Unisys

DATE: October 22, 1999 PPM-99-030
TO: D. Krus/300.1
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on **KM48C8000AS-6U (Samsung) (LDC various)**
PROJECT: TRIANA

cc: R. Reed/562, A. Sharma/562, OFA Library/300.1

A radiation evaluation was performed on **KM48C8000AS-6U 8Mb DRAM (Samsung)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co^{60} gamma ray source. There were six different wafer lots among the parts provided for radiation testing [TCD220AA (SN 1, 11, 12), TCD325AA (SN 21, 22), TCD331AA (SN 31, 32), TCD348AA (SN 41, 42), TCE004AA (SN 51, 52), and UWKF07BA (SN 2, 71, 72)]. Initial electrical measurements were made on 14 samples. Six samples (SN's 11, 21, 31, 41, 51, and 71) were used as radiation samples in the first batch, six samples (SN's 12, 22, 32, 42, 52, and 72) were used as radiation samples in the second batch, and SN's 1 and 2 were used as control samples. All parts had readings greater than the specification limit of 60mA for ICC4 initially with readings in the range of 61 to 72mA, but showed only very minor degradation from those initial measurements. These readings should not, therefore, be considered radiation induced failures. Any changes in the readings are noted below. All parts passed all tests during initial electrical measurements.

The total dose radiation levels for Batch 1 were 2.5, 5.0, 10.0, 20.0, 50.0, and 100.0kRads.[1] The total dose radiation levels for Batch 2 were 20.0, 50.0, 75.0, and 100.0kRads. The average dose rate was 0.314kRads/hour (0.09Rads/s) for Batch 1 and 0.214kRads/hour (0.06Rads/s) for Batch 2. See Table II for the radiation schedule and average dose rate calculation. After the 100kRad irradiation the parts were annealed under bias at 25°C for 168 hours.[2] After each radiation exposure and annealing step, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III. An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step.

BATCH 1: All six parts passed all parametric tests up to 20kRads and all functional tests up to 50kRads. After the 50kRad irradiation, some parts showed degradation in ICC1 and a slight increase in ICC2, ICC4 and ICC5. After the 100kRad irradiation, three parts failed all functional tests and showed significant degradation in most other parameters. A fourth part showed significant degradation in ICC2 and ICC5. After annealing the parts at 25°C for 168 hours, the three parts that failed functionally, showed no recovery. The fourth part that showed significant degradation in ICC2 and ICC5 showed no recovery in these parameters. However, the remaining two parts (SN's 11 and 51) showed significant recovery in ICC1 and ICC4 and passed all tests.

BATCH 2: All parts passed all functional and parametric tests up to 50kRads. After the 75 and 100kRad irradiations, some parts failed the Write_Read_One functional test. Two parts marginally exceeded the specification limit of 90mA for ICC1. After annealing the parts at 25°C for 168 hours, two parts failed most functional tests and many parametric tests with readings similar to those in Batch 1. All other parts showed no significant change. Three parts (SN's 12, 42 and 52) passed all tests after annealing.

---

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

Batch 1 [SN 11 (TCD220AA), SN 21 (TCD325AA), SN 31 (TCD331AA), SN 41 (TCD348AA), SN 51 (TCE004AA), and SN 71 (UWKF07BA)]

All parts passed all tests up to 20kRads.

After the 50kRad irradiation, SN's 11, 21, 31, 41, and 71 marginally exceeded the specification limit of 90mA for ICC1 with readings in the range of 98 to 140mA. A very slight increase in ICC4 readings was noted, with readings in the range of 73 to 133mA. SN 71 exceeded the specification limit of 2.00mA for ICC2 with a reading of 7.58mA and exceeded the specification limit of 1.00mA for ICC5 with a reading of 8.24mA. **All parts passed all other tests.**

After the 100kRad irradiation, SN's 21, 31 and 41 failed all three functional tests and numerous additional tests showed significant degradation. SN's 11, 21 and 31marginally exceeded the specification limit of 90mA for ICC1 with readings in the range of 91 to 186mA. SN 41 failed ICC1 with a reading of >500mA. An increase in ICC4 readings was noted, with readings in the range of 73 to 214mA, except for SN 41, which had a reading of >500mA. SN 71 exceeded the specification limit of 2.00mA for ICC2 with a reading of 20mA and exceeded the specification limit of 1.00mA for ICC5 with a reading of 35mA. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, SN's 21, 31 and 41 showed no recovery in any parameter. SN's 11, 51 and 71 showed recovery in ICC1 and ICC4 with readings similar to initial electrical measurements and passed all other tests. The readings of ICC2 and ICC5 for SN 71 showed no significant change.

Batch 2 [SN 12 (TCD220AA), SN 22 (TCD325AA), SN 32 (TCD331AA), SN 42 (TCD348AA), SN 52 (TCE004AA), and SN 72 (UWKF07BA)]

All parts passed all tests up to 50kRads.

