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To

T. Miccolis
Department

From Code 300.1

K. Sahu *KS*
Department

Subject 7809

Radiation Report on 54AC299LMQB
SMEX Common Buy Part No. 5962-88754012A
Control No. 1401

Date PPM-92-060

Locator Feb. 11, 1992

Telephone Lanham

Location 731-8954

cc: Lanham

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A radiation evaluation was performed on 54AC299LMQB 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 steps were 10, 20, 30, 50, 75, 100 and 200 krads*. After 200 krads, the parts were annealed at +25°C for 168 hours with measurements taken after 24 hours and 168 hours. After this annealing, parts were irradiated to 300 krads after which they were annealed under bias at +100°C for 168 hours. The dose rate was between 0.3 and 5.3 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, the parts were electrically tested @ +25°C according to the test conditions and the specification limits listed in Table III. These tests included three functional tests (two at 1 MHz and one at 40 MHz).

All parts passed functionally throughout testing to 300 krads and upon the subsequent high temperature annealing for 168 hours. The parts passed all parametric tests and stayed within the specification limits up to 100 krads of irradiation. However, after 200 krads, 2 parts failed to meet the specification limits for IIH, IIL, IOZH, IOZL, ICCH, ICCL, and ICCZ. The maximum readings for these parameters were as follows: IIH = 94 uA (limit 1 uA), IIL = -72 uA (limit -1 uA), IOZH = 94 uA (limit 10 uA), IOZL = -70 uA (limit -10 uA), ICCH = 383 uA (limit 160 uA), ICCL = 382 uA (limit 160 uA) and ICCZ = 388 uA (limit 160 uA). In addition, one other device marginally exceeded the specification limit of 1 uA maximum for IIH. After the 168 hour annealing at 25°C, the parts showed significant recovery and were within the specified limits for IOZL, ICCH, ICCL and ICCZ. However, 2 parts were still marginally above the limits for IIH, IIL, and IOZH. Upon further irradiation to 300 krads the same 2 parts were again exceeding the specification limits for IIH, IIL, IOZH, IOZL, ICCH, ICCL, and ICCZ. The ICCH, ICCL and ICCZ readings for these two parts were in excess of 1 mA. Also, one part was marginally exceeding IIH. On annealing the parts for

168 hours at 100°C, the parts showed significant recovery and all parts were within the specification limits for all test parameters. Table IV provides the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps. It also provides a summary of functional test results after these radiation/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.

*In this report, the term "rads" is used as an abbreviation for rads (Si).

TABLE I. Part Information

Generic Part Number:	54AC299LMQB
SMEX Common Buy Part Number:	5962-88754012A
SMEX Common Buy Control Number:	1401
Charge Number:	C90351
Manufacturer:	National Semiconductor
Lot Date Code:	9021
Quantity Tested:	10
Serial Numbers of Radiation Samples:	82, 83, 84, 85, 86, 87, 88, 89
Serial Numbers of Control Samples:	80, 81
Part Function:	UNIVERSAL SHIFT/STORAGE REGISTER WITH TRI-STATE OUTPUTS
Part Technology:	CMOS
Package Style:	20 pin LCC
Test Engineer:	C. Nguyen

TABLE II. Radiation Schedule for 54AC299LMQB

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements	11/13/91
2) 10-KRAD IRRADIATION (500 rads/hour)	12/10/91
POST 10-KRAD ELECTRICAL MEASUREMENT	12/11/91
3) 20-KRAD IRRADIATION (525 rads/hour)	12/11/91
POST 20-KRAD ELECTRICAL MEASUREMENT	12/12/91
4) 30-KRAD IRRADIATION (500 rads/hour)	12/12/91
POST 30-KRAD ELECTRICAL MEASUREMENT	12/13/91
5) 50-KRAD IRRADIATION (300 rads/hour)	12/13/91
POST 50-KRAD ELECTRICAL MEASUREMENT	12/16/91
6) 75-KRAD IRRADIATION (1550 rads/hour)	12/16/91
POST 75-KRAD ELECTRICAL MEASUREMENT	12/17/91
7) 100-KRAD IRRADIATION (1315 rads/hour)	12/17/91
POST 100-KRAD ELECTRICAL MEASUREMENT	12/18/91
8) 200-KRAD IRRADIATION (5260 rads/hour)	12/18/91
POST 200-KRAD ELECTRICAL MEASUREMENTS	12/19/91
9) 24 HOURS ANNEALING AT +25°C	12/19/91
POST 24-HOURS ELECTRICAL MEASUREMENT	12/20/91
10) 168 HOURS ANNEALING AT +25°C	12/19/91
POST 168-HOURS ELECTRICAL MEASUREMENT	12/27/91
11) 300-KRAD IRRADIATION (1470 rads/hour)	12/27/91
POST 300-KRAD ELECTRICAL MEASUREMENTS	12/30/91
12) 168 HOURS ANNEALING AT +100°C	12/30/91
POST 168 HOURS AT +100°C ELECTRICAL MEASUREMENTS	01/06/92

