

UNISYS

DATE: January 13, 1994
TO: B. Fafaul/311.1
FROM: K. Sahu/300.1 *K-S*
SUBJECT: Radiation Report on SMEX/FAST
Part No. 5962-8954702CA (54ACQT08)
Control No. 9642

PPM-94-003

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on 54ACQT08 (Quad 2-input AND Gate) 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 levels were 5, 10, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.07 and 1.32 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III. The electrical tests included two functional tests at 1.0 MHz, one at $V_{CC} = 4.5$ V and one at $V_{CC} = 5.5$ V.

All parts passed initial electrical measurements. Both irradiated parts passed all parametric tests up to and including the 10 krad irradiation level.

At the 20 krad level, one part (S/N 9) marginally exceeded the maximum specification limit of 8.0 μ A for ICCH, with a reading of 8.42 μ A. At the 30 krad level, five parts (S/N 5, 6, 7, 8 and 9) exceeded the maximum specification limit for ICCH, with readings ranging from 9.67 to 37.29 μ A. In addition, S/N 9 also exceeded the maximum specification limit of 8.0 μ A for ICCL, with a reading of 17.42 μ A. At the 50 krad level, all irradiated parts failed ICCH, with readings ranging from 11.17 to 157.1 μ A and all parts except S/N 4 failed ICCL, with readings ranging from 14.77 to 96.70 μ A.

At the 75 krad level, only four parts (S/N 5, 6, 7 and 9) failed ICCH, with readings ranging from 8.08 to 66.80 μ A and only one part (S/N 9) failed ICCL, with a reading of 38.40 μ A. At the 100 krad level, all parts again failed ICCH, with readings ranging from 9.13 to 139.1 μ A and all parts except S/N 4 failed ICCL, with readings ranging from 8.91 to 86.60 μ A. After annealing for 168 hours at 25°C and annealing for 168 hours at 100°C, all parts recovered to within specification limits for all test parameters. All parts passed both functional tests throughout all irradiation and annealing steps.

Table IV provides the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

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TABLE I. Part Information

Generic Part Number:	54ACQ108
SMEX/FAST Part Number:	5962-8954702CA*
SMEX/FAST Control Number:	9642
Charge Number:	C42867
Manufacturer:	National Semiconductor
Lot Date Code:	9335A
Quantity Tested:	10
Serial Number of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	3, 4, 5, 6, 7, 8, 9, 10
Part Functions:	Quad 2-input AND Gate
Part Technology:	CMOS
Package Style:	14-pin DIP
Test Equipment:	S-50
Test Engineer:	A. Karygiannis

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for 54ACQT08

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	12/01/93
2) 5 KRAD IRRADIATION (0.073 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	12/03/93 12/06/93
3) 10 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	12/06/93 12/07/93
4) 20 KRAD IRRADIATION (0.50 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	12/07/93 12/08/93
5) 30 KRAD IRRADIATION (0.63 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	12/08/93 12/09/93
6) 50 KRAD IRRADIATION (1.00 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	12/09/93 12/10/93
7) 75 KRAD IRRADIATION (0.37 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT	12/10/93 12/13/93
8) 100 KRAD IRRADIATION (1.32 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	12/13/93 12/14/93
9) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/14/93 12/21/93
10) 168-HOUR ANNEALING @100°C** POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/21/93 01/03/94

