UNISYS

PPM-97-012

DATE: April 15, 1997
TO: J.Lohr/311
FROM: K. Sahu/300.1 KSahu
SUBJECT: Radiation Report on: OP420CRC/883c
Project: SMEX-LITE
Job #: EE71382
Project part #: OP420

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OFA Library/300.1

A radiation evaluation was performed on OP420CRC/883c 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 0.25 kRads/hour (see Table II for radiation schedule). Between the 5.0 and 10.0 kRad exposures, the parts were annealed for 96 hours at 25°C. Between the 15.0 and 20.0 kRad exposures, the parts were annealed for 888 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.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 216, 217, 218, 219, 220, 221, 222, and 223) were used as radiation samples while SN's 214 and 215 were used as control samples. All parts passed all tests during initial electrical measurements.

After the 2.5 kRad irradiation, no significant degradation was observed in any part except SN 217 and SN223 which marginally exceeded the Iio specification limit of 2.5nA with readings between 2.7 and 3.3 nA. All irradiated parts continued to pass all other tests at this level.

After the 5.0 kRad irradiation, all irradiated parts showed significant degradation in Avs_10k. The Avs_10k readings were within the range of 2 to 20 V/mV for most parts, against the specification limit of 400 V/mV. All irradiated parts continued to pass all other tests at this level.

The parts were annealed at 25°C for 72 hours to determine if the parts would show any significant recovery in Avs_10k. Some recovery was observed, but most parts failed to meet the minimum specification with values from 10 to 50 V/mV.

After 10.0 kRads, all parts continued to show increased degradation in Avs_10k with readings between 1 to 3 V/mV. Parts also showed some degradation in Ibias but continued to meet the specification limit of +/-30 nA. The readings were typically around 20 nA. No other parameters showed any significant degradation at this level.

After 15.0 kRads, all parts continued to show very low values for Avs_10k. Parts also showed increased degradation in Ibias with readings in the range of 30 to 50 nA against the specification limit of 30 nA.

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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 annealing the parts for 888 hours at 25°C, some recovery was observed in the Ibias current, however the parts continued to read between 1 to 3 V/mV for Avs_10k.

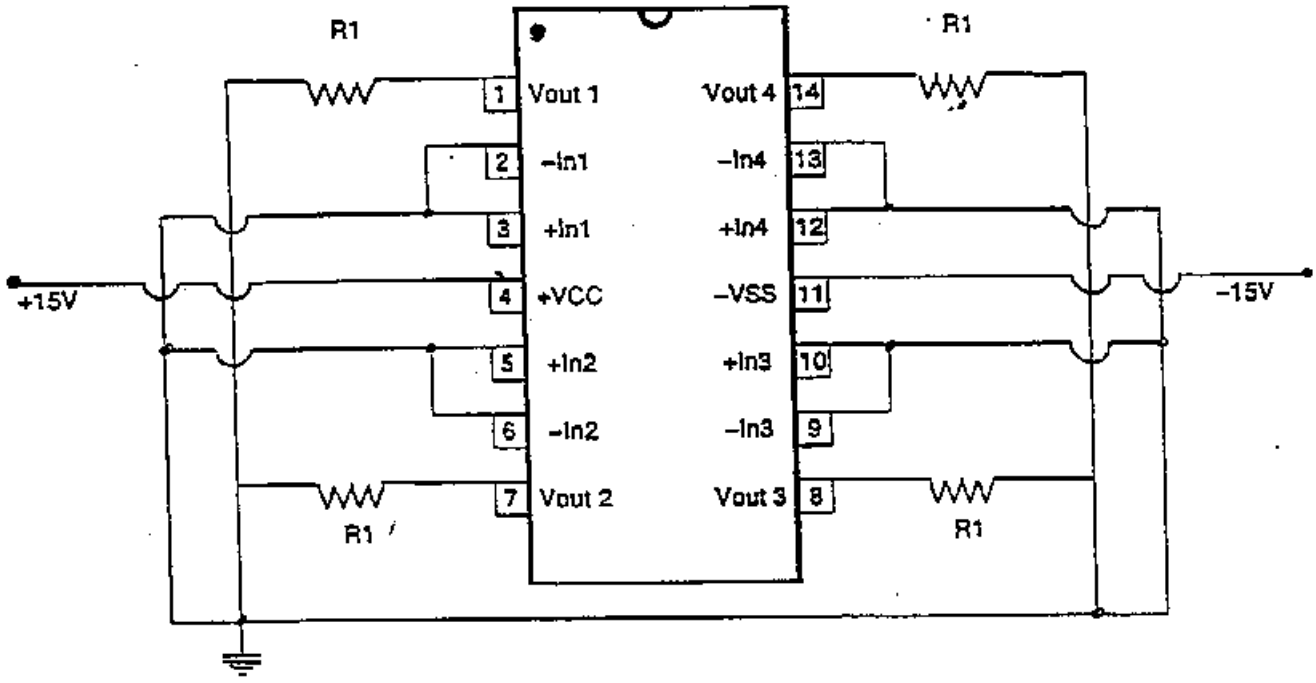
After 20 kRads, four parts failed the psrr tests and no measurements could be made for this parameter for these parts. There was increased degradation in Ibias for all parts. Low readings for Avs_10k continued, with readings in the range of 0.8 to 3.0 V/mV for most parts.

