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DATE: December 10, 1997 PPM-97-052
TO: S. Hull/562
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on: 54ABT245
Project: IRAC
Job #: M78281
Project part #: 54ABT245 (5962-9214801QSA)

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A radiation evaluation was performed on 54ABT245 (5962-9214801QSA) Transceiver with Tri-State I/O (National Semiconductor) 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, eight parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as a control samples. The total dose radiation levels were 5.0, 10.0, 15.0, 20.0, 30.0, 50.0, and 100.0 kRads.* The dose rate was between 0.125 and 0.625 kRads/hour (0.035 to 0.174 Rads/s). After the 50.0 kRad exposure, the parts were annealed for 96 hours at 25°C. After the 100.0 kRad exposure, the parts were annealed for 168 hours at 25°C and for 168 hours at 100°C. See Table II for the radiation schedule and effective dose rate calculation. The Effective dose rate overall testing was 0.032 Rads/sec. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 63, 64, 65, 66, 67, 68, 69, and 70) were used as radiation samples while SN's 61 and 62 were used as a control samples. All parts passed all tests during initial electrical measurements.

Due to problems with the chip fixture, SN 66 was removed from testing at 30kRads and SN 70 was removed from testing at 50kRads.

All parts passed all tests up to 30.0 kRads with no significant degradation in any parameter.

After the 50.0 kRad irradiation, all parts marginally exceeded the specification limit of 20µA for IOZH with readings in the range of 28.2 to 34.1µA. **All parts passed all other tests (functional and parametric).**

After annealing the parts for 96 hours at 25°C, parts showed modest recovery in IOZH with readings in the range of 21.6 to 27.0µA. **All parts passed all other tests (functional and parametric).**

After the 100.0 kRad irradiation, SN 63 marginally exceeded the specification limit of 550mV for one VOL3 test with a reading of 605mV. All parts exceeded the specification limit of 100µA for IIH with readings in the range of 366 to 419µA. All parts exceeded the specification limit for IOZH with readings in the range of 364 to 417µA. All parts exceeded the specification limit of 250µA for ICCH with readings in the range of 1.20 to 1.46mA. **All parts passed all other tests (functional and parametric).**

After annealing the parts for 168 hours at 25°C, parts showed no significant recovery in any parameter.

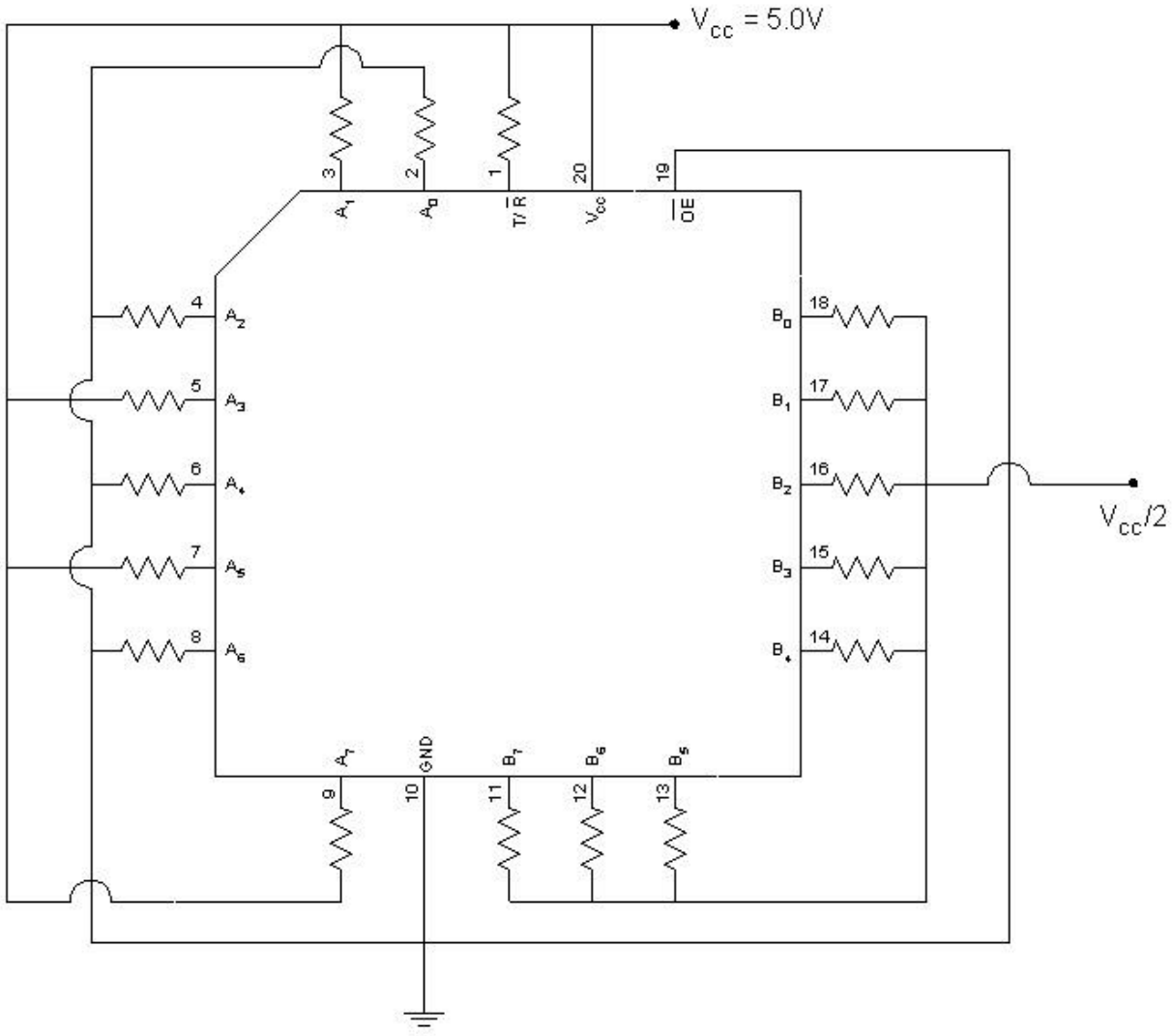
* The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
** These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After annealing the parts for 168 hours at 100°C, parts showed no rebound effects.

