PPM 92-253

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PARAMAX

Memorandum

PPM-92-253

DATE: Oct. 27, 1992

TO: B. Fafaul/311

FROM: K. Sahu

SUBJECT: Radiation Report on FAST/MUE
Part No. M38510/75101BCA (54AC02)

cc: R. Kolecki/740.4
T. Miccolis
A. Sharma/311
Library/300.1
L. Cusick/740.4

A radiation evaluation was performed on 54AC02 (Quad 2-Input NOR) 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, 20, 40 and 60 krads*. After 60 krads, parts were annealed at +25°C for 168 hours, and then the irradiation was continued to 100 krads (cumulative). The dose rate was between 0.25 and 2.0 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 two functional tests (1.0 MHz) at 3.0V and 4.5V.

All 10 parts passed initial (pre-rad) electrical tests. All 8 irradiated parts passed all electrical tests on irradiation up to 15 krads. After the 20-krad irradiation, seven parts exceeded the maximum specification limit of 1 uA for ICCH, with a maximum reading of 2.34 uA. After the 40-krad irradiation, All eight parts exceeded the maximum specification limits for ICCH, with a maximum reading of 7.44 uA and six parts exceeded the maximum specification limit for ICCL of 1 uA, with a maximum reading of 1.73 uA. After the 60-krad irradiation, all eight irradiated parts exceeded the maximum specification limits for ICCH and ICCL, with maximum readings of 10.98 uA for ICCH and 2.78 uA for ICCL. All parts passed all electrical tests after annealing for 168 hours at 25°C.

*The term rads, as used in this document, means rads(silicon).
**These are manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

On continued irradiation to 100 krads cumulative exposure, all eight irradiated parts exceeded the maximum specification limit for ICCH, with a maximum reading of 31.60 uA and seven parts exceeded the maximum specification limit for ICCL, with a maximum reading of 4.71 uA. After a final annealing at 100°C, no rebound effects were observed.

All parts passed both functional tests throughout all irradiation and annealing steps.

Table IV provides a summary of the functional test results, as well as 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.

TABLE I. Part Information

Generic Part Number:	54AC02
Part Number:	M38510/75101BCA
FAST/MUE Control Number:	6307
Charge Number:	C23973
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9214A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	52, 53, 54, 55, 56, 57, 58, 59
Serial Numbers of Control Samples:	50, 51
Part Function:	Quad 2-input NOR Gate
Part Technology:	CMOS
Package Style:	14-pin DIP
Test Engineer:	C. Arcila

TABLE II. Radiation Schedule for 54AC02

EVENTS	DATE
1) Initial Electrical Measurements	09/18/92
2) 5 KRAD IRRADIATION (0.25 krads/hour)	09/24/92
POST-5 KRAD ELECTRICAL MEASUREMENT	09/25/92
3) 10 KRAD IRRADIATION (0.076 krads/hour)	09/25/92
POST-10 KRAD ELECTRICAL MEASUREMENT	09/28/92
4) 20 KRAD IRRADIATION (0.5 krads/hour)	09/28/92
POST-20 KRAD ELECTRICAL MEASUREMENT	09/29/92
5) 40 KRAD IRRADIATION (1.0 KRADS/HOUR)	09/29/92
POST-40 KRAD ELECTRICAL MEASUREMENT	09/30/92
6) 60 KRAD IRRADIATION (1.0 KRADS/HOUR)	09/30/92
POST-60 KRAD ELECTRICAL MEASUREMENT	10/01/92
7) 168 HOUR ANNEALING @25°C	10/01/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/08/92
8) 100 KRAD IRRADIATION (2.05 KRADS/HOUR)	10/08/92
POST-100 KRAD ELECTRICAL MEASUREMENT	10/09/92
9) 168 HOUR ANNEALING @100°C*	10/09/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/16/92

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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 54AC02

DEVICE	PART NO : M38510/75101BCA (54AC02)	PART TYPE : QUAD 2-INPUT NOR GATE (14 PIN DIP)
LOCATION		TEST SPECIFICATIONS
PWN NUMBER : 5I1056UA DISK LABEL : LIB_24 DIRECTORY : DUAT:[PROGRAMS.56U]		MIL-M-38510//51 DATE 09/11/1990

