PPM 92-85

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Interoffice Memorandum

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PPM-92-0075
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February 24, 1992
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Radiation Report on CD54HC74F3
GGS/WIND/WAVES Control No. 5732

A radiation evaluation was performed on the CD54HC74F3 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, four parts were irradiated under bias (see Figure 1 for bias configuration), and one part was used as a control sample. The total dose radiation steps were 5, 8.6, 15, and 20 krads. After 20 krads, the parts were annealed at +25°C for 168 hours and at 100°C for 168. The dose rate was between 50 and 150 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, the parts were electrically tested at +25°C according to the test conditions and the specification limits listed in Table III. These tests included three functional tests at 1 MHz after each radiation and annealing step.

All parts passed all three functional tests on irradiation to 20 krads and on the subsequent annealing treatment under bias for 168 hours at 25°C followed by 168 hours at 100°C. However, after 5 krads of exposure, all four irradiated parts exceeded the specification limit of 4 uA maximum for ICCH and ICCL. The readings were as high as 20 uA for each of these parameters. The ICCH and ICCL parameters continued to degrade throughout the testing to 20 krads. After 20 krads of exposure these parameters had readings up to 2 mA. Also, after 20 krads of exposure all of the parts were unable to switch their outputs to the appropriate state during the VOH1 and VOL1 tests. The test conditions for these two tests were Vcc = 2.0 V with a load of 20 uA. However, all of the parts passed the VOH and VOL tests at Vcc = 4.5 V and 6.0 V throughout testing to 20 krads and on the subsequent annealing.

The parts showed slight recovery on annealing at 25°C for 168 hours and at 100°C for 168 hours; however, all of the parts were still well in excess of the specified limits for ICCH and ICCL. Also the switching problem at Vcc = 2.0 V continued throughout the annealing steps.

Table IV provides the mean and standard deviation values for each parameter after each radiation exposure and annealing treatment. It also provides a summary of the functional test results after each radiation/annealing step. Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301)731-8954.

In this report, the term "rads" is used as an abbreviation for rads (Si).

TABLE I. Part Information

Generic Part Number:	54HC74
GGS/WIND/WAVES Part Number:	CD54HC74F3
Control Number:	5732
Charge Number:	C23417
Manufacturer:	R C A
Lot Date Code:	8619
Quantity Tested:	4
Serial Numbers of Radiation Samples:	502, 503, 504, 505
Serial Number of Control Sample:	501
Part Function:	DUAL D-TYPE POSITIVE EDGE TRIGGERED FLIP FLOP
Part Technology:	CMOS
Package Style:	14-pin DIP

TABLE II. Radiation Schedule for CD54HC74F3

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements	01/07/92
2) 5 KRAD IRRADIATION (0.10 krads/hour)	01/07/92
POST 5 KRAD ELECTRICAL MEASUREMENT	01/09/92
3) 8.6 KRAD IRRADIATION * (0.05 krads/hour)	01/09/92
POST 8.6 KRAD ELECTRICAL MEASUREMENT	01/13/92
3) 15 KRAD IRRADIATION (0.15 krads/hour)	01/13/92
POST 15 KRAD ELECTRICAL MEASUREMENT	01/15/92
4) 20 KRAD IRRADIATION (0.12 krads/hour)	01/15/92
POST 20 KRAD ELECTRICAL MEASUREMENT	01/17/92
5) 168 HOURS ANNEALING AT 25°C	01/17/92
POST 168 HOURS ELECTRICAL MEASUREMENT	01/24/92
6) 168 HOURS ANNEALING AT 100°C	01/29/92
POST 168 HOURS ELECTRICAL MEASUREMENT	02/05/92

* Anomolous Event:

Due to a power failure in the radiation lab, the parts received 8.6 krads of exposure instead of the 10 krads as planned.

Notes:

- All parts were radiated under bias at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at +25°C.
- All annealing steps were performed under bias.

