotted versus Equivalent Fluence levels for 60 MeV incident energy protons. Fluences are expressed in protons/cm^2 in Silicon.

For each parameter, a drift calculation table is provided computing the drift between a given exposure step with respect to initial readings:

$$\Delta\text{(Parameter value)}=\text{(Parameter value}_{POSTRAD}\text{)} - \text{(Parameter value}_{PRERAD}\text{)}$$

Test conditions : Protons
Parameter : Reference Voltage : VREF
IL=1mA
Unit :
Spec Limit Min : 2.495
Spec Limit Max : 2.505
Spec limits are represented in bold lines on the graphic.



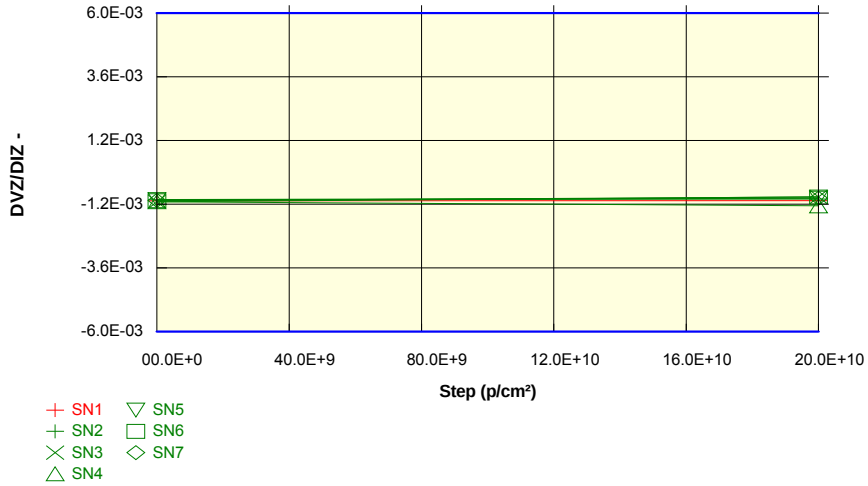
Measurements

VREF	0 p/cm²	2E+11 p/cm²
SN1_REF	2.499	2.499
OFF samples		
SN2	2.500	2.511
SN3	2.498	2.507
SN4	2.500	2.511
SN5	2.500	2.509
SN6	2.504	2.513
SN7	2.500	2.509
Statistics		
Min	2.498	2.507
Max	2.504	2.513
Average	2.501	2.510
Sigma	0.002	0.002

Drift Calculation

VREF	0 p/cm²	2E+11 p/cm²
OFF samples		
SN2	-	10.44E-03
SN3	-	8.93E-03
SN4	-	10.54E-03
SN5	-	8.33E-03
SN6	-	8.74E-03
SN7	-	9.04E-03
Average	-	9.34E-03
Sigma	-	844.93E-06

Test conditions : Protons
Parameter : Zener Voltage Versus Zener Current : DVZ/DIZ
400µA=IR=8mA
Unit :
Spec Limit Min : -6.0E-03
Spec Limit Max : 6.0E-03
Spec limits are represented in bold lines on the graphic.



