Unisys

DATE: January 10, 1999 PPM-99-006
TO: S Hull/562
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SUBJECT: Radiation Report on **DAC8222 (Analog Devices) (LDC 9738)**
PROJECT: IRAC

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A radiation evaluation was performed on **DAC8222AW (5962/8967201LA) Dual 12-Bit Double Buffered Multiplying CMOS D/A Converter (Analog Devices)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co^{60} gamma ray source. Two groups of parts were irradiated during the radiation testing. In test group A, five parts were irradiated under bias at 0.015kRads/hour (0.004Rads/s), and in test group B, four parts were irradiated under bias at 0.011kRads/hour (0.003Rads/s) (see Figure 1 for bias configuration), and one part was used as a control sample. The total dose radiation levels were 2.5 and 5.0kRads for the test group A and 1.0, 2.5, 5.0, 7.5, and 10.0kRads for test group B.[1] See Table II for the radiation schedule and effective dose rate calculation. In test group A, after the 2.5kRad irradiation, the parts were annealed under bias at 25°C and tested after 216 hours.[2] In test group B, the parts were annealed at 25°C for 74 hours after 1.0kRad, 56 hours after 2.5kRads, 72 hours after 7.5kRads and 168 hours after 10.0kRads. After each radiation exposure and annealing treatment, the 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. For detailed information, refer to Tables I through IV and Figures 1 through 7.

For test group A, all parts passed all initial electrical tests. All parts showed severe degradation in all INL, DNL, GFSE, and most IDD measurements after 2.5kRads. For example DNL readings were in the range of 1365 to 3517lsb versus a specification limit of 1.0lsb. A slight increase in degradation was observed in most failing parameters after annealing the parts for 246 hours at 25°C. After 5.0kRads, the parts continued to show increased degradation in all INL, DNL, GFSE, and IDD parameters. See Table IVa, Figures 2, 3, and 4 for more details.

For test group B, all parts passed all initial electrical tests. All parts showed some degradation in INL, DNL, GFSE, PSRR, and IDD_15V after 1kRad. The parts showed no significant recovery after annealing the parts for 74 hours at 25°C. All parts showed significant degradation in INL, DNL, PSRR, and IDD after 2.5kRads. The parts showed no significant recovery after annealing the parts for 56 hours at 25°C. After the 5.0kRad through 10kRad irradiations, the parts showed increasing degradation in INL, DNL, GFSE, PSRR, and IDD parameters. See Figure IVb, Figures 5, 6, and 7 for more details.

Initial electrical measurements were made on 6 samples. Five samples (SN's 81, 82, 83, 84, and 85) were used as radiation samples while SN 80 was used as a control sample at the higher dose rate. Four samples (SN's 80, 88, 89, and 90) were used as radiation samples while SN 87 was used as a control sample at the lower dose rate. All parts passed all tests during initial electrical measurements.

Test Group A Parts (0.004R/s)

[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 2.5kRad irradiation, all parts showed severe degradation in all INL and DNL parameters. Readings were in the ranges of 80 to 884lsb for INL at 5V, 1365 to 3517lsb for DNL at 5V, 1.6 to 3.5lsb for INL at 15V, and 1.9 to 14.1lsb for DNL at 15V. SN 85 had 2 readings that were not stable and were not included in the mean and standard deviation. SN 85 also failed GFSE_DAC_B with a reading of -29lsb, PSRR+5%_DAC_B and PSRR-5%_DAC_B with readings of 0.01664 and 0.01974%/%. All parts also failed IDD_0V_5V, IDD_5V_5V, IDD_0V_15V, and IDD_15V_15V with readings greater than 1mA. All parts also failed all IDD_VINL_15V and IDD_VINH_15V with readings in the range of 2 to 5mA.

After annealing the parts for 216 hours at 25°C, the parts showed no recovery, several parameters showed a marginal increase in degradation.

After the 5.0kRad irradiation, all parts showed increased degradation in all INL and DNL tests. All parts failed GFSE_DAC_A, SN 85 continued to fail GFSE_DAC_B, four parts failed PSRR±5%_DAC_A, SN85 continued to fail PSRR±5%_DAC_B, one part failed IDD_VINL_5V, and all parts failed all other IDD tests. See Table 4 for details.

Test Group B Parts (0.003R/s)

After the 1.0kRad irradiation, all parts showed significant degradation in most INL and DNL parameters. Readings were in the ranges of 0.6 to 0.9lsb for INL at 5V and 1.0 to 1.9lsb for DNL at 5V. SN 80 also failed GFSE_DAC_A with a reading of -4.4lsb. All parts exceeded the specification limit of 0.002%/% for all PSRR_DAC measurements with readings in the range of 0.00213 and 0.00296%/%. Most parts exceeded the specification limit of 100µA for IDD_0V_15V, and IDD_15V_15V with readings in the range of 101 to 136µA. **All parts passed all other tests.**

After annealing the parts for 74 hours at 25°C, the parts showed no significant change in any parameter.

After the 2.5kRad irradiation, all parts showed increased degradation in all INL and DNL parameters. Readings were in the ranges of 1.2 to 484lsb for INL at 5V, 1.2 to 3680lsb for DNL at 5V, 0.8 to 2.9lsb for INL at 15V, and 2.3 to 4.7lsb for DNL at 15V. SN 86 also failed GFSE_DAC_A with a reading of -1.1lsb and exceeded the specification limit for all PSRR_DAC parameters with readings in the range of 0.00202 and 0.00412%/%. Three parts failed IDD_0V_5V, IDD_5V_5V, IDD_0V_15V, and IDD_15V_15V with readings greater than 1mA. Three parts also failed all IDD_VINL_15V and IDD_VINH_15V with readings in the range of 2 to 5mA.

After annealing the parts for 56 hours at 25°C, the parts showed no significant change in any parameter.

