PPM 92-286

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Paramax Systems
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Memorandum

PARAMAX
A Unisys Company

PPM-92-286

DATE: Dec. 4, 1992
TO: B. Fafaul
FROM: K. Sahu KS
SUBJECT: Radiation Report on FAST/HCI
Part No. JANTXV2N2222A
Control No. 7348

cc: L. Shiflett/745.1
A. Sharma/311
Library/300.1
L. Cusick/740.4
SMEX, PPM File

A radiation evaluation was performed on 2N2222 (NPN Transistor) 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 steps were 5, 10, 20, 30 and 40 krads*. After 40 krads, parts were annealed at +25°C for 168 hours. The irradiation was then continued to 60 krads (cumulative). The dose rate was between 0.07 and 1.0 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 at 25°C according to the test conditions and the specification limits** listed in Table III.

All ten parts passed initial (pre-rad) electrical tests. All irradiated parts passed all electrical tests up to and including the 20-krad irradiation step. After the 30-krad irradiation, seven parts (SN 272, 273, 274, 275, 277, 278 and 279) did not meet the minimum specification limit of 50 for HFEs1, five parts (SN 272, 273, 274, 278 and 279) did not meet the minimum specification limit of 75 for HFEs2, and one part (SN 273)did not meet the minimum specification limit of of 100 for HFEs3.

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

Readings ranged from 36.90 to 49.26 (HFEs1) and 67.98 to 74.79 (HFEs2). The reading was 96.6 for HFEs3. The one remaining irradiated part continued to pass at this irradiation step. After the 40-krad irradiation, All eight irradiated parts failed to meet the minimum specification limits for both HFEs1 and HFEs2, with readings slightly lower than at the 30-krad step and five parts (SN 272, 273, 274, 278 and 279) failed to meet the minimum specification limit for HFEs3, with readings ranging from 89.45 to 99.50.

After annealing for 168 hours at 25°C, three parts (SN 272, 278 and 279) recovered to within specification limits for HFEs3 and one part (SN 276) recovered to within specification limits for HFEs2. After continued irradiation to 60 krads (cumulative), all eight irradiated parts failed to meet minimum specification limits for HFEs1-3, with readings ranging from 21.98 to 32.68 (HFEs1), 47.62 to 60.83 (HFEs2) and 77.82 to 93.90 (HFEs3). In addition, one part (SN273) failed to meet the minimum specification limit of 100 for HFEs4, with a reading of 95.24. No appreciable change was noted in any other parameters throughout all irradiation and annealing steps.

After a final annealing at 100°C, no rebound effects were observed.

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.

(c) GSFC does not warrant the accuracy of the information when applied or used under other than unique GSFC laboratory conditions;
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TABLE I. Part Information

Generic Part Number:	2N2222
Part Number:	JANTXV2N2222A
FAST/HCI Control Number:	7348
Charge Number:	C33110
Manufacturer:	Motorola
Lot Date Code:	9112
Quantity Tested:	10
Serial Numbers of Radiation Samples:	272, 273, 274, 275, 276, 277, 278,289
Serial Numbers of Control Samples:	270, 271
Part Function:	NPN Transistor
Part Technology:	Bipolar
Package Style:	20-pin DIP3-pin TOx can
Test Engineer:	A. Phung

TABLE II. Radiation Schedule for 2N2222

EVENTS	DATE
1) Initial Electrical Measurements	10/20/92
2) 5 KRAD IRRADIATION (0.25 krads/hour)	10/29/92
POST-5 KRAD ELECTRICAL MEASUREMENT	10/30/92
3) 10 KRAD IRRADIATION (0.074 krads/hour)	10/30/92
POST-10 KRAD ELECTRICAL MEASUREMENT	11/02/92
4) 20 KRAD IRRADIATION (0.513 krads/hour)	11/02/92
POST-20 KRAD ELECTRICAL MEASUREMENT	10/03/92
5) 30 KRAD IRRADIATION (0.50 KRADS/HOUR)	11/03/92
POST-30 KRAD ELECTRICAL MEASUREMENT	11/04/92
6) 40 KRAD IRRADIATION (0.56 KRADS/HOUR)	11/04/92
POST-40 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) 60 KRAD IRRADIATION (1.03 KRADS/HOUR)	11/12/92
POST-60 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 2N2222

Test	Conditions	Min.	Max.	Units
VBRCBO	Ic = 10 uA DC	75		V DC
VBREBO	Ie = 10 uA DC	6		V DC
VBRCEO	Ic = 10 mA DC	50		V DC
ICES	Vc = 50 V DC	0	10	nA DC
ICBO	Vcb = 60 V DC	0	50	nA DC
IEBO	Veb = 4 V DC	0	50	nA DC
HFEs1	Ic = 0.1 mA DC	50		
HFEs2	Ic = 1.0 mA DC	75	325	
HFEs3	Ic = 10 mA DC	100		
HFEs4	Ic = 150 mA DC	100	300	
HFEs5	Ic = 500 mA DC	30		
VCESAT1	Ic = 150 mA DC	0	0.3	V DC
VCESAT2	Ic = 500 mA DC	0	1.0	V DC
VBESAT1	Ic = 150 mA DC	0.6	1.2	V DC
VBESAT2	Ic = 500 mA DC	0	2.0	V DC

