PPM 92-307

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Paramax Systems
Corporation

4700 Boston Way
Lanham MD 20706

Memorandum

PARAMAX
A Unisys Company

PPM-92-307

DATE: Dec. 17, 1992
TO: B. Fafaul
FROM: K. Sahu KS
SUBJECT: Radiation Report on FAST/HCI
Part No. M38510/10102BIC (LM747)
Control No. 7351

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

A radiation evaluation was performed on LM747 (Dual Op Amp) 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 0.08 and 0.54 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 eight irradiated parts passed all electrical tests up to and including the 10-krad step. After the 20-krad exposure, three parts (SN 810, 812 and 814) did not meet the minimum specification limit of -3.0 mV for Vos@50(1) (Readings ranged from -44.43 to -113 mV.) and one part (SN 816) did not meet the minimum specification of -3.0 mV for Vos@50(2), with a reading of -60.69 mV. After the 30-krad irradiation, the same four parts again failed Vos@50, with readings ranging from -67.56 to -126.1 mV for Vos@50(1) and a reading of -72.25 mV for Vos@50(2). After the 40-krad irradiation, the same failures occurred, with the highest reading -61.86 mV (Vos@50(1)) and the lowest reading lower than -120 mV. In addition, two parts (SN 812 and 815) exceeded the maximum specification limit of 100 nA for

Ib+(2), with readings ranging from 111.8 to 118.2 nA and one part (SN 815) exceeded the maximum specification limit of 100 nA for Ib-(2), with a reading of 111.6 nA.

After annealing for 168 hours at 25°C, the Ib+ and Ib- failures recovered, but SN 810, 812, 814 and 816 continued to fail Vos@50, with readings ranging from -48.65 to -118.5 mV.

After continued irradiation to 60 krads (cumulative), no Vos@50 failures were observed, but six parts (SN 810, 811, 812, 814, 815 and 817) exceeded the maximum specification limit of 100 nA for Ib+(2) and Ib-(2), with readings ranging from 112.2 to 140.5 nA for Ib+(2) and from 110.3 to 145.4 nA for Ib-(2). One part (SN 812) exceeded the maximum specification limit of 100 nA for Ib+(3) and Ib-(3), with a maximum reading of 114.8 nA for Ib+(3) and a reading of 110.0 nA for Ib-(3), and one part (SN 815) exceeded the maximum specification limit for Ib-(3), with a reading of 110.3 nA.

After a final annealing at 100°C to observe rebound effects, three parts (SN 810, 812 and 814) again failed to meet the mimimum specification limit of -3.0 mV for Vos@50(1), with readings ranging from -26.8 to -113.9 mV, and one part (SN 816) failed to meet the minimum specification limit of -3.0 mV for Vos@50(2), with a reading of -41.03 mV.

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.

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

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TABLE I. Part Information

Generic Part Number:	LM747
Part Number:	M38510/10102BIC
FAST/HCI Control Number:	7351
Charge Number:	C33113
Manufacturer:	Raytheon
Lot Date Code:	9224
Quantity Tested:	10
Serial Numbers of Radiation Samples:	810, 811, 812, 813, 814, 815, 816, 817
Serial Numbers of Control Samples:	808, 809
Part Function:	Dual Op Amp
Part Technology:	Bipolar
Package Style:	10-lead TOx Can
Test Engineer:	A. Phung

