PPM 92-101

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UNISYS

Interoffice Memorandum

To
J. Lohr

Department
Code 311

From
K. Sahu

Department
7809

Subject
Radiation Report on HCC4011BM2RB
GGS/WIND/WAVES Control No. 5730

PPM-92-101

Date
March 9, 1992

Location
Lanham

Telephone
731-8954

Location
Lanham

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A radiation evaluation was performed on the HCC4011BM2RB 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 74 and 115 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 100 kHz after each radiation and annealing step.

All four parts passed all three functional tests on irradiation to 10 krads. However, after 15 krads of exposure, all four parts failed functionally at Vdd = 5 V. The parts continued to fail this functional test on irradiation to 20 krads and on the subsequent annealing steps at 25°C for 168 hours and at 100°C for 168 hours. However, the parts passed functional tests at Vdd = 10 V and Vdd = 15 V throughout the radiation testing and annealing treatments. Parametrically, the parts passed every test through 5 krads of exposure. However, after 10 krads of exposure, all four parts exceeded the specification limit for at least one of the following three tests: IDD1 (@ Vdd = 5 V), IDD2 (@ Vdd = 10 V) and IDD3 (@ Vdd = 15 V). The maximum readings were 1.85 uA for IDD1, 1.88 uA for IDD2, and 1.94 uA for IDD3 with maximum limits of 0.25 uA, 0.50 uA, and 1.00 uA respectively. The parts degraded further upon continued irradiation to 15 and 20 krads with all four devices exceeding the specification limits for IDD1, IDD2, IDD3 and IDD4 (@ Vdd = 20 V). After 20 krads the maximum readings for these parameters were 184 uA for IDD1, 187.5 uA for IDD2, 191.5 uA for IDD3, and 205 uA for IDD4. The maximum limit for IDD4 is 5 uA. The parts showed some recovery after annealing at 25°C for 168 hours and at 100°C for 168 hours. However, all four parts remained well above the specification limits for the IDD parameters. The maximum final readings were 69 uA for IDD1, 70 uA for IDD2, 72 uA for IDD3, and 78 uA for IDD4.

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:	HCC4011
GGS/WIND/WAVES Part Number:	HCC4011BM2RB
Control Number:	5730
Charge Number:	C23415
Manufacturer:	S G S Thomson
Lot Date Code:	8719
Quantity Tested:	4
Serial Numbers of Radiation Samples:	2, 3, 4, 5
Serial Number of Control Sample:	1
Part Function:	Quad 2-Input NAND Gate
Part Technology:	CMOS
Package Style:	14-pin DIP

TABLE II. Radiation Schedule for HCC4011BM2RB

EVENTS	DATE
1) Initial (Pre-Irradiation) Electrical Measurements	02/05/92
2) 5 KRAD IRRADIATION (115 rads/hour)	02/05/92
POST 5 KRAD ELECTRICAL MEASUREMENT	02/07/92
3) 10 KRAD IRRADIATION (74 rads/hour)	02/07/92
POST 10 KRAD ELECTRICAL MEASUREMENT	02/10/92
4) 15 KRAD IRRADIATION (115 rads/hour)	02/10/92
POST 15 KRAD ELECTRICAL MEASUREMENT	02/12/92
5) 20 KRAD IRRADIATION (115 rads/hour)	02/12/92
POST 20 KRAD ELECTRICAL MEASUREMENT	02/14/92
6) 168 HOURS ANNEALING AT 25°C	02/14/92
POST 168 HOURS ELECTRICAL MEASUREMENT	02/21/92
7) 168 HOURS ANNEALING AT 100°C	02/21/92
POST 168 HOURS ELECTRICAL MEASUREMENT	02/28/92

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 HCC4011BM2RB

FUNCTIONAL TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	PINS
FUNCT 1	5 V	1.5 V	3.5 V	FREQ=100 kHz	I/O
FUNCT 2	10 V	3.0 V	7.0 V	FREQ=100 kHz	I/O
FUNCT 3	15 V	4.0 V	11 V	FREQ=100 kHz	I/O

