

UNISYS

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TO: J. Lohr/311

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SUBJECT: Radiation Report on CASSEN/CIRS  
Part No. DAC08A  
Control No. 11529

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OFA Library/300.1

A radiation evaluation was performed on DAC08A (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  $^{60}\text{Co}$  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, 10, 15, 20, 30, and 50 krad\*. The dose rate was between 0.04 and 0.31 krad/hour, depending on the total dose level (see Table II for radiation schedule). After the 50 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 tests up to and including the 2.5 krad level.

At the 5 krad irradiation level, all parts except S/N 54 exceeded the maximum specification limit -3  $\mu\text{A}$  for  $I_{\text{ref}}$ , with readings ranging from -3.13  $\mu\text{A}$  to -3.49  $\mu\text{A}$ .

At the 10 krad irradiation level, S/N 53, 55, 58 and 59 exceeded the maximum specification limit of  $\pm 0.10\%$  for  $\pm\text{NL}$  with a reading of 0.11%. S/N 54 exceeded the maximum specification limit for  $I_{\text{ref}}$ , with a reading of -5.75  $\mu\text{A}$ , and the degradation in  $I_{\text{ref}}$  continued for all other parts.

At the 15 krad irradiation level, the degradation in  $I_{\text{ref}}$  and  $\pm\text{NL}$  continued.

At the 20 krad irradiation level, S/N 53, 55 and 58 marginally exceeded the maximum specification limit of -10  $\mu\text{A}$  for  $I_{\text{il}}$ , with readings ranging from -10.1  $\mu\text{A}$  to -10.8  $\mu\text{A}$ , and the degradation in  $I_{\text{ref}}$  and  $\pm\text{NL}$  continued.

After the 30 and 50 krad irradiations, the degradation in  $I_{\text{ref}}$ ,  $\pm\text{NL}$  and  $I_{\text{il}}$  continued for all parts with readings in the range of -9  $\mu\text{A}$  to -12  $\mu\text{A}$ , -0.11% to -0.14%, and -11  $\mu\text{A}$  to -18  $\mu\text{A}$  respectively.

\*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.

After annealing for 168 hours at 25°C, no significant recovery was observed. Readings for Iref, ±NL and Iil were in the range of -8 μA to -10 μA, -0.11% to -0.14%, and -13 μA to -16 μA.

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

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) 751-8954.

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TABLE I. Part Information

Generic Part Number:	DAC08A
CASSIN/CIRS Part Number:	M38510/11302BEX
CASSIN/CIRS Control Number:	11529
Charge Number:	EE44632
Manufacturer:	Analog Devices Inc
Lot Date Code:	9335
Quantity Tested:	8
Serial Number of Control Sample:	51, 52
Serial Numbers of Radiation Sample:	53, 54, 55, 56, 57, 58, 59, 60
Part Function:	8 Bit D/A Converter
Part Technology:	Bipolar
Package Style:	16 Pin DIP
Test Equipment:	A540
Test Engineer:	Cu Nguyen

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

TABLE II. Radiation Schedule for DAC08A

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	10/12/94
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	10/13/94 10/14/94
3) 5 KRAD IRRADIATION (0.04 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	10/14/94 10/17/94
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	10/17/94 10/18/94
5) 15 KRAD IRRADIATION (0.29 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	10/18/94 10/19/94
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	10/19/94 10/20/94
7) 30 KRAD IRRADIATION (0.59 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	10/20/94 10/21/94
8) 50 KRAD IRRADIATION (0.31 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	10/21/94 10/24/94
10) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/24/94 10/31/94
11) 168-HOUR ANNEALING @100°C* POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/31/94 11/09/94

