PPM 92-054

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UNISYS

Interoffice Memorandum

PPM-92-054

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Department
Code 300.1

From
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Department
7809

Date
February 06, 1992

Location
Lanham

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Location
Lanham

Subject
Radiation Report on 54AC646LMQB
SMEX Part No. 5962-89682013A
Control No. 1412

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A radiation evaluation was performed on the 54AC646LMQB 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, and 100 krads*. After 100 krads, the parts were annealed under bias at 25°C for 264 hours. After this annealing, the parts were irradiated to 200 and 300 krads (cumulative). Finally, the parts were annealed under bias for 168 hours at 100°C followed by an additional 192 hours without bias at 25°C. The dose rate was between 300 and 6,250 rads/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 at 25°C according to the test conditions and the specification limits listed in Table III. These tests included two functional tests at 1 MHz after each radiation and annealing step.

All parts passed both functional tests on irradiation up to 300 krads and on subsequent annealing treatment under bias for 168 hours at 100°C followed by 168 hours without bias at 25°C. Also, all parts stayed within the specification limits for all parameters on irradiation up to 20 krads. However, after radiation exposure to 30 krads, 3 devices exceeded the maximum specification limit of 160 uA for ICCH and ICCZ. These parts had readings ranging from 188 uA to 449 uA. Upon continued exposure to 50 krads, 5 devices were over the limit for ICCH and ICCZ. The readings ranged from 365 uA to 4.5 mA. In addition, one part exceeded the limit of 1 uA for IIH with an actual reading of 8.83 uA. The ICCH, ICCZ and IIH parameters continued to degrade through 100 krads of exposure. After 100 krads, 6 devices were over the limit for ICCH and ICCZ with readings from 1.8 mA to more than 16 mA. Also, 5 of these 6 devices exceeded the IIH limit with readings from 22 uA to 676 uA. The 264 hour annealing step enabled the devices to recover slightly, however, the same 6 parts were outside the specified limits. These 6 parts had readings for ICCH and ICCZ ranging from 0.5 mA to more than 16 mA and IIH decreased to a range of 2.5 uA to 384 uA. Upon further irradiation to 200 krads and then 300 krads, the degradation in the ICCH, ICCZ and IIH

parameters continued. All 8 samples exceeded the limits for these three parameters after 300 krads. Readings for ICCH and ICCZ were in excess of 16 mA. Readings for IIH ranged from slightly over 1 uA to 3.8 mA. The post 300 krads annealing step consisted of 168 hours under bias at 100°C plus an additional 192 hours of unbiased room temperature annealing. This annealing enabled 3 devices to recover enough to be within the limits for ICCH, ICCZ and IIH. The other 5 devices also recovered, but remained outside the specification limits for ICCH, ICCZ and IIH. Readings ranged from 200 uA to 9 mA for ICCH and ICCZ and from 2 uA to 85 uA for IIH.

Table IV provides the mean and standard deviation values for each parameter after each radiation exposure and annealing treatment. It also provides a summary of the functional test results after each radiation/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.

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

TABLE I. Part Information

Generic Part Number:	54AC646LMQB
SMEX Common Buy Part Number:	5962-89682013A
SMEX Common Buy Control Number:	1412
Charge Number:	C90353
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9109A
Quantity Tested:	8
Serial Numbers of Radiation Samples:	302, 303, 304, 305, 306, 307, 308, 309
Serial Number of Control Sample:	300, 301
Part Function:	OCTAL TRANSCEIVER/REGISTER
Part Technology:	CMOS
Package Style:	28-pin LCC

TABLE II. Radiation Schedule for 54AC646LMQB

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements	11/18/91
2) 10 KRAD IRRADIATION (500 rads/hour)	12/09/91
POST 10 KRAD ELECTRICAL MEASUREMENT	12/10/91
3) 20 KRAD IRRADIATION (500 rads/hour)	12/10/91
POST 20 KRAD ELECTRICAL MEASUREMENT	12/11/91
4) 30 KRAD IRRADIATION (525 rads/hour)	12/11/91
POST 30 KRAD ELECTRICAL MEASUREMENT	12/13/91
5) 50 KRAD IRRADIATION (300 rads/hour)	12/13/91
POST 50 KRAD ELECTRICAL MEASUREMENT	12/17/91
6) 75 KRAD IRRADIATION (1,320 rads/hour)	12/17/91
POST 75 KRAD ELECTRICAL MEASUREMENT	12/18/91
7) 100 KRAD IRRADIATION (1,320 rads/hour)	12/18/91
POST 100 KRAD ELECTRICAL MEASUREMENT	12/19/91
8) 96 HOURS ANNEALING AT 25°C	12/19/91
POST 96 HOURS ELECTRICAL MEASUREMENT	12/23/91
9) 264 HOURS ANNEALING AT 25°C	12/19/91
POST 264 HOURS ELECTRICAL MEASUREMENT	12/30/91
10) 200 KRAD IRRADIATION (6,250 rads/hour)	12/30/91
POST 200 KRAD ELECTRICAL MEASUREMENT	12/31/91
11) 300 KRAD IRRADIATION (2,130 rads/hour)	12/31/91
POST 300 KRAD ELECTRICAL MEASUREMENT	01/02/92
12) 168 HOURS ANNEALING AT +100°C PLUS 192 HOURS AT 25°C WITHOUT BIAS	01/02/92
POST ANNEALING ELECTRICAL MEASUREMENTS	01/18/92