TABLE II. Radiation Schedule for LM747

EVENTS	DATE
1) Initial Electrical Measurements	11/05/92
2) 5 KRAD IRRADIATION (0.08 krads/hour)	11/15/92
POST-5 KRAD ELECTRICAL MEASUREMENT	11/16/92
3) 10 KRAD IRRADIATION (0.29 krads/hour)	11/16/92
POST-10 KRAD ELECTRICAL MEASUREMENT	11/17/92
4) 20 KRAD IRRADIATION (0.49 krads/hour)	11/17/92
POST-20 KRAD ELECTRICAL MEASUREMENT	11/18/92
5) 30 KRAD IRRADIATION (0.54 KRADS/HOUR)	11/18/92
POST-30 KRAD ELECTRICAL MEASUREMENT	11/19/92
6) 40 KRAD IRRADIATION (0.50 KRADS/HOUR)	11/19/92
POST-40 KRAD ELECTRICAL MEASUREMENT	11/20/92
7) 168 HOUR ANNEALING @25°C	11/20/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/27/92
8) 60 KRAD IRRADIATION (0.30 KRADS/HOUR)	11/27/92
POST-60 KRAD ELECTRICAL MEASUREMENT	11/30/92
9) 168 HOUR ANNEALING @100°C*	11/30/92
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/07/92

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 LM747

DC Electrical Characteristics:

T_A=25°C, Rs=50 Ohm Unless Otherwise Specified.

TEST	CONDITIONS	LIMIT		UNITS
		Min	Max	
+Icc	Vcc+=+15V,Vcc-=-15V,Vo=0V		7.6	mA
-Icc	Vcc+=+15V,Vcc-=-15V,Vo=0V	-7.6		mA
Vos50	(1) Vcc+=35V,Vcc-=-5V	-3.0	3.0	mV
	(2) Vcc+=5V,Vcc-=-35V	-3.0	3.0	mV
	(3) Vcc+=20V,Vcc-=-20V	-3.0	3.0	mV
	(4) Vcc+=5V,Vcc-=-5V	-3.0	3.0	mV
Ios	(1) Vcc+=35V,Vcc-=-5V	-30	30	nA
	(2) Vcc+=5V,Vcc-=-35V	-30	30	nA
	(3) Vcc+=20V,Vcc-=-20V	-30	30	nA
	(4) Vcc+=5V,Vcc-=-5V	-30	30	nA
Ib+	(1) Vcc+=35V,Vcc-=-5V		110	nA
	(2) Vcc+=5V,Vcc-=-35V		110	nA
	(3) Vcc+=20V,Vcc-=-20V		110	nA
	(4) Vcc+=5V,Vcc-=-5V		110	nA

Table III. Electrical Characteristics of LM747 (cont.)

TEST CONDITIONS	LIMIT		UNITS
	Min	Max	
Ib- (1) Vcc+=35V,Vcc-=-5V		110	nA
(2) Vcc+=5V,Vcc-=-35V		110	nA
(3) Vcc+=20V,Vcc-=-20V		110	nA
(4) Vcc+=5V,Vcc-=-5V		110	nA
CMRR Vcm=+/-15V	80		dB
+PSRR Vcc+=(+20,+10), Vcc-=-20V	86		dB
-PSRR Vcc+=+20V, Vcc-=(-20,-10)	86		dB
Aol (1) Vo=+/-15V,RL=2K,Vcc=+/-20V	50		kV/V
(2) Vo=+/-15V,RL=10K,Vcc=+/-20V	50		kV/V
(3) Vo=+/-2V,RL=2K,Vcc=+/-5V	10		kV/V
+Vo. RL=10K, Vcc+=20V,Vcc-=-20V	16		V
-Vo. RL=10K, Vcc+=20V,Vcc-=-20V		-16	V

