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Memorandum

PARAMAX
A Unisys Company

DATE: December 29, 1992
TO: B. Fafaul/311
FROM: K. Sahu/300.1 *ks*
SUBJECT: Radiation Report on FAST/MUE
Part No. CD54AC112F3A
Control No. 6002

PPM-92-315

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

A radiation evaluation was performed on 54AC112 (Dual J-K 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 with VCC = 1.5, 4.5, 5.0 and 5.5 V.

All ten parts passed initial (pre-rad) electrical tests. After the 5-krad irradiation, two parts (SN 21 and 24) exceeded the maximum specification limit of 4.0 uA for ICC, with readings of 4.3 and 16.7 uA, respectively. After the 10-krad irradiation, two additional parts (SN 20 and 22) failed ICC, with readings of 19.1 and 4.4 uA, respectively. At the 10-krad level, SN 21 and

*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.

24 had readings for ICC around 200 uA. At the 20-krad level, SN 17 failed ICC with a reading of 6.9 uA. ICC readings continued to increase in SN 20, 21 and 24, while SN 22 measured within specification limits. After the 40-krad irradiation, all irradiated parts exceeded the maximum specification limit for ICC, with readings ranging from 14.6 uA to 3.8 mA. In addition, three parts (SN 20, 21 and 24) failed functional test #1 (VCC = 1.5 V). All irradiated parts continued to fail ICC throughout all subsequent irradiation levels and annealing steps with the exception of SN 18, which recovered to within specification limits after annealing for 168 hours at 100°C. Failures in functional test #1 (VCC = 1.5 V) also continued throughout all subsequent irradiation levels and annealing steps. After the 60-krad irradiation, SN 20, 21 and 24 failed the VOH1 and VOL1 tests with VCC = 1.5 V. Some reduction was observed in ICC readings after annealing at 25°C for 168 hours, although all irradiated parts continued to fail all the same parameters as they failed at 40 krads. After 100 krads cumulative irradiation, all irradiated parts except SN 18 failed VOH1 and VOL1. No VOH, VOL or functional failures were observed at VCC = 3.0, 4.5, 5.0 or 5.5 V.

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:	54AC112
Part Number:	CD54AC112F3A
FAST/MUE Control Number:	6002
Charge Number:	C33076
Manufacturer:	Harris Corp.
Lot Date Code:	9221
Quantity Tested:	10
Serial Numbers of Radiation Samples:	17, 18, 19, 20, 21, 22, 23, 24
Serial Numbers of Control Samples:	15, 16
Part Function:	Dual J-K Flip-Flop
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Engineer:	T. Scharer

TABLE II. Radiation Schedule for 54AC112

EVENTS	DATE
1) Initial Electrical Measurements	11/13/92
2) 5 KRAD IRRADIATION (0.07 krads/hour)	11/20/92
POST-5 KRAD ELECTRICAL MEASUREMENT	11/23/92
3) 10 KRAD IRRADIATION (0.25 krads/hour)	11/23/92
POST-10 KRAD ELECTRICAL MEASUREMENT	11/24/92
4) 20 KRAD IRRADIATION (0.50 krads/hour)	11/24/92
POST-20 KRAD ELECTRICAL MEASUREMENT	11/25/92
5) 40 KRAD IRRADIATION (0.47 KRADS/HOUR)	11/25/92
POST-40 KRAD ELECTRICAL MEASUREMENT	11/27/92
6) 60 KRAD IRRADIATION (0.30 KRADS/HOUR)	11/27/92
POST-60 KRAD ELECTRICAL MEASUREMENT	11/30/92
7) 168 HOUR ANNEALING @25°C	11/30/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/07/92
8) 100 KRAD IRRADIATION (2.00 KRADS/HOUR)	12/07/92
POST-100 KRAD ELECTRICAL MEASUREMENT	12/08/92
9) 168 HOUR ANNEALING @100°C*	12/08/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/15/92

