PPM 93-049

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Paramax Systems
Corporation

4700 Boston Way
Lanham MD 20706

PARAMAX
A Unisys Company

Memorandum

PPM-93-049

DATE: April 2, 1993
TO: B. Fafaul/311
FROM: K. Sahu/300.1 KS.
SUBJECT: Radiation Report on FAST/MUE
Part No. 54ACT112DMQB (54ACT112)
Control No. 6002A

cc: R. Kolecki/740.4
T. Miccolis/300.1
A. Sharma/311
Library/300.1
E. Bentley/740.4
SMEX, PPM File

A radiation evaluation was performed on 54ACT112 (Dual JK 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 0.07 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 four functional tests at 1.0 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 60-krad irradiation and subsequent 168-hour anneal at 25°C. After the 100-krad irradiation, one part (S/N 254) marginally exceeded the maximum specification limit of 8.0 uA for ICCL, with a reading of 8.7 uA.

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*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.

All other irradiated parts passed all electrical tests throughout all irradiation and annealing steps. No significant sensitivity to radiation was observed in any test parameter.

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:	54ACT112
Part Number:	54ACT112DMQB
FAST/MUE Control Number:	6002A
Charge Number:	C33294
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9139A
Quantity Tested:	10
Serial Numbers of Radiation Samples:	252, 253, 254, 255, 256, 257, 258, 259
Serial Numbers of Control Samples:	250, 251
Part Function:	Dual JK Flip-Flop
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Equipment:	S-50
Test Engineer:	A. Karygiannis

TABLE II. Radiation Schedule for 54ACT112

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/03/93
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR)	03/04/93
POST-5 KRAD ELECTRICAL MEASUREMENT	03/05/93
3) 10 KRAD IRRADIATION (0.07 KRADS/HOUR)	03/05/93
POST-10 KRAD ELECTRICAL MEASUREMENT	03/08/93
4) 20 KRAD IRRADIATION (0.50 KRADS/HOUR)	03/08/93
POST-20 KRAD ELECTRICAL MEASUREMENT	03/09/93
5) 40 KRAD IRRADIATION (1.01 KRADS/HOUR)	03/09/93
POST-40 KRAD ELECTRICAL MEASUREMENT	03/10/93
6) 60 KRAD IRRADIATION (1.00 KRADS/HOUR)	03/11/93
POST-60 KRAD ELECTRICAL MEASUREMENT	03/11/93
7) 168 HOUR* ANNEALING @25°C	03/11/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/18/93
8) 100 KRAD IRRADIATION (2.00 KRADS/HOUR)	03/23/93
POST-100 KRAD ELECTRICAL MEASUREMENT	03/24/93
9) 168 HOUR ANNEALING @100°C*	03/24/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/31/93

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 54ACT112

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	COMPARISON LEVELS
FUNCT 1	4.5V	0.0V	4.5V	FREQ=1.000MHz	ALL I/O	VOL<2.25V , VOH>2.25V
FUNCT 2	5.0V	0.0V	5.0V	FREQ=1.000MHz	ALL I/O	VOL<2.50V , VOH>2.50V
FUNCT 3	5.5V	0.0V	5.5V	FREQ=1.000MHz	ALL I/O	VOL<2.75V , VOH>2.75V
FUNCT 4	5.0V	0.0V	5.0V	FREQ=1.000MHz	ALL I/O	VOL<2.50V , VOH>2.50V

DC PARAMETRIC TESTS PERFORMED @ 25C

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
VOH1	4.5V	0.80V	2.00V	LOAD=-50UA	OUTS	>+4.40V , <+4.50V
VOH2	5.5V	0.80V	2.00V	LOAD=-50UA	OUTS	>+5.40V , <+5.50V
VOH3	4.5V	0.80V	2.00V	LOAD=-24MA	OUTS	>+3.86V , <+4.50V
VOH4	5.5V	0.80V	2.00V	LOAD=-24MA	OUTS	>+4.86V , <+5.50V
VOHD	5.5V	0.00V	5.50V	LOAD=-50MA	OUTS	>+3.85V , <+5.50V
VOL1	4.5V	0.80V	2.00V	LOAD=+50UA	OUTS	>+0.00V , <+0.10V
VOL2	4.5V	0.80V	2.00V	LOAD=+50UA	OUTS	>+0.00V , <+0.10V
VOL3	4.5V	0.80V	2.00V	LOAD=+24MA	OUTS	>+0.00V , <+0.36V
VOL4	5.5V	0.80V	2.00V	LOAD=+24MA	OUTS	>+0.00V , <+0.36V
VOLD	5.5V	0.00V	5.50V	LOAD=+50MA	OUTS	>+0.00V , <+1.65V
IIH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	>-0.1UA , <+0.1UA
IIL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-0.1UA , <+0.1UA
ICCH	5.5V	0.0V	5.5V	SET STATE	VCC	>+0.0UA , <+8.0UA
ICCL	5.5V	0.0V	5.5V	RESET STATE	VCC	>+0.0UA , <+8.0UA
ICCT	5.5V	0.0V	5.5V	VINH = 3.4V	VCC	>+0.0UA , <+1.0MA