Table IV provides a summary of the test results with 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 54ABT245



Note:
1. Resistors are 2kΩ ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	54ABT245
IRAC Part Number	54ABT245
Charge Number:	M78281
Manufacturer:	National Semiconductor
Lot Date Code (LDC):	9637
Quantity Tested:	10
Serial Number of Control Samples:	61, 62
Serial Numbers of Radiation Samples:	63, 64, 65, 66, 67, 68, 69, and 70
Part Function:	Transceiver with tri-state I/O
Part Technology:	Bipolar
Package Style:	20 Pin Flat Pack
Test Equipment:	AD540
Test Engineer:	D. Davis

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

TABLE II. Radiation Schedule for 54ABT245

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	10/16/97
2) 5.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	10/22/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT	10/24/97
3) 10.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	10/24/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	10/29/97
4) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	10/29/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT	10/31/97
5) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	10/31/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT	11/03/97
6) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	11/03/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT	11/06/97
7) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR)	11/06/97
POST-50.0 KRAD ELECTRICAL MEASUREMENT	11/10/97
8) 96 HOUR ANNEALING @25°C	11/10/97
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/14/97
9) 100.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	11/14/97
POST-100.0 KRAD ELECTRICAL MEASUREMENT	11/17/97
10) 168 HOUR ANNEALING @25°C	11/17/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/24/97
11) 168 HOUR ANNEALING @100°C	11/24/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/10/97

Effective Dose Rate = 100,000 RADS/36 DAYS=115.7 RADS/HOUR=0.032 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim-annealing step.

The interim annealing following the 50.0 kRad step was added due to degradation in the parts. The addition of an interim annealing step better simulates the space environment's lower dose rate for very sensitive devices. This may allow the parts to show satisfactory performance at higher doses or indicate that the part can not be used beyond the previous dose level.

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

Table III. Electrical Characteristics of 54ABT245 /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1	VOH1	V	V_{IN} = 2.0V or 0.8V, I_{OH} = -3mA, V_{CC} = 4.5V	2.5	4.5
2	VOH2	V	V_{IN} = 2.0V or 0.8V, I_{OH} = -3mA, V_{CC} = 5.0V	2.0	4.5
3	VOH3	V	V_{IN} = 2.0V or 0.8V, I_{OH} = -24mA, V_{CC} = 4.5V	2.0	4.5
4	VOL1	mV	V_{IN} = 2.0V or 0.8V, I_{OH} = 48mA, V_{CC} = 4.5V	0	500
5	VOL2	mV	V_{IN} = 2.0V or 0.8V, I_{OH} = 48mA, V_{CC} = 4.5V	0	500
6	VOL3	mV	V_{IN} = 2.0V or 0.8V, I_{OH} = 48mA, V_{CC} = 4.5V	0	550
7	IIH	mA	V_{IN} = V_{CC}, V_{CC} = 5.5V	-100	100
8	IIL	mA	V_{IN} = GND, V_{CC} = 5.5V	-100	100
9	IOZH	mA	V_{IN} = V_{IH} or V_{IL}, V_{IH} = 2.0V, V_{IL} = 0.8V, V_{OUT} = 2.7V, V_{CC} = 5.5V	-20.0	20.0
10	IOZL	mA	V_{IN} = V_{IH} or V_{IL}, V_{IH} = 2.0V, V_{IL} = 0.8V, V_{OUT} =0.5V, V_{CC} = 5.5V	-20.0	20.0
11	ICCH	mA	V_{IN} = V_{CC} or GND, I_{OUT} = 0A, V_{CC} = 5.5V	0	250
12	ICCL	mA	V_{IN} = V_{CC} or GND, I_{OUT} = 0A, V_{CC} = 5.5V	0	30
13	ICCZ	mA	V_{IN} = V_{CC} or GND, I_{OUT} = 0A, V_{CC} = 5.5V	0	250