Notes:

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.

- All electrical measurements were performed off-site at +25°C.

- All Annealing steps were performed under bias except as noted.

Table III. Electrical Characteristics of 54AC646LMQB

TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
FUNCT #1	3.0V	0.0V	3.0V	FREQ = 1MHz	ALL I/O	VOL<1.00V ; VOH>1.00V
FUNCT #2	5.5V	0.0V	5.5V	FREQ = 1MHz	ALL I/O	VOL<1.50V ; VOH>1.50V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS -55C, 25C, +125C MIN	MAX
VOH1	3.0V	0.9V	2.10V	LOAD = -50UA	OUTS	2.900V	3.000V
VOH2	4.5V	1.35V	3.15V	LOAD = -50UA	OUTS	4.400V	4.500V
VOH3	5.5V	1.65V	3.85V	LOAD = -50UA	OUTS	5.400V	5.500V
VOH4	3.0V	0.9V	2.10V	LOAD = -4MA	OUTS	2.400V	3.000V
VOH5	4.5V	1.35V	3.15V	LOAD = -24MA	OUTS	3.700V	4.500V
VOH6	5.5V	1.65V	3.85V	LOAD = -24MA	OUTS	4.700V	5.500V
VOH7	5.5V	1.65V	3.85V	LOAD = -50MA	OUTS	3.850V	5.500V
VOL1	3.0V	0.9V	2.10V	LOAD = +50UA	OUTS	0.000V	0.100V
VOL2	4.5V	1.35V	3.15V	LOAD = +50UA	OUTS	0.000V	0.100V
VOL3	5.5V	1.65V	3.85V	LOAD = +50UA	OUTS	0.000V	0.100V
VOL4	3.0V	0.9V	2.10V	LOAD = +12MA	OUTS	0.000V	0.500V
VOL5	4.5V	1.35V	3.15V	LOAD = +24MA	OUTS	0.000V	0.500V
VOL6	5.5V	1.65V	3.85V	LOAD = +24MA	OUTS	0.000V	0.500V
VOL7	5.5V	1.65V	3.85V	LOAD = +50MA	OUTS	0.000V	1.650V
IIL	5.5V	0.00V	5.50V	VIN = 0.0V	INS	-1.00UA	+1.00UA
IIH	5.5V	0.00V	5.50V	VIN = 5.5V	INS	-1.00UA	+1.00UA
ICCH	5.5V	0.00V	5.50V	OUTPUTS HIGH	VCC	0.00UA	160.00UA
ICCL	5.5V	0.00V	5.50V	OUTPUTS LOW	VCC	0.00UA	160.00UA
ICCZ	5.5V	0.00V	5.50V	OUTPUTS HI-Z	VCC	0.00UA	160.00UA

AC PARAMETRIC TESTS PROPAGATION DELAY TIMING

PARAMETER	VCC	VIL	VIH	PINS	LIMITS @25C,-55C,125C MIN	MAX
TPLH CLK->A	4.5V	0.0V	3.0V	OUT	1.0NS	14NS
TPHL CLK->A	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPLH CLK->B	4.5V	0.0V	3.0V	OUT	1.0NS	14NS
TPHL CLK->B	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPLH BBUS ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	10NS
TPHL BBUS ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	9.5NS
TPLH ABUS ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	10NS
TPHL ABUS ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	9.5NS
TPLH SEL ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPHL SEL ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPLH SEL ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPHL SEL ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPLZ OE_ ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	11NS
TPHZ OE_ ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	11.5NS
TPLZ OE_ ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	11NS
TPHZ OE_ ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	11.5NS
TPZL OE_ ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	11NS
TPZH OE_ ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	9.5NS
TPZL OE_ ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	11NS
TPZH OE_ ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	9.5NS
TPLZ DIR ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPHZ DIR ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPLZ DIR ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPHZ DIR ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	12NS
TPZL DIR ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	12.5NS
TPZH DIR ->ABUS	4.5V	0.0V	3.0V	OUT	1.0NS	10.5NS
TPZL DIR ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	12.5NS
TPZH DIR ->BBUS	4.5V	0.0V	3.0V	OUT	1.0NS	10.5NS

COMMENTS/EXCEPTIONS

(1) FUNCTIONAL TEST #1 & #2 IS PERFORMED WITH IOH= -7.2mA AND IOL=7.2mA.

