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DATE: April 10, 1998 PPM-98-005
TO: S. Hull/562
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on: **AD524 (Analog Devices) (LDC 9650A)**
Project: MAP Subsystems
Job #: C80720
Project part #: AD524SD/883

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A radiation evaluation was performed on **AD524SD/883 Precision Instrumentation Amplifier (Analog Devices)** 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 5.0, 10.0, 15.0, 20.0, 30.0, 50.0, 75.0, and 100.0 kRads.* The dose rate was between 0.125 and 0.625 Rads/hour (0.035 to 0.174 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. The effective dose rate over all testing was 0.072 Rads/sec. After the 100.0 kRad irradiation, 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 9 samples. Eight samples (SN's 161, 162, 163, 164, 165, 166, 167, and 168) were used as radiation samples while SN 160 was used as a control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 20.0kRads.

After the 30.0 kRad irradiation, SN's 162, 163 and 164 fell marginally below the specification limit of –3.0mV for VOSO_0V with readings of -3.4, -3.4 and -4.0mV respectively. SN's 162, 163 and 164 also fell marginally below the specification limit of –100.0µV for VOSI_0V with readings of -104, -103 and –103µV respectively. SN's 162, 163 and 165 marginally exceeded the specification limit of 50nA for P_IIB and N_IIB with readings in the range of 51 to 55nA for both. **All parts passed all other tests.**

After the 50.0 kRad irradiation, all parts fell below the specification limit for VOSO_0V with readings in the range of –3.15 to –4.05mV. Several parts exceeded the specification limit for VOSI_0V, all with readings of 103µV. All parts exceeded the specification limit for P_IIB and N_IIB with readings in the range of 50 to 87nA for both. **All parts passed all other tests.**

After the 75.0 and 100.0 kRad irradiations, all parts fell below the specification limit for VOSO_0V with readings in the range of –3.4 to –5.9mV. Several parts continued to exceed the specification limit for VOSI_0V, all with readings of 103µV. All parts exceeded the specification limit for P_IIB and N_IIB with readings in the range of 94 to 136nA for both. **All parts passed all other tests.**

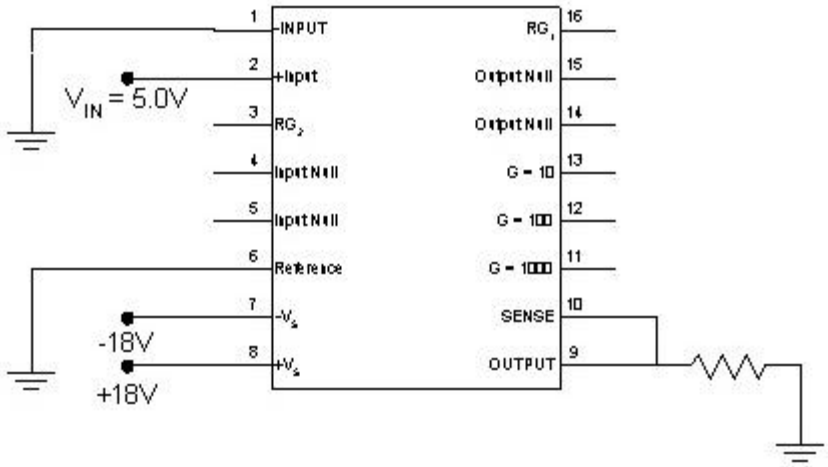
* The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
** These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After annealing the parts for 168 hours at 25°C, parts showed some recovery in VOSO_0V with all parts passing and only one part exceeded the specification limit for VOSI_0V with a reading of 103µV. All parts however, showed some increase in P_IIB and N_IIB with readings in the range of 120 to 161nA for both. This implies that there may be a more significant increase in these parameters at a lower dose rate than that used in this testing.

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 AD524



Resistor is 2kΩ ±5%, ½W.

Note: Decoupling capacitors may be added to power supply connections as needed to eliminate device oscillation.

