Unisys

DATE: September 28, 1999 PPM-99-029
TO: R. Reed/562
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SUBJECT: Radiation Report on **AD620SQ/883B (Analog Devices) (LDC 9815)**
PROJECT: GLAS

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A radiation evaluation was performed on **AD620SQ/883B Low Power Instrumentation 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, one part was irradiated under bias to determine the initial degradation level. Seven parts were then 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, 20.0, and 25.0kRads.[1] The average dose rate was 0.14kRads/hour (0.04 Rads/s). See Table II for the radiation schedule and average dose rate calculation. After the 25.0kRad irradiation, the tester suffered a severe power surge and was off line for about two weeks. The parts were stored without bias until the tester was repaired. The parts were annealed under bias at 25°C for 168 hours.[2] After each radiation exposure and annealing step, parts were electrically tested according to the test conditions and the specification limits[3] 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.

All parts passed all initial electrical tests. The parts showed some degradation in ±Ib at 5 and 10kRads. The readings after 10kRads ranged from 5.4 to 13.9nA against a specification limit of 2.0nA. After 20kRads, the parts showed increasing degradation in ±Ib with readings in the range of 21.5 to 41.4nA. After 25kRads, the parts showed significant degradation in ±Ib, gain_error and PSRR_pos. After annealing the parts at 25°C for 168 hours, the parts showed significant recovery in most parameters. See Table 4 and Figure 2 for more details.

Initial electrical measurements were made on 10 samples. One part was used to determine the initial degradation level (SN 17). Seven samples (SN's 19, 20, 21, 22, 23, 24, and 25) were used as radiation samples while SN's 16 and 18 were used as control samples. All parts passed all tests during initial electrical measurements.

After the 5kRad irradiation, SN 23 marginally exceeded the specification limit of 2.00nA for +Ib and -Ib with readings of 2.44 and 2.64nA respectively. **All parts passed all other tests.**

After the 10 and 20kRad irradiations, all parts exceeded the specification limit for +Ib and -Ib with readings in the range of 5.41 to 13.93nA after 10kRads and 21.49 to 41.37nA after 20kRads. SN 23 exceeded the specification limit of 0.10% for gain_error_x1 with a reading of 0.55% after 10kRads and 0.75% after 20kRads. **All parts passed all other tests.**

After the 25kRad irradiation, all parts showed significant degradation in +Ib and -Ib with all parts reading greater than 212nA, which was the maximum reading permitted by the ATE for this parameter. Six parts fell below the specification limit of 80dB for PSRR_pos with readings in the range of 75 to 78dB. One part fell below the specification limit of 13.8V for +Swing with a reading of 9.2V. The readings for gain_error_x1, x100 and x1000 became unreliable after this dose step. See Table 4 for more details. **All parts passed all other tests.**

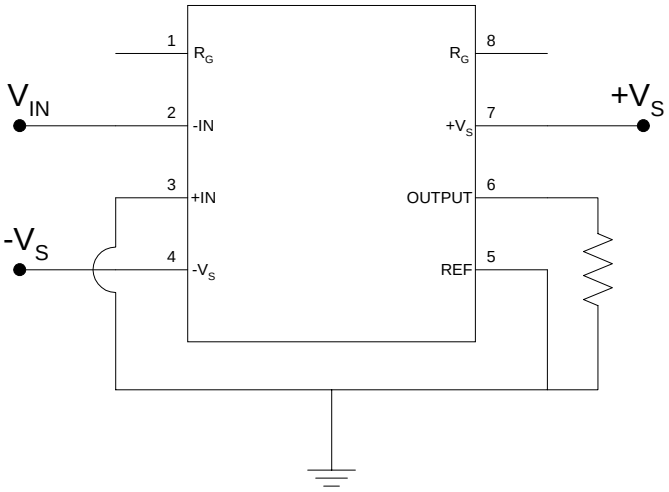
[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After annealing the parts for 168 hours at 25°C, significant recovery was seen in most parameters. However, the parts showed a slight increase in Iio with three parts marginally exceeding the specification limit. All parts showed complete recovery in PSRR_pos, +Swing, gain_error_x10, x100, and x1000.

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.

Figure 1. Radiation Bias Circuit for AD620SQ/883B



Notes:
1. $+V_S$ = +15.0V ±0.5V.
2. $-V_S$ = -15.0V ±0.5V.
3. V_{IN} = +1.0V
4. R = 10kΩ ±5%, ¼W.
5. R_G (Pins 1 and 8) Open → Gain = 1

TABLE I. Part Information

Generic Part Number:	AD620
GLAS Part Number	AD620SQ/883B
GLAS TID Requirement	25kRads (RDM = 5)
Charge Number:	M90432
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9815
Quantity Tested:	10
Serial Numbers of Control Samples:	16, 18
Serial Number of Initial Degradation Sample:	17
Serial Numbers of Radiation Samples:	19, 20, 21, 22, 23, 24, 25
Part Function:	Low Power Instrumentation Amplifier
Part Technology:	Bipolar with super β processing in the input stage
Package Style:	8 Pin DIP
Test Equipment:	A540
Test Engineer:	S. Norris

