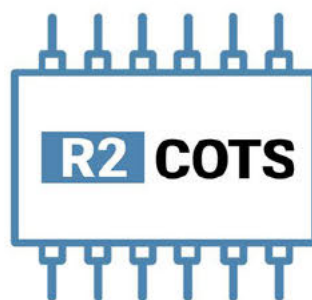


Heavy ion

TEST REPORT



DESTRUCTIVE Single EVENT EFFECTS

[REDACTED]
(DC2146)

From
[REDACTED]

Abbreviations and acronyms

LET	Linear Energy Transfer
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Abstract

The main objective of this test was to evaluate the sensitivity of the ██████████, a an MRAM versus SEL.

The irradiation was performed at ██████████ (██████████) with a maximum LET / energy of 62.5 MeV.cm²/mg.

The main conclusions are the following.

The SEL test was performed under SEL test conditions.

In config SEL test configuration

SEL was observed with a LET of 62.5 MeV.cm²/mg, Xe heavy ion.

1. Introduction

This report includes the test results of the heavy ion SEE test sequence carried out on the [REDACTED], an MRAM from [REDACTED], susceptible to show SEL induced by heavy ions.

2. Documents

2.1. Reference documents

- [RD1] ESCC Basic specification No. 25100 Issue 2 of October 2014
[RD2] Data-sheet: [REDACTED] Rev. 9.5 3/2018

3. Parts information

3.1. Identification

Part designation	[REDACTED]
Manufacturer	[REDACTED]
Part function	MRAM

Table 1: Part identification

3.2. Procurement information

Package	DFN-8
Date code	2146

3.3. Test method

With respect to reference documents (see 2 Documents), runs were performed:

- Up to a fluence of $1\text{E}+7$ cm⁻² with only SEL monitoring.

3.4. Test principle

3.4.1. SEL test principle

SEL event is a permanent and potentially destructive state of the device under test whereby a parasitic thyristor structure is triggered by an ion strike and a low impedance, high current path is created. This phenomenon will be detected by monitoring the current of the power supply. The Device Under Test (DUT) will be supplied through the GeV system. This test bench is continuously recording the current consumption during irradiation. A delatching system is incorporated and is activated if the current consumption exceeds a defined threshold current (identified as an unexpected current consumption). The GeV system will analyse the current consumption during a defined "hold time" (set as default to 1ms). If the current consumption remains above the threshold current, the DUT will be powered down during a defined "off time" (set as default to 7ms). Then, the DUT will be powered on with the nominal current consumption expected and the SEL counter is incremented. Current consumption and latch-ups recorded are observable in real-time at any moment during irradiation. Dedicated for SEL characterization, the GeV

system also manages the DUT temperature (heating and regulation). As performed for the current consumption, the temperature is sampled and recorded during all of irradiation.

Figure 1 shows a common SEL characteristic, with and without the GeV system protection.