DC PARAMETRIC TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	PINS	LIMITS @ 25°C
IDD1	5 V	0 V	5 V		VDD	> 0.0 nA ; <0.25 uA
IDD2	10 V	0 V	10 V		VDD	> 0.0 nA ; <0.50 uA
IDD3	15 V	0 V	15 V		VDD	> 0.0 nA ; <1.00 uA
IDD4	20 V	0 V	20 V		VDD	> 0.0 nA ; <5.00 uA
IOL1	5 V	0 V	5 V	Vo = 0.4 V	OUTS	> 0.51 mA
IOL2	10 V	0 V	10 V	Vo = 0.5 V	OUTS	> 1.30 mA
IOL3	15 V	0 V	15 V	Vo = 1.5 V	OUTS	> 3.40 mA
IOH1	5 V	0 V	5 V	Vo = 2.5 V	OUTS	> 0.0 V ; <-1.60 mA
IOH2	5 V	0 V	5 V	Vo = 4.6 V	OUTS	> 0.0 V ; <-0.51 mA
IOH3	10 V	0 V	10 V	Vo = 9.5 V	OUTS	> 0.0 V ; <-1.30 mA
IOH4	15 V	0 V	15 V	Vo =13.5 V	OUTS	> 0.0 V ; <-3.40 mA
VOL1	5 V	0 V	5 V		OUTS	> 0.0 V ; < 50 mV
VOL2	10 V	0 V	10 V		OUTS	> 0.0 V ; < 50 mV
VOL3	15 V	0 V	15 V		OUTS	> 0.0 V ; < 50 mV
VOH1	5 V	0 V	5 V		OUTS	> 4.95 V
VOH2	10 V	0 V	10 V		OUTS	> 9.95 V
VOH3	15 V	0 V	15 V		OUTS	>14.95 V
IIH	18 V	0 V	18 V		INS	> 0.0 uA ; <+0.1 uA
IIL	18 V	0 V	18 V		INS	>-0.1 uA ; < 0.0 uA

AC PARAMETRIC TESTS PERFORMED

PARAMETER	VDD	VIL	VIH	CONDITIONS	LIMITS @ 25°C
TPLH1	5 V	0 V	5 V		>1.0 nS ; <250.0 nS
TPLH2	10 V	0 V	10 V		>1.0 nS ; <120.0 nS
TPLH3	15 V	0 V	15 V		>1.0 nS ; < 90.0 nS

Exceptions: 1/ VIH and VIL are tested during functional testing.

2/ There are no loads for the A.C. tests.

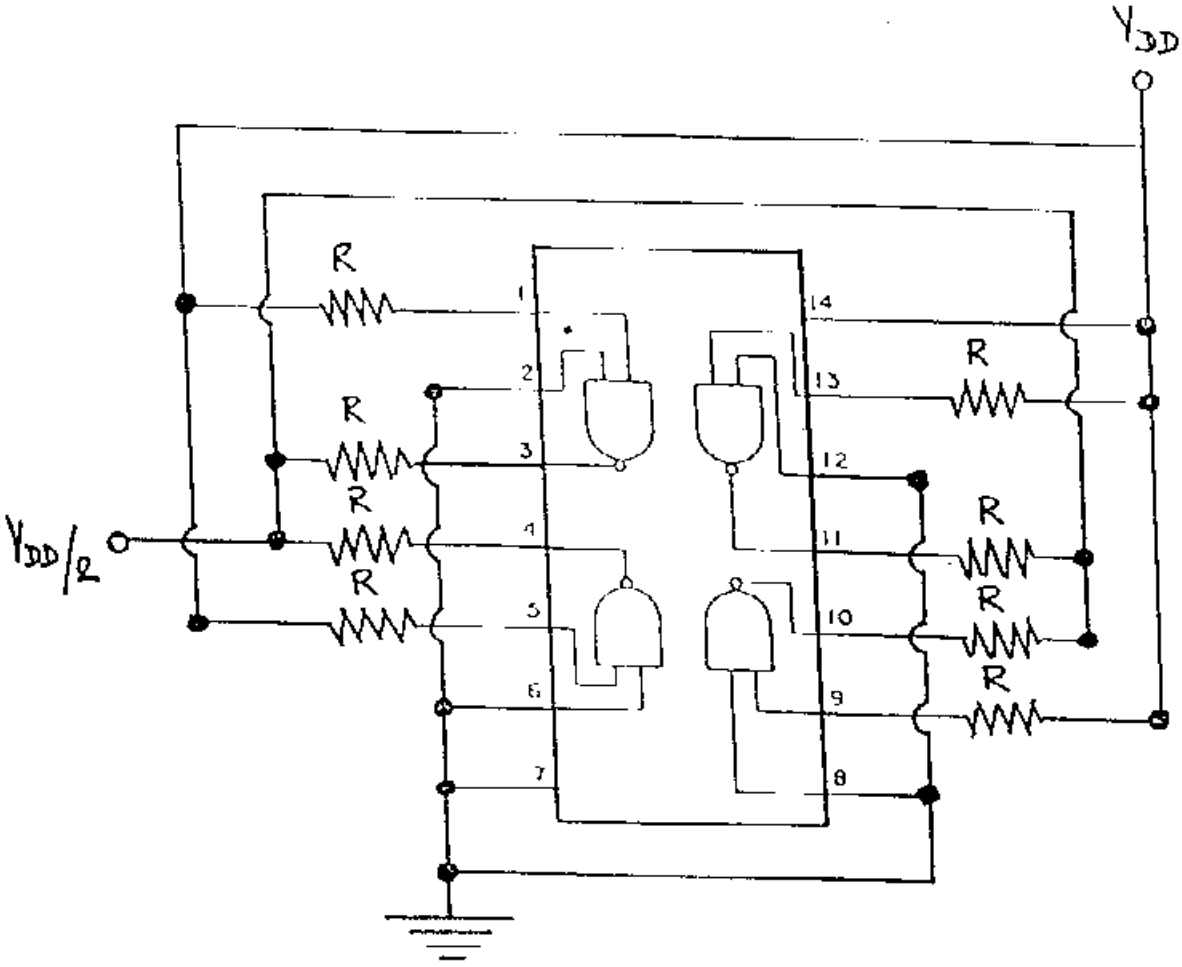
TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for HCC4011BM2RB 1/

