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To

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DepartmentCode 311
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Department7809
SubjectRadiation Report on CD54HC40103F3A
GGS/WIND/WAVES Control No. 5734

Date PPM-92-115

Location March 20, 1992

Telephone GSFC

Location 731-8954

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A radiation evaluation was performed on CD54HC40103F3A 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, 10, 15 and 20 krads*. After 20 krads, parts were annealed at +25°C for 168 hours and then at +100°C for 168 hours. The dose rate was between 0.05 and 0.12 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 three functional tests (1 MHz) at 2.0, 4.5 and 6.0V.

All four irradiated parts exceeded the maximum specification limits for ICCH and ICCL after the first radiation exposure to 5 krads. Parts showed increased degradation in ICCH and ICCL on continued irradiation to 10, 15 and 20 krads. Additionally, after 20 krads, all four irradiated parts failed functional test #1 and exceeded the maximum specification limit for VOL1. Parts continued to fail functional test #1 on annealing at 25°C and 100°C, but showed some recovery in ICCH and ICCL.

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.

*In this report, the term krads means krads (Si).

TABLE I. Part Information

Generic Part Number:	54HC40103
GGG/WIND/WAVES Part Number:	CD54HC40103F3A
GGG/WIND/WAVES Control Number:	5734
Charge Number:	C23419
Manufacturer:	RCA
Lot Date Code:	8907
Quantity Tested:	5
Serial Numbers of Radiation Samples:	154, 155, 156, 157
Serial Numbers of Control Sample:	153
Part Function:	8-bit down counter
Part Technology:	CMOS
Package Style:	16-lead DIP
Test Engineer:	Anh Phung

TABLE II. Radiation Schedule for 54HC40103

EVENTS	DATE
1) Initial Electrical Measurements	02/05/92
2) 5 KRAD IRRADIATION (0.12 krads/hour) POST-5 KRAD ELECTRICAL MEASUREMENT	02/10/92 02/12/92
3) 10 KRAD IRRADIATION (0.12 krads/hour) POST-10 KRAD ELECTRICAL MEASUREMENT	02/12/92 02/14/92
4) 15 KRAD IRRADIATION (0.11 krads/hour) POST-15 KRAD ELECTRICAL MEASUREMENT	02/18/92 02/20/92
5) 20 KRAD IRRADIATION (0.05 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	02/20/92 02/24/92
6) 168 HOUR ANNEALING @ 25°C POST-168 HOUR 25°C ANNEAL ELECTRICAL MEASUREMENT	02/24/92 03/02/92
7) 168 HOUR ANNEALING @ 100°C POST-168 HOUR 100°C ANNEAL ELECTRICAL MEASUREMENT	03/02/92 03/10/92

all electrical measurements performed at 25°C.

All parts irradiated under bias, see Figure 1.

All annealings performed under bias, see Figure 1.