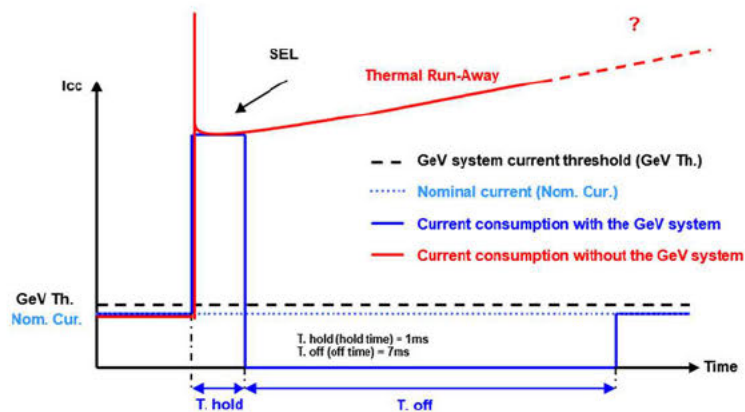


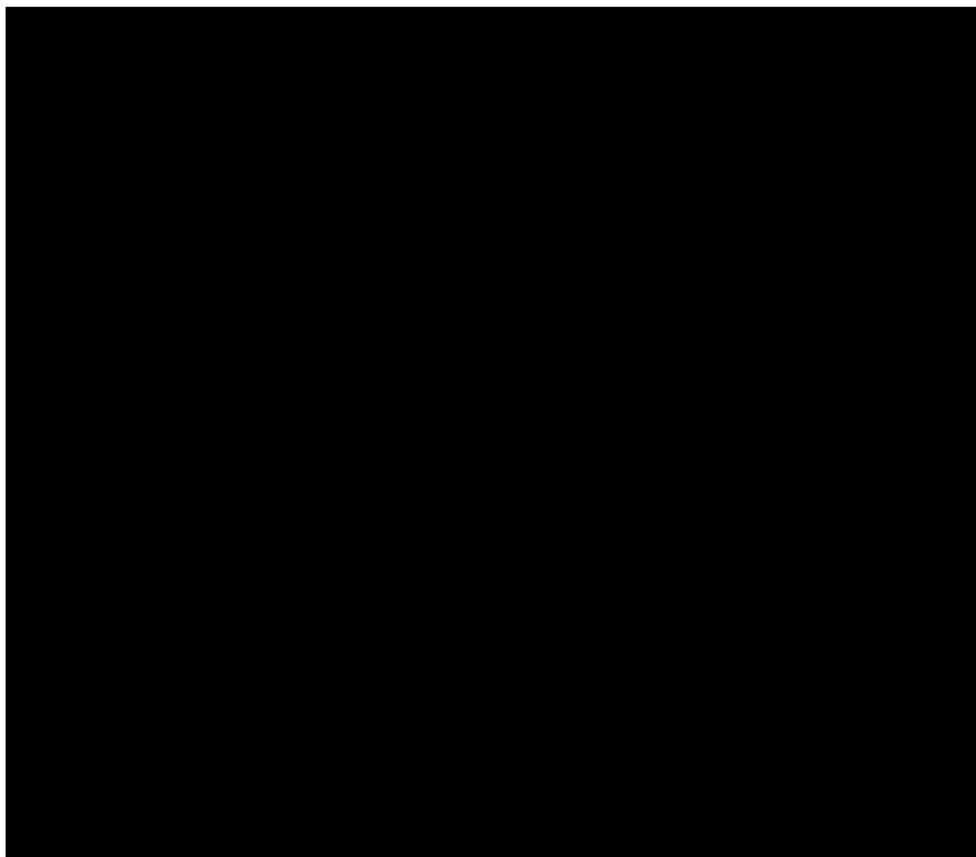
Figure 1: Common SEL characteristic

The SEL test was performed under SEL test conditions.

TRAD uses a dedicated system to heat and regulate the DUT temperature. The temperature is visualized and regulated from outside of the vacuum chamber during the irradiation.

3.4.2. Test board description

The TRAD test board schematic is illustrated in Figure 2.



3.4.3. Test conditions and event detection thresholds

SEL test

	Vcc1	VIO	Fspi
Parameter	3.6 V	3.6 V	20 MHz
I _{threshold}	20.0 mA	20.0 mA	20.0 mA
T _{hold}	1.0 ms	1.0 ms	1.0 ms
T _{cut off}	7.0 ms	7.0 ms	7.0 ms
Temperature	100 °C	100 °C	100 °C

Table 2: SEL test conditions and detection thresholds

4. Results

In this chapter are presented the SEE test results.

First, test runs summary tables provides details of the runs performed during this campaign, their parameters and results.

Then, for each event type are given their corresponding LET threshold, cross section and worst cases when it is applicable.

On the cross section curves are plotted their corresponding error bars.

The following formulas is used to calculate these error bars. It can be found in ESCC Basic specification No. 25100.

$$\delta\sigma \times F = \sqrt{(\delta N_{events})^2 + (N_{events} \times \frac{\delta F}{F})^2}$$

where :

- F is the fluence
- $\sigma = N_{events} / F$
- $\delta F/F$ is the uncertainty on the measured fluence ($\pm 10\%$).
- δN_{events} is the variance on the measured number of events.

Assuming that SEE events are random, the probability of events follows a Poisson distribution. The variance on the number of events is calculated from the chi-square distribution for a given confidence level. In this test report, we used a confidence level of 95%.

4.1. Test run summary

Run	Reference	Test configuration	Part	T° (°C)	Ion	Energy (MeV)	Range (µm)	LET (MeV.cm²/mg)	Tilt (°)	Eff. LET (MeV.cm²/mg)	Eff. Range (µm Si)	Flux (φ) (cm-2.s-1)	Time (s)	Run Fluence (cm-2)	Run Dose (krad)	Cumulated Dose (krad)	SEL	SEL Cross Section (cm²)
5		SEL	1	100	124 Xe 35+	995	73.1	62.5	0	62.5	73.1	1022.7	22	22500	0.0225		18	8.000e-04
5		SEL	2	100	124 Xe 35+	995	73.1	62.5	0	62.5	73.1	1022.7	22	22500	0.0225		20	8.889e-04

Table 3: test run table

Setting run not taken into account

SEE detailed results are described in the following sections.

4.2. SEL test results

4.2.1. SEL LET threshold

The SEL test was performed under SEL test conditions.

In SEL test configuration

SEL was observed with a LET of 62.5 MeV.cm²/mg, Xe heavy ion.