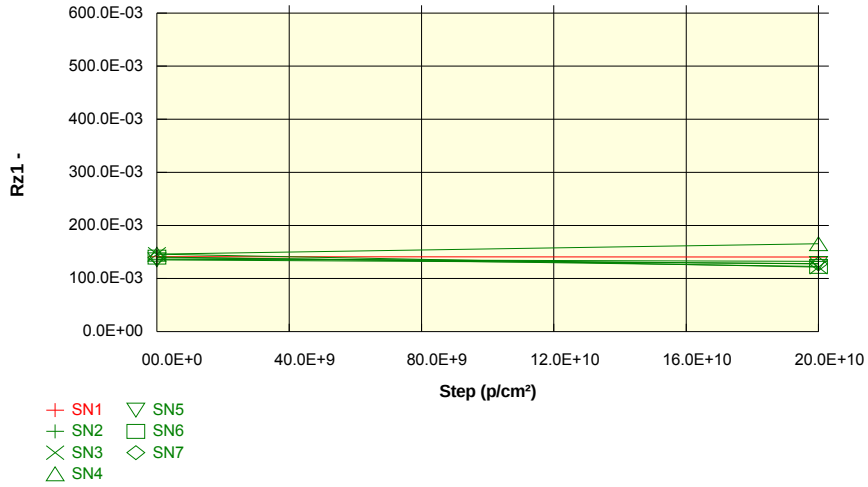
Measurements

DVZ/DIZ	0 p/cm²	2E+11 p/cm²
SN1_REF	-1.1E-03	-1.1E-03
OFF samples		
SN2	-1.0E-03	-1.0E-03
SN3	-1.1E-03	-922.9E-06
SN4	-1.1E-03	-1.3E-03
SN5	-1.0E-03	-974.9E-06
SN6	-1.1E-03	-932.2E-06
SN7	-1.1E-03	-970.1E-06
Statistics		
Min	-1.1E-03	-1.3E-03
Max	-1.0E-03	-922.9E-06
Average	-1.1E-03	-1.0E-03
Sigma	32.0E-06	114.3E-06

Drift Calculation

DVZ/DIZ	0 p/cm²	2E+11 p/cm²
OFF samples		
SN2	-	28.85E-06
SN3	-	185.97E-06
SN4	-	-150.92E-06
SN5	-	52.21E-06
SN6	-	133.75E-06
SN7	-	87.98E-06
Average	-	56.31E-06
Sigma	-	106.09E-06

Test conditions : Protons
Parameter : Shunt Resistance : Rz1
IR=400µA
Unit :
No spec limit specified.



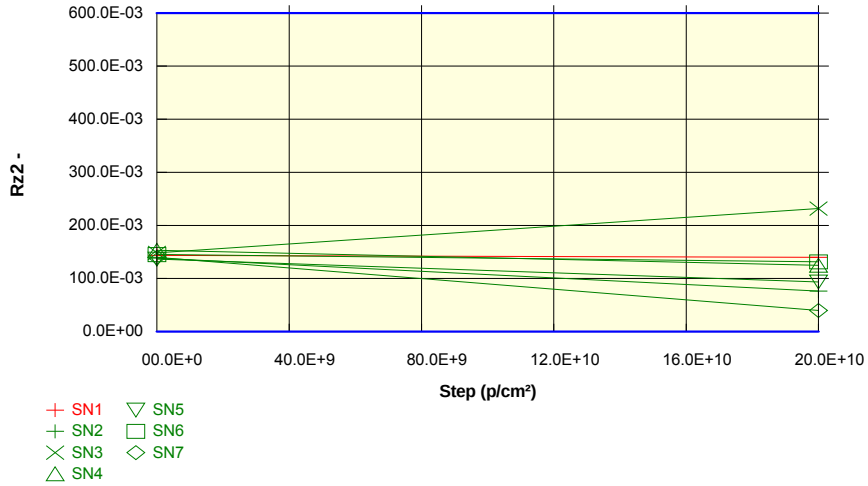
Measurements

Rz1	0 p/cm²	2E+11 p/cm²
SN1_REF	141.0E-03	140.4E-03
OFF samples		
SN2	136.2E-03	132.4E-03
SN3	145.9E-03	121.4E-03
SN4	145.8E-03	165.6E-03
SN5	135.1E-03	128.3E-03
SN6	140.3E-03	122.7E-03
SN7	139.2E-03	127.6E-03
Statistics		
Min	135.1E-03	121.4E-03
Max	145.9E-03	165.6E-03
Average	140.4E-03	133.0E-03
Sigma	4.2E-03	15.0E-03

Drift Calculation

Rz1	0 p/cm²	2E+11 p/cm²
OFF samples		
SN2	-	-3.80E-03
SN3	-	-24.47E-03
SN4	-	19.86E-03
SN5	-	-6.87E-03
SN6	-	-17.60E-03
SN7	-	-11.58E-03
Average	-	-7.41E-03
Sigma	-	13.96E-03

Test conditions : Protons
Parameter : Shunt Resistance : Rz2
IR=1mA
Unit :
Spec Limit Min : 0.0E+00
Spec Limit Max : 600.0E-03
Spec limits are represented in bold lines on the graphic.



