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UNISYS

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Interoffice Memorandum

PPM-91-508

Date

August 8, 1991

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Subject
Radiation Report on 54AC02DMQB
SMEX Common Buy Part No. 5962-8761201CA

A radiation evaluation was performed on 54AC02 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 0.6 - 5.0 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 10MHz) after each radiation and annealing step.

All (8) parts passed all initial electrical measurements. However, after the first radiation exposure of 10 krads, a significant increase in ICCH and ICCL was observed in all parts. ICCH readings ranged from 0.7 to 6.9 mA, and ICCL readings ranged from 1.1 to 10 mA (against maximum specification limits of 80uA). Some continued degradation was observed in ICCH and ICCL throughout the radiation testing to 100 krads, and only slight recovery was observed after annealing the parts for 24 and 168 hours. After 200 and 300 krads, all parts began failing some VOH tests in addition to failing ICCH and ICCL tests. However, all parts passed all functional tests to 300 krads. 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:	54AC02
SMEX Common Buy Part Number:	5962-8761201CA (HA124223)
SMEX Common Buy Control Number:	1643
Charge Number:	C90089
Manufacturer:	National Semiconductor Corporation
Quantity Procured:	166
Lot Date Code:	9036A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	62, 63, 64, 65, 66, 67, 68, 69
Serial Numbers of Control Samples:	60, 61
Part Function:	Quad 2-Input NOR Gate
Part Technology:	CMOS
Package Style:	14-Pin DIP
Test Engineer:	R. Tosh

TABLE II. Radiation Schedule

EVENTS	DATE
1) Initial Electrical Measurements	03/04/91
2) 10 krads irradiation @ 630 rads/hr Post 10 krads Electrical Measurements	03/14/91 03/15/91
3) 20 krads irradiation @ 560 rads/hr Post 20 krads Electrical Measurements	03/15/91 03/16/91
4) 30 krads irradiation @ 560 rads/hr Post 30 krads Electrical Measurements	03/17/91 03/18/91
5) 50 krads irradiation @ 1000 rads/hr Post 50 krads Electrical Measurements	03/18/91 03/19/91
6) 75 krads irradiation @ 1250 rads/hr Post 75 krads Electrical Measurements	03/19/91 03/20/91
7) 100 krads irradiation @ 1250 rads/hr Post 100 krads Electrical Measurements	03/20/91 03/22/91
8) 24 hrs annealing Post 24 hr Electrical Measurements	03/22/91 03/23/91
9) 168 hrs annealing Post 168 hr Electrical Measurements	03/22/91 03/29/91
10) 200 krads irradiation @ 5000 rads/hr Post 200 krads Electrical Measurements	03/29/91 03/30/91
11) 300 krads irradiation @ 2270 rads/hr Post 300 krads Electrical Measurements	03/30/91 04/03/91