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of 54ACQ08

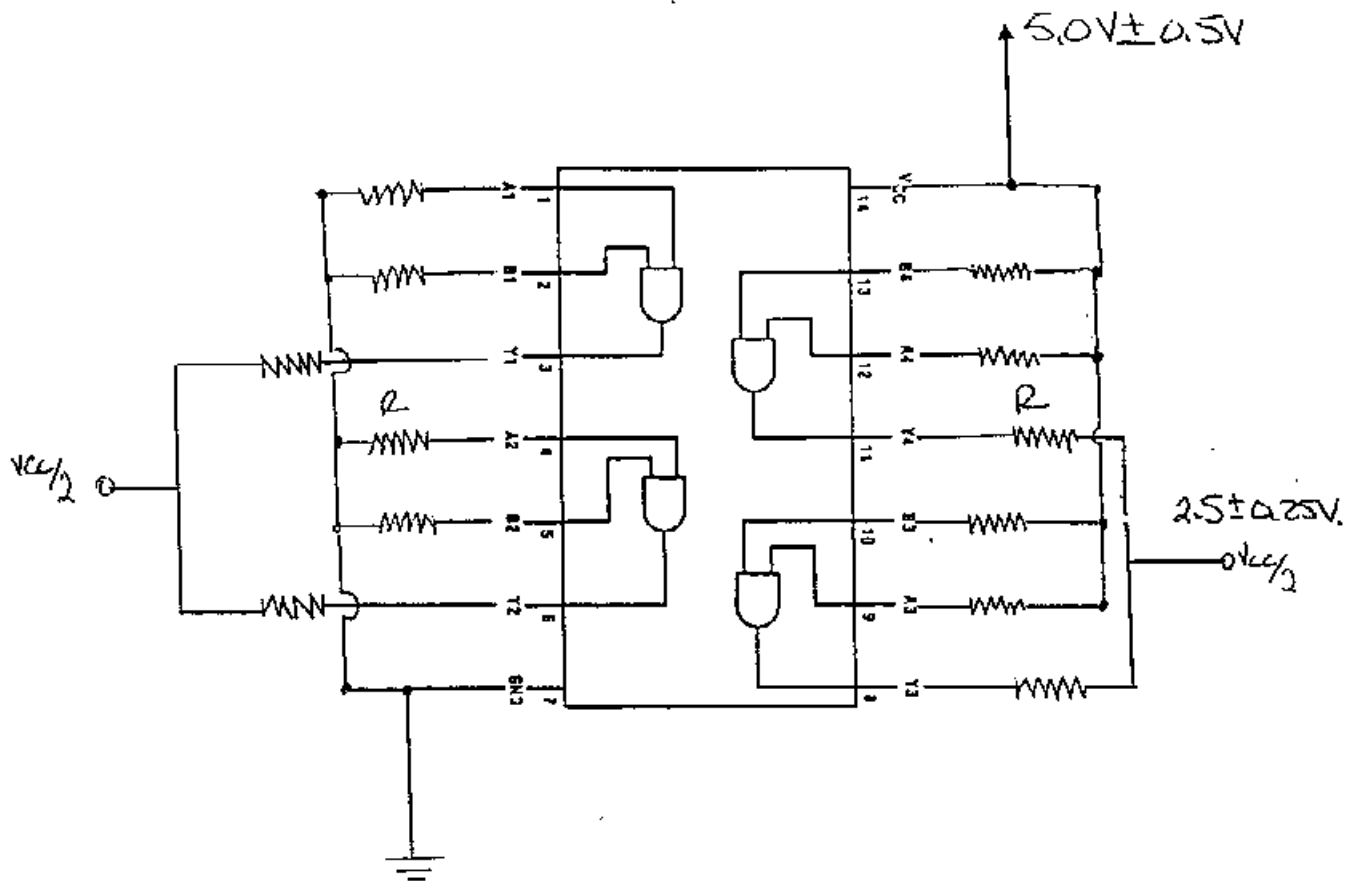
DC PARAMETRIC TESTS PERFORMED							
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55C / +125C	
VOH1 (1)	4.5V	0.4V	4.5V	LOAD = -50UA	OUTS	>+4.4V	<+4.5V
VOH2 (1)	4.5V	0.0V	2.4V	LOAD = -50UA	OUTS	>+4.4V	<+4.5V
VOH3	4.5V	0.0V	4.5V	LOAD = -24MA	OUTS	>+3.7V	<+4.5V
VOH4 (1)	5.5V	0.4V	2.4V	LOAD = -50UA	OUTS	>+5.4V	<+5.5V
VOH5	5.5V	0.0V	5.5V	LOAD = -24MA	OUTS	>+4.7V	<+5.5V
VOH6	5.5V	0.0V	5.5V	LOAD = -50MA	OUTS	>+3.85V	<+5.5V
VOL1 (1)	4.5V	0.4V	4.5V	LOAD = +50UA	OUTS	>+0.0V	<+0.1V
VOL2 (1)	4.5V	0.0V	2.4V	LOAD = +50UA	OUTS	>+0.0V	<+0.1V
VOL3	4.5V	0.0V	4.5V	LOAD = +24MA	OUTS	>+0.0V	<+0.5V
VOL4 (1)	5.5V	0.4V	2.4V	LOAD = +50UA	OUTS	>+0.0V	<+0.1V
VOL5	5.5V	0.0V	5.5V	LOAD = +24MA	OUTS	>+0.0V	<+0.5V
VOL6	5.5V	0.0V	5.5V	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	<+160UA
I _{CCL}	5.5V	0.0V	5.5V	V _{IN} = 0.0V	VCC	>+0.0UA	<+160UA
DEL _{ICC}	5.5V	0.0V	5.5V	V _{IN} = 3.4V	VCC	>+0.0UA	<+1.6MA