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 54AC112

FUNCTIONAL TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT -55C TO +125C
FUNCT 1	1.5V	0.0V	1.5V	FREQ=1.000MHz	ALL I/O	VOL<0.75V , VOH>0.75V
FUNCT 2	4.5V	0.0V	4.5V	FREQ=1.000MHz	ALL I/O	VOL<2.25V , VOH>2.25V
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	1.5V	0.30V	1.20V	LOAD=-50UA	OUTS	>+1.40V , <+1.50V
VOH2	3.0V	0.90V	2.10V	LOAD=-50UA	OUTS	>+2.90V , <+3.00V
VOH3	4.5V	0.00V	4.50V	LOAD=-50UA	OUTS	>+4.40V , <+4.50V
VOH4	3.0V	0.90V	2.10V	LOAD=- 4MA	OUTS	>+2.58V , <+3.00V
VOH5	4.5V	0.00V	4.50V	LOAD=-24MA	OUTS	>+3.94V , <+4.50V
VOH6	5.5V	1.65V	3.85V	LOAD=-75MA	OUTS	>+3.85V , <+5.50V
VOH7	5.5V	1.65V	3.85V	LOAD=-50MA	OUTS	>+3.85V , <+5.50V
VOL1	1.5V	0.30V	1.20V	LOAD=+50UA	OUTS	>+0.00V , <+0.10V
VOL2	3.0V	0.90V	2.10V	LOAD=+50UA	OUTS	>+0.00V , <+0.10V
VOL3	4.5V	0.00V	4.50V	LOAD=+50UA	OUTS	>+0.00V , <+0.10V
VOL4	3.0V	0.90V	2.10V	LOAD=+12MA	OUTS	>+0.00V , <+0.36V
VOL5	4.5V	0.00V	4.50V	LOAD=+24MA	OUTS	>+0.00V , <+0.36V
VOL6	5.5V	1.65V	3.85V	LOAD=+75MA	OUTS	>+0.00V , <+1.65V
VOL7	5.5V	1.65V	3.85V	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
ICC	5.5V	0.0V	5.5V	SET STATE	VCC	>+0.0UA , <+4.0UA
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	> 2.6NS , < 10.3NS
TPLH_CP_Q	5.0V	0.0V	5.0V	CP_ -> Q_	Q_	> 2.6NS , < 10.3NS
TPHL_CP_Q	5.0V	0.0V	5.0V	CP_ -> Q	Q	> 2.6NS , < 10.3NS
TPHL_CP_Q	5.0V	0.0V	5.0V	CP_ -> Q_	Q_	> 2.6NS , < 10.3NS
TPLH_S_Q	5.0V	0.0V	5.0V	S_ -> Q	Q	> 3.1NS , < 12.1NS
TPLH_R_Q	5.0V	0.0V	5.0V	R_ -> Q_	Q_	> 3.1NS , < 12.1NS
TPHL_R_Q	5.0V	0.0V	5.0V	R_ -> Q	Q	> 3.1NS , < 12.1NS
TPHL_S_Q	5.0V	0.0V	5.0V	S_ -> Q_	Q_	> 3.1NS , < 12.1NS

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC112 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, 1.5 V/3				PASS		PASS		PASS		PASS		5P3F		5P3F		5P3F		1P7F		4P4F	
FUNC2, 1 MHz, 4.5 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 /4	V	1.4	1.5	1.49	0	1.49	0	1.49	0	1.49	0	1.44	.26	1.21	.26	1.26	.54	0.79	.74	1.19	.57
VOH3	V	4.4	5.5	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
VOH5	V	3.94	4.5	4.27	.03	4.26	.06	4.26	.07	4.26	.03	4.29	.01	4.25	.08	4.29	.01	4.28	.01	4.28	.01
VOH7	V	3.85	5.5	5.06	.06	5.06	.05	5.04	.14	5.05	.08	5.11	.01	5.05	.08	5.10	.01	5.10	.01	5.09	.02
VOL1	mV	0	100	0	0	0	0	0	0	0	0	0	0	187	497	188	497	610	738	344	618
VOL7	mV	0	1650	451	107	466	74	437	61	457	88	382	9.2	451	90	378	19	390	40	425	76
I _{IH}	nA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I _{IL}	nA	-100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICC	uA	0	4.0	0	0	4.37	6.4	54.7	86	258	373	1235	1581	2558	3056	2299	2810	6005	6461	3495	4345
TP _{LH} CQ	ns	2.6	10.3	4.66	.19	4.58	.24	4.66	.24	4.69	.21	4.74	.24	4.83	.26	4.79	.24	4.81	.32	4.79	.29
TP _{LH} CQ	ns	2.6	10.3	4.91	.20	4.94	.20	4.90	.20	4.93	.19	4.96	.20	5.04	.18	5.04	.16	5.16	.19	5.22	.32
TP _{HL} CQ	ns	2.6	10.3	3.68	.12	3.62	.13	3.66	.16	3.71	.10	3.74	.10	3.83	.11	3.82	.12	3.97	.11	3.89	.12
TP _{HL} CQ	ns	2.6	10.3	3.88	.11	3.85	.09	3.87	.11	3.92	.11	4.00	.12	4.05	.15	4.07	.17	4.10	.18	4.10	.19
TP _{LH} SQ	ns	3.1	12.2	4.77	.41	4.92	.83	4.78	.43	4.84	.44	4.99	.48	5.02	.48	4.94	.46	5.17	.53	5.13	.49
TP _{LH} RQ	ns	3.1	12.2	4.74	.18	4.77	.15	4.73	.17	4.76	.16	4.81	.13	4.88	.14	4.88	.14	5.10	.23	5.12	.31
TP _{HL} RQ	ns	3.1	12.2	4.24	.18	4.17	.16	4.21	.19	4.24	.14	4.28	.15	4.36	.14	4.34	.16	4.59	.19	4.54	.24
TP _{HL} SQ	ns	3.1	12.2	4.45	.16	4.37	.12	4.42	.13	4.49	.16	4.55	.17	4.66	.17	4.63	.18	4.87	.20	4.86	.24

