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DATE: August 4, 1994 PPM-94-016

TO: T. Mecum/311.1
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on FUSE
Part No. OP177A
Control No. 10869

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on OP177 (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 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, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.07 and 1.25 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. 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. After the 5 krad and 10 krad irradiation levels, all parts exceeded the maximum specification limit of ± 15 nA for Ibias, with readings in the range of 2 nA to 4 nA. After the 15 krad irradiation, all parts continued to exceed the maximum limit for Ibias with readings in the range of 4 nA to 6 nA. The CMRR value for three parts, S/N 25, S/N 26, and S/N 30, was in the range of 128 dB to 129 dB, which was less than the minimum specification value of 130 dB. After the 20 krad irradiation, the same failures continued for Ibias and CMRR, with readings in the range of 5 nA to 8 nA, and 127 dB to 128 dB. The PSRR value for S/N 27 was 119.7 dB, which is less than the minimum specification limit of 120 dB. After the 30 krad irradiation, the same failures continued for Ibias, CMRR and PSRR, with readings in the range of 9 nA to 15 nA, 121 dB to 126 dB, and 115 dB. In addition, S/N 24 and S/N 29 failed the CMRR test with readings of 127 dB and 129 dB, and all parts except S/N 26 and S/N 30 failed the PSRR test with readings in the range of 113 dB to 119 dB. After the 50 krad irradiation, the same failures continued for Ibias, CMRR and PSRR, with readings in the range of 21 nA to 32 nA, 116 dB to 126 dB, and 109 dB to 112 dB. In addition S/N 23 failed the CMRR test with a reading of 127 dB. After the 75 krad irradiation, the same failures continued for Ibias, CMRR and PSRR, with readings in the range of 40 nA to 55 nA, 112 dB to 128 dB, and 109 dB to 122 dB. In addition S/N 23, S/N 27, and S/N 28 failed the CMRR test with a reading of 126 dB, and all parts except S/N 24 to S/N 26 exceeded the maximum specification limit of ± 1 nA for Ilo, with readings in the range of 1.6 nA to 2.9 nA. At the 100 krad irradiation level, the same failures continued for Ibias, CMRR,PSRR, and Ilo with the readings in the range of 56 nA to 77 nA, 110 dB to 127 dB, 119 dB to 127 dB, and 1.9 nA to 4 nA. In addition, the S/N 30 reading for PSRR is 111 dB, which was less than the specification limit, and S/N 24 and S/N 25 exceeded the maximum limit for Ilo with readings of 1.3 nA and 1.4 nA. At this level, the S/N 28 PSRR reading, and S/N 25 CMRR reading were within the specification limits.

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

After annealing for 168 hours at 25°C, all parts continued to exceed the maximum limit for Ibias, with readings in the range of 36 nA to 50 nA, and all parts except S/N 25 and S/N 26 continued to exceed the maximum limit for Ilo, with readings in the range of 1.2 nA to 3 nA, and all parts except S/N 25 and S/N 29 continued to exceed the minimum limit for CMRR, with readings in the range of 114 dB to 127 dB, and S/N 23, S/N 27, S/N 29 and S/N 30 exceeded the minimum limit for PSRR, with readings in the range of 113 dB to 118 dB.

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

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and anncaling 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:	OP177A
FUSE Part Number:	OP177A
FUSE Control Number:	10869
Charge Number:	C44369
Manufacturer:	Analog Devices
Lot Date Code:	9332
Quantity Tested:	8
Serial Number of Control Samples:	21, 22
Serial Numbers of Radiation Sample:	23, 24, 25, 26, 27, 28, 29, 30
Part Function:	OP-AMP
Part Technology:	Linear
Package Style:	8 Pin CAN
Test Equipment:	Sentry S-50
Test Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for OP177A

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	05/11/94
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR)	06/13/94
POST-5 KRAD ELECTRICAL MEASUREMENT	06/14/94
3) 10 KRAD IRRADIATION (0.25 KRADS/HOUR)	06/14/94
POST-10 KRAD ELECTRICAL MEASUREMENT	06/15/94
4) 15 KRAD IRRADIATION (0.25 KRADS/HOUR)	06/15/94
POST-15 KRAD ELECTRICAL MEASUREMENT	06/16/94
5) 20 KRAD IRRADIATION (0.07 KRADS/HOUR)	06/17/94
POST-20 KRAD ELECTRICAL MEASUREMENT	06/20/94
6) 30 KRAD IRRADIATION (0.65 KRADS/HOUR)	06/20/94
POST-30 KRAD ELECTRICAL MEASUREMENT	06/21/94
7) 50 KRAD IRRADIATION (1 KRADS/HOUR)	06/21/94
POST-50 KRAD ELECTRICAL MEASUREMENT	06/22/94
8) 75 KRAD IRRADIATION (1.25 KRADS/HOUR)	06/22/94
POST-75 KRAD ELECTRICAL MEASUREMENT	06/23/94
9) 100 KRAD IRRADIATION (1.25 KRADS/HOUR)	06/23/94
POST-100 KRAD ELECTRICAL MEASUREMENT	06/24/94
10) 168-HOUR ANNEALING @25°C	06/24/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/01/94
11) 168-HOUR ANNEALING @100°C*	07/05/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/14/94