After the 5.0 and 7.5kRad irradiations, all parts showed significant degradation in all INL and DNL parameters. Readings were in the ranges of 1.2 to 342lsb for INL at 5V, 7.1 to 3414lsb for DNL at 5V, 1.0 to 311lsb for INL at 15V, and 2.2 to 3441lsb for DNL at 15V. SN 86 also failed GFSE_DAC_A with readings of -3.66 and -3.37lsb and failed GFSE_DAC_B with a reading of -2.53lsb at 7.5kRads. Three parts exceeded the specification limit for all PSRR_DAC parameters with readings in the range of 0.01106 to 19.73%/% at 5.0kRads and only SN86 exceeded the specification limits for all PSRR_DAC parameters with readings from 0.00288 to 0.00441%/% at 7.5kRads. At 5kRads (but not at 7.5kRads) three parts exceeded the specification limit of 2.0mA for IDD_VINL_5V with readings in the range of 3.0 to 3.7mA. Three parts exceeded the specification limit of 2.0mA for IDD_VINH_5V with readings in the range of 2.9 to 3.2mA. Three parts failed IDD_0V_5V, IDD_5V_5V, IDD_0V_15V, and IDD_15V_15V with readings greater than 1mA. Three parts also failed all IDD_VINL_15V and IDD_VINH_15V with readings in the range of 2 to 5mA.

After annealing the parts for 72 hours at 25°C, the parts showed no significant change in any parameter.

After the 10.0kRad irradiation, all parts showed significant degradation in all INL and DNL parameters. Readings were in the ranges of 55 to 138lsb for INL at 5V, 3042 to 3564lsb for DNL at 5V, 13 to 2471lsb for INL at 15V, and 12 to 3587lsb for DNL at 15V. SN 86 and 90 failed GFSE_DAC_A with readings of -1.74 and -2.04lsb and SN 86 failed GFSE_DAC_B with a reading of -8.26lsb. Three parts exceeded the specification limit for IDD_VINH_5V

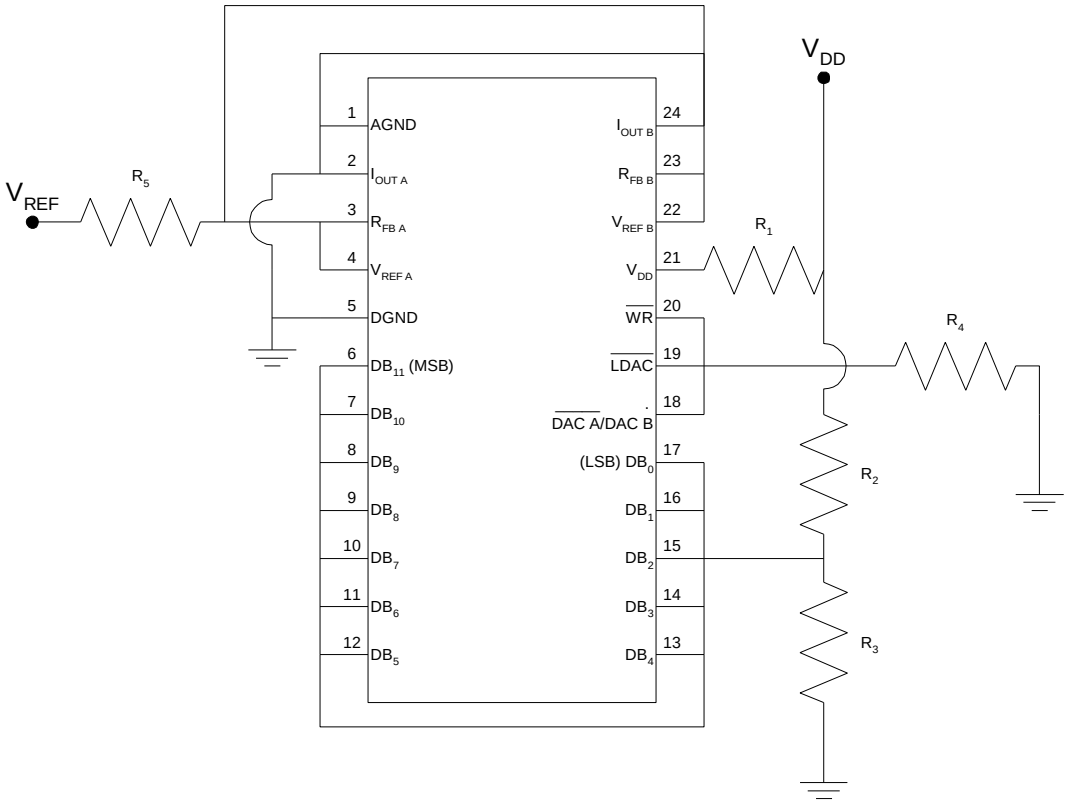
with readings in the range of 2.9 to 3.2mA. All parts failed IDD_0V_5V, IDD_5V_5V, IDD_0V_15V, and IDD_15V_15V with readings greater than 2mA. Three parts also failed all IDD_VINL_15V and IDD_VINH_15V with readings >5mA.

After annealing the parts for 168 hours at 25°C, the parts showed no significant change in any 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.

Figure 1. Radiation Bias Circuit for DAC8222



Notes:
1. V_{DD} = +15V ±0.5V, V_{REF} = +10V ±0.5V.
2. R_1 = 1kΩ ±5%, ¼W.
3. R_2 = 5kΩ ±5%, ¼W.
4. R_3 = 100kΩ ±5%, ¼W.
5. R_4 = 5kΩ ±5%, ¼W.
6. R_5 = 100Ω ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	DAC82222
IRAC Part Number:	DAC8222AW (5962/8967201LA)
Charge Number:	M88532
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9738
Quantity Tested:	10
Serial Number of Control Samples:	80, 87
Serial Numbers of Radiation Samples:	81, 82, 83, 84, 85 (FDR) 80, 88, 89, 90 (SDR)
Part Function:	Dual 12-Bit Double Buffered Multiplying DAC
Part Technology:	CMOS
Package Style:	24 Pin Dip
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE IIa. Radiation Schedule for DAC8222

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	10/07/98
2) 2.5 KRAD IRRADIATION (0.038 KRADS/HOUR)	10/19/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	10/21/98
3) 216 HOUR ANNEALING @25°C	10/21/98
POST-216 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/30/98
4) 5.0 KRAD IRRADIATION (0.147 KRADS/HOUR)	10/30/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	11/02/98

Effective Dose Rate = 5,000 RADS/14 DAYS=14.9 RADS/HOUR=0.004 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim annealing step and time needed to test the parts.

