

PPM 92-112

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From
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7809
Subject
Radiation Report on HCC4053BM2RB
GGG/WIND/WAVES Control No. 5731

PPM-92-122
Date
March 31, 1992
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A radiation evaluation was performed on the HCC4053BM2RB 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, the parts were annealed at 25°C for 168 hours and at 100°C for 168 hours. The dose rate was between 52 and 114 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 VDD = 5 V, 10 V and 15 V (frequency = 100 kHz).

All four parts passed all three functional tests upon irradiation to 5 krads. However, after 10 krads of exposure, one part failed functionally at VDD = 5 V. All of the functional failures were caused by a shift in the required input threshold levels on the control pins A, B, C, and INH due to the radiation exposure. After 15 krads all four parts failed functionally at VDD = 5 V and three failed functionally at VDD = 10 V. Upon further irradiation to 20 krads, the parts continued to degrade with all four failing functionally at VDD = 5 V and 10 V, and three parts failing functionally at VDD = 15 V. The 168 hour annealing step at 25°C did not produce any changes in the functional test results. However, the 168 hour annealing at 100°C reduced the number of functional failures. At this stage all four parts passed the functional test at VDD = 15 V. However, all four parts failed functionally at VDD = 5 V and two failed functionally at VDD = 10 V.

Parametrically, the parts remained within the specification limits through 5 krads of exposure. After 10 krads of exposure, all four parts were in excess of the +/-100 nA specification limit for IOFF with a maximum reading of -1 uA. Upon further irradiation to 15 krads, the parts continued to degrade for the IOFF parameter with maximum readings approaching -43 uA. In addition, all four parts exceeded the specification limits of 5 uA, 10 uA and 20 uA for IDD at 5 V, 10 V and 15 V respectively. The readings for each of these

parameters averaged 38 uA. After 20 krads of exposure, the parts exceeded the specification limits for all IDD tests including IDD at 20 V (maximum limit = 100 uA). At this stage all of the IDD parameters averaged 200 uA. The IOFF parameter also continued to degrade with maximum readings of -225 uA. Some recovery was observed for the IDD and IOFF parameters after annealing for 168 hours at 25°C. The IDD parameters averaged 170 uA and the maximum IOFF reading was -191 uA. Further recovery was observed after an additional 168 hour annealing at 100°C. At this stage all parts passed the IDD test at 20 V. However, all four parts continued to exceed the specification limits for the other IDD tests and the IOFF test. The IDD readings averaged 52 uA and the maximum IOFF reading was -65 uA.

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:	CD4053
GGG/WIND/WAVES Part Number:	HCC4053BM2RB
Control Number:	5731
Charge Number:	C23416
Manufacturer:	S.G.S Thomson
Lot Date Code:	8719
Quantity Tested:	4
Serial Numbers of Radiation Samples:	79, 80, 81, 82
Serial Number of Control Sample:	78
Part Function:	Triple 2-channel Multiplexer/Demultiplexer
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Engineer:	T. Scharer

TABLE II. Radiation Schedule for HCC4053BM2RB

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements	02/20/92
2) 5 KRAD IRRADIATION (52 rads/hour)	02/20/92
POST 5 KRAD ELECTRICAL MEASUREMENT	02/24/92
3) 10 KRAD IRRADIATION (110 rads/hour)	02/24/92
POST 10 KRAD ELECTRICAL MEASUREMENT	02/26/92
4) 15 KRAD IRRADIATION (114 rads/hour)	02/26/92
POST 15 KRAD ELECTRICAL MEASUREMENT	02/28/92
5) 20 KRAD IRRADIATION (74 rads/hour)	02/28/92
POST 20 KRAD ELECTRICAL MEASUREMENT	03/02/92
6) 168 HOURS ANNEALING AT 25°C	03/02/92
POST 168 HOURS ELECTRICAL MEASUREMENT	03/09/92
7) 168 HOURS ANNEALING AT 100°C	03/09/92
POST 168 HOURS ELECTRICAL MEASUREMENT	03/17/92

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 HCC4053BM2RB

FUNCTIONAL TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	PINS	LIMITS AT 25°C.
FUNCT 1	5 V	1.5V	3.5V	FREQ=100 kHz	I/O	VOL<0.5V; VOH>4.5 V
FUNCT 2	10 V	3.0V	7.0V	FREQ=100 kHz	I/O	VOL<0.5V; VOH>9.5 V
FUNCT 3	15 V	4.0V	11 V	FREQ=100 kHz	I/O	VOL<0.5V; VOH>14.5V

