

UNISYS

DATE: June 6, 1997
 TO: J.Lohr/311
 FROM: K. Sahu/300.1 *KS*
 SUBJECT: Radiation Report on: AD624SD/883B
 Project: MAP INSTRUMENT
 Job #: EE78120
 Project part #: AD624SD/883B

PPM-97-024

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A radiation evaluation was performed on AD624SD/883B 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, ten 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 1.25 kRads/hour (see Table II for 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 62, 63, 64, 65, 66, 67, 68, and 69) were used as radiation samples while SN's 60 and 61 were used as the control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests upon irradiation to 5.0 kRads. No significant degradation was observed in any test parameter.

After the 10.0 kRad irradiation, SN 65 fell marginally below the specification limit for P_cmrr_1x with a reading of 68.2dB against the specification limit of 70dB. Most parts fell marginally below the specification limit of 110dB for both P_cmrr_500x and N_cmrr_500x with readings in the range of 102 to 109dB. All parts passed all other tests.

After the 15.0 kRad irradiation, SN 65 remained marginally below the specification limit for P_cmrr_1x with a reading of 68.9dB. SN's 62, 64 and 68 fell below the specification limit of 100dB for both P_cmrr_100x and N_cmrr_100x with readings in the range of 95 to 99dB. SN's 62 and 68 fell marginally below the specification limit of 100dB for both P_cmrr_200x and N_cmrr_200x with readings within 10% of the specification limits. All parts except SN 65 fell below the specification limit for both P_cmrr_500x and N_cmrr_500x with readings in the ranges of 98 to 107dB. SN 68 marginally exceeded the specification limit of 0.5% for ERROR_x500 % with a reading of 0.519%. All parts passed all other tests.

After the 20.0 kRad irradiation, SN's 62 and 68 fell marginally below the specification limit for P_cmrr_1x with a reading of 67dB for both. SN 62 also fell below the specification limit for N_cmrr_1x with a reading of 69dB. Most parts fell below the specification limit for P_cmrr_100x and N_cmrr_100x, P_cmrr_200x, N_cmrr_200x, P_cmrr_500x, and N_cmrr_500x with readings within 10% of the specification limits. Several parts exceeded the

* 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.

specification limit for ERROR_x500_% with readings in the range of 0.632 to 0.821%. **All parts passed all other tests.**

After the 30.0 kRad irradiation, SN's 62 and 68 fell below the specification limit for both P_cmrr_1x and N_cmrr_1x and with readings in the range of 65 to 68dB. Most parts fell marginally below the specification limits for P_cmrr_100x, N_cmrr_100x, P_cmrr_200x, and N_cmrr_200x with readings within 10% of the specification limits. All parts fell marginally below the specification limit for both P_cmrr_500x and N_cmrr_500x with readings in the range of 93 to 105dB for both. SN 69 exceeded the specification limit of 0.5% for ERROR_x200_% with a reading of 0.806%. SN's 64, 68 and 69 exceeded the specification limit for ERROR_x500_% with readings in the range of 0.504 to 1.2%. SN's 64, 66 and 69 exceeded the specification limit of 50nA for both Piib and Niib with readings in the range 53 to 54nA and 51 to 52nA respectively. **All parts passed all other tests.**

After the 50.0 kRad irradiation, Most parts marginally failed P_cmrr_1x, N_cmrr_1x, P_cmrr_100x, and N_cmrr_100x with readings similar to those at 30.0 kRads. All parts fell slightly below the specification limit for P_cmrr_200x, N_cmrr_200x, P_cmrr_500x, and N_cmrr_500x with readings much the same as at previous levels. SN 68 exceeded the specification limit of 0.5% for ERROR_x200_% with a reading of 0.793%. All parts exceeded the specification limit for ERROR_x500_% with readings in the range of 0.546 to 1.5%. All parts exceeded the specification limit for both Piib and Niib with readings in the range of 74 to 110nA. **All parts passed all other tests.**