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

TABLE IIb. Radiation Schedule for DAC8222

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	11/04/98
2) 1.0 KRAD IRRADIATION (0.023 KRADS/HOUR)	11/04/98
POST-1.0 KRAD ELECTRICAL MEASUREMENT	11/06/98
3) 74 HOUR ANNEALING @25°C	11/06/98
POST-74 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/09/98
4) 2.5 KRAD IRRADIATION (0.017 KRADS/HOUR)	11/09/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	11/13/98
5) 56 HOUR ANNEALING @25°C	11/13/98
POST-56 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/16/98
6) 5.0 KRAD IRRADIATION (0.015 KRADS/HOUR)	11/16/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	11/23/98
7) 7.5 KRAD IRRADIATION (0.015 KRADS/HOUR)	11/23/98
POST-7.5 KRAD ELECTRICAL MEASUREMENT	11/30/98
8) 72 HOUR ANNEALING @25°C	11/30/98
POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/04/98
9) 10.0 KRAD IRRADIATION (0.015 KRADS/HOUR)	12/04/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	12/11/98
10) 168 HOUR ANNEALING @25°C	12/11/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/18/98

Effective Dose Rate = 10,000 RADS/37 DAYS=11.3 RADS/HOUR=0.003 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim annealing steps and time needed to test the parts.

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

Table III. Electrical Characteristics of DAC8222 /1

Test #	Parameter	Units	Test Conditions /2	Spec. Lim. min	Spec. Lim. max
100	INL_A_5V	lsb	V_{DD} = 5V, V_{IL} = 0.8V, V_{IH} = 2.4V, V_{REF} = -10V	-0.5	0.5
101	DNL_A_5V	lsb	V_{DD} = 5V, V_{IL} = 0.8V, V_{IH} = 2.4V, V_{REF} = -10V	-1	1
102	INL_B_5V	lsb	V_{DD} = 5V, V_{IL} = 0.8V, V_{IH} = 2.4V, V_{REF} = -10V	-0.5	0.5
103	DNL_B_5V	lsb	V_{DD} = 5V, V_{IL} = 0.8V, V_{IH} = 2.4V, V_{REF} = -10V	-1	1
104	INL_A_15V	lsb	V_{DD} = 15V, V_{IL} = 1.5V, V_{IH} = 13.5V, V_{REF} = -10V	-0.5	0.5
105	DNL_A_15V	lsb	V_{DD} = 15V, V_{IL} = 1.5V, V_{IH} = 13.5V, V_{REF} = -10V	-1	1
106	INL_B_15V	lsb	V_{DD} = 15V, V_{IL} = 1.5V, V_{IH} = 13.5V, V_{REF} = -10V	-0.5	0.5
107	DNL_B_15V	lsb	V_{DD} = 15V, V_{IL} = 1.5V, V_{IH} = 13.5V, V_{REF} = -10V	-1	1
200	GFSE_DAC_A	lsb	V_{DD} = 5V, V_{TEST} = 9.997558V	-1	1
201	GFSE_DAC_B	lsb	V_{DD} = 5V, V_{TEST} = 9.997558V	-1	1
300	PSRR=+5%_DAC_A	%/%	V_{DD} = 5.00V to 5.25V, Dig. In: 011111111111	0	0.00200
301	PSRR=-5%_DAC_A	%/%	V_{DD} = 4.75V to 5.00V, Dig. In: 011111111111	0	0.00200
302	PSRR=+5%_DAC_B	%/%	V_{DD} = 5.00V to 5.25V, Dig. In: 011111111111	0	0.00200
303	PSRR=-5%_DAC_B	%/%	V_{DD} = 4.75V to 5.00V, Dig. In: 011111111111	0	0.00200
400	RIN_REF_A	kW	V_{DD} = 5V, V_{REF} = 10V	0	15
401	RIN_REF_B	kW	V_{DD} = 5V, V_{REF} = 10V	0	15
402	DELTA RRF	%	V_{DD} = 5V, V_{REF} = 10V	-1.00	1.00
500-514	Iih_5V	nA	V_{DD} = 5V, V_{IN} = 5V, all digital inputs	-1000	1000
515-529	Iil_5V	nA	V_{DD} = 5V, V_{IN} = 0V, all digital inputs	-1000	1000
600-614	Iih_15V	nA	V_{DD} = 15V, V_{IN} = 15V, all digital inputs	-1000	1000
700-714	Iil_15V	nA	V_{DD} = 15V, V_{IN} = 0V, all digital inputs	-1000	1000
800	IDD_VINL_5V	mA	V_{DD} = 5V, all digital inputs = 0.8V	0.0	2.0
801	IDD_VINH_5V	mA	V_{DD} = 5V, all digital inputs = 2.4V	0.0	2.0
802	IDD_0V_5V	mA	V_{DD} = 5V, all digital inputs = 0.0V	0.0	100
803	IDD_5V_5V	mA	V_{DD} = 5V, all digital inputs = 5.0V	0.0	100
804	IDD_VINL_15V	mA	V_{DD} = 15V, all digital inputs = 1.5V	0.0	2.0
805	IDD_VINH_15V	mA	V_{DD} = 15V, all digital inputs = 13.5V	0.0	2.0
806	IDD_0V_15V	mA	V_{DD} = 15V, all digital inputs = 0.0V	0.0	100
807	IDD_15V_15V	mA	V_{DD} = 15V, all digital inputs = 15.0V	0.0	100

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_{DD} = +5V or +15V, V_{REFA} = V_{REFB} = +10V, V_{OUTA} = V_{OUTB} = 0V, AGND = DGND = 0V, unless otherwise specified.

