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DATE: September 16, 1994 PPM-94-027

TO: V. Patel/406.0
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on EOS/AM
Part No. 54AC374
Control No. 8439

cc: P. Dudek/300.1
A. Sharma/311
Library/300.1

A radiation evaluation was performed on 54AC374 (Octal D-type Flip-Flop) 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 cobalt-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 control samples. The total dose radiation levels were 5, 10, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.15 and 1.39 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, the parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

All parts passed initial electrical measurements. All irradiated parts passed all electrical tests up to the 30 krad irradiation level.

At the 30 krad level, S/N 92, 93, 94, 95, 96 and 98 exceeded the maximum specification limit of 2.0 µA for ICCH, with readings ranging from 2.16 to 3.00 µA. In addition, S/N 93, 95 and 96 exceeded the maximum specification limit of 2.0 µA for ICCL, with readings ranging from 2.03 to 2.94 µA and S/N 95 and 96 exceeded the maximum specification limit of 2.0 µA for ICCZ, with readings of 2.20 and 2.30 µA, respectively.

At the 50 krad level, S/N 92, 93, 94, 95, 96 and 98 exceeded the maximum specification limit of 2.0 µA for ICCH, with readings ranging from 2.03 to 3.98 µA, S/N 92, 93, 94, 95, 96 and 98 exceeded the maximum specification limit of 2.0 µA for ICCL, with readings ranging from 2.25 to 3.89 µA and S/N 93, 95 and 96 exceeded the maximum specification limit of 2.0 µA for ICCZ, with readings ranging from 2.20 to 3.00 µA.

At the 75 krad level, all irradiated parts exceeded the maximum specification limit of 2.0 µA for ICCH, with readings ranging from 2.02 to 4.21 µA, S/N all irradiated parts except S/N 97 exceeded the maximum specification limit of 2.0 µA for ICCL, with readings ranging from 2.07 to 4.10 µA and S/N 92, 93, 94, 95 and 96 exceeded the maximum specification limit of 2.0 µA for ICCZ, with readings ranging from 2.20 to 3.40 µA.

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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 non-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed. No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

At the 100 krad level, all irradiated parts except S/N 97 exceeded the maximum specification limit of 2.0 μA for ICCH, ICCL and ICCZ, with readings ranging from 2.12 to 4.54 μA. S/N 97 read 2.00 μA for ICCZ. S/N 92, 95 and 98 had readings of 0.0 V for VOH1, VOH2 and VOH3, for which the lower limits are 2.9 V, 4.4 V and 5.4 V, respectively.

All irradiated parts passed all functional tests throughout all iradiation steps up to the 100 krad level and through both annealing steps.

After annealing for 168 hours at 25°C, all irradiated parts recovered to within specification limits for all test parameters.

After annealing for 168 hours at 100°C, no rebound effects were observed.

Table IV provides a summary of the failures for each parameter after different irradiation exposures and annealing steps.

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

TABLE I. Part Information

Generic Part Number:	54AC374
EOS/AM Part Number:	54AC374*
EOS/AM Control Number:	8439
Charge Number:	C44406
Manufacturer:	National Semiconductor
Lot Date Code:	9418A
Quantity Tested:	10
Serial Number of Control Samples:	90, 91
Serial Numbers of Radiation Sample:	92, 93, 94, 95, 96, 97, 98, 99
Part Function:	Octal D-type Flip-Flop
Part Technology:	CMOS
Package Style:	20-pin DIP
Test Equipment:	S-50
Test Engineer:	T. Scharer

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

TABLE II. Radiation Schedule for 54AC374

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	08/05/94
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	08/08/94 08/09/94
3) 10 KRAD IRRADIATION (0.25 KRADS/HOUR)* POST-10 KRAD ELECTRICAL MEASUREMENT	08/18/94 08/19/94
4) 20 KRAD IRRADIATION (0.15 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	08/19/94 08/22/94
5) 30 KRAD IRRADIATION (0.56 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	08/22/94 08/23/94
6) 50 KRAD IRRADIATION (1.11 KRADS/HOUR) POST-50KRAD ELECTRICAL MEASUREMENT	08/23/94 08/24/94
7) 75 KRAD IRRADIATION (1.39 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT	08/24/94 08/25/94
8) 100 KRAD IRRADIATION (1.39 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	08/25/94 08/26/94
9) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	08/26/94 09/02/94
10) 168-HOUR ANNEALING @100°C** POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/02/94 09/09/94

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

*The parts were stored at room temperature under bias for nine days while the Co-60 irradiator was undergoing maintenance.

