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DATE: October 3, 1994

PPM-94-026

TO: V. Patel/406.0
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on EOS/AM
Part No. 54AC299
Control No. 8431

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

A radiation evaluation was performed on 54AC299 (8-input Universal Shift/Storage Register, 3-state) 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 1.47 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 10 krad irradiation level.

At the 20 krad irradiation level, all irradiated parts exceeded the maximum specification limit of 2.0 μA for ICCH, ICCL and ICCZ, with readings ranging from 2.3 to 3.7 μA.

At the 30 krad level, all irradiated parts recovered to within specification limits for all tests.

At the 50 krad level, all irradiated parts exceeded the maximum specification limit of 2.0 μA for ICCH, ICCL and ICCZ, with readings ranging from 3.9 to 7.4 μA.

At the 75 krad level, the same parts exceeded the maximum specification limit of 2.0 μA for ICCH, ICCL and ICCZ, with readings ranging from 5.8 to 7.8 μA. In addition, S/N 62 exceeded the maximum specification limit of 14.0 ns for TPHZ1, with a reading of 1000 μs and S/N 64 and 69 marginally exceeded the maximum specification limit of 0.10 V for VOL3, with readings of 0.101 and 0.105 V.

At the 100 krad level, the same parts exceeded the maximum specification limit of 2.0 μA for ICCH, ICCL and ICCZ, with readings ranging from 4.4 to 6.8 μA. In addition, S/N 64 failed VOH tests #3, 4 and 6. The readings were 0 V in each case. S/N 67 also marginally exceeded the maximum specification limit for VOL3, with a reading of 0.111 V.

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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.

All parts passed all functional tests throughout all irradiation steps up to 100 krads and through both annealing steps.

After annealing for 168 hours at 25°C, S/N 04 passed all VOH tests. No significant recovery was observed in ICCH, ICCL or ICCZ.

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

Table IV provides a summary of the results 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:	54AC299
EOS/AM Part Number:	54AC299*
EOS/AM Control Number:	8431
Charge Number:	C44406
Manufacturer:	National Semiconductor
Lot Date Code:	9420
Quantity Tested:	10
Serial Number of Control Samples:	60, 61
Serial Numbers of Radiation Sample:	62, 63, 64, 65, 66, 67, 68, 69
Part Function:	8-input Universal Shift/Storage Register, 3-state
Part Technology:	CMOS
Package Style:	20-pin DIP
Test Equipment:	S-50
Test Engineer:	A. Karygiannis

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

TABLE II. Radiation Schedule for 54AC299

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	08/23/94
2) 5 KRAD IRRADIATION (0.21 KRADS/HOUR)	08/23/94
POST-5 KRAD ELECTRICAL MEASUREMENT	08/24/94
3) 10 KRAD IRRADIATION (0.28 KRADS/HOUR)	08/24/94
POST-10 KRAD ELECTRICAL MEASUREMENT	08/25/94
4) 20 KRAD IRRADIATION (0.56 KRADS/HOUR)	08/25/94
POST-10 KRAD ELECTRICAL MEASUREMENT	08/26/94
5) 30 KRAD IRRADIATION (0.15 KRADS/HOUR)	08/26/94
POST-30 KRAD ELECTRICAL MEASUREMENT	08/29/94
6) 50 KRAD IRRADIATION (1.05 KRADS/HOUR)	08/29/94
POST-50KRAD ELECTRICAL MEASUREMENT	08/30/94
7) 75 KRAD IRRADIATION (1.47 KRADS/HOUR)	08/30/94
POST-75 KRAD ELECTRICAL MEASUREMENT	08/31/94
8) 100 KRAD IRRADIATION (0.57 KRADS/HOUR)	08/31/94
POST-100 KRAD ELECTRICAL MEASUREMENT	09/01/94
9) 168-HOUR ANNEALING @25°C	09/02/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/09/94
10) 168-HOUR ANNEALING @100°C*	09/09/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT**	09/19/94

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

*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.

