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Interoffice Memorandum

To
T. Miccolis
Department
Code 300.1
From
K. Sahu
Department
7809
Subject
Radiation Report on 54AC139DMQB
SMEX Common Buy Part No. 5962-8762301EA

PPM-91-628
Date
October 10, 1991
Location
Lanham
Telephone
731-8954
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Lanham
cc
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A radiation evaluation was performed on 54AC139 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 krad. After 100 krad, parts were annealed at 25°C for 72 and 168 hours, and then irradiation was continued to 200 and 300 krad (cumulative). Parts were then annealed at high temperature (100°C) for 168 hours. The dose rate was between 0.1 - 5.6 krad/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III. These tests included two functional tests (1MHz, at VCC voltages of 5.5V and 3.0V, respectively) after each radiation and annealing step.

All (8) parts passed all parametric tests, except ICCH/L, and both functional tests up to 300 krad. ICCH and ICCL failures were observed after the first radiation exposure to 10 krad as three parts (SNs 604, 607 and 609) exceeded the maximum specification limit of 80uA for ICCH and ICCL. Failed readings ranged from 175uA to 609uA for ICCH, and 164uA to 567uA for ICCL. ICCH and ICCL readings degraded as the cumulative radiation exposures increased. By 100 krad, all parts except one, SN 603, had exceeded the specification limit for ICCH and ICCL, with four parts exceeding the 16mA measurement limit of the test equipment. Little recovery was observed after 72 and 168 hour annealings at 25°C.

On continued irradiation to 300 krads, all parts failed ICCH and ICCL. After 168 hours of high temperature annealing (100°C), all parts had measurable ICCH/L values, although all parts continued to exceed the specification limits for these parameters. Table IV provides the mean and standard deviation values for each parameter after different radiation exposures and annealing treatments. 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.

TABLE I. Part Information

Generic Part Number:	54AC139
SMEX Common Buy Part Number:	5962-8762301EA (HA124231)
SMEX Common Buy Control Number:	1653
Charge Number:	C90357
Manufacturer:	National Semiconductor Inc.
Quantity Procured:	100
Lot Date Code:	9036A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	603, 604, 605, 606 607, 608, 609, 610
Serial Numbers of Control Samples:	601, 602
Part Function:	2 to 4 Line Decoder
Part Technology:	CMOS
Package Style:	16-Pin DIP
Test Engineer:	A. Karygiannis

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	07/16/91
2) 10 krads irradiation @ 500 rads/hr Post 10 krads Electrical Measurements	08/14/91 08/15/91
3) 20 krads irradiation @ 150 rads/hr Post 20 krads Electrical Measurements	08/16/91 08/19/91
4) 30 krads irradiation @ 500 rads/hr Post 30 krads Electrical Measurements	08/19/91 08/20/91
5) 50 krads irradiation @ 1000 rads/hr Post 50 krads Electrical Measurements	08/20/91 08/21/91
6) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	08/21/91 08/22/91
7) 100 krads irradiation @ 1300 rads/hr Post 100 krads Electrical Measurements	08/22/91 08/23/91
8) 72 hrs annealing at 25°C Post 72 hr Electrical Measurements	08/23/91 08/26/91
9) 168 hrs annealing at 25°C Post 168 hr Electrical Measurements	08/23/91 08/30/91
10) 200 krads irradiation @ 2170 rads/hr Post 200 krads Electrical Measurements	08/30/91 09/03/91
11) 300 krads irradiation @ 5550 rads/hr Post 300 krads Electrical Measurements	09/03/91 09/04/91
12) 168 hrs annealing at 100°C Post 168 hr Electrical Measurements	09/04/91 09/11/91

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.
- Annealing was performed at 25°C under bias (except high temp. annealing at 100°C).

