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PPM-97-034

DATE: August 5, 1997
TO: J. Lohr/311
FROM: K. Sahu / 300.1 KS
SUBJECT: Radiation Report on: AS58C1001SF
Project: SMEX/LITE
Job #: ER61243
Project part #: AS58C1001SF

cc: T. Miccolis/300.1
A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on AS58C1001SF (1 MEG 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 Figure 1, and Tables I through IV.

The total dose testing was performed using a Co^{60} gamma ray source. During the radiation testing, five parts (SN's 70, 71, 72, 73, and 75) were irradiated under bias (see Figure 1 for bias configuration) and one part (SN 74) was used as a control sample. The total dose radiation levels were 5.0, 10.0, 15.0, 25.0, 30.0, 50.0, and 100 kRads*. The dose rate was between 0.125 and 0.625 kRads/hour (0.035 to 0.174Rads/s). See Table II for the radiation schedule. After the 100 kRad irradiation, the parts were annealed under bias for 265 hours at 25°C. After each radiation exposure and the annealing step, the parts were electrically tested according to the test conditions and the specification limits** listed in Table III. The electrical tests included twelve functional tests. These were as follows: 1-3. READ CHECKERBOARD, 4-6. WRITE/READ ONES, 7-9. WRITE/READ ZEROS, 10-12. WRITE/READ CHECKERBOARD.

SN 75 failed the IIL test initially and gave erratic readings in both timing parameters as well as functional tests from 10 to 100 kRads. For comparison, the data for this part is included in Table IV functional tests but it is not included in the parametric or timing tests in the bottom half of the table.

All parts except SN 75 passed all functional tests up to and including 100 kRads. All parts except SN 75 passed all electrical tests initially and on irradiation up to 25 kRads. No significant degradation was observed in any DC or AC parameter.

After the 30 to 100 kRad irradiations, all parts fell marginally below the specification limit of –2.0µA for IIL with readings in the range of –2.3 to –4.8µA for all. All parts passed all other tests.

The parts were annealed at 25°C for 265 hours and showed some recovery in IIL with SN 73 passing and all other parts in the range of –2.4 to –3.0µA.

Table IV provides a summary of 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.

* The term Rads, as used in this document, means Rads (SiO_2). All radiation levels cited are cumulative.
** These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

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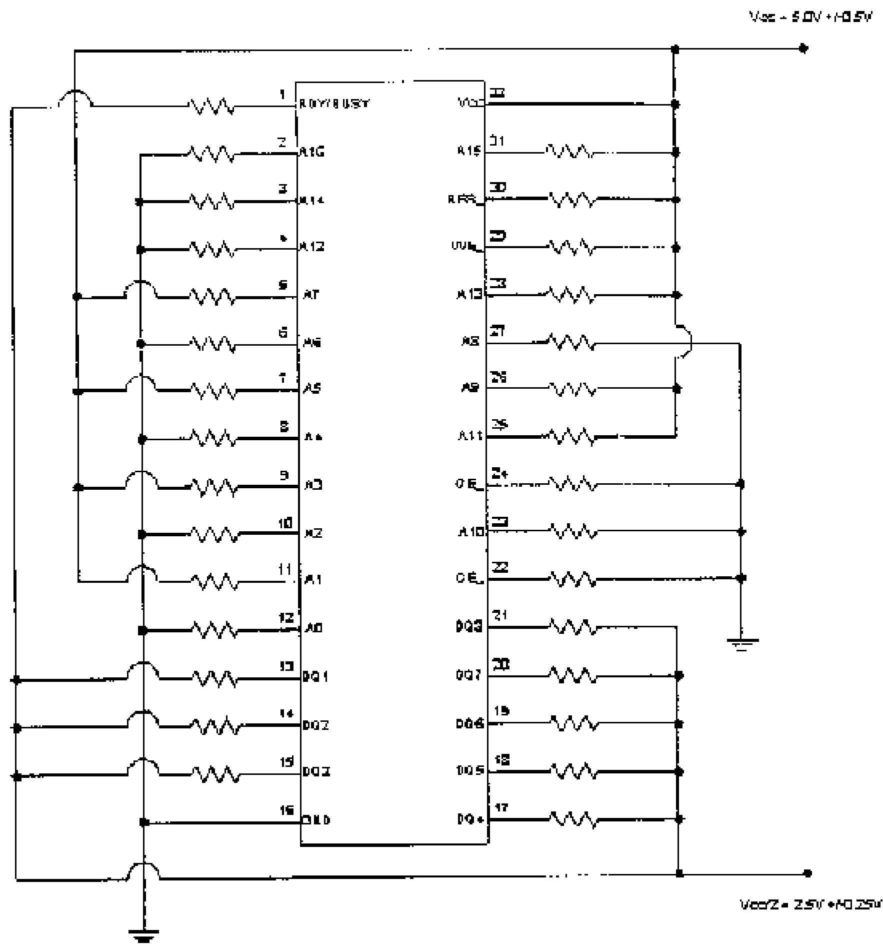
Figure 1. Radiation Bias Circuit for AS58C1001SF (1 MEG EEPROM)