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 54ACQT08 /1

Parameters	Spec. Lim. /2	min	max	Total Dose Exposure (krads)														Annealing					
				Initials		5		10		20		30		50		75		100		168 hrs @25°C		168 hrs @100°C	
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
VOH1	V	4.40	4.50	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0
VOH2	V	4.40	4.50	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0
VOH3	V	3.86	4.50	4.19	.01	4.18	.01	4.18	.01	4.18	.01	4.18	.01	4.16	.02	4.17	.01	4.16	.02	4.18	.01	4.16	.01
VOH4	V	5.40	5.50	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0
VOH5	V	4.86	5.50	5.23	.01	5.23	.01	5.23	.01	5.23	.01	5.23	.01	5.21	.02	5.22	.01	5.21	.02	5.21	.01	5.22	.01
VOH6	V	3.85	5.50	4.93	.01	4.92	.02	4.91	.02	4.91	.02	4.91	.02	4.98	.03	4.90	.03	4.87	.04	4.86	.02	4.89	.02
VOL1	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL2	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL3	mV	0	360	158	3.6	150	7.3	162	7.5	160	4.9	165	8.8	153	8.8	168	11	162	12	160	6.8	159	3.3
VOL4	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL5	mV	0	360	136	3.1	139	7.4	140	7.9	139	5.2	145	9.1	142	8.9	148	12	142	12	140	7.1	139	3.5
VOL6	mV	0	1650	293	7	299	16	302	16	300	11	312	20	300	19	325	36	307	30	301	15	298	7.3
IIH	nA	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	nA	-100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH	µA	0	8.0	0	0	0	0	0.05	.03	0.53	2.2	11.8	10	49.0	42	15.3	20	35.5	40	1.13	1.6	0.01	0
ICCL	µA	0	8.0	0	0	0	0	0	0	0.47	.42	4.70	4.9	30.8	26	8.91	11	21.4	25	0.47	.61	0	0
DEL_ICC	µA	0	1600	666	39	657	39	648	40	631	40	618	42	610	53	541	62	512	81	492	80	481	86
FUNC1, 1.0 MHz, 4.5V/3				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2, 1.0 MHz, 5.5V/3				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	

- 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/ These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
- 3/ "PASS" means that all irradiated parts passed this functional test at this irradiation or annealing level.
 "FAIL" means that all irradiated parts failed this test at this irradiation or annealing level.
 "np/mF" means that n parts passed and m parts failed the test at this level.

Figure 1. Radiation Bias Circuit for 54ACQ08



1) $V_{cc} = 5.0 V \pm 0.5 V.$

2) $R = 2.0 k\Omega \pm 10\%, 1/4 W.$