Unisys

DATE: October 30, 1998 PPM-98-029
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SUBJECT: Radiation Report on **OP270 (Analog Devices) (LDC 9815)**
PROJECT: IRAC

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A radiation evaluation was performed on **OP270 (M5962/8872101PA) Dual Very Low Noise Precision Operational Amplifier (Analog Devices)** to determine the total dose tolerance of these parts. 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, 30.0, and 50.0kRads.[1] The dose rate was 0.141kRads/hour (0.04 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 50.0kRad irradiation, the parts were annealed under bias at 25°C and tested after and 168 hours.[2] After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III.

An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step. For detailed information, refer to Tables I through IV and Figure 1.

All parts passed all tests up to 5kRads with no significant degradation observed in any parameter. All parts showed some degradation in Ios_A and Ios_B from 10 to 50kRads and in +Ib_A, -Ib_A, +Ib_B, and -Ib_B from 20 to 50kRads and showed some recovery after annealing for 168 hours at 25℃. (See Table 4 and Figures 2 and 3 for details.) Most parts showed some degradation in Open Loop Gain after 30 to 50kRads, but recovered to within specification limits after annealing for 168 hours at 25℃.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 52, 53, 54, 55, 56, 57, 58, and 59) were used as radiation samples while SN's 50 and 51 were used as control samples. All parts passed all tests during initial electrical measurements.

After the 10.0kRad irradiation, two parts marginally exceeded the specification limit of 10nA for Ios_A and Ios_B with readings in the range of 10.3 to 13.1 for both. **All parts passed all other tests.**

After the 15.0kRad irradiation, seven parts marginally exceeded the specification limit for Ios_A with readings in the range of 10.6 to 18.0nA. Six parts marginally exceeded the specification limit for Ios_B with readings in the range of 10.4 to 18.3nA. **All parts passed all other tests.**

After the 20.0kRad irradiation, three parts marginally exceeded the specification limit of 20nA for +Ib_A, -Ib_A, +Ib_B, and -Ib_B with readings in the range of 21 to 27nA. All parts marginally exceeded the specification limit for Ios_A and Ios_B with readings in the range of 13.1 to 24.5nA for both. **All parts passed all other tests.**

After the 30.0kRad irradiation, all parts exceeded the specification limit for +Ib_A, -Ib_A, +Ib_B, and -Ib_B with readings in the range of 33 to 57nA. All parts marginally exceeded the specification limit for Ios_A and Ios_B with readings in the range of 33 to 52nA for both. One part fell marginally below the specification limit of 117.5dB for Open Loop Gain B with a reading of 116.5dB. **All parts passed all other tests.**

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

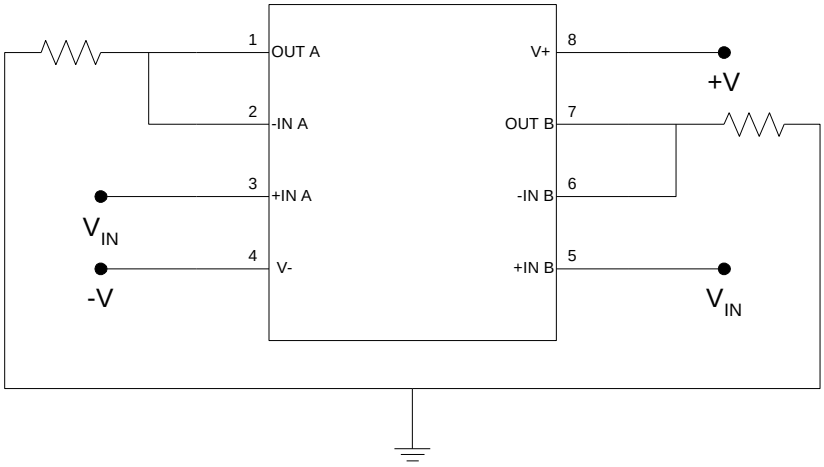
After the 50.0kRad irradiation, all parts exceeded the specification limit for +Ib_A, -Ib_A, +Ib_B, and -Ib_B with readings in the range of 79 to 130nA. All parts marginally exceeded the specification limit for Ios_A and Ios_B with readings in the range of 79 to 123nA for both. Six parts fell marginally below the specification limit for Open Loop Gain B with readings in the range of 114.3 to 117.3dB. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed some recovery. All parts exceeded the specification limit for +Ib_A, -Ib_A, +Ib_B, and -Ib_B with readings in the range of 54 to 97nA. All parts marginally exceeded the specification limit for Ios_A and Ios_B with readings in the range of 54 to 90nA. All parts passed Open Loop Gain B and all other tests.

