UNISYS

DATE: April 15, 1997
TO: J.Lohr/311
FROM: K. Sahu/300.1 KSahu
SUBJECT: Radiation Report on: OP400
Project: SMEX-LITE
Job #: EE71381
Project part #: OP400

PPM-97-013

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OFA Library/300.1

A radiation evaluation was performed on OP400 (5962-8777101M3A) 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 Co^{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 2.5, 5.0, 10.0, 15.0, 20.0 and 30.0 kRads.* The dose rate was between 0.06 and 0.125 kRads/hour (see Table II for radiation schedule). Between the 10.0 and 15.0 kRad exposures, the parts were annealed for 936 hours at 25°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, except for slew rate. See the note for slew rate test in tables III and IV.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 90, 91, 92, 93, 94, 97, 98, and 99) were used as radiation samples while SN's 95 and 96 were used as control samples. All parts passed all tests during initial electrical measurements.

After the 2.5 kRad irradiation, all devices passed all tests except SN 91 and 93. These parts failed to meet the specification limit for Avs_10k for section 4 only. The readings were 3808 and 4626 V/mV, respectively. The specification limit for Avs_10k is 5000 V/mV.

After the 5.0 kRad irradiation, parts showed degradation in Avs_10k and Ibias. Four parts (SN's 90, 92, 93, and 94) failed to meet the specification limit for Avs_10k with readings between 3000 and 5000 V/mV. Ibias readings for these parts ranged from 3.0-5.0 nA, against the specification limit of 3.0 nA.

After the 10.0 kRad irradiation, all parts failed to meet the specification limit for Avs_10k and Ibias. The readings for these parameters were in the range of 2800 to 4500 V/mV for Avs_10k and 5.0 to 7.5 nA for Ibias. Five parts also failed to meet the specification limit for Avs_2k. Readings for this parameter were in the range of 1600 to 1900 V/mV against the specification limit of 2000 V/mV.

After annealing the parts for 168 hours at 25°C, parts showed some recovery, but most parts failed to meet the specification limit for Avs_10k and Ibias.

After the 15.0 kRad irradiation, parts showed increased degradation in Avs_2k, Avs_10k, and Ibias. Readings for these parameters ranged from 1400 to 1900 V/mV, 1900 to 4000 V/mV, and 6 to 10 nA respectively.

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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 pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After the 20.0 kRad irradiation, parts continued to show increased degradation in Avs_2k, Avs_10k, and Ibias. Readings for these parameters ranged from 1000 to 1500 V/mV, 1900 to 3600 V/mV, and 10 to 13 nA respectively.

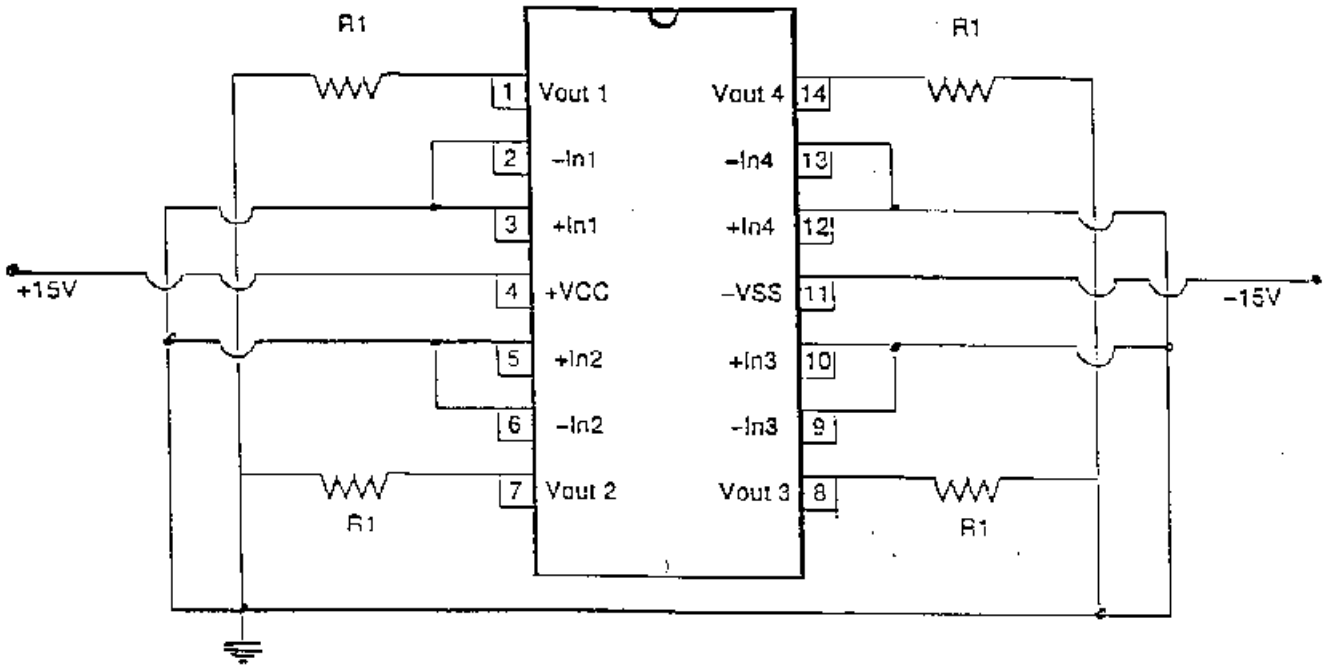
After the 30.0 kRad irradiation, parts again continued to show increased degradation in Avs_2k, Avs_10k, and Ibias. Readings for these parameters ranged from 800 to 1300 V/mV, 1000 to 2000 V/mV, and 16 to 20 nA respectively.