After the 100.0 kRad irradiation, SN's 62 and 68 fell marginally below the specification limit for both P_cmrr_1x and N_cmrr_1x and with readings within 10% of the specification limit. Most parts fell marginally below the specification limit for P_cmrr_100x, N_cmrr_100x, P_cmrr_200x, and N_cmrr_200x with readings much the same as before. All parts fell below the specification limit for both P_cmrr_500x and N_cmrr_500x with readings in the range of 93 to 108dB. Most parts exceeded the specification limit for ERROR_x500_% with readings in the range of 0.624 to 1.26%. All parts exceeded the specification limit for both Piib and Niib with readings in the range 132 to 159nA. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, the parts showed some recovery in several parameters. Only SN 68 fell below the specification limit for both P_cmrr_1x and N_cmrr_1x and with readings of 66 and 70dB respectively. SN's 64 and 68 fell below the specification limit for both P_cmrr_100x and N_cmrr_100x with readings in the range of 92 to 99dB and 93 to 99dB respectively. SN's 64 and 68 fell below the specification limit for both P_cmrr_200x and N_cmrr_200x with readings in the range of 94 to 99dB for both. SN's 64 to 69 fell below the specification limit for both P_cmrr_500x and N_cmrr_500x with readings in the range of 95 to 107dB and 95 to 109dB respectively. SN's 64, 68 and 69 exceeded the specification limit for ERROR_x500_% with readings in the range of 0.541 to 1.03%. All parts continued to exceed the specification limit for both Piib and Niib with readings in the range 118 to 142nA.

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.

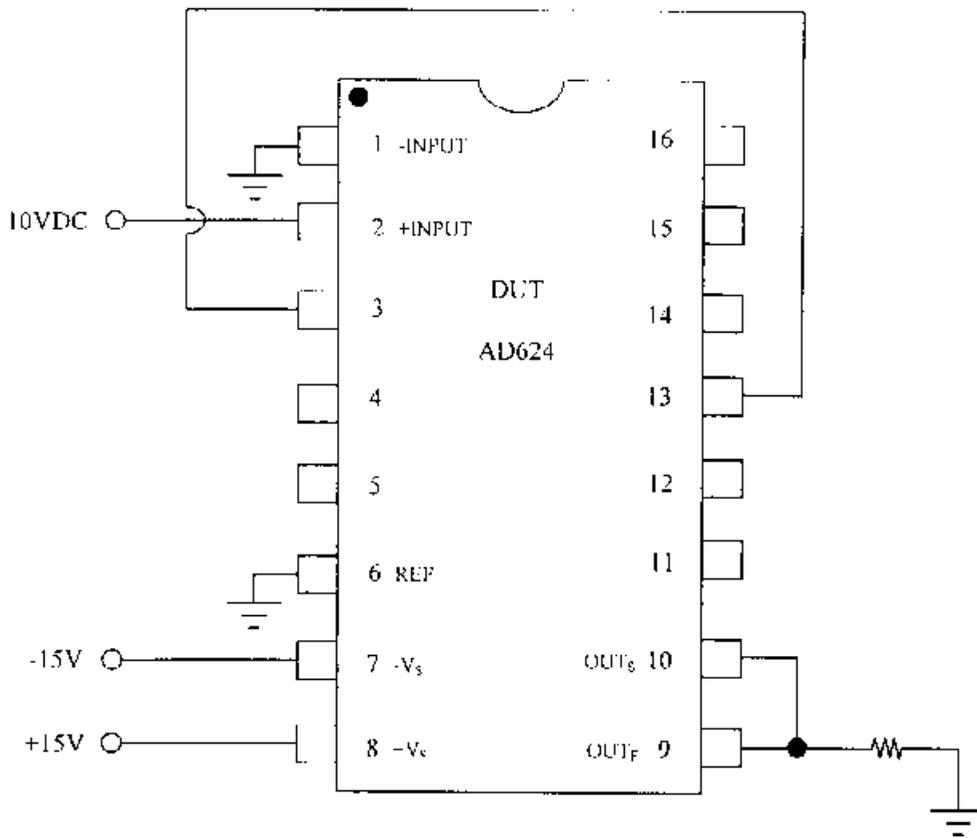
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for AD624SD/883B



Notes:

1. Resistors 2.0k Ω , ¼ W, 5%.
2. Gain = 100. See manufacturer's data book for optional bias conditions. Shorting pin 3 (RG₂) to pin 13 (RG₁) results in overall gain of 100 for the device.