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 us at (301) 731-8954.

Figure 1. Radiation Bias Circuit for OP270



Notes:
1. V+ = 15V ±0.5V, V- = -15V ±0.5V. V_{+IN} = 0.5V ±0.05V.
2. Both R = 300Ω ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	OP270
IRAC Part Number:	M5962/8872101PA
Charge Number:	M88544
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9815
Quantity Tested:	10
Serial Number of Control Samples:	50, 51
Serial Numbers of Radiation Samples:	52, 53, 54, 55, 56, 57, 58, and 59
Part Function:	Dual Very Low Noise Precision Op Amp
Part Technology:	Bipolar
Package Style:	8 Pin Dip
Test Equipment:	A540
Test Engineer:	A. Duvalsaint

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for OP270

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/11/98
2) 2.5 KRAD IRRADIATION (0.038 KRADS/HOUR)	09/11/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	09/14/98
3) 5.0 KRAD IRRADIATION (0.147 KRADS/HOUR)	09/14/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	09/15/98
4) 10.0 KRAD IRRADIATION (0.121 KRADS/HOUR)	09/15/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	09/17/98
5) 15.0 KRAD IRRADIATION (0.121 KRADS/HOUR)	09/17/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	09/18/98
6) 20.0 KRAD IRRADIATION (0.077 KRADS/HOUR)	09/18/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	09/21/98
7) 30.0 KRAD IRRADIATION (0.244 KRADS/HOUR)	09/21/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	09/23/98
8) 50.0 KRAD IRRADIATION (0.488 KRADS/HOUR)	09/23/98
POST-50.0 KRAD ELECTRICAL MEASUREMENT	09/25/98
9) 168 HOUR ANNEALING @25°C	09/25/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/02/98

Effective Dose Rate = 50,000 RADS/14 DAYS=148.8 RADS/HOUR=0.04 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the time needed to test the parts.

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

Table III. Electrical Characteristics of OP270 /1

Test #	Parameter	Units	Test Conditions /2	Spec. Lim. min	Spec. Lim. max
1	+Icc	mA	No Load		6.50
2	-Icc	mA	No Load	-6.50	
3	Vos_A	mV		-75	75
4	Vos_B	mV		-75	75
5	+Ib_A	nA	V_{CM} = 0V	-20	20
6	-Ib_A	nA	V_{CM} = 0V	-20	20
7	+Ib_B	nA	V_{CM} = 0V	-20	20
8	-Ib_B	nA	V_{CM} = 0V	-20	20
9	Ios_A	nA	V_{CM} = 0V	-10	10
10	Ios_B	nA	V_{CM} = 0V	-10	10
11	CMRR_A	dB	V_{CM} = ±11V	106	
12	CMRR_B	dB	V_{CM} = ±11V	106	
13	+Swing_A	V	R_L ³ 2kW	12	
14	-Swing_A	V	R_L ³ 2kW		-12
15	+Swing_B	V	R_L ³ 2kW	12	
16	-Swing_B	V	R_L ³ 2kW		-12
17	Open Loop Gain A	dB	V_O = ±10V, R_L = 10kW	117.5	
18	Open Loop Gain B	dB	V_O = ±10V, R_L = 10kW	117.5	
19	P_PSRR_A	dB	V_S = +4.5V to +18V	109	
20	P_PSRR_B	dB	V_S = +4.5V to +18V	109	
21	N_PSRR_A	dB	V_S = -4.5V to -18V	109	
22	N_PSRR_B	dB	V_S = -4.5V to -18V	109	
A	Slew Rate /3	V/ms	A_{VCL} = +20, R_L = 10kW	1.7	
B	Slew Rate /3	V/ms	A_{VCL} = +20, R_L = 10kW	1.7	

Notes:

1/ These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

2/ V_S = +15V, R_S = 50Ω unless otherwise specified.

