PPM 93-65

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Paramax Systems
Corporation

4700 Boston Way
Lanham MD 20706

Memorandum

PARAMAX
A Unisys Company

DATE: June 17, 1993 PPM-93-065
TO: B. Fafaul/311.0
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on SMEX/FAST
Part No. HM628128LP-10 (128Kx8 RAM)
Control No. 8175

cc: R. Kolecki/740.4
T. Miccolis/300.1
A. Sharma/311.0
Library/300.1
E. Bentley/740.4
SMEX, PPM File

A radiation evaluation was performed on HM628128LP-10 (128Kx8 CMOS RAM) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through VI and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, two parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation levels were 5, 10, 15, 20, 50, 75 and 100 krads*. After 50 krads, 75 krads and 100 krads, the parts were annealed at 25°C for 96, 96 and 192 hours, respectively. The dose rate was between 0.06 and 0.69 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III. Electrical tests included two functional tests at Vcc = 5.00 VDC, one at 1 MHz and one at 10 MHz. The functional tests were performed using an Algorithm Pattern Generator (APG) and consist of both simple and complex functional tests. Details of the functional tests are provided in Table IV.

The simple functional tests (Read/Write ones, Zeroes and Checkerboard) detect individual cell failures, while the complex functional tests (March, Row and Column Address, Sliding Diagonal, Ping-Pong, Surround and Row and Column Galloping) detect pattern sensitive failures.

There were no Read/Write Ones and Zeroes failures during the entire radiation evaluation up to 100 krads exposure. There were intermittent failures in complex functional tests (Checkerboard and Ping-Pong) after the 50 and 75 krad irradiations. The results of the functional testing are shown in detail in Table V. When the parts were annealed at 25°C for 96 hours after the 75 krad exposure, both parts showed recovery in functional tests. No functional failures were observed after the 100 krad exposure. After the final 192-hour anneal, there were two additional functional failures (Checkerboard and Ping-Pong). The intermittent functional failures seen at these steps could be due

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
**These are manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

to an increase in ambient temperature of the ATE Lab beyond the operating specifications of the equipment for a short interval of time.

Table VI provides mean and standard deviation values for each parameter after different irradiation exposures and annealing steps. Both parts stayed within the specification limits for all parameters except IIL. Both parts exceeded the specification limit of -5.0 μA after 50 krads exposure, with readings ranging from -5.1 μA to -11.2 μA. Both parts recovered to within specification limits after annealing for 96 hours, but after 75 krads, both parts again exceeded the specification limit for IIL and continued to fail IIL throughout all subsequent irradiation and annealing steps, with readings ranging from -5.3 μA to -14.7 μA.

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

TABLE I. Part Information

Generic Part Number:	628128
Part Number:	HM628128LP-10*
SMEX/FAST Control Number:	8175
Charge Number:	C33581
Manufacturer:	Harris
Lot Date Code:	8928
Quantity Tested:	2
Serial Numbers of Radiation Samples:	50, 51
Serial Numbers of Control Samples:	351, 352
Part Function:	128K X 8 CMOS RAM
Part Technology:	CMOS
Package Style:	32-pin Plastic DIP
Test Equipment:	Schlumberger S-50
Test Engineer:	A. Karygiannis

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for HM628128LP-10

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	05/12/93
2) 5 KRAD IRRADIATION (0.07 KRADS/HOUR)	05/14/93
POST-5 KRAD ELECTRICAL MEASUREMENT	05/17/93
3) 10 KRAD IRRADIATION (0.13 KRADS/HOUR)	05/18/93
POST-10 KRAD ELECTRICAL MEASUREMENT	05/20/93
4) 15 KRAD IRRADIATION (0.06 KRADS/HOUR)	05/20/93
POST-15 KRAD ELECTRICAL MEASUREMENT	05/24/93
5) 20 KRAD IRRADIATION (0.12 KRADS/HOUR)	05/24/93
POST-20 KRAD ELECTRICAL MEASUREMENT	05/26/93
6) 50 KRAD IRRADIATION (0.69 KRADS/HOUR)	05/26/93
POST-50 KRAD ELECTRICAL MEASUREMENT	05/28/93
7) 96 HOUR ANNEALING @25°C	05/28/93
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/01/93
8) 75 KRAD IRRADIATION (0.61 KRADS/HOUR)	06/01/93
POST-75 KRAD ELECTRICAL MEASUREMENT	06/03/93
9) 96 HOUR ANNEALING @25°C	06/03/93
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/07/93
10) 100 KRAD IRRADIATION (0.57 KRADS/HOUR)	06/07/93
POST-100 KRAD ELECTRICAL MEASUREMENT	06/09/93
11) 192 HOUR ANNEALING @25°C	06/09/93
POST-192 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/17/93

