PPM-92-314

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Paramax Systems
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Memorandum

PARAMAX
A Unisys Company

DATE: December 29, 1992 PPM-92-314
TO: B. Fafaul/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on FAST/MUE
Part No. 5962-87548023A(MD8251)
Control No. 6143

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

A radiation evaluation was performed on MD8251 (Programmable Communication Interface) 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 levels 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 (cumulative). The dose rate was between 0.07 and 2.0 krads/hour, depending on the total dose level (see Table II for radiation schedule). Finally, the parts were annealed for 168 hours at 100°C. 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 eleven functional tests (eight at 1.0 MHz and three at 3.125 MHz).

All ten parts passed initial (pre-rad) electrical tests. All irradiated parts passed all electrical tests up to and including the 20-krad irradiation level. After the 40-krad irradiation, one part (SN 154) failed VOH1 and VOH2 (see Note 1 at bottom of Table III for more details). All other irradiated parts continued to pass at this irradiation level. After the 60-krad

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*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
**These are manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

irradiation, all eight irradiated parts failed VOH1 and VOH2 in the same way. After annealing for 168 hours at 25°C, the VOH1 and VOH2 failures continued. In addition, one part (SN 156) failed the VOL2 test (see Note 1 at the bottom of Table III for more details). After continued irradiation to 100 krads (cumulative), the VOH and VOL failures continued. SN 157 also failed functional test #5, with VCC = 5.0 V and frequency of 1.0 MHz.

After a final annealing at 100°C to investigate rebound effects, all eight irradiated parts failed at least eight functional tests with TRDZH and TDFHZ, which have a maximum specification limit of 200 and 250 ns, respectively, showing values exceeding 1 ms. There were also additional VOL failures.

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:	MD8251
Part Number:	5962-87548023A
FAST/MUE Control Number:	6145
Charge Number:	C24022
Manufacturer:	Intel Corp.
Lot Date Code:	9213
Quantity Tested:	10
Serial Numbers of Radiation Samples:	152, 153, 154, 155, 156, 157, 158, 159
Serial Numbers of Control Samples:	150, 151
Part Function:	Programmable Communication Interface
Part Technology:	CMOS
Package Style:	20-pin DIP
Test Engineer:	A. Karygiannis

TABLE II. Radiation Schedule for MD8251

EVENTS	DATE
1) Initial Electrical Measurements	10/28/92
2) 5 KRAD IRRADIATION (0.25 krads/hour)	10/29/92
POST-5 KRAD ELECTRICAL MEASUREMENT	10/30/92
3) 10 KRAD IRRADIATION (0.25 krads/hour)	10/30/92
POST-10 KRAD ELECTRICAL MEASUREMENT	11/02/92
4) 20 KRAD IRRADIATION (0.51 krads/hour)	11/02/92
POST-20 KRAD ELECTRICAL MEASUREMENT	11/03/92
5) 40 KRAD IRRADIATION (1.00 KRADS/HOUR)	11/03/92
POST-40 KRAD ELECTRICAL MEASUREMENT	11/04/92
6) 60 KRAD IRRADIATION (1.00 KRADS/HOUR)	11/04/92
POST-60 KRAD ELECTRICAL MEASUREMENT	11/05/92
7) 168 HOUR ANNEALING @25°C	11/05/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/12/92
8) 100 KRAD IRRADIATION (2.05 KRADS/HOUR)	11/12/92
POST-100 KRAD ELECTRICAL MEASUREMENT	11/13/92
9) 168 HOUR ANNEALING @100°C*	11/13/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/20/92