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 DAC08A

Test temperature : 25oC

Sequencer: vdd\_5v

tst	Test name	Min	Max	Condition
1	Icc	0.40 ma	3.80 ma	
2	Iss	-7.80 ma	-0.80 ma	all inputs = 15v
3	Iref	-3.00ua	0.00 ua	all inputs = 15v
4	+IFS	1.984 ma	2.000 ma	all inputs = 15v
5	+IZS	-1.00 ua	1.00 ua	all inputs = 0v
6	-IFS	1.984 ma	2.000 ma	all inputs = 0v
7	-IZS	-1.00 ua	1.00 ua	all inputs = 15v
8	+Pss_Ifs1	-4.0 ua	4.0 ua	VCC=4.5v to 5.5v, VSS=-18v
9	+Pss_Ifs2	-8.0 ua	8.0 ua	VCC=+12v to +18v, VSS=-18v
10	+Pss_Ifs3	-8.0 ua	8.0 ua	VSS=-12v to -18v, VCC= 18v
11	+Pss_Ifs4	-2.0 ua	2.0 ua	VSS=-4.5v to -5.5v, VCC=18v
12	-Pss_Ifs1	-4.0 ua	4.0 ua	VCC=4.5v to 5.5v, VSS=-18v
13	-Pss_Ifs2	-8.0 ua	8.0 ua	VCC=+12v to +18v, VSS=-18v
14	-Pss_Ifs3	-8.0 ua	8.0 ua	VSS=-12v to -18v, VCC= 18v
15	-Pss_Ifs4	-2.0 ua	2.0 ua	VSS=-4.5v to -5.5v, VCC=18v
16	Iih B1 (note)	-10.00 ua	10.00 ua	Vin = 18v, vil = 0.8v
17	Iih B2	-10.00 ua	10.00 ua	Vin = 18v, vil = 0.8v
18	Iih B3	-10.00 ua	10.00 ua	Vin = 18v, vil = 0.8v
19	Iih B4	-10.00 ua	10.00 ua	Vin = 18v, vil = 0.8v
20	Iih B5	-10.00ua	10.00 ua	Vin = 18v, vil = 0.8v
21	Iih B6	-10.00ua	10.00 ua	Vin = 18v, vil = 0.8v
22	Iih B7	-10.00ua	10.00 ua	Vin = 18v, vil = 0.8v
23	Iih B8	-10.00ua	10.00 ua	Vin = 18v, vil = 0.8v
24	Iil B1	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
25	Iil B2	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
26	Iil B3	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
27	Iil B4	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
28	Iil B5	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
29	Iil B6	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
30	Iil B7	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
31	Iil B8	-10.00 ua	0.05 ua	Vin = -10v, vih = 2.0v
32	+NL	-0.10 %	0.10 %	all codes
33	-NL	-0.10 %	0.10 %	all codes
34	dNL	-0.30 %	0.30 %	
35	+Monotonicity	0.00ua	16.00ua	all codes
36	-Monotonicity	0.00ua	16.00ua	all codes
37	dMonotonicity	-4.00ua	4.00ua	all codes

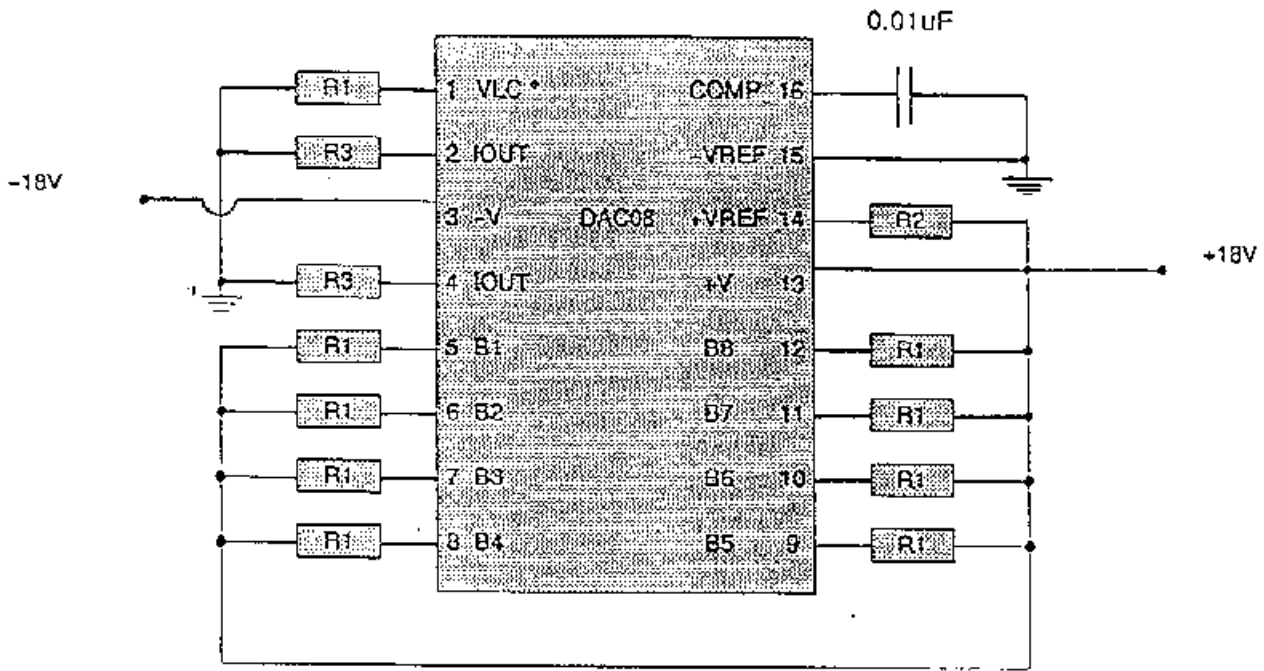
**TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DAC08A /1**