(2) VIL & VIH ARE TESTED GO/NO GO DURING THE VOL & VOH TESTS.

(3) THIS PROGRAM DETECTS IMPROPER OUT INSERTION.*

(3) THE FOLLOWING AC EXCEPTIONS WERE TAKEN:
TPLZ OE_ TO BBUS
TPLZ DIR TO ABUS
TPHZ DIR TO ABUS
TPLZ DIR TO BBUS
TPZH DIR TO ABUS
TPZL DIR TO BBUS
TPZH DIR TO BBUS

(3) THIS PROGRAM DETECTS IMPROPER OUT INSERTION.

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC646LMQB 1/ 2/ 3/ 4/

		Spec Limits @ 25°C		Total Dose Exposure (TDE) (krads)												Anneal		(TDE) (krads)				Anneal
				0 (Pre-Rad)		10		30		50		75		100		264 hour @ 25°C		200		300		168 hours @ 100°C & 192 hours @ 25°C
Parameters		min	max	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	
VOH1_3.0V	V	2.9	3.0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0.01	2.99	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	4.48	0.01	4.48	0
VOH3_5.5V	V	5.4	5.5	5.50	0	5.49	0	5.49	0	5.13	0.84	5.34	0.57	5.20	0.76	5.45	0.56	5.34	0.55	5.41	0.38	5.49	0
VOH4_3.0V	V	2.4	3.0	2.92	0	2.92	0	2.92	0	2.91	0	2.91	0	2.91	0	2.91	0	2.90	0.01	2.89	0.01	2.91	0
VOH5_4.5V	V	3.7	4.5	4.14	0.01	4.14	0.01	4.14	0.02	4.13	0.01	4.13	0.01	4.12	0.01	4.12	0.01	4.10	0.01	4.09	0.02	4.11	0.01
VOH6_5.5V	V	4.7	5.5	5.19	0.01	5.19	0.01	5.19	0.01	5.18	0.01	5.18	0.01	5.17	0.01	5.17	0.01	5.16	0.01	5.14	0.02	5.17	0.01
VOH7_5.5V	V	3.85	5.5	4.83	0.02	4.82	0.02	4.81	0.03	4.81	0.02	4.80	0.02	4.79	0.02	4.79	0.02	4.76	0.03	4.73	0.03	4.77	0.02
VOL1_3.0V	V	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL2_4.5V	V	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0
VOL3_5.5V	V	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0
VOL4_3.0V	V	0	0.5	0.15	0	0.15	0	0.15	0.01	0.15	0	0.15	0.01	0.15	0.01	0.15	0.01	0.16	0.01	0.16	0.01	0.16	0.01
VOL5_4.5V	V	0	0.5	0.21	0.01	0.21	0.01	0.22	0.01	0.21	0.01	0.21	0.01	0.21	0.01	0.22	0.01	0.22	0.01	0.23	0.01	0.22	0.01
VOL6_5.5V	V	0	0.5	0.18	0.01	0.18	0.01	0.19	0.01	0.18	0.01	0.18	0.01	0.18	0.01	0.19	0.01	0.19	0.01	0.20	0.01	0.19	0.01
VOL7_5.5V	V	0	1.65	0.39	0.02	0.39	0.02	0.40	0.03	0.39	0.02	0.40	0.02	0.40	0.02	0.40	0.02	0.41	0.02	0.42	0.02	0.41	0.02
IIL	uA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	-0.01	0.02	0	0.02	-0.02	0.07	-0.08	0.15	0	0
IIH	uA	-1.0	1.0	0	0	0	0	0	0	0.06	0.67	2.25	18.3	9.18	57.8	3.91	20.5	40.4	212.2	109.4	484.8	0.67	7.06
ICCL	uA	0	160	0	0	0	0	0	0	0.01	0	0.06	0.01	0.06	0.01	0.01	0	0.32	0.44	5.69	9.64	0	0.01
ICCH	uA	0	160	0	0	0	0	111.5	144.5	1585	1745	6442	6020	8934	6855	7643	6895	11399	6724	12132	6703	2876	3373
ICCZ	uA	0	160	0	0	0	0	114.8	147.0	1619	1784	6603	6161	9016	6877	7709	6922	11436	6714	12142	6687	2897	3386
TPLHCLK>A	nS	1.0	14.0	8.09	0.26	8.57	0.35	8.53	0.33	9.58	0.35	9.57	0.37	9.57	0.36	****	****	9.45	0.30	9.88	0.84	9.55	0.34
TPHLCLK>A	nS	1.0	12.0	6.38	0.22	6.79	0.36	6.74	0.35	7.76	0.36	7.72	0.35	7.70	0.37	****	****	7.56	0.24	7.62	0.33	7.64	0.26
TPLHCLK>B	nS	1.0	14.0	9.76	0.62	8.18	0.72	8.19	0.70	9.32	0.69	9.31	0.69	9.34	0.69	****	****	9.34	0.65	9.72	0.82	9.14	0.56
TPHLCLK>B	nS	1.0	12.0	6.55	0.60	6.99	0.58	6.98	0.57	8.09	0.60	****	****	8.07	0.61	****	****	7.95	0.59	8.06	0.62	7.87	0.56
TPLHB>A	nS	1.0	10.0	6.97	0.58	7.44	0.59	7.34	0.57	8.26	0.56	8.22	0.59	8.22	0.56	8.19	0.56	8.19	0.53	8.52	0.79	8.07	0.44
TPHLB>A	nS	1.0	9.5	6.44	0.60	6.97	0.76	6.94	0.75	7.89	0.79	7.91	0.80	7.93	0.82	7.89	0.63	7.80	0.66	8.35	0.92	8.02	0.78
TPLHA>B	nS	1.0	10.0	6.61	0.68	7.09	0.73	7.01	0.73	8.02	0.70	7.97	0.70	7.95	0.69	7.87	0.63	7.87	0.62	8.01	0.69	7.66	0.59
TPHLA>B	nS	1.0	9.5	6.50	0.62	7.08	0.62	7.05	0.62	8.10	0.67	8.11	0.68	8.13	0.68	8.00	0.63	8.09	0.67	8.47	0.84	8.00	0.61

