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Radiation Evaluation of INTEL 28F008SA 1Mbit x 8 FLASH-EPROM.

by

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I. INTRODUCTION

This report presents some radiation results obtained on two INTEL 28F008SA 1M8 FLASH-EPROM devices. These devices, forwarded by MMS for radiation pre-screening purposes, were both Heavy ion Single Event Effects (SEE) and Co-60 Total Ionizing Dose (TID) tested.

II. 1M8 FLASH-EPROM DEVICES

The two devices received were packed in ceramic 600 mils wide SOJ 42-pin packages. Lid marking was; 5962-9455702QXA M111132B 1996. Die identification was found to be; 28F008SA INTEL 1992 (die size 63.3 mm²).

III. TEST SYSTEM AND TEST FACILITIES

Following programming with a random generated 2M-bit test pattern, testing was carried out using QCA's dedicated memory test system running the devices at 5.0 Volt, in read mode and checking for functionality errors and current (ICCSB & ICCOP) behavior [1][2].

The Heavy Ion Facility (HIF) at the University Catholique de Louvain (UCL) accelerator, CYCLONE, Belgium was used for the SEE tests (UCL9711). Testing was carried out with $^{84}Kr^{17+}$ ions at 316MeV, with $^{40}Ar^{8+}$ ions at 150 MeV and $^{20}Ne^{4+}$ ions at 78 MeV covering a LET range of 34 to 11.7 MeV/(mg/cm^2).

TID testing was carried out using the ESA/ESTEC GAMMABEAM 150C Co-60 facility at a dose rate of 2.9 Krad(Si)/hour (ESA9828).

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IV. HEAVY ION RESULTS

One device, read mode tested, gave results as summarized in Table 1. No Transient errors, Single Event Upset (SEU) or Single Event Latch-ups (SEL) were seen up to a LET of 14.1 MeV/(mg/cm^2) and a fluence of 5.0E5 ions/cm^2. At a LET of 34.0 MeV/(mg/cm^2) and a fluence of 7.7E4 ions/cm^2, one SEU's occurred. One block error resulting in functional failure was recorded. A power-off returned the device back to full functionality with no loss of memory content. A second test at the same LET also resulted in a block error causing functional failure and requiring a power-off for recovery. Further at a LET of 28.2 MeV/(mg/cm^2) and fluences of 4.6E5 ions/cm^2 and 4.6E5 ions/cm^2, similar block errors caused functional failures and required power-off. Finally at a LET of 19.9 MeV/(mg/cm^2) and a fluence of 7.5E4 ions/cm^2, the lowest LET block error was recorded. Again, a power-off returned the device back to full functionality. No further upsets or latch-ups were seen in any of the tests as detailed in Table 1.

FLASH-EPROM, HEAVY ION SEE RESULTS						
Manufacturer Capacity Device I.D.	**Fluence ion cm^2**	**Upset's TRANS./SEU/SEL**	**LET MeV mg/cm^2**	**Cross Section cm^2/device**		
				Transient	**SEU**	**SEL**
INTEL 1M8 s/n I01	7.7E4	0/(1)/0	34.0	<1.3E-5	1.3E-5	<1.3E-5
	3.4E5	0/(1)/0	34.0	<2.9E-6	2.9E-6	<2.9E-6
	1.3E5	0/(1)/0	28.2	<7.7E-6	7.7E-6	<7.7E-6
	4.6E5	0/(1)/0	28.2	<2.2E-6	2.2E-6	<2.2E-6
	7.5E4	0/(1)/0	19.9	<1.3E-6	1.3E-6	<1.3E-6
	5.0E5	0/0/0	14.1	<2.0E-6	<2.0E-6	<2.0E-6
	5.0E5	0/0/0	11.7	<2.0E-6	<2.0E-6	<2.0E-6

Table 1. Heavy ion SEE results for INTEL FLASH-EPROM tested in Read mode.