TABLE IVa: Summary of Electrical Measurements

after Total Dose Exposures and Annealing for DAC8222 /1

Test Group A Dose Rate = 0.004R/s

					TDE (kRads Si)				Annealing		TDE (kRads Si)	
			Spec. Lim. /2		Initial		2.5		216 hours @25°C		5.0	
Test #	Parameters	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd
100	INL_A_5V	lsb	-0.5	0.5	0.2	0.2	164	63	278	284	331	462
101	DNL_A_5V	lsb	-1	1	0.4	0.3	2907	418	2927	314	1515	1024
102	INL_B_5V	lsb	-0.5	0.5	0.3	0.1	134	17	139	28	260	160
103	DNL_B_5V	lsb	-1	1	0.9	0	3112	261	3273	87	3163	489
104	INL_A_15V	lsb	-0.5	0.5	0.02	0.02	2.3	0.7	2.0	0.0	2.6	0.6
105	DNL_A_15V	lsb	-1	1	0.1	0	7.2	3.8	5.5	0.1	7.3	2.0
106	INL_B_15V	lsb	-0.5	0.5	0.3	0.1	2.2	0.4	2.4	0.2	9.6	4.6
107	DNL_B_15V	lsb	-1	1	0.8	0.1	7.4	3.7	5.9	0.4	291	160
200	GFSE_DAC_A	lsb	-1	1	-0.5	0.1	-0.6	0.1	-1.3	1.9	-85	9.3
201	GFSE_DAC_B	lsb	-1	1	-0.5	0.1	-6.1	12.8	-6.1	12.7	-4.7	9.3
300	PSRR=+5%_DAC_A	%/%	0	0.00200	0.00004	0.00003	0.001	0	0.0001	0	3.785	8.404
301	PSRR=-5%_DAC_A	%/%	0	0.00200	0.00003	0.00002	0.001	0	0.0003	0	0.0267	0.0366
302	PSRR=+5%_DAC_B	%/%	0	0.00200	0.00004	0.00002	0.0033	0.074	0.0033	0.0073	0.0019	0.0042
303	PSRR=-5%_DAC_B	%/%	0	0.00200	0.00003	0.00001	0.0040	0.0088	0.0039	0.0087	0.0022	0.0049
400	RIN_REF_A	k?	0	15	10.4	0.1	10.3	0.2	10.3	0.2	10.3	0.2
401	RIN_REF_B	k?	0	15	10.4	0.1	10.3	0.2	10.3	0.2	10.3	0.2
402	DELTA RRF	%	-1.00	1.00	0	0.1	0	0.1	0	0.1	0	0.1
500-514	Iih_5V	nA	-1000	1000	1	0.3	1	0.3	1	0.1	1	0.1
515-529	Iil_5V	nA	-1000	1000	0	0.3	0	0.3	0	0.2	0	0.2
600-614	Iih_15V	nA	-1000	1000	1	0.4	1	0.4	1	0.4	1	0.3
700-714	Iil_15V	nA	-1000	1000	0	0.3	0	0.3	0	0.2	0	0.2
800	IDD_VINL_5V	mA	0.0	2.0	0	0	1.3	0.0	1.3	0.0	1.8	0.3
801	IDD_VINH_5V	mA	0.0	2.0	0.7	0	1.9	0.1	1.9	0.1	2.8	0.6
802	IDD_0V_5V	?A	0.0	100	0.1	0.1	1366	98	1340	91	2432	585
803	IDD_5V_5V	?A	0.0	100	0.2	0.2	1362	102	1342	94	2434	586
804	IDD_VINL_15V	mA	0.0	2.0	0.3	0	5.0	0	5.0	0	5.0	0.0
805	IDD_VINH_15V	mA	0.0	2.0	0.1	0	2.2	0.2	2.1	0.2	4.3	0.9
806	IDD_0V_15V	?A	0.0	100	0.2	0.3	2104	186	2082	183	4245	962
807	IDD_15V_15V	?A	0.0	100	0.6	0.9	2104	183	2081	184	4245	961

Notes:

1/ The mean and standard deviation values were calculated over the five 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: INL, DNL, GFSE, PSRR, IDD.

