PPM 93-051

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Paramax Systems
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Memorandum

PARAMAX
A Unisys Company

DATE: April 14, 1993
TO: B. Fafaul/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on FAST/MUE
Part No. 54AC193F/3A (54AC193)
Control No. 6130

PPM-93-051

cc: R. Kolecki/740.4
T. Miccolis/300.1
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SMEX, PPM File

A radiation evaluation was performed on 54AC193 (4-Bit Binary Counter) 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 0.26 and 1.0 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 six 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 10-krad irradiation. After the 20-krad irradiation, all irradiated parts exceeded the maximum specification limit of 8.0 uA for ICC, with readings ranging from 58 to 392 uA. At the 40-krad level, the same failures occurred, with readings ranging from 1.33 to 3.28 mA. At the 60-krad level, the same failures continued, with

*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.

readings ranging from 3.45 to 6.81 mA.

After annealing for 168 hours at 25°C, all irradiated parts showed little recovery, but continued to exceed the maximum specification limit of 8.0 uA for ICC, with readings ranging from 2.68 to 5.83 mA. Upon continued irradiation to 100 krads (cumulative), all irradiated parts still continued to fail ICC, with readings ranging from 8.80 to 13.62 mA. In addition, all irradiated parts exceeded the maximum specification limit of 100 mV for VOL1 and VOL2, with Vcc = 1.5 and 3.0 V, with readings of 1.50 V for both parameters. All irradiated parts also exceeded the maximum specification limit of 360 mV for VOL4, with Vcc = 3.0 V, with readings ranging from 1.49 to 1.59 V. All irradiated parts passed the VOL5 and VOL6 tests, with Vcc = 4.5 and 5.5 V, respectively.

After a final annealing at 100°C, no rebound effects were observed. All irradiated parts passed all other functional and electrical tests throughout all irradiation and annealing steps. No significant sensitivity to radiation was observed in any other 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.

TABLE I. Part Information

Generic Part Number:	54AC193
Part Number:	54AC193F/3A*
FAST/MUE Control Number:	6130
Charge Number:	C33295
Manufacturer:	Harris
Lot Date Code:	9246
Quantity Tested:	10
Serial Numbers of Radiation Samples:	27, 28, 29, 30, 31, 32, 33, 34
Serial Numbers of Control Samples:	25, 26
Part Function:	4-Bit Binary Counter
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Equipment:	S-50
Test Engineer:	C. Arcila

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

TABLE II. Radiation Schedule for 54AC193

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/12/93
2) 5 KRAD IRRADIATION (0.26 KRADS/HOUR)	03/15/93
POST-5 KRAD ELECTRICAL MEASUREMENT	03/17/93
3) 10 KRAD IRRADIATION (0.28 KRADS/HOUR)	03/18/93
POST-10 KRAD ELECTRICAL MEASUREMENT	03/18/93
4) 20 KRAD IRRADIATION (0.50 KRADS/HOUR)	03/23/93
POST-20 KRAD ELECTRICAL MEASUREMENT	03/24/93
5) 40 KRAD IRRADIATION (1.00 KRADS/HOUR)	03/24/93
POST-40 KRAD ELECTRICAL MEASUREMENT	03/25/93
6) 60 KRAD IRRADIATION (1.08 KRADS/HOUR)	03/25/93
POST-60 KRAD ELECTRICAL MEASUREMENT	03/26/93
7) 168 HOUR ANNEALING @25°C	03/26/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/02/93
8) 100 KRAD IRRADIATION (0.59 KRADS/HOUR)	04/02/93
POST-100 KRAD ELECTRICAL MEASUREMENT	04/06/93
9) 168 HOUR ANNEALING @100°C*	04/06/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/13/93