- Notes:
- All electrical measurements were performed off-site at +25°C.
 - All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
 - Annealing was performed under bias.

Table III. Electrical Characteristics of 54AC299LMQB

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS OVER TEMP.
FUNCT 1	3.0V	0.0V	3.0V	FREQ=1.00MHz	I/O	VOL<1.50V; VOH>1.50V
FUNCT 2	5.5V	0.0V	5.5V	FREQ=1.00MHz	I/O	VOL<2.75V; VOH>2.75V
FUNCT 3	4.5V	0.0V	4.5V	FREQ=40.0MHz	I/O	VOL<2.25V; VOH>2.25V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ 25°C
VOH1	3.0V	0.90V	2.10V	LOAD=-50uA	OUTS	> 2.9V ; <3.0V
VOH2	4.5V	1.35V	3.15V	LOAD=-50uA	OUTS	> 4.4V ; <4.5V
VOH3	5.5V	1.65V	3.85V	LOAD=-50uA	OUTS	> 5.4V ; <5.5V
VOH4	3.0V	0.90V	2.10V	LOAD= -4mA	OUTS	> 2.4V ; <3.0V
VOH5	4.5V	1.35V	3.15V	LOAD=-24mA	OUTS	> 3.7V ; <4.5V
VOH6	5.5V	1.65V	3.85V	LOAD=-24mA	OUTS	> 4.7V ; <5.5V
VOH7	5.5V	1.65V	3.85V	LOAD=-50mA	OUTS	>3.85V ; <5.5V
VOL1	3.0V	0.90V	2.10V	LOAD=+50uA	OUTS	> 0.0V ; <0.10V
VOL2	4.5V	1.35V	3.15V	LOAD=+50uA	OUTS	> 0.0V ; <0.10V
VOL3	5.5V	1.65V	3.85V	LOAD=+50uA	OUTS	> 0.0V ; <0.10V
VOL4	3.0V	0.90V	2.10V	LOAD= +4mA	OUTS	> 0.0V ; <0.50V
VOL5	4.5V	1.35V	3.15V	LOAD=+24mA	OUTS	> 0.0V ; <0.50V
VOL6	5.5V	1.65V	3.85V	LOAD=+24mA	OUTS	> 0.0V ; <0.50V
VOL7	5.5V	1.65V	3.85V	LOAD=+50mA	OUTS	> 0.0V ; <1.65V
I _{IH}	5.5V	0.0V	5.5V	V _{IN} = 5.5V	INS	> 0.0uA ; <1.0uA
I _{IL}	5.5V	0.0V	5.5V	V _{IN} = 0.0V	INS	>-1.0uA ; <0.0uA
I _{OZH}	5.5V	0.0V	5.5V	V _{OUT} = 5.5V	OUTS	> 0.0uA ; < 10uA
I _{OZL}	5.5V	0.0V	5.5V	V _{OUT} = 0.0V	OUTS	> -10uA ; <0.0uA
I _{CCH}	5.5V	0.0V	5.5V	V _{IN} = 0.0V	VCC	> 0.0uA ; <160uA
I _{CCL}	5.5V	0.0V	5.5V	V _{IN} = 5.5V	VCC	> 0.0uA ; <160uA
I _{CCZ}	5.5V	0.0V	5.5V	V _{IN} = 5.5V	VCC	> 0.0uA ; <160uA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	PINS	LIMITS @ 25°C
TPHL_C_Q	4.5V	0.0V	4.5V	CLK TO QN	>1.0nS ; <16.0nS
TPLH_Q07	4.5V	0.0V	4.5V	CLK TO Q0&Q7	>1.0nS ; <14.5nS
TPLH_C_Q	4.5V	0.0V	4.5V	CLK TO QN	>1.0nS ; <14.5nS
TPLH_Q07	4.5V	0.0V	4.5V	CLK TO Q0&Q7	>1.0nS ; <14.0nS
MR_QN	4.5V	0.0V	4.5V	MR TO QN	>1.0nS ; <15.0nS
MR_Q0Q7	4.5V	0.0V	4.5V	MR TO Q0&Q7	>1.0nS ; <15.5nS
TPZH_QQN	4.5V	0.0V	4.5V	OE TO QN	>1.0nS ; <12.5nS
TPZL_QQN	4.5V	0.0V	4.5V	OE TO QN	>1.0nS ; <13.0nS
TPHZ_QQN	4.5V	0.0V	4.5V	OE TO QN	>1.0nS ; <14.0nS
TPLZ_QQN	4.5V	0.0V	4.5V	OE TO QN	>1.0nS ; <12.5nS