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 54AC02

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS: -55C TO +125C
FUNC 1	2.0V	0.0V	2.0V	FREQ = 10KHZ	ALL I/O	V _{OH} > 1.7V, V _{OL} < 0.5V
FUNC 2	3.0V	0.00V	3.00V	FREQ = 10KHZ	ALL I/O	V _{OH} > 2.0V, V _{OL} < 1.00V
FUNC 3	5.5V	0.00V	5.50V	FREQ = 10KHZ	ALL I/O	V _{OH} > 3.50V, V _{OL} < 1.00V
V _{OH1}	5.0V	INPUTS	AT 0.90V	AND 2.10V	EACH OUTPUT	AT -50UA 2.90V MIN
V _{OH2}	4.5V	INPUTS	AT 1.35V	AND 3.15V	EACH OUTPUT	AT -50UA 4.40V MIN
V _{OH3}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT -50UA 5.40V MIN
V _{OH4}	3.0V	INPUTS	AT 0.90V	AND 2.10V	EACH OUTPUT	AT -4MA 2.40V MIN
V _{OH5}	4.5V	INPUTS	AT 1.35V	AND 3.15V	EACH OUTPUT	AT -24MA 3.70V MIN
V _{OH6}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT -24MA 4.70V MIN
V _{OH7}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT -50MA 3.85V MIN
V _{OL1}	3.0V	INPUTS	AT 0.90V	AND 2.10V	EACH OUTPUT	AT 50UA 0.1V MAX
V _{OL2}	4.5V	INPUTS	AT 1.35V	AND 3.15V	EACH OUTPUT	AT 50UA 0.1V MAX
V _{OL3}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT 50UA 0.1V MAX
V _{OL4}	3.0V	INPUTS	AT 0.90V	AND 2.10V	EACH OUTPUT	AT 12MA 0.5V MAX
V _{OL5}	4.5V	INPUTS	AT 1.35V	AND 3.15V	EACH OUTPUT	AT 24MA 0.5V MAX
V _{OL6}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT 24MA 0.5V MAX
V _{OL7}	5.5V	INPUTS	AT 1.65V	AND 3.85V	EACH OUTPUT	AT 50MA 1.65V MAX
I _{IL}	5.5V	EACH INPUT	TESTED AT	V _{IN} = 0.0V		-1UA TO 0.0UA
I _{IH}	5.5V	EACH INPUT	TESTED AT	V _{IN} = 5.5V		0.0UA TO +1.0UA
I _{CC1}	5.5V	INPUTS	AT	0.0V		80.0UA MAX
I _{CC2}	5.5V	INPUTS	AT	5.5V		80.0UA MAX

PARAMETER	VCC	CONDITIONS	PINS	LIMITS: 25C
TPHL1 A TO Y	5.0V	V _{IN} = 0V TO VCC	COMP = 1.5V	1NS TO 7.5NS
HL1 B TO Y	5.0V	V _{IN} = 0V TO VCC	COMP = 1.5V	1NS TO 7.5NS
HL1 A TO Y	5.0V	V _{IN} = 0V TO VCC	COMP = 1.5V	1NS TO 7.5NS
HL1 B TO Y	5.0V	V _{IN} = 0V TO VCC	COMP = 1.5V	1NS TO 7.5NS
TPHL2 A TO Y	4.5V	V _{IN} = 0V TO VCC	COMP = 2.25V	1NS TO 6.5NS
TPHL2 B TO Y	4.5V	V _{IN} = 0V TO VCC	COMP = 2.25V	1NS TO 6.5NS
TPLH2 A TO Y	4.5V	V _{IN} = 0V TO VCC	COMP = 2.25V	1NS TO 6.0NS
TPLH2 B TO Y	4.5V	V _{IN} = 0V TO VCC	COMP = 2.25V	1NS TO 6.0NS

COMMENTS/EXCEPTIONS

- * V_{IL} AND V_{IH} WERE TESTED WHILE PERFORMING V_{OL} AND V_{OH} TESTS.
- * AC TESTS WERE PERFORMED WITH OUTPUTS LOADED AT I_{CL} = 10MA AND I_{OH} = -10MA.

TABLE IV: Summary of Electrical Measurements after
Total Dose Exposures and Annealing for 54AC02

