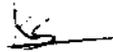


Unisys

DATE: July 29, 1997
TO: J. Lohr/311
FROM: K. Sahu/300.1 
SUBJECT: Radiation Report on: OP77
Project: MAP/SC
Job #: M78168
Project part #: OP77 (5962-87738012A)

PPM-97-031

cc: M. Delmont/303
A. Reyes/OSC
A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on OP77 (5962-87738012A) 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, 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 5.0, 10.0, 15.0, 20.0 30.0, 50.0 and 100.0 kRads.* The dose rate was between 0.06 and 0.50 kRads/hour (0.017 to 0.139 Rads/s). See Table II for the radiation schedule. After the 100.0 kRad exposure, the parts were annealed for 168 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 252, 253, 254, 255, 256, 257, 258, and 259) were used as radiation samples while SN's 250 and 251 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests to 10.0 kRads. No significant degradation was noted in any parameter.

After the 15.0 kRad irradiation, SN 256 marginally exceeded the specification limit of 4.0nA for P_IIB_0V and N_IIB_0V with readings of 4.3nA and 4.2nA respectively. **All parts passed all other tests.**

After the 20.0 kRad irradiation, all but one part marginally exceeded the specification limit for P_IIB_0V and N_IIB_0V with readings in the range of 5.7 to 7.5nA for both. **All parts passed all other tests.**

After the 30.0 kRad irradiation, all partsexceeded the specification limit forP_IIB_0V and N_IIB_0V with readings in the range of 7.0to 13.8nA for both. **All parts passed all other tests.**

After the 50.0 kRad irradiation, all parts continued to degrade in P_IIB_0V and N_IIB_0V with readings in the range of 15.1 to 19.8nA for both. Additionally, most parts fell below the specification limit of -60.0µV for VOS_0V with readings in the range of -62.9 to -82.8µV. **All parts passed all other tests.**

After the 100.0 kRad irradiation,all parts continued to degradein P_IIB_0V and N_IIB_0V with readings in the range of 14.3 to 19.8nA for both. All but one part fell below the specification limit for VOS_0V with readings in the range of -60.4 to -82.4µV. **All parts passed all other tests.**

* 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 168 hours at 25°C, parts showed modest recovery in VOS_0V with only three parts falling marginally below the specification limit. No recovery was noted in P_IIB_0V and N_IIB_0V.

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.