Please note that due to the test set-up problem with the Automatic Test Equipment (ATE), A-540, no data is available on the slew rate after each radiation and annealing step. However, some slew rate measurements were made with a bench set-up on one control sample and two radiation samples after 30 kRads. This data is provided in note 3 on Table III.

Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure 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.

Figure 1. Radiation Bias Circuit for OP400



R1 = 15 Kohms ; +/- 10% ; 1/2 w

Note: Use 28 pin LCC to 14 pin DIP socket adapters with 14 pin DIP radiation bias boards.

TABLE I. Part Information

Generic Part Number:	OP400
SIMEX-LITE Part Number	5962-8777101M3A
Charge Number:	EE71381
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9614A
Quantity Tested:	10
Serial Number of Control Samples:	95, 96
Serial Numbers of Radiation Samples:	90, 91, 92, 93, 94, 97, 98, and 99
Part Function:	Quad OP-AMP
Part Technology:	Bipolar
Package Style:	28 Pin LCC
Test Equipment:	A540
Test Engineer:	A. Naji

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

TABLE II. Radiation Schedule for OP400

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	01/24/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR)	01/31/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT	02/03/97
3) 5 KRAD IRRADIATION (0.062 KRADS/HOUR)	02/03/97
POST-5 KRAD ELECTRICAL MEASUREMENT	02/06/97
4) 10.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	02/06/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	02/10/97
5) 936 HOUR ANNEALING @25°C	02/10/97
POST-936 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/24/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/24/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT	03/28/97
7) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/31/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT	04/02/97
8) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	04/02/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT	04/04/97

Effective Dose Rate = 30,000 RADS/62 DAYS=20.2 RADS/HOUR=0.006 RADS/SEC

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

Table III. Electrical Characteristics of OP400 /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1	+Idd	mA	Vs=+15V, no load	0.0	2.9
2	-Idd	mA	Vs=-15V, no load	-2.9	0.0
3	Voh_2k	V	Rl=2k	11.0	-
4	Vol_2k	V	Rl=2k	-	-11.0
5	Voh_10k	V	Rl=10k	12.0	0
6	Vol_10k	V	Rl=10k	-	-12.0
7	Vio	µV		-150.0	150.0
8	+Ibias	nA	Vcm=0V	-3.0	3.0
9	-Ibias	nA	Vcm=0V	-3.0	3.0
10	Iio /2	nA	Vcm=0V	-3.00	3.00
11	Avs_2k	V/mV	Rl=2k, Vo=+/-10V	2000	-
12	Avs_10k	V/mV	Rl=10k, Vo=+/-10V	5000	-
13	PSRR	µV/V	V=+/-3V to +/-18V	-	1.80
14	CMRR	dB	Vcm=+/-12V	120.0	-
15	+SR /3	V/µs		0.10	-
16	-SR /3	V/µs		0.10	-

Note:

1/ These are the manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
Vio = input offset voltage, Iio = input offset current.