**Due to a power failure, the annealing at 100°C was interrupted for three days.

Table III. Electrical Characteristics of 54AC299

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
FUNCT #1	3.0V	0.45V	2.5V	FREQ = 1MHZ	ALL I/O	VOL<1.50V , VOH>1.50V
FUNCT #2	4.5V	0.6V	3.7V	FREQ = 1MHZ	ALL I/O	VOL<2.25V , VOH>2.25V
FUNCT #3	4.5V	0.0V	4.5V	FREQ = 40MHZ	ALL I/O	VOL<2.25V , VOH>2.25V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOH1	3.0V	0.90V	2.10V	LOAD = -50UA	OUTS	>2.90V , <3.00V
VOH2	4.5V	1.35V	3.15V	LOAD = -50UA	OUTS	>4.40V , <4.50V
VOH3	5.5V	1.65V	3.85V	LOAD = -50UA	OUTS	>5.40V , <5.50V
VOH4	3.0V	0.90V	2.10V	LOAD = -4MA	OUTS	>2.40V , <3.00V
VOH5	4.5V	1.35V	3.15V	LOAD = -24MA	OUTS	>3.70V , <4.50V
VOH6	5.5V	1.65V	3.85V	LOAD = -24MA	OUTS	>4.70V , <5.50V
VOH7	5.5V	1.65V	3.85V	LOAD = -50MA	OUTS	>3.85V , <5.50V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
VOL1	3.0V	0.90V	2.10V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL2	4.5V	1.35V	3.15V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL3	5.5V	1.65V	3.85V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL4	3.0V	0.90V	2.10V	LOAD = +12MA	OUTS	>0.00V , <0.40V
VOL5	4.5V	1.35V	3.15V	LOAD = +24MA	OUTS	>0.00V , <0.40V
VOL6	5.5V	1.65V	3.85V	LOAD = +24MA	OUTS	>0.00V , <0.40V
VOL7	5.5V	1.65V	3.85V	LOAD = +50MA	OUTS	>0.00V , <1.65V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
IIH	5.5V	0.00V	5.50V	VIN = 5.5V	INS	> 0.0UA , < +0.1UA
IIL	5.5V	0.00V	5.50V	VIN = 0.0V	INS	> -0.1UA , < 0.0UA
IOZH	5.5V	0.00V	5.50V	VOUT = 5.5V	OUTS	> 0.0UA , < +0.6UA
IOZL	5.5V	0.00V	5.50V	VOUT = 0.0V	OUTS	> -0.6UA , < 0.0UA
ICCH	5.5V	0.00V	5.50V	VIN = 0.0V	VCC	> 0.0UA , < 2.0UA
ICCL	5.5V	0.00V	5.50V	VIN = 5.5V	VCC	> 0.0UA , < 2.0UA
ICCZ	5.5V	0.00V	5.50V	VIN = 5.5V	VCC	> 0.0UA , < 2.0UA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	PINS	LIMITS AT +25C
TPHL1	4.5V	0.0V	4.5V	CLK TO QN	> 1.0NS < 16.0NS
TPHL2	4.5V	0.0V	4.5V	CLK TO Q0 & Q7	> 1.0NS < 14.5NS
TPLH1	4.5V	0.0V	4.5V	CLK TO QN	> 1.0NS < 14.5NS
TPLH2	4.5V	0.0V	4.5V	CLK TO Q0 & Q7	> 1.0NS < 14.0NS
TPHL3	4.5V	0.0V	4.5V	MR TO Q0 & Q7	> 1.0NS < 15.5NS
TPHL4	4.5V	0.0V	4.5V	MR TO QN	> 1.0NS < 15.0NS
TPZH1	4.5V	0.0V	4.5V	OE TO QN	> 1.0NS < 13.0NS
TPZL1	4.5V	0.0V	4.5V	OE TO QN	> 1.0NS < 13.0NS
TPHZ1	4.5V	0.0V	4.5V	OE TO QN	> 1.0NS < 14.0NS
TPLZ1	4.5V	0.0V	4.5V	OE TO QN	> 1.0NS < 14.0NS

