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## Interoffice Memorandum

PPM-91-376

Date

May 31, 1991

Location

Lanham

Telephone

731-8954

Location

Lanham

cc

B. Fafaul/311

J. Denis/311

V. Edson

S. Esmacher

A. Casasnovas

M. Fowler

A. Moor

To

T. Miccolis

Department

Code 300.1

From

K. Sahu KS

Department

7809

Subject

Radiation Report on 54AC04  
SMEX Common Buy Part No. 5962-8760901CA

A radiation evaluation was performed on 54AC04 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, parts were annealed at 25°C for 24 and 168 hours, and then irradiation was continued to 200 and 300 krads (cumulative). The dose rate was between 0.5 - 5.6 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 a total of three functional tests (at 1MHz) after each radiation and annealing step.

All (8) parts passed all functional tests up to 300 krads. However, parts began failing parametrically after the first radiation step of 10 krads. Seven of the eight parts failed to meet the maximum specification limit of 80uA for ICCL, with readings ranging from 1uA to 276uA. Similarly, six parts failed to meet the same specification limit for ICCH, with readings ranging from 2uA to 191uA. All parts passed all other parametric tests. ICCH/L degradation increased after 20 krads. ICCL readings ranged from 8uA to 1.9mA and ICCH readings ranged from 20uA to 1.6mA after this radiation step. Subsequent radiation steps showed further degradation in ICCH/L; however, all parts continued to pass all other tests up to 100 krads. Upon annealing the parts for 24 168 hours, some recovery was observed in ICCH/L, but the readings were still far above the maximum specification

limit (readings ranged from 500uA to 10mA). After 200 krads, ICCH/L continued to degrade while all parts continued to pass all other tests. After 300 krads, two parts, SNS 3 and 6, failed VOH1, while all other parts passed all tests except for ICCH/L. 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 I. Part Information

Generic Part Number:	54AC04
SMEX Common Buy Part Number:	5962-8760901CA, HA124219
SMEX Common Buy Control Number:	1644
Manufacturer:	National Semiconductor Corporation
Quantity Procured:	116
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
Part Technology:	CMOS
Package Style:	14-Pin DIP

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	03/17/91
2) 10 krads irradiation @ 555 rads/hr Post 10 krads Electrical Measurements	04/29/91 04/30/91
3) 20 krads irradiation @ 540 rads/hr Post 20 krads Electrical Measurements	04/30/91 05/01/91
4) 30 krads irradiation @ 500 rads/hr Post 30 krads Electrical Measurements	05/01/91 05/02/91
5) 50 krads irradiation @ 1111 rads/hr Post 50 krads Electrical Measurements	05/02/91 05/03/91
6) 75 krads irradiation @ 378 rads/hr Post 75 krads Electrical Measurements	05/03/91 05/06/91
7) 100 krads irradiation @ 1388 rads/hr Post 100 krads Electrical Measurements	05/06/91 05/07/91
8) 24 hrs annealing Post 24 hr Electrical Measurements	05/07/91 05/08/91
9) 168 hrs annealing Post 168 hr Electrical Measurements	05/08/91 05/14/91
10) 200 krads irradiation @ 5263 rads/hr Post 200 krads Electrical Measurements	05/14/91 05/15/91
11) 300 krads irradiation @ 5555 rads/hr Post 300 krads Electrical Measurements	05/15/91 05/16/91

