Federal Systems

CAREPORTS\285.DOC

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DATE: November 2, 1995

PPM-95-182

TO: G. Kramer/311

FROM: K. Sahu/300.1 KS

SUBJECT: Radiation Report on: 28C010

Project: AXAF/Gulton
Control #: 13958
Job #: EE61730
Project part #: 28C010TRPFE

cc: T. Canales/Gulton
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A radiation evaluation was performed on 28C010 (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 Co^{60} 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 levels were 2.5, 5, 10, 15, 20, 25, 30, 50, 75 and 100 krads*. The dose rate was between 0.06 and 0.13 krads/hour (see Table II for radiation schedule). After the 100 krad exposure, the parts were annealed for 168 hours at 25°C, after which the parts were annealed for 168 hours at 100°C. After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits** listed in Table III The initial electrical measurements included nine functional tests: three with Vcc = 4.5 V (WR/RD ZEROES, WR/RD ONES, WR/RD CHKBD), the same three with Vcc = 5.0 V and the same three with Vcc = 5.5 V. Prior to the first irradiation, a checkerboard pattern was written into the parts to be irradiated. After the start of the radiation exposures, three additional functional tests were added to the original six: READ CHKBD at Vcc = 4.5 V, 5.0 V and 5.5 V.

All parts passed initial electrical measurements. All irradiated parts passed all functional and parametric tests throughout all irradiation steps up to and including the 20 krad irradiation level.

After the 25 krad irradiation, all irradiated parts fell below the minimum specification limit of -2.00 µA for IIL, with readings ranging from -2.01 to -3.14 µA. All irradiated parts continued to pass all other parametric and functional tests at this level.

From the 30 krad irradiation to the 100 krad irradiation, the same parametric degradation continued to be observed, with readings ranging from -2.19 to -7.09 µA at the 30 krad level, up to -2.36 to -57.0 µA at the 100 krad level. All irradiated parts continued to pass all other parametric and functional tests at this level.

After annealing for 168 hours at 25°C, the same parametric degradation continued to be observed, with readings ranging from -2.09 to -42.5 µA. All irradiated parts continued to pass all other parametric and functional tests at this level.

After annealing for 168 hours at 100°C, no rebound effects 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 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 each irradiation exposure and annealing step.