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 54AC193

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ -55C TO +125C
FUNCT #1	4.5V	0.0V	4.5V	FREQ = 1.0MHz	ALL I/O	VOL<2.25V , VOH>2.25V
FUNCT #2	5.0V	0.0V	5.0V	FREQ = 1.0MHz	ALL I/O	VOL<2.50V , VOH>2.50V
FUNCT #3	5.5V	0.0V	5.5V	FREQ = 1.0MHz	ALL I/O	VOL<2.75V , VOH>2.75V
FUNCT #4	5.0V	0.0V	5.0V	FREQ = 1.0MHz	ALL I/O	VOL<2.50V , VOH>2.50V
FUNCT #5	5.0V	0.0V	5.0V	FREQ = 1.0MHz	ALL I/O	VOL<2.50V , VOH>2.50V
FUNCT #6	5.0V	0.0V	5.0V	FREQ = 1.0MHz	ALL I/O	VOL<2.50V , VOH>2.50V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ +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 =-50MA	OUTS	>3.85V , <5.50V
VOL1	1.5V	0.30V	1.20V	LOAD =+50UA	OUTS	>0.10V , <1.50V
VOL2	3.0V	0.90V	2.10V	LOAD =+50UA	OUTS	>0.10V , <3.00V
VOL3	4.5V	0.00V	4.50V	LOAD =+50UA	OUTS	>0.10V , <4.50V
VOL4	3.0V	0.90V	2.10V	LOAD =+12MA	OUTS	>0.36V , <3.00V
VOL5	4.5V	0.00V	4.50V	LOAD =+24MA	OUTS	>0.36V , <4.50V
VOL6	5.5V	1.65V	3.85V	LOAD =+50MA	OUTS	>1.65V , <5.50V
IIH	5.5V	0.00V	5.50V	VTST=5.5V	INS	> 0.0UA , <+0.1UA
IIL	5.5V	0.00V	5.50V	VTST=0.0V	INS	>-0.1UA , <+0.0UA
ICCH	5.5V	0.00V	5.50V	OUTPUTS OPEN	VCC	> 0.0UA , <+8.0UA
ICCL	5.5V	0.00V	5.50V	OUTPUTS OPEN	VCC	> 0.0UA , <+8.0UA
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	>2.40V , <3.00V
VOH5	4.5V	0.00V	4.50V	LOAD =-24MA	OUTS	>3.70V , <4.50V
VOH6	5.5V	1.65V	3.85V	LOAD =-50MA	OUTS	>3.85V , <5.50V
VOL1	1.5V	0.30V	1.20V	LOAD =+50UA	OUTS	>0.10V , <1.50V
VOL2	3.0V	0.90V	2.10V	LOAD =+50UA	OUTS	>0.10V , <3.00V
VOL3	4.5V	0.00V	4.50V	LOAD =+50UA	OUTS	>0.10V , <4.50V
VOL4	3.0V	0.90V	2.10V	LOAD =+12MA	OUTS	>0.50V , <3.00V
VOL5	4.5V	0.00V	4.50V	LOAD =+24MA	OUTS	>0.50V , <4.50V
VOL6	5.5V	1.65V	3.85V	LOAD =+50MA	OUTS	>1.65V , <5.50V
IIH	5.5V	0.00V	5.50V	VTST=5.5V	INS	> 0.0UA , <+1.0UA
IIL	5.5V	0.00V	5.50V	VTST=0.0V	INS	>-1.0UA , <+0.0UA
ICCH	5.5V	0.00V	5.50V	OUTPUTS OPEN	VCC	> 0.0UA , <+160UA
ICCL	5.5V	0.00V	5.50V	OUTPUTS OPEN	VCC	> 0.0UA , <+160UA

AC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	PINS	COMMENTS	LIMITS @ +25C
TPLH_LQ	5.0V	0.0V	5.0V	OUT	Load-> Q	> 3.8NS , < 15.0NS
TPHL_LQ	5.0V	0.0V	5.0V	OUT	Load-> Q	> 3.8NS , < 15.0NS
TPLH_CQ	5.0V	0.0V	5.0V	OUT	Up -> Q	> 3.5NS , < 14.0NS
TPHL_CQ	5.0V	0.0V	5.0V	OUT	Up -> Q	> 3.5NS , < 14.0NS
TPHL_CB	5.0V	0.0V	5.0V	OUT	Dn->Borrow	> 3.6NS , < 11.2NS
TPHL_MQ	5.0V	0.0V	5.0V	OUT	MR -> Q	> 4.0NS , < 16.0NS
TPLH_DQ	5.0V	0.0V	5.0V	OUT	Data -> Q	> 4.1NS , < 16.5NS
TPHL_DQ	5.0V	0.0V	5.0V	OUT	Data -> Q	> 4.1NS , < 16.5NS