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
FUNCT 1	3.0V	0.45V	2.50V	FREQ = 1MHz	ALL I/O	VOL<1.50V , VOH>1.50V
FUNCT 2	4.5V	0.60V	3.70V	FREQ = 1MHz	ALL I/O	VOL<2.50V , VOH>2.50V

DC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
VOH1	3.0V	0.90V	2.10V	LOAD=-50UA	OUTS	>+2.90V , <+3.00V
VOH2	4.5V	1.35V	3.15V	LOAD=-50UA	OUTS	>+4.40V , <+4.50V
VOH3	5.5V	1.65V	3.85V	LOAD=-50UA	OUTS	>+5.40V , <+5.50V
VOH4	3.0V	0.90V	2.10V	LOAD=-4.0MA	OUTS	>+2.40V , <+3.00V
VOH5	4.5V	1.35V	3.15V	LOAD=-24MA	OUTS	>+3.7V , <+4.50V
VOH6	5.5V	1.65V	3.85V	LOAD=-24MA	OUTS	>+4.7V , <+5.50V
VOH7	5.5V	1.65V	3.85V	LOAD=-50MA	OUTS	>+5.85V , <+5.50V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
VOL1	3.0V	0.90V	2.10V	LOAD=+50UA	OUTS	>+0.0V , <+0.10V
VOL2	4.5V	1.35V	3.15V	LOAD=+50UA	OUTS	>+0.0V , <+0.10V
VOL3	5.5V	1.65V	3.85V	LOAD=+50UA	OUTS	>+0.0V , <+0.10V
VOL4	3.0V	0.90V	2.10V	LOAD=+12MA	OUTS	>+0.0V , <+0.40V
VOL5	4.5V	1.35V	3.15V	LOAD=+24MA	OUTS	>+0.0V , <+0.40V
VOL6	5.5V	1.65V	3.85V	LOAD=+24MA	OUTS	>+0.0V , <+0.40V
VOL7	5.5V	1.65V	3.85V	LOAD=+50MA	OUTS	>+0.0V , <+1.65V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
IIL	5.5V	0.0V	5.5V	VIN = +0.0V	INS	>-0.10UA , <+0.0A
IIH	5.5V	0.0V	5.5V	VIN = +5.5V	INS	>+0.0A , <+0.10UA

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
VIOP	3.0V			IIN = -18MA	INS	>+1.40V , <+1.50V
VION	3.0V			IIN = -18MA	INS	>-1.5V , <-0.40V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
ICCL	5.5V	0.0V	5.5V	VIN = +5.0V	VCC	>+0.0A , <+1UA
ICCH	5.5V	0.0V	5.5V	VIN = +5.5V	VCC	>+0.0A , <+1UA

HARDWARE REQUIREMENTS		TEST TEMPERATURES		
DEVICE CONFIGURATION : 14-PIN DIP 5-5U LOAD BOARD # 17 : PIN 7 SWITCHED OR JUMPERED TO GND.		+25 DEG. C. -55 DEG. C. +125 DEG. C.	|X| | |	ONLY
PROGRAMMER : CARLOS A. ARCILA		DATE : 08-20-92		

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC02 1/

Parameters		Spec. Limits/2 min	max	Total Dose Exposure (TDE) (krads)														Anneal		TDE		Anneal	
				Initial		5		10		20		40		60		168 hrs @25°C		100 krads		168 hrs @100°C	
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1, 1 MHz, 3.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VOH1/3	V	2.9	3.0	2.99	0	2.99	0	2.99	0	2.99	0	2.98	.03	2.99	0	2.99	0	2.99	0	2.99	0	2.99	0
VOH3	V	5.4	5.5	5.49	0	5.49	0	5.49	0	5.49	0	5.50	.04	5.49	0	5.49	0	5.49	0	5.49	0	5.49	0
VOH5	V	3.7	4.5	4.20	.03	4.20	.01	4.20	.01	4.20	.02	4.18	.04	4.17	.06	4.17	.05	4.18	.03	4.18	.02	4.18	.02
VOH7	V	3.85	5.5	4.92	.05	4.94	.03	4.94	.03	4.93	.03	4.66	0.6	4.90	.07	4.88	0.1	4.91	.06	4.91	.04	4.91	.04
VOL1	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL7	mV	0	1650	406	57	379	23	377	22	378	23	412	54	399	46	447	115	392	55	406	41	406	41
IIL	nA	-100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIH	nA	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VICP	mV	400	1500	791	0.8	791	0.5	787	1.0	785	0.9	774	21	781	1.6	785	2.9	782	1.7	782	2.4	782	2.4
VICN	mV	-1500	-400	-741	0.6	-741	0.5	-740	0.8	-739	1.4	-737	1.0	-736	1.1	-741	3.0	-738	1.4	-733	2.4	-733	2.4
ICCL	uA	0	1.0	0	.01	.01	.02	.02	.03	0.36	.08	1.22	0.3	1.90	0.6	0.18	.08	2.05	1.1	.01	.02	.01	.02
ICCH	uA	0	1.0	0	0	0	0	.07	.02	1.55	0.4	4.73	1.3	6.41	2.1	0.53	0.1	8.45	9.0	.05	0	.05	0