TABLE IV (CONTINUED) : Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC646LMQB 1/ 2/ 3/ 4/

		Spec Limits @ 25°C		Total Dose Exposure (TDE) (krads)												Anneal		(TDE) (krads)				Anneal	
				0 (Pre-Rad)		10		30		50		75		100		264 hour @ 25°C		200		300		168 hours @ 100°C & 192 hours @ 25°C	
Parameters		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
TPLHSEL>A	nS	1.0	12.0	7.93	0.22	8.41	0.38	8.37	0.40	9.34	0.65	9.36	0.36	9.38	0.38	9.32	0.20	9.40	0.21	10.15	1.13	9.32	0.25
TPHLSEL>A	nS	1.0	12.0	9.02	0.80	9.74	0.81	9.70	0.81	10.61	0.71	10.59	0.80	10.58	0.84	10.29	0.84	10.23	0.85	9.77	1.06	9.85	0.76
TPLHSEL>B	nS	1.0	12.0	7.07	0.59	7.63	0.56	7.58	0.55	8.63	1.06	8.59	0.59	8.60	0.59	8.47	0.59	8.54	0.58	8.83	0.70	8.46	0.59
TPHLSEL>B	nS	1.0	12.0	5.69	0.58	6.30	0.58	6.24	0.58	7.23	0.82	7.16	0.61	7.16	0.61	7.03	0.56	7.01	0.58	6.97	0.58	6.97	0.56
TPLZOE>A	nS	1.0	11.0	6.04	0.28	6.84	0.27	6.77	0.23	7.74	0.19	7.72	0.27	7.73	0.25	7.38	0.24	7.15	0.73	7.17	0.83	7.27	0.22
TPHZOE>A	nS	1.0	11.5	7.78	0.29	7.94	0.28	7.85	0.27	8.81	0.24	8.79	0.30	8.78	0.32	9.03	0.31	8.95	0.34	****	****	8.55	0.37
TPHZOE>B	nS	1.0	11.5	8.01	0.57	8.32	0.52	8.25	0.51	9.28	0.22	9.24	0.50	9.26	0.52	9.44	0.51	9.49	0.64	****	****	8.91	0.54
TPZLOE>A	nS	1.0	11.0	7.14	0.76	8.00	0.76	7.89	0.75	8.85	0.13	8.90	0.85	9.00	0.92	8.66	0.89	8.96	0.97	8.94	1.07	8.40	0.92
TPZHOE>A	nS	1.0	9.5	6.83	0.72	7.05	0.73	6.98	0.71	7.91	0.14	7.91	0.71	7.92	0.68	8.18	0.69	8.25	0.62	9.36	1.76	8.17	0.47
TPZLOE>B	nS	1.0	11.0	6.82	0.71	7.66	0.69	7.53	0.71	8.78	0.44	8.65	0.80	8.52	0.83	7.93	0.82	****	****	****	****	7.93	0.81
TPZHOE>B	nS	1.0	9.5	6.76	0.81	6.85	0.97	6.76	0.98	7.92	1.03	7.88	1.03	7.89	1.03	7.98	1.02	8.15	0.73	8.73	1.14	8.09	1.21
TPHZDIR>A	nS	1.0	12.0	6.49	1.40	6.33	0.40	6.31	0.41	7.43	0.40	7.48	0.44	7.52	0.46	7.66	0.46	7.72	0.49	****	****	7.35	0.53
TPHZDIR>B	nS	1.0	12.0	5.01	0.61	5.29	0.52	5.28	0.51	6.44	0.52	6.44	0.52	6.51	0.52	6.57	0.53	6.74	0.57	****	****	6.49	0.55