3/ Slew rate was measured with a bench setup.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for MTR2805F /1

					Total Dose Exposure (kRads Si)																Annealing	
					Initial		2.5		5.0		10.0		15.0		20.0		30.0		50.0		168 hours @25°C	
Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	+Icc	mA		6.50	3.8	0.1	3.8	0.1	3.8	0.1	3.8	0.1	3.9	0.1	3.9	0.1	3.9	0.1	4.0	0.1	3.9	0.1
2	-Icc	mA	-6.50		-3.8	0.1	-3.8	0.1	-3.8	0.1	-3.8	0.1	-3.9	0.1	-3.9	0.1	-3.9	0.1	-4.0	0.1	-3.9	0.1
3	Vos_A	?V	-75	75	-0.1	12	0.5	16	-5.2	12	3.4	17	1.1	17	-1.2	12	-0.4	15	2.6	19	0.9	18
4	Vos_B	?V	-75	75	-21	13	-21	17	-25	17	-23	14	-17	14	-18	15	-16	21	-11	20	-10	15
5	+Ib_A	nA	-20	20	0.4	2	2.1	2	4.1	2	9.4	3	15	3	20	4	46	8	112	17	78	15
6	-Ib_A	nA	-20	20	-0.1	2	1.3	2	4.2	3	8.4	3	14	4	18	4	42	8	104	17	71	14
7	+Ib_B	nA	-20	20	-0.1	2	1.5	2	3.8	3	8.4	3	14	4	18	4	42	8	104	17	70	16
8	-Ib_B	nA	-20	20	0.4	2	2.0	2	4.0	2	9.4	3	15	3	20	4	46	8	112	17	78	15
9	Ios_A	nA	-10	10	-0.3	2	1.4	2	3.8	3	8.4	3	14	3	18	5	42	8	104	17	71	15
10	Ios_B	nA	-10	10	-0.3	2	1.3	2	3.3	2	9.5	3	13	3	18	4	42	8	104	17	71	15
11	CMRR_A	dB	106		114	2.8	113	0.5	113	0.9	113	0.3	113	0.3	113	0.3	113	0.4	113	0.6	113	0.3
12	CMRR_B	dB	106		114	2.5	113	0.3	113	0.3	113	0.2	113	0.2	113	0.2	113	0.3	113	0.3	113	0.2
13	+Swing_A	V	12		13.9	0	13.8	0	13.8	0	13.8	0	13.8	0	13.8	0	13.8	0	13.8	0	13.9	0
14	-Swing_A	V		-12	-13.5	0	-13.5	0	-13.5	0	-13.4	0	-13.4	0	-13.4	0	-13.4	0	-13.3	0	-13.3	0
15	+Swing_B	V	12		13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.8	0	13.8	0	14.4	0
16	-Swing_B	V		-12	-13.5	0	-13.5	0	-13.5	0	-13.4	0	-13.4	0	-13.4	0	-13.4	0	-13.3	0	-13.3	0
17	Open Loop Gain A	dB	117.5		134	11	128	6	138	13	132	8	135	11	130	10	125	5	121	4	121	9
18	Open Loop Gain B	dB	117.5		131	10	130	8	137	11	129	9	128	13	131	10	124	6	118	3	126	11
19	P_PSRR_A	dB	109		158	5	142	1	143	1	142	1	142	0	142	1	143	1	144	3	143	1
20	P_PSRR_B	dB	109		134	13	129	9	127	1	127	9	126	7	126	7	127	8	126	7	126	9
21	N_PSRR_A	dB	109		116	7	119	9	115	7	119	11	119	8	119	7	118	4	117	2	118	3
22	N_PSRR_B	dB	109		115	6	118	9	115	7	117	7	118	6	118	5	118	5	118	3	118	4
A	Slew Rate /3	V/?s	1.7		2.5	0															2.0	0.1
B	Slew Rate /3	V/?s	1.7		2.5	0.1															2.0	0.1

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout 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.

3/ Slew Rate was measured on the bench initially and after annealing only due to the complexity of the bench setup.

Radiation sensitive parameters: +Ib_A, -Ib_A, +Ib_B, -Ib_B, Ios_A, Ios_B, Open Loop Gain B.