After 30 kRads, six of the eight parts had degraded so much that no measurements could be made on them. The remaining two parts (SN 216 and 217) also showed significant degradation. The +Vo swing, PSRR, and Ibias tests could not be measured adequately for these parts as well.

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 OP420



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

Note: Use 20 pin LCC to 14 pin DIP socket adapters with 14 pin DIP radiation bias boards.

TABLE I. Part Information

Generic Part Number:	OP420
EO-1Part Number	OP420CRC/883c
Charge Number:	EE71382
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9617
Quantity Tested:	10
Serial Number of Control Samples:	214, 215
Serial Numbers of Radiation Samples:	216, 217, 218, 219, 220, 221, 222, 223
Part Function:	Quad-OP-AMP
Part Technology:	Bipolar
Package Style:	20 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 OP420

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	01/24/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR)	01/29/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT	01/31/97
3) 5 KRAD IRRADIATION (0.062 KRADS/HOUR)	01/31/97
POST-5 KRAD ELECTRICAL MEASUREMENT	02/03/97
4) 72 HOUR ANNEALING @25°C	02/03/97
POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/06/97
5) 10.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	02/06/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	02/10/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	02/10/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT	02/12/97
7) 888 HOUR ANNEALING @25°C	02/12/97
POST-888 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/31/97
8) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/31/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT	04/02/97
9) 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/63 DAYS = 19.8 RADS/HOUR=0.006 RADS/SEC

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

Table III. Electrical Characteristics of OP420 /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1	+Idd	mA	Vs=+15V, no load	0.0	0.4
2	-Idd	mA	Vs=-15V, no load	-0.4	0.0
3	+Vo swing	V	Rl=10k, +V=5V, -V=0V	4.0	-
4	-Vo swing	V	Rl=10k, +V=5V, -V=0V	-	0.8
5	Vio	mV	Vs=+/-2.5V to +/-15V	-4.0	4.0
6	+Ibias	nA	Vcm=0.0V	-30.0	30.0
7	-Ibias	nA	Vcm=0.0V	-30.0	30.0
8	Iio /2	nA	Calculated	-2.5	2.5
9	Avs_10k	V/mV	Vo=+/-10V	400	-
10	PSRR	µV/V	Vs=+/-2.5V to +/-15V	-	50.0
11	CMRR /3	dB	Vs=+/-12V	80	-

Notes:

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/ CMRR was measured at Vs=±12V instead of ±15V as specified in the manufacturer's data sheet to avoid tester alarm. A comparison of CMRR at Vs=±12V and Vs=±15V are as follows:
CMRR @ Vs=±15V = 85.5dB.
CMRR @ Vs=±12V = 105dB.