Table III. Electrical Characteristics of CD54HC74F3

FUNCTIONAL TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS OVER TEMP.
FUNCT 1	2.0V	0.0V	2.0V	FREQ=1.0 MHz	I/O	VOL<1.00V; VOH>1.00V
FUNCT 2	4.5V	0.0V	4.5V	FREQ=1.0 MHz	I/O	VOL<2.25V; VOH>2.25V
FUNCT 3	6.0V	0.0V	6.0V	FREQ=1.0 MHz	I/O	VOL<3.00V; VOH>3.00V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS @ 25°C
VOH1	2.0V	0.50V	1.50V	LOAD= -20uA	OUTS	> 1.90V ; <2.0V
VOH2	4.5V	1.35V	3.15V	LOAD= -20uA	OUTS	> 4.40V ; <4.5V
VOH3	6.0V	1.80V	4.20V	LOAD= -20uA	OUTS	> 5.90V ; <6.0V
VOH4	4.5V	1.35V	3.15V	LOAD= -4mA	OUTS	> 3.98V ; <4.5V
VOH5	6.0V	1.80V	4.20V	LOAD=-5.2mA	OUTS	> 5.48V ; <6.0V
VOL1	2.0V	0.50V	1.50V	LOAD= +20uA	OUTS	> 0.0V ; <0.10V
VOL2	4.5V	1.35V	3.15V	LOAD= +20uA	OUTS	> 0.0V ; <0.10V
VOL3	6.0V	1.80V	4.20V	LOAD= +20uA	OUTS	> 0.0V ; <0.10V
VOL4	4.5V	1.35V	3.15V	LOAD= +4mA	OUTS	> 0.0V ; <0.26V
VOL5	6.0V	1.80V	4.20V	LOAD=+5.2mA	OUTS	> 0.0V ; <0.26V
IIH	6.0V	0.0V	6.0V	VIN = 6.0V	INS	>-0.1uA ; <0.1uA
IIL	6.0V	0.0V	6.0V	VIN = 0.0V	INS	>-0.1uA ; <0.1uA
ICCH	6.0V	0.0V	6.0V	VIN = 6.0V	VCC	> 0.0uA ; <4.0uA
ICCL	6.0V	0.0V	6.0V	VIN = 0.0V	VCC	> 0.0uA ; <4.0uA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	LIMITS @ 25°C
TPLH1 CP>Q,Q_	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <35.0nS
TPHL1 CP>Q,Q_	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <35.0nS
TPLH1 CD_>Q_	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <40.0nS
TPHL1 CD_>Q	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <40.0nS
TPLH1 SD_>Q	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <40.0nS
TPHL1 SD_>Q_	4.5V	0.0V	4.5V	FREQ=1MHz	>1.0nS ; <40.0nS

