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Interoffice Memorandum

to
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Department
Code 300.1 ks
From
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7809
Subject
Radiation Report on 54AC14DMQB
SMEX Common Buy Part No. 5962-8762401CA

PPM-91-423
Date
July 2, 1991
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A radiation evaluation was performed on 54AC14 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 5, 10, 15, 20, 30, and 50 krads. After 50 krads, parts were annealed at 25°C for 24 and 168 hours, and then irradiation was continued to 150 and 250 krads (cumulative). The dose rate was between 0.3 - 5.7 krads/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 (at 1 MHz) after each radiation and annealing step.

All (8) parts passed all parametric tests up to 5 krads and both functional tests up to 250 krads. After 10 krads exposure, all parts failed to meet the maximum specification limit of 80uA for ICCH (readings ranged from 85uA to 297uA) and four parts failed to meet the same specification limit for ICCL with readings ranging from 30uA to 143uA. All parts failed ICCH and ICCL tests after 15 krads exposure. Continued degradation in ICCH/L was observed at the subsequent radiation steps of 20, 30, and 50 krads; however, all parts continued to pass all other parametric tests and both functional tests at these steps.

After annealing the parts for 24 and 168 hours, some recovery was observed in ICCH/L, but readings were still way beyond the specification limits. After the next radiation steps of 150 and 250 krads, ICCH/L had increased beyond the maximum limit of 16mA that the test equipment could measure. In addition, six parts

began failing VOH1 and VOH2 after 250 krads irradiation. 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 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 1. Part Information

Generic Part Number:	54AC14
SMEX Common Buy Part Number:	5962-8762401CA (HA124233)
SMEX Common Buy Control Number:	1736
Charge No.:	C90092
Manufacturer:	National Semiconductor Corp.
Quantity Procured:	100
Lot Date Code:	9036A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	3, 4, 5, 6 7, 8, 9, 10
Serial Numbers of Control Samples:	1, 2
Part Function:	Hex Inverter Schmidt Trigger
Part Technology:	CMOS
Package Style:	14-Pin DIP

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	03/17/91
2) 5 krads irradiation @ 280 rads/hr Post 5 krads Electrical Measurements	05/16/91 05/17/91
3) 10 krads irradiation @ 280 rads/hr Post 10 krads Electrical Measurements	05/17/91 05/18/91
4) 15 krads irradiation @ 250 rads/hr Post 15 krads Electrical Measurements	05/18/91 05/19/91
5) 20 krads irradiation @ 260 rads/hr Post 20 krads Electrical Measurements	05/19/91 05/20/91
6) 30 krads irradiation @ 540 rads/hr Post 30 krads Electrical Measurements	05/20/91 05/21/91
7) 50 krads irradiation @ 1080 rads/hr Post 50 krads Electrical Measurements	05/21/91 05/22/91
8) 24 hrs annealing Post 24 hr Electrical Measurements	05/22/91 05/23/91
9) 168 hrs annealing Post 168 hr Electrical Measurements	05/22/91 05/29/91
10) 150 krads irradiation @ 5555 rads/hr Post 150 krads Electrical Measurements	05/29/91 05/30/91
11) 250 krads irradiation @ 5700 rads/hr Post 250 krads Electrical Measurements	05/30/91 05/31/91

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.

TABLE III. Electrical Characteristics of 54AC14

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	5.5V	0.0V	5.5V	FREQ=1.000MHZ	ALL I/O	VOL<2.5V / VOH>2.5V
LOAD USED <= $\begin{cases} I_{OH} = -4.80MA \\ V_{REF} = 1.5V \\ I_{OL} = +4.8MA \end{cases}$						
DC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
VOH1	3.0V	0.9V	2.1V	LOAD=-50UA	OUTS	>+2.9V / <+3.0V
VOH2	3.0V	0.9V	2.1V	LOAD=-04MA	OUTS	>+2.4V / <+3.0V
VOH3	4.5V	1.35V	3.15V	LOAD=-50UA	OUTS	>+4.4V / <+4.5V
VOH4	4.5V	1.35V	3.15V	LOAD=-24MA	OUTS	>+3.7V / <+4.5V
VOH5	5.5V	1.65V	3.85V	LOAD=-50UA	OUTS	>+5.4V / <+5.5V
VJH6	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	0.9V	2.1V	LOAD=+50UA	OUTS	>+0.0V / <+0.1V
VOL2	3.0V	0.9V	2.1V	LOAD=+12MA	OUTS	>+0.0V / <+0.5V
VOL3	4.5V	1.35V	3.15V	LOAD=+50UA	OUTS	>+0.0V / <+0.1V
VOL4	4.5V	1.35V	3.15V	LOAD=+24MA	OUTS	>+0.0V / <+0.5V
VOL5	5.5V	1.65V	3.85V	LOAD=+50UA	OUTS	>+0.0V / <+0.1V
VOL6	5.5V	1.65V	3.85V	LOAD=+24MA	OUTS	>+0.0V / <+0.5V
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 _{CCH}	5.5V	0.0V	5.5V	V _{IN} = 5.5V	VCC	>+0.0UA / <+80UA
I _{CCL}	5.5V	0.0V	5.5V	V _{IN} = 0.0V	VCC	>+0.0UA / <+80UA
COMMENTS/EXCEPTIONS						
(1) VIL & VIH WERE TESTED DURING VOL & VOH TESTS AS GO/NOGO.						
(2) THIS PROGRAM DOES NOT PERFORM ANY AC PARAMETRIC TESTS.						
(3) IIL TESTS ARE PERFORMED WITH ALL INPUTS LOW.						
(4) IiH TESTS ARE PERFORMED WITH ALL INPUTS HIGH.						