Table III. Electrical Characteristics of 54AC139

FUNCTIONAL TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
FUNCT 1	3.0V	0.0V	3.0V	FREQ=1.000MHz	ALL I/O	VOL<1.5V / VOH>1.5V
FUNCT 2	4.5V	0.0V	4.5V	FREQ=1.000MHz	ALL I/O	VOL<1.5V / VOH>1.5V
LOAD USED <= (ICM = -4.0mA (VREF = 1.5V (IOL = +4.0mA						
DC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55, +25, & +125C
V _{OH1}	3.0V	0.9V	2.1V	LOAD=-300A	OUTS	>+2.9V / <+6.5V
V _{OH2}	4.5V	1.35V	3.15V	LOAD=-300A	OUTS	>+4.4V / <+6.5V
V _{OH3}	3.5V	1.65V	3.85V	LOAD=-300A	OUTS	>+5.4V / <+6.5V
V _{OH4}	3.0V	0.9V	2.1V	LOAD=-4mA	OUTS	>+2.4V / <+6.5V
V _{OH5}	4.5V	1.35V	3.15V	LOAD=-24mA	OUTS	>+3.7V / <+6.5V
V _{OH6}	4.5V	1.65V	3.85V	LOAD=-24mA	OUTS	>+4.7V / <+6.5V
V _{OH7}	5.5V	1.65V	3.85V	LOAD=-30mA	OUTS	>+3.85V / <+6.5V
V _{OL1}	3.0V	0.9V	2.1V	LOAD=+300A	OUTS	>+0.0V / <+0.1V
V _{OL2}	4.5V	1.35V	3.15V	LOAD=+300A	OUTS	>+0.0V / <+0.1V
V _{OL3}	3.5V	1.65V	3.85V	LOAD=+300A	OUTS	>+0.0V / <+0.1V
V _{OL4}	3.0V	0.9V	2.1V	LOAD=+12mA	OUTS	>+0.0V / <+0.5V
V _{OL5}	4.5V	1.35V	3.15V	LOAD=+24mA	OUTS	>+0.0V / <+0.5V
V _{OL6}	5.5V	1.65V	3.85V	LOAD=+24mA	OUTS	>+0.0V / <+0.5V
V _{OL7}	5.5V	1.65V	3.85V	LOAD=+30mA	OUTS	>+0.0V / <+1.65V
I _{AH}	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 _{CCH}	5.5V	0.0V	5.5V	V _{IN} = 5.5V	VCC	>+0.0UA / <+80UA
I _{CL}	5.5V	0.0V	5.5V	V _{IN} = 3.3V	VCC	>+0.0UA / <+80UA
AC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
EN_TPLH1	3.0V	0.0V	3.0V	VTST=1.5V	OUTS	>+1.0NS / <+12.0NS
EN_TPHL1	3.0V	0.0V	3.0V	VTST=1.5V	OUTS	>+1.0NS / <+10.0NS
SELTPH1	3.0V	0.0V	3.0V	VTST=1.5V	OUTS	>+1.0NS / <+11.5NS
SELTPHL1	3.0V	0.0V	3.0V	VTST=1.5V	OUTS	>+1.0NS / <+10.0NS
EN_TPLH2	4.5V	0.0V	4.5V	VTST=2.25V	OUTS	>+1.0NS / <+8.5NS
EN_TPHL2	4.5V	0.0V	4.5V	VTST=2.25V	OUTS	>+1.0NS / <+8.0NS
SELTPH2	4.5V	0.0V	4.5V	VTST=2.25V	OUTS	>+1.0NS / <+9.0NS
SELTPHL2	4.5V	0.0V	4.5V	VTST=2.25V	OUTS	>+1.0NS / <+8.0NS
COMMENTS/EXCEPTIONS						
(1) V _{IL} & V _{IH} were tested during V _{OL} & V _{OH} tests as Go/NoGo.						

TABLE IV: Summary of Electrical Measurements after
Total Dose Exposures and Annealing for 54AC139

