

Unisys

DATE: January 19, 1999 PPM-99-015
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SUBJECT: Radiation Report on **AMP-01A (Analog Devices) (LDC 9818)**
PROJECT: IRAC

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A radiation evaluation was performed on **AMP-01A (5962-8863001VA) Low Noise Precision Instrumentation Amplifier (Analog Devices)** to determine the total ionizing dose (TID) tolerance of these parts. The TID 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 TID radiation levels were 2.5, 5.0, 10.0, 15.0, 20.0, 30.0, and 50.0kRads.¹ The dose rate was 0.060kRads/hour (0.02Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 10.0 and 50.0kRad irradiations, the parts were annealed under bias at 25°C and tested after 288 and 168 hours respectively.² 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 Figure 1.

All parts passed all tests initially and upon irradiation to 5kRads. After the 10 and 15kRad irradiations, most parts showed marginal degradation in Voos. From the 20 to 50kRad irradiations, most parts showed some degradation in Gain_err_100x and continued degradation in Voos. After the 50kRad irradiation, two parts showed some degradation in Gain_err_1x. After annealing the parts for 168 hours at 25°C, all parts showed significant recovery in Gain_err_1x, Gain_err_100x and Voos. No significant change was noted in any other parameters.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 13, 14, 15, 16, 17, 18, 19, and 20) were used as radiation samples while SN's 11 and 12 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 5kRads.

After the 10kRad irradiation, five parts marginally exceeded the specification limit of 3.0mV for Voos with readings in the range of 5.1 to 8.8mV. **All parts passed all other tests.**

After annealing the parts for 288 hours at 25°C, the five parts showed modest recovery in Voos with readings in the range of 3.29 to 6.19mV.

After the 15kRad irradiation, six parts exceeded the specification limit for Voos with readings in the range of 4.50 to 14.15mV. **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 20kRad irradiation, all parts exceeded the specification limit for Voos with readings in the range of 5.4 to 27.4mV. Seven parts exceeded the specification limit of 0.60% for Gain_err_100x with readings in the range of 0.68 to 1.90%. **All parts passed all other tests.**

After the 30kRad irradiation, six parts exceeded the specification limit for Voos with readings in the range of 9.5 to 44mV. All parts exceeded the specification limit for Gain_err_100x with readings in the range of 0.65 to 1.37%. **All parts passed all other tests.**

After the 50kRad irradiation, all parts exceeded the specification limit for Voos with readings in the range of 5.7 to 65mV. Two parts marginally exceeded the specification limit of 0.60% for Gain_err_1x with readings of 0.92 and 1.00%. Six parts exceeded the specification limit for Gain_err_100x with readings in the range of 0.73 to 1.63%. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed significant recovery in Gain_err_1x and Gain_err_100x with only one part marginally exceeding the specification limit for Gain_err_100x with a reading of 0.62%. Modest recovery was noted in Voos although all parts exceeded the specification limit with readings in the range of 3.6 to 32.1mV. No significant change was noted in any other parameter.

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.

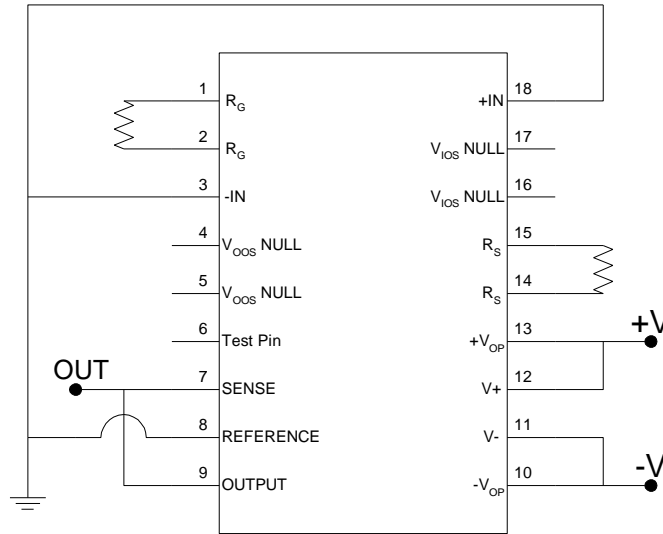
Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for AMP-01A



Notes:

1. $+V = +18.0V \pm 0.5V$, $-V = -18.0V \pm 0.5V$.
2. $R = 10k\Omega \pm 5\%$, $\frac{1}{4}W$.