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 54AC299 /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initials mean	Initials sd	5 krads mean	5 krads sd	10 krads mean	10 krads sd	20 krads mean	20 krads sd	30 krads mean	30 krads sd	50 krads mean	50 krads sd	75 krads mean	75 krads sd	100 krads mean	100 krads 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
1	FUNC1, Vcc=3.0V, Freq.= 1 MHz		P		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		P	
3	FUNC3, Vcc=4.5V, Freq.=40 MHz		P		P		P		P		P		P		P		P		P		P		P	
4	VOH1	V	2.90	3.00	3.00	0	3.00	0	2.99	.01	2.99	.01	3.00	.01	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0
5	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	4.49	0	4.49	0	4.49	0
6	VOH3/3	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	7P1F		5.49	0	5.49	0
7	VOH4	V	2.40	3.00	2.93	0	2.93	0	2.93	0	2.93	.01	2.93	.01	2.92	.01	2.92	0	2.92	.01	2.92	.01	2.92	0
8	VOH5	V	3.70	4.50	4.19	.01	4.19	.01	4.18	.04	4.18	.02	4.17	.02	4.16	.04	4.16	.02	4.15	.03	4.15	.03	4.16	.02
9	VOH6/3	V	4.70	5.50	5.23	.01	5.23	.01	5.23	.02	5.22	.03	5.21	.02	5.20	.03	5.20	.02	7P1F		5.19	.03	5.21	.02
10	VOH7/3	V	3.85	5.50	4.92	.03	4.92	.03	4.91	.06	4.89	.07	4.88	.05	4.86	.06	4.86	.07	7P1F		4.83	.08	4.86	.06
11	VOL1	mV	0.00	100	19.4	1.9	19.4	1.9	19.8	2.5	28.6	8.0	29.2	6.6	27.4	6.9	35.2	6.7	28.3	6.6	22.5	4.0	26.7	8.2
12	VOL2	mV	0.00	100	32.2	2.8	32.2	2.8	33.0	3.6	45.9	13	47.9	11	44.8	11	57.9	11	46.4	11	37.1	6.3	44.5	13
13	VOL3	mV	0.00	100	40.4	3.7	40.4	3.7	41.4	4.8	60.4	18	60.9	14	57.3	15	75.1	15	59.6	15	46.8	8.0	56.5	17
14	VOL4	mV	0.00	400	154	7.2	154	7.2	157	9.8	169	17	170	12	167	13	181	14	172	14	168	15	191	14
15	VOL5	mV	0.00	400	221	14	221	14	225	18	246	31	247	22	243	24	287	26	253	26	244	30	263	27
16	VOL6	mV	0.00	400	203	14	203	14	208	25	239	43	234	24	230	28	262	29	241	31	227	31	243	31
17	VOL7	mV	0.00	1650	390	29	390	29	400	62	438	60	435	47	431	56	510	93	450	65	436	72	465	75
18	IIH	nA	0.0	100	0.13	1.4	0.13	1.4	0.11	1.2	2.59	7.5	1.70	5.6	9.34	10	18.8	20	13.5	14	7.39	7.7	0.13	1.4
19	IIL	nA	-100	0.0	0	0	0	0	0	0	0	0	0	0	-8.55	8.9	-18.5	19	-18.3	19	-10.7	11	0	0
20	IOZH	nA	0.0	600	0.27	2.0	0.27	2.0	0.31	1.9	3.39	9.2	2.86	7.8	18.7	4.9	37.0	13	28.8	5.2	14.5	3.0	0.25	2.0
21	IOZL	nA	-600	0.0	0	0	0	0	0	0	0	0	0	0	-16.9	3.5	-35.2	6.7	-34.9	6.3	-20.3	3.5	0	0
22	ICCH	µA	0.0	2.0	0	0	0	0	0.40	.07	3.13	.37	0.62	.08	5.89	.90	6.61	.95	5.88	.72	4.29	.49	0.76	.32
23	ICCL	µA	0.0	2.0	0	0	0	0	0.44	.09	3.11	.36	0.65	.08	5.80	.85	6.76	.91	5.88	.70	4.26	.48	0.74	.34
24	ICCZ	µA	0.0	2.0	0	0	0	0	0.40	.07	3.01	.38	0.61	.06	5.66	.92	6.66	.88	5.73	.69	4.21	.49	0.86	.54
25	TPHL1	ns	1.0	16.0	11.9	.27	11.9	.27	12.0	.28	11.9	.28	11.9	.28	11.9	.27	8.63	.30	8.62	.30	6.89	.25	9.00	.31
26	TPHL2	ns	1.0	14.5	12.8	.22	12.8	.22	12.8	.20	12.8	.21	12.8	.21	12.8	.20	9.59	.23	9.61	.25	10.2	2.3	10.0	.24