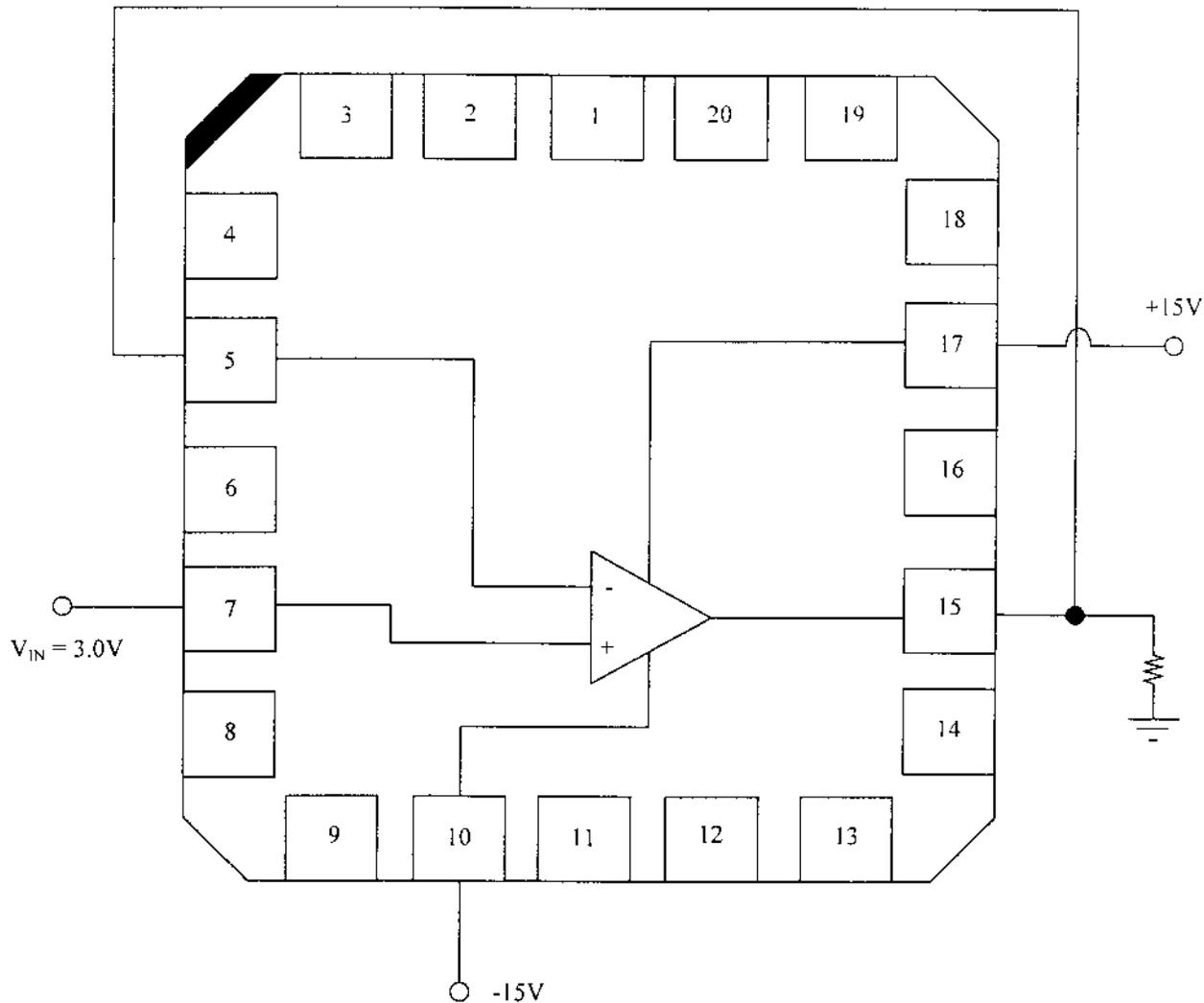
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for OP77



Pin connection list:

| | | | | | | | | | |
|--------|--------------------|--------|--------|---------|--------|--------|--------|--------|---------------------|
| 1: NC | 2: V _{OS} | 3: NC | 4: NC | 5: -IN | 6: NC | 7: +IN | 8: NC | 9: NC | 10: -V |
| 11: NC | 12: NC | 13: NC | 14: NC | 15: OUT | 16: NC | 17: +V | 18: NC | 19: NC | 20: V _{OS} |

Resistor is 402Ω ± 5%, ½ W.

TABLE I. Part Information

| | |
|--------------------------------------|--|
| Generic Part Number: | OP77 |
| MAP/SC Part Number | 5962-9452101M2A |
| Charge Number: | M78168 |
| Manufacturer: | Analog Devices |
| Lot Date Code (LDC): | 9525 |
| Quantity Tested: | 10 |
| Serial Number of Control Samples: | 250, 251 |
| Serial Numbers of Radiation Samples: | 252, 253, 254, 255, 256, 257, 258, and 259 |
| Part Function: | OP-AMP |
| Part Technology: | Bipolar |
| Package Style: | 20 Pin LCC |
| Test Equipment: | A540 |
| Test Engineer: | S. Norris |

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

TABLE II. Radiation Schedule for OP77

| EVENT..... | DATE |
|---|----------|
| 1) INITIAL ELECTRICAL MEASUREMENTS..... | 06/24/97 |
| 2) 5.0 KRAD IRRADIATION (0.125 KRADS/HOUR)..... | 06/25/97 |
| POST-5.0 KRAD ELECTRICAL MEASUREMENT..... | 06/27/97 |
| 3) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR)..... | 06/27/97 |
| POST-10.0 KRAD ELECTRICAL MEASUREMENT..... | 07/01/97 |
| 4) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)..... | 07/01/97 |
| POST-15.0 KRAD ELECTRICAL MEASUREMENT..... | 07/03/97 |
| 5) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)..... | 07/03/97 |
| POST-20.0 KRAD ELECTRICAL MEASUREMENT..... | 07/07/97 |
| 6) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)..... | 07/07/97 |
| POST-30.0 KRAD ELECTRICAL MEASUREMENT..... | 07/09/97 |
| 7) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR)..... | 07/09/97 |
| POST-50.0 KRAD ELECTRICAL MEASUREMENT..... | 07/11/97 |
| 8) 100.0 KRAD IRRADIATION (0.500 KRADS/HOUR)..... | 07/11/97 |
| POST-100.0 KRAD ELECTRICAL MEASUREMENT..... | 07/14/97 |
| 9) 168 HOUR ANNEALING @25°C..... | 07/14/97 |
| POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT..... | 07/21/97 |