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 54AC04

FUNCTIONAL TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
FUNCT 1	4.5V	0.0V	5.5V	PARAM = 1.000MHZ	ALL I/O	VOL < 1.5V / VDH > 1.5V
FUNCT 2	4.5V	0.0V	5.5V	PARAM = 1.000MHZ	ALL I/O	VOL < 2.5V / VDH > 2.5V
FUNCT 3	5.5V	0.0V	5.5V	PARAM = 1.000MHZ	ALL I/O	VOL < 2.5V / VDH > 2.5V
LOAD USED <= 4.8mA IOL = +4.8mA IIL = -4.8mA VREF = 1.5V IOM = -14.50mA						
DC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
VDM1	4.5V	0.9V	2.1V	LOAD = -500A	OUTS	> +2.9V / < +3.0V
VDM2	4.5V	0.9V	2.1V	LOAD = -100A	OUTS	> +2.4V / < +3.0V
VDM3	4.5V	1.05V	3.15V	LOAD = -500A	OUTS	> +4.4V / < +4.5V
VDM4	4.5V	1.05V	3.15V	LOAD = -100A	OUTS	> +3.7V / < +4.5V
VDM5	4.5V	1.05V	3.15V	LOAD = -500A	OUTS	> +4.4V / < +4.5V
VDM6	4.5V	1.05V	3.15V	LOAD = -100A	OUTS	> +3.7V / < +4.5V
VDM7	4.5V	1.05V	3.15V	LOAD = -500A	OUTS	> +2.85V / < +3.5V
VOL1	4.5V	0.9V	2.1V	LOAD = +500A	OUTS	> +0.0V / < +0.1V
VOL2	4.5V	0.9V	2.1V	LOAD = +100A	OUTS	> +0.0V / < +0.5V
VOL3	4.5V	1.05V	3.15V	LOAD = +500A	OUTS	> +0.0V / < +0.1V
VOL4	4.5V	1.05V	3.15V	LOAD = +200A	OUTS	> +0.0V / < +0.5V
VOL5	4.5V	1.05V	3.15V	LOAD = +500A	OUTS	> +0.0V / < +0.1V
VOL6	4.5V	1.05V	3.15V	LOAD = +200A	OUTS	> +0.0V / < +0.5V
VOL7	4.5V	1.05V	3.15V	LOAD = +500A	OUTS	> +0.0V / < +1.65V
IIM	4.5V	0.0V	5.5V	VIN = 5.5V	INS	> +0.00A / < +1.00A
IIL	4.5V	0.0V	5.5V	VIN = 0.0V	INS	> -1.00A / < +0.00A
ICCL	4.5V	0.0V	5.5V	VIN = 0.0V	VCC	> +0.00A / < +500A
ICCH	4.5V	0.0V	5.5V	VIN = 5.5V	VCC	> +0.00A / < +800A
COMMENTS/EXCEPTIONS						
(1) VIL & VIH were tested during VOL & VDH tests as Go/NoGo.						
(2) This program does not perform any AC Parametric Tests.						

TABLE IV: Summary of Electrical Measurements  
after Total Dose Exposures and Annealing for 54AC04

1/, 2/, 3/

Parameters	Spec. Limits min max	Initials		Total Dose Exposure (krads)							
				10		20		30		50	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Func1 @ 1MHz		Pass		Pass		Pass		Pass		Pass	
Func2 @ 1MHz		Pass		Pass		Pass		Pass		Pass	
Func3 @ 1MHz		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
VOH2 V	2.4 3.0	2.93	0	2.93	0	2.93	0	2.93	0	2.93	.01
VOH3 V	4.4 4.5	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0
VOH4 V	3.7 4.5	4.21	.01	4.21	.01	4.20	.02	4.20	.01	4.20	.01
VOH5 V	5.4 5.5	5.50	0	5.49	0	5.49	0	5.49	0	5.49	0
VOH6 V	4.7 5.5	5.24	.01	5.24	.01	5.24	.01	5.24	0	5.23	.01
VOH7 V	3.85 5.5	4.95	.01	4.95	.01	4.95	.01	4.95	.01	4.94	.02
VOL1 $\mu$ V	0 100	0	0	0	0	0	0	0.8	1.6	3.1	3.6
VOL2 mV	0 500	141	3	140	2	141	3	138	3	140	7
VOL3 mV	0 100	0	0	0	0	0	0	1.1	1.8	3.2	3.7
VOL4 $\mu$ V	0 500	198	5	198	3	197	3	194	4	198	8
VOL5 mV	0 100	0	0	0	0	0	0	1.7	2.1	3.5	4.0
VOL6 mV	0 500	171	4	171	3	173	4	168	4	173	10
VOL7 mV	0 1650	367	9	367	6	365	5	358	6	366	25
IIL nA	-1000 0	0	0	0	0	0	0	0	0	0	0
IIR nA	0 1000	0	0	0	0	0	0	0	0	0	0
ICCL $\mu$ A	0 80	0	0	161	80	1.4E3	560	2.9E3	1.1E3	6.6E3	2.3E3
ICCH $\mu$ A	0 80	0	0	123	61	1.1E3	470	2.9E3	1.1E3	6.6E3	2.3E3

TABLE IV. (continued)