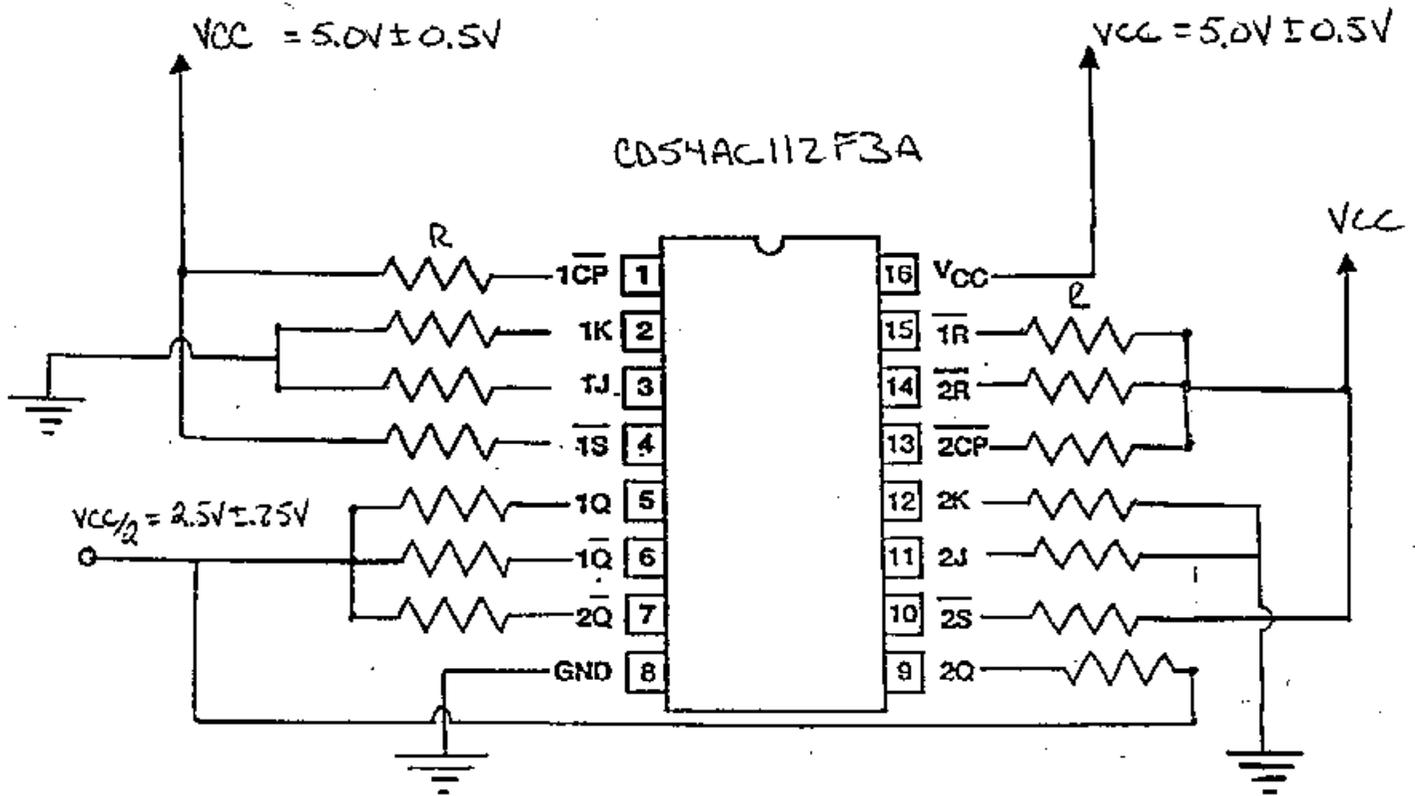
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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/ "nPmF" indicates that n parts passed and m parts failed this test at this radiation or annealing level.

4/ No significant variation was observed in VOH2-5 or VOL2-7 during irradiation and annealing. Additional data are available on request.

Figure 1. Radiation Bias Circuit for 54AC112



NOTES!

1) ALL RESISTOR VALUES $R = 2.0K\Omega \pm 10\%$ $\frac{1}{4}W$