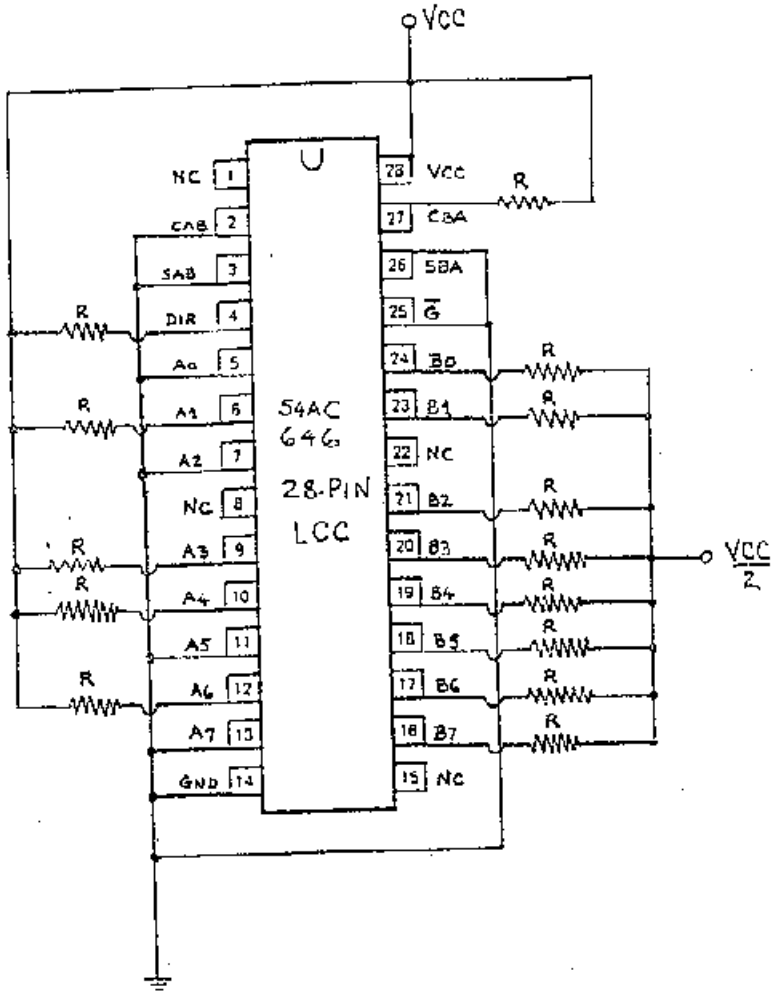
1/ These statistics do not include the control samples which remained constant throughout testing.

2/ The statistics for the post 20 krads and 96 hour annealing steps are available upon request.

3/ It shall be noted that beyond 50 krads of exposure, three devices were reading below the minimum limit for VOH3. This trend was not consistent with some parts passing VOH3 at later radiation steps.

4/ **** - indicates that statistics are not available due to fluctuations with the Automated Test Equipment (ATE).

Figure 1. Radiation Bias Circuit for 54AC646LMQB



54AC 646
28 PIN LCC

V_{CC} = 5.0V ±10%, $\frac{V_{CC}}{2}$ = 2.5V ±10%

R = 1.0K Ohm, 5%, ¼ W

TA = 25°C