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Parameters	Spec. Limits min max	Total Dose Exposure (krads)													
		Initials		10		20		30		50		75			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
Func1 VCC=2.0V		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
Func1 VCC=3.0V		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
Func1 VCC=5.5V		Pass		Pass		Pass		Pass		Pass		Pass		Pass	
VOH1	V 2.9	3.0	0	2.99	.01	2.99	.01	2.99	.01	2.99	.01	2.99	.01	2.99	.01
VOH2	V 4.4	4.49	0	4.49	0	4.49	0	4.49	.01	4.49	.01	4.48	.01	4.48	.01
VOH3	V 5.4	5.49	0	5.49	0	5.48	.01	5.48	.01	5.49	.01	5.48	.01	5.48	.01
VOH4	V 2.4	2.94	0	2.93	.01	2.93	.01	2.93	.01	2.93	.01	2.92	.01	2.92	.01
VOH5	V 3.7	4.22	.01	4.19	.03	4.19	.02	4.19	.02	4.20	.01	4.18	.03	4.18	.03
VOH6	V 4.7	5.25	.01	5.23	.03	5.22	.02	5.22	.02	5.24	.01	5.22	.03	5.22	.03
VOH7	V 3.85	4.97	.02	4.92	.06	4.92	.04	4.93	.03	4.95	.01	4.92	.04	4.92	.04
VOL1	mV	100	0	6.8	6.7	5.0	5.9	5.94	6.3	6.6	6.4	10.0	7.5	10.0	7.5
VOL2	mV	100	0	11.3	10.6	9.1	8.5	11.3	8.4	8.5	8.0	16.0	9.2	16.0	9.2
VOL3	mV	100	1.5	3.1	18.0	12.7	12.1	4.7	17.3	8.8	14	6.5	22.8	10.9	10.9
VOL4	mV	500	140	5.2	144	11.7	140	9.0	141	8.9	138	6.1	147	13.4	13.4
VOL5	mV	500	202	9.7	216	22	213	21	211	15	202	8.8	219	22	22
VOL6	mV	500	179	9.7	199	24	190	18	195	19	183	9.3	203	24	24
VOL7	mV	1650	379	20	409	48	395	35	401	39	378	14	412	44	44
IIL	nA	-1000 0	0	0	0	0	0	0	0	0	0	0	0	0	0
IILH	nA	0 1000	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH	uA	80	0	0	4.5E3	1.8E3	4.5E3	1.8E3	4.7E3	1.8E3	5.7E3	2E3	6.8E3	2.2E3	2.2E3
ICCL	uA	80	0	0	6.5E3	2.5E3	6.4E3	2.4E3	6.5E3	2.3E3	7.5E3	2.5E3	8.6E3	2.5E3	2.5E3
TPLH1	ns	1 7.5	4.5	.2	4.7	.3	4.8	.2	4.7	.2	4.8	.2	4.7	.2	.2
TPHL1	ns	1 7.5	3.7	.2	3.5	.2	3.6	.2	3.5	.3	3.5	.3	3.6	1.3	1.3
TPLH2	ns	1 5.0	4.6	.3	4.7	.2	4.8	.2	4.8	.2	4.8	.2	4.7	.2	.2
TPHL2	ns	1 7.5	3.9	.2	3.8	.2	3.9	.3	3.8	.2	3.8	.3	3.7	.2	.2

<Table IV continued on next page>

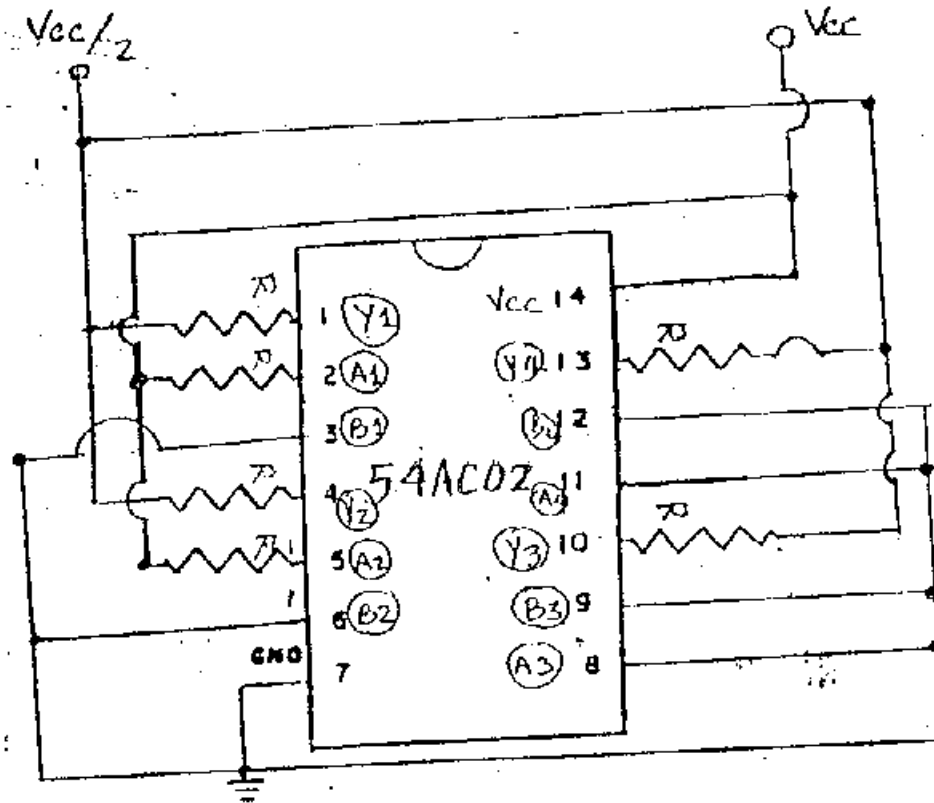
Table IV. (continued)

