



DATE: August 16, 1994 PPM-94-017

TO: T. Mecum/311.1

FROM: K. Sahu/300.1 *KS*

SUBJECT: Radiation Report on FUSE
Part No. AD7545ABQ
Control No. 10975

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on AD7545ABQ (D/A converter) 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 cobalt-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 2.5, 5, 7.5, 10, 15, 20, 30, 50, and 75 krad*. The dose rate was between 0.074 and 1.43 krad/hour, depending on the total dose level (see Table II for radiation schedule). After the 75 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

All parts passed initial electrical measurements. All irradiated parts passed all electrical and functional tests up to and including the 7.5 krad irradiation level. At the 10 krad irradiation level, all parts exceeded the maximum specification limit of $\pm 20 \mu\text{V}$ for Psrr at Vdd=5V, with readings in the range of 22 μV to 32 μV .

After the 15 krad irradiation, all parts continued to exceed the maximum specification limit for Psrr at Vdd=5V and all parts exceeded the maximum specification limit of $\pm 7 \text{ mV}$ for AE at Vdd=5V and AE at Vdd=15V, with readings in the range of 30 mV to 94 mV, and 12 mV to 29 mV. In addition, all parts exceeded the maximum specification limit of $\pm 20 \mu\text{V}$ for Psrr at Vdd=15V, with readings in the range of 158 μV to 477 μV .

After the 20 krad irradiation, the same failures continued and, in addition, the Iout leakage at Vdd=5V reading for S/N 7 thru S/N 10 was in the range of 11 nA to 13 nA, which exceeds the maximum specification limit of $\pm 7 \text{ nA}$.

After the 30 krad irradiation, the same parts continued to fail the same tests, with gradually increasing readings. In addition S/N 3 to S/N 6 exceeded the maximum specification limit of Iout leakage at Vdd=5V with readings in the range of 20 nA to 24 nA. All parts exceeded the maximum specification limit of 100 μA for Icc_5V at Vdd=5V and Icc_15V at Vdd=15V, with readings in the range of 101 mA to 319 mA, and 146 mA to 506 mA. The reading for RA at Vdd=5V and at Vdd=15V, for S/N 3 and S/N 7 thru S/N 10 exceeded the maximum specification limit of $\pm 1.2 \text{ mV}$, with readings in the range of 1.2 mV to 2 mV, and 1.3 mV to 2.4 mV.

After the 50 krad irradiation, the same failures continued with increasing readings. In addition, all parts except

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

**These are manufacturer's non-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

S/N 5 exceeded the maximum specification limit of 2,000 μA for I_{cc_Vih} at $V_{dd}=15\text{V}$, with the readings in the range of 2,001 μA to 2,723 μA , and all parts exceeded the maximum specification limit of ± 10 nA for I_{out} leakage at $V_{dd}=15\text{V}$, with the readings in the range of 54 nA to 105 nA. The reading for DNL at $V_{dd}=15\text{V}$ for S/N 7 thru S/N 10 exceeds the maximum specification limit of ± 2.4 mV, with the readings in the range of 5 mV to 12 mV.

After the 75 krad irradiation, the same failures continued, with increasing readings. In addition S/N 5 exceeded the maximum specification limit for I_{cc_Vih} at $V_{dd}=15\text{V}$, with a reading of 4,573 μA .

After annealing for 168 hours at 25°C , all parts continued to exceed the maximum limit for I_{cc_5V} at $V_{dd}=5\text{V}$, I_{cc_15V} at $V_{dd}=15\text{V}$, I_{cc_Vih} at $V_{dd}=15\text{V}$, I_{out} leakage at $V_{dd}=5\text{V}$ and at $V_{dd}=15\text{V}$, $Psrr$ at $V_{dd}=15\text{V}$, AE at $V_{dd}=5\text{V}$ and at $V_{dd}=15\text{V}$, and RA at $V_{dd}=15\text{V}$, with readings in the range of 852 μA to 1,040 μA , 2,747 μA to 3,686 μA , 2,748 μA to 2,870 μA , 42 nA to 77 nA, 18 nA to 43 nA, 21,580 mV to 27,907 mV, 9,999 mV to 10,000 mV, 1,873 mV to 2,629 mV, and 3.2 mV to 5.2 mV. The readings for $Psrr$ at $V_{dd}=5\text{V}$ for all parts except S/N 6 were within the specification limits.