1/, 2/, 3/

Parameters	Spec. Limits min max	Initials		Total Dose Exposure (krads)													
		mean	sd	10		20		30		50		75		100			
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
Func1 @5.5V		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
Func2 @3.0V		Pass		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
VOH1 V	2.9 6.5	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	.01	2.99	.01
VOH3 V	5.4 6.5	5.48	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	.01	5.48	.01	5.48	.01
VOH5 V	3.7 6.5	4.16	.01	4.16	.01	4.16	.01	4.16	.01	4.16	.01	4.15	.01	4.15	.01	4.15	.01
VOH7 V	3.85 6.5	4.86	.02	4.86	.02	4.85	.02	4.85	.02	4.85	.02	4.84	.02	4.84	.02	4.83	.02
VOL1 mV	0 100	0	0	0	0	0	0	0	0	0	0	.8	3	3	4	4	5
VOL3 mV	0 100	6	0.9	6	2	6	2	7	2	9	4	11	6	11	6	13	7
VOL5 mV	0 500	209	7	209	7	212	7	209	7	212	8	212	8	212	8	215	8
VOL7 mV	0 1650	391	14	391	13	397	14	391	14	396	16	397	14	400	14	400	14
IIH nA	0 1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL nA	-1000 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH uA	0 80	0	0	173	229	270	768	2.3E3	2.5E3	6.7E3	6.3E3	>16E3	-	>16E3	-	>16E3	-
ICCL uA	0 80	0	0	138	173	637	616	2.1E3	2.1E3	6.2E3	5.8E3	>16E3	-	>16E3	-	>16E3	-
EN TPLH1 ns	1 12	8.0	.3	7.9	.3	8.2	.6	8.0	.3	7.8	.3	8.0	.6	7.6	.3	7.6	.3
EN TPHL1 ns	1 10	6.7	.5	7.8	.4	8.1	.5	7.9	.3	7.8	.3	8.2	.5	7.8	.3	7.8	.3
SEL TPLH1 ns	1 11.5	6.9	1	6.9	1	6.9	1	6.9	1	6.9	1	6.9	1	6.8	1	6.8	1
SEL TPHL1 ns	1 10	6.0	.9	6.9	1.2	6.8	1.2	6.8	1.2	6.9	1.2	6.8	1.3	6.9	1.3	6.9	1.3

<Table IV continued on next page>

Table IV. (cont. ued)

Parameters	Spec. Limits min max	Initials				Annealing				TDE (krads)				Anneal, 100°C	
		mean		sd		72 hrs		168 hrs		200		300		168 hrs	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Func1 @5.5V				Pass		Pass		Pass		Pass		Pass		Pass	
Func2 @3.0V				Pass		Pass		Pass		Pass		Pass		Pass	
VOH1	V	2.9	6.5	2.99	0	2.99	.01	2.99	.01	2.99	.01	2.98	.02	2.99	.01
VOH3	V	5.4	6.5	5.48	0	5.48	.01	5.48	.01	5.48	.01	5.48	.02	5.49	.01
VOH5	V	3.7	6.5	4.16	.01	4.15	.01	4.15	.01	4.13	.02	4.12	.03	4.13	.02
VOH7	V	3.85	6.5	4.86	.02	4.83	.03	4.83	.03	4.81	.04	4.79	.05	4.81	.03
VOL1	mV	0	100	0	0	4	5	4	5	3	4	7	6	9	2
VOL3	mV	0	100	6	0.9	12	6	12	7	11	6	23	16	9	8
VOL5	mV	0	500	209	7	215	10	216	11	216	14	223	17	216	16
VOL7	mV	0	1650	391	14	401	20	403	22	404	27	426	41	404	29
I IH	nA	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
I IL	nA	-1000	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH	uA	0	80	0	0	>16E3	-	>16E3	-	>16E3	-	>16E3	-	4.5E3	3.7E3
ICCL	uA	0	80	0	0	>16E3	-	>16E3	-	>16E3	-	>16E3	-	4.5E3	3.6E3
EN I PLH1	ns	1	12	8.0	.3	8.0	.6	7.7	.3	8.3	.6	8.3	.6	*	
EN T PHL1	ns	1	10	6.7	.5	8.2	.5	7.9	.3	7.6	.5	7.7	.5	*	
SEL I PLH1	ns	1	11.5	6.9	1	6.9	.9	6.9	1	7.2	1.1	7.1	1.1	*	
SEL T PHL1	ns	1	10	6.0	.9	6.9	1.2	6.9	1.3	6.5	1	6.5	1	*	

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/ Data from the other VOL, VOH and AC tests listed in Table III but not shown in Table IV is available on request.
- 3/ '>16E3' for ICCH and ICCL in Table IV denotes that parts were exceeding the 16mA measurement limit of the test equipment.
- * Accurate AC measurements were not available after high temperature annealing due to calibration problems with the test equipment.