Federal Systems

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DATE: October 27, 1995 PPM-95-176

TO: S. Hull/311.1
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on HST/ADD
Part No. DAC8408A
Control No. 10995A

cc: A. Sharma/311.0
R. Williams/300.1
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A radiation evaluation was performed on DAC8408A (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 Co^{60} gamma ray source. During the radiation testing, three 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 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6 and 7 krads*. The dose rate was between 0.029 and 0.058 krads/hour, depending on the total dose level, giving an effective average dose rate of approximately 0.01 krads/hour (see Table II for radiation schedule). After each radiation exposure parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

This radiation test is a continuation of that performed in PPM-95-151, dated May 18, 1995, using unirradiated samples from the same LDC. In that test, all irradiated parts exceeded specification limits for many test parameters after the 1 krad irradiation. The effective average dose rate in that test was approximately 0.07 krads/hour, which was seven times greater than in the present test. In this test, smaller increments of radiation dose were used, and the irradiated parts were annealed after each irradiation. This was done in an attempt to determine if the parts could tolerate somewhat more total dose radiation and show less degradation in Icc and other radiation-sensitive parameters at 2, 3, 4, 5, 6 and 7 krads, which are the levels of interest for the project.

All parts passed initial electrical measurements.

All parts passed all electrical tests throughout all irradiation steps up to and including the 1 krad irradiation level.

After the 1.5 krad irradiation, all irradiated parts exceeded the maximum specification limit of ±0.0010% nA for PSR_B with readings ranging from 0.0014% to 0.0022%. In addition S/N 96 and 98 exceeded the maximum specification limit of ±0.0010% for PSR_D with readings of 0.0011% and 0.0017%. After annealing for 24 hours at 25°C, all irradiated parts continued to exceed the maximum specification limit for PSR_B with readings ranging from 0.0015% to 0.0022% and S/N 96 and 98 exceeded the maximum specification limit for PSR_D with readings of 0.0011% and 0.0017%. After annealing second time for 24 hours at 25°C, same degradation continued.

*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. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

After the 2 krad irradiation, all irradiated parts exceeded the maximum specification for PSR_B and PSR_D with readings ranging from 0.0014% to 0.0066% and 0.0051% to 0.0067%. In addition all irradiated parts exceeded the maximum specification limit of 50 µA for ICC_5V with readings ranging from 78 µA to 122 µA, and S/N 98 exceeded the maximum specification limit of ±0.0010% for PSR_A and PSR_C with readings of 0.0014% and 0.0010%. After annealing for 72 hours at 25°C, all parts continued to degrade with the same parameters.

and ICC_5V with readings ranging from 0.0020% to 0.0032%, 0.0126% to 0.0133%, 0.0110% to 0.0122% and 246 µA and 323 µA, and S/N 97 and 98 exceeded the maximum specification limit for PSR_C with readings of 0.0011% and 0.0016%.

In addition, after the 2.5 Krad irradiation, all irradiated parts:

- exceeded the maximum specification limit of 50 µA for ICC_0V with readings ranging from 89 µA to 123 µA
- exceeded the maximum specification limit of 50 µA for ICC_0V with readings ranging from 89 µA to 123 µA
- exceeded the maximum specification limit of ±1 lsb for GFSE_D with readings ranging from 1.03 lsb to 1.15 lsb
- readings for INL_B are less than the minimum specification limit of -0.25 lsb with readings ranging from -0.332 lsb to -0.431 lsb
- readings for INL_D are less than the minimum specification limit of -0.25 lsb with readings ranging from -0.353 lsb to -0.441 lsb.

In addition S/N 98 reading for INL_A is less than the minimum specification limit of -0.25 lsb with reading of -0.287 lsb and the same part exceeded the maximum specification limit of -0.5 lsb for DNL_B and DNL_D with readings of 0.503 lsb and 0.525 lsb.