After annealing for 168 hours at 100°C , no rebound effects were observed.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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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TABLE I. Part Information

Generic Part Number:	AD7545ABQ
FUSE Part Number:	AD7545ABQ
FUSE Control Number:	10975
Charge Number:	C44405
Manufacturer:	Analog Devices
Lot Date Code:	9409
Quantity Tested:	10
Serial Number of Control Samples:	1, 2
Serial Numbers of Radiation Sample:	3, 4, 5, 6, 7, 8, 9, 10
Part Function:	D/A Converter
Part Technology:	CMOS
Package Style:	20 PIN DIP
Test Equipment:	Sentry S-50
Test Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for AD7545ABQ

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	05/27/94
2) 2.5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	06/13/94 06/14/94
3) 5 RAD IRRADIATION (0.125 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT (AD540 was down from 6/15/94 to 6/29/94)	06/14/94 06/15/94
4) 7.5 KRAD IRRADIATION (0.125 KRADS/HOUR) POST-7.5 KRAD ELECTRICAL MEASUREMENT	06/29/94 06/30/94
5) 10 KRAD IRRADIATION (0.07 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	07/1/94 07/6/94
6) 15 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	07/06/94 07/07/94
7) 20 KRAD IRRADIATION (0.07 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	06/17/94 06/20/94
8) 30 KRAD IRRADIATION (0.3 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	07/07/94 07/08/94
9) 50 KRAD IRRADIATION (0.15 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	07/08/94 07/11/94
10) 75 KRAD IRRADIATION (1.4 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT	07/11/94 07/12/94
11) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/24/94 07/01/94
12) 168-HOUR ANNEALING @100°C** POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/05/94 07/14/94

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

*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of AD7545ABQ

TEST CONDITIONS: VCC = 5V, 15V; VREF = -10V unless otherwise noted;

Test temperature : 25°C LIMITS for B version

Sequencer: vdd_5v

tst	Test name	Min	Max	Condition
---	-----	-----	-----	-----
1	Icc_Vil	0.0 ua	2000.0 ua	Inputs = 0.8v
2	Icc_Vih	0.0 ua	2000.0 ua	Inputs = 2.4v
3	Icc_0v	0.0 ua	100.0 ua	Inputs = 0.0v
4	Icc_5v	0.0 ua	100.0 ua	Inputs = 5.0v
5	Iih B0	-1000.0 na	1000.0 na	
6	Iih B1	-1000.0 na	1000.0 na	
7	Iih B2	-1000.0 na	1000.0 na	
8	Iih B3	-1000.0 na	1000.0 na	
9	Iih B4	-1000.0 na	1000.0 na	
10	Iih B5	-1000.0 na	1000.0 na	
11	Iih B6	-1000.0 na	1000.0 na	
12	Iih B7	-1000.0 na	1000.0 na	
13	Iih B8	-1000.0 na	1000.0 na	
14	Iih B9	-1000.0 na	1000.0 na	
15	Iih B10	-1000.0 na	1000.0 na	
16	Iih B11	-1000.0 na	1000.0 na	
17	Iih CS_	-1000.0 na	1000.0 na	
18	Iih WR_	-1000.0 na	1000.0 na	
19	Iil B0	-1000.0 na	1000.0 na	
20	Iil B1	-1000.0 na	1000.0 na	
21	Iil B2	-1000.0 na	1000.0 na	
22	Iil B3	-1000.0 na	1000.0 na	
23	Iil B4	-1000.0 na	1000.0 na	
24	Iil B5	-1000.0 na	1000.0 na	
25	Iil B6	-1000.0 na	1000.0 na	
26	Iil B7	-1000.0 na	1000.0 na	
27	Iil B8	-1000.0 na	1000.0 na	
28	Iil B9	-1000.0 na	1000.0 na	
29	Iil B10	-1000.0 na	1000.0 na	
30	Iil B11	-1000.0 na	1000.0 na	
31	Iih CS_	-1000.0 na	1000.0 na	
32	Iih WR_	-1000.0 na	1000.0 na	
33	Iout leakage	-10.0 na	10.0 na	
34	Psrr	-20.00 uv	20.00 uv	Vdd = +/- 5%
35	AE	-7.326 mv	7.326 mv	+/- 3 LSB
37	RA	-1.221 mv	1.221 mv	+/- 1/2 LSB
38	DNL	-2.442 mv	2.442 mv	+/- 1 LSB