Effective Dose Rate = 100,000 RADS/20 DAYS=208.3 RADS/HOUR=0.058 RADS/SEC

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

Table III. Electrical Characteristics of OP77 /1

| Test # | Parameter | Units | Test Conditions /2 | Spec. min | Lim. max |
|--------|------------------|-------|--|-----------|----------|
| 1 | +I _{CC} | mA | No Load | 0.0 | 2.0 |
| 2 | -I _{CC} | mA | No Load | -2.0 | 0.0 |
| 3 | VOS_0V | μV | | -60.0 | 60.0 |
| 4 | P_IIB_0V | nA | | -4.0 | 4.0 |
| 5 | N_IIB_0V | nA | | -4.0 | 4.0 |
| 6 | IIOS_0V | nA | | -3.8 | 3.8 |
| 7 | CMRR | dB | V _{CM} = IVR = ±13V | 110 | |
| 8 | +PSRR | dB | V _S = +3V to +18V | 106 | |
| 9 | -PSRR | dB | V _S = -3V to -18V | 106 | |
| 10 | P_VOUT_1k | V | R _L = >1kΩ | 12.0 | |
| 11 | P_VOUT_2k | V | R _L = >2kΩ | 12.5 | |
| 12 | N_VOUT_1k | V | R _L = >1kΩ | | -12.0 |
| 13 | N_VOUT_2k | V | R _L = >2kΩ | | -12.5 |
| 14 | P_AOL | V/mV | R _L = >2kΩ, V _O = ±12V | 400 | |
| 15 | N_AOL | V/mV | R _L = >2kΩ, V _O = ±12V | 400 | |
| 16 | +ISC | mA | | -65.0 | |
| 17 | -ISC | mA | | | 65.0 |

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.

2/ For all tests, V_S = ±15V unless otherwise specified.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP77 /1