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	PINS	LIMITS @ 25°C
IDD5V	5 V	0 V	5 V		VDD	> 0 uA ; < 5 uA
IDD10V	10 V	0 V	10 V		VDD	> 0 uA ; < 10 uA
IDD15V	15 V	0 V	15 V		VDD	> 0 uA ; < 20 uA
IDD20V	20 V	0 V	20 V		VDD	> 0 uA ; <100 uA
RON5V	5 V	0 V	5 V	R1 = 10 k	I/O	> 0 ohms; <1050 ohms
RON10V	10 V	0 V	10 V	R1 = 10 k	I/O	> 0 ohms; < 400 ohms
RON15V	15 V	0 V	15 V	R1 = 10 k	I/O	> 0 ohms; < 280 ohms
IOFF	18 V	0 V	18 V	VINH = 18 V	I/O	>-100 nA; <100 nA
IIH	18 V			VIN = 18 V	CTL	>-0.1 uA; <0.1 uA
IIL	18 V			VIN = 18 V	CTL	>-0.1 uA; <0.1 uA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	LIMITS @ 25°C
TON5V	5 V	0 V	5 V	R1=10k, C1=35pF	> 0 nS ; <720 nS
TON10V	10 V	0 V	10 V	R1=10k, C1=35pF	> 0 nS ; <320 nS
TON15V	15 V	0 V	15 V	R1=10k, C1=35pF	> 0 nS ; <240 nS
TOFF5V	5 V	0 V	5 V	R1=10k, C1=35pF	> 0 nS ; <450 nS
TOFF10V	10 V	0 V	10 V	R1=10k, C1=35pF	> 0 nS ; <210 nS
TOFF15V	15 V	0 V	15 V	R1=10k, C1=35pF	> 0 nS ; <160 nS

EXCEPTIONS:

- 1) VIL and VIH are tested Go/No-Go in the functional test.
- 2) Input conditions for RON were taken from the RCA 1983 CMOS Data Book. (Dynamic RON Test: VIN=0 to VDD with the output terminated to VDD/2 through a 10k load).
- 3) The following tests are not performed: Off Channel Leakage All Channels Common, Propagation Delay Time Address to Signal, Propagation Delay Time Inhibit to Signal at VEE=-10 V.

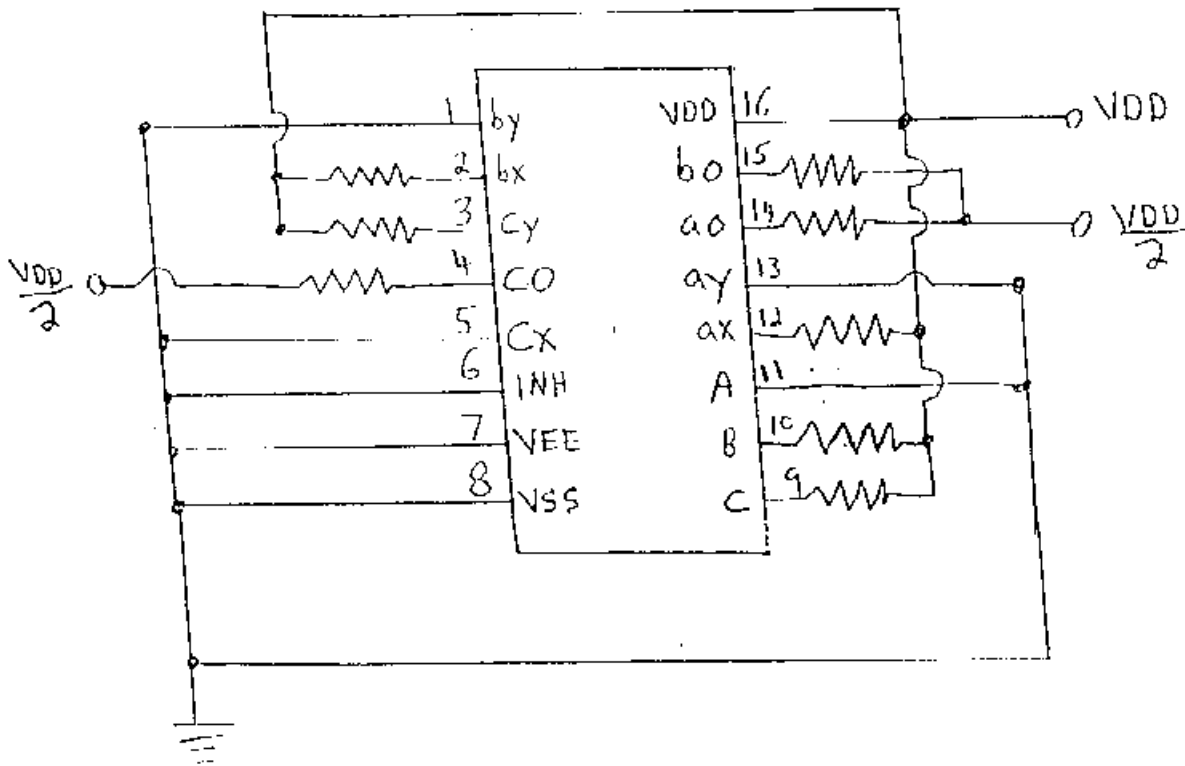
TABLE IV: Summary of Electrical Measurements After
Total Dose Exposures and Annealing for HCC4053BM2RB 1/