After 3, 4, 5, 6 and 7 Krad irradiation and annealing at least 24 hours at 25 °C, after every irradiation step, all parts continued to degrade in the above parameters.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and annealing step. A comparison of the degradation in the parts in this test vs. the previous testing shows that the parts exhibited less radiation-induced degradation; for example, in the previous test, all parts exceeded specification limits for Icc after 1 krad, whereas, in this test, the parts did not exceed specification limits for Icc until after 2.5 krads irradiation. In addition, there were no other failures at the 1 krad level, and the parts remained functional throughout the test up to 7 krads.

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 1. Part Information

Generic Part Number:	DAC8408A
HST/ADD Part Number:	5962-8967801XA
HST/ADD Control Number:	10995A
Charge Number:	EE61735
Manufacturer:	Analog Devices Inc.
Lot Date Code:	9449
Quantity Tested:	5
Serial Number of Control Samples:	80, 81
Serial Numbers of Radiation Samples:	96, 97, 98
Part Function:	D/A Converter
Part Technology:	CMOS
Package Style:	28-pin DIP
Test Equipment:	A540
Test Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for DAC8408A

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	07/05/95
2) 0.5 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-0.5 KRAD ELECTRICAL MEASUREMENT	07/05/95 07/06/95
3) 1 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-1 KRAD ELECTRICAL MEASUREMENT	07/06/95 07/07/95
4) 72-HOUR ANNEALING @25°C POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/07/95 07/10/95
5) 1.5 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-1.5 KRAD ELECTRICAL MEASUREMENT	07/10/95 07/11/95
6) 24-HOUR ANNEALING @25°C POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/11/95 07/12/95
7) 24-HOUR ANNEALING @25°C POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/12/95 07/13/95
8) 2 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-2 KRAD ELECTRICAL MEASUREMENT	07/13/95 07/14/95
9) 72-HOUR ANNEALING @25°C POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/14/95 07/17/95
10) 2.5 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	07/18/95 07/19/95
11) 24-HOUR ANNEALING @25°C POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/20/95 07/21/95
12) 3 KRAD IRRADIATION (0.029 KRADS/HOUR) POST-3 KRAD ELECTRICAL MEASUREMENT	07/25/95 07/26/95
13) 24-HOUR ANNEALING @25°C POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/26/95 07/27/95
14) 72-HOUR ANNEALING @25°C POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/27/95 08/01/95
15) 4 KRAD IRRADIATION (0.058 KRADS/HOUR) POST-4 KRAD ELECTRICAL MEASUREMENT	08/01/95 08/02/95
16) 5 KRAD IRRADIATION (0.058 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	08/02/95 08/03/95
17) 6 KRAD IRRADIATION (0.058 KRADS/HOUR) POST-6 KRAD ELECTRICAL MEASUREMENT	08/03/95 08/04/95
18) 72-HOUR ANNEALING @25°C POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	08/05/95 08/07/95
19) 7 KRAD IRRADIATION (0.058 KRADS/HOUR) POST-7 KRAD ELECTRICAL MEASUREMENT	08/07/95 08/08/95

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

Total irradiation time = 34 days = 816 hours, Total radiation dose = 7 krads; Average dose rate = 0.0086 krads/hour

