PPM 92-272

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Paramax Systems Corporation
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Memorandum

PARAMAX
A Unisys Company

DATE: November 6, 1992 PPM-92-272
TO: B. Fafaul/311
FROM: K. Sahu KS
SUBJECT: Radiation Report on FAST/MUE
Part No. 54AC169DMQB (54AC169)

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

A radiation evaluation was performed on 54AC169 (Bidirectional 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 steps 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 and to 140 krads (cumulative). The dose rate was between 0.15 and 2.2 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 five functional tests (three at 1.0MHz with VCC = 3.0V, 4.5V, and 5.5V and two at 10.0 MHz with VCC = 3.3V and 5.0V).

All ten parts passed initial (pre-rad) electrical tests. All eight irradiated parts passed all electrical tests up to and including the 40-krad irradiation. After the 60-krad irradiation, two parts (SN 253 and 255) exceeded the maximum specification limits of 160 uA for ICCL and ICCH with readings of 516 and 575 uA, respectively, for SN 255 and 185 and 231 uA for SN 253. However, after annealing for 168 hours at 25°C, only one part (SN 255) exceeded the limits for ICCL and ICCH, with readings of 267 and 301 uA, respectively. After irradiation to 100 and 140 krads, four parts (SN 253, 255, 257 and 258) exceeded the limits for ICCL and ICCH with readings (after 140 krads) varying from 2.0 to 6.8 mA.

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*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.

After a final annealing at 100°C, none of the parts exhibited any rebound effect.

All parts passed the five 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:	54AC169
Part Number:	54AC169DMQB
FAST/MUE Control Number:	6306
Charge Number:	C24017
Manufacturer:	National Semiconductor Corp.
Lot Date Code:	9228A
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:	Bidirectional Counter
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Engineer:	K. Kim

TABLE II. Radiation Schedule for 54AC169

EVENTS	DATE
1) Initial Electrical Measurements	10/07/92
2) 5 KRAD IRRADIATION (0.28 krads/hour)	10/07/92
POST-5 KRAD ELECTRICAL MEASUREMENT	10/08/92
3) 10 KRAD IRRADIATION (0.26 krads/hour)	10/08/92
POST-10 KRAD ELECTRICAL MEASUREMENT	10/09/92
4) 20 KRAD IRRADIATION (0.15-0.24 krads/hour*)	10/09/92
POST-20 KRAD ELECTRICAL MEASUREMENT	10/14/92
5) 40 KRAD IRRADIATION (1.18 KRADS/HOUR)	10/15/92
POST-40 KRAD ELECTRICAL MEASUREMENT	10/16/92
6) 60 KRAD IRRADIATION (1.25 KRADS/HOUR)	10/16/92
POST-60 KRAD ELECTRICAL MEASUREMENT	10/19/92
7) 168 HOUR ANNEALING @25°C	10/19/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/26/92
8) 100 KRAD IRRADIATION (2.1 KRADS/HOUR)	10/26/92
POST-100 KRAD ELECTRICAL MEASUREMENT	10/27/92
9) 140 KRAD IRRADIATION (2.22 KRADS/HOUR**)	10/27/92
POST-100 KRAD ELECTRICAL MEASUREMENT	10/28/92
10) 168 HOUR ANNEALING @100°C***	10/29/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/05/92

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

*Due to a power outage, irradiation stopped after 20 hrs. at .15 krads/hr. After 37 hrs. of annealing at 25°C, irradiation resumed for 23 hrs. at .24 krads/hr.

**The originally scheduled step was the 100°C annealing at this point. However, the parts erroneously received an additional 40 krads of radiation exposure.

***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 54AC169

PART NO : 54AC169DMQB	PART TYPE : 4-STAGE SYNCHRONOUS BIDIRECTIONAL COUNTER (16-PIN DIP).
LOCATION	TEST SPECIFICATIONS
PCN NUMBER : SI10577A DISK LABEL : LIB_25 DIRECTORY : DQAT:[PROGRAMS.577]	NATIONAL SEMI. DATABOOK 1990

TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @-55C TO +125C
FUNCT #1	3.0V	0.0V	3.0V	FREQ = 1MHz	ALL I/O	VOL<1.50V , VOH>1.50V
FUNCT #2	4.5V	0.0V	4.5V	FREQ = 1MHz	ALL I/O	VOL<2.25V , VOH>2.25V
FUNCT #3	5.5V	0.0V	5.5V	FREQ = 1MHz	ALL I/O	VOL<2.75V , VOH>2.75V
FUNCT #4 *	3.3V	0.0V	3.3V	FREQ = 10MHz	ALL I/O	VOL<1.50V , VOH>1.50V
FUNCT #5 *	5.0V	0.0V	5.0V	FREQ = 10MHz	ALL I/O	VOL<2.75V , VOH>2.75V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @-55C TO +125C
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 = -12MA	OUTS	>2.40V , <3.00V
VOH5	4.5V	1.35V	3.15V	LOAD = -24MA	OUTS	>3.70V , <4.50V
VOH6	5.5V	1.65V	3.85V	LOAD = -24MA	OUTS	>4.70V , <5.50V
VOH7 &	5.5V	1.65V	3.35V	LOAD = -50MA	OUTS	>5.85V , <5.50V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @-55C TO +125C
VOL1	3.0V	0.90V	2.10V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL2	4.5V	1.35V	3.15V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL3	5.5V	1.65V	3.85V	LOAD = +50UA	OUTS	>0.00V , <0.10V
VOL4	3.0V	0.90V	2.10V	LOAD = +12MA	OUTS	>0.00V , <0.40V
VOL5	4.5V	1.35V	3.15V	LOAD = +24MA	OUTS	>0.00V , <0.40V
VOL6	5.5V	1.65V	3.85V	LOAD = +24MA	OUTS	>0.00V , <0.40V
VOL7 &	5.5V	1.65V	3.85V	LOAD = +50MA	OUTS	>0.00V , <1.65V

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @-55C TO +125C
IIH	5.5V	0.00V	5.50V	VIN = 5.5V	INS	> 0.00UA , <+1.00UA
IIL	5.5V	0.00V	5.50V	VIN = 0.0V	INS	> -1.00UA , < 0.00UA

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @-55C TO +125C
ICCH	5.5V	0.00V	5.50V		VCC	> 0.00UA , < 160UA
ICCL	5.5V	ALL INPUTS AT 0.00V			VCC	> 0.00UA , < 160UA

Table III (cont.). Electrical Characteristics of 54AC169

GO/NO-GO AC TESTS PERFORMED DURING FUNCTIONAL TEST #4

PARAMETER	VCC	VIL	VIH	FREQUENCY	PINS	LIMITS AT -55C TO +125C
Ts (Pn)	3.3V	0.0V	3.3V	10.0 MHz	Pn -> CP	> 7.0nS (Min.)
Th (Pn)	3.3V	0.0V	3.3V	10.0 MHz	CP -> Pn	> 2.0nS (Min.)
Ts (CEP_)	3.3V	0.0V	3.3V	10.0 MHz	CEP_ -> CP	>13.5nS (Min.)
Th (CEP_)	3.3V	0.0V	3.3V	10.0 MHz	CP -> CEP_	> 0.5nS (Min.)
Ts (CET_)	3.3V	0.0V	3.3V	10.0 MHz	CET_ -> CP	>13.5nS (Min.)
Th (CET_)	3.3V	0.0V	3.3V	10.0 MHz	CP -> CET_	> 0.5nS (Min.)
Ts (PE_)	3.3V	0.0V	3.3V	10.0 MHz	PE_ -> CP	> 8.5nS (Min.)
Th (PE_)	3.3V	0.0V	3.3V	10.0 MHz	CP -> PE_	> 0.5nS (Min.)
Ts (UD_)	3.3V	0.0V	3.3V	10.0 MHz	UD_ -> CP	>13.0nS (Min.)
Th (UD_)	3.3V	0.0V	3.3V	10.0 MHz	CP -> UD_	> 0.5nS (Min.)
Tw (CP)	3.3V	0.0V	3.3V	10.0 MHz	CP	> 5.0nS (Min)