TABLE I. Part Information

Generic Part Number:	AD624SD/883B
MAP INSTRUMENT Part Number	none given
Charge Number:	EE78120
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9609
Quantity Tested:	10
Serial Number of Control Samples:	60, 61
Serial Numbers of Radiation Samples:	62, 63, 64, 65, 66, 67, 68, 69
Part Function:	Instrument Amplifier
Part Technology:	Bipolar
Package Style:	16 Pin DIP
Test Equipment:	A540
Test Engineer:	A. Naji

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

TABLE II. Radiation Schedule for AD624SD/883B

EVENT.....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	04/15/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR).....	05/02/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT.....	05/05/97
3) 5.0 KRAD IRRADIATION (0.062 KRADS/HOUR).....	05/05/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT.....	05/08/97
4) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR).....	05/08/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT.....	05/12/97
5) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR).....	05/12/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT.....	05/14/97
6) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR).....	05/14/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT.....	05/16/97
7) 30.0 KRAD IRRADIATION (0.250 KRADS/HOUR).....	05/16/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT.....	05/19/97
8) 50.0 KRAD IRRADIATION (0.500 KRADS/HOUR).....	05/19/97
POST-50.0 KRAD ELECTRICAL MEASUREMENT.....	05/21/97
9) 100.0 KRAD IRRADIATION (1.250 KRADS/HOUR).....	05/21/97
POST-100.0 KRAD ELECTRICAL MEASUREMENT.....	05/23/97
10) 168 HOUR ANNEALING @25°C.....	05/23/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	05/30/97

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 I.

Table III. Electrical Characteristics of AD674SD/883B 1/

Test #	Parameters	Units	Test Conditions	Spec. Lim.	
				min	max
1	+I _{CC}	mA	G = 100	0	5.0
2	-I _{CC}	mA	G = 100	-5.0	0
3	P _{cmrr_x1}	dB	G = 1, V _{IN} = 0V to -10V	70	
4	N _{cmrr_x1}	dB	G = 1, V _{IN} = 0V to -10V	70	
5	P _{cmrr_100x}	dB	G = 100, V _{IN} = 0V to +10V	100	
6	N _{cmrr_100x}	dB	G = 100, V _{IN} = 0V to -10V	100	
7	P _{cmrr_200x}	dB	G = 200, V _{IN} = 0V to +10V	100	
8	N _{cmrr_200x}	dB	G = 200, V _{IN} = 0V to -10V	100	
9	P _{cmrr_500x}	dB	G = 500, V _{IN} = 0V to +10V	110	
10	N _{cmrr_500x}	dB	G = 500, V _{IN} = 0V to -10V	110	
11	ERROR_x1_%	±% max	G = 1, V _O = +10V		0.05
12	ERROR_x100_%	±% max	G = 100, V _O = ±10V		0.05
13	ERROR_x200_%	±% max	G = 200, V _O = ±10V		0.05
14	ERROR_x500_%	±% max	G = 500, V _O = +10V		0.05
15	P _{psrr_x1}	dB	G = 1, V _S = +12V, +15V	75	
16	N _{psrr_x1}	dB	G = 1, V _S = -12V, -15V	75	
17	V _{os}	μV	V _{IN} = 0V	-75.0	75.0
18	P _{lib}	nA	G = 100	-50.0	50.0
19	N _{lib}	nA	G = 100	-50.0	50.0
20	I _{os}	nA	G = 100	35.0	35.0