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

*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 MD8251 /1

TESTS PERFORMED

PARAMETER	VCC	VIL	VIH	CONDITIONS	MODE	LIMITS AT +25C
FUNCT # 1	4.5V	0.0V	4.5V	FREQ =1.000MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 2	5.0V	0.8V	2.0V	FREQ =1.000MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 3	5.5V	0.0V	5.5V	FREQ =1.000MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 4	4.5V	0.0V	4.5V	FREQ =1.000MHz	SYNC	VOL<1.5V , VOH>1.5V
FUNCT # 5	5.0V	0.8V	2.0V	FREQ =1.000MHz	SYNC	VOL<1.5V , VOH>1.5V
FUNCT # 6	5.5V	0.0V	5.5V	FREQ =1.000MHz	SYNC	VOL<1.5V , VOH>1.5V
FUNCT # 7	5.0V	0.45V	2.4V	FREQ =1.000MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 8	5.0V	0.45V	2.4V	FREQ =3.125MHz	SYNC	VOL<1.5V , VOH>1.5V
FUNCT # 9	5.0V	0.45V	2.4V	FREQ =3.125MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 10	5.0V	0.45V	2.4V	FREQ =1.000MHz	ASYNC	VOL<1.5V , VOH>1.5V
FUNCT # 11	5.0V	0.45V	2.4V	FREQ =3.125MHz	ASYNC	VOL<1.5V , VOH>1.5V

DC PARAMETERS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
VOH1	4.5V	0.0V	4.5V	LOAD=-400UA	OUTS	>+2.4V , <+5.5V
VOH2	4.5V	0.8V	2.2V	LOAD=-400UA	OUTS	>+2.4V , <+5.5V
VOL1	4.5V	0.0V	4.5V	LOAD=+2.2MA	OUTS	>+0.0V , <+0.45V
VOL2	4.5V	0.8V	2.2V	LOAD=+2.2MA	OUTS	>+0.0V , <+0.45V
IIH	5.5V	0.0V	5.5V	VTST= 5.50V	INS	>+0.0A , <+10.0UA
IIL	5.5V	0.0V	5.5V	VTST= 0.00V	INS	>-10.0UA, <+0.0A
IOZH	5.5V	0.0V	5.5V	VOUT= 5.50V	OUTS	>-10UA , <+10UA
IOZL	5.5V	0.0V	5.5V	VOUT= 0.00V	OUTS	>-10UA , <+10UA
ICC	5.5V	0.0V	5.5V	VIN = 5.50V	VCC	>+0.0A , <+120MA

AC PARAMETERS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C
TRDZL	4.5V	0.45V	2.4V	VTEST= 0.8V	DATA	>+0.0NS , <+200.0NS
TRDZH	4.5V	0.45V	2.4V	VTEST= 2.0V	DATA	>+0.0NS , <+200.0NS
TDFL2	4.5V	0.45V	2.4V	VTEST= 1.3V	DATA	>+10.0NS , <+250.0NS
TDFHZ	4.5V	0.45V	2.4V	VTEST= 0.8V	DATA	>+10.0NS , <+250.0NS

1/ After 40 krads, SN 154 failed VOH1 and VOH2. In order to perform the VOH tests, a functional test patern is executed and then VOH is measured on each output pin. The output did not transition in this case, although it did during the functional test. It is not clear from the data what is actually causing the VOH failures. This type of failure occurs on other serial numbers as the radiation exposure continues. The VOH test results may be affacted by shifts in the input threshold values, timing characteristics, loading conditions, and/or increased sensitivity to the test conditions. After 168 hours annealing at 25°C, there was also a VOL failure. The VOL test is performed the same way as the VOH test.

Table III. Electrical Characteristics of MD8251 (cont.)

GO/NOGO PARAMETERS
(1) Address Stable before Read Tar 0.0 ns.
(2) Address Hold Time to Read Tra 0.0ns.
(3) Read Pulse Width Trr 250.0ns.
(4) Address Stable before Write Taw 0.0ns.
(5) Address Hold Time to Write Twa 20.0ns.
(6) Write Pulse Width Tww 250.0ns.
(7) Data Setup Time for Write Tdw 150.0ns.
(8) Data Hold Time for Write Twd 20.0ns.
(9) Recovery Time beteen Writes Trv for Mode Instruction 6 Clock Cycles.
(10) Minimum Clock Period Tcy 320.0ns.
(11) Minimum Clock High Pulse Width 140.0ns.
(12) Minimum Clock Low Pulse Width 90.0ns.
(13) Transmitter Input Clock Pulse Width Ttpw 1x Baud Rate = 12 Clock Cycles
(14) Receiver Input Clock Pulse Width Trpw 1x Baud Rate = 12 Clock Cycles.
(15) Maximum Clock Frequency = 3.125MHz.