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

Figure 1. Radiation Bias Circuit for 28C010

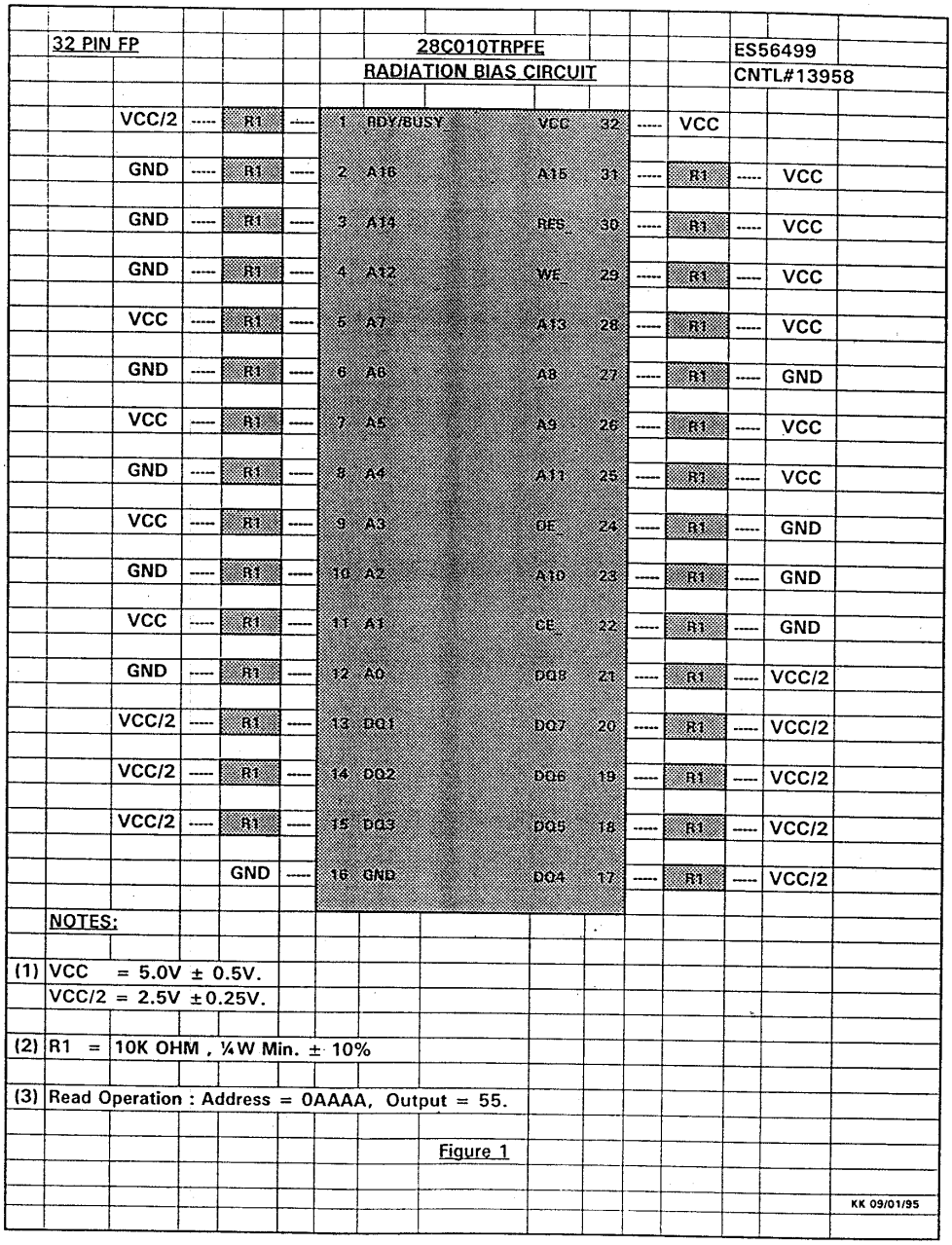

TABLE I. Part Information

Generic Part Number:	28C010*
AXAF/Gulton Part Number	28C010TRPFE
AXAF/Gulton Control Number:	13958
Charge Number:	EE61730
Manufacturer:	SEI/Hitachi
Lot Date Code (LDC):	9530
Quantity Tested:	6
Serial Number of Control Samples:	90, 91
Serial Numbers of Radiation Samples:	92, 93, 94, 95
Part Function:	EEPROM
Part Technology:	CMOS
Package Style:	32-pin Flatpack
Test Equipment:	S-50
Engineer:	K. Kim

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

TABLE II. Radiation Schedule for 28C010

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/15/95
2) 2.5 KRAD IRRADIATION (0.39 KRADS/HOUR)	09/15/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	09/18/95
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR)	09/19/95
POST-5 KRAD ELECTRICAL MEASUREMENT	09/20/95
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/20/95
POST-10 KRAD ELECTRICAL MEASUREMENT	07/21/95
5)15 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/21/95
POST-10 KRAD ELECTRICAL MEASUREMENT	09/22/95
6) 20 KRAD IRRADIATION (0.27 KRADS/HOUR)	09/25/95
POST-20 KRAD ELECTRICAL MEASUREMENT	07/26/95
7) 25 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/26/95
POST-25 KRAD ELECTRICAL MEASUREMENT	09/27/95
8) 30 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/27/95
POST-30 KRAD ELECTRICAL MEASUREMENT	09/28/95
9) 50 KRAD IRRADIATION (1.18 KRADS/HOUR)	09/28/95
POST-50 KRAD ELECTRICAL MEASUREMENT	09/29/95
10) 75 KRAD IRRADIATION (0.38 KRADS/HOUR)	09/29/95
POST-75 KRAD ELECTRICAL MEASUREMENT	10/02/95
11) 100 KRAD IRRADIATION (1.47 KRADS/HOUR)	10/02/95
POST-100 KRAD ELECTRICAL MEASUREMENT	10/03/95
12) 168-HOUR ANNEALING @25°C	10/03/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/10/95
13) 168-HOUR ANNEALING @100°C*	10/10/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/17/95

*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-8830, Method 1019, Para. 3.10.1.