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

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD624SD/833B /1

Test #	Parameters	Units	Spec. Lim. /2	Total Dose (kRad/s)												Annealing							
				Initial		2.5		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	mean	sd
1	+ICC	mA	0	3.93	0.05	3.91	0.05	3.89	0.05	3.86	0.05	3.84	0.05	3.83	0.05	3.81	0.04	3.76	0.05	3.72	0.04	3.73	0.05
2	-ICC	mA	0	-3.96	0.04	-3.94	0.05	-3.94	0.05	-3.89	0.05	-3.87	0.05	-3.86	0.05	-3.82	0.05	-3.80	0.05	-3.74	0.05	-3.75	0.05
3	P_cmrr_x1	dB	70	89	4.7	82	3.3	78	9.6	76	2.6	80	9.7	78	9.7	76	7.7	72	7.9	75	8.0	76	6.6
4	N_cmrr_x1	dB	70	84	8.6	86	7.4	82	7.3	76	6.6	78	7.4	76	5.7	76	7.0	70	5.8	75	5.7	77	6.3
5	P_cmrr_x100	dB	100	126	6.5	121	5.9	110	3.9	109	8.0	102	5.1	101	5.3	98	4.8	95	4.1	101	7.2	104	6.2
6	N_cmrr_x100	dB	100	124	8.5	123	8.0	112	5.6	112	11.1	102	6.1	101	5.8	98	4.4	95	4.4	98	4.0	103	5.4
7	P_cmrr_x200	dB	100	127	6.5	121	9.7	116	6.6	109	5.5	103	4.3	102	4.7	99	4.5	96	3.9	101	6.8	104	5.5
8	N_cmrr_x200	dB	100	122	5.3	127	9.8	117	8.2	109	6.0	103	4.2	102	4.6	99	4.5	96	3.8	99	3.8	104	5.8
9	P_cmrr_x500	dB	110	122	11.7	119	5.2	121	5.1	109	4.7	104	3.7	103	4.4	100	4.3	97	3.9	100	4.4	106	6.1
10	N_cmrr_x500	dB	110	118	3.6	117	3.2	122	5.8	110	4.6	104	3.8	103	4.4	100	4.3	97	3.7	100	4.0	106	6.6
11	ERROR_x1_%	% max	0.05	0.001	7E-4	0.001	6E-4	7.5E-4	4.7E-4	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.002	0.003	0.002	0.003	0.002	0.003	0.002
12	ERROR_x100_%/3	% max	0.25	0.051	0.034	0.094	0.037	0.042	0.036	0.053	0.034	0.059	0.049	0.074	0.064	0.108	0.072	0.180	0.082	0.141	0.082	0.082	0.082
13	ERROR_x200_%/3	% max	0.5	0.100	0.028	0.108	0.039	0.099	0.040	0.094	0.043	0.101	0.105	0.156	0.101	0.252	0.234	0.378	0.189	0.304	0.101	0.152	0.107
14	ERROR_x500_%/3	% max	0.5	0.115	0.051	0.099	0.067	0.122	0.080	0.105	0.096	0.035	0.112	0.480	0.197	0.491	0.314	0.950	0.289	0.701	0.308	0.531	0.214
15	P_parr_x1	dB	75	81	1.5	81	2.0	84	2.0	80	2.5	82	3.9	82	3.6	84	3.5	86	4.4	84	5.6	80	2.7
16	N_parr_x1	dB	75	101	12.6	96	6.5	99	4.4	89	14.5	95	8.1	99	7.0	98	4.6	94	6.3	97	3.5	96	4.0
17	Vos	mV	-75.0	-1.4	0.4	-2.0	0.5	-2.4	0.8	-1.6	1.4	-1.9	1.5	-1.9	1.7	-4.1	1.8	-2.7	2.2	-2.1	1.9	-1.1	1.4
18	P_jib	nA	50.0	-3.0	1.6	3.3	2.1	8.8	2.3	18.2	2.7	26.4	3.0	34.4	3.4	49.5	3.6	102	9.2	451	6.5	136	5.6
19	N_jib	nA	50.0	-3.3	1.6	2.9	2.2	8.2	2.3	17.1	2.6	25.3	2.6	32.4	3.2	47.1	3.7	84	5.1	143	5.4	130	6.1
20	Ios	nA	35.0	0.3	0.2	0.4	0.3	0.6	0.4	3.1	0.3	1.4	0.4	1.8	0.5	2.2	0.4	19.0	4.9	8.6	1.9	5.6	3.2

Notes:

- 1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The centro. 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.
- 3/ These tests were performed on bench top due to the limitations of the ADS4C.

Radiation sensitive parameters: P_cmrr_x1, 100x, 200x, 500x; N_cmrr_x1, 100x, 200x, 500x; ERROR_200X, 500X; P_jib; N_jib.