Government Systems Group

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DATE: March 28, 1995
TO: A. Sharma/311
FROM: K. Sahu/300.1 *KS*
SUBJECT: Radiation Report on: 28C256
Project: AXAF
Control #: 12737
Job #: ER52811
Project part #: 5962-88525032A

PPM-95-141

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A radiation evaluation was performed on 28C256 (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 ^{60}Co gamma ray source. During the radiation testing, four parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation level was 2.5 krads*. The dose rate was 0.13 krads/hour (see Table II for radiation schedule). After the 2.5 krad irradiation, the parts were annealed at 25°C for 96 hours. After the 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 0.5 Mhz.

All parts passed initial electrical measurements. Prior to irradiation, a checkerboard pattern was written into the parts. At the 2.5 krad irradiation level, all parts passed Functional Tests 1 and 2, indicating that the checkerboard pattern remained intact in the parts after irradiation. However, all parts failed Functional Tests 3, 4, 6 and 7, which consisted of writing and reading zeroes and ones into the parts, indicating that the checkerboard pattern could not be written over, but was permanently imprinted in the parts. Two of the four parts also failed Functional Test 8, which involved writing and reading a checkerboard pattern into the parts.

After the 2.5 krad irradiation, the parts also failed the following parametric tests: All irraiated parts fell below the minimum specification limit of -100 nA for IIL, with readings ranging from -344 to -114 nA and exceeded the maximum specification limit of 500 nA for IOZH, with readings ranging from 641 to 10320 nA. In addition, all iradiated parts also exceeded the maximum specification limit of 3.0 mA for both ICCL2 and ICCH2, with readings ranging from 5.99 to 8.96 mA, and exceeded the maximum specification limit of 350 μA for both ICCL3 and ICCH3, with readings ranging from 4.54 to 7.63 mA. S/N 3, 5 and 6 also exceeded the maximum specification limit of 500 nA for IOZL, with readings ranging from 537 to 2225 nA..

After annealing for 96 hours at 25°C, no recovery was observed, and the parts continued to faill a number of write/read tests.

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

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter after the irradiation exposure and annealing.

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

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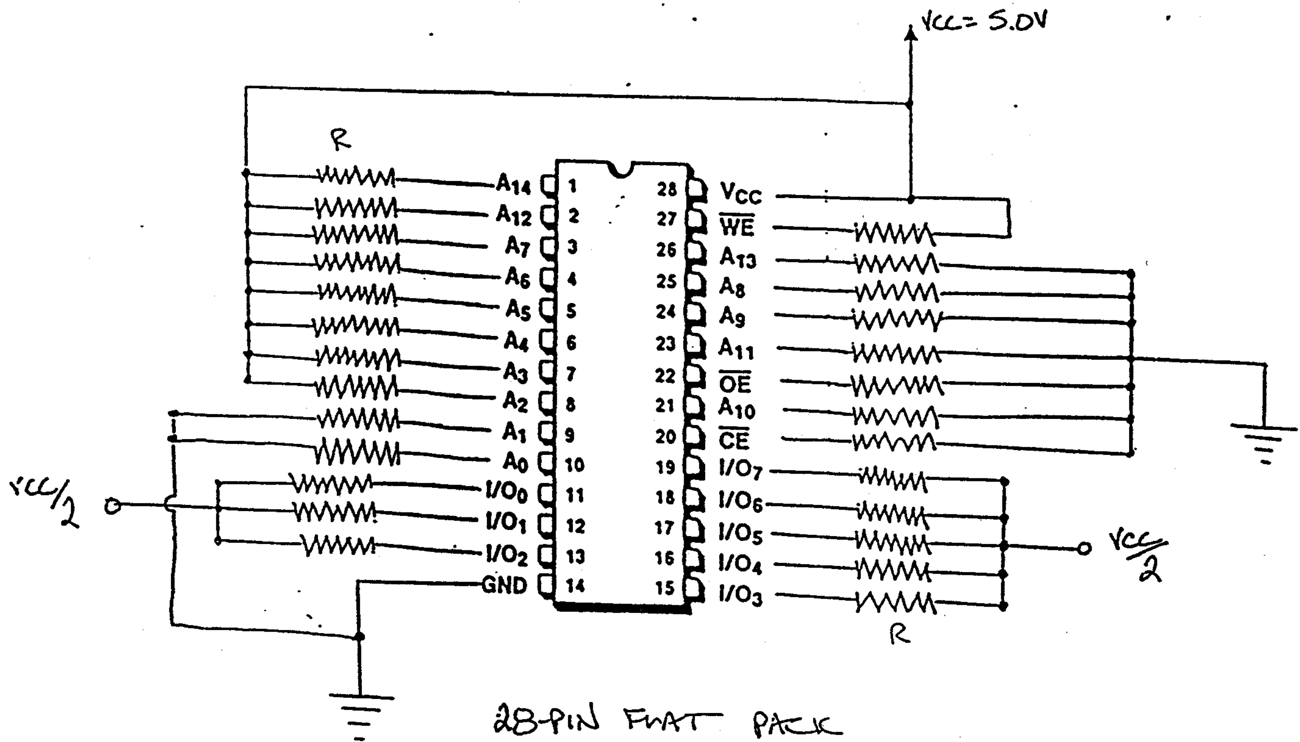
Figure 1. Radiation Bias Circuit for 28C256