Parameters	Spec. Limits min max	Initials				Total Dose (krads)				Annealing				Total Dose (krads)			
		75		100		24 hrs		168 hrs		200		300					
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd				
Func1 @ 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass			
Func2 @ 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass			
Func3 @ 1MHz		Pass		Pass		Pass		Pass		Pass		Pass		Pass			
VCH1	V	2.9	3.0	3.0	0	2.98	.01	2.99	0	2.99	.01	2.99	.01	2.97	.02	2.87	.34
VCH2	V	2.4	3.0	2.93	0	2.92	.01	2.92	.01	2.92	.01	2.92	.01	2.90	.02	2.89	.03
VCH3	V	4.4	4.5	4.49	0	4.48	.01	4.49	.01	4.49	.01	4.48	.01	4.48	.01	4.47	.02
VCH4	V	3.7	4.5	4.21	.01	4.18	.01	4.19	.02	4.19	.01	4.19	.01	4.17	.02	4.15	.03
VCH5	V	5.4	5.5	5.50	0	5.48	0	5.49	0	5.49	0	5.48	.01	5.47	.01	5.47	.02
VOH6	V	4.7	5.5	5.24	.01	5.22	.01	5.22	.01	5.22	.01	5.22	.02	5.21	.01	5.19	.03
VOH7	V	3.85	5.5	4.95	.01	4.92	.01	4.92	.02	4.93	.01	4.92	.03	4.90	.02	4.87	.03
VOL1	mV	0	100	0	0	5.1	5.2	3.6	4.1	3.4	0	3.1	3.6	7.6	8.3	8.8	9.3
VOL2	mV	0	500	141	3	141	6	137	6	135	5	137	4	138	6	137	6
VOL3	mV	0	100	0	0	5.1	5.1	3.5	4.0	3.4	3.9	3.1	3.6	8.0	8.4	11	9.2
VOL4	mV	0	500	198	5	201	7	197	9	194	6	196	5	198	8	200	8
VOL5	mV	0	100	0	0	5.5	5.4	3.8	4.3	3.6	4.1	3.4	3.9	9.6	7.8	12	9.0
VOL6	mV	0	500	171	4	176	7	172	9	170	6	171	4	176	8	179	9
VOL7	mV	0	1650	367	9	371	10	364	18	359	9	362	7	365	9	370	11
IIL	nA	-1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIR	nA	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0.4	2.0
ICCL	uA	0	80	0	0	11E3	576	8.9E3	3.1E3	8.6E3	3.1E3	8.1E3	3E3	21E3	5E3	27E3	6E3
ICCH	uA	0	80	0	0	11E3	580	8.9E3	3.1E3	8.6E3	3.1E3	8.1E3	3E3	21E3	5E3	27E3	6E3

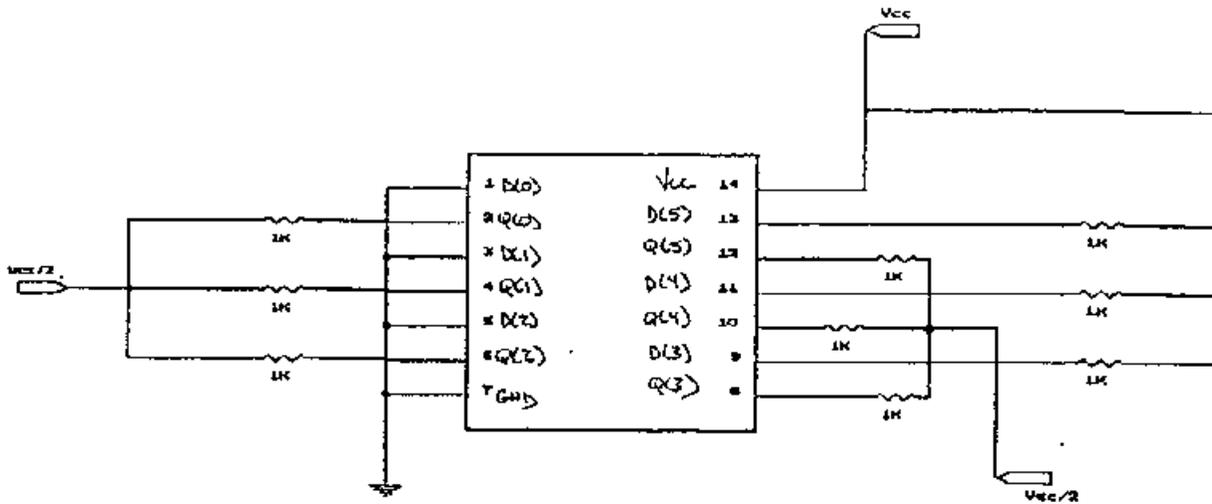
## Notes:

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/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing treatments. The data at other radiation exposures and annealing treatments is available and can be obtained upon request.

3/ At the radiation step of 20 krads, electrical measurement data from SN 9 was not used in Table IV for tests VOH5,6,7 and VOL1 thru VOL7, because of unreliable measurements from pin 4.

Figure 1. Radiation Bias Circuit for 54AC04



Vcc = 5.0 volts +/- .5 volts  
 Vcc/2 = 2.5 volts +/- .25 volts  
 ALL RESISTORS ARE 1/4 WATT