Notes:

1. All resistors 10kΩ ±10%, ¼ W min.
2. Read Operation: Address = 0AAAA, Output = 55

TABLE I. Part Information

Generic Part Numbers:	AS58C1001SF
Part Numbers	AS58C1001SF
Charge Number:	ER61243
Manufacturer:	Austin Semiconductor/Hitachi die
Lot Date Code (LDC):	9646
Quantities Tested:	6
Serial Numbers of Control Sample:	74
Serial Numbers of Radiation Samples:	70, 71, 72, 73, 75
Part Function:	1 MEG EEPROM
Part Technology:	CMOS
Package Style:	32 PIN FLAT PACK
Test Equipment:	S-50
Engineer:	A. Duvalsaint

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

TABLE II. Radiation Schedule for AS58C1001SF

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/27/97
2) 5.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	06/27/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT	06/30/97
3) 10.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	06/30/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	07/02/97
4) 15.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	07/02/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT	07/03/97
5) 25.0 KRAD IRRADIATION (0.12 KRADS/HOUR)	07/03/97
POST-25.0 KRAD ELECTRICAL MEASUREMENT	07/07/97
6) 30.0 KRAD IRRADIATION (0.12 KRADS/HOUR)	07/15/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT	07/17/97
7) 50.0 KRAD IRRADIATION (0.12 KRADS/HOUR)	07/17/97
POST-50.0 KRAD ELECTRICAL MEASUREMENT	07/23/97
8) 100.0 KRAD IRRADIATION (0.25 KRADS/HOUR)	07/23/97
POST-100.0 KRAD ELECTRICAL MEASUREMENT	07/25/97
9) 265-HOUR ANNEALING @25°C	07/25/97
POST-265 HOUR ANNEAL ELECTRICAL MEASUREMENT	08/05/97

Effective dose rate = 100,000 RADS/29 DAYS = 143.7 RADS/HOUR = 0.040 RADS/SEC.

All parts were irradiated and annealed under bias. See Figure 1

Table III: Electrical Characteristics of AS58C1001SF

Functional Tests

Test #	Test	Test Conditions
1	Read Checkerboard	V_{CC}=4.5V, V_{IL}=0.0V, V_{IH}=4.5V, f=1MHz
2	Read Checkerboard	V_{CC}=5.0V, V_{IL}=0.0V, V_{IH}=5.0V, f=1MHz
3	Read Checkerboard	V_{CC}=5.5V, V_{IL}=0.0V, V_{IH}=5.5V, f=1MHz
4	Write/Read Ones	V_{CC}=4.5V, V_{IL}=0.0V, V_{IH}=4.5V, f=1MHz
5	Write/Read Ones	V_{CC}=5.0V, V_{IL}=0.0V, V_{IH}=5.0V, f=1MHz
6	Write/Read Ones	V_{CC}=5.5V, V_{IL}=0.0V, V_{IH}=5.5V, f=1MHz
7	Write/Read Zeros	V_{CC}=4.5V, V_{IL}=0.0V, V_{IH}=4.5V, f=1MHz
8	Write/Read Zeros	V_{CC}=5.0V, V_{IL}=0.0V, V_{IH}=5.0V, f=1MHz
9	Write/Read Zeros	V_{CC}=5.5V, V_{IL}=0.0V, V_{IH}=5.5V, f=1MHz
10	Write/Read Checkerboard	V_{CC}=4.5V, V_{IL}=0.0V, V_{IH}=4.5V, f=1MHz
11	Write/Read Checkerboard	V_{CC}=5.0V, V_{IL}=0.0V, V_{IH}=5.0V, f=1MHz
12	Write/Read Checkerboard	V_{CC}=5.5V, V_{IL}=0.0V, V_{IH}=5.5V, f=1MHz

Parametric Tests

Test #	Parameter	Units	Test Conditions /1	Spec. min	Lim. max
1	VOL	V	Load = 2.1mA	0	0.45
2	VOH	V	Load = -400μA	2.4	4.5
3	IIL	μA	TSTV = 0.0V	-2.0	2.0
4	IIL(res_)	μA	TSTV = 0.0V	-100	100
5	IIH	μA	TSTV = 5.5V	-2.0	2.0
6	IIH(res_)	μA	TSTV = 5.5V	-100	100
7	IOZL	μA	TSTV = 0.0V	-2.0	2.0
8	IOZH	μA	TSTV = 5.5V	-2.0	2.0
9	ICC1	μA	CE = 5.5V	0	20
10	ICC2	μA	CE = 2.8V	0	1000
11	ICC3	mA	Freq. = 1.0MHz	0	15
12	ICC4	mA	Freq. = 5.0MHz	0	50
13	TACCLH	ns	VCOMP = 2.0V	0	200
14	TACCHL	ns	VCOMP = 0.8V	0	200