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

TABLE I. Part Information

Generic Part Number:	28C256*
AXAF Part Number	5962-88525032A
AXAF Control Number:	12737
Charge Number:	ER52811
Manufacturer:	SEEQ
Lot Date Code (LDC):	9133A
Quantity Tested:	8
Serial Number of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	3, 4, 5, 6
Part Function:	EEPROM
Part Technology:	MOSFET
Package Style:	28-pin DIP
Test Equipment:	S-50
Engineer:	K. Kim

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

TABLE II. Radiation Schedule for 28C256

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/14/95
2) 2.5 KRAD IRRADIATION (0.13 KRADS/HOUR)	03/17/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	03/20/95
3) 96-HOUR ANNEALING @25°C	03/20/95
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/24/95

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

Table III. Electrical Characteristics of 28C256

PVT OR INITIAL EM'S FUNCTIONAL TESTS PERFORMED

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

POST RADIATION/ANNEALING EM'S FUNCTIONAL TESTS PERFORMED*

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 CHKBD	FREQ=0.5 MHZ	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 7	5.5V	0.0V	5.5V	WR/RD ZEROS	FREQ=0.5 MHZ	I/O'S	VOL<1.0V , VOH>2.0V
FUNCT # 8	5.5V	0.0V	5.5V	WR/RD ONES	FREQ=0.5 MHZ	I/O'S	VOL<1.0V , VOH>2.0V
				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

* Before irradiation, the parts were programmed with a checkerboard pattern. After irradiation, 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 28C256 /1

#	Functional Test /2	Pattern	Initial		TDE (krads) 2.5		Annealing 96 hrs@25°C	
1	Func1, Vcc=4.5V, Vil=0.0V, Vih=4.5V, Freq.=0.5MHz	READ CHKBD	/3		P		P	
2	Func2, Vcc=5.5V, Vil=0.0V, Vih=5.5V, Freq.=0.5MHz	READ CHKBD	/3		P		P	
3	Func3, Vcc=4.5V, Vil=0.0V, Vih=4.5V, Freq.=0.5MHz	WR/RD ZEROES	P		F		F	
4	Func4, Vcc=4.5V, Vil=0.0V, Vih=4.5V, Freq.=0.5MHz	WR/RD ONES	P		F		F	
5	Func5, Vcc=4.5V, Vil=0.0V, Vih=4.5V, Freq.=0.5MHz	WR/RD CHKBD	P		P		P	
6	Func6, Vcc=5.5V, Vil=0.0V, Vih=5.5V, Freq.=0.5MHz	WR/RD ZEROES	P		F		F	
7	Func7, Vcc=5.5V, Vil=0.0V, Vih=5.5V, Freq.=0.5MHz	WR/RD ONES	P		F		F	
8	Func8, Vcc=5.5V, Vil=0.0V, Vih=5.5V, Freq.=0.5MHz	WR/RD CHKBD	P		2P2F		1P3F	

#	Parameters	Units	Spec. Lim./4 min	max	Initial mean	sd	2.5 mean	sd	96 hrs@25°C mean	sd
1	VOL	mV	0	450	79.4	2.2	76.7	2.3	76.0	2.2
2	VOH	V	2.4	4.5	3.69	.01	3.74	.02	3.75	.02
3	IIL	nA	-100	100	0	0	-36.3	73	-34.3	68
4	IIH	nA	-100	100	0	0	0	0	0	0
5	IOZL	nA	-500	500	0	0	421	732	207	474
6	IOZH	nA	-500	500	0	0	2031	2976	1033	1657
7	IOE	µA	-10	100	7.37	.15	8.60	.17	8.58	.17
8	ICC1	mA	0	80	7.07	.09	15.5	2.0	12.6	.65
9	ICCL2	mA	0	3	1.78	.03	7.39	1.4	4.71	.80
10	ICCH2	mA	0	3	1.78	.03	7.38	1.4	4.71	.81
11	ICCL3	µA	0	350	46.0	3.5	5990	1391	3300	837
12	ICCH3	µA	0	350	46.0	3.5	5997	1393	3305	.83

Notes:

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

2/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.

3/ This test is performed only after irradiation and annealing.

4/ 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: IIL, IOZL, IOZH, ICCL2, ICCH2, ICCL3, ICCH3, Functional Tests.