SINGLE EVENT EFFECTS RADIATION TEST REPORT

Part Type : HM6216255H

Package : 44-SOJ

256Kx16 Bit High Speed Static RAM(5V Operating)

Manufacturer : Hitachi

Report Reference : ESA_QCA0104S_C

Issue : 01

Date : January 19th, 2001

ESA Contract no. 13528/99/NL/MV CCN N°3 dated 24/11/00

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The work described in this report was done under ESA contract.
Responsibility for the contents resides in the author or organization that prepared it

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SINGLE EVENT EFFECTS RADIATION TEST REPORT on 256Kx16 Bit High Speed Static RAM(5V Operating) , HM6216255H, from Hitachi

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1 Abstract

Under ESA Contract no. 13528/99/NL/MV CCN N°3 dated 24/11/00, covering "Radiation Evaluation of COTS semiconductor Components", four different commercially available 4Mb Static RAM device types were radiation assessed. Results from these assessments, primarily focussing on the sensitivity of these devices to Total Ionizing Dose (TID) and Single Event Effects (SEE), are reported in individual TID and SEE reports. The below summary table lists manufacturer and evaluated types, and gives references to the various reports issued.

Manufacturer	Type	TID Report	SEE Report
Hitachi	HM6216255H	ESA_QCA0104T_C	ESA_QCA0104S_C
Samsung	KM684002AJ	-	ESA_QCA0101S_C
Samsung	K6R4008C1C	ESA_QCA0102T_C	ESA_QCA0102S_C
Samsung	K6R4008V1C	ESA_QCA0103T_C	ESA_QCA0103S_C

2 INTRODUCTION

This report presents the results of a Single Event Effects (SEE) test program carried out on 256Kx16 Bit High Speed Static RAM(5V Operating) HM6216255H from Hitachi

Test was conducted on commercial samples procured from Hitachi and provided to HIREX by ESA.

Heavy ion tests have not been performed as the assembly of these commercial devices is based on a Lead On Chip (LOC) technology. The presence of a lead frame on top of the chip thus does not allow a direct access to the die active area.

For proton test, these tests took place at the low energy OPTIS area of Paul Scherrer Institute in Villingen, Switzerland.

This work was performed for ESA/ESTEC under ESA Contract no. 13528/99/NL/MV CCN N°3 dated 24/11/00.

3 REFERENCE DOCUMENTS

RD1. Hitachi data sheet
RD2. Single Event Effects Test method and Guidelines ESA/SCC basic specification No 25100
RD3. The Heavy Ion Irradiation Facility at CYCLONE, UCL document, Centre de Recherches du Cyclotron (IEEE NSREC'96, Workshop Record, Indian Wells, California, 1996)
RD4. Radiation Effects Testing Facility in PSI Low Energy OPTIS Area, IEEE 1998, Radiation Effects Data Workshop, p. 152

4 DEVICE INFORMATION

Relevant device identification information is presented here after.

Part type :	HM6216255H
Manufacturer :	Hitachi
Package :	44-SOJ
Quality Level :	Commercial
Date Code :	9928
Die Technology :	CMOS
Top Marking:	JAPAN 9928 HM6216255HL-JP-15 103A9NN0

External Photo is shown in Figure 1.

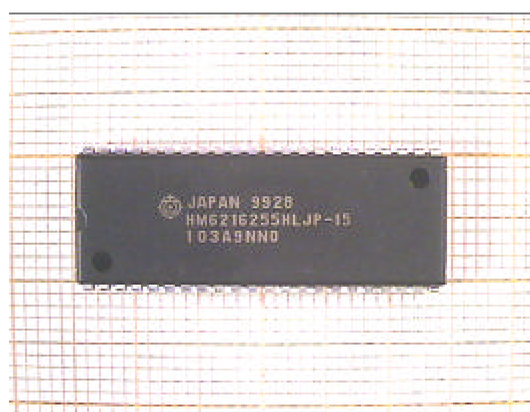

Photo # 1 :

External Visual Inspection

Part Type : HM6216255H

S/N

Magnification :

Figure 1 – HM6216255H External Photo

5 Test Definition

5.1 Test Set-up

Hirex test equipment is composed of a modular rack coupled with a generic memory test board :

This modular rack is derived from Hirex BILT modular instrumentation system and present 8 slots for modular instruments.
In addition to the existing power supply modules which cover the SEE test needs for precision measurements, remote control, LU detection, data storage , scope observation, etc, a specific modular board has been designed to provide :

- A high speed communication link with the test board under vacuum (up to 500 ko/s)
- Management of DUT positioning (mover)
- Particle and test time counting

Dedicated to the test of memories, the generic test board is based on a 12 MIPs on-board processor which controls the test sequence and the communication with the rack.
The board include programmable logic circuits with a total capacity of 30000cells and 960 macrocells. This logic circuitry can work at high speed (up to 100 MHz) while being compatible with thermal requirements imposed by vacuum environment.
Today, the board has a capacity of 50 pin-drivers (this number can be extended if needed), using transceivers able to interface memory devices with voltage supply requirements between 1 and 7 volts. The DUT can have two different power supplies.
A mechanism called mover allows positioning the DUT under or outside the beam within less than 100ms. During translations, particles count and test time is automatically stopped. This solution has been selected mainly for proton tests where the DUT can be translated behind a lead shielding for instance.