| Test # | Parameters | Units | Spec. Lim. /2 | min | max | Total Dose Exposure (kRads) | | | | | | | | | | | | Annealing | | | | | | |
|--------|------------|-------|---------------|------|-------|-----------------------------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|-----------|-------|-------|-------|-----------------|-------|------|
| | | | | | | Initial | | 5.0 | | 10.0 | | 15.0 | | 20.0 | | 30.0 | | 50.0 | | 100.0 | | 168 hours @25°C | | |
| | | | | | | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | |
| 1 | +ICC | mA | 0.0 | 2.0 | 1.5 | 0 | 1.5 | 0.03 | 1.4 | 0.03 | 1.4 | 0.03 | 1.4 | 0.03 | 1.4 | 0.03 | 1.4 | 0.03 | 1.2 | 0.05 | 1.2 | 0.05 | 1.3 | 0.03 |
| 2 | -ICC | mA | -2.0 | 0.0 | -1.5 | 0 | -1.5 | 0.03 | -1.4 | 0 | -1.4 | 0.03 | -1.4 | 0.03 | -1.3 | 0.04 | -1.3 | 0.03 | -1.2 | 0.05 | -1.2 | 0.05 | -1.3 | 0.03 |
| 3 | VOS_0V | µV | -60.0 | 60.0 | -5.1 | 11.8 | -12.8 | 10.2 | -15.7 | 11.1 | -18.7 | 10.4 | -21.2 | 11.2 | -26.9 | 10.3 | -54.9 | 21.1 | -68.9 | 9.0 | -88.9 | 9.0 | -49.4 | 13.3 |
| 4 | P_IIB_0V | nA | -4.0 | 4.0 | 0.7 | 0.1 | 1.4 | 0.1 | 2.5 | 0.2 | 3.8 | 1.0 | 6.2 | 1.1 | 11.5 | 2.0 | 16.8 | 2.4 | 18.2 | 1.5 | 18.3 | 0.4 | 18.8 | 0.4 |
| 5 | N_IIB_0V | nA | -4.0 | 4.0 | 0.7 | 0.1 | 1.4 | 0.1 | 2.5 | 0.3 | 3.4 | 0.6 | 6.3 | 1.1 | 11.8 | 2.0 | 19.2 | 1.4 | 19.0 | 1.4 | 18.8 | 0.4 | 18.8 | 0.4 |
| 6 | IIOS_0V | nA | -3.8 | 3.8 | -0.02 | 0.01 | 0.02 | 0.01 | 0.06 | 0.01 | 0.13 | 0.02 | -0.16 | 0.02 | -0.24 | 0.05 | -0.73 | 0.13 | -0.83 | 0.08 | -0.47 | 0.11 | -0.47 | 0.11 |
| 7 | CMRR | dB | 110 | | 146 | 10.5 | 143 | 12.0 | 136 | 4.6 | 134 | 4.2 | 132 | 4.0 | 131 | 4.3 | 128 | 7.4 | 134 | 2.8 | 129 | 7.3 | 129 | 7.3 |
| 8 | +PSRR | dB | 106 | | 131 | 4.4 | 132 | 5.8 | 130 | 5.2 | 128 | 4.6 | 127 | 4.5 | 125 | 4.3 | 125 | 3.9 | 128 | 4.9 | 127 | 4.1 | 127 | 4.1 |
| 9 | -PSRR | dB | 106 | | 126 | 1.2 | 126 | 1.5 | 125 | 1.8 | 123 | 2.1 | 122 | 2.2 | 120 | 1.7 | 134 | 18.0 | 133 | 7.5 | 125 | 4.3 | 125 | 4.3 |
| 10 | P_VOUT_1k | V | 12.0 | | 13.8 | 0 | 13.8 | 0 | 13.8 | 0 | 13.8 | 0 | 13.8 | 0 | 13.8 | 0 | 13.8 | 0 | 13.8 | 0.03 | 13.8 | 0 | 13.8 | 0 |
| 11 | P_VOUT_2k | V | 12.5 | | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 | 14.0 | 0 |
| 12 | N_VOUT_1k | V | -12.0 | | -12.6 | 0 | -12.6 | 0 | -12.6 | 0 | -12.5 | 0.03 | -12.5 | 0 | -12.4 | 0.03 | -12.4 | 0.04 | -12.4 | 0.04 | -12.4 | 0.04 | -12.4 | 0.04 |
| 13 | N_VOUT_2k | V | -12.5 | | -13.1 | 0 | -13.0 | 0 | -12.9 | 0 | -12.9 | 0 | -12.8 | 0.03 | -12.8 | 0 | -12.7 | 0.03 | -12.7 | 0.03 | -12.7 | 0.03 | -12.7 | 0.05 |
| 14 | P_AOL | V/mV | 400 | | 6264 | 411 | 5091 | 315 | 4644 | 683 | 3936 | 648 | 3671 | 1073 | 2930 | 721 | 2640 | 435 | 2285 | 1001 | 2776 | 847 | 2776 | 847 |
| 15 | N_AOL | V/mV | 400 | | 6193 | 387 | 5140 | 275 | 4644 | 509 | 3406 | 462 | 2222 | 886 | 913 | 339 | 548 | 54 | 512 | 16 | 528 | 30 | 528 | 30 |
| 16 | +ISC | mA | -65.0 | | -26.1 | 0.2 | -26.0 | 0.2 | -25.9 | 0.2 | -25.5 | 0.2 | -25.8 | 0.2 | -25.4 | 0.3 | -25.3 | 0.2 | -25.2 | 0.2 | -25.0 | 0.2 | -25.0 | 0.2 |
| 17 | -ISC | mA | 65.0 | | 36.2 | 0.3 | 35.9 | 0.4 | 35.6 | 0.4 | 34.9 | 0.4 | 35.2 | 0.5 | 34.2 | 0.6 | 33.2 | 0.6 | 32.4 | 0.6 | 32.3 | 0.5 | 32.3 | 0.5 |

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 parameters: VOS_0V, P_IIB_0V, N_IIB_0V.