Note:

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.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AS58C1001SF /1

#	Functional Tests /2 /3 /4 /5				Total Dose Exposure (kRads)																Annealing	
					Initial		5.0		10		15		25		30		50		100		265hrs @25°C	
1	Vcc=4.5V,Vil=0.0V,Vih=4.5V,Freq=1MHz				6/		P		P		P		P		P		P		P		P	
2	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=1MHz				6/		P		P		P		P		P		P		P		P	
3	Vcc=5.5V,Vil=0.0V,Vih=5.5V,Freq=1MHz				6/		P		P		P		P		P		P		P		P	
4	Vcc=4.5V,Vil=0.0V,Vih=4.5V,Freq=1MHz				P		P		P		P		4P1F		4P1F		4P1F		4P1F		4P1F	
5	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=1MHz				P		P		4P1F		P		4P1F		4P1F		4P1F		4P1F		4P1F	
6	Vcc=5.5V,Vil=0.0V,Vih=5.5V,Freq=1MHz				P		P		P		P		4P1F		4P1F		4P1F		4P1F		4P1F	
7	Vcc=4.5V,Vil=0.0V,Vih=4.5V,Freq=1MHz				P		P		P		P		4P1F		4P1F		4P1F		4P1F		4P1F	
8	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=1MHz				P		P		P		P		4P1F		4P1F		4P1F		4P1F		4P1F	
9	Vcc=5.5V,Vil=0.0V,Vih=5.5V,Freq=1MHz				P		P		P		P		4P1F		4P1F		4P1F		4P1F		4P1F	
10	Vcc=4.5V,Vil=0.0V,Vih=4.5V,Freq=1MHz				P		P		P		P		P		P		P		P		P	
11	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=1MHz				P		P		P		P		P		P		P		P		P	
12	Vcc=5.5V,Vil=0.0V,Vih=5.5V,Freq=1MHz				P		P		P		P		P		P		P		P		P	
#	Parameters	Units	Spec. Lim. min	Spec. Lim. max																		
1	VOL	mV	0	450	94	2.6	89	0.4	88	0.8	90	0.7	83	1.0	82	0.8	83	0.8	83	1.1	84	1.4
2	VOH	V	2.4	4.5	4.4	0	4.6	0	4.6	0	4.6	0	4.6	0	4.6	0	4.6	0	4.6	0	4.6	0
3	IIL	µA	-2.0	2.0	0	0	0	0	0	0	-0.1	0.1	-0.6	0.1	-3.0	0.5	-3.2	1.6	-3.2	0.9	-2.3	0.7
4	IIL(res_)	µA	-100	100	-39.9	4.0	-38.1	3.8	-38.1	3.8	-38.2	3.8	-38.2	3.8	-39.4	3.8	-39.4	3.1	-39.2	3.5	-40.4	2.4
5	IIH	µA	-2.0	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0.001	0.001	0.001	0	0
6	IIH(res_)	µA	-100	100	0.000	0.005	-0.04	0.05	-0.04	0.05	-0.06	0.06	-0.04	0.05	-0.01	0.06	-0.01	0.01	0.05	0.04	0.02	0.01
7	IOZL	µA	-2.0	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0
8	IOZH	µA	-2.0	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.02	0
9	ICC1	µA	0	20	6.0	7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	ICC2	µA	0	1000	85	0	116	7.2	116	7.2	114	6.7	116	7.2	126	11.8	129	15.7	126	13.0	129	6.0
11	ICC3	mA	0	15	5.0	0.1	4.6	0.1	4.6	0.1	4.5	0.1	4.5	0.1	4.5	0.1	4.5	0.1	4.4	0.1	4.3	0.1
12	ICC4	mA	0	50	29.3	0.6	27.4	0.3	27.4	0.4	27.4	0.3	27.4	0.4	27.3	0.3	27.2	0.3	26.9	0.2	26.9	0.2
13	TACCLH	ns	0	200	67.9	1.1	66.4	4.0	68.4	0.3	69.0	0.3	68.7	0.3	68.9	0.2	68.9	0.3	69.9	0.2	70.0	0.3
14	TACCHL	ns	0	200	54.8	0.6	54.5	0.5	54.7	0.8	55.3	0.8	54.6	0.8	54.8	0.8	54.6	0.8	55.3	0.8	56.4	0.8

Notes:

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

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

3/ "P" ("F") indicates that all parts passed (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 annelaing step.

4/ The limits for all functional tests are: VOL < 1.5V and VOH > 1.5V. Funct. 1-3: Read Checkerboard, Funct. 4-6: W/R Zeroes, Funct. 7-9: W/R Ones, Funct. 10-12: W/R Checkerboard.

5/ SN75 is included in the functional test portion of the table for comparison only. It is not included in the parametric test results because the parametric measurements for this part were very erratic.

6/ This test was not performed at this level, the memory had no data stored in it initially.

Radiation Sensitive Parameter: IIL.