

Unisys

DATE: April 23, 1998 PPM-98-008
TO: J. Dafnis/303
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on **OP15 (Analog Devices) (LDC 9722A)**
PROJECT: GOES (ITT)

cc: D. Maus/ITT, C. Chiming/ITT, L. Deemer/300.1, R. Reed/562, A. Sharma/562, OFA Library/300.1

A radiation evaluation was performed on **OP15 Precision, JFET-Input 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 three parts were used as control samples. The total dose radiation levels were 20.0, 40.0, 60.0, 80.0, 100.0, 150.0, and 200.0 kRads.¹ The dose rate was 1.200 kRads/hour (0.333 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 200.0 kRad irradiation, the parts were annealed under bias at 25°C ² and tested at 4, 24 and 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits³ 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 Figures 1 through 3.

All irradiated parts except one stayed within the specification limits for all tests on irradiation to 40 kRads. One part marginally exceeded the specification limits for VOS after 20 and 40 kRads exposures. After the 60 to 200 kRad exposures, some parts exceeded the specification limits for VOS and all parts exceeded the specification limits for \pm Ibias, and Iio. After annealing the parts at 25°C for 4, 24 and 168 hours, the parts showed some increase in VOS and some recovery in \pm Ibias. Figures 2 and 3 show the degradation in the radiation sensitive parameters VOS and Ibias with increasing radiation exposure. The increased degradation in VOS with annealing at 25°C indicates that the parts may show more degradation in the low dose rates of the space environment. A detailed summary of test results is provided below.

Initial electrical measurements were made on 11 samples. Eight samples (SN's 1150, 1153, 1154, 1155, 1157, 1207, 1218, and 1219) were used as radiation samples while SN's 1151, 1152 and 1220 were used as control samples. All parts passed all tests during initial electrical measurements.

After the 20.0 kRad irradiation, SN 1218 marginally exceeded the specification limit of $500\mu\text{V}$ for VOS with a reading of $505\mu\text{V}$. **All parts passed all other tests.**

After the 40.0 kRad irradiation, SN 1218 continued to marginally exceed the specification limit for VOS with a reading of $692\mu\text{V}$. **All parts passed all other tests.**

After the 60.0 kRad irradiation, three parts marginally exceeded the specification limit for VOS with readings in the range of 504 to $823\mu\text{V}$. All parts exceeded the specification limit of 50pA for $-$ Ibias with readings in the range of 600 to 750pA . The bench measurements of \pm Ibias became somewhat unstable (readings could not be repeated to less than 20pA); therefore, I_{IO} became difficult to calculate at this level and remained so throughout the rest of the testing. **All parts passed all other tests.**

After the 80.0 kRad irradiation, three parts exceeded the specification limit for VOS with readings in the range of 520 to $849\mu\text{V}$. All parts exceeded the specification limit of 50pA for \pm Ibias with readings in the range of 630 to

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.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP15 /1

Test #	Parameters	Units	Spec. Lim. /2	min	max	Total Dose Exposure (kRads Si)																Annealing							
						Initial		20.0		40.0		60.0		80.0		72 hours @25°C		100.0		150.0		200.0		4 hours @25°C		24 hours @25°C		168 hours @25°C	
						mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	+Icc	mA	0.0	4.0	3.3	0.1	3.0	0.2	2.8	0.2	2.6	0.2	2.5	0.2	2.5	0.1	2.4	0.1	2.2	0.1	2.3	0.1	2.2	0.1	2.2	0.1			
2	-Icc	mA	-4.0	0.0	-3.3	0.2	-3.0	0.2	-2.8	0.2	-2.6	0.2	-2.5	0.2	-2.5	0.1	-2.4	0.1	-2.2	0.1	-2.3	0.1	-2.2	0.1	-2.2	0.1			
3	Power_Diss	mW		120	50	2.4	45	2.3	42	5.5	39	2.5	37	1.9	39	2.1	35	1.9	34	1.8	34	1.7	34	1.3	33	1.2	33	0.9	
4	VOS	?V	-500	500	-70	201	-19	216	165	205	409	248	443	255	769	256	1132	332	1622	474	1864	626	1736	658	2529	779	3499	1093	
5	CMRR	dB	86		101	2.4	101	2.5	102	2.8	102	3.3	103	3.9	105	5.5	110	14	103	4.7	103	4.7	105	5.5	102	4.8	106	13	
6	PSRR	dB	84		104	4.1	105	4.7	106	5.0	107	5.4	107	5.6	108	6.3	111	8.5	116	11	117	12	117	14	116	18	105	6.2	
7	P_VOUT_10k	V	12.0		13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	
8	N_VOUT_10k	V		-12.0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	-13.5	0	
9	P_VOUT_2k	V	11.0		13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	13.1	0	
10	N_VOUT_2k	V		-11.0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	-13.0	0	
11	P_AOL_2k	V/mV	100		396	42	344	27	322	29	302	25	289	19	305	24	282	19	266	17	276	14	284	20	285	16	307	19	
12	N_AOL_2k	V/mV	100		312	26	278	22	256	20	244	19	236	16	243	19	228	17	216	11	223	11	226	11	226	13	233	15	
13	Slew Rate	V/?s	10.0		19.5	4.1	24.9	2.4	24.8	2.6	24.9	2.5	24.8	2.4	24.6	2.4	24.1	2.3	25.5	2.4	25.5	2.5	25.0	2.6	24.8	1.9	25.2	2.6	
14	+Ibias /3	pA	-50	50	1	0.5	1	0.9	3	2.1	/4		700	61	450	53	740	59	1400	132	1050	100	900	82	875	43	790	170	
15	-Ibias /3	pA	-50	50	-2	0	-2	0	-1	0.4	660	55	700	56	460	51	740	56	1400	111	1050	122	900	88	875	45	824	184	
16	Iio /3 /4	pA	-10	10	2.3	0.2	2.7	0.5	4.8	1.7	/4		/4		/4		/4		/4		/4		/4		/4		/4		

- 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/ These measurements were performed on the bench due to limitations in the automatic test equipment. (Can not measure below 1nA.)
 - 4/ Due to instability in +Ibias and -Ibias, no reliable calculation of Iio was possible after 60 kRads.

Radiation sensitive parameters: VOS, +/- Ibias, Iio.

