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Memorandum

PARAMAX
A Unisys Company

DATE: January 15, 1993
TO: B. Fafaul/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on FAST/MUE
Part No. 5962-8965801RA (54ACT534)
Control No. 5996

PPM-93-004

cc: R. Kolecki/740.4
T. Miccolis/300.1
A. Sharma/311
Library/300.1 ✓
L. Cusick/740.4
SMEX, PPM File

A radiation evaluation was performed on 54ACT534 (Octal D-type Flip-Flop) 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, 40 and 60 krads*. After 60 krads, parts were annealed at 25°C for 168 hours. The irradiation was then continued to 100 krads (cumulative). The dose rate was between 0.14 and 2.0 krads/hour, depending on the total dose level (see Table II for radiation schedule). Finally the parts were annealed for 168 hours at 100°C. 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 three functional tests at 1.0 MHz and one functional test at 40 MHz.

All ten parts passed initial (pre-rad) electrical tests. All eight irradiated parts passed all electrical tests at each irradiation and annealing level up to and including the 100-krad irradiation. ICCH, ICCL and ICCZ readings increased at each radiation level, but did not exceed the maximum specification limit of 160 uA for these parameters.

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

**These are manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

After a final annealing at 100°C, no rebound effects were observed.

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.

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TABLE I. Part Information

Generic Part Number:	54ACT534
Part Number:	5962-8965801RA
FAST/MUE Control Number:	5996
Charge Number:	C23981
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9233A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	32, 33, 34, 35, 36, 37, 38, 39
Serial Numbers of Control Samples:	30, 31
Part Function:	Octal D-type Flip-Flop
Part Technology:	CMOS
Package Style:	20-pin DIP
Test Engineer:	T. Scharer

TABLE II. Radiation Schedule for 54ACT534

EVENTS	DATE
1) Initial Electrical Measurements	12/14/92
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR)	12/15/92
POST-5 KRAD ELECTRICAL MEASUREMENT	12/16/92
3) 10 KRAD IRRADIATION (0.25 KRADS/HOUR)	12/16/92
POST-10 KRAD ELECTRICAL MEASUREMENT	12/18/92
4) 20 KRAD IRRADIATION (0.14 KRADS/HOUR)	12/18/92
POST-20 KRAD ELECTRICAL MEASUREMENT	12/21/92
5) 40 KRAD IRRADIATION (1.16 KRADS/HOUR)	12/21/92
POST-40 KRAD ELECTRICAL MEASUREMENT	12/22/92
6) 60 KRAD IRRADIATION (1.07 KRADS/HOUR)	12/22/92
POST-60 KRAD ELECTRICAL MEASUREMENT	12/23/92
7) 168 HOUR ANNEALING @25°C	12/23/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/30/92
8) 100 KRAD IRRADIATION (2.00 KRADS/HOUR)	12/30/92
POST-100 KRAD ELECTRICAL MEASUREMENT	12/31/92
9) 168 HOUR ANNEALING @100°C*	12/31/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/08/93