Functional Tests				
Test #	V_{CC}	V_{IL}	V_{IH}	Frequency
1	4.50V	0.0V	4.50V	1.000MHz
2	5.00V	0.0V	5.00V	1.000MHz
3	5.50V	0.0V	5.50V	1.000MHz

Note:

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

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54ABT245 (National Semiconductor) /1

#	Functional Tests /2 /3				Initial		Total Dose Exposure (kRads) 5		10		15		20		30		50		Annealing 96 hrs @ 25°C		TID (kRads) 100		Annealing 168 hrs @ 25°C		Annealing 168 hrs @ 100°C	
1	Vcc=4.5V, Vil=0.0V, Vih=4.5V, Freq=1MHz				P		P		P		P		P		P		P		P		P		P		P	
2	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=1MHz				P		P		P		P		P		P		P		P		P		P		P	
3	Vcc=5.5V, Vil=0.0V, Vih=5.5V, Freq=1MHz				P		P		P		P		P		P		P		P		P		P		P	
#	Parameters	Units	Spec. Lim. /4 min	max	Initial		5		10		15		20		30		50		96 hrs @ 25°C		100		168 hrs @ 25°C		168 hrs @ 100°C	
1	VOH1	V	2.5	4.5	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0	2.9	0
2	VOH2	V	2.0	4.5	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0
3	VOH3	V	2.0	4.5	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0	3.5	0
4	VOL1	mV	0	500	183	3.1	183	3.5	184	3.3	185	3.7	186	3.9	187	4.2	188	4.2	187	5.5	188	6.3	189	1.5	189	3.0
5	VOL2	mV	0	500	327	4.0	328	5.2	330	7.7	330	6.8	329	6.2	336	12.9	340	14.9	336	5.2	340	17.4	344	5.6	347	13.5
6	VOL3	mV	0	550	449	5.9	451	9.8	453	13	455	11	456	11	455	3.9	475	29.6	468	8.7	501	60.8	510	56.5	488	25.0
7	IIH	µA	-100	100	14.5	0.5	14.6	0.5	14.7	0.5	15.1	0.6	16.9	0.8	14.8	0.5	31.5	2.3	25.0	1.9	385	18.1	297	22.6	19.0	2.3
8	IIL	µA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	-0.2	0.06	-0.2	0.04	-0.6	0.4	-0.5	0.1	0	0
9	IOZH	µA	-20.0	20.0	14.4	0.5	14.5	0.5	14.6	0.5	15.1	0.7	16.8	0.8	14.8	0.5	31.0	2.5	24.5	1.9	383	18.2	295	22.7	18.3	2.2
10	IOZL	µA	-20.0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.05	0.1	0	0.6	0.07	0.4	0.06	0	0
11	ICCH	µA	0	250	10.9	14.0	7.3	12.6	7.3	12.6	18.5	14.0	29.6	13.3	4.1	10.1	53.2	8.8	43.2	6.3	1270	68	926	89	24.2	10.8
12	ICCL	mA	0	30	22.0	0.1	22.0	0.1	22.1	0.1	22.1	0.1	22.1	0.1	22.2	0.1	22.2	0.1	22.2	0.1	22.2	0.1	22.2	0.1	22.1	0.1
13	ICCZ	µA	0	250	0	0	0	0	0	0	4.1	10.1	14.5	14.5	4.1	10.1	9.7	13.7	5.8	11.6	14.5	14.5	9.7	13.7	24.2	10.8

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing.

2/ The control samples remained constant throughout the testing are are not included in this table.

3/ "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 annelaing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.

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

Radiation sensitive parameters: VOL3, IH, IOZH, ICCH.