**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-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of 54AC374

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
FUNCT. #1	3.0V	0.45V	2.5V	FREQ= 1.0MHz	I/O	VOH > 1.5V , VOL < 1.5V
FUNCT. #2	4.5V	0.60V	3.7V	FREQ= 1.0MHz	I/O	VOH > 2.5V , VOL < 2.5V
FUNCT. #3	5.5V	0.00V	5.5V	FREQ= 1.0MHz	I/O	VOH > 2.75V, VOL < 2.75V
FUNCT. #4	3.0V	0.45V	2.5V	FREQ= 10.0MHz	I/O	VOH > 1.5V , VOL < 1.5V
FUNCT. #5	4.5V	0.60V	3.7V	FREQ= 10.0MHz	I/O	VOH > 2.5V , VOL < 2.5V
FUNCT. #6	5.5V	0.00V	5.5V	FREQ= 10.0MHz	I/O	VOH > 2.75V, VOL < 2.75V

ACTIVE LOADS: IOH = -4MA
VCOM = VCC/2 V
IOL = +4MA

DC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOH1	3.0V	0.90V	2.10V	LOAD= -50.0uA	OUTS	>+2.9V , <+3.0V
VOH2	4.5V	1.35V	3.15V	LOAD= -50.0uA	OUTS	>+4.4V , <+4.5V
VOH3	5.5V	1.65V	3.85V	LOAD= -50.0uA	OUTS	>+5.4V , <+5.5V
VOH4	3.0V	0.90V	2.10V	LOAD= -4.0mA	OUTS	>+2.4V , <+3.0V
VOH5	4.5V	1.35V	3.15V	LOAD= -24.0mA	OUTS	>+3.7V , <+4.5V
VOH6	5.5V	1.65V	3.85V	LOAD= -24.0mA	OUTS	>+4.7V , <+5.5V
VOH7	5.5V	1.65V	3.85V	LOAD= -50.0mA	OUTS	>+3.85V , <+5.5V
VOL1	3.0V	0.90V	2.10V	LOAD= +50.0uA	OUTS	>+0.0V , <+0.1V
VOL2	4.5V	1.35V	3.15V	LOAD= +50.0uA	OUTS	>+0.0V , <+0.1V
VOL3	5.5V	1.65V	3.85V	LOAD= +50.0uA	OUTS	>+0.0V , <+0.1V
VOL4	3.0V	0.90V	2.10V	LOAD= +12.0mA	OUTS	>+0.0V , <+0.4V
VOL5	4.5V	1.35V	3.15V	LOAD= +24.0mA	OUTS	>+0.0V , <+0.4V
VOL6	5.5V	1.65V	3.85V	LOAD= +24.0mA	OUTS	>+0.0V , <+0.4V
VOL7	5.5V	1.65V	3.85V	LOAD= +50.0mA	OUTS	>+0.0V , <+1.65V
VIC+	0.0V			Iin=+1.0MA	INPUTS	>0.4V , <+1.5V
VIC-	OPEN			Iin=-1.0MA	INPUTS	>-1.5V , <-0.4V
IIL	5.5V	0.0V	5.5V	VIN = +0.0V	INPUTS	>-0.1uA , < 0A
IIH	5.5V	0.0V	5.5V	VIN = +5.5V	INPUTS	> 0A , < +0.1uA
IOZH	5.5V	1.65V	3.85V	Vout = +5.5V	OUTS	> 0A , < +0.5uA
IOZL	5.5V	1.65V	3.85V	Vout = +0.5V	OUTS	>-0.5uA , <.0A
ICCH	5.5V	0.0V	5.5V	INPUTS HIGH	VCC	>0.0A , < +2.0uA
ICCL	5.5V	0.0V	5.5V	INPUTS LOW	VCC	>0.0A , < +2.0uA
ICCZ	5.5V	0.0V	5.5V	OUTPUTS DISABLED	VCC	>0.0A , < +2.0uA