TABLE I. Part Information

Generic Part Number:	AMP-01A
IRAC Part Number:	AMP-01A (5962-8863001VA)
Charge Number:	M99715
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9818
Quantity Tested:	10
Serial Number of Control Samples:	11, 12
Serial Numbers of Radiation Samples:	13, 14, 15, 16, 17, 18, 19, and 20
Part Function:	High Precision Voltage Reference
Part Technology:	Bipolar
Package Style:	18 Pin DIP
Test Equipment:	A540
Test Engineer:	S. Norris

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

TABLE II. Radiation Schedule for AMP-01A

EVENT.....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	12/02/98
2) 2.5 KRAD IRRADIATION (0.147 KRADS/HOUR)	12/07/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	12/08/98
3) 5.0 KRAD IRRADIATION (0.147 KRADS/HOUR)	12/08/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	12/09/98
4) 10.0 KRAD IRRADIATION (0.294 KRADS/HOUR)	12/09/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	12/10/98
5) 288 HOUR ANNEALING @25°C	12/10/98
POST-288 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/23/98
6) 15.0 KRAD IRRADIATION (0.044 KRADS/HOUR)	12/23/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	12/28/98
7) 20.0 KRAD IRRADIATION (0.294 KRADS/HOUR)	01/05/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	01/06/98
8) 30.0 KRAD IRRADIATION (0.588 KRADS/HOUR)	01/06/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	01/07/98
9) 50.0 KRAD IRRADIATION (0.225 KRADS/HOUR)	01/07/98
POST-50.0 KRAD ELECTRICAL MEASUREMENT	01/11/98
10) 168 HOUR ANNEALING @25°C	01/11/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/19/98

Effective Dose Rate = 50,000 RADS/35 DAYS=59.5 RADS/HOUR=0.02 RADS/SEC

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

Table III. Electrical Characteristics of AMP-01A /1

Test #	Parameter	Units	Test Conditions /2 /3	Spec. Lim.	
				min	max
1	I _{cc}	mA	No Load		4.80
2	I _{ss}	mA	No Load	-4.80	
3	V _{ios}	mV		-50	50
4	+swing	V	R _L = 2kW	13.0	
5	-swing	V	R _L = 2kW		-13.0
6	slew rate	V/ms	A _v = 10	3.500	
7	+psrr_Av_1	dB	Gain = 1, +V _{cc} = 5V to 15V	75	
8	-psrr_Av_1	dB	Gain = 1, +V _{cc} = -5V to -15V	50	
9	+psrr_Av_10	dB	Gain = 10, +V _{cc} = 5V to 15V	95	
10	-psrr_Av_10	dB	Gain = 10, +V _{cc} = -5V to -15V	70	
11	+psrr_Av_100	dB	Gain = 100, +V _{cc} = 5V to 15V	110	
12	-psrr_Av_100	dB	Gain = 100, +V _{cc} = -5V to -15V	90	
13	+psrr_Av_1k	dB	Gain = 1000, +V _{cc} = 5V to 15V	120	
14	-psrr_Av_1k	dB	Gain = 1000, +V _{cc} = -5V to -15V	105	
15	cmrr_Av_1	dB	Gain = 1, V _{CM} = ±10.0V	80	
16	cmrr_Av_10	dB	Gain = 10, V _{CM} = ±10.0V	95	
17	cmrr_Av_100	dB	Gain = 100, V _{CM} = ±10.0V	115	
18	+I _{bias}	nA		-4.00	4.00
19	-I _{bias}	nA		-4.00	4.00
20	I _{os}	nA	(Calculated)	1.00	1.00
21	Gain_err_1x	%	Bench Test		0.6
22	Gain_err_100x	%	Bench Test		0.6
23	V _{oos}	mV	Bench Test		3.00

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 = 10kΩ, R_L = 2kΩ, and T_A = 25°C unless otherwise specified.