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing Steps for LM747 1/

				Total Dose Exposure (TDE) (krads)												Anneal		TDE		Anneal	
		Spec.	Lim./2	0 (Pre-Rad.)		5		10		20		30		40		168 hrs @25°C		50		168 hrs @+100°C	
Parameters/3		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
+Icc	mA	-	7.6	3.82	.08	3.86	.07	3.78	.07	3.71	.08	3.60	.08	3.56	.08	3.60	.08	3.45	.08	3.61	.08
-Icc	mA	-7.6	-	-3.81	.08	-3.88	.07	-3.79	.07	-3.70	.08	-3.62	.08	-3.54	.08	-3.59	.08	-3.45	.08	-3.60	.08
Vos@50(1)	mV	-3.0	3.0	-0.37	.12	-0.60	.25	-0.60	.24	-31.1	46	-38.5	55	-37.4	54	-33.1	49	-0.92	.40	-28.8	46
Vos@50(2)	mV	-3.0	3.0	-0.38	.31	-0.46	.28	-0.42	.32	-0.44	.32	-0.43	.33	-0.43	.33	-0.43	.33	-0.44	.34	-0.43	.33
Vos@50(3)	mV	-3.0	3.0	-0.46	.32	-0.51	.33	-0.52	.34	-0.55	.34	-0.56	.35	-0.57	.36	-0.56	.36	-0.60	.37	-0.55	.34
Vos@50(4)	mV	-3.0	3.0	-0.15	.31	-0.16	.32	-0.21	.27	-0.12	.32	-0.08	.32	-0.05	.32	-0.08	.32	-0.03	.34	-0.11	.31
Ios(1)	nA	-30	30	-7.10	1.4	-5.74	0.9	-5.62	0.8	-5.50	0.6	-5.71	.31	-5.92	.46	-7.61	.89	-6.12	.78	-8.40	.51
Ios(2)	nA	-30	30	-4.92	1.4	-3.71	.93	-3.73	0.9	-3.74	0.9	-3.95	0.9	-4.01	1.0	-5.24	1.0	-4.44	.95	-5.75	.69
Ios(3)	nA	-30	30	-6.10	1.0	-4.28	.79	-4.32	.63	-4.37	.59	-4.44	.63	-4.54	.72	-6.04	.76	-4.82	.66	-6.83	0.8
Ios(4)	nA	-30	30	-6.30	1.4	-4.65	.85	-4.51	.83	-4.29	.71	-4.21	.71	-4.17	.72	-6.25	.71	-4.16	.68	-7.62	.58
Ib+(1)	nA	-	110	24.8	3.3	30.5	3.7	35.5	4.2	46.4	5.9	57.8	7.7	65.3	9.0	55.1	7.1	79.7	9.9	47.0	5.8
Ib+(2)	nA	-	110	42.7	3.9	49.5	4.6	56.3	5.4	70.6	7.6	85.7	9.6	97.7	11	85.2	9.3	118	13	75.1	7.4
Ib+(3)	nA	-	110	32.1	3.5	38.3	3.9	43.6	4.7	55.6	6.3	67.9	8.3	77.9	9.4	66.8	8.2	94.6	11	58.6	6.7
Ib+(4)	nA	-	110	28.9	3.0	35.2	3.6	39.9	4.2	50.9	5.5	62.0	7.1	70.5	8.2	60.3	7.1	86.1	9.9	53.0	5.5
Ib-(1)	nA	-	110	31.8	3.3	36.3	3.2	43.9	4.1	51.9	5.7	60.7	8.2	71.3	9.0	62.7	7.4	85.8	10	55.4	6.0
Ib-(2)	nA	-	110	47.6	3.6	53.2	4.1	66.5	5.3	74.3	7.3	87.1	10	102	11	90.4	9.1	122	13	80.8	7.2
Ib-(3)	nA	-	110	38.2	3.3	42.6	3.7	52.6	5.1	60.0	6.3	70.0	8.1	85.2	15	72.9	7.9	99.4	11	65.5	5.2
Ib-(4)	nA	-	110	35.2	2.9	39.8	3.0	45.1	4.0	55.2	5.6	66.8	7.2	74.6	8.0	66.6	6.9	90.2	9.8	60.6	5.4
Aol(1)	KV/V	50	-	457	59	368	45	301	40	247	36	211	31	180	25	199	29	153	20	220	28
Aol(2)	KV/V	50	-	495	57	405	53	342	44	278	39	242	33	211	29	230	33	180	25	248	31
Aol(3)	KV/V	50	-	472	117	530	135	481	79	323	51	285	43	211	34	235	27	193	26	243	39
CMRR	dB	80	-	106	1.9	106	1.8	105	2.0	104	2.3	102	2.3	101	2.3	102	2.2	100	1.7	103	2.1
+PSRR	dB	86	-	98.7	1.2	97.8	1.1	97.1	1.2	96.1	1.4	95.5	1.4	94.7	1.4	95.1	1.4	94.0	1.3	95.5	1.3
-PSRR	dB	86	-	105	1.2	104	1.1	104	1.0	103	.99	103	.91	102	.83	102	.83	102	.73	102	1.0
+Vo	V	16	-	19.1	.03	19.1	.03	19.1	.03	19.1	.03	19.1	.03	19.1	0	19.1	.03	19.1	.03	19.1	.03
-Vo	V	-	-16	-17.7	.03	-17.6	.02	-17.6	.02	-17.7	.04	-17.7	.03	-17.7	.03	-17.7	.03	-17.7	.03	-17.7	.02