AC PARAMETRIC TESTS PERFORMED @ 25C

PARAMETER	VCC	VIL	VIH	COMMENTS	PINS	LIMITS AT +25C ONLY
TPLH_CP_Q	5.0V	0.0V	5.0V	CP_ -> Q	Q	> 2.5NS , < 13.0NS
TPLH_CP_Q_	5.0V	0.0V	5.0V	CP_ -> Q_	Q_	> 2.5NS , < 13.0NS
TPHL_CP_Q	5.0V	0.0V	5.0V	CP_ -> Q	Q	> 2.5NS , < 13.0NS
TPHL_CP_Q_	5.0V	0.0V	5.0V	CP_ -> Q_	Q_	> 2.5NS , < 13.0NS
TPLH_S_Q	5.0V	0.0V	5.0V	S_ -> Q	Q	> 2.5NS , < 10.0NS
TPLH_R_Q_	5.0V	0.0V	5.0V	R_ -> Q_	Q_	> 2.5NS , < 10.0NS
TPHL_R_Q	5.0V	0.0V	5.0V	R_ -> Q	Q	> 2.5NS , < 12.5NS
TPHL_S_Q_	5.0V	0.0V	5.0V	S_ -> Q_	Q_	> 2.5NS , < 12.5NS

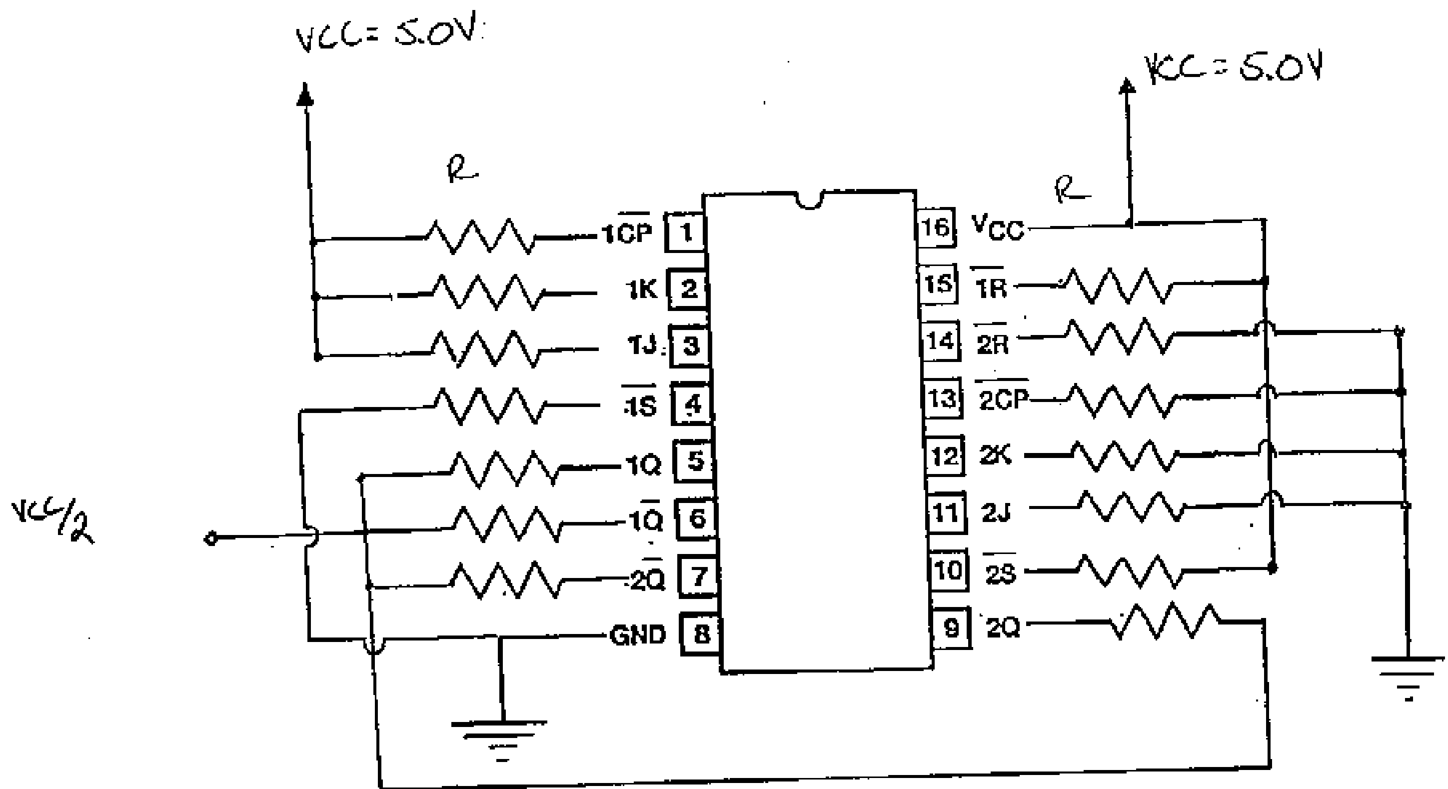
TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54ACT112 1/