Sequencer: vdd_15v

tst	Test name	Min	Max	Condition
39	Icc_Vil	0.0 ua	2000.0 ua	Inputs = 1.5v
40	Icc_Vih	0.0 ua	2000.0 ua	Inputs = 13.5v
41	Icc_0v	0.0 ua	100.0 ua	Inputs = 0.0v
42	Icc_51v	0.0 ua	100.0 ua	Inputs = 15.0v
43	Iih B0	-1000.0 na	1000.0 na	
44	Iih B1	-1000.0 na	1000.0 na	
45	Iih B2	-1000.0 na	1000.0 na	
46	Iih B3	-1000.0 na	1000.0 na	
47	Iih B4	-1000.0 na	1000.0 na	
48	Iih B5	-1000.0 na	1000.0 na	
49	Iih B6	-1000.0 na	1000.0 na	
50	Iih B7	-1000.0 na	1000.0 na	
51	Iih B8	-1000.0 na	1000.0 na	
52	Iih B9	-1000.0 na	1000.0 na	
53	Iih B10	-1000.0 na	1000.0 na	
54	Iih B11	-1000.0 na	1000.0 na	
55	Iih CS_	-1000.0 na	1000.0 na	
56	Iih WR_	-1000.0 na	1000.0 na	
57	Iil B0	-1000.0 na	1000.0 na	
58	Iil B1	-1000.0 na	1000.0 na	
59	Iil B2	-1000.0 na	1000.0 na	
60	Iil B3	-1000.0 na	1000.0 na	
61	Iil B4	-1000.0 na	1000.0 na	
62	Iil B5	-1000.0 na	1000.0 na	
63	Iil B6	-1000.0 na	1000.0 na	
64	Iil B7	-1000.0 na	1000.0 na	
65	Iil B8	-1000.0 na	1000.0 na	
66	Iil B9	-1000.0 na	1000.0 na	
67	Iil B10	-1000.0 na	1000.0 na	
68	Iil B11	-1000.0 na	1000.0 na	
69	Iih CS_	-1000.0 na	1000.0 na	
70	Iih WR_	-1000.0 na	1000.0 na	
71	Iout leakage	-10.0 na	10.0 na	
72	Psrr	-20.00 uv	20.00 uv	Vdd = +/- 5%
73	AE	-7.326 mv	7.326 mv	+/- 3 LSB
74	RA	-1.221 mv	1.221 mv	+/- 1/2 LSB
75	DNL	-2.442 mv	2.442 mv	+/- 1 LSB

TABLE IVa: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD7545A at Vdd=5v /1

