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Memorandum

PARAMAX
A Unisys Company

DATE: April 23, 1993 PPM-93-052
TO: G. Krishnan/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on BCMS (GCMS)
Part No. M38510/26104BZC (CJ28C256)
Control No. 7732

cc: A. Sharma/311
Library/300.1 ✓

A radiation evaluation was performed on CJ28C256 (32Kx8 EEPROM) 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 IV and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, four parts were irradiated under bias (see Figure 1 for bias configuration), and one part was used as a control sample. The parts were programmed with a checkerboard pattern during irradiation. The total dose radiation levels were 2.5, 5, 7.5, and 10 krads*. After 10 krads, parts were annealed at 25°C for 168 hours. The irradiation was then continued to 15 krads (cumulative). The dose rate was between 0.07 and 0.13 krads/hour, depending on the total dose level (see Table II for radiation schedule). Finally the parts were annealed for 168 hours at 100°C. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III. These tests included eight functional tests at 1.0 MHz, four at Vcc = 4.5 V and four at Vcc = 5.5 V.

All five parts passed initial (pre-rad) electrical tests. All four irradiated parts passed all electrical tests at each irradiation and annealing level up to and including the 10-krad irradiation and subsequent 168-hour anneal at 25°C. After the 15-krad irradiation, one part (S/N 180) failed two functional tests. These tests were FUNC5 (Writing/Reading Checkerboard at Vcc = 4.5 V) and FUNC8 (Writing/Reading Checkerboard at Vcc = 5.5 V). No other failures were observed.

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*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.

During the testing, some sensitivity to radiation was observed in ICCL3 and ICCH3, but the specification limits were never exceeded. All irradiated parts passed all other functional and electrical tests throughout all irradiation and annealing steps.

After a final annealing at 100°C, a slight rebound effect was observed in all irradiated samples in VOL (approximately 2-3 mV within a mean of 87.5 mV).

Table IV provides a summary of the functional test results, as well as the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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:	CJ28C256
Part Number:	M38510/26104BZC*
BCMS (GCMS) Control Number:	7732
Charge Number:	C33299
Manufacturer:	SEEQ Technologies
Lot Date Code:	9136
Quantity Tested:	5
Serial Numbers of Radiation Samples:	177, 178, 179, 180
Serial Numbers of Control Samples:	176
Part Function:	32Kx8 EEPROM
Part Technology:	CMOS
Package Style:	28-pin DIP
Test Equipment:	S-50
Test Engineer:	A. Karygiannis

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

TABLE II. Radiation Schedule for CJ28C256

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/25/93
2) 2.5 KRAD IRRADIATION (0.13 KRADS/HOUR)	03/30/93
POST-2.5 KRAD ELECTRICAL MEASUREMENT	03/17/93
3) 5 KRAD IRRADIATION (0.12 KRADS/HOUR)	03/30/93
POST-5 KRAD ELECTRICAL MEASUREMENT	03/31/93
4) 7.5 KRAD IRRADIATION (0.13 KRADS/HOUR)	03/31/93
POST-7.5 KRAD ELECTRICAL MEASUREMENT	04/01/93
5) 10 KRAD IRRADIATION (0.13 KRADS/HOUR)	04/01/93
POST-10 KRAD ELECTRICAL MEASUREMENT	04/02/93
6)168 HOUR ANNEALING @25°C	04/02/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/09/93
8) 15 KRAD IRRADIATION (0.07 KRADS/HOUR)	04/12/93
POST-15 KRAD ELECTRICAL MEASUREMENT	04/12/93
9) 168 HOUR ANNEALING @100°C*	04/12/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/19/93