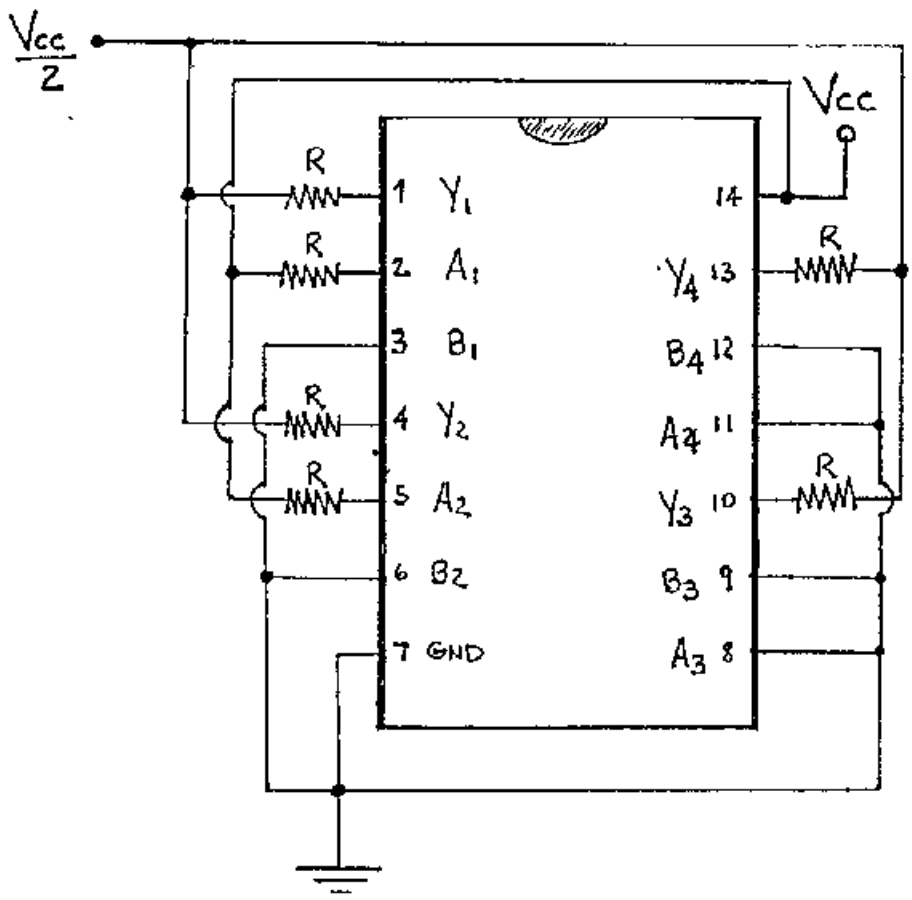
Note:

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.

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/ No significant variation was observed in any VOH or VOL measurement during irradiation and annealing. Additional data on VOH2, VOH4, VOH6 and VOL2 thru VOL6 are available on request.

Figure 1. Radiation Bias Circuit for 54AC02



1.- $V_{CC} = 5\,Vdc \pm 10\%$

2.- $R = 1.0\,K\Omega$, $\pm 5\%$, $1/4$ WATTS.

3.- $T_A = +25^{\circ}C$