GO/NO-GO AC TESTS PERFORMED DURING FUNCTIONAL TEST #5

PARAMETER	VCC	VIL	VIH	FREQUENCY	PINS	LIMITS AT -55C TO +125C
Ts (Pn)	5.0V	0.0V	5.0V	10.0 MHz	Pn -> CP	> 4.5nS (Min.)
Th (Pn)	5.0V	0.0V	5.0V	10.0 MHz	CP -> Pn	> 2.5nS (Min.)
Ts (CEP_)	5.0V	0.0V	5.0V	10.0 MHz	CEP_ -> CP	> 9.0nS (Min.)
Th (CEP_)	5.0V	0.0V	5.0V	10.0 MHz	CP -> CEP_	> 2.5nS (Min.)
Ts (CET_)	5.0V	0.0V	5.0V	10.0 MHz	CET_ -> CP	> 9.5nS (Min.)
Th (CET_)	5.0V	0.0V	5.0V	10.0 MHz	CP -> CET_	> 2.5nS (Min.)
Ts (PE_)	5.0V	0.0V	5.0V	10.0 MHz	PE_ -> CP	> 6.5nS (Min.)
Th (PE_)	5.0V	0.0V	5.0V	10.0 MHz	CP -> PE_	> 2.0nS (Min.)
Ts (UD_)	5.0V	0.0V	5.0V	10.0 MHz	UD_ -> CP	> 9.0nS (Min.)
Th (UD_)	5.0V	0.0V	5.0V	10.0 MHz	CP -> UD_	> 2.0nS (Min.)
Tw (CP)	5.0V	0.0V	5.0V	10.0 MHz	CP	> 5.0nS (Min)

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	FREQUENCY	PINS	LIMITS AT -55C TO +125C
TPLH1 (PE=0)	5.0V	0.0V	5.0V	1.0 MHz	CP to Qn	> 1.0nS , < 12.0nS
TPHL1 (PE=0)	5.0V	0.0V	5.0V	1.0 MHz	CP to Qn	> 1.0nS , < 13.0nS
TPLH2 (PE=1)	5.0V	0.0V	5.0V	1.0 MHz	CP to Qn	> 1.0nS , < 12.0nS
TPHL2 (PE=1)	5.0V	0.0V	5.0V	1.0 MHz	CP to Qn	> 1.0nS , < 13.0nS
TPLH3	5.0V	0.0V	5.0V	1.0 MHz	CP to TC	> 1.0nS , < 16.0nS
TPHL3	5.0V	0.0V	5.0V	1.0 MHz	CP to TC	> 1.0nS , < 16.0nS
TPLH4	5.0V	0.0V	5.0V	1.0 MHz	CET_ to TC	> 1.0nS , < 13.0nS
TPHL4	5.0V	0.0V	5.0V	1.0 MHz	CET_ to TC	> 1.0nS , < 11.0nS
TPLH5	5.0V	0.0V	5.0V	1.0 MHz	UD_ to TC	> 1.0nS , < 13.0nS
TPHL5	5.0V	0.0V	5.0V	1.0 MHz	UD_ to TC	> 1.0nS , < 12.0nS

COMMENTS/EXCEPTIONS

(1) VIH and VIL are tested during VOH and VOL tests as GO/NO-GO tests.

(4) IODH and IODL are tested during VOH7 and VOL7 tests as GO/NO-GO tests.

(3) GO/NO-GO AC tests are performed during FUNTIONAL test#'s 4 and 5.

(4) AC parametric tests at VCC = 3.3V is NOT performed.

(5) This program detects improper DUT insertion.

HARDWARE REQUIREMENTS	TEST TEMPERATURES
DEVICE CONFIGURATION : 16-PIN DIP S-50 LOAD BOARD # 17 : DUT pin#8 jumped to GND.	+25 DEG. C. [x] -55 DEG. C. [x] +125 DEG. C. [x]
PROGRAMMER : K. Kim	DATE : 09-17-92