TABLE IVb: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DAC8222 /1

Test Group B Dose Rate = 0.003R/s

Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	Initial mean	Initial sd	TDE (kRads Si) 1.0 mean	TDE (kRads Si) 1.0 sd	Annealing 74 hours @25°C mean	Annealing 74 hours @25°C sd	TDE (kRads Si) 2.5 mean	TDE (kRads Si) 2.5 sd	Annealing 56 hours @25°C mean	Annealing 56 hours @25°C sd	Total Dose Exposure (kRads Si) 5.0 mean	Total Dose Exposure (kRads Si) 5.0 sd	Total Dose Exposure (kRads Si) 7.5 mean	Total Dose Exposure (kRads Si) 7.5 sd	Annealing 72 hours @25°C mean	Annealing 72 hours @25°C sd	TDE (kRads Si) 10.0 mean	TDE (kRads Si) 10.0 sd	Annealing 168 hours @25°C mean	Annealing 168 hours @25°C sd
100	INL_A_5V	lsb	-0.5	0.5	0.2	0	0.6	0.2	0.6	0.2	188	232	146	218	2.1	1.3	86	61	91	70	3/		143	29
101	DNL_A_5V	lsb	-1	1	0.1	0.1	1.4	0.4	1.4	0.4	1199	1396	656	751	5.4	3.3	2333	1556	2477	1661	3/		3170	231
102	INL_B_5V	lsb	-0.5	0.5	0.3	0.1	0.5	0.2	0.6	0.1	57	51	114	89	130	161	97	84	3/		108	28	3/	
103	DNL_B_5V	lsb	-1	1	0.8	0.1	1.2	0.3	1.2	0.3	2472	1655	2525	1683	722	752	2384	1612	3/		3480	88	3/	
104	INL_A_15V	lsb	-0.5	0.5	0.03	0.03	0.28	0.19	0.25	0.15	1.66	0.40	1.53	0.83	0.88	0.62	3.37	1.87	3.41	2.10	122	95	155	117
105	DNL_A_15V	lsb	-1	1	0.1	0	0.6	0.3	0.6	0.2	4.0	1.1	3.6	1.9	2.2	1.4	11.1	7.0	9.5	6.0	2089	95	2124	1522
106	INL_B_15V	lsb	-0.5	0.5	0.26	0.07	0.36	0.08	0.34	0.05	1.43	0.44	1.23	0.67	0.80	0.41	3/		159	120	184	114	154	109
107	DNL_B_15V	lsb	-1	1	0.8	0.1	0.8	0	0.9	0.1	3.0	1.5	3.0	1.4	2.0	0.8	3/		2409	1611	2725	1574	2565	1468
200	GFSE_DAC_A	lsb	-1	1	0.6	0.1	-1.5	1.9	-1.0	0.8	-0.2	0.9	-0.6	0.1	-1.4	1.5	-1.3	1.4	-3.0	4.6	-1.3	0.7	-2.4	2.8
201	GFSE_DAC_B	lsb	-1	1	-0.5	0.4	-0.5	0.3	-0.4	0.5	-0.6	0.1	-0.6	0.1	-0.5	0.2	-1.2	0.9	-1.6	1.6	-2.6	3.8	-2.2	3.4
300	PSRR=+5%_DAC_A	%/%	0	0.00200	0.0000	0	0.0023	0	0.0023	0	4.8670	9.7318	4.8679	9.7335	0.0117	0.0072	0.0007	0.0014	0.0008	0.0015	0.0001	0.0000	0.0009	0.0014
301	PSRR=-5%_DAC_A	%/%	0	0.00200	0.0000	0	0.0027	0	0.0028	0	0.0011	0.0020	0.0010	0.0019	0.0133	0.0082	0.0008	0.0016	0.0009	0.0016	0.0001	0.0000	0.0020	0.0037
302	PSRR=+5%_DAC_B	%/%	0	0.00200	0.0000	0	0.0024	0	0.0024	0	0.0005	0.0000	0.0006	0.0010	4.9392	9.8616	0.0010	0.0020	0.0011	0.0020	0.0001	0.0000	0.0001	0.0000
303	PSRR=-5%_DAC_B	%/%	0	0.00200	0.0000	0	0.0027	0	0.0028	0	0.0007	0.0012	0.0007	0.0012	4.9330	9.8469	0.0011	0.0022	0.0012	0.0022	0.0001	0.0000	0.0001	0.0000
400	RIN_REF_A	k?	0	15	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.3	10.2	0.2	10.2	0.2
401	RIN_REF_B	k?	0	15	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2	10.2	0.2
402	DELTA RRF	%	-1.00	1.00	-0.02	0.11	-0.01	0.10	-0.02	0.08	-0.04	0.08	-0.04	0.06	-0.0052	0.0997	-0.0313	0.0565	-0.0046	0.1356	-0.0183	0.0704	0.0133	0.0525
500-514	Iih_5V	nA	-1000	1000	1	0.1	1	0.1	1	0.1	0	0.3	0	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.2
515-529	Iil_5V	nA	-1000	1000	0	0.3	0	0.3	0	0.3	0	0.2	0	0.2	0	0.2	0	0.2	0	0.3	0	0.3	0	0.3
600-614	Iih_15V	nA	-1000	1000	1	0.2	1	0.3	1	0.3	1	0.2	1	0.5	2	0.2	1	0.4	1	0.6	1	0.3	1	0.4
700-714	Iil_15V	nA	-1000	1000	0	0.2	0	0.2	0	0.2	0	0.3	0	0.3	0	0.3	0	0.2	0	0.3	0	0.3	0	0.3
800	IDD_VINL_5V	mA	0.0	2.0	0	0	0.2	0	0.2	0	1.0	0.7	1.0	0.7	2.4	1.6	1.0	0.6	1.0	0.6	1.2	0.1	1.2	0.1
801	IDD_VINH_5V	mA	0.0	2.0	0.7	0	0.7	0	0.7	0	1.2	0.4	1.2	0.4	1.5	0.6	2.5	1.3	2.5	1.3	2.8	0.7	2.8	0.7
802	IDD_0V_5V	?A	0.0	100	0	0.1	56	10	56	6	647	428	642	425	955	644	2053	1377	2054	1377	2457	684	2457	691
803	IDD_5V_5V	?A	0.0	100	0.1	0.1	56	9	56	6	647	429	640	423	954	644	2056	1379	2058	1379	2460	680	2459	689
804	IDD_VINL_15V	mA	0.0	2.0	0.3	0	0.7	0	0.7	0	3.9	2.2	3.9	2.2	4.0	2.1	4.0	1.9	4.0	1.9	5.0	0	5.0	0
805	IDD_VINH_15V	mA	0.0	2.0	0.1	0	0.2	0	0.2	0	1.7	1.1	1.7	1.1	1.3	0.9	3.6	2.4	3.6	2.4	4.3	1.4	4.3	1.4
806	IDD_0V_15V	?A	0.0	100	0.3	0.6	106	16	97	22	1597	1078	1588	1069	1290	869	3629	2429	3631	2430	4283	1423	4278	1434
807	IDD_15V_15V	?A	0.0	100	0.4	0.4	105	21	95	14	1599	1079	1590	1067	1284	864	3630	2430	3631	2430	4284	1422	4278	1433

Notes:

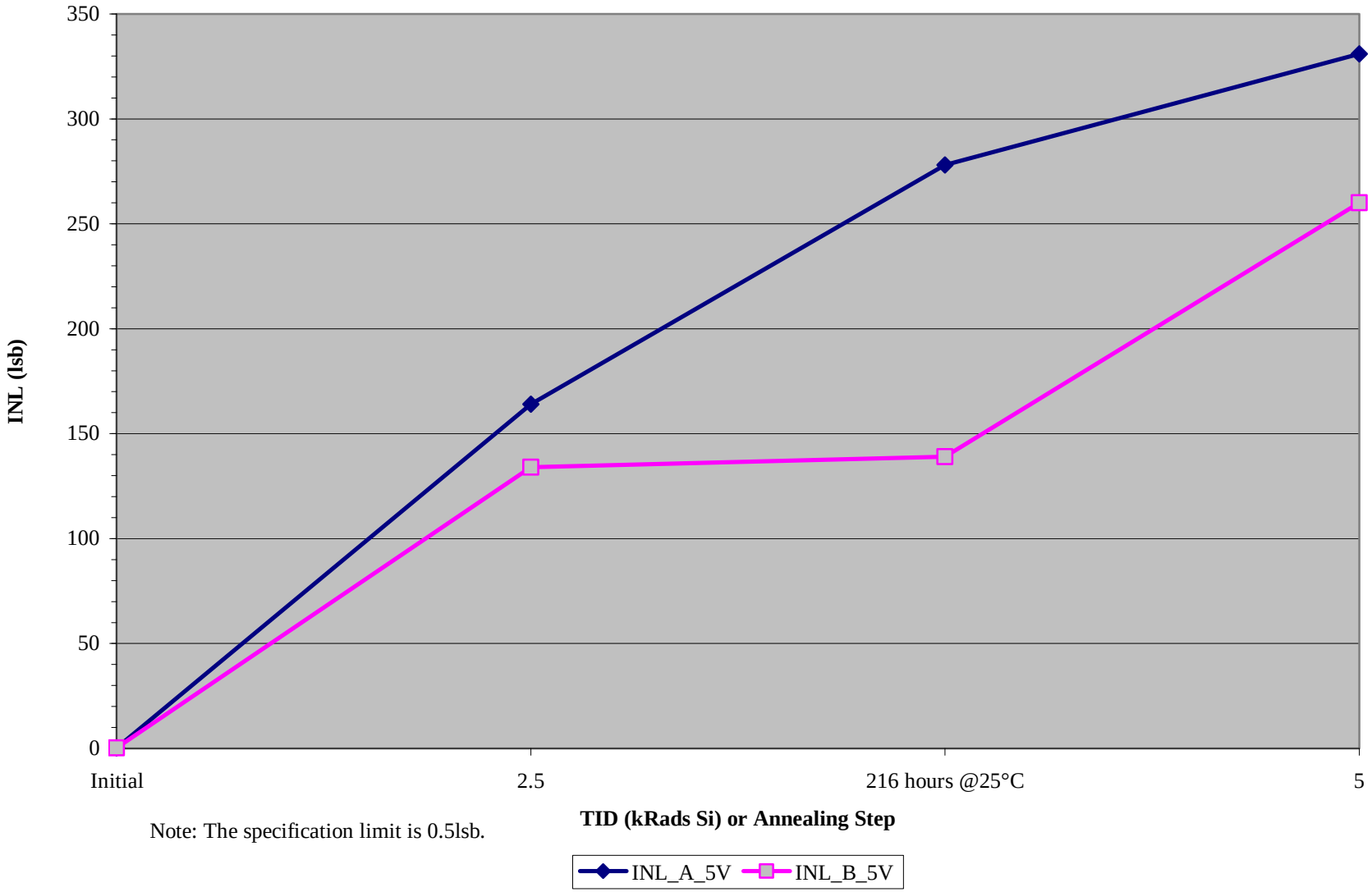
1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout testing and are not included in this table.

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/ No realiable measurements could be made for this test at this level.

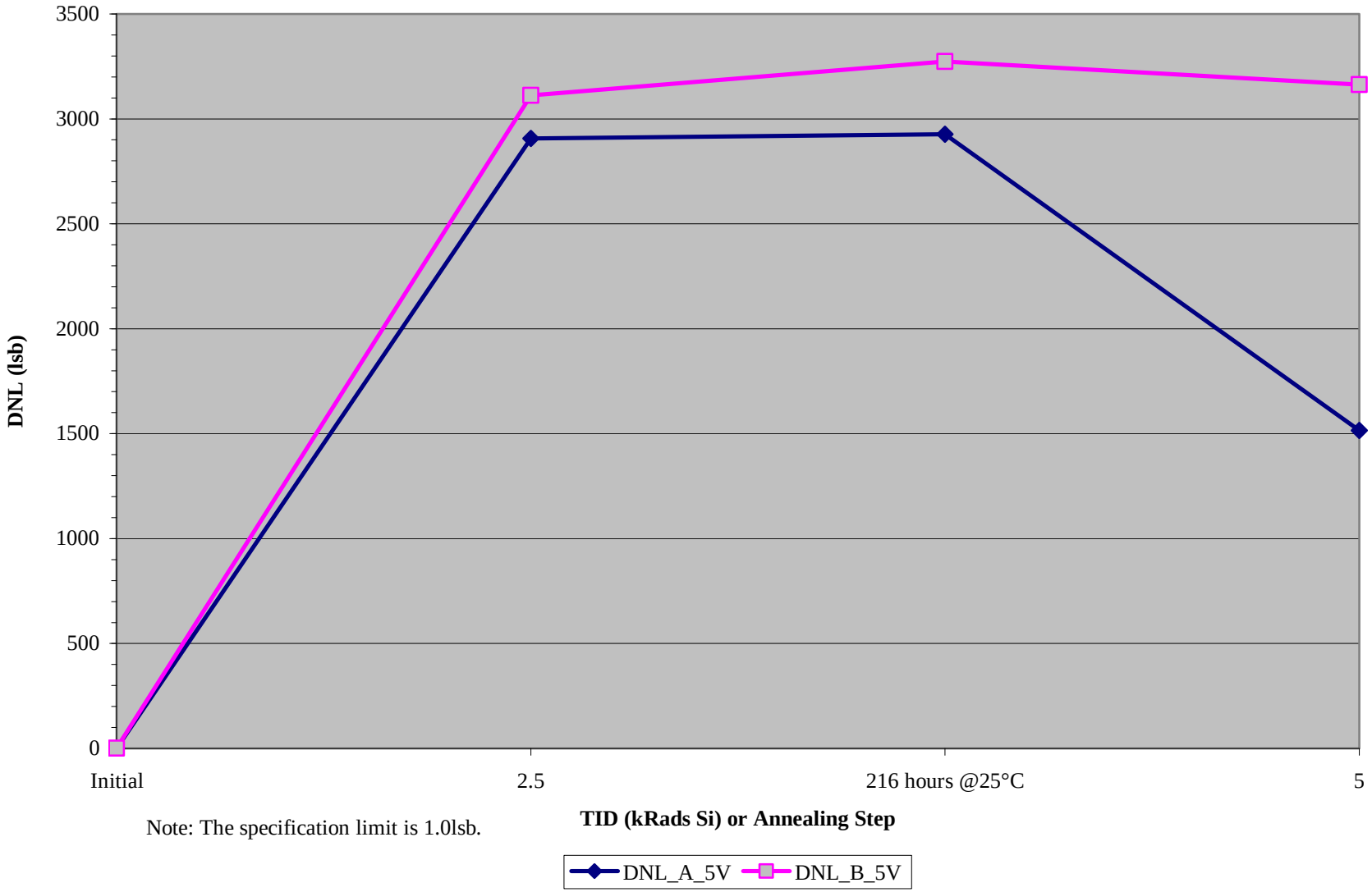
Radiation sensitive parameters: DNL, INL, GFSE, PSRR, IDD.