TABLE IV: Summary of Electrical Measurements
after Total Dose Exposures and Annealing for 54AC14 1/

Parameters	Spec. Limits min max	Total Dose Exposure (krads)														
		Initials		5		10		15		20		30		50		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
Func1 3 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass		
Func2 3 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass		
VOH1 V	2.9 3.0	3.0	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0	*
VOH2 V	2.4 3.0	2.94	.01	2.94	0	2.94	0	2.94	0	2.94	0	2.94	0	2.94	0	*
VOH3 V	4.4 4.5	4.49	0	4.50	0	4.49	0	4.49	0	4.50	0	4.49	.01	4.49	.01	*
VOH4 V	3.7 4.5	4.23	.04	4.24	.01	4.24	.01	4.24	.01	4.24	.01	4.24	.01	4.22	.02	*
VOH5 V	5.4 5.5	5.50	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	*
VOH6 V	4.7 5.5	5.26	.04	5.27	.01	5.27	.01	5.27	.01	5.27	.01	5.27	.01	5.26	.02	*
VOH7 V	3.85 5.5	5.00	.05	5.02	.02	5.02	.02	5.02	.02	5.02	.02	5.02	.02	5.02	.02	*
VOL1 mV	0 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*
VOL2 mV	0 500	129	10	125	5	124	4	124	4	125	5	124	4	124	4	*
VOL3 mV	0 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*
VOL4 mV	0 500	184	17	176	6	176	6	176	5	177	6	175	7	175	7	*
VOL5 mV	0 100	0.6	1.6	0	0	0	0	0	0	0	0	0	0	0	0	*
VOL6 mV	0 500	161	17	152	5	153	5	153	4	154	5	153	6	153	6	*
VOL7 mV	0 1650	344	37	326	11	326	11	326	10	328	12	327	10	327	10	*
IIL nA	-1000 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIH nA	0 1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH uA	0 80	0	0	1.3	1.2	1.62	.73	1.47	.201	1.3E3	.579	3.3E3	0.3E3	8.3E3	3.0E3	
ICCL uA	0 80	0	0	0.9	0.8	.84	.38	.397	.137	.819	.386	2.5E3	0.4E3	6.6E3	2.0E3	

<Table IV continued on next page>

* Post 50 krad VOH/L measurements were not reliable due to some problems with the test equipment.

TABLE IV. (continued)

Parameters		Spec. Limits		Initials		Annealing				Total Dose (krads)			
						24 hrs		168 hrs		150		250	
		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Func1 @ 1MHz				Pass		Pass		Pass		Pass		Pass	
Func2 @ 1MHz				Pass		Pass		Pass		Pass		Pass	
VOH1	V	2.9	3.0	3.0	0	2.99	0	2.99	0	2.97	.02	2.11	1.35
VOH2	V	2.4	3.0	2.94	.01	2.94	.01	2.94	.01	2.92	.02	2.07	1.33
VOH3	V	4.4	4.5	4.49	0	4.49	0	4.49	0	4.48	.01	4.47	.02
VOH4	V	3.7	4.5	4.23	.04	4.24	.01	4.22	.04	4.21	.02	4.20	.03
VOH5	V	5.4	5.5	5.50	0	5.49	0	5.49	0	5.48	.01	5.47	.02
VOH6	V	4.7	5.5	5.26	.04	5.27	.01	5.27	.01	5.25	.02	5.24	.02
VOH7	V	3.85	5.5	5.00	.05	5.01	.02	5.01	.01	4.98	.03	4.97	.03
VOL1	mV	0	100	0	0	3.3	3.8	4.2	2.1	9.0	9.2	9.5	9.7
VOL2	mV	0	500	129	10	125	5	126	7	127	8	126	8
VOL3	mV	0	100	0	0	3.4	3.9	3.0	1.5	9.3	9.6	10	10
VOL4	mV	0	500	184	17	177	5	176	8	182	10	184	11
VOL5	mV	0	100	0.6	1.6	3.7	4.0	6	5	10	10	12.7	9.0
VOL6	mV	0	500	161	17	155	5	155	5	162	10	165	11
VOL7	mV	0	1650	344	37	327	10	330	20	334	17	338	19
II1	nA	-1000	0	0	0	0	0	0	0	0	0	0	0
IIH	nA	0	1000	0	0	0	0	0	0	0	0	0	0
ICCH	uA	0	80	0	0	6.6E3	1.0E3	5.5E3	0.5E3	>16E3	-	>16E3	-
ICCL	uA	0	80	0	0	5.4E3	810	4.5E3	0.6E3	>16E3	-	>16E3	-

Note:

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.

Figure 1. Radiation Bias Circuit for 54AC14