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

Table III. Electrical Characteristics of 28C010

PARAMETER	VCC	VIL	VIH	PATTERN	CONDITIONS	PINS	LIMITS
FUNCT # 1	4.5V	0.0V	4.5V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 2	5.0V	0.0V	5.0V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 3	5.5V	0.0V	5.5V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 4	4.5V	0.0V	4.5V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 5	5.0V	0.0V	5.0V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 6	5.5V	0.0V	5.5V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 7	4.5V	0.0V	4.5V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 8	5.0V	0.0V	5.0V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 9	5.5V	0.0V	5.5V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V

POST RADIATION/ANNEALING EMS FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	PATTERN	CONDITIONS	PINS	LIMITS
FUNCT # 1	4.5V	0.0V	4.5V	READ CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 2	5.0V	0.0V	5.0V	READ CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 3	5.5V	0.0V	5.5V	READ CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 4	4.5V	0.0V	4.5V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 5	5.0V	0.0V	5.0V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 6	5.5V	0.0V	5.5V	WR/RD ZEROS	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 7	4.5V	0.0V	4.5V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 8	5.0V	0.0V	5.0V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT # 9	5.5V	0.0V	5.5V	WR/RD ONES	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT #10	4.5V	0.0V	4.5V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT #11	5.0V	0.0V	5.0V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V
FUNCT #12	5.5V	0.0V	5.5V	WR/RD CHKBD	FREQ=1.0MHZ	I/O'S	VOL<1.5V , VOH>1.5V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOL	4.5V	0.4V	2.8V	LOAD = +2.1MA	OUTS	> 0.0V , < 0.45V
VOH1	4.5V	0.4V	2.8V	LOAD = -400UA	OUTS	> 2.4V , < 4.5V
IIL	5.5V	0.0V	5.5V	TSTV = +0.0V	INS	> -2UA , < +2UA
IIL(RES_)	5.5V	0.0V	5.5V	TSTV = +0.0V	INS	> -100UA , < +100UA
IIH	5.5V	0.0V	5.5V	TSTV = +5.5V	INS	> -2UA , < +2UA
IIH(RES_)	5.5V	0.0V	5.5V	TSTV = +5.5V	INS	> -100UA , < +100UA
IOZL	5.5V	0.0V	5.5V	TSTV = +0.0V	OUTS	> -2UA , < +2UA
IOZH	5.5V	0.0V	5.5V	TSTV = +5.5V	OUTS	> -2UA , < +2UA
ICC1	5.5V	0.0V	5.5V	CE = 5.5V	VCC	> 0A , < 2CUA
ICC2	5.5V	0.0V	5.5V	CE = 2.8V	VCC	> 0A , < 1MA
ICC3	5.5V	0.0V	5.5V	FREQ = 1.0MHZ	VCC	> 0A , < 15MA
ICC4	5.5V	0.0V	5.5V	FREQ = 5.0MHZ	VCC	> 0A , < 50MA

AC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
TACCLH	4.5V	0.4V	2.8V	VCOMP = 2.0V	A->Q	>0NS , <200NS
TACCHL	4.5V	0.4V	2.8V	VCOMP = 0.8V	A->Q	>0NS , <200NS

TABLE IV: Summary of Functional Measurements After Total Dose Exposures and Annealing for 28C010 /1

Initial Functional Tests/2

Test #	Test Name	Test Conditions	Freq.	Pattern	Initial
1	FUNC1	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD ZEROES	P
2	FUNC2	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD ZEROES	P
3	FUNC3	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD ZEROES	P
4	FUNC4	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD ONES	P
5	FUNC5	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD ONES	P
6	FUNC6	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD ONES	P
7	FUNC7	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD CHKBD	P
8	FUNC8	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD CHKBD	P
9	FUNC9	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD CHKBD	P