Test #	Parameters	Units	Spec. Lim/2 min max		Total Dose Exposure (krads)																Annealing															
					Initials		2.5		5		10		15		20		30		50		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												
1	Icc	mA	0.4	3.8	2.4	0.12	2.4	0.09	2.3	0.09	2.3	0.09	2.4	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09	2.3	0.09
2	Iss	mA	-7.8	-0.8	-6.5	0.13	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.6	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09	-6.5	0.09
3	Iref	uA	-3.0	0	-2	1	-3	0.14	-3	0.18	-5	0.31	-6	0.42	-8	0.48	-10	0.49	-11	0.39	-9	0.27	-4	0.15	0	0	0	0	0	0	0	0	0	0	0	0
4	+IFS	mA	1.98	2	1.9	0	1.9	0	1.9	0	1.9	0	1.9	1	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0
5	+IZS	nA	-1000	1000	-4.2	3.4	2.5	2.1	3.1	2.1	6.1	2.3	15	2.9	20	3.9	31	4.7	56	6.9	39	5.4	9.1	2.9	0	0	0	0	0	0	0	0	0	0	0	0
6	-IFS	mA	1.98	2	1.9	0	1.9	0	1.9	0	1.9	0	1.9	1	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0	1.9	0
7	-IZS	nA	-1000	1000	-3.2	3.6	3.75	2.4	4.8	2.5	10	2.8	17	3.5	22	4.2	33	4.7	44	5.8	30	4.7	8.1	3.1	0	0	0	0	0	0	0	0	0	0	0	0
8	+Pss Ifs1	uA	-4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	+Pss Ifs2	uA	-8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	+Pss Ifs3	uA	-8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11	+Pss Ifs4	uA	-2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	-Pss Ifs1	uA	-4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	-Pss Ifs2	uA	-8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	-Pss Ifs3	uA	-8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	-Pss Ifs4	uA	-2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	Iih /3	uA	-10	10	-1	0.11	-1	0.18	-1	0.19	-1	0.17	-1	0.12	-1	0.22	-0.09	0.13	-0.1	0.18	-1	0.19	-0.09	0.13	0	0	0	0	0	0	0	0	0	0	0	
11	Iil /3	uA	-10	0.05	-3	0.25	-4	0.23	-4	0.32	-6	0.58	-8	0.74	-9	0.85	-12	0.09	-17	0.09	-15	0.08	-7	0.26	0	0	0	0	0	0	0	0	0	0	0	
12	+NL	%	-0.1%	0.1%	0.05	0.01	0.07	0.01	0.08	0.01	0.1	0.01	0.01	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	
13	-NL	%	-0.1%	0.1%	0.05	0.01	0.07	0.01	0.08	0.01	0.1	0.01	0.01	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	
14	dNL	%	-0.3%	0.3%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	Monotonicity	uA	0	16	9	0.11	9	0.17	9	0.21	9	0.19	10	0.16	10	0.16	10	0.21	10	0.23	10	0.18	9	0.17	0	0	0	0	0	0	0	0	0	0	0	0
16	dMonotonicity	uA	-4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes:

- 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.
- 3/ Values shown for Iih and Iil are averages of IihB1-8 and IilB1-8, respectively. Readings for IihB1-8 and IilB1-8 were very similar at each irradiation and annealing level. Radiation-sensitive parameters were Iref, Iil and ±NL.

Figure 1. Radiation Bias Circuit for DAC08A



- (1) R1 2K to 47K, 1/4W Min.  $\pm 5\%$  , R2 = 10.0K, 1/2W Min.  $\pm 5\%$   
 (2) R3 5.1K, 1/2W Min.  $\pm 5\%$