



DATE: September 11, 1995

PPM-95-172

TO: G. Kramer/311.0

FROM: K. Sahu/300.1 *KS*SUBJECT: Radiation Report
Part No. PA51M
Control No. 11006cc: A. Sharma/311.0
OFA Library/300.1

A radiation evaluation was performed on PA51M (Operational Amplifier) 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 Co⁶⁰ gamma ray source. During the radiation testing, six parts were irradiated under bias (see Figure 1 for bias configuration), and three parts were used as control samples. The total dose radiation levels were 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.08 and 1.47 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 according to the test conditions and the specification limits** listed in Table III.

All parts passed initial electrical measurements.

All parts passed all electrical tests throughout all irradiation steps up to and including the 30 krad irradiation level.

After the 50 krad irradiation, S/N 73, 74, 75, 77 and 79 exceeded the maximum specification limit of 40 nA for P_IIB_0V, with readings ranging from 41 nA to 60 nA. In addition S/N 75, 77 and 79 exceeded the maximum specification limit of 40 nA for N_IIB_0V, with readings ranging from 41 nA to 48 nA, and the same parts exceeded the maximum specification limit of 10 nA for IIOS_0V, with readings ranging from 10.4 nA to 11.7 nA.

After the 75 krad irradiation, all irradiated parts except S/N 76 and 78 exceeded the maximum specification limit for P_IIB_0V, with readings ranging from 42 nA to 68 nA. In addition all irradiated parts except S/N 76, 78 and 80 exceeded the maximum specification limit for N_IIB_0V, with readings ranging from 45 nA to 63 nA. S/N 75, 77 and 79 readings for IIOS_0V are within the specification limits.

After the 100 krad irradiation, all irradiated parts continued to exceed the maximum specification limit for P_IIB_0V, with readings ranging from 43 nA to 83 nA. In addition all irradiated parts except S/N 80 continued to exceed the maximum specification limit for N_IIB_0V, with readings ranging from 46 nA to 79 nA.

After annealing for 168 hours at 25°C, all irradiated parts except S/N 76 and 78 exceeded the maximum specification limit for P_IIB_0V, with readings ranging from 41 nA to 67 nA. In addition all irradiated parts except S/N 76, 78 and 80 continued to exceed the maximum specification limit for N_IIB_0V, with readings ranging from 48 nA to 65 nA.

After annealing for 168 hours at 100°C, no rebound effects were observed.

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

**These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and 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.

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TABLE I. Part Information

Generic Part Number:	PA51M
Part Number:	5962-8762002YX
Control Number:	11006
Charge Number:	C52804
Manufacturer:	Apex Microtech
Lot Date Code:	8914
Quantity Tested:	11
Serial Number of Control Samples:	70, 71, 72
Serial Numbers of Radiation Samples:	73, 74, 75, 76, 77, 78, 79, 80
Part Function:	Power Op-Amp
Part Technology:	CMOS
Package Style:	TO-5
Test Equipment:	A540
Test Engineer:	P. Srioudom

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for PA51M

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	12/23/94
2) 2.5 KRAD IRRADIATION (0.16 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	06/13/95 06/14/95
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	06/14/95 06/15/95
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	06/15/95 06/16/95
5) 15 KRAD IRRADIATION (0.08 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	06/16/95 06/19/95
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	06/19/95 06/20/95
7) 30 KRAD IRRADIATION (0.59 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	06/20/95 06/21/95
8) 50 KRAD IRRADIATION (1.18 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	06/21/95 06/22/95
9) 75 KRAD IRRADIATION (0.38 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT	06/22/95 06/23/95
10) 100 KRAD IRRADIATION (1.47 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	06/23/95 06/26/95
11) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/26/95 07/03/95
12) 168-HOUR ANNEALING @100°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/03/95 07/12/95

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

Table III. Electrical Characteristics of PA51M

Unless Otherwise Specified: $T_A = 25$, $V_{CC} = \pm 34Vdc$, $V_{OUT} = 0V$, Gain = 100

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
SUPPLY CURRENT				
Plus_Icc	Icc	$V_{OUT} = 0V$	0.0ma	10.0mA
Minus_Icc	Icc	$V_{OUT} = 0V$	-10.0mA	0.0mA
INPUT OFFSET TESTS				
VOS_10V	V_{IO}	$V_{OUT} = 0V$, $V_{CC} = \pm 10Vdc$	-16.00mV	16.00mV
VOS_34V	V_{IO}	$V_{OUT} = 0V$, $V_{CC} = \pm 34Vdc$	-10.00mV	10.00mV
VOS_40V	V_{IO}	$V_{OUT} = 0V$, $V_{CC} = \pm 40Vdc$	-11.200mV	11.200mV
P_IIB_0V	+IIB	$V_{OUT} = 0V$	-40.00nA	40.00nA
N_IIB_0V	-IIB	$V_{OUT} = 0V$	-40.00nA	40.00nA
IIO_0V	I_{IO}	$V_{OUT} = 0V$	-10.00nA	10.00nA
CMR_18V	CMRR	$V_{CC} = \pm 15Vdc$, $V_{CM} = \pm 9V$	70dB	
AMPLIFIER OUTPUT TESTS				
P_VOUT	V_{OP}	$I_{out} = 68mA$, $V_{CC} = \pm 40Vdc$	34.0V	
P_VOUT	V_{OP}	$I_{out} = 200mA$, $V_{CC} = \pm 40Vdc$	34.0V	
N_VOUT	V_{OP}	$I_{out} = -68mA$, $V_{CC} = \pm 40Vdc$		-34.0V
N_VOUT	V_{OP}	$I_{out} = -200mA$, $V_{CC} = \pm 40Vdc$		-34.0V