Parameters		Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (TDE) (krads) Initial mean	sd	5 mean	sd	10 mean	sd	20 mean	sd	40 mean	sd	60 mean	sd	Anneal 168 hrs @25°C mean	sd	TDE 100 krads mean	sd	Anneal 168 hrs @100°C mean	sd
FUNC1, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2, 1 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4, 1 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VOH1	V	4.4	1.5	4.49	0	4.50	.01	4.49	.01	4.49	.01	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0
VOH2	V	5.4	5.5	5.49	0	5.50	0	5.50	.01	5.49	.01	5.49	0	5.49	0	5.49	0	5.49	0	5.49	.01
VOH3	V	3.86	4.5	4.17	.01	4.17	.01	4.17	.01	4.16	.01	4.16	.01	4.16	.01	4.12	.05	4.15	.19	4.15	.01
VOH4	V	4.86	5.5	5.21	.01	5.21	.01	5.21	.01	5.20	.01	5.20	.01	5.20	.01	5.17	.03	5.19	.17	5.19	.01
VOHD	V	3.85	5.5	4.87	.02	4.87	.02	4.87	.02	4.86	.03	4.66	.02	4.86	.02	4.79	.08	4.85	.33	4.85	.02
VOL1	mV	0	100	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
VOL3	mV	0	360	232	5.7	235	7.2	228	5.9	230	10	236	9.9	238	6.2	259	25	231	13	245	17
VOL4	mV	0	360	203	5.8	206	7.7	200	6.0	202	10	208	10	211	5.9	230	25	201	12	212	13
VOLD	mV	0	1650	435	12	441	16	428	13	433	22	444	20	448	12	494	60	432	27	455	30
IIH	nA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	nA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH	uA	0	8.0	0	0	0	0	0.07	.07	0.23	.24	0.52	.58	0.53	.58	0.09	.06	1.08	2.0	0.31	.01
ICCL	uA	0	8.0	0	0	0	0	0.11	.11	0.36	.43	0.75	.96	0.74	.95	0.12	.07	1.54	2.7	0.32	0
ICCT	uA	0	1000	476	50	468	50	455	49	443	49	416	48	396	48	394	48	354	48	360	44
TPLH_CQ	ns	2.5	13.0	9.90	.91	9.96	.92	9.86	.88	9.79	.88	9.61	.88	9.59	.89	9.41	.89	9.51	.89	9.79	.96
TPLH_CQ_	ns	2.5	13.0	9.19	.90	9.17	.89	9.10	.88	9.09	.89	9.09	.89	8.83	.90	8.72	.93	8.92	.94	8.43	.86
TPHL_CQ	ns	2.5	13.0	11.4	.88	11.4	.90	11.4	.96	11.3	.99	11.1	.99	11.0	.90	10.9	.81	11.0	.62	11.2	1.5
TPHL_CQ_	ns	2.5	13.0	9.28	.33	9.30	.38	9.26	.42	9.20	.42	9.15	.42	8.91	.41	8.77	.41	8.84	.38	9.00	.38
TPLH_SQ	ns	2.5	10.0	8.60	.87	8.61	.86	8.62	.85	8.61	.85	8.57	.85	8.29	.85	8.13	.85	8.23	.87	8.69	.95
TPLH_RQ_	ns	2.5	10.0	8.58	.97	8.55	.97	8.54	.97	8.48	.98	8.39	.99	8.29	1.0	8.12	1.0	8.19	.99	7.77	.88
TPHL_RQ	ns	2.5	12.5	10.8	.43	10.9	.41	10.9	.41	10.9	.41	10.8	.40	10.7	.39	10.5	.37	10.6	.29	10.8	1.1
TPHL_SQ_	ns	2.5	12.5	11.1	.76	11.2	.86	11.2	.87	11.2	.88	11.1	.89	11.0	.99	10.8	1.0	10.9	1.1	11.1	.23

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.

Figure 1. Radiation Bias Circuit for 54ACT112



1) Vcc = 5.0VDC±0.5VDC

2) Vcc/2 = 2.5VDC±0.25VDC

3) All resistors R = 2.0Kohms±10%, 1/4W