4/ No slew rate measurements were made because the manufacturer supplied no minimum/maximum specification limits for this parameter. The typical value of slew rate provided by the manufacturer is 50 mV/µs. After 30 kRads, the slew rate was measured using a bench set-up on one control sample and two radiation samples. The measurements are provided below:

Control Sample (SN 214)
OUT1 = 56 mV/µs OUT2 = 55 mV/µs OUT3 = 56 mV/µs OUT4 = 57 mV/µs

Post 30 kRads (SN 216)
OUT1 = 30 mV/µs OUT2 = 29 mV/µs OUT3 = 33 mV/µs OUT4 = 29 mV/µs

Post 30 kRads (SN 217)
OUT1 = 17 mV/µs OUT2 = 18 mV/µs OUT3 = 17 mV/µs OUT4 = 17 mV/µs

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP420RC /1

Test #	Parameter	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	Dose Exposure (kRads) 2.5 mean	2.5 sd	5 mean	5 sd	Anneal 72 hrs @25°C mean	Anneal 72 hrs @25°C sd	Rad Level 10 kRad mean	Rad Level 10 kRad sd	Rad Level 15 kRad mean	Rad Level 15 kRad sd	Anneal 888 hrs @25°C mean	Anneal 888 hrs @25°C sd	Rad Level 20 kRad mean	Rad Level 20 kRad sd	Rad Level 30 kRad /3 mean	Rad Level 30 kRad /3 sd
1	+Idd	mA	0.0	0.4	0.25	0.01	0.24	0.01	0.22	0.01	0.22	0.01	0.19	0.02	0.16	0.02	0.17	0.02	0.14	0.02	6F	
2	-Idd	mA	-0.4	0.0	-0.24	0.01	-0.23	0.01	-0.22	0.02	-0.21	0.02	-0.19	0.02	-0.16	0.02	-0.18	0.02	-0.14	0.02	6F	
3	+Vo swing	V	4.0	-	4.9	0.1	5.0	0.1	5.0	0.1	4.9	0.1	4.9	0.1	4.9	0	4.9	0	4.9	0	6F	
4	-Vo swing	V	-	0.8	0	0	0	0.05	0	0.05	0	0.05	0	0.04	0	0.04	0.02	0.05	0.02	0.05	6F	
5	Vio	mV	-4.0	4.0	-0.5	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.2	-0.3	0.3	-0.4	0.1	-0.02	0.3	-0.4	0.2	8F	
6	+Ibias	nA	-30.0	30.0	-9.9	0.9	-7.3	0.3	-11.4	1.4	-10.8	1.1	-20.8	1.5	-30.4	2.4	-25.3	1.2	-36.4	3.2	8F	
7	-Ibias	nA	-30.0	30.0	-9.7	1.2	-7.4	0.4	-11.5	1.4	-11.0	1.2	-21.1	1.8	-31.3	2.7	-26.6	2.7	-37.1	2.7	8F	
8	Iio	nA	-2.5	2.5	-0.03	2.52	1.2	2.1	-0.5	2.5	0.81	2.5	-0.1	2.2	0.5	2.6	-0.03	2.1	-0.07	2.5	8F	
9	Avs_10k	V/mV	400	-	609.9	31.3	579.9	33.6	27.2	83.0	111.5	196.5	2.0	0.9	1.6	0.07	2.0	1.2	1.6	0.8	6F	
10	PSRR	µV/V	-	50.0	1.5	1.5	1.7	1.5	1.8	1.6	1.7	1.6	2.2	1.8	3.6	1.9	2.7	1.8	4F/4F		6F	
11	CMRR	dB	80	-	105.9	4.9	105.7	4.7	105.6	4.7	105.7	4.9	105.8	4.8	105.9	5.5	106.7	5.7	106.4	5.9	6F	
12	SR /4	mV/µs	-	-	56	0.5															24	3.1

Notes:

1/ The mean and standard deviation values were calculated over the eight parts irradiated in this test. The control samples remained constant throughout the testing and are not included in this table. For all parameters except Avs_10k, the mean and standard deviation were calculated using the worst case value from the four measurements of each parameter on each part. For Avs_10k, the mean and standard deviation were calculated across all four measurements for this parameter.
Vio = input offset voltage, Iio = input 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/ At 30kRads, the parts have degraded so much that meaningful measurements can not be obtained.

4/ Slew rate measurements were only made after 30 kRads using a bench set-up on one control sample and two radiation samples. See Note 4 on Table III.

The radiation-sensitive parameters were Avs, Ibias, Iio, Vout swing, and PSRR.