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC169 1/

Parameters		Spec. Lim./2 min	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 (krads) 100 mean	sd	140/4 mean	sd	Anneal 168 hrs. @100°C 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	
FUNC3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4, 10 MHz, 3.3 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC5, 10 MHz, 5.0 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	.01	2.99	.01	2.99	.01	2.99	.01	2.99	.01	2.99	.01	2.99	.01	2.99	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	5.49	0
VOH5	V	3.7	4.5	4.20	.02	4.20	.02	4.20	.02	4.20	.02	4.20	.02	4.20	.02	4.20	.02	4.19	.02	4.19	.02	4.19	.02
VOH7	V	3.85	5.5	4.94	.03	4.93	.03	4.94	.03	4.94	.03	4.93	.03	4.93	.04	4.93	.04	4.91	.03	4.91	.04	4.92	.03
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	518	54	520	93	428	34	489	52	592	90	489	96	420	32	444	71	437	76	503	141
IIH	nA	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	nA	-1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCL	uA	0	160	0	0	0.03	.07	4.98	1.9	18.0	6.4	34.8	39	103	167	53.3	85	1029	1275	2005	2308	13.8	8.6
ICCH	uA	0	160	0	0	0.03	.07	4.15	1.6	13.2	5.1	37.9	48	122	187	66.5	96	916	1249	1832	2173	1.9	1.4
TPLH1	ns	0	12.0	7.21	.17	7.15	.18	7.16	.17	7.23	.20	7.13	.18	7.10	.18	7.08	.19	6.98	.18	6.90	.18	7.13	.16
TPHL1	ns	0	13.0	6.67	.12	6.60	.14	6.61	.13	6.66	.12	6.53	.14	6.50	.13	6.95	.13	6.88	.13	6.79	.12	7.08	.15
TPLH2	ns	0	12.0	7.04	.16	6.97	.17	6.99	.15	7.06	.17	6.95	.15	6.94	.17	7.17	.28	7.08	.29	7.04	.30	7.00	.14
TPHL2	ns	0	13.0	6.68	.26	6.60	.26	6.62	.26	6.67	.26	6.53	.25	6.50	.26	6.72	.33	6.62	.32	6.52	.32	7.12	.35

Note:

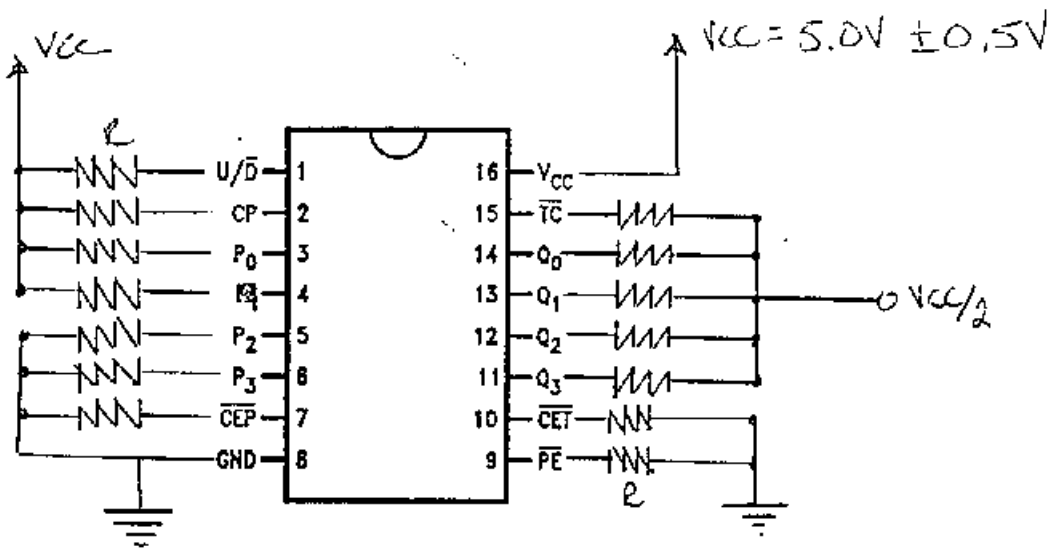
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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 VOH or VOL during irradiation and annealing. Additional data are available on request.

4/The originally scheduled step was the 100°C annealing at this point. However, the parts were irradiated to an additional 40 krads due to operator error.

Figure 1. Radiation Bias Circuit for 54AC169



Pin Names	Description
$\overline{CEP}$	Count Enable Parallel Input
$\overline{CET}$	Count Enable Trickle Input
CP	Clock Pulse Input
P_0–P_3	Parallel Data Inputs
$\overline{PE}$	Parallel Enable Input
U/$\overline{D}$	Up-Down Count Control Input
Q_0–Q_3	Flip-Flop Outputs
$\overline{TC}$	Terminal Count Output

Mode Select Table

$\overline{PE}$	$\overline{CEP}$	$\overline{CET}$	U/$\overline{D}$	Action on Rising Clock Edge
L	X	X	X	Load (P_n to Q_n)
H	L	L	H	Count Up (Increment)
H	L	L	L	Count Down (Decrement)
H	H	X	X	No Change (Hold)
H	X	H	X	No Change (Hold)

NOTES)

1) ALL RESISTOR VALUES R = 20 kΩ ±10% 1/4 W

2) Vcc = 5.0V ±0.5V Vcc/2 = 2.5V ± 0.25V

3) TEMPERATURE = +25°C AND +125°C (+8/-0)