Parameters		Spec Limits min	Spec Limits max	Total Dose Exposure (TDE) (krads) 0 (Pre-Rad) mean	0 (Pre-Rad) sd	5 mean	5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	Anneal 168 hrs @ 25°C mean	168 hrs @ 25°C sd	168 hrs @ 100°C mean	168 hrs @ 100°C sd
FUNC1	1 MHz			Pass		Pass		Pass		4 Fail		4 Fail		4 Fail		4 Fail	
FUNC2	1 MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass	
FUNC3	1 MHz			Pass		Pass		Pass		Pass		Pass		Pass		Pass	
IDD1	uA	0	0.25	0.00	0.00	0.41	0.00	1.10	0.51	26.06	10.04	115.6	43.0	98.17	36.5	43.5	16.88
IDD2	uA	0	0.50	0.00	0.00	1.83	0.00	1.12	0.52	26.44	10.21	117.3	43.9	99.67	37.3	44.2	17.24
IDD3	uA	0	1.00	0.00	0.00	3.41	0.00	1.15	0.54	27.02	10.48	119.8	45.0	101.8	38.3	45.0	17.73
IDD4	uA	0	5.00	0.00	0.00	5.83	0.00	1.22	0.57	28.87	11.35	127.6	48.5	108.8	41.4	48.2	19.27
IOL1	mA	0.51	-	1.20	0.03	1.26	0.04	1.26	0.04	1.25	0.04	1.22	0.04	1.24	0.05	1.25	0.05
IOL2	mA	1.30	-	2.77	0.11	2.83	0.13	2.80	0.11	2.78	0.12	2.76	0.13	2.81	0.14	2.80	0.14
IOL3	mA	3.40	-	10.43	0.42	10.61	0.48	10.47	0.43	10.36	0.40	10.36	0.45	10.60	0.50	10.57	0.53
IOH1	mA	0	-1.60	-3.47	0.31	-3.24	0.30	-2.98	0.30	-2.75	0.30	-2.53	0.29	-2.57	0.30	-2.57	0.31
IOH2	mA	0	-0.51	-0.83	0.05	-0.80	0.05	-0.76	0.05	-0.72	0.05	-0.68	0.05	-0.68	0.05	-0.69	0.06
IOH3	mA	0	-1.30	-1.93	0.08	-1.91	0.08	-1.87	0.08	-1.84	0.07	-1.81	0.07	-1.85	0.09	-1.86	0.12
IOH4	mA	0	-3.40	-7.49	0.26	-7.47	0.26	-7.37	0.26	-7.28	0.25	-7.18	0.25	-7.29	0.26	-7.36	0.27
VOL1	mV	0	50.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VOL2	mV	0	50.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VOL3	mV	0	50.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VOH1	mV	4.95	-	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00
VOH2	mV	9.95	-	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.01	10.00	0.00	10.00	0.00
VOH3	mV	14.95	-	15.00	0.01	15.00	0.01	15.00	0.00	15.00	0.00	15.00	0.01	15.00	0.00	15.00	0.00
IIH	nA	-	100.0	0.68	1.44	1.02	1.55	0.97	1.59	0.88	1.57	0.66	1.41	1.43	2.28	1.42	2.13
IIL	nA	-100.0	-	-0.10	0.54	0.00	0.00	0.00	0.00	-0.09	0.53	0.00	0.00	0.00	0.00	0.00	0.00
TPLH1	nS	1.00	250.0	55.22	6.79	57.81	6.29	59.33	6.56	62.36	7.03	65.16	7.76	67.47	8.84	67.77	8.28
TPLH2	nS	1.00	120.0	15.81	3.28	27.00	2.88	26.45	2.72	26.91	2.71	27.00	2.66	28.75	3.31	28.78	3.27
TOLH3	nS	1.00	90.0	18.92	2.85	19.95	2.54	19.30	2.49	19.50	2.40	19.42	2.45	21.14	2.85	21.17	2.72

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 HCC4011BM2RB



R = 2.2 Kohms + / - 5 %, @ 1/2 W

Vdd = 15 + / - 0.5 V

Vdd / 2 = 7.5 + / - 0.5 V