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing Steps for 2N2222 1/

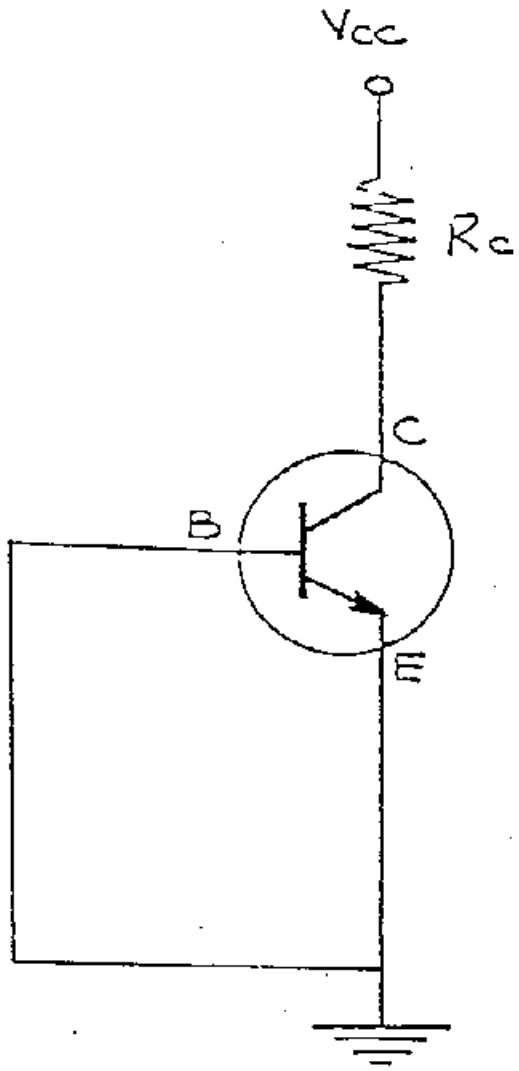
				Total Dose Exposure (TDE) (krads)														Anneal		TDE		Anneal	
		Spec. Lim./2		0 (Pre-Rad.)		5		10		20		30		40		168 hrs @25°C		60		168 hrs @+100°C	
Parameters		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
VERCBO	V	75	-	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VEREBO	V	6	-	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
VERCEO	V	50	-	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
ICES	nA	0	10	1.2	0.2	1.2	0.3	1.2	0.3	1.3	0.2	1.3	0.3	1.7	0.3	1.2	0.4	1.3	0.7	0.88	0.2
ICBO	nA	0	50	0.25	.02	0.32	.02	0.49	.07	0.66	0.2	0.88	0.2	1.24	0.4	0.98	0.3	1.44	0.7	0.28	.02
IEBO	nA	0	50	-.09	.02	-.08	.02	-.08	.02	-.06	.01	-.04	.02	-.02	.02	-.02	.02	0	.02	-.08	.02
HFEs1		50	-	170	9.7	119	5.4	68.2	6.3	58.4	6.3	44.1	5.3	36.3	4.8	38.6	4.8	26.6	3.4	78.5	3.1
HFEs2		75	325	177	10	138	5.5	116	4.9	88.6	5.5	74	5.5	65.3	5.4	68.2	5.2	52.8	4.5	105	3.7
HFEs3		100	-	184	11	156	7.1	140	5.7	119	5.3	106	5	98.9	5.1	102	5	86.3	4.7	132	5.8
HFEs4		100	300	172	10	155	7.8	146	6.6	131	5.8	122	5.2	117	5.1	120	5	106	4.7	140	6.9
HFEs5		30	-	111	4.7	104	4	98.5	3.6	90.3	3.4	85	3.3	81.2	3.2	83.5	3.3	75.6	3.2	97.0	3.6
VCESAT1	V	0	0.3	0.13	0	0.13	0	0.13	0	0.14	0	0.14	0	0.14	0	0.14	0	0.14	0	0.13	0
VCESAT2	V	0	1.0	0.33	0	0.33	0	0.33	0	0.34	.01	0.34	.01	0.35	.01	0.34	.01	0.35	.01	0.33	0
VBESAT1	V	0.6	1.2	0.79	0	0.80	0	0.79	0	0.79	0	0.80	0	0.80	0	0.79	0	0.79	0	0.79	0
VBESAT2	V	0	2.0	1.06	0	1.07	0	1.07	0	1.08	0	1.08	0	1.08	0	1.08	0	1.09	0	1.08	.01

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.

Figure 1. Radiation Bias Circuit for 2N2222



Vcc = 40 Vdc

Rc = 10 Kohm +/- 5 %, 1/4 W