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC193 1/

Parameters		Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (TDE) (krads) Initial mean	Initial sd	5 mean	5 sd	10 mean	10 sd	20 mean	20 sd	40 mean	40 sd	60 mean	60 sd	Anneal 168 hrs @25°C mean	Anneal 168 hrs @25°C sd	TDE 100 krads mean	TDE 100 krads sd	Anneal 168 hrs @100°C mean	Anneal 168 hrs @100°C 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, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC5, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC6, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VOH1/3	V	1.4	1.5	1.49	0	1.49	0	1.49	0	1.49	0	1.49	0	1.49	0	1.49	0	1.49	.01	1.49	0
VOH3/3	V	4.4	4.5	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
VOH5/3	V	3.94	4.5	4.28	.02	4.27	.02	4.27	.02	4.29	.01	4.28	.01	4.28	.01	4.28	.01	4.28	.01	4.27	.01
VOL1/3	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	901	735	843	735
VOL2/3	mV	0	100	0	0	0	0	0	0	0	0	0	0	2.85	3.0	0	0	272	544	157	415
VOL4/3	mV	0	360	146	11	154	7.8	150	9.5	137	6.2	144	6.6	144	7.5	131	6.6	413	572	334	479
VOL5/3	mV	0	360	218	19	233	14	227	19	205	9.9	218	11	218	11	198	10	198	13	204	12
VOL6/3	mV	0	1650	422	46	462	30	452	53	392	19	432	20	431	21	390	20	382	23	398	23
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
ICC	uA	0	8.0	0	0	1.31	2.7	3.50	3.50	228	102	2432	616	5303	1042	4442	989	11mA	1714	7202	1525
TPLH_LQ	ns	3.8	15.0	9.65	.58	9.68	.57	9.57	.59	9.39	.64	9.43	0.7	9.47	.76	9.34	.74	9.26	.93	9.25	.84
TPHL_LQ	ns	3.8	15.0	8.92	.62	8.93	.63	8.82	.61	8.70	.67	8.78	.63	8.81	.64	8.66	.63	8.62	.65	8.59	0.6
TPLH_CQ	ns	3.5	14.0	9.67	.32	9.71	.32	9.54	.31	9.14	.36	8.89	.36	8.70	.34	8.61	.36	8.28	.39	8.32	.38
TPHL_CQ	ns	3.5	14.0	9.36	.42	9.32	.43	9.18	.41	8.78	.43	8.55	.41	8.38	.42	8.21	.44	7.77	.39	7.87	.35
TPHL_CB	ns	2.8	11.0	6.24	0.2	6.21	.21	6.30	.19	6.40	.21	6.55	.21	6.71	.22	6.58	.22	6.56	0.2	6.54	.22
TPHL_MQ	ns	4.0	15.0	11.5	.62	11.6	.52	11.4	.62	11.1	.71	11.0	.71	10.9	.69	10.7	0.7	10.9	0.2	10.9	2.3
TPLH_DQ	ns	4.1	16.5	10.2	.41	10.2	.35	9.90	0.4	9.65	.47	9.47	.61	9.37	.71	9.20	.67	9.07	.83	9.13	.74
TPHL_DQ	ns	4.1	16.5	10.2	.49	10.3	.43	9.94	0.5	9.68	.56	9.46	.69	9.36	.80	9.21	.76	9.03	.92	9.07	.84