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 54ACT534

FUNCTIONAL TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
FUNCT 1	4.5V	0.0V	4.5V	FREQ=1.000MHz	ALL I/O	VOL<2.0V , VOH>2.0V
FUNCT 2	5.5V	0.0V	5.5V	FREQ=1.000MHz	ALL I/O	VOL<2.5V , VOH>2.5V
FUNCT 3	4.5V	0.0V	4.5V	FREQ=1.000MHz	ALL I/O	VOL<2.5V , VOH>2.5V
FUNCT 4	4.5V	0.0V	4.5V	FREQ=40.00MHz	ALL I/O	VOL<2.5V , VOH>2.5V
				{ IOH = -1.0mA		
				{ VREF = 1.5V		
				{ IOL = +1.0mA		
				LOAD USED <=		
DC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +125C,+25C,-55C
VOH1	4.5V	0.8V	2.0V	LOAD=-50UA	OUTS	>+4.4V , <+4.5V
VOH2	4.5V	0.8V	2.0V	LOAD=-24MA	OUTS	>+3.7V , <+4.5V
VOH3	5.5V	0.8V	2.0V	LOAD=-50UA	OUTS	>+5.4V , <+5.5V
VOH4	5.5V	0.8V	2.0V	LOAD=-24MA	OUTS	>+4.7V , <+5.5V
VOH5	5.5V	0.8V	2.0V	LOAD=-50MA	OUTS	>+3.85V , <+5.5V
VOL1	4.5V	0.8V	2.0V	LOAD=+50UA	OUTS	>+0.0V , <+0.1V
VOL2	4.5V	0.8V	2.0V	LOAD=+24MA	OUTS	>+0.0V , <+0.5V
VOL3	5.5V	0.8V	2.0V	LOAD=+50UA	OUTS	>+0.0V , <+0.1V
VOL4	5.5V	0.8V	2.0V	LOAD=+24MA	OUTS	>+0.0V , <+0.5V
VOL5	5.5V	0.8V	2.0V	LOAD=+50MA	OUTS	>+0.0V , <+1.65V
I _{IH}	5.5V	0.0V	5.5V	INPUTS HIGH	INS	> 0.0UA , <+1.0UA
I _{IL}	5.5V	0.0V	5.5V	INPUTS LOW	INS	>-1.0UA , < 0.0UA
IOZH	5.5V	0.8V	2.0V	VTST= 5.5V	OUTS	> 0UA , <+10UA
IOZL	5.5V	0.8V	2.0V	VTST= 0.0V	OUTS	>-10UA , < 0UA
ICCH	5.5V	0.0V	5.5V	VIN = 5.5V	VCC	>+0.0UA , <+160UA
ICCL	5.5V	0.0V	5.5V	VIN = 0.0V	VCC	>+0.0UA , <+160UA
ICCZ	5.5V	0.0V	5.5V	VIN = 0.0V OE ₁ = 5.5V	VCC	>+0.0UA , <+160UA
ICCMAX	5.5V	0.0V	3.4V	VIN = 3.4V	VCC	>+0.0UA , <+1.6MA
^ ICCMAX IS TESTED WITH ALL INPUTS 0V AND ONE INPUT AT A TIME 3.4V.						
AC PARAMETRIC TESTS						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +25C
TPLH	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <11.5ns
TPHL	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <10.5ns
TPLZ	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <10.5ns
TPHZ	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <12.5ns
TPZL	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <11.0ns
TPZH	4.5V	0.0V	4.5V	F=1 MHz,	OUTPUTS	> 1.0ns , <12.0ns