2/ Iio was calculated from Vio and Ibias.

3/ Slew rate measurements could not be made reliably due to a test set-up problem with the automatic tester, A-540. The measurements were made with a bench set-up on one control sample (SN96) and two radiation samples (SN's 98 and 99) after 30 kRads. The measurements are provided below:

Control Sample (SN 96)
OUT1 = 160 mV/µs OUT2 = 160 mV/µs OUT3 = 160 mV/µs OUT4 = 160 mV/µs

Post 30 kRads (SN 98)
OUT1 = 133 mV/µs OUT2 = 129 mV/µs OUT3 = *** mV/µs OUT4 = 129 mV/µs

Post 30 kRads (SN 99)
OUT1 = *** mV/µs OUT2 = 121 mV/µs OUT3 = 125 mV/µs OUT4 = 125 mV/µs

*** implies that the part had degraded to the point where no reliable measurement could be taken.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP400AY /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	Total Dose Exp. (kRads) 2.5 mean	2.5 sd	5 mean	5 sd	Rad Level 10 kRads mean	10 kRads sd	Anneal 936 hrs. @25°C mean	Anneal 936 hrs. @25°C sd	Rad Level 15 kRads mean	15 kRads sd	Rad Level 20 kRads mean	20 kRads sd	Rad Level 30 kRads mean	30 kRads sd
1	+Idd	mA	0.0	2.9	2.3	0.1	2.2	0.1	2.2	0.1	2.0	0.1	1.9	0.1	1.9	0.1	1.8	0.03	1.6	0.06
2	-Idd	mA	-2.9	0.0	-2.3	0.05	-2.2	0.05	-2.2	0.05	-2.0	0.08	-1.84	0.06	-1.91	0.03	-1.92	0.4	-1.59	0.06
3	Voh_2k	V	11.0	-	12.2	0.1	12.2	0.1	12.2	0.1	12.2	0.03	12.2	0	12.2	0	12.2	0	12.2	0
4	Vol_2k	V	-	-11.0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0.1	-12.9	0.1	-12.7	0.34	-12.2	0.7
5	Voh_10k	V	12.0	0	12.8	0	12.8	0	12.8	0	12.8	0	12.8	0	12.8	0	12.8	0	12.7	0
6	Vol_10k	V	-	-12.0	-13.6	0	-13.6	0	-13.6	0	-13.6	0.1	-13.5	0.1	-13.5	0	-13.5	0	-13.5	0
7	Vio	µV	-150.	150.0	-6.6	61.8	-4.4	60	-11.3	63.1	17.8	67.8	-9.2	44.1	24.2	73.3	37.3	73.2	5.5	83.5
8	+Ibias	nA	-3.0	3.0	0.8	0.1	2.3	0.2	4.7	0.2	7.3	0.2	6.3	1	9.9	0.6	13.2	0.9	18.7	1.5
9	-Ibias	nA	-3.0	3.0	0.9	0.1	2.2	0.2	4.2	0.7	6.4	1.6	9.8	3.7	9.1	0.6	13.0	0.9	18.9	1.2
10	Iio	nA	-3.00	3.00	0.03	0.18	-0.17	0.16	1.28	1.94	0.89	2.34	1.49	1.9	-0.23	2.11	0.35	2.45	0.96	1.78
11	Avs_2k	V/mV	2000	-	2506	273	2298	148	2556	188	1999	314	2382	700	1831	179	1195	131	889	114
12	Avs_10k	V/mV	5000	-	6955	1320	6050	1645	4841	1403	3300	553	4359	1256	2305	502	1851	454	1037	126
13	PSRR	µV/V	-	1.80	0.31	0.12	0.33	0.13	0.32	0.13	0.31	0.11	0.27	0.08	0.27	0.12	0.25	0.15	0.24	0.21
14	CMRR	dB	120.0	-	226.2	124.8	134.6	1.7	134.1	3.0	138.4	3.3	135.4	3.6	137.1	2.2	143.9	6.2	141.9	3.6
15	SR /3	V/µs	0.10	-	0.16														0.12	

Notes:

1/ The mean and standard deviation 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.
Vio = input offset voltage, Iio = output offset current.

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/ Slew rate measurements were only made after 30 kRads using a bench setup on one control sample and two radiation samples. See Note 3 on Table III.

The radiation-sensitive parameters were Ibias, Avs, Iio, SR and Vio.