5.2 Test Configuration

Two main different test conditions can been used:

Cond 1: Dynamic conditions, which consist in the following test sequence:
Write the entire memory
Then read/write the memory sequentially by page of 128 words
Under dynamic conditions the device is continuously exposed to the beam

Cond 2: Static conditions, which consist in the following cycle, repeated continuously:
Write the entire memory with the device not exposed to the beam
Expose the memory for a given time period
Read the memory outside the beam

An additional condition, cond 3, can also be used, called "full static", which consist in the here above static conditions but with only one cycle. The beam exposure time corresponds then to the run duration.

Advantage of cond 2 over cond 3 is that the occurrence of temporary or permanent stuck bits can be easily detected.

Test principle is based on the use of a rotating pattern, which allows checking that at each cycle every word has been effectively rewritten with new data.

The table here below provides the repetitive pattern of 14 different words in a 16 bits organisation.

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	1	0	0	1	0	0	1	0	1	0	0	1	0	0	1
1	0	1	1	0	1	1	0	1	0	1	1	0	1	1	0
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	1	0	0	1	0	0	1	0	1	0	0	1	0	0	1
1	0	1	1	0	1	1	0	1	0	1	1	0	1	1	0
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

At each cycle, the here above table is shifted by three positions :

	address 0	address 1	address 2	address 3	etc.
cycle 1 :	0101…	1010…	0000…	1111…	…
cycle 2 :	0000…	1111…	0110…	1100…	…

Only the 4 first bits of each 16-bit word are represented here above

Errors which can be detected and counted are the following :

- Any single error in the memory block with identification of the transition (1->0 or 0->1)
- Any word with at least one bit flip with the identification of the word address

DUT power supply module is monitored and each time the current consumption exceeds a programmable threshold, a power reset cycle is done and latch-up error counter is incremented.
In addition the use of a fast latch-up detection with a high speed comparator avoid the counting of errors which could be induced by the latch-up condition.

DUT power supply is 5V.

6 TEST FACILITIES

6.1 Protons

6.1.1 Beam Source

The description of the beam source is given in RD4.
Irradiation is carried out in air.

6.1.2 Beam Set-up

6.1.2.1 Proton Beam Selection

The following monoenergetic proton beams have been selected

Energy (MeV)	LET(Si) (MeV/mg/cm²)
60.9	8.5 E-3
40.6	1.17 E-2
33.3	1.36 E-2
23.3	1.8 E-2
17.6	2.25 E-2
12.4	2.95 E-2
7.3	4.43 E-2

For each run, information is provided on the beam characteristics in the detailed results tables provided in paragraph 7.1.

6.1.2.2 Flux Range

Particle flux was set between 1 to 2 E8 protons/cm²/sec under normal operations (tilt 0°).

6.1.2.3 Particle Fluence Levels

Fluence level was set to 1 E10 protons/cm².

6.1.2.4 Dosimetry

The current OPTIS dosimetry system and procedures were used.

6.1.2.5 Accumulated Total Dose

For each run, the computed equivalent cumulated doses received by the DUT sample, are provided in the detailed results tables of paragraph 7.1.

6.1.2.6 Test Temperature

Tests have been performed at 22 deg. C.

7 RESULTS

7.1 Protons

Detailed results are provided in Table 1.

This device has been found to be not sensitive when exposed to protons of 60.9 MeV incident energy.

Run #	Test	Sample	Proton Energy (MeV)	LET (MeV)/(mg.cm²)	Range (µm)	Angle (deg.)	Time (s)	Eff_Time (s)	Flux (p/cm².s)	Run TID rads(Si)	Sample TID rads(Si)	Fluence (p/cm²)	Eff_Fluence (p/cm²)	Bits up (0 to 1)	Bits down (1 to 0)	Words	Stuck bits	SEUs
R00055	Static	#9A	60.9	8.50E-03	17300	0	52	45	1.92E+08	1360	1360	1.00E+10	8.64E+09	0	0	0	0	0
R00056	Static	#9A	60.9	8.50E-03	17300	0	45	45	2.22E+08	1360	2720	1.00E+10	1.00E+10	0	0	0	0	0
R00057	Full Static	#9A	60.9	8.50E-03	17300	0	49	49	2.04E+08	1360	4090	1.00E+10	1.00E+10	0	1	1	0	1
R00058	Full Static	#9B	60.9	8.50E-03	17300	0	244	244	2.05E+08	6810	6810	5.00E+10	5.00E+10	0	1	0	0	1
R00059	Static	#9B	60.9	8.50E-03	17300	0	244	205	2.05E+08	6810	13600	5.00E+10	4.20E+10	0	0	0	0	0

Table 1 – HM6216255H proton detailed results per run

8 CONCLUSION

Proton test have been conducted on commercial samples of 256Kx16 Bit High Speed Static RAM(5V Operating) HM6216255H from Hitachi, using the OPTIS proton beam at the Paul Scherrer Institut, Switzerland.

This device has been found to be not sensitive when exposed to 60.9 MeV protons with a fluence as high as 5 E 10 protons / cm².