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

TABLE II. Radiation Schedule for AD620SQ/883B

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	08/11/99
One Part Test Runs	
2) 8 KRAD IRRADIATION (0.124 KRADS/HOUR)	08/13/99
POST-8 KRAD ELECTRICAL MEASUREMENT	08/16/99
3) 16.0 KRAD IRRADIATION (0.181 KRADS/HOUR)	08/16/99
POST-16.0 KRAD ELECTRICAL MEASUREMENT	08/18/99
4) 24.0 KRAD IRRADIATION (0.180 KRADS/HOUR)	08/18/99
POST-24.0 KRAD ELECTRICAL MEASUREMENT	08/20/99
All Remaining Parts	
5) 5.0 KRAD IRRADIATION (0.122 KRADS/HOUR)	08/23/99
POST-5.0 KRAD ELECTRICAL MEASUREMENT	08/25/99
6) 10.0 KRAD IRRADIATION (0.227 KRADS/HOUR)	08/25/99
POST-10.0 KRAD ELECTRICAL MEASUREMENT	08/27/99
7) 20.0 KRAD IRRADIATION (0.114 KRADS/HOUR)	08/27/99
POST-20.0 KRAD ELECTRICAL MEASUREMENT	08/30/99
8) 25.0 KRAD IRRADIATION (0.217 KRADS/HOUR) *	08/30/99
POST-25.0 KRAD ELECTRICAL MEASUREMENT	09/15/99
9) 168 HOUR ANNEALING @25°C	09/15/99
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	09/22/99

Average Dose Rate = 25,000 RADS/174 HOURS=143.7 RADS/HOUR=0.04RADS/SEC

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

* The parts were tested after sitting unbiased for 360 hours due to a severe problem with the A-540.

Table III. Electrical Characteristics AD620SQ/883B (1)

Test #	Parameter	Units	Spec. Limit min	Spec. Limit max	Test Conditions (2)
1	Iq	mA		1.30	
2	Voffset	µV	-125	125	V_S = ±5V to ±15V
3	+Ib	nA	-2.00	2.00	
4	-Ib	nA	-2.00	2.00	
5	Iio	nA	-1.00	1.00	
6	PSRR_pos	dB	80		V_S = +2.3V to +18V
7	PSRR_neg	dB	80		V_S = -2.3V to -18V
8	+Swing	V	13.8		V_S = +2.3V to +5V, Gain = 1
9	-Swing	V		13.9	V_S = -2.3V to -5V, Gain = 1
10	Slew_Rate	V/µs	0.750		
A	gain_error_x1	%	-0.10	0.10	V_{OUT} = ±10V
B	gain_error_x10	%	-0.30	0.30	V_{OUT} = ±10V
C	gain_error_x100	%	-0.30	0.30	V_{OUT} = ±10V
D	gain_error_x1000	%	-0.70	0.70	V_{OUT} = ±10V

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 and R_L = 2kΩ unless otherwise noted.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD620SQ/883B (1)

					Total Dose Exposure (kRads Si)										Annealing	
					Initial		5.0		10.0		20.0		25.0 + 360 hours unbiased		168 hours @25°C	
Test #	Parameters	Units	Spec. Lim. (2) min	Spec. Lim. (2) max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Iq	mA		1.30	0.96	0.01	0.95	0.02	0.90	0.02	0.91	0.02	0.86	0.02	0.89	0.02
2	Voffset	?V	-125	125	-42	0.7	-42	0.6	-38	0.7	-39	0.9	-29	3.4	-39	0.9
3	+Ib	nA	-2.00	2.00	-0.65	0.06	1.73	0.31	7.25	2.77	26	6.7	>212		33	7.7
4	-Ib	nA	-2.00	2.00	-0.64	0.04	1.85	0.34	7.16	2.23	26	6.8	>212		33	8.3
5	Iio	nA	-1.00	1.00	0.03	0.03	0.16	0.06	0.35	0.30	0.41	0.44	0.80	0.03	1.01	0.79
6	PSRR_pos	dB	80		126	5.7	132	10.3	100	4.9	104	2.3	76	2.2	98	5.9
7	PSRR_neg	dB	80		135	12.8	132	6.4	125	6.0	131	13.0	105	6.8	128	11.9
8	+Swing	V	13.8		14.6	0	14.1	0	14.1	0.1	14.1	0.1	13.4	1.7	14.5	0.1
9	-Swing	V		13.9	-14.3	0	-14.3	0	-14.3	0	-14.3	0	-14.8	0.4	-15.2	0
10	Slew_Rate	V/?s	0.750		1.371	0.078	1.274	0.091	1.462	0.114	1.313	0.202	1.562	0.188	1.474	0.052
A	gain_error_x1	%	-0.10	0.10	0.005	0.003	0.005	0.003	0.081	0.190	0.110	0.259	(4)		0.342	0.322
B	gain_error_x10	%	-0.30	0.30	0.14	0.01	0.03	0.01	-0.01	0.01	0.03	0.02	0.08	0.10	-0.12	0.04
C	gain_error_x100	%	-0.30	0.30	0.21	0.01	0.16	0.02	0.16	0.01	0.16	0.02	(4)		0.16	0.01
D	gain_error_x1000	%	-0.70	0.70	-0.07	0.04	-0.19	0.04	-0.16	0.06	-0.19	0.05	(4)		-0.22	0.19