Parameters	spec. Lim./2 min max	Total Dose Exposure (krads)												Annealing																				
		Initial			5			7.5			10			15			20			30			50			75			168 hrs @25°C			168 hrs @100°C		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd			
Icc_Vil	0	2000	2.9	0.9	11.7	3.6	9.6	1.3	22.5	3.6	23.2	3.6	32.5	15.9	84.1	8.4	99.7	8.6	133	15.9	111	16	16	59	9.1	22	3.1	22	3.1					
Icc_Vih	0	2000	429	27.3	356	24	298	21	267	8.4	218	16.3	169	15.8	250.1	8.1	250	72	3217	65	1010	92	971	54	310	172	310	172						
Icc_0v	0	100	1.9	1.03	10.2	0.8	0.1	0.06	0.1	0	0.2	0.12	0.21	0.03	0	0	0.1	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0.1	0.1					
Icc_5v	0	100	2.9	1.2	9.7	0.9	0.1	0.06	0.1	0	0.2	0.09	2.9	1.6	30.4	16.9	199	89.7	3209	65	996	92	959	54.4	310	172	310	172						
Iih	0	1000	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0				
Iil	0	1000	-82	2.8	-84	3	-82	2.8	-82	2.8	-80	2.2	-83	2.6	-86	2.8	-86	2.8	-86	2.8	-86	2.8	-86	2.8	-82	2.8	-82	2.8	-82	2.8				
Iout leakage	0	10	-0.6	1.4	-0.09	1.2	-4.7	1.6	-2.7	1.2	-2.9	1.9	-2.8	1.9	-7.9	4.6	-29.5	8.6	-168	25	-237	48	-55	11.1	172	3.6	172	3.6						
psrr	-20	20	-0.3	0.7	-2.5	0.89	-2	0.8	5.2	0.8	30.2	4.4	942	423	4125	2402	19432	5147	660515	531068	34	5.8	9361	24742	36965	24159	24159							
AE	-7.3	7.3	-0.1	0.5	-0.2	0.5	0.1	0.5	0.2	0.5	1.3	0.5	32.7	22.5	347	141	1158	322	5673	2705	5950	1.4	9999	0	1631	1039	1039							
RA	-1.2	1.2	0.2	0	0.19	0.02	0.2	0.02	-0.2	0	0.2	0.03	0.22	0.02	0.51	0.13	1.4	0.36	38.7	32.7	0.2	0	0.2	0	8.9	4.2	4.2							
DNL	-2.4	2.4	0.1	0	0.06	0.04	0.2	0.3	0.2	0.3	0.09	0	0.09	0	0.09	0	0.12	0.02	5.6	5.9	0.04	0.02	0.04	0	1.7	0.8	0.8							

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

2/ These are manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation sensitive parameters were Icc, Iout leakage, Psrr, AE, RA, and DNL.

TABLE IVb: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD7545A at Vdd=15v /1