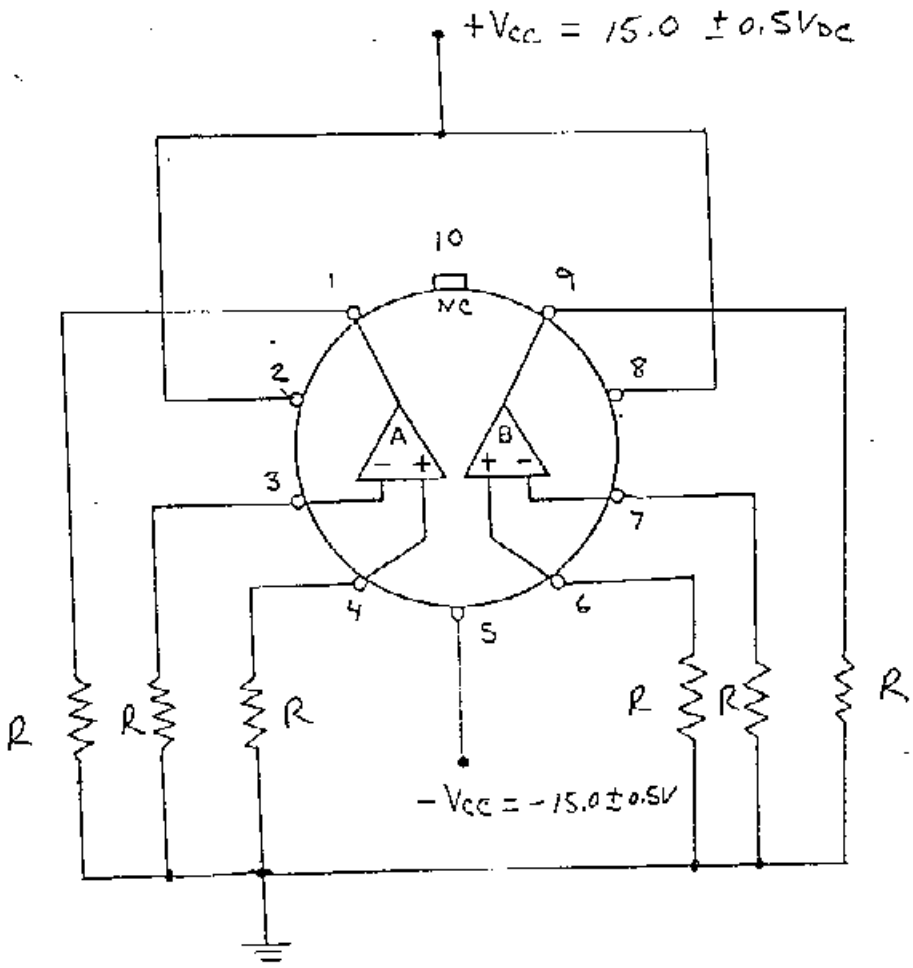
Notes:

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/ Data in this table are for section 1 only. Data for section 2 are similar and are available on request.

Figure 1. Radiation Bias Circuit for LM747



$+ Vcc = + 15.0 + / - 0.5$ Vdc

$- Vcc = - 15.0 + / - 0.5$ Vdc

$R = 10$ Kohm $+ / - 5\ \%$, 1/4 W