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

Table III. Electrical Characteristics of HM628128LP-10

Parameter	Units	Spec. Limits		Test Conditions
		Min.	Max.	
FUNC1/1				Vil = 0, Vih = 5.0V, FREQ = 1 MHz
FUNC2/1				Vil + 0, Vih = 5.0V, FREQ =10 MHz
VOH	V	2.40	5.50	Vil = 0, Vih = 4.5V, Load = -1 mA
VOL	mV	0	400	Vil = 0, Vih = 4.5V, Load =2.1 mA
IIH	μA	0	5.00	Vil = 0, Vih = 5.5V, VTST = 5.5V
IIL	μA	-5.00	0	Vil = 0, Vih = 5.5V, VTST = 0V
IOH	μA	-5.00	5.00	Vil = 0, Vih = 5.5V, VOUT = 5.5V
IOL	μA	-5.00	5.00	Vil = 0, Vih = 5.5V, VOUT = 0.5V
ISBH	mA	0	20.0	Vil = 0, Vih = 5.5V, VIN = GND
ISBL	mA	0	20.0	Vil = 0, Vih = 5.5V, VIN = VCC
ISB1H	mA	0	5.00	Vil = 0.2, Vih = 5.3V, VIN = GND
ISB1L	mA	0	5.00	Vil = 0.2, Vih = 5.3V, VIN = VCC
ICCD	mA	0	95.0	Vil = 0, Vih = 5.5V

1/ Functional testing consists of the following:

1 - ALL_ONES	2 - ALL_ZEROS
3 - CHECKERBOARD	4 - INVERSE CHECKERBOARD
5 - "10N" MARCH	6 - ROW_ADDRESS
7 - COL_ADDRESS	8 - SLIDING_DIAGONALLY
9 - PING_PONG	10 - SURROUND
11 - ROW_GALPAT	12 - COL_GALPAT

2/ VIL and VIH are tested GO/NOGO in the VOH and VOL tests.

Table IV. AUTOMATIC PATTERN GENERATOR (APG)
TEST PATTERNS AND FAILURE DESCRIPTION

PATTERN NAME	TYPE OF FAILURES DETECTED BY PATTERN
ALL ZEROES & ALL ONES	- Opposite Logic State, Minimal Functional testing, Minimal check on Cell Interactions.
+CHECKERBOARD & -CHECKERBOARD	- Faulty operation of device address decoders, Minimal Functional testing.
MARCH	- Tests whether each DUT cell (bit) can be accessed and written into with a Zero and One.
ROW ADDRESS & COLUMN ADDRESS	- Faulty Access or Write into a cell. - Faulty Noise Coupling within a Column. - Faulty Noise Coupling within a Row. - Slow Sense-Amplifier Recovery. - Faulty Address Transitions between each Cell and Cells row. - Faulty Address Transitions between each Cell and Cells Column. - Faulty Refresh Sensitivity in Dynamic RAMS.
SLIDE DIAGONAL	- Faulty Internal multiple-address selection. - Destruction of stored data due to noise coupling. - Faulty Sense Amplifiers. - Slow Sense-Amplifier Recovery.
PING PONG	- Unsatisfactory address transitions between each Cell and every other Cell. - Slow Sense-Amplifier Recovery. - Destruction of stored data due to noise coupling between cells within a column. - Destruction of stored data due to noise coupling between cells within a row. - Faulty Refresh Sensitivity in Dynamic RAMS.
SURROUND	- Destruction of stored data within a cell due to opposite state writes to surrounding cells. - Faulty Access or Write into a cell. - Slow Sense-Amplifier Recovery.
ROW GALPAT & COLUMN GALPAT	- Uncovers internal multiple-address selection. - Slow Sense-Amplifier Recovery. - Destruction of stored data due to noise coupling between column and/or rows.