TABLE IV: Summary of Electrical Measurements After
Total Dose Exposures and Annealing for 54AC299LMQB 1/ 2/

Parameters	Spec Limits min max		Total Dose Exposure (TDE) (krads)														Anneal		TDE (krads)		Anneal	
			0 (Pre-Rad)		10		20		50		75		100		200		168 hrs @ 25°C		300		168 hrs @ 100°C	
			mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1 @ 1 MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
FUNC2 @ 1 MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
FUNC3 @ 40 MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
VOH1_3.0V V	2.9	3.0	3.00	0	3.00	0	3.00	0	3.00	0	3.00	0.01	3.00	0	3.00	0.01	2.99	0	2.99	0	3.00	0
VOH2_4.5V V	4.4	4.5	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
VOH3_5.5V V	5.4	5.5	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0
VOH4_3.0V V	2.4	3.0	2.93	0	2.92	0	2.92	0	2.92	0	2.92	0	2.92	0	2.91	0	2.91	0	2.90	0	2.91	0
VOH5_4.5V V	3.7	4.5	4.17	0.02	4.17	0.01	4.17	0.01	4.16	0.01	4.16	0.01	4.15	0.01	4.14	0.01	4.13	0.02	4.12	0.01	4.14	0.01
VOH6_5.5V V	4.7	5.5	5.21	0.02	5.21	0.01	5.21	0.01	5.21	0.01	5.21	0.01	5.21	0.01	5.20	0.01	5.19	0.02	5.18	0.01	5.19	0.01
VOH7_5.5V V	3.85	5.5	4.88	0.04	4.89	0.03	4.88	0.03	4.88	0.02	4.87	0.01	4.86	0.01	4.84	0.02	4.82	0.04	4.81	0.03	4.84	0.01
VOL1_3.0V V	0	0.10	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0	0.01	0
VOL2_4.5V V	0	0.10	0.02	0	0.02	0	0.02	0	0.01	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0
VOL3_5.5V V	0	0.10	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0	0.02	0
VOL4_3.0V V	0	0.50	0.15	0.01	0.15	0.01	0.15	0.01	0.15	0	0.15	0	0.15	0	0.14	0.01	0.16	0.01	0.15	0.01	0.18	0.01
VOL5_4.5V V	0	0.50	0.22	0.02	0.21	0.01	0.21	0.01	0.21	0.01	0.21	0	0.21	0	0.21	0.01	0.22	0.02	0.22	0.01	0.24	0.01
VOL6_5.5V V	0	0.50	0.19	0.02	0.19	0.01	0.19	0.01	0.19	0.01	0.18	0	0.18	0	0.18	0	0.20	0.02	0.19	0.01	0.20	0.01
VOL7_5.5V V	0	1.65	0.39	0.04	0.38	0.02	0.38	0.02	0.38	0.01	0.37	0.01	0.37	0.01	0.37	0.01	0.40	0.04	0.39	0.02	0.42	0.02
I1H uA	0	1.0	0	0	0	0.01	0	0.01	0.01	0.01	0.02	0.02	0.04	0.05	1.23	8.70	0.15	1.12	5.31	30.79	0.01	0.01
I1L uA	-1.0	0	0	0.03	0	0.03	-0.01	0.03	-0.02	0.04	-0.04	0.06	-0.07	0.10	-1.06	7.13	-0.09	0.40	-3.24	16.65	-0.03	0.03
IOZH uA	0	10	0	0	0	0.01	0	0.02	0.01	0.04	0.02	0.07	0.04	2.45	12.15	0.30	1.57	10.58	42.76	0.02	0.01	
IOZL uA	-10	0	0	0	0	0	0	-0.04	0.02	-0.07	0.04	-0.13	0.09	-2.13	9.91	-0.16	0.55	-6.41	23.01	-0.05	0.02	
ICCH uA	0	160	0	0	2.16	1.21	9.40	6.14	11.49	6.68	15.28	8.67	20.64	12.06	89.54	133.1	16.50	133.1	274.6	449.2	121.0	9.41
ICCL uA	0	160	0	0	2.14	1.27	9.00	6.12	11.43	6.65	15.20	8.63	20.45	12.00	89.18	132.8	16.41	132.8	274.1	448.7	120.8	9.36
ICCZ uA	0	160	0	0	2.03	1.13	5.80	3.03	11.11	6.46	14.74	8.38	19.94	11.72	88.44	132.4	16.09	132.4	274.5	448.2	120.3	9.28