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 54AC374 /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initials mean	Initials sd	5 mean	5 sd	10 mean	10 sd	20 mean	20 sd	30 mean	30 sd	50 mean	50 sd	75 mean	75 sd	100 mean	100 sd	Annealing 168 hrs @25°C mean	Annealing 168 hrs @25°C sd	Annealing 168 hrs @100°C mean	Annealing 168 hrs @100°C sd
							Total Dose Exposure (krads)																	
1	FUNC1, Vcc=3.0V, Freq.= 1 MHz				P		P		P		P		P		P		P		P		P		P	
2	FUNC2, Vcc=4.5V, Freq.= 1 MHz				P		P		P		P		P		P		P		P		P		P	
3	FUNC3, Vcc=5.5V, Freq.= 1 MHz				P		P		P		P		P		P		P		P		P		P	
4	FUNC4, Vcc=3.0V, Freq.=10 MHz				P		P		P		P		P		P		P		P		P		P	
5	FUNC5, Vcc=4.5V, Freq.=10 MHz				P		P		P		P		P		P		P		P		P		P	
6	FUNC6, Vcc=5.5V, Freq.=10 MHz				P		P		P		P		P		P		P		P		P		P	
7	VOH1	V	2.90	3.00	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	1.87	1.4	2.99	0	2.99	0
8	VOH2	V	4.40	4.50	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	2.81	2.2	4.49	0	4.49	0
9	VOH3	V	5.40	5.50	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	3.52	2.6	5.49	0	5.49	0
10	VOH4	V	2.40	3.00	2.92	0	2.92	0	2.92	0	2.92	0	2.92	0	2.91	0	2.91	0	2.91	0	2.91	0	2.91	0
11	VOH5	V	3.70	4.50	4.14	.01	4.14	.01	4.14	.01	4.14	.01	4.14	.01	4.13	.01	4.13	.01	4.12	.01	4.12	.02	4.13	.01
12	VOH6	V	4.70	5.50	5.18	.01	5.18	.01	5.18	.01	5.18	.01	5.18	.01	5.18	.01	5.17	.01	5.17	.01	5.16	.02	5.17	.01
13	VOH7	V	3.85	5.50	4.81	.03	4.82	.02	4.82	.01	4.82	.01	4.81	.01	4.81	.02	4.80	.03	4.79	.04	4.78	.03	4.80	.01
14	VOL1	mV	0.00	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	VOL2	mV	0.00	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	VOL3	mV	0.00	100	0.76	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	VOL4	mV	0.00	400	149	9.4	144	5.7	143	5.8	144	6.2	143	6.1	143	5.7	142	6.9	143	7.6	145	8.4	146	6.7
18	VOL5	mV	0.00	400	216	17	211	8.7	210	8.7	210	9.4	209	9.1	209	8.3	211	12	213	12	215	14	212	9.4
19	VOL6	mV	0.00	400	193	17	187	8.1	186	8.0	187	8.5	185	8.5	186	7.5	188	11	190	12	192	13	188	8.2
20	VOL7	mV	0.00	1650	412	36	401	17	399	17	400	18	397	18	399	16	402	29	409	42	416	53	403	18
21	VIC+	mV	400	1500	791	7.7	790	7.0	788	6.4	785	6.2	783	5.8	781	4.9	779	5.3	778	5.1	782	5.0	787	6.2
22	VIC-	mV	-1500	-400	-746	2.1	-746	1.4	-746	1.4	-745	2.1	-745	2.1	-745	1.4	-745	2.5	-745	2.1	-748	2.1	-745	1.9
23	IIL	nA	-100	0.0	0	0	0	0	-1.25	2.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	IIH	nA	0.0	100	0	0	0	0	5.59	9.7	0.48	2.2	0	0	0	0	.48	2.2	2.40	7.3	1.38	4.3	0.34	1.5
25	IOZH	nA	0.0	500	0	0	0	0	6.72	13	2.34	6.8	0	0	0	0	.94	4.2	5.00	11	0.94	4.2	0	0
26	IOZL	nA	-500	0.0	0	0	0	0	-2.03	7.1	0	0	0	0	0	0	-1.25	4.8	-3.59	9.6	-0.94	4.2	0	0
27	ICCH	µA	0.0	2.0	0	0	0.05	.01	0.61	.16	1.44	.32	2.26	.65	2.82	.69	3.08	.76	3.36	.66	1.28	.13	0.20	.19
28	ICCL	µA	0.0	2.0	0	0	0.05	.01	0.40	.07	0.77	.19	1.92	.56	2.60	.72	2.77	.73	3.01	.68	1.05	.13	0.10	.44
29	ICCZ	µA	0.0	2.0	0	0	0	0	0.25	.17	1.04	.24	1.56	.50	2.03	.65	2.34	.59	2.66	.54	1.01	.13	0	0