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Table V. Functional Test Results for HM628128LP after Total Dose Irradiations and Annealings @ +25°C/1

Functional Pattern	Test Frequency	Initial EM's	Post 5Krad	Post 10Krad	Post 15Krad	Post 20Krad	Post 50Krad/2	Post 96Hr Anneal/2	Post 75Krad/2	Post 96Hr Annealing	Post 100Krad	Post 168Hr Anneal/2
All Ones	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
All Ones	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
All Zeroes	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
All Zeroes	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Checkerboard	1 MHz	2P	2P	2P	2P	2P	2P	2P	0P/2F	2P	2P	0P/2F
Checkerboard	10 MHz	2P	2P	2P	2P	2P	2P	2P	0P/2F	2P	2P	2P
Inv Checkerboard	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Inv Checkerboard	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
March	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
March	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Row Address	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Row Address	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Column Address	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Column Address	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Sliding Diagonal	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Sliding Diagonal	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Ping Pong	1 MHz	2P	2P	2P	2P	2P	0P/2F	0P/2F	0P/2F	2P	2P	0P/2F
Ping Pong	10 MHz	2P	2P	2P	2P	2P	0P/2F	0P/2F	0P/2F	2P	2P	0P/2F
Surround	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Surround	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Row Galpat	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Row Galpat	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Column Galpat	1 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P
Column Galpat	10 MHz	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P	2P

NOTES:

1/ "P" means that all parts passed this functional test at this irradiation or annealing level. "F" means that all parts failed this functional test at this irradiation or annealing level. "nP/mF" means that n parts passed and m parts failed this functional test at this irradiation or annealing level.

2/ The intermittent functional failures at these steps could be due to an increase in ambient temperature of the ATE Lab beyond the operating specifications of the equipment for a short interval of time.