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 OP177A

TEST CONDITIONS: VS= +/- 15V unless otherwise noted;

Test temperature : 25oC

tst	Test name	Min	Max	Condition
1	Idd_15v	0.00 ma	2.00 ma	No load
2	Iss_15v	-2.00 ma	0.00 ma	No load
3	+Vo_10k	13.5 v		Rl = 10k
4	+Vo_2K	12.5 v		Rl = 2k
5	-Vo_10k		< -13.5 v	Rl = 10k
6	-Vo_2k		< -12.5 v	Rl = 2k
7	vio	10.0 uv	10.0 uv	
8	+ibias	-1.500 na	1.500 na	
9	-ibias	-1.500 na	1.500 na	
10	iio	-1.000 na	1.000 na	
11	Avs_2k (V/mv)	5000.0		Rl = 2k
12	cmrr	130.0 db		
13	psrr	120.0 db		

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP177A /1

				Total Dose Exposure (krads)																		Annealing			
		Spec. Lim./2		Initials		5		10		15		20		30		50		75		100		168 hrs @25°C		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	mean	sd
Idd_15v	mA	0	2	1.55	0.02	1.50	0.01	1.47	0.04	1.39	0.01	1.39	0.02	1.31	0.03	1.21	0.03	1.17	0.02	1.14	0.02	1.23	0.02	1.41	0.02
Iss_15v	mA	-2	0	-1.54	0.02	-1.49	0.01	-1.47	0.04	-1.39	0.01	-1.38	0.01	-1.31	0.03	-1.22	0.03	-1.18	0.03	-1.14	0.03	-1.23	0.02	-1.41	0.02
+Vo_10v	V	13.5		14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0	14.3	0
+Vo_2k	V	12.5		14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0	14.2	0
-Vo_10v	V		-14	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0	-14.2	0
-Vo_2k	V		-13	-14.1	0	-14.1	0	-14.1	0	-14.1	0	-14.1	0	-14.1	0	-14.1	0	-13.9	0.17	-13.8	0.13	-14.1	0	-14.1	0
vio	uV	-10	10	-1.32	0.67	0.18	0.81	0.21	0.86	-0.15	0.58	0.2	0.97	-0.45	0.77	0.75	1.06	1.32	0.51	1.61	1.25	0.28	0.74	0.31	0.35
+ibias	nA	-1.5	1.5	0.55	0.22	2.39	0.36	3.18	0.48	4.7	0.75	5.96	1.03	12.8	2.33	27.5	3.98	46.3	5.63	67.6	7.23	43.13	4.45	5.97	1.03
-ibias	nA	-1.5	1.5	0.56	0.12	2.35	0.21	3.31	0.45	4.66	0.64	5.86	0.88	12.3	2.13	28.5	3.51	46.9	5.14	65.4	6.47	42.7	4.67	6.44	0.86
iio	nA	-1	1	0	0.25	0.07	.30	-0.1	0.41	0.82	0.35	0.89	0.3	0.53	0.49	0.91	0.75	1.40	0.84	2.22	1.02	1.57	0.86	1.53	0.49
Avs_2k	V/mv	5000		45496	24927	58872	66331	38644	15092	29191	5450	28641	4538	24041	4416	16598	3241	12075	3539	8504	1884	14503	4490	31061	6218
cmrr	DB	130		144.4	6.07	140.2	5.54	141.7	12.4	135.2	7.3	134.3	8.6	128.9	5.99	126.2	7.03	123.2	4.77	122	6.97	126.9	10.8	134.5	6.55
psrr	DB	120		131.8	12.6	124.2	5.44	129.6	13.3	132.3	13.3	127	9.2	119.2	5.99	115.5	7.4	113.1	4.68	115	6.0	122.9	10.2	125.6	5.23

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 is not included in this table.

2/ These are manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

3/ The radiation sensitive parameters were Ibias, CMRR, PSRR and IIO.

Figure 1. Radiation Bias Circuit for OP177A