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DATE: December 10, 1997 PPM-97-053
TO: S. Hull/562
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on: 54ABT245
Project: IRAC
Job #: M78281
Project part #: 54ABT245 (5962-9214801QRA)

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A radiation evaluation was performed on 54ABT245 (5962-9214801QRA) Transceiver with Tri-State I/O (Texas Instruments) 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 20.0 kRad exposure, the parts were annealed for 48 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 77, 78, 79, 80, 81, 82, 83, and 84) were used as radiation samples while SN's 75 and 76 were used as a control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 10.0 kRads with no significant degradation in any parameter.

After the 15.0 kRad irradiation, all parts exceeded the specification limit of 250µA for ICCH with readings in the range of 562 to 695µA. All parts exceeded the specification limit of 250µA for ICCZ with readings in the range of 309 to 397µA. **All parts passed all other tests (functional and parametric).**

After the 20.0 kRad irradiation, all parts exceeded the specification limit for ICCH with readings in the range of 2400 to 3500µA. All parts exceeded the specification limit for ICCZ with readings in the range of 1200 to 1800µA. **All parts passed all other tests (functional and parametric).**

After annealing the parts for 48 hours at 25°C, the parts showed modest recovery. All parts exceeded the specification limit for ICCH with readings in the range of 1600 to 2300µA. All parts exceeded the specification limit for ICCZ with readings in the range of 835 to 1326µA. **All parts passed all other tests (functional and parametric).**

After the 30.0 kRad irradiation, all parts exceeded the specification limit for ICCH with readings in the range of 4.3 to 9.1mA. All parts exceeded the specification limit of 30mA for ICCL with readings in the range of 27 to 32mA.

* 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.

All parts exceeded the specification limit for ICCZ with readings in the range of 2.1 to 4.5mA. **All parts passed all other tests (functional and parametric).**

After the 50.0 kRad irradiation, all parts exceeded the specification limit for ICCH with readings in the range of 9.2 to 12.3mA. All parts exceeded the specification limit for ICCL with readings in the range of 30 to 32mA. All parts exceeded the specification limit for ICCZ with readings in the range of 4.1 to 6.1mA. **All parts passed all other tests (functional and parametric).**

After the 100.0 kRad irradiation, all parts exceeded the specification limit for ICCH with readings in the range of 20.9 to 26.0mA. All parts exceeded the specification limit for ICCL with all readings greater than 32mA. All parts exceeded the specification limit for ICCZ with readings in the range of 10.6 to 13.7mA. **All parts passed all other tests (functional and parametric).**

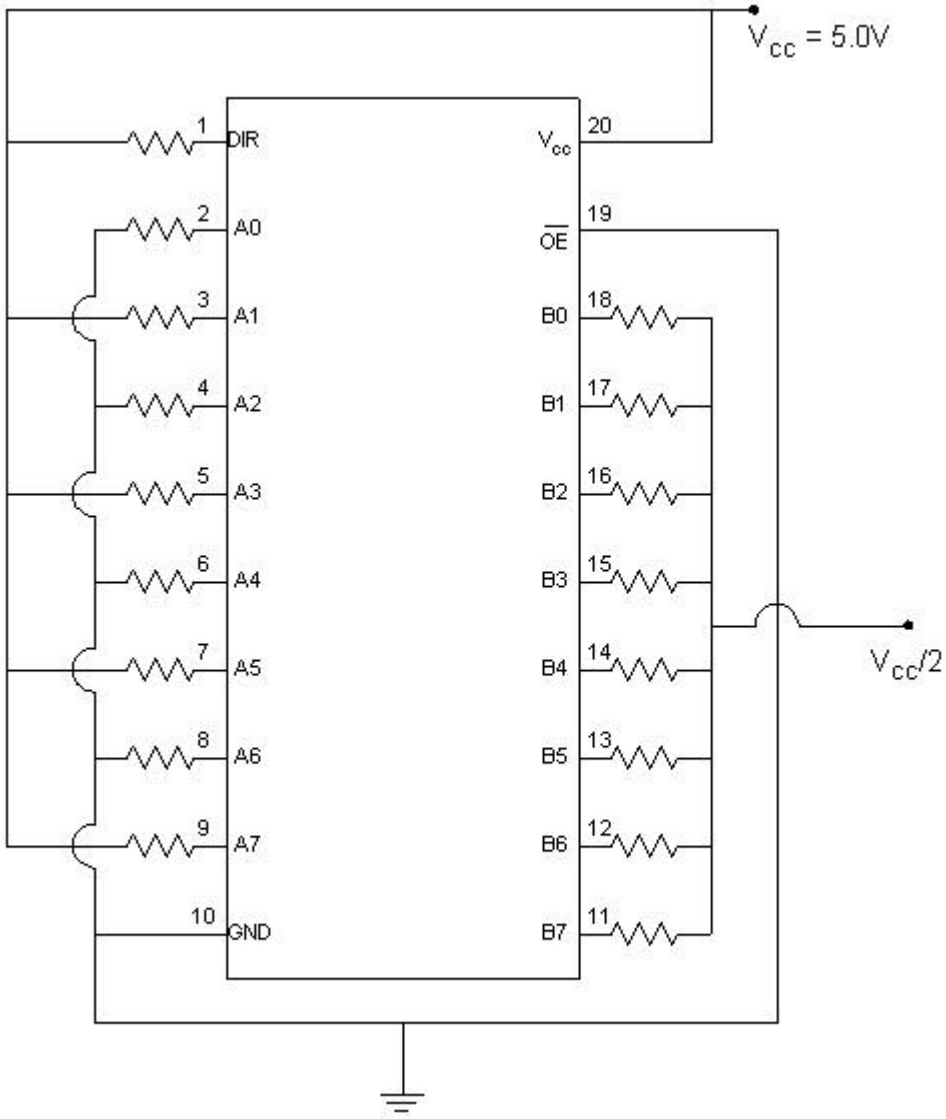
After annealing the parts for 168 hours at 25°C, parts showed some recovery in ICCH, ICCL, and ICCZ however, two parts fell below the specification limit of -20μA for IOZH with readings of -22 and -25μA. The readings for ICCH, ICCL and ICCZ were in the ranges of 7.3 to 12.6mA, 30 to 32mA, and 3.6 to 6.3mA respectively. **All parts passed all other tests (functional and parametric).**