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for PA51M /1

Test #	Parameters	Units	Spec. Lim./2	min	max	Total Dose Exposure (krads)												Annealing														
						Initial		2.5		5		10		15		20		30		50		75		100		168 hrs @25°C		168 hrs @100°C				
						mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd			
1	Plus_ICC	mA	0.0	10	2.37	0.14	2.32	0.12	2.32	0.13	2.31	0.12	2.27	0.12	2.27	0.12	2.24	0.11	2.22	0.12	2.11	0.10	2.12	0.11	2.11	0.11	2.12	0.11	2.12	0.11	2.12	0.11
2	Minus_ICC	mA	-10	0.0	-0.23	0.12	-2.30	0.13	-2.29	0.12	-2.29	0.13	-2.25	0.12	-2.25	0.12	-2.23	0.12	-2.19	0.11	-2.09	0.11	-2.11	0.11	-2.11	0.11	-2.11	0.11	-2.11	0.11	-2.11	0.11
3	VOS_10V	mV	-16	16	-0.35	1.33	-0.31	1.37	-0.32	1.36	-0.25	1.36	-0.34	1.37	-0.34	1.37	-0.32	1.38	-0.15	2.26	0.52	0.16	1.39	0.06	1.35	0.06	1.35	0.06	1.35	0.06	1.35	0.06
4	VOS_34V	mV	-10	10	-0.16	1.34	0.20	1.34	0.19	1.34	0.26	1.33	0.20	1.33	0.20	1.34	0.23	1.34	-0.26	1.47	1.11	0.76	1.34	0.61	1.31	0.61	1.31	0.61	1.31	0.61	1.31	0.61
5	VOS_40V	mV	-11.2	11.2	0.30	1.31	0.35	1.33	0.33	1.32	0.40	1.32	0.35	1.32	0.35	1.33	0.39	1.33	-0.77	1.38	1.27	0.93	1.31	0.76	1.29	0.76	1.29	0.76	1.29	0.76	1.29	0.76
6	P_IIB_0V	nA	-40	40	9.16	2.91	9.45	2.90	10.5	3.07	11.8	3.34	14.2	3.81	16.9	4.43	22.9	5.79	44.1	10.6	61.8	14.9	61.8	11.2	22.2	11.2	22.2	11.2	22.2	11.2	22.2	11.2
7	N_IIB_0V	nA	-40	40	9.15	2.92	9.57	2.95	10.6	3.12	12.4	3.51	14.6	3.93	17.1	4.54	20.8	5.89	34.9	8.87	46.7	11.9	46.7	11.7	21.7	11.7	21.7	11.7	21.7	11.7	21.7	11.7
8	IIOS_0V	nA	-10	10	0.0	0.0	-0.12	0.08	-0.10	0.09	-0.55	0.19	-0.38	0.14	-0.36	0.16	-0.37	0.25	9.11	1.85	3.87	1.79	3.46	1.81	2.63	1.71	2.63	1.71	2.63	1.71	2.63	1.71
9	CMR_18V	dB	70	-	114	6.46	121	17.6	117	10.3	116	9.68	116	13.0	113	111	8.56	79.4	11.5	112	11.9	104	6.84	114	10.3	113	10.3	113	10.3	113	10.3	113
10	P_VOUT	V	34	-	38.1	0.42	37.5	0.40	37.6	0.40	37.5	0.41	37.6	0.40	37.6	0.40	37.6	0.40	37.6	0.41	37.6	0.41	37.6	0.41	37.6	0.41	37.6	0.41	37.6	0.41	37.6	0.41
11	N_VOUT	V	34	-	37.7	0.42	37.4	0.40	37.4	0.40	37.4	0.41	37.5	0.40	37.5	0.39	37.5	0.40	37.4	0.41	37.5	0.41	37.5	0.41	37.4	0.41	37.4	0.41	37.4	0.41	37.5	0.39
12	N_VOUT	V	-	-34	-36.3	0.55	-36.5	0.54	-36.5	0.54	-36.5	0.54	-36.5	0.53	-36.5	0.53	-36.4	0.53	-36.4	0.52	-36.4	0.51	-36.4	0.51	-36.4	0.51	-36.4	0.51	-36.4	0.51	-36.5	0.52
13	N_VOUT	V	-	-34	-36.3	0.54	-36.4	0.54	-36.4	0.54	-36.4	0.54	-36.4	0.53	-36.4	0.53	-36.3	0.53	-36.3	0.52	-36.3	0.51	-36.3	0.51	-36.3	0.51	-36.3	0.51	-36.3	0.51	-36.3	0.51

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 manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation-sensitive paramete P_IIB_0V, N_IIB_0V and IIOS_0V.

Figure 1. Radiation Bias Circuit for PA51M