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of CJ28C256

POST RADIATION/ANNEALING EM'S FUNCTIONAL TESTS PERFORMED /1

PARAMETER	VCC	VIL	VIH	PATTERN	CONDITIONS	PINS	LIMITS
FUNCT # 1	4.5V	0.0V	4.5V	READ CHKBD	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 2	5.5V	0.0V	5.5V	READ CHKBD	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 3	4.5V	0.0V	4.5V	WR/RD ZEROS	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 4	4.5V	0.0V	4.5V	WR/RD ONES	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 5	4.5V	0.0V	4.5V	WR/RD CHKBD	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 6	5.5V	0.0V	5.5V	WR/RD ZEROS	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 7	5.5V	0.0V	5.5V	WR/RD ONES	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 8	5.5V	0.0V	5.5V	WR/RD CHKBD	FREQ=0.5 MHz	I/O'S	VOL<1.0V , VOH>2.0V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOL	4.5V	0.8V	2.0V	LOAD = +2.1mA	OUTS	> 0.0V , < 0.45V
VOH	4.5V	0.8V	2.0V	LOAD = -400uA	OUTS	> 2.4V , < 4.5V
IIL	5.5V	0.1V	5.5V	TSTV = +0.1V	INS	>-100nA , <+100nA
IIH	5.5V	0.0V	5.5V	TSTV = +5.5V	INS	>-100nA , <+100nA
IOZL	5.5V	0.1V	5.5V	TSTV = +0.1V	OUTS	>-500nA , <+500nA
IOZH	5.5V	0.0V	5.5V	TSTV = +5.5V	OUTS	>-500nA , <+500nA
IOE	5.5V	0.0V	5.5V	TSTV = +13.0V	OE	>-10uA , <+100uA
ICC1	5.5V	0.0V	5.5V	FREQ = 5.0MHz	VCC	> 0mA , < 80mA
ICCL2	5.5V	0.8V	2.0V	CE=VIH, VI&OE=VIL	VCC	> 0mA , < 3mA
ICCH2	5.5V	0.8V	2.0V	VI&CE=VIH, OE=VIL	VCC	> 0mA , < 3mA
ICCL3	5.5V	0.0V	5.2V	CE=VIH, VI=VIL	VCC	> 0uA , < 350uA
ICCH3	5.5V	0.0V	5.2V	CE=VIH, VI=VIH	VCC	> 0uA , < 350uA

1/ Before each radiation exposure, the parts were programmed with a checkerboard pattern. After each radiation exposure, read tests (FUNC1 and FUNC2) were performed to determine if the parts retained the checkerboard pattern during the radiation exposure.

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for CJ28C256 1/

Parameters		Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (TDE) (krads) Initial mean	Initial sd	2.5 mean	2.5 sd	5 mean	5 sd	7.5 mean	7.5 sd	10 mean	10 sd	Anneal 168 hrs @25°C mean	Anneal 168 hrs @25°C sd	TDE 15 krads mean	TDE 15 krads sd	Anneal 168 hrs @100°C mean	Anneal 168 hrs @100°C sd
FUNC1/3, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2/3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC3/3, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4/3, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC5/3, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		3P1F		PASS	
FUNC6/3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC7/3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC8/3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		3P1F		PASS	
VOL	mV	0	450	80.9	1.4	80.3	1.3	79.5	1.4	79.7	1.3	78.8	1.3	82.6	1.3	80.8	1.4	87.5	6.0
VOH	V	2.4	4.5	3.72	7.9	3.73	10	3.74	9.7	3.75	9.7	3.76	9.9	3.74	11	3.75	12	3.67	.02
IIL	nA	-100	100	0	0	0	0	0	0	0	0	-.29	1.4	-.31	1.5	-10	12	0	0
IIH	nA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	8.50	2.0	0	0
IOZL	nA	-500	500	0	0	0	0	0	0	0	0	-5.5	6.0	-12	13	-53	54	0	0
IOZH	nA	-500	500	0	0	0	0	0	0	0	0	0	0	0	0	1.72	2.8	0	0
IOE	uA	-10	100	5.52	.03	5.70	.03	5.89	.04	6.07	.03	6.31	.04	6.26	.03	6.66	.03	5.85	.02
ICC1	mA	0	80	6.13	0.1	6.34	0.1	6.55	.09	6.69	.09	6.92	0.1	6.76	.09	7.17	.12	6.50	.09
ICCL2	mA	0	3.0	1.63	.02	1.59	.02	1.54	.02	1.51	.02	1.51	.03	1.48	.03	1.45	.04	1.34	.02
ICCH2	mA	0	3.0	1.63	.02	1.63	.02	1.54	.02	1.51	.02	1.51	.03	1.47	.03	1.45	.04	1.34	.02
ICCL3	uA	0	350	45.0	4.0	45.0	4.0	47.0	3.5	67.0	6.4	106	13	81.5	11	156	20	48.0	0
ICCH3	uA	0	350	47.0	3.5	47.0	3.5	45.0	4.0	67.0	6.4	106	13	81.5	11	158	24	48.0	3.5