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54ACT534 1/

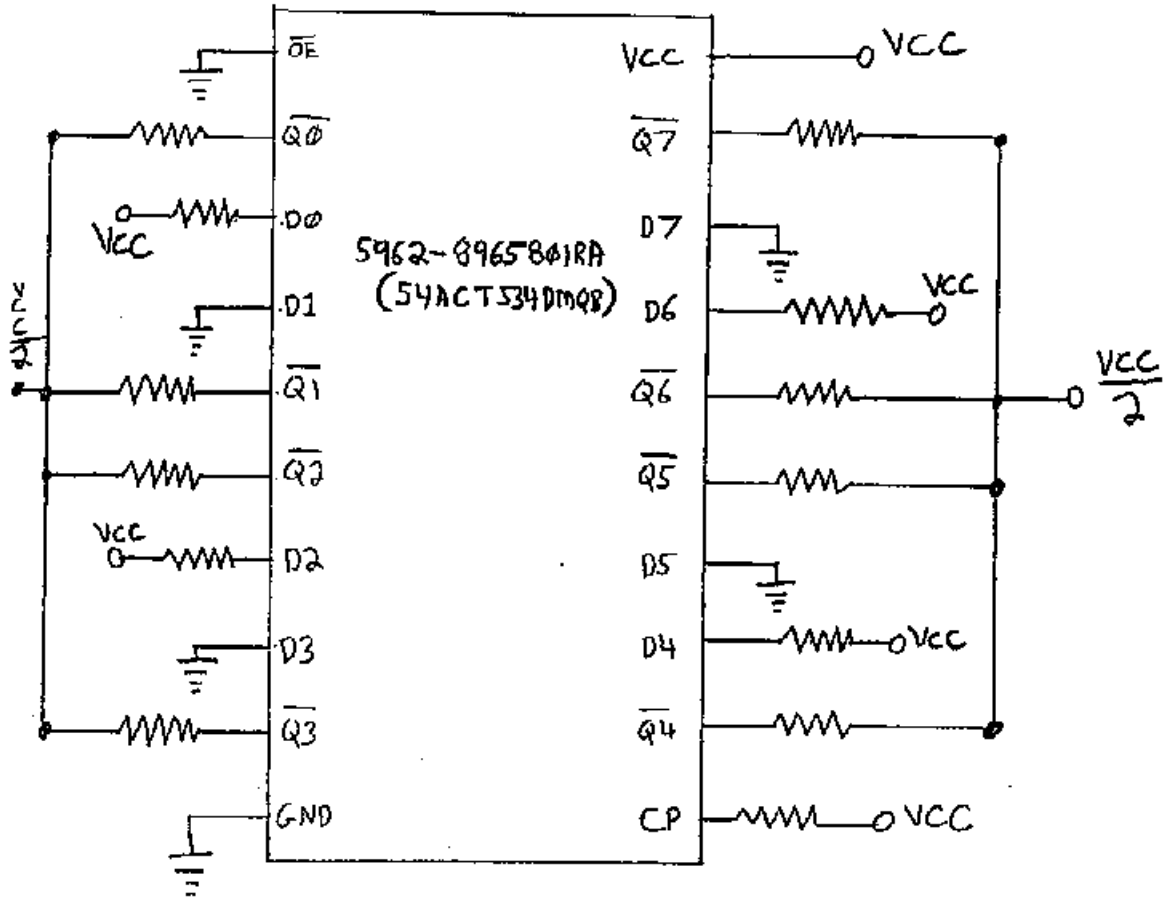
Parameters	Spec. Lim./2	min	max	Total Dose Exposure (TDE) (krads)										Anneal		TDE		Anneal			
				Initial		5		10		20		40		60		168 hrs @25°C		100 krads		168 hrs @100°C	
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC3, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4, 40 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VOH1 /3	V	4.4	3.0	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	5.4	5.5	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	3.85	4.5	4.82	.03	4.81	.03	4.83	.01	4.79	.05	4.78	.06	4.76	.09	4.77	.08	4.75	.06	4.77	.02
VOL1	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL5	mV	0	1650	439	51	443	30	415	16	448	54	456	62	475	89	483	95	473	56	454	32
IIH	uA	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	uA	-1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOZH	uA	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOZL	uA	-10	0	0	0	0	0	0	0	0	0	0	0	0.01	.01	0	.01	0.01	.02	0	0
ICCH	uA	0	160	0	0	0.29	.08	3.45	.98	1.34	.74	4.91	2.8	6.06	3.6	1.59	.41	8.72	10	0.18	.02
ICCL	uA	0	160	0	0	0.04	.01	0.23	.15	1.23	.64	3.39	2.0	4.15	2.5	0.85	.16	5.44	5.5	0.09	.01
IC CZ	uA	0	160	0	0	0.02	.01	0.09	.03	0.61	.25	2.47	1.4	3.26	2.0	0.63	.12	4.60	5.1	0.06	.01
ICCMAX	uA	0	1600	170	163	167	160	165	158	160	154	154	147	147	140	144	141	135	129	127	128
TPLH	ns	1.0	11.5	8.98	.11	8.93	.11	8.07	.12	8.91	.13	8.87	.12	8.89	.13	8.92	.11	8.90	.12	9.80	.23
TPHL	ns	1.0	10.5	8.20	.16	8.09	.17	7.41	.20	8.14	.13	8.12	.13	8.08	.16	8.07	.18	7.76	.25	8.84	.21
TPLZ	ns	1.0	10.5	6.57	.20	6.56	.18	5.98	.16	6.51	.20	6.51	.17	6.49	.17	6.47	.21	6.48	.24	6.91	.21
TPHZ	ns	1.0	12.5	9.16	.28	9.13	.27	8.60	.27	9.09	.30	9.13	.30	9.14	.29	9.11	.30	9.11	.29	9.61	.30
TPZL	ns	1.0	11.0	6.89	.14	6.89	.14	6.19	.17	6.87	.15	6.92	.15	6.92	.14	6.91	.14	6.94	.15	8.03	.13
TPZH	ns	1.0	12.0	8.81	.63	8.81	.62	7.85	.47	8.90	.63	8.99	.60	8.95	.55	8.86	.60	8.73	.57	10.3	.63

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 VOH2-4 or VOL2-4 during irradiation and annealing. Additional data are available on request.

Figure 1. Radiation Bias Circuit for 54ACT534



VCC = 5.0 VDC + 0.5 VDC

VCC/2 = 2.5 VDC + 250mVDC

All resistors are 1 kOhm, 1/4W minimum,

Ta = 25°C, 100°C

10% maximum tolerance