Table III. Electrical Characteristics of 54HC40103

NO.	PARAMETER	TEST CONDITIONS	MIN 25°C MAX		UNIT	PINS
1	FUNC # 1	V _{CC} = 2 V V _{IH} = 2.0 V V _{IL} = 0 V f = 1 Mhz				INS, OUT
2	FUNC # 2	V _{CC} = 4.5 V V _{IH} = 4.5 V V _{IL} = 0 V f = 1 Mhz				INS, OUT
3	FUNC # 3	V _{CC} = 6 V V _{IH} = 6.0 V V _{IL} = 0 V f = 1 Mhz				INS, OUT
4	VOH1	V _{CC} = 2 V V _{IH} = 1.5 V V _{IL} = 0.5 V I _O = -20 μ A	1.9		V	OUT
5	VOH2	V _{CC} = 4.5 V V _{IH} = 3.15 V V _{IL} = 1.35 V I _O = -20 μ A	4.4		V	OUT
6	VOH2	V _{CC} = 6.0 V V _{IH} = 4.2 V V _{IL} = 1.8 V I _O = -20 μ A	5.9		V	OUT
7	VOH4	V _{CC} = 4.5 V V _{IH} = 3.15 V V _{IL} = 1.35 V I _O = -4.0 mA	3.98		V	OUT
8	VOH5	V _{CC} = 6.0 V V _{IH} = 4.2 V V _{IL} = 1.8 V I _O = -5.2 mA	5.48		V	OUT
9	VOL1	V _{CC} = 2.0 V V _{IH} = 1.5 V V _{IL} = 0.5 V I _O = +20 μ A	0	0.1	V	OUT
10	VOL2	V _{CC} = 4.5 V V _{IH} = 3.15 V V _{IL} = 1.35 V I _O = +20 μ A	0	0.1	V	OUT
11	VOL3	V _{CC} = 6.0 V V _{IH} = 4.2 V V _{IL} = 1.8 V I _O = +20 μ A	0	0.1	V	OUT
12	VOL4	V _{CC} = 4.5 V V _{IH} = 3.15 V V _{IL} = 1.35 V I _O = +4.0 mA	0	0.26	V	OUT
13	VOL5	V _{CC} = 6.0 V V _{IH} = 4.2 V V _{IL} = 1.8 V I _O = +5.2 mA	0	0.26	V	OUT
14	I _{IH}	V _{CC} = 6.0 V V _{IH} = 6.0 V V _{IL} = 0	0	100	nA	INS
15	I _{IL}	V _{CC} = 6.0 V V _{IH} = 6.0 V V _{IL} = 0	-100	0	nA	INS
16	I _{CC_H}	V _{CC} = 6.0 V V _{IH} = 6.0 V V _{IL} = 0	0	8	μ A	V _{CC}
17	I _{CC_L}	V _{CC} = 6.0 V V _{IH} = 6.0 V V _{IL} = 0	0	8	μ A	V _{CC}
18	TP _{LH}	V _{CC} = 4.5 V V _{IH} = 4.5 V V _{IL} = 0	1	60	nS	OUT

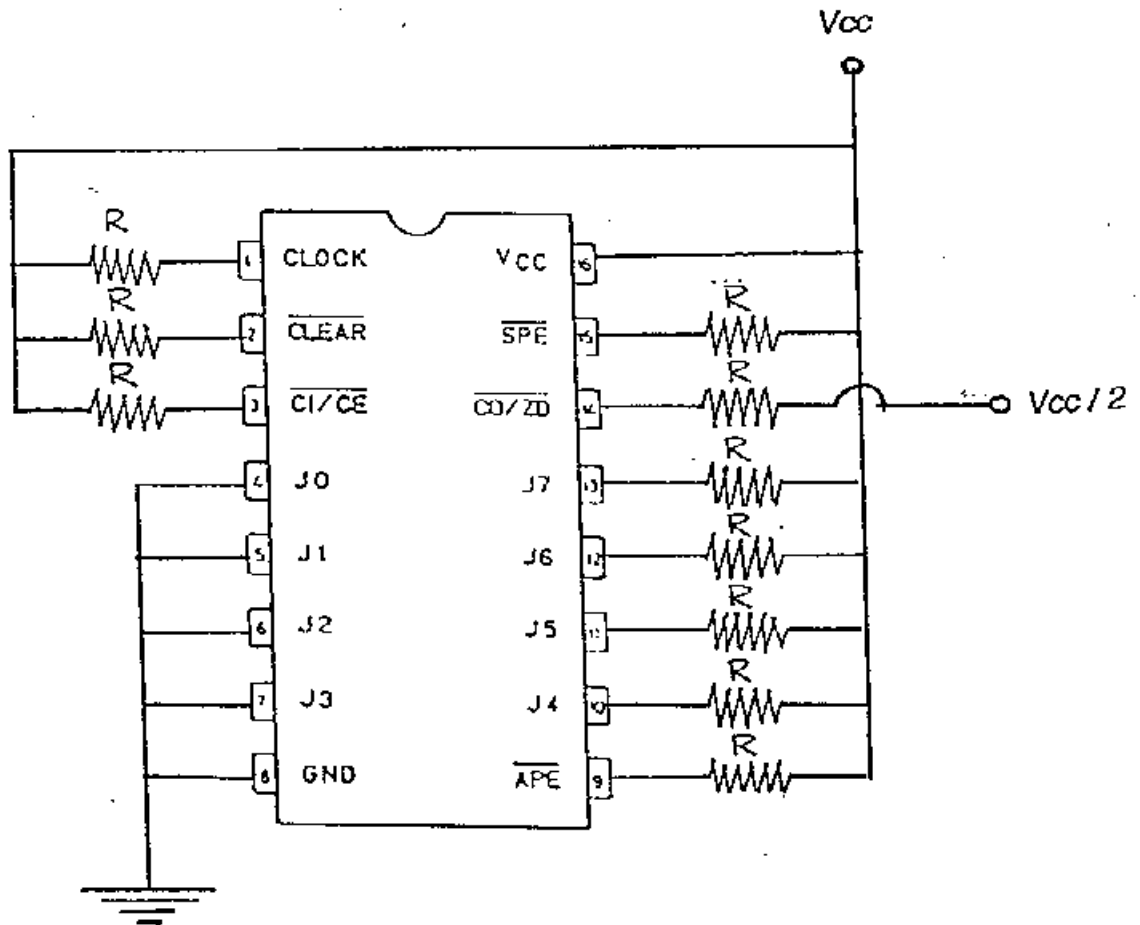
TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing Steps for 54HC40103 1/