Post Radiation Functional Tests/2

Test #	Test Name	Test Conditions	Freq.	Pattern	Total Dose Exposure (TDE)										Annealing	
					2.5	5	10	15	20	25	30	50	75	100	168 hrs @25°C	168 hrs @100°C
1	FUNC1	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	READ CHKBD	P	P	P	P	P	P	P	P	P	P	P	P
2	FUNC2	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	READ CHKBD	P	P	P	P	P	P	P	P	P	P	P	P
3	FUNC3	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	READ CHKBD	P	P	P	P	P	P	P	P	P	P	P	P
4	FUNC4	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD ZEROES	P	P	P	P	P	P	P	P	P	P	P	P
5	FUNC5	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD ZEROES	P	P	P	P	P	P	P	P	P	P	P	P
6	FUNC6	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD ZEROES	P	P	P	P	P	P	P	P	P	P	P	P
7	FUNC7	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD ONES	P	P	P	P	P	P	P	P	P	P	P	P
8	FUNC8	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD ONES	P	P	P	P	P	P	P	P	P	P	P	P
9	FUNC9	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD ONES	P	P	P	P	P	P	P	P	P	P	P	P
10	FUNC1	VCC=4.5V, VIL=0V, VIH=4.5V	1.0 MHz	WR/RD CHKBD	P	P	P	P	P	P	P	P	P	P	P	P
11	FUNC1	VCC=5.0V, VIL=0V, VIH=5.0V	1.0 MHz	WR/RD CHKBD	P	P	P	P	P	P	P	P	P	P	P	P
12	FUNC1	VCC=5.5V, VIL=0V, VIH=5.5V	1.0 MHz	WR/RD CHKBD	P	P	P	P	P	P	P	P	P	P	P	P

TABLE IV (Cont'd.): Summary of Electrical Measurements After Total Dose Exposures and Annealing for 28C010 /2

Test			Spec. Lim./3		Initial		Total Dose Exposure (TDE)																		Annealing			
							2.5		5		10		15		20		25		30		50		75		100		168 hrs @25°C		168 hrs @100°C	
#	Parameter	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	VOL	mV	0	450	80.0	1.5	80.5	1.5	80.5	1.5	80.6	1.6	80.4	1.6	80.8	1.6	81.3	1.5	80.9	1.5	82.0	1.7	82.1	1.8	82.4	1.6	82.4	1.8	82.2	1.4
2	VOH	V	2.4	4.5	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0	4.39	0
3	IIL	uA	-2.00	2.00	-1.31	6.9	-1.31	6.9	-1.31	6.9	-1.31	6.9	-1.32	6.9	0	0	-1.69	7.0	-2.11	7.2	-3.96	8.8	-4.37	9.4	-5.78	12	-4.64	9.9	-1.31	6.9
4	IIH	uA	-2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	.02	0.03	.03	0.07	.11	0.02	.02	0	0
5	IOZL	uA	-2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.10	.03	-0.05	.14	-0.09	.26	-0.19	.55	-0.13	.37	0	0
6	IOZH	uA	-2.00	2.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	.01	0.02	.02	0.06	.07	0.02	.02	0	0
7	ICC1	uA	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	ICC2	mA	0	1	0.10	0	0.10	0	0.09	.01	0.08	.01	0.09	.01	0.09	.01	0.08	.01	0.11	0	0.16	.03	0.17	.03	0.21	.06	0.17	.03	0.07	.01
9	ICC3	mA	0	15	5.09	.07	5.17	.20	5.00	.04	5.03	.12	4.97	.10	4.90	.10	4.98	0	4.93	.08	5.30	.10	5.33	.01	4.80	.05	4.80	.06	4.62	.11
10	ICC4	mA	0	50	29.6	.09	29.8	.56	29.4	.07	29.5	.18	29.4	.31	29.3	.16	29.5	.06	29.3	.17	30.1	.21	26.4	5.8	28.7	.17	28.8	.38	29.0	.17
11	TACCLH	nS	0	200	56.9	4.4	57.7	4.9	57.4	4.3	57.8	4.2	58.5	3.9	58.7	3.9	56.0	4.2	56.8	3.9	59.1	5.5	59.8	5.1	61.5	3.1	61.5	3.0	60.0	3.7
12	TACCHL	nS	0	200	56.1	1.6	56.0	1.6	55.9	1.7	56.0	1.7	56.0	1.8	56.1	1.8	54.5	1.6	54.3	1.7	54.5	1.7	54.6	1.9	57.0	2.1	56.6	2.3	56.3	1.6

Notes:

1/ In the functional tests, "P" means that all parts passed this test at this irradiation or annealing level, "F" means that all parts failed this test at this irradiation or annealing level and "nPmF" means that n parts passed at this level and m parts failed at this level.

2/ Additional functional tests were performed after the initial irradiation.

3/ 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.

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