TABLE IV (Continued): Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC299LMQB 1/2/

Parameters	Spec Limits min max	Total Dose Exposure (TDE) (krads)														Anneal		TDE (krads)		Anneal	
		0 (Pre-Rad)		10		20		50		75		100		200		168 hrs @ 25°C		300		168 hrs @ 100°C	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
TPHL_C_Q ns	1.0 16.0	8.77	0.30	9.30	0.38	9.28	0.38	10.26	0.37	10.24	0.36	10.20	0.37	10.24	0.40	10.31	0.36	10.42	0.40	10.52	0.42
TPHL_Q07 ns	1.0 14.5	9.59	0.24	10.34	0.24	10.33	0.24	11.27	0.25	11.29	0.26	11.22	0.26	11.29	0.29	11.20	0.32	11.29	0.36	11.42	0.33
TPLH_C_Q ns	1.0 14.5	8.31	0.28	8.85	0.35	8.88	0.35	9.93	0.34	9.94	0.33	9.94	0.33	10.09	0.36	10.02	0.31	10.27	0.37	10.06	0.36
TPLH_Q07 ns	1.0 14.0	9.43	0.25	9.92	0.35	9.97	0.34	11.03	0.31	11.08	0.34	11.06	0.32	11.28	0.36	11.28	0.32	11.52	0.38	11.28	0.35
MR_QN ns	1.0 15.0	12.50	0.49	12.76	0.43	12.80	0.42	13.88	0.43	13.93	0.44	13.96	0.44	14.23	0.47	14.71	0.54	15.02	0.61	14.95	0.59
MR_Q07 ns	1.0 15.5	13.35	0.31	13.56	0.30	13.50	0.30	14.68	0.31	14.80	0.34	14.80	0.34	15.15	0.38	15.71	0.40	16.01	0.46	16.01	0.40
TPZH_QQN ns	1.0 12.5	7.83	0.24	8.04	0.20	8.06	0.20	9.16	0.22	9.28	0.21	9.27	0.21	9.38	0.22	9.47	0.23	9.64	0.21	9.79	0.27
TPZL_QQN ns	1.0 13.0	7.96	0.27	8.72	0.22	8.72	0.22	9.69	0.22	9.76	0.23	9.71	0.23	9.68	0.24	9.33	0.25	9.34	0.29	9.80	0.36
TPHZ_QQN ns	1.0 14.0	7.70	0.87	8.25	1.11	8.35	1.02	9.45	0.95	9.38	1.05	9.34	1.04	9.39	1.05	8.94	1.10	9.09	1.12	8.73	1.13
TPLZ_QQN ns	1.0 12.5	10.55	0.33	10.74	0.26	10.75	0.26	11.80	0.27	11.89	0.26	11.87	0.27	12.01	0.28	12.11	0.30	12.30	0.30	11.96	0.32

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/ Post 30 krads and post 24 hour annealing measurements at 25°C are not included in Table IV. This data is available upon request.

Figure 1. Radiation Bias Circuit for 54AC299LMQB