After the 75kRad irradiation, SN's 12, 22, 32, 42, and 52 failed the Write_Read_One functional test. SN's 12 and 52 exceeded the specification limit of 90mA for ICC1 with readings of 114 and 129mA. No significant change was noted in ICC4. SN 72 exceeded the specification limit of 2.00mA for ICC2 with a reading of 6.07mA and exceeded the specification limit of 1.00mA for ICC5 with a reading of 6.90mA. **All parts passed all other tests.**

After the 100kRad irradiation, SN's 22, 32 and 42 failed the Write_Read_One functional test. All readings for ICC1 and ICC4 were similar to those at 20kRads. SN 72 exceeded the specification limit of 2.00mA for ICC2 with a reading of 8.34mA and exceeded the specification limit of 1.00mA for ICC5 with a reading of 8.00mA. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, SN's 22 and 32 showed significant degradation in nearly all parameters including functional tests; ICC1 and ICC4 readings were greater than 500mA. SN 72 showed no significant change in ICC2 or ICC5. SN's 12, 42 and 52 passed all tests.

Since the parts were from different wafer lots and showed very significant variation in the parametric test results, no mean and standard deviation calculations were made. In summary, the parts from all wafer lots except for UWKF07BA passed all tests up to 50kRads. However, most parts failed above 50kRads.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

ADVISORY ON THE USE OF THIS DOCUMENT

The information contained in this document has been developed solely for the purpose of providing general guidance to employees of the Goddard Space Flight Center (GSFC). This document may be distributed outside GSFC only as a courtesy to other government agencies and contractors. Any distribution of this document, or application or use of the information contained herein, is expressly conditional upon, and is subject to, the following understandings and limitations:

(a) The information was developed for general guidance only and is subject to change at any time;

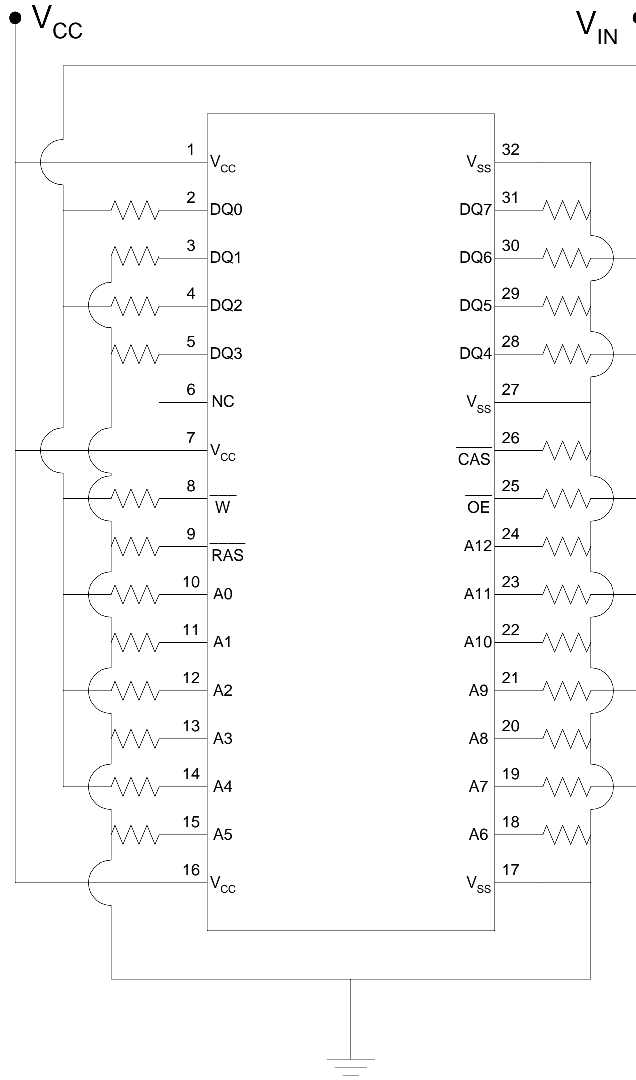
(b) The information was developed under unique GSFC laboratory conditions which may differ substantially from outside conditions;

(c) GSFC does not warrant the accuracy of the information when applied or used under other than unique GSFC laboratory conditions;

(d) The information should not be construed as a representation of product performance by either GSFC or the manufacturer;

(e) Neither the United States government nor any person acting on behalf of the United States government assumes any liability resulting from the application or use of the information.