TABLE I. Part Information

Generic Part Number:	AD524
MAP Subsystem Part Number	AD524SD/883
Charge Number:	C80720
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9650
Quantity Tested:	9
Serial Number of Control Samples:	160
Serial Numbers of Radiation Samples:	161, 162, 163, 164, 165, 166, 167, and 168
Part Function:	Precision Instrumentation Amplifier
Part Technology:	Bipolar
Package Style:	16 Pin DIP
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE II. Radiation Schedule for AD524

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	02/26/98
2) 5.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	02/27/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	03/02/98
3) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/02/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	03/04/98
4) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/04/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	03/06/98
5) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	03/06/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	03/09/98
6) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR)	03/09/98
POST-30.0 KRAD ELECTRICAL MEASUREMENT	03/11/98
7) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR)	03/11/98
POST-50.0 KRAD ELECTRICAL MEASUREMENT	03/13/98
8) 75.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	03/13/98
POST-75.0 KRAD ELECTRICAL MEASUREMENT	03/16/98
9) 100.0 KRAD IRRADIATION (0.625 KRADS/HOUR)	03/16/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	03/18/98
10) 168 HOUR ANNEALING @25°C	03/18/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/24/98

Effective Dose Rate = 100,000 RADS/20 DAYS=208.3 RADS/HOUR=0.058 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim-annealing step.

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

Table III. Electrical Characteristics of AD524 /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1	Plus_Icc	mA	G = 1	0	5.0
2	Minus_Icc	mA	G = 1	-5.0	0
3	VOSO_0V	mV	V_{IN} = 0V	-3.0	3.0
4	VOSI_0V	mV	V_{IN} = 0V	-100	100
5	P_CMRR_x1	dB	G = 1, V_{IN} = 0 to +10V	70	
6	N_CMRR_x1	dB	G = 1, V_{IN} = 0 to -10V	70	
7	P_CMRR_x10	dB	G = 10, V_{IN} = 0 to +10V	90	
8	N_CMRR_x10	dB	G = 10, V_{IN} = 0 to -10V	90	
9	P_CMRR_x100	dB	G = 100, V_{IN} = 0 to +10V	100	
10	N_CMRR_x100	dB	G = 100, V_{IN} = 0 to -10V	100	
11	P_CMRR_x1000	dB	G = 1000, V_{IN} = 0 to +10V	110	
12	N_CMRR_x1000	dB	G = 1000, V_{IN} = 0 to -10V	110	
13	PSRR_x1	dB	G = 1, V_S = ±15V w/ swing to ±12V	75	
14	PSRR_x10	dB	G = 10, V_S = ±15V w/ swing to ±12V	95	
15	PSRR_x100	dB	G = 100, V_S = ±15V w/ swing to ±12V	105	
16	PSRR_x1000	dB	G = 1000, V_S = ±15V w/ swing to ±12V	110	
17	P_IIB	nA	G = 1	-50	50
18	N_IIB	nA	G = 1	-50	50
19	IIOS	nA	G = 1, $I_{IO} = (I_{B+})-(-I_{B-})$	-35	35
20	ERROR_x1	%	G = 1, V_O = ±10V	-0.050	0.050
21	ERROR_x10	%	G = 10, V_O = ±10V	-0.250	0.250
22	ERROR_x100	%	G = 100, V_O = ±10V	-0.500	0.500
23	ERROR_x1000	%	G = 1000, V_O = ±10V	-2.000	2.000

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.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD524 /1

Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	Initial mean	Initial sd	Total Dose Exposure (kRads Si) 5.0 mean	5.0 sd	10.0 mean	10.0 sd	15.0 mean	15.0 sd	20.0 mean	20.0 sd	30.0 mean	30.0 sd	50.0 mean	50.0 sd	75.0 mean	75.0 sd	100.0 mean	100.0 sd	Annealing 168 hours @25°C mean	Annealing 168 hours @25°C sd
1	Plus_Icc	mA	0	5.0	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1	3.4	0.1
2	Minus_Icc	mA	-5.0	0	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1	-3.4	0.1
3	VOSO_0V	mV	-3.0	3.0	0.5	0.3	-0.5	0.2	-1.1	0.3	-1.6	0.4	-2.1	0.6	-2.9	0.7	-3.9	0.8	-3.9	1.0	-4.0	1.1	0.3	1.5
4	VOSI_0V	mV	-100	100	3.1	4.7	-19	10	-37	21	-49	17	-67	20	-82	18	-99	6.5	-91	14.7	-95	10.1	-58	20.1
5	P_CMRR_x1	dB	70		95	7.8	94	5.9	91	8.1	95	11.0	91	6.9	91	4.7	104	13	95	9.5	88	7.6	99	7.7
6	N_CMRR_x1	dB	70		101	10.1	102	13.2	103	17.1	97	8.5	97	11.5	98	10.1	93	6.7	95	9.6	90	10.4	110	19.3
7	P_CMRR_x10	dB	90		123	11.7	118	11.5	113	12.0	114	12.2	116	13.1	118	11.1	121	10.4	114	10.5	110	8.5	124	14.3
8	N_CMRR_x10	dB	90		120	11.4	119	11.8	118	12.3	115	10.0	113	6.9	114	9.5	115	8.1	112	8.9	107	8.4	127	14.2
9	P_CMRR_x100	dB	100		141	7.9	140	9.7	139	13.8	141	14.1	144	14.5	139	12.2	135	10.7	132	15.1	127	15.8	134	5.4
10	N_CMRR_x100	dB	100		126	3.1	125	4.4	124	6.2	125	5.4	126	3.2	129	4.8	132	7.7	127	7.0	126	17.0	128	4.2
11	P_CMRR_x1000	dB	110		133	2.7	132	2.4	132	2.2	133	2.2	134	2.1	133	2.2	132	2.1	131	2.7	130	6.4	135	4.3
12	N_CMRR_x1000	dB	110		131	2.0	131	1.8	131	1.5	131	1.8	132	2.6	131	2.3	130	1.7	130	3.1	132	10.2	130	2.5
13	PSRR_x1	dB	75		95	14.5	95	9.3	94	8.7	93	9.3	91	9.5	91	9.6	93	10.7	91	9.9	91	9.2	95	10.4
14	PSRR_x10	dB	95		115	9.6	114	9.2	113	7.0	114	6.9	113	6.7	114	6.9	113	7.1	113	7.6	113	8.4	115	6.5
15	PSRR_x100	dB	105		132	7.3	133	7.4	133	7.4	135	7.7	136	8.1	134	8.2	132	8.4	133	7.9	133	6.8	132	7.2
16	PSRR_x1000	dB	110		129	1.5	129	1.8	129	2.2	129	1.8	129	1.6	129	1.7	129	2.1	128	1.4	128	1.1	129	2.5
17	P_IIB	nA	-50	50	1.8	0.9	10	2.6	15	3.1	22	3.8	34	4.4	49	5.4	75	8.0	117	11	118	13	143	12.4
18	N_IIB	nA	-50	50	1.4	0.7	9	2.6	14	3.1	20	3.5	33	4.2	47	5.3	73	8.0	114	11	115	12.2	141	12.0
19	IIOS	nA	-35	35	0.6	0.1	0.8	0.1	1.1	0.1	1.1	0.1	1.2	0.1	1.8	0.1	1.8	0.1	2.8	0.2	2.7	0.24	2.8	0.21
20	ERROR_x1 /3 /4	%	-0.050	0.050	P		P		P		P		P		P		P		P		P		P	
21	ERROR_x10	%	-0.250	0.250	-0.08	0.01	-0.07	0.01	-0.07	0.01	-0.07	0.02	-0.08	0.02	-0.07	0.01	-0.05	0.03	-0.03	0.06	-0.05	0.02	-0.06	0.02
22	ERROR_x100	%	-0.500	0.500	-0.26	0.08	-0.19	0.07	-0.16	0.09	-0.17	0.12	-0.22	0.08	-0.14	0.15	-0.10	0.19	-0.09	0.14	0.06	0.10	0.08	0.14
23	ERROR_x1000	%	-2.000	2.000	-1.76	0.18	-1.15	0.28	-1.29	0.41	-1.16	0.60	-1.47	0.29	-0.97	0.60	-1.06	0.69	-0.96	0.76	-0.33	1.03	0.21	0.78

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/ "P" ("F") implies all parts passed (failed) this test at this level. nPmF implies that "n" parts passed and "m" parts failed this test at this level.

4/ Due to limitations in the the automatic test equipment, occasional bench measurements of ERROR_x1 were made to confirm that there were no failures. However, the measurement was not made after each radiation step.

Radiation sensitive parameters: VOSO_0V, VOSI_0V, P_IIB, N_IIB.