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:	Texas Instruments
Lot Date Code (LDC):	9717
Quantity Tested:	10
Serial Number of Control Samples:	75, 76
Serial Numbers of Radiation Samples:	77, 78, 79, 80, 81, 82, 83, and 84
Part Function:	Transceiver with tri-state I/O
Part Technology:	Bipolar
Package Style:	20 Pin DIP
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) 168 HOUR ANNEALING @25°C	11/03/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/10/97
7) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	11/10/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT	11/13/97
8) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR)	11/13/97
POST-50.0 KRAD ELECTRICAL MEASUREMENT	11/17/97
9) 100.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	11/17/97
POST-100.0 KRAD ELECTRICAL MEASUREMENT	11/19/97
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 20.0 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 (Texas Instruments) /1

					Total Dose Exposure (kRads)										Annealing		Total Dose Exposure (kRads)						Annealing		Annealing	
#	Functional Tests /2 /3				Initial		5		10		15		20		48 hrs @ 25°C		30		50		100		168 hrs @ 25°C		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	
			Spec. Lim. /4																							
#	Parameters	Units	min	max	Initial		5		10		15		20		48 hrs @ 25°C		30		50		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	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0	2.8	0
3	VOH3	V	2.0	4.5	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0	3.6	0
4	VOL1	mV	0	500	189	1.7	189	1.7	189	1.7	189	1.7	190	1.9	190	1.7	192	1.8	195	1.8	205	1.9	194	2.2	191	1.4
5	VOL2	mV	0	500	304	1.8	304	1.8	304	1.8	304	1.8	304	1.8	304	1.8	304	1.8	304	1.8	323	3.9	312	3.2	310	4.1
6	VOL3	mV	0	550	393	3.4	393	3.4	393	3.4	394	6.8	394	7.4	386	1.4	389	5.9	395	10.1	415	4.3	412	17.8	408	5.9
7	IIH	µA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	IIL	µA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-8	2.4	-18	4.7	0	0
9	IOZH	µA	-20.0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	IOZL	µA	-20.0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-8	2.1	-16	4.7	0	0
11	ICCH	µA	0	250	148	7.5	141	8.7	145	8.7	607	68	2930	386	2072	309	7237	1580	10360	1337	24230	1790	9967	1777	1863	677
12	ICCL	mA	0	30	23	0	23	0	23	0	23	0	26	0.6	25	0.6	30	2.0	32	0.3	>32		31	0.5	25	1.0
13	ICCZ	µA	0	250	134	0	134	0	134	0	362	31	1495	198	1063	152	3485	778	5135	674	12690	1119	4936	895	952	329

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: IOZH, ICCH, ICCL, ICCZ.