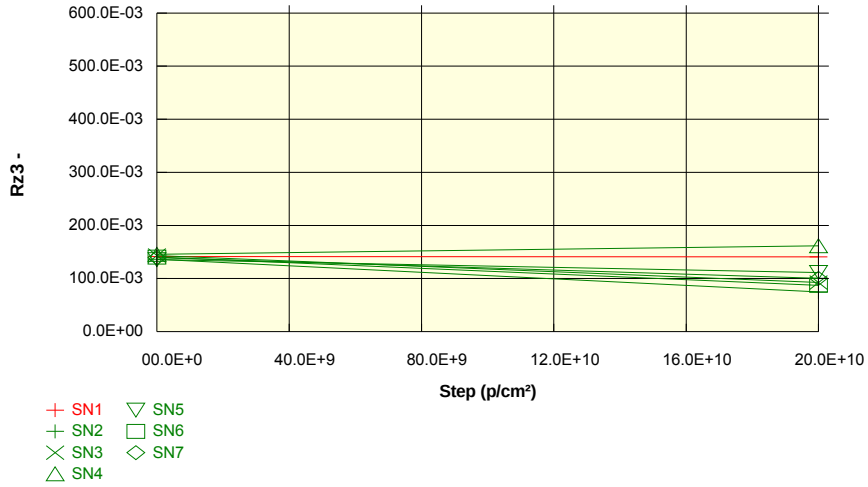
Measurements

Rz2	0 p/cm²	2E+11 p/cm²
SN1_REF	143.4E-03	139.9E-03
OFF samples		
SN2	138.3E-03	76.3E-03
SN3	148.2E-03	231.7E-03
SN4	153.0E-03	124.8E-03
SN5	136.7E-03	93.4E-03
SN6	145.0E-03	131.5E-03
SN7	139.9E-03	39.7E-03
Statistics		
Min	136.7E-03	39.7E-03
Max	153.0E-03	231.7E-03
Average	143.5E-03	116.2E-03
Sigma	5.8E-03	60.0E-03

Drift Calculation

Rz2	0 p/cm²	2E+11 p/cm²
OFF samples		
SN2	-	-61.99E-03
SN3	-	83.45E-03
SN4	-	-28.21E-03
SN5	-	-43.31E-03
SN6	-	-13.51E-03
SN7	-	-100.14E-03
Average	-	-27.29E-03
Sigma	-	56.60E-03

Test conditions : Protons
Parameter : Shunt Resistance : Rz3
IR=8mA
Unit :
No spec limit specified.



Measurements

Rz3	0 p/cm²	2E+11 p/cm²
SN1_REF	141.6E-03	140.9E-03
OFF samples		
SN2	136.1E-03	74.9E-03
SN3	143.3E-03	92.6E-03
SN4	145.6E-03	161.7E-03
SN5	135.4E-03	111.3E-03
SN6	140.4E-03	87.3E-03
SN7	139.2E-03	100.4E-03
Statistics		
Min	135.4E-03	74.9E-03
Max	145.6E-03	161.7E-03
Average	140.0E-03	104.7E-03
Sigma	3.6E-03	27.8E-03

Drift Calculation

Rz3	0 p/cm²	2E+11 p/cm²
OFF samples		
SN2	-	-61.27E-03
SN3	-	-50.72E-03
SN4	-	16.14E-03
SN5	-	-24.15E-03
SN6	-	-53.13E-03
SN7	-	-38.73E-03
Average	-	-35.31E-03
Sigma	-	25.86E-03