Figure 2: INL vs Total Ionizing Dose (kRads Si) for Test Group A



Note: The specification limit is 0.5lsb.

Figure 3: DNL vs Total Ionizing Dose (kRads Si) for Test Group A



Note: The specification limit is 1.0lsb.

Figure 4: IDD vs Total Ionizing Dose (kRads Si) for Test Group A

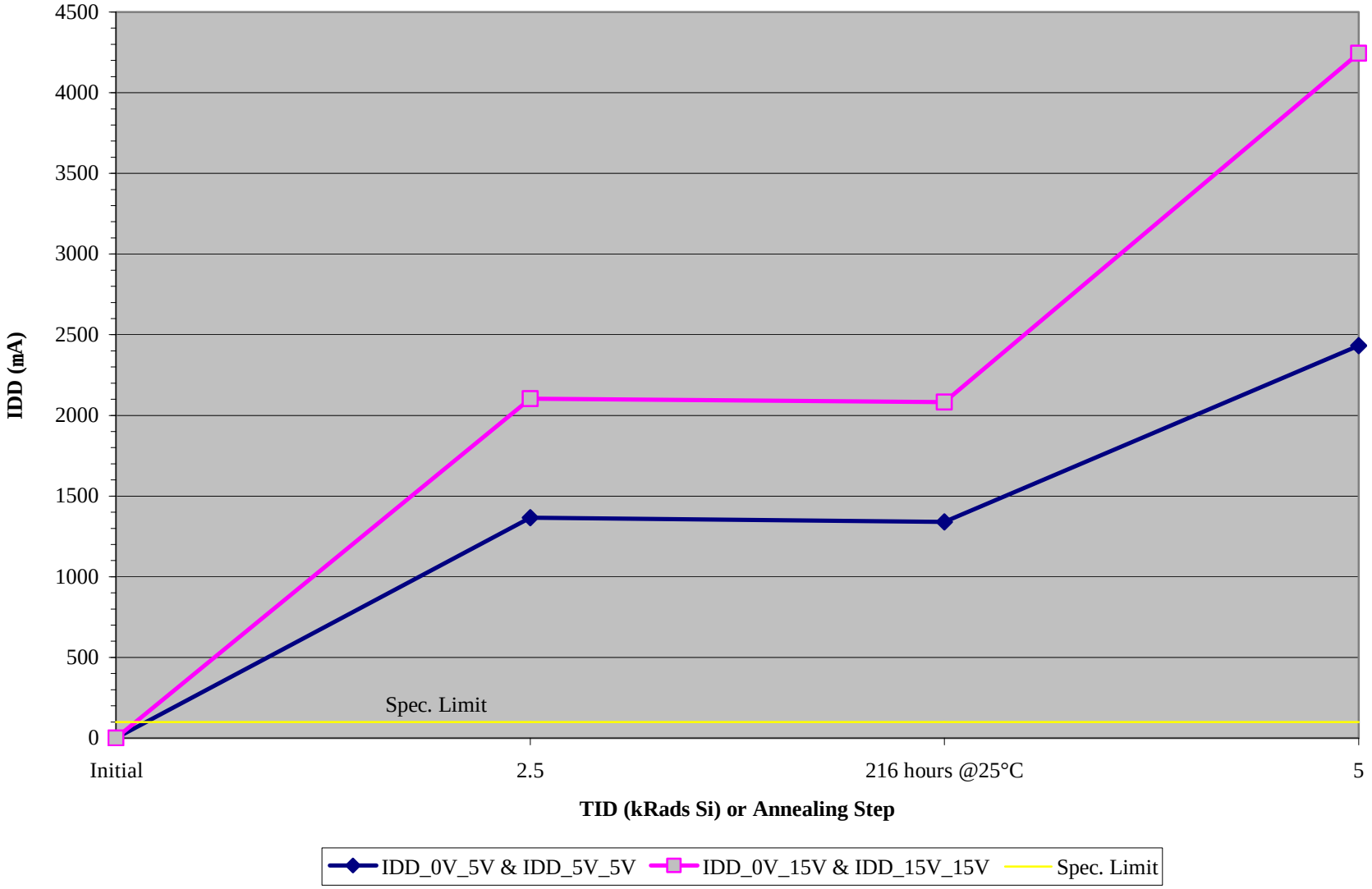
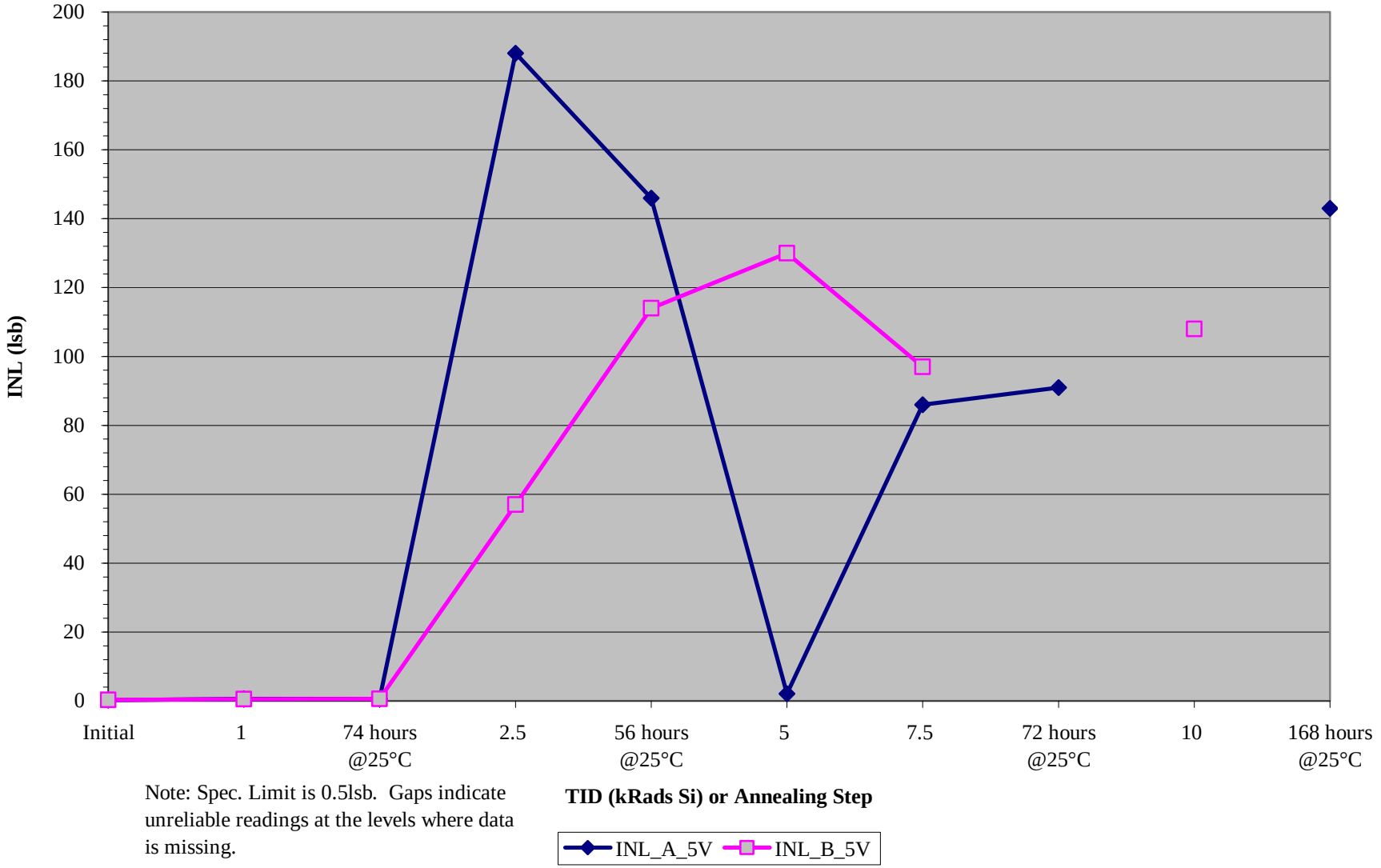
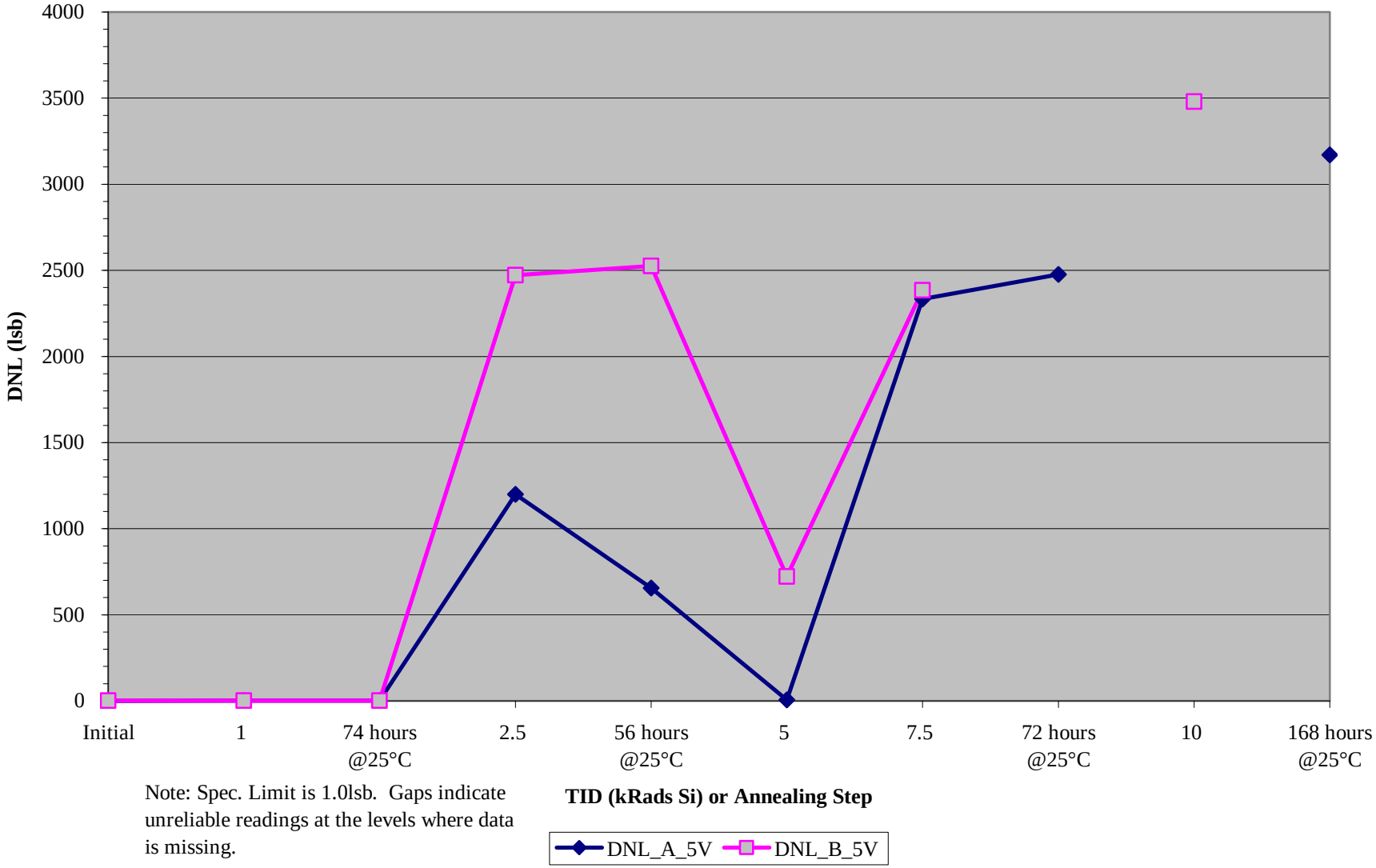


Figure 5: INL vs Total Ionizing Dose (kRads Si) for Test Group B



Note: Spec. Limit is 0.5lsb. Gaps indicate unreliable readings at the levels where data is missing.

Figure 6: DNL vs Total Ionizing Dose (kRads Si) for Test Group B



Note: Spec. Limit is 1.0lsb. Gaps indicate unreliable readings at the levels where data is missing.

Figure 7: IDD vs Total Ionizing Dose (kRads Si) for Test Group B