Table III. Electrical Characteristics of DAC8408A

Test #	Test Name	Min	Max	Condition
1	Icc_0v		50.00 µA	Vin = 0.0 V
2	Icc_5V		50.00 µA	Vin = 5.0 V
3	Icc_vil		1.00 mA	Vin = 0.8 V
4	Icc_vih		1.00 mA	Vin = 2.4 V
5	Iih DB7	-1.00 µA	1.00 µA	Vtest = 5.0 V
6	Iih DB6	-1.00 µA	1.00 µA	Vtest = 5.0 V
7	Iih DB5	-1.00 µA	1.00 µA	Vtest = 5.0 V
8	Iih DB4	-1.00 µA	1.00 µA	Vtest = 5.0 V
9	Iih DB3	-1.00 µA	1.00 µA	Vtest = 5.0 V
10	Iih DB2	-1.00 µA	1.00 µA	Vtest = 5.0 V
11	Iih DB1	-1.00 µA	1.00 µA	Vtest = 5.0 V
12	Iih DB0	-1.00 µA	1.00 µA	Vtest = 5.0 V
13	Iih DS1	-1.00 µA	1.00 µA	Vtest = 5.0 V
14	Iih DS2	-1.00 µA	1.00 µA	Vtest = 5.0 V
15	Iih AB_	-1.00 µA	1.00 µA	Vtest = 5.0 V
16	Iih RW_	-1.00 µA	1.00 µA	Vtest = 5.0 V
17	Iil DB7	-1.00 µA	1.00 µA	Vtest = 0.0 V
18	Iil DB6	-1.00 µA	1.00 µA	Vtest = 0.0 V
19	Iil DB5	-1.00 µA	1.00 µA	Vtest = 0.0 V
20	Iil DB4	-1.00 µA	1.00 µA	Vtest = 0.0 V
21	Iil DB3	-1.00 µA	1.00 µA	Vtest = 0.0 V
22	Iil DB2	-1.00 µA	1.00 µA	Vtest = 0.0 V
23	Iil DB1	-1.00 µA	1.00 µA	Vtest = 0.0 V
24	Iil DB0	-1.00 µA	1.00 µA	Vtest = 0.0 V
25	Iil DS1	-1.00 µA	1.00 µA	Vtest = 0.0 V
26	Iil DS2	-1.00 µA	1.00 µA	Vtest = 0.0 V
27	Iil AB_	-1.00 µA	1.00 µA	Vtest = 0.0 V
28	Iil RW_	-1.00 µA	1.00 µA	Vtest = 0.0 V
29	Voh DB7	4.00 V		Iout = 0.4 mA
30	Voh DB6	4.00 V		Iout = 0.4 mA
31	Voh DB5	4.00 V		Iout = 0.4 mA
32	Voh DB4	4.00 V		Iout = 0.4 mA
33	Voh DB3	4.00 V		Iout = 0.4 mA
34	Voh DB2	4.00 V		Iout = 0.4 mA
35	Voh DB1	4.00 V		Iout = 0.4 mA
36	Voh DB0	4.00 V		Iout = 0.4 mA
37	Vol DB7		0.400 V	Iout = 1.6 mA
38	Vol DB6		0.400 V	Iout = 1.6 mA
39	Vol DB5		0.400 V	Iout = 1.6 mA
40	Vol DB4		0.400 V	Iout = 1.6 mA
41	Vol DB3		0.400 V	Iout = 1.6 mA
42	Vol DB2		0.400 V	Iout = 1.6 mA
43	Vol DB1		0.400 V	Iout = 1.6 mA
44	Vol DB0		0.400 V	Iout = 1.6 mA
45	GSFE_A	-1.00 lsb	1.00 lsb	Gain error DAC A
46	GFSE_B	-1.00 lsb	1.00 lsb	Gain error DAC B
47	GFSE_C	-1.00 lsb	1.00 lsb	Gain error DAC C
48	GFSE_D	-1.00 lsb	1.00 lsb	Gain error DAC D
49	PSR_A	-0.0010 %	0.0010 %	Delta VDD = +/-10%
50	PSR_B	-0.0010 %	0.0010 %	Delta VDD = +/-10%
51	PSR_C	-0.0010 %	0.0010 %	Delta VDD = +/-10%
52	PSR_D	-0.0010 %	0.0010 %	Delta VDD = +/-10%
53	INL_A	-0.250 lsb	0.250 lsb	
54	DNL_A	-0.500 lsb	0.500 lsb	
55	INL_B	-0.250 lsb	0.250 lsb	
56	DNL_B	-0.500 lsb	0.500 lsb	
57	INL_C	-0.250 lsb	0.250 lsb	
58	DNL_C	-0.500 lsb	0.500 lsb	
59	INL_D	-0.250 lsb	0.250 lsb	
60	DNL_D	-0.500 lsb	0.500 lsb	