Notes:

(1) The mean and standard deviation values were calculated over the seven parts irradiated in this testing. The control samples remained constant throughout testing and are not included

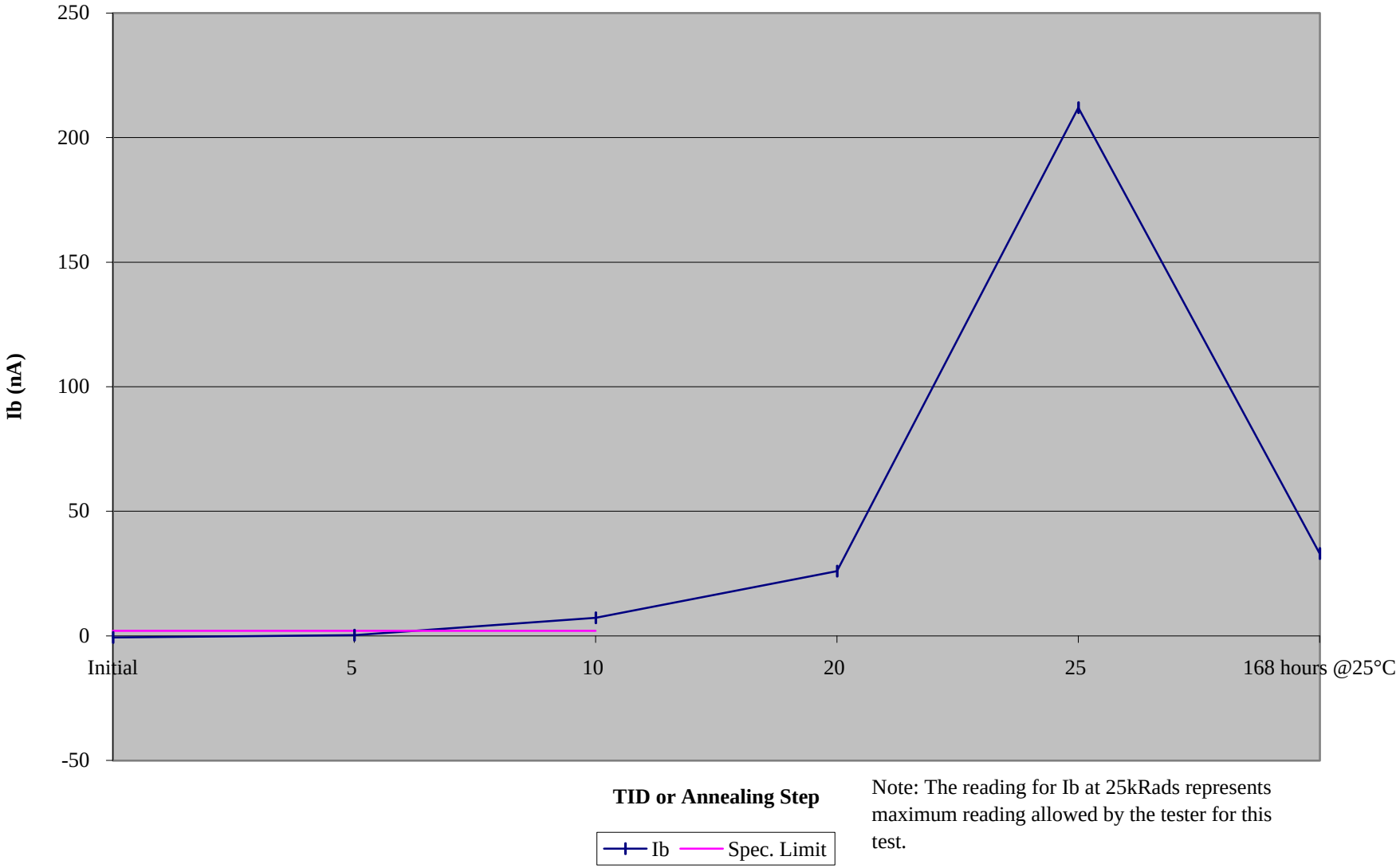
(2) These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

(3) nP/mF means that n parts passed this test and m parts failed. This is done is cases where the range is so extreme that the mean and standard deviation loose all meaning.

(4) The A540 was down for some time before these measurements were made. One of the new test cards was not functioning optimally, making these measurements unreliable at this dos The problem was fixed prior to the final annealing measurement.

Radiation sensitive parameters: +Ib, -Ib, PSRR_pos, +Swing, gain_error (all).

Figure 2: Ib vs Total Ionizing Dose (kRads Si)



Note: The reading for Ib at 25kRads represents maximum reading allowed by the tester for this test.