Parameters	Spec. Limits min max	Total Dose Exposure (TDE) (krads)										Anneal		Anneal			
		(Pre-Rad.)		0		5		10		15		20		168 hrs @25°C		168 hrs @+100°C	
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1				P		P		P		P		P		P		P	
FUNC2				P		P		P		P		P		P		P	
FUNC3				P		P		P		P		P		P		P	
VOH1	V 1.9 -	2.00	0	2.00	0	2.00	0	2.00	.01	1.99	.01	1.99	.01	1.99	.01	2.00	.02
VOH2	V 4.4 -	4.51	0	4.51	.01	4.51	0	4.50	0	4.50	.01	4.50	.01	4.50	.01	4.50	.01
VOH3	V 5.9 -	6.00	.01	6.01	0	6.01	.01	6.00	.01	5.99	0	5.99	.02	5.99	.02	5.99	.02
VOH4	V 3.98 -	4.31	.01	4.33	.01	4.33	.01	4.32	.01	4.31	.01	4.29	.01	4.29	.01	4.32	.01
VOH5	V 5.48 -	5.81	.01	5.82	0	5.82	.01	5.82	.01	5.82	.01	5.79	.02	5.79	0	5.80	.01
VOL1	V 0 100	3.56	.06	3.55	.09	3.53	.12	4.13	.31	1984	12	1998	18	2003	16		
VOL2	V 0 100	3.28	0.3	3.54	.59	4.04	1.4	4.89	1.2	6.56	2.2	9.95	6.6	5.96	1.1		
VOL3	V 0 100	4.96	1.0	5.34	2.0	6.23	3.7	7.00	2.3	8.69	3.4	14.24	10	8.03	1.8		
VOL4	V 0 260	135.8	2.0	131.6	5.2	131.1	7.5	129.9	1.7	134.9	7.9	142.5	15	131.4	6.0		
VOL5	V 0 260	140.9	2.5	136.8	7.6	137.8	11	136.4	3.3	142.5	10	153.3	21	138.5	8.2		
IIR	nA 0 100	1.54	1.8	0	-	0	-	0	0.1	0	-	1.56	1.8	3.48	0.2		
IIL	nA -100 0	0	-	0	-	0	-	0	-	0	-	0	-	0	-		
ICCH	uA 0 8	.0059	0	14.61	3.5	240.5	33	906.9	106	1820	245	1636	221	1274	165		
ICCL	uA 0 8	.002	.002	13.05	1.0	212.6	9.4	1052	54	2589	101	2360	94	1828	66		
TPLH	ns 1 60	33.1	1.1	31.9	.85	30.5	0.9	29.9	0.9	30.8	1.0	23.9	14	30.9	1.8		

Note:

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

Figure 1. Radiation Bias Circuit for 54HC40103



$R = 2.2 \text{ Kohms} \pm 5\%, @ 1/2 \text{ W}$

$V_{cc} = 5.0 \text{ V} \pm 10\%$