V. Co-60 TID RESULTS

Two devices were tested with a dose rate of 2.9 Krad(Si)/hour. Results from these tests are presented in a summary format in Figure 1. TID level in Krad(Si) are presented per device using three criteria for failures. Firstly (a) the Krad(Si) level where the first bit failure occur, (b) the Krad(Si) level where functional failure occur (defined as showing 1024 errors or more in a single run) and (c) the Krad(Si) level where ICCSB (stand-by current) increased to 120 %.

Fairly consistent 1st error and functional failure levels were found for these devices whereas the 20% ICCSB current increase levels vary. The 20 % stand-by current increase level is believed, in general, to indicate the failure level where possible parametric and AC failures could be expected.

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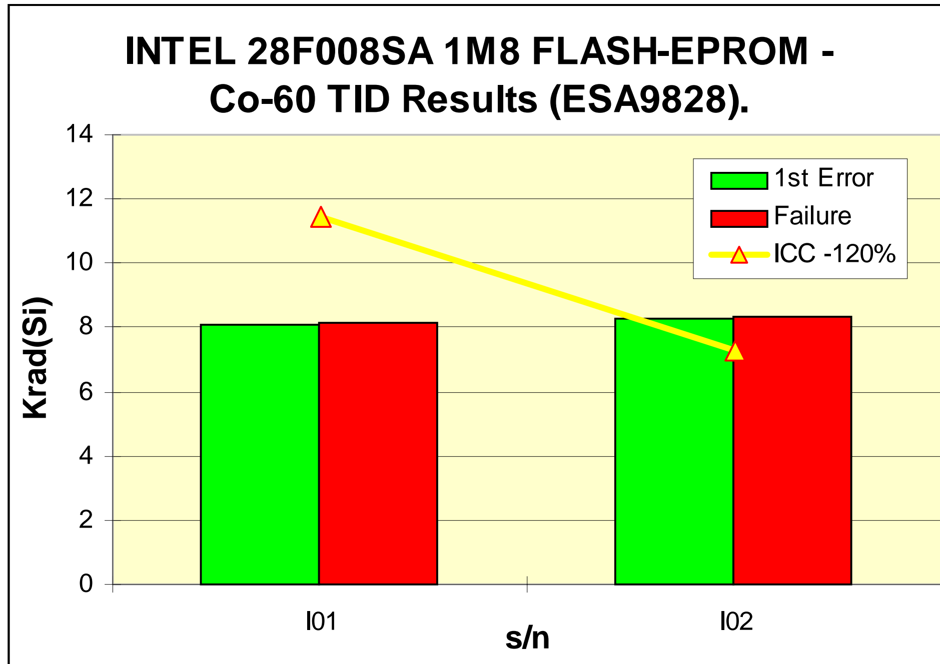

Figure 1. Co-60 TID result – dose rate 2.9 Krad(Si)/hour.

VI. CONCLUSIONS

The following preliminary radiation conclusions can be drawn from testing two 28F008SA FLASH-EPROM devices in read mode;

SEE - No transient errors, SEUs or SELs were seen up to a LET of 14.1 MeV/(mg/cm^2). At a LET of 19.9 MeV/(mg/cm^2) block SEU (functional failure) start to occur requiring a power switch-off for regaining functionality. None of the five events reported here resulted in loss of memory content.

Co-60 - TID level with performances around 8 Krad(Si) can be reported for both devices.

VII. REFERENCES

[1] R. Harboe Sørensen and R. Müller, "Cost Effective Radiation Testing of Commercially Available Memories", 3rd EECC, ESTEC, Noodwijk, April 1997. Conference Proceedings, ESA SP-395, pp 245-50.

[2] R. Harboe Sørensen and R. Müller, "Radiation Testing of UV-EPROMs, FLASH-EPROMs and EEPROMS for Space Applications", ESTEC Working Paper EWP-1859, Noodwijk, January 1996.