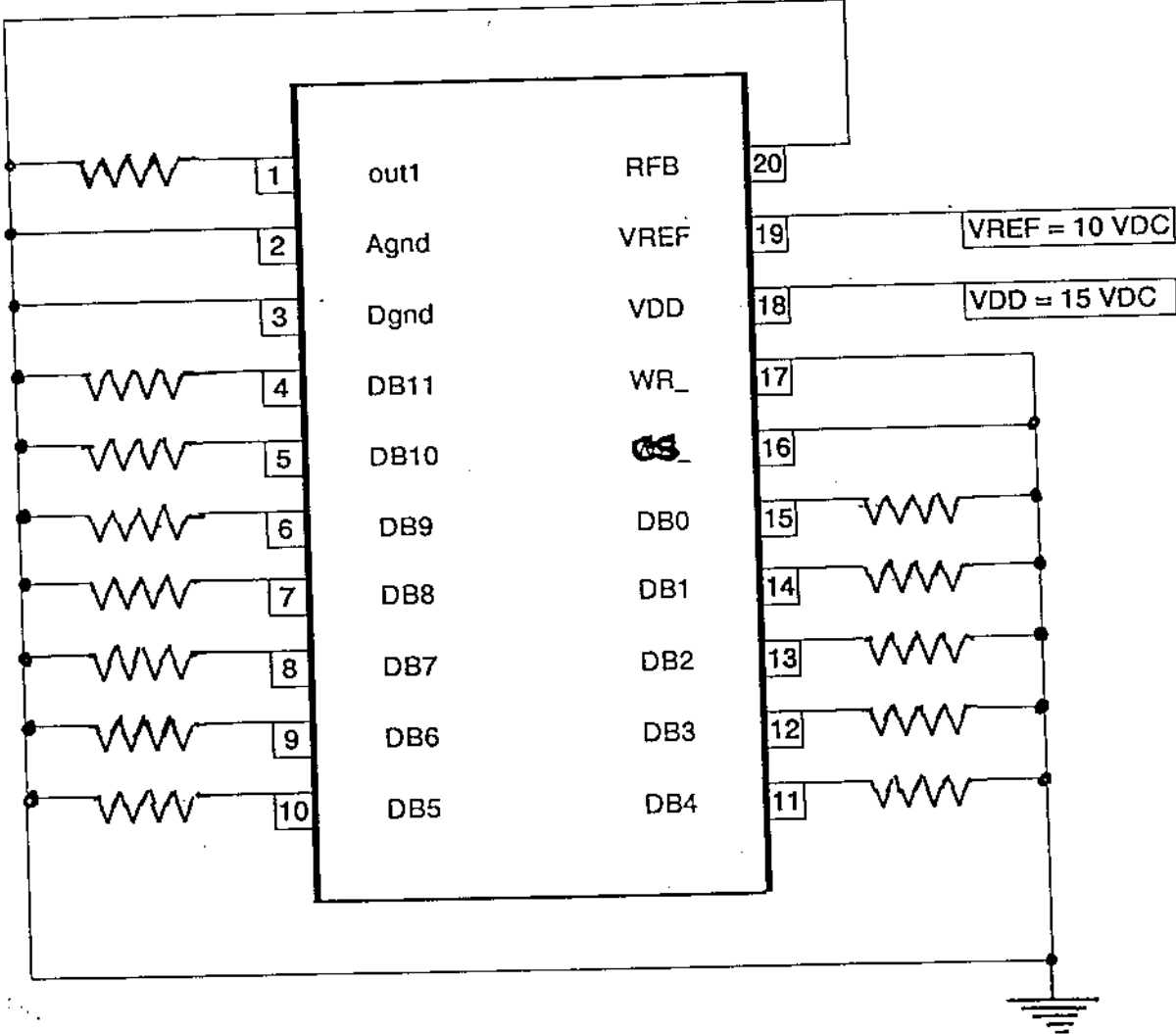
Parameters	Spec. Lim./2 min max	Total Dose Exposure (krads)												Annealing																					
		Initial			3			5			7.5			10			15			20			30			50			75			168 hrs @25°C		168 hrs @100°C	
		mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd	sd	mean	sd					
Icc_Vih	0 2000	682	64.9	944	74	1009	75	1194	59	1259	85	1452	79	46.8	79	1540	96	1592	132	1328	126	927	96.7	619	57.2										
Icc_Vih	0 2000	186	13.9	70	10	35.6	7.03	23.5	1.8	10.2	2.5	7.4	0.9	0.1	26	315	143	2250	282	3846	360	2907	860	559	335										
Icc_0v	0 100	7.03	1.6	12.5	0	0.3	0.1	0.2	0.1	0.22	0.1	0.3	0	45.4	0	0.3	0	0.3	0	0.73	0.31	0.1	0	0.3	0.01										
Icc_5v	0 100	7.02	0.8	12.5	0	0.3	0.1	0.2	0.1	0.2	0.1	0.3	0	2.3	1	26	293	133	2250	282	5049	360	3241	396	559	334									
Iih	-1000 1000	1	0	1	0	1	0	1	0	1	0	1	0	0	0	1	0	1	0	1	0	1	0	1	0										
Iil	-1000 1000	-82	2.8	-84	3	-82	2.8	-82	2.8	-81	2.4	-82	2.8	-3.8	2.9	-82	2.8	-82	2.8	-82	2.82	-60	1.6	-82	2.9										
Icut leakage	-10 10	1.06	0.9	1.08	0.8	-5.1	1.2	-3.6	1.5	-3.4	1.9	-1.5	1.2	1.842	1.3	-11	3.4	100	40	-132	26.1	-33	9.33	9.5	1.8										
psrr	-20 20	4.5	1.2	-3.5	0.7	3.3	0.8	3.6	0.6	7.7	1.6	264	118	149	773	5334	1785	1785	1120	23269	8825	24226	2262	14329	-3149										
AE	-7.3 7.3	-8.02	0.54	0.2	0.6	0.22	0.5	0.4	0.5	0.6	0.4	21.2	9.2	0.5	63	338	152	1617	127	2573	189	2183	292	841	640										
RA	-1.2 1.2	0.24	0.02	0.08	0.02	0.3	0.02	0.3	0.02	0.3	0.03	0.3	0.02	0.1	0.1	1.5	0.5	4.3	0.3	189	199	4.7	0.62	4.3	2.1										
DNL	-2.4 2.4	0.09	0	0	0	0.08	0	0.08	0	0.1	0	0.1	0	0	0	0.1	0	0.2	0	624375	483638	0.3	0.1	0.64	0.35										

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

2/ These are manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation sensitive parameters were Icc, Iout leakage, Psrr, AE, RA, and DNL.

Figure 1. Radiation Bias Circuit for AD7545ABQ



-- All resistors are 15K 1/4W