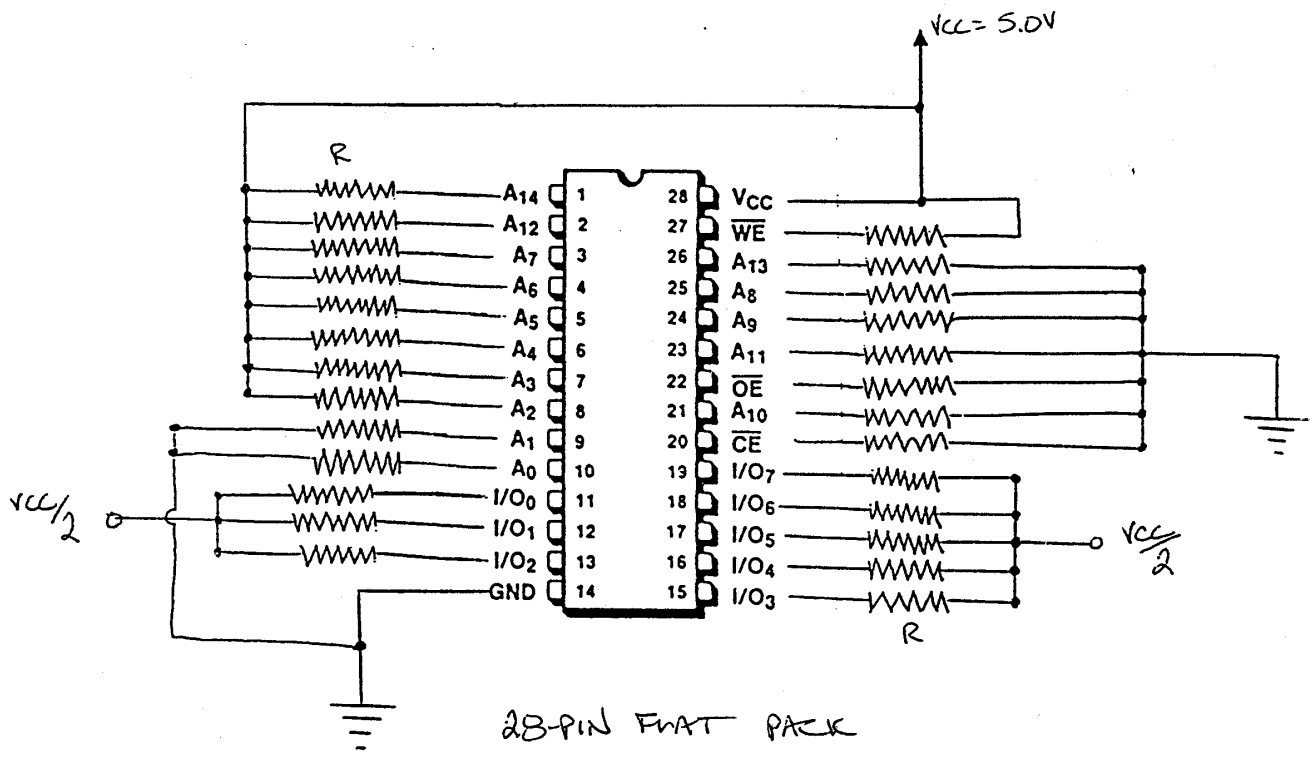
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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.

3/ "PASS" means that all parts passed this functional test at this radiation or annealing level. "FAIL" means that all parts failed this functional test at this radiation or annealing level. "nPmF" means that n parts passed and m parts failed the functional test at this radiation or annealing level.

Radiation-sensitive tests were FUNC5 and FUNC8.

Figure 1. Radiation Bias Circuit for CJ28C256



1) Vcc = +5.0 VDC ± 0.5 VDC, Vcc/2 = 2.5 VDC ± 0.25 VDC

2) All resistors R = 2.0K Ohms ± 10%, 1/4 W

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