Figure 1. Radiation Bias Circuit for KM48C8000AS-6U



Notes:
1. V_{CC} = +5.0V ±0.25V.
2. V_{IN} = +2.4V ±0.25V.
3. R = 2kΩ ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	KM48C8000
TRIANA Part Number	KM48C8000AS-6U
TRIANA TID Requirement	2 Year: 7kRads(RDM=2), 5Year: 17kRads(RDM=2)
Charge Number:	M99355
Manufacturer:	Samsung
Lot Date Code (LDC):	Various Wafer Lots
Quantity Tested:	14
Serial Numbers of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	11, 12, 21, 22, 31, 32, 41, 42, 51, 52, 71, 72
Part Function:	8M x 8bit CMOS Dynamic RAM w/ Fast Page Mode
Part Technology:	CMOS
Package Style:	32 Pin TSOP
Test Equipment:	A540 and HP82000
Test Engineer:	S. Archer-Davies

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for KM48C8000AS-6U

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	08/16/99
Batch 1 Runs	
2) 2.5 KRAD IRRADIATION (0.139 KRADS/HOUR)	08/17/99
POST-2.5 KRAD ELECTRICAL MEASUREMENT	08/18/99
3) 5.0 KRAD IRRADIATION (0.147 KRADS/HOUR)	08/18/99
POST-5.0 KRAD ELECTRICAL MEASUREMENT	08/19/99
4) 10.0 KRAD IRRADIATION (0.058 KRADS/HOUR)	08/19/99
POST-10.0 KRAD ELECTRICAL MEASUREMENT	08/23/99
5) 20.0 KRAD IRRADIATION (0.145 KRADS/HOUR)	08/23/99
POST-20.0 KRAD ELECTRICAL MEASUREMENT	08/26/99
6) 50.0 KRAD IRRADIATION (0.323 KRADS/HOUR)	08/26/99
POST-50.0 KRAD ELECTRICAL MEASUREMENT	08/30/99
7) 100.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	08/30/99
POST-100.0 KRAD ELECTRICAL MEASUREMENT	09/07/99
8) 168 HOUR ANNEALING @25°C	09/07/99
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/15/99

Average Dose Rate = 100,000 RADS/319 HOURS=314 RADS/HOUR=0.087RADS/SEC

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/21/99
Batch 2 Runs	
2) 20.0 KRAD IRRADIATION (0.990 KRADS/HOUR)	09/21/99
POST-20.0 KRAD ELECTRICAL MEASUREMENT	09/30/99
3) 50.0 KRAD IRRADIATION (0.313 KRADS/HOUR)	09/30/99
POST-50.0 KRAD ELECTRICAL MEASUREMENT	10/04/99
4) 75.0 KRAD IRRADIATION (0.260 KRADS/HOUR)	10/04/99
POST-75.0 KRAD ELECTRICAL MEASUREMENT	10/08/99
5) 100.0 KRAD IRRADIATION (0.260 KRADS/HOUR)	10/08/99
POST-100.0 KRAD ELECTRICAL MEASUREMENT	10/12/99
6) 168 HOUR ANNEALING @25°C	10/12/99
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/19/99

Average Dose Rate = 100,000 RADS/468 HOURS=214 RADS/HOUR=0.059RADS/SEC

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS, SEE FIGURE 1.

Table III. Electrical Characteristics KM48C8000AS-6U (1)

Test #	Parameter	Units	Spec. Limit min	max	Test Conditions
100	Write_Read_One	P/F			
110	Write_Read_Checker	P/F			
120	Write_Read_Zero	P/F			
300-307	VOH (dq0 - dq7)	V	2.40		I_{OH} = -5mA
350-357	VOL (dq0 - dq7)	mV		400	I_{OL} = 4.2mA
400-415	IIH (a0 - a12, w, oe, cas)	µA	-10.0	10.0	Any Input 0V ≤ V_{IN} ≤ V_{CC} + 0.5V, all other pins not under test = 0V
450-465	IIL (a0 - a12, w, oe, cas)	µA	-10.0	10.0	Any Input 0V ≤ V_{IN} ≤ V_{CC} + 0.5V, all other pins not under test = 0V
500-507	IOZH (dq0 - dq7)	µA	-5.0	5.0	Data is disabled, 0V ≤ V_{OUT} ≤ V_{CC}
550-557	IOZL (dq0 - dq7)	µA	-5.0	5.0	Data is disabled, 0V ≤ V_{OUT} ≤ V_{CC}
600	ICC1	mA	0.0	90.0	Operating Current (RAS and CAS, Address cycling @ t_{RC} = min.)
610	ICC2	mA	0.0	2.00	Standby Current (RAS = CAS = W = V_{IH})
620	ICC4	mA	0.0	60.0	Fast Page Mode Current (RAS=V_{IL}, CAS, t_{PC} = min.)
630	ICC5	mA	0.0	1.00	Standby Current (RAS = CAS = W = V_{CC} - 0.2V)

Notes:

(1) These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

3LE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for KM48C8000AS-6U

NO Table, data too messy

Test #	Parameters	Units	Spec. Lim. (2) min	Spec. Lim. (2) max	Initial mean	Initial sd	Total Dose Exposure (kRads Si) 5.0 mean	5.0 sd	10.0 mean	10.0 sd	20.0 mean	20.0 sd	25.0 + 360 hours unbiased mean	25.0 + 360 hours unbiased sd	Annealing 168 hours @25°C mean	Annealing 168 hours @25°C sd
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
A																
B																
C																
D																

Notes:

(1) The mean and standard deviation values were calculated over the seven parts irradiated in this testing. The control samples remained constant throughout testing and are nc

(2) These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation sensitive parameters: .