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 54AC299 /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initials mean	Initials sd	Total Dose Exposure (krads) 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	168 hrs @25°C sd	168 hrs @100°C mean	168 hrs @100°C sd
27	TPLH1	ns	1.0	14.5	11.3	.34	11.3	.34	11.4	.35	11.4	.35	11.4	.35	11.4	.34	8.10	.37	8.10	.36	6.85	.34	8.22	.35
28	TPLH2	ns	1.0	14.0	12.6	.28	12.6	.28	12.6	.24	12.6	.24	12.6	.24	12.6	.22	9.40	.24	9.43	.25	9.90	2.0	9.58	.30
29	TPHL3	ns	1.0	15.5	13.7	.34	13.7	.34	13.8	.35	13.8	.35	13.8	.36	13.9	.37	10.0	.36	10.1	.38	8.19	.33	10.1	.35
30	TPHL4	ns	1.0	15.0	14.9	.19	14.9	.19	15.0	.18	15.0	.18	15.0	.20	15.1	.20	11.2	.24	11.3	.25	11.9	2.3	11.5	.27
31	TPZH1	ns	1.0	13.0	10.7	.18	10.7	.18	10.7	.19	10.7	.19	10.7	.19	10.7	.19	7.46	.19	7.35	.19	5.49	.16	7.55	.18
32	TPZL1	ns	1.0	13.0	10.9	.16	10.9	.16	11.0	.16	11.0	.16	10.9	.16	10.9	.16	7.48	.17	7.57	.17	5.65	.15	8.09	.17
33	TPHZ1	ns	1.0	14.0	11.6	1.0	11.6	1.0	11.6	.99	11.6	.98	11.5	1.0	11.5	1.0	1.584	1.285	8.10	.94	6.30	.91	8.25	.97
34	TPLZ1	ns	1.0	14.0	12.1	.17	12.1	.17	12.1	.19	12.1	.19	12.1	.18	12.0	.18	8.62	.17	8.69	.17	6.89	.19	8.64	.19

Notes:

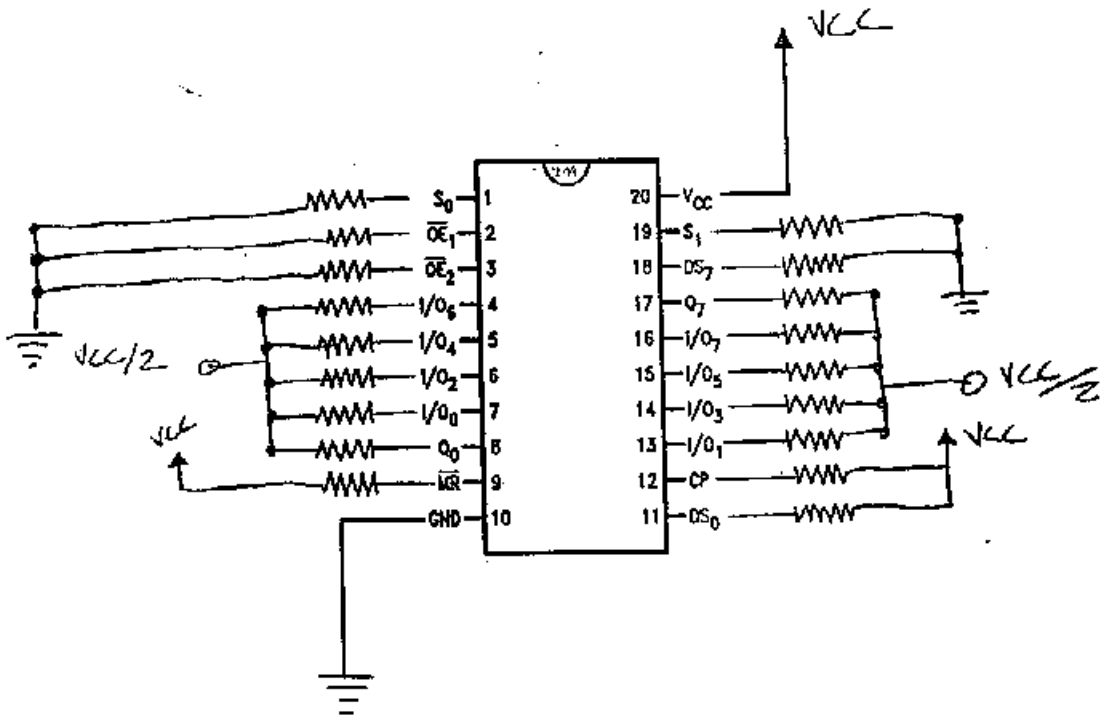
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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.

3/ One part (S/N 64) failed these tests at this irradiation level, therefore, the results for this level are given as "nPmF, where n is the number of parts passing the test and m is the number of parts failing the test.

The radiation sensitive parameters were ICCH, ICCL, ICCZ, TPHZ1, VOL3, VOH3, VOH6 and VOH7.

Figure 1. Radiation Bias Circuit for 54AC299



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

2) All resistors 2kΩ ± 10%, 1/4 W.