Parameters	Spec Limits min max		Total Dose Exposure (TDE) (krads)										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		
FUNC1 @ 5V			Pass		Pass		1 Fail		4 Fail		4 Fail		4 Fail		4 Fail		2 Fail	
FUNC2 @ 10V			Pass		Pass		Pass		3 Fail		3 Fail		4 Fail		3 Fail		Pass	
FUNC3 @ 15V			Pass		Pass		Pass		Pass		3 Fail		3 Fail		3 Fail		Pass	
IDD5V uA	0	5.0	0.00	0.00	0.00	0.00	0.82	0.27	37.46	3.84	199.9	13.1	168.2	11.8	49.6	5.5		
IDD10V uA	0	10.0	0.00	0.00	0.00	0.00	0.84	0.27	38.31	3.93	203.7	13.5	171.4	12.2	50.9	5.6		
IDD15V uA	0	20.0	0.01	0.00	0.00	0.00	0.88	0.27	39.65	4.00	209.6	13.8	176.3	12.4	52.6	5.8		
IDD20V uA	0	100.0	0.01	0.00	0.00	0.00	0.99	0.29	43.56	4.19	227.4	14.0	191.8	12.6	57.7	6.3		
RON5V ohms	0	1050	322.1	6.7	329.9	8.1	332.5	16.1	331.6	21.8	337.4	35.6	336.0	33.0	340.3	22.1		
RON10V ohms	0	400	185.3	4.7	189.8	5.2	189.5	5.8	188.5	6.3	190.9	8.6	190.7	9.1	194.7	8.3		
RON15V ohms	0	280	143.8	4.3	147.4	4.7	146.7	4.8	146.0	4.8	148.1	5.4	147.8	5.8	150.9	6.6		
IOFF nA	-100	100	-5.89	1.13	-2.95	1.42	-281.5	418.9	-13420	19090	-79430	10240	-65450	87620	-20420	29980		
IIB nA	-100	100	7.59	2.66	1.35	1.81	4.74	0.69	4.27	0.69	2.93	1.52	4.72	0.78	2.44	2.43		
IIL nA	-100	100	-1.50	1.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.62	1.33		
TONS5V nS	0	720	217.9	8.4	212.1	6.9	195.9	9.0	189.3	10.9	187.1	17.2	187.0	14.4	202.7	9.6		
TON10V nS	0	320	112.9	2.9	114.4	2.9	111.1	3.7	110.1	4.9	112.3	7.3	112.0	7.0	111.6	4.6		
TON15V nS	0	240	82.8	2.1	84.9	1.9	82.7	2.5	82.3	3.0	83.5	4.1	83.1	3.9	81.3	2.7		
TCFF5V nS	0	450	200.0	8.6	204.0	7.8	203.6	10.7	205.9	12.1	212.8	20.1	214.2	18.4	209.1	8.8		
TCFF10V nS	0	210	116.8	4.6	119.3	9.1	118.5	9.9	114.8	14.0	115.2	13.9	115.5	14.3	120.1	3.5		
TOFF15V nS	0	160	102.1	4.0	104.7	7.4	104.1	8.4	100.6	12.7	100.3	12.1	100.4	12.7	105.7	2.6		

Notes:

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 HCC4053BM2RB



$$VDD = +15V \pm 10\%$$

$$\frac{VDD}{2} = +7.5V \pm 10\%$$

$$R = 3.9k\Omega \pm 10\%, \frac{1}{4} W \text{ minimum}$$

$$T_A = 25^\circ C, 1^{st} \text{ annealing}$$

$$T_A = 100^\circ C, 2^{nd} \text{ annealing}$$