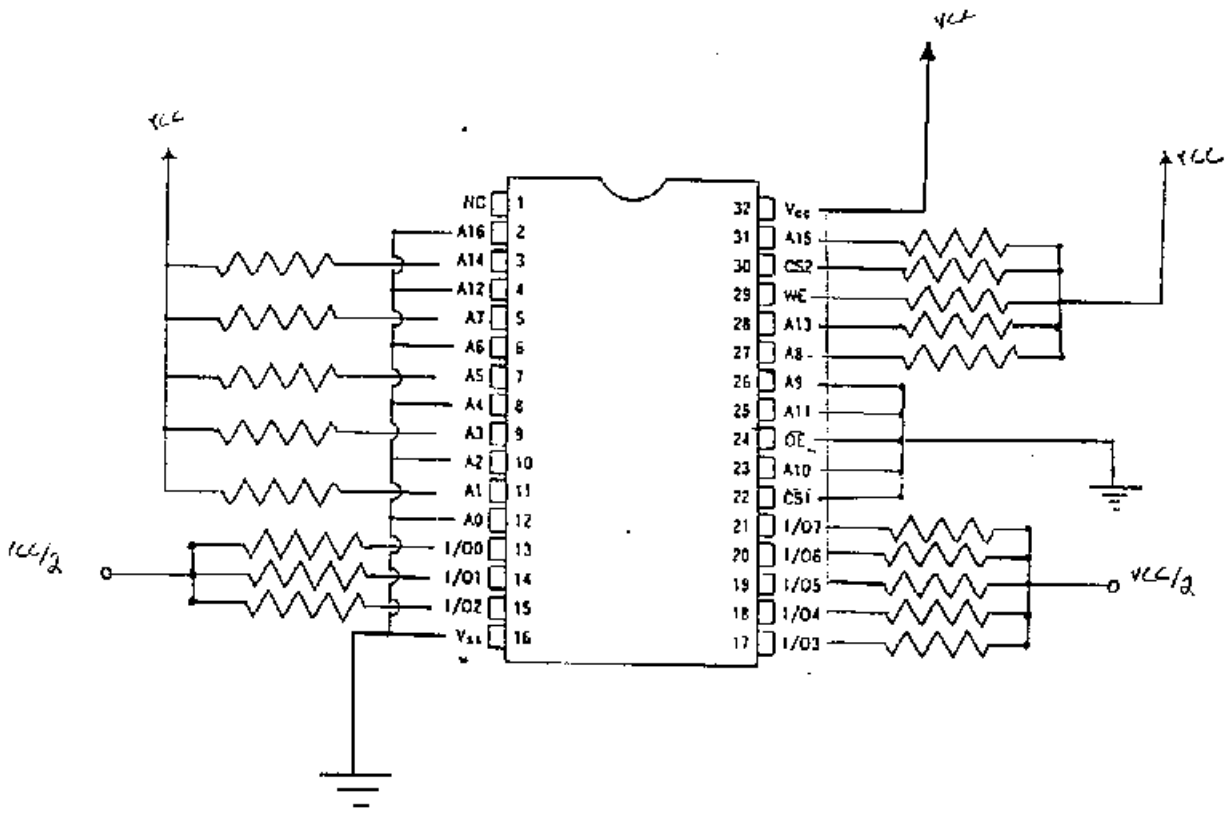
TABLE VI: Summary of Electrical Measurements After Selected Total Dose Exposures and Annealing for HM628128LP-10/1

Parameters		Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (TDE) Initial 0 mean	Initial 0 sd	20 krads mean	20 krads sd	50 krads mean	50 krads sd	Anneal 96 hrs. @25°C mean	Anneal 96 hrs. @25°C sd	TDE 75 krads mean	TDE 75 krads sd	Anneal 96 hrs. @25°C mean	Anneal 96 hrs. @25°C sd	TDE 100 krads mean	TDE 100 krads sd	Anneal 192 hrs. @25°C mean	Anneal 192 hrs. @25°C sd
VOH	V	2.40	5.50	3.52	.02	3.54	.01	3.54	.01	3.54	.01	3.52	.01	3.53	.01	3.52	0	3.54	.01
VOL	mV	0	400	190	24	181	2.3	181	2.4	182	1.9	211	42	189	2.6	183	2.7	187	.01
IIH	µA	0	5.00	0	.01	0	.02	0.09	.04	0.02	.03	0.05	.06	0.07	0	0.07	.08	0.04	.05
IIL	µA	-5.00	0	0	0	-.33	.53	-3.0	5.0	-.48	.70	-2.2	3.4	-3.6	5.5	-2.4	3.4	-1.1	1.5
ICH	µA	-5.00	5.00	0	0	0	0	0	0	0	0	0	.01	0	0	0	.01	0	0
IOL	µA	-5.00	5.00	0	0	-.03	.01	-.06	.04	0	0	-.04	.03	-.05	.05	-.06	.04	-.02	.01
ISBH	mA	0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	.03	0	0
ISBL	mA	0	20.0	0	0	0	0	0.11	.02	0	0	0.10	0	0.12	.02	0.12	.02	0.07	0
ISB1H	mA	0	5.00	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0
ISB1L	mA	0	5.00	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0
ICCD	mA	0	95.0	33.6	.46	33.7	.18	33.8	.15	33.5	.18	33.0	.77	33.6	.15	33.6	.15	33.3	.10

1/ The mean and standard deviation values were calculated over the two parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

2/ These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Figure 1. Radiation Bias Circuit for HM628128LP-10



1) Vcc = +5.0 VDC ± 10%

2) Vcc/2 = +2.5 VCD ± 10%

3) All resistor values are 2K Ohms ± 10%, 1/4 W minimum.