Parameters	Spec. Limits min max		Initials mean sd		TDE (krads)		Annealing				Total Dose (krads)				
					100		24 hrs		168 hrs		200		300		
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
Func1 VCC=2.0V			Pass		Pass		Pass		Pass		Pass		Pass		
Func1 VCC=3.0V			Pass		Pass		Pass		Pass		Pass		Pass		
Func1 VCC=5.5V			Pass		Pass		Pass		Pass		Pass		Pass		
VOH1	V	2.9		3.0	0	2.98	.01	2.99	.01	2.99	.01	2.24	.8	1.93	1.2
VOH2	V	4.4		4.49	0	4.48	.01	4.48	.01	4.48	.01	4.38	.4	4.62	.5
VOH3	V	5.4		5.49	0	5.48	.01	5.48	.01	5.48	.01	5.42	.3	5.47	.02
VOH4	V	2.4		2.94	0	2.92	.01	2.92	.01	2.92	.01	2.24	.7	1.87	1.1
VOH5	V	3.7		4.22	.01	4.19	.02	4.19	.02	4.18	.03	4.17	.02	3.83	.5
VOH6	V	4.7		5.25	.01	5.22	.02	5.22	.02	5.21	.03	5.14	.3	5.20	.03
VOH7	V	3.85		4.97	.02	4.92	.03	4.93	0.03	4.90	.07	4.69	.06	4.88	.06
VOL1	mV		100	0	0	9.7	7.4	7.8	7.3	6.3	6.6	19	7.0	19	6.1
VOL2	mV		100	0	0	12.8	8.5	11.8	6.7	9.6	7.6	28	6.7	32	7.0
VOL3	mV		100	1.5	3.1	18.1	8.6	17.4	7.2	13.9	6.4	38	8.9	43	9.2
VOL4	mV		500	140	5.2	140	9.9	139	8.1	143	14	151	9.7	154	12
VOL5	mV		500	202	9.7	209	16.5	207	12.8	216	27	236	19	247	21
VOL6	mV		500	179	9.7	192	16.3	190	12.7	201	30	232	22	243	22
VOL7	mV		1650	379	20	390	30	396	56	417	61	454	36	469	45
IIL	nA	-1000	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
ICCH	uA		80	0	0	7.4E3	2.3E3	7.2E3	2.2E3	6.8E3	2.2E3	9.9E3	2.4E3	10.2E3	2.5E3
ICCL	uA		80	0	0	9.1E3	2.7E3	8.8E3	2.5E3	8.3E3	2.6E3	11E3	2.5E3	10.7E3	2.6E3
TPLH1	ns	1	7.5	4.5	.2	4.7	.3	4.7	.3	4.6	.3	4.8	.3	5.0	.3
TPLH1	ns	1	7.5	3.7	.2	3.3	.2	3.3	.2	3.3	.2	3.2	.2	3.4	.3
TPLH2	ns	1	6.0	4.6	.3	4.8	.2	4.8	.2	4.7	.2	4.9	.3	5.1	.3
TPLH2	ns	1	7.5	3.9	.2	3.6	.2	3.6	.2	3.6	.2	3.5	.2	3.7	.2

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 54AC02



NOTE:

- 1) $V_{cc} = 5V \pm 10\%$
- 2) $R = 1.0K\Omega, \pm 5\%, \frac{1}{4}$ WATT
- 3) $T_A = 25^\circ C$