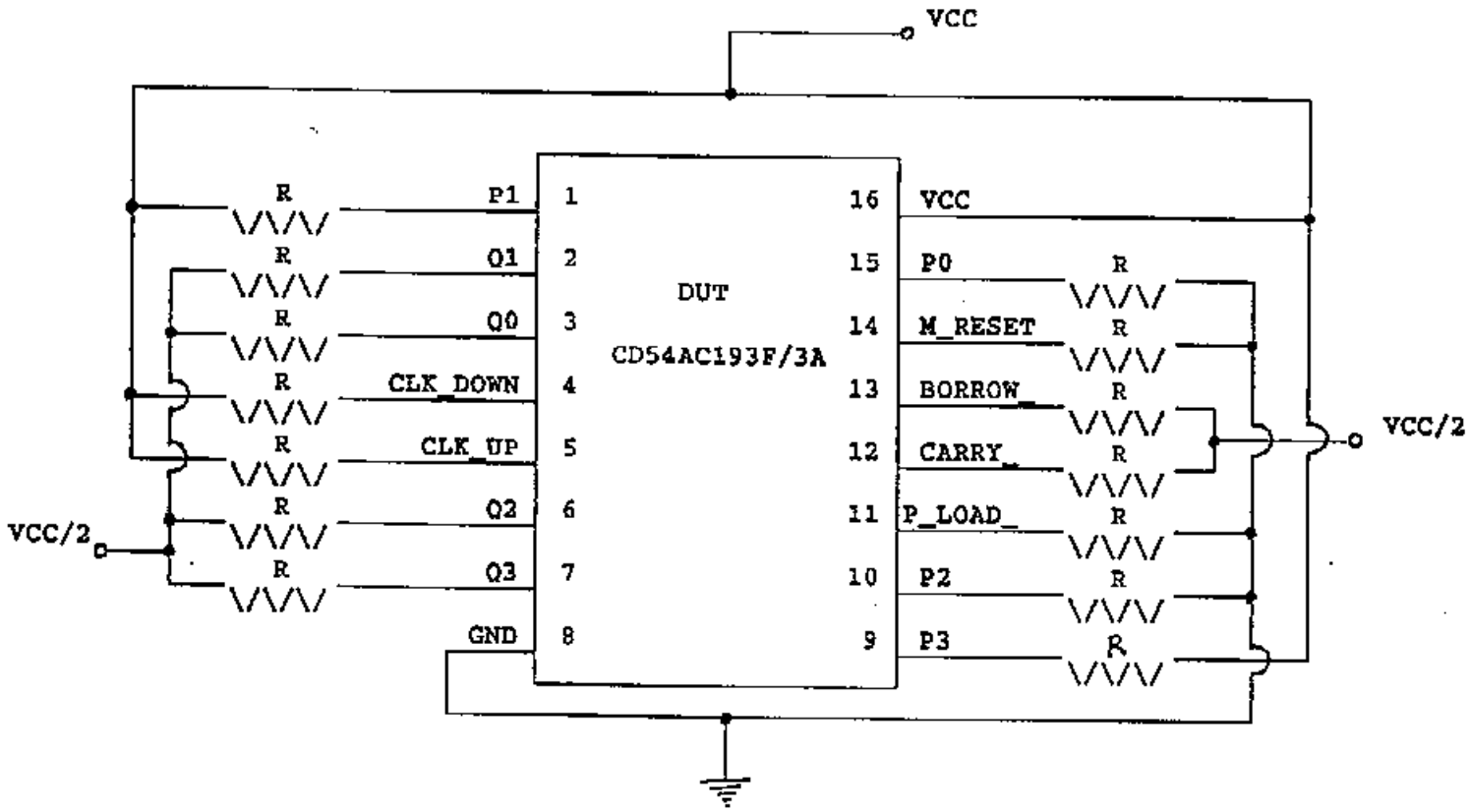
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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, VOH4, VOH6, or VOL3 throughout all irradiation and annealing steps. Additional data are available on request.

Radiation-sensitive parameters were ICC, VOL1, VOL2 and VOL4.

Figure 1. Radiation Bias Circuit for 54AC193



1) Vcc = +5.0 VDC ± 0.5 VDC

2) All resistors R = 2.0K Ohms ± 10%, 1/4 W