3/ CMRR_1k not performed due to system gain of 10 million.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AMP-01A /1

Test #	Parameters	Units	Spec. Lim. /2		Total Dose Exposure (kRads Si)												Annealing		Total Dose Exposure (kRads Si)												Annealing	
					Initial		2.5		5.0		10.0		288 hours @25°C		15.0		20.0		30.0		50.0		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						
1	Icc	mA		4.80	3.60	0.10	3.61	0.12	3.60	0.11	3.64	0.11	3.51	0.19	3.51	0.13	3.12	0.10	3.55	0.17	3.56	0.19	3.54	0.18								
2	Iss	mA	-4.80		-3.58	0.11	-3.59	0.12	-3.59	0.11	-3.63	0.11	-3.82	0.20	-3.84	0.13	-3.43	0.10	-3.88	0.18	-3.88	0.19	-3.86	0.18								
3	Vios	?V	-50	50	-19	1	-16	1	-14	1	-9	1	32	0.3	32	0.3	32	0.3	33	0.6	32	1	33	1								
4	+swing	V	13.0		13.8	0.1	13.8	0	13.8	0.2	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0								
5	-swing	V		-13.0	-14.2	0	-14.2	0	-14.1	0	-14.2	0	-13.8	0	-14.3	0	-14.3	0.1	-14.5	0.1	-14.3	0	-14.3	0								
6	slew rate	V/?s	3.500		5.044	0.736	5.012	0.914	4.703	0.656	5.087	0.710	6.441	0.282	6.575	0.199	5.825	0.179	5.625	0.171	6.715	0.217	6.685	0.256								
7	+psrr_Av_1	dB	75		140	0.3	140	0.3	140	0.3	140	0.2	146	10	147	7	140	0	139	2	143	5	142	5								
8	-psrr_Av_1	dB	50		120	0	120	0	120	0	120	0	142	5	144	6	140	0	142	7	141	6	140	6								
9	+psrr_Av_10	dB	95		140	0.4	140	0.4	140	0.2	140	0.3	140	1	140	1	140	0	140	0	140	1	140	0								
10	-psrr_Av_10	dB	70		120	0	120	0	120	0	120	0	140	0	140	1	140	0	140	1	140	1	140	0								
11	+psrr_Av_100	dB	110		140	0.2	140	0.2	140	0.3	140	0.2	140	0	140	0	140	1	140	0	140	0	140	0								
12	-psrr_Av_100	dB	90		120	0	120	0	120	0	120	0	140	0	140	0	140	1	140	0	140	0	140	0								
13	+psrr_Av_1k	dB	120		140	0.2	140	0.2	140	0.3	140	0.2	140	0	140	0	140	0	140	0	140	0	140	0								
14	-psrr_Av_1k	dB	105		120	0	120	0	120	0	120	0.1	140	0	140	0	140	0	140	0	140	0	140	0								
15	cmrr_Av_1	dB	80		119	0	119	0	119	0	119	0.1	152	9	150	6	157	9	146	9	151	7	147	9								
16	cmrr_Av_10	dB	95		119	0.1	119	0.1	119	0	119	0	155	6	153	5	162	11	154	3	153	4	156	11								
17	cmrr_Av_100	dB	115		119	0	119	0	119	0	119	0.1	153	1	154	3	155	6	155	4	156	4	156	4								
18	+Ibias	nA	-4.00	4.00	0.18	0.26	0.52	0.36	0.06	0.28	0.15	0.19	0.46	0.29	0.62	0.21	-0.36	0.77	0.62	0.33	1.21	0.52	0.23	0.41								
19	-Ibias	nA	-4.00	4.00	0.03	0.01	-0.03	0.03	0.14	0.06	0.16	0.17	0.13	0.20	0.17	0.13	0.53	0.08	1.12	0.32	2.35	0.32	1.56	0.27								
20	Ios	nA	1.00	1.00	0.18	0.26	0.53	0.35	0.00	0.28	0.08	0.15	0.41	0.27	0.59	0.17	-0.57	0.78	0.18	0.35	0.27	0.51	-0.40	0.37								
21	Gain_err_1x	%		0.60	0.22	0.04	0.23	0.04	0.24	0.04	0.28	0.04	0.25	0.04	0.28	0.03	0.28	0.04	0.38	0.05	0.53	0.26	0.38	0.05								
22	Gain_err_100x	%		0.60	0.12	0.08	0.27	0.10	0.37	0.04	0.28	0.14	0.39	0.07	0.59	0.40	1.34	0.48	0.93	0.21	0.93	0.38	0.51	0.09								
23	Voos	mV		3.00	1.26	0.51	1.47	0.74	1.96	1.27	5.10	2.25	3.35	1.55	7.34	5.30	11.93	6.79	22.04	16.86	26.60	16.35	15.78	8.95								

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.

Radiation sensitive parameters: Voos.