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for CD54HC74F3 1/ 2/

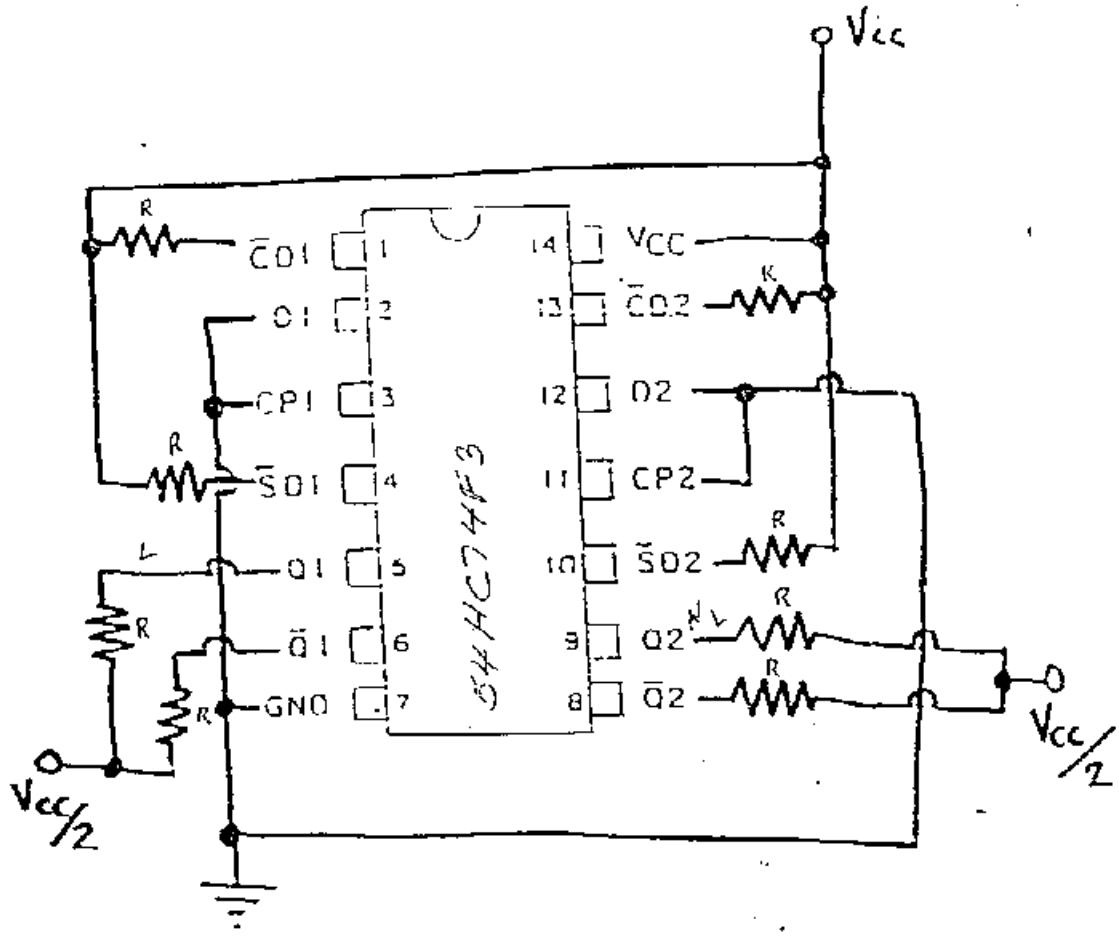
Parameters		Spec Limits min	max	Total Dose Exposure (TDE) (krads) 0 (Pre-Rad) mean	sd	5 mean	sd	10 mean	sd	15 mean	sd	20 mean	sd	Anneal 168 hrs @25°C mean	sd	168 hrs @100°C mean	sd
FUNC1 @ 1	MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass	
FUNC2 @ 1	MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass	
FUNC3 @ 1	MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass	
VOH1_2.0V	V	1.90	2.00	1.99	0	1.99	0	1.99	0	1.99	0	****	****	****	****	****	****
VOH2_4.5V	V	4.40	4.50	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0	4.49	0
VOH3_6.0V	V	5.90	6.00	5.99	0	5.99	0	5.99	0	5.99	0	5.99	0	5.99	0	5.99	0
VOH4_4.5V	V	3.90	4.50	4.38	0.01	4.37	0	4.37	0	4.37	0	4.36	0	4.36	0	4.36	0
VOH5_6.0V	V	5.40	6.00	5.87	0	5.87	0	5.87	0	5.86	0	5.86	0	5.86	0	5.86	0.01
VOL1_2.0V	mV	0	100	0	0	0	0	0	0	0	0	****	****	****	****	****	****
VOL2_4.5V	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL3_6.0V	mV	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOL4_4.5V	mV	0	260	70.3	0	68.0	0	66.6	0	65.5	0	65.1	0	64.9	0	67.0	0
VOL5_6.0V	mV	0	260	72.8	0	70.8	0	70.1	0	69.6	0	69.8	0	69.4	0	72.6	0
IIH	uA	-0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	uA	-0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICCH	uA	0	4.0	0	0	11.55	4.49	277.9	86.25	944.5	219.8	1762	349.0	1548	333.6	1075	309.2
ICCL	uA	0	4.0	0	0	15.45	5.29	341.8	86.50	978.3	203.6	1711	317.0	1507	300.7	1080	268.8
TPLH CP>Q	ns	1.0	35.0	15.33	2.28	16.31	2.64	17.21	2.99	17.94	3.29	18.41	3.54	18.48	3.50	18.86	3.49
TPHL CP>Q	ns	1.0	35.0	16.75	3.25	17.32	3.36	17.16	3.35	17.04	3.33	16.90	3.30	19.92	3.30	17.28	3.33

Notes:

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

2/ After 20 krads of exposure and the annealing steps, all four samples were unable to switch their outputs to the appropriate state for VOH1 and VOL1. The statistics for these two parameters at these steps are default readings which indicate the inability to switch states properly.

Figure 1. Radiation Bias Circuit for CD54HC74F3



R= 1KOHM, 1/4W 5% Tol.

V_{CC} = 5V ± 10%, $V_{CC/2}$ = 2.5V ± 10%.

TA = +25°C