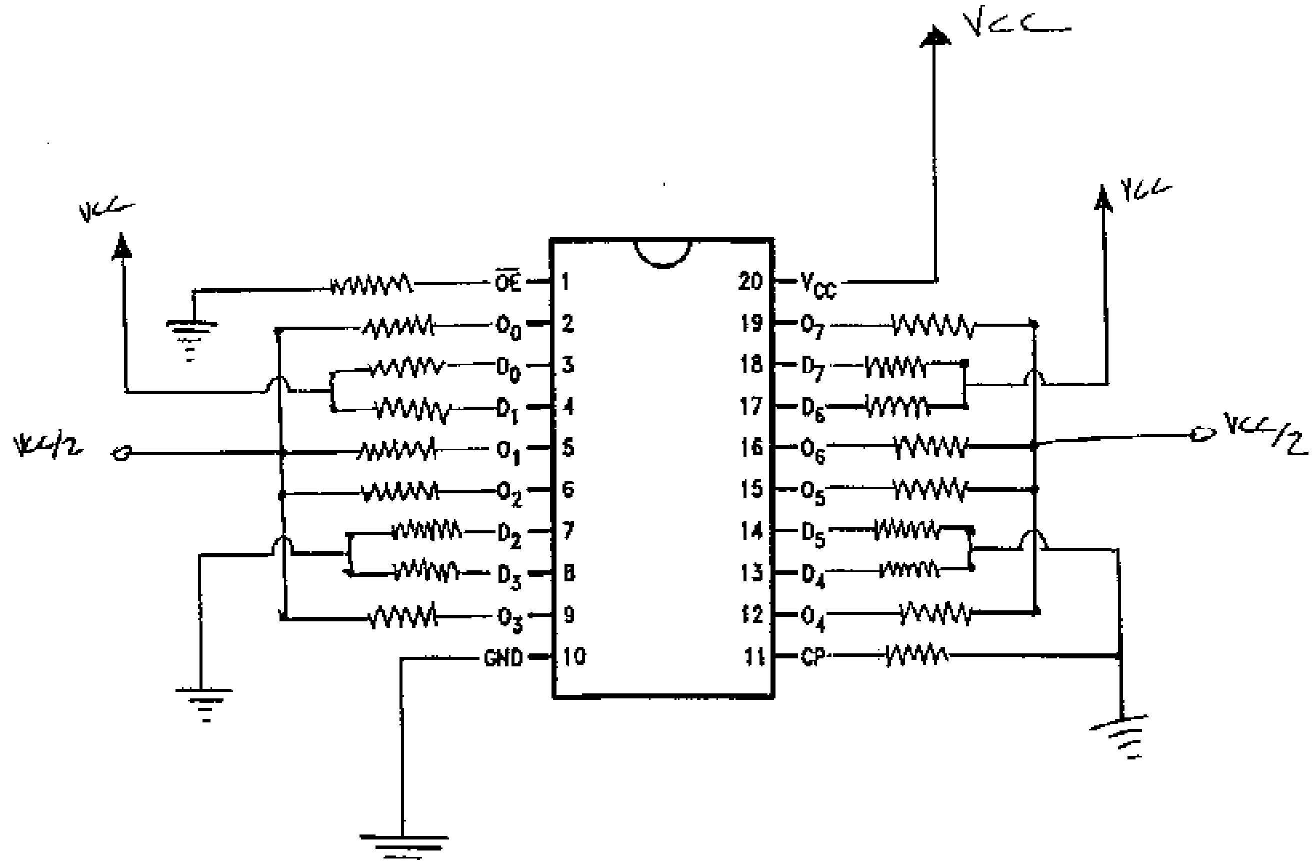
Notes:

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

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

The radiation sensitive parameters were ICCH, ICCL, ICCZ, VOH1, VOH2 and VOH3.

Figure 1. Radiation Bias Circuit for 54AC374



1) Vcc = 5.0 V ± 0.5 V, Vcc/2 = 2.5 V ± 0.25 V.

2) All resistors = 2.0 kΩ ± 10%.