FUNCTIONAL TEST DESCRIPTION
(1) Functional Test #1,2,3 tests the device in the Asynchronous Mode.
(2) Functional Test #4,5,6 tests the device in the Synchronous Mode.
(3) Functional Test #7 tests Go/NoGo parameters in the Asynchronous Mode.
(4) Functional Test #8 is performed at maximum frequency in the Synchronous Mode.
(5) Functional Test #9 tests Go/NoGo parameters at maximum frequency.
(6) Functional Test #10 tests the device at 16x Baud Rate in the Asynch. Mode.
(7) Functional Test #11 tests the device at 16x Baud Rate in the Asynch. Mode at maximum frequency of 3.125MHz.
(8) Functional Tests 7 - 11 test Vol and Voh go/nogo.

COMMENTS/EXCEPTIONS
(1) VIL and VIH tests were performed go/nogo during FUNCTIONAL and VOL and VOH tests.
(2) VOH Test not performed on TXRDY and RXRDY pins because PMU cannnot measure the value of a momentarily high output.
(3) TXD delay from falling edge of TXC Tdtx 1.0us maximum not tested.
(4) TXRDY delay from center of last bit Ttxrdy 12 clock cycles not tested.
(5) TXRDY from leading edge of Write Ttxrdy Clear 400ns maximum not tested.
(6) This program does not test the device in the 64x Baud Rate Mode.

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for MD8251 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 100 krads mean	sd	Anneal 168 hrs @100°C mean	sd
FUNC1, 1 MHz, 4.5 V/3				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC2, 1 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC3, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		1P7F	
FUNC5, 1 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		7P1F		FAIL	
FUNC6, 1 MHz, 5.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC7, 1 MHz, 4.5 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC8, 3.125 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC9, 3.125 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC10, 1 MHz, 5.0 V				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
FUNC11, 3.125 MHz, 5.0				PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		FAIL	
VOH1	V	2.4	5.5	3.50	.11	3.51	.09	3.53	.09	3.55	.07	3.44	.07	1.36	1.8	1.97	1.8	1.21	1.7	3.34	.65
VOH2	V	2.4	5.5	3.55	.05	3.55	.04	3.56	.04	3.58	.03	3.47	.07	1.21	1.7	2.06	1.8	1.21	1.7	3.24	.98
VOL1	mV	0	450	153	43	184	50	227	47	215	50	202	51	241	54	225	50	176	378	992	1114
VOL2	mV	0	450	153	43	183	48	226	45	210	46	202	52	240	53	208	194	176	378	683	1505
IIH	uA	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIL	uA	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOZH	uA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	.14	0	0
IOZL	uA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ICC	mA	0	120	70.8	3.2	71.2	2.6	72.1	2.6	74.6	2.9	77.1	2.8	78.2	3.0	75.8	3.3	78.8	3.6	67.4	2.9
TRDZL	ns	0	200	32.6	1.9	33.7	2.0	35.3	1.9	35.0	2.2	35.0	2.1	37.6	2.4	40.9	2.8	41.1	3.4	73.0	3.4
TRDZH/4	ns	0	200	28.0	1.6	28.1	1.5	27.8	1.7	27.4	1.7	27.8	1.6	29.2	1.8	32.5	2.1	32.3	2.2	>1ms	-
TDFLZ	ns	10	250	48.4	1.0	47.1	1.4	45.1	1.4	45.4	1.8	46.1	1.7	44.1	1.8	44.0	1.3	43.9	1.7	41.2	1.7
TDFHZ/4	ns	10	250	36.2	2.1	37.1	2.0	38.4	2.1	40.4	1.7	41.4	1.7	40.7	1.7	30.2	3.7	30.9	3.5	>1ms	-

Notes:

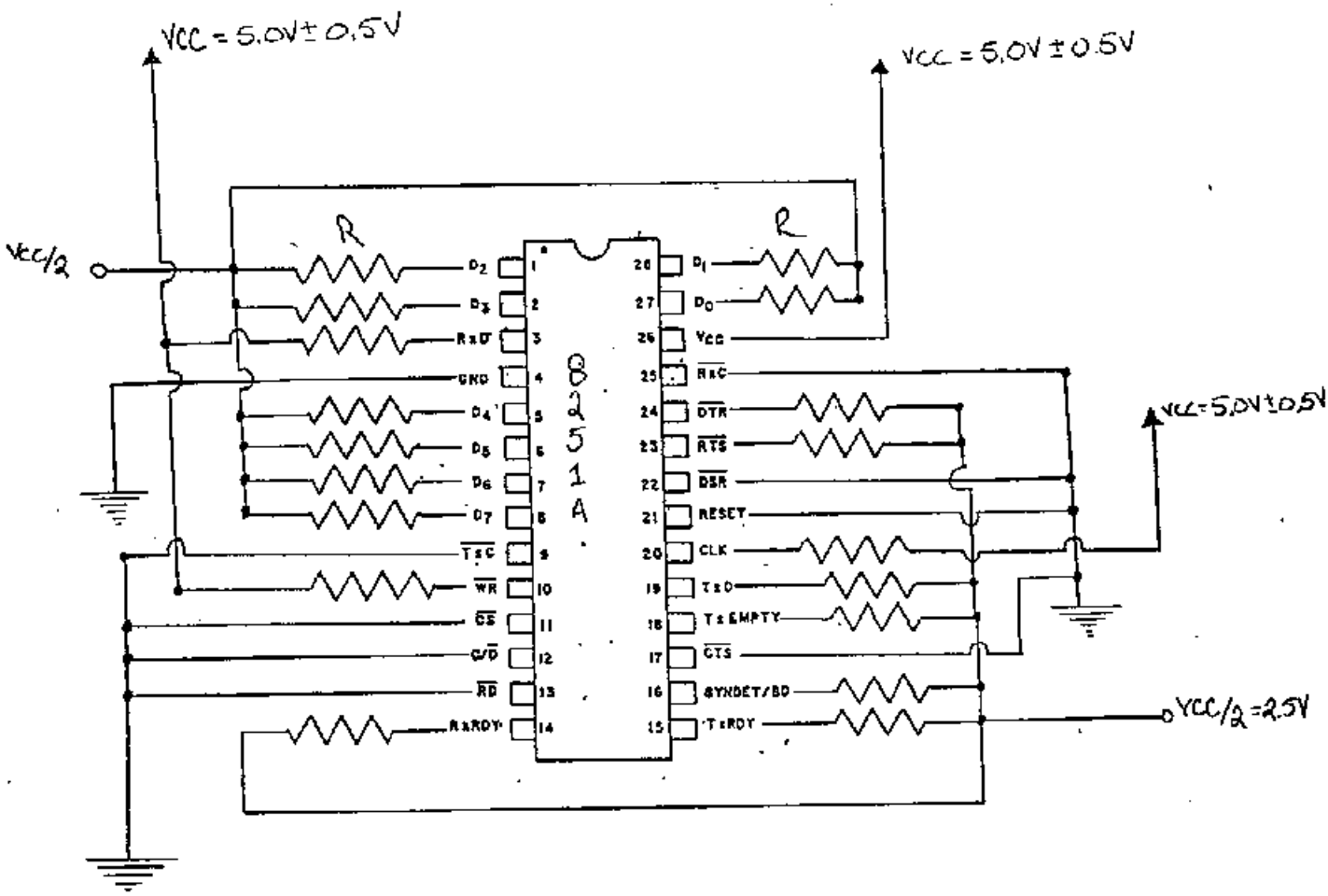
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

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/ "nPmF" indicates that n parts passed and m parts failed this test at this radiation or annealing level.

4/ After 168 hours of annealing at 100°C, TRDZH and TDFHZ increased to more than 1 ms, the maximum value that the ATE could measure for this parameter.

Figure 1. Radiation Bias Circuit for MD8251 1/, 2/



1/ VCC = 5.0 V ± 0.5 V. VCC/2 = 2.5 V ± 0.25 V.
2/ All resistor values R = 1.0Kohm ± 10%, 1/4W.