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DAC8408A /1

Test			Spec. Lim./2		Total Dose Exposure (Krads)								Annealing		Rad level		Annealing		Rad level	
					Initial		0.5		1		1.5		24 hrs @25°C		2		72 hrs @25°C		2.5	
#	Parameters/3	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Icc_0V	uA	-	50	0	0	0	0	0	0	0	0	2	2	32	10	31	10	106	19
2	Icc_5V	uA	-	50	0	0	0	0	2	2	8	3	13	5	96	23	95	23	284	38
3	Icc_vil	mA	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Icc_vih	mA	-	1	0.45	0.01	0.42	0.01	0.40	0.01	0.39	0.01	0.40	0.01	0.46	0.03	0.46	0.02	0.64	0.04
5	Iih DB	uA	-1	1	-0.21	0.01	-0.2	0.04	-0.2	0.03	-0.2	0.01	-0.19	0.03	-0.2	0.03	-0.2	0	-0.2	0
6	Iih DS	uA	-1	1	-0.32	0.07	-0.4	0.04	-0.4	0.01	-0.4	0.01	-0.3	0.07	-0.3	0.02	-0.4	0.05	-0.4	0
7	Iih AB_	uA	-1	1	-0.2	0.08	-0.2	0.02	-0.27	0.03	-0.3	0.04	-0.3	0.02	-0.3	0.02	-0.3	0.02	-0.3	0.07
8	Iih RW_	uA	-1	1	-0.4	0.01	-0.3	0.08	-0.4	0.02	-0.3	0.09	-0.4	0.04	-0.3	0.15	-0.37	0.06	-0.4	0.08
9	Iil DB	uA	-1	1	-0.15	0.01	-0.2	0.05	-0.1	0.03	-0.2	0.03	-0.2	0.01	-0.2	0.02	-0.2	0	-0.2	0
10	Iil DS	uA	-1	1	-0.2	0.03	-0.2	0.01	-0.3	0.05	-0.2	0.05	-0.2	0.02	-0.35	0.04	-0.2	0.01	-0.2	0.03
11	Iil AB_	uA	-1	1	-0.2	0.03	-0.2	0.04	-0.2	0.02	-0.2	0.01	0.1	0	-0.19	0.04	-0.2	0.03	-0.2	0.02
12	Iil RW_	uA	-1	1	-0.2	0.02	-0.19	0.06	-0.2	0.02	-0.2	0.03	-0.17	0.01	-0.2	0.06	-0.2	0.01	-0.2	0.04
13	Voh DB	V	4	-	4.29	0.01	4.25	0.09	4.29	0.02	4.29	0	4.28	0	4.29	0	4.29	0	4.25	0.02
14	Vol DB	V	-	4	0.09	0	0.09	0	0.10	0.01	0.10	0.01	0.09	0	4.29	0	0.09	0.01	0.10	0.03
15	GFSE_A	lsb	-1	1	-0.54	0.09	-0.54	0.12	-0.51	0.11	-0.52	0.09	-0.52	0.09	-0.49	0.11	-0.48	0.12	-0.47	0.22
16	GFSE_B	lsb	-1	1	-0.61	0.18	-0.60	0.19	-0.58	0.18	-0.42	0.16	-0.42	0.16	0.15	0.14	0.20	0.13	0.83	0.35
17	GFSE_C	lsb	-1	1	-0.43	0.07	-0.44	0.09	-0.37	0.06	-0.42	0.11	0.44	0.12	-0.39	0.16	-0.41	0.16	-0.35	0.18
18	GFSE_D	lsb	-1	1	-0.51	0.13	-0.49	0.13	-0.21	0.52	-0.33	0.08	-0.39	0.14	0.26	0.08	0.28	0.01	1.09	0.06
19	PSR_A	%	-0.0010	0.0010	.0002	4E-4	.0005	4E-4	.0007	8E-5	.0005	6E-5	.0005	7E-5	.0009	4E-4	.0008	4E-4	.0026	6E-4
20	PSR_B	%	-0.0010	0.0010	.00002	3E-5	.00009	5E-5	.0004	5E-5	.0017	4E-4	.0017	4E-4	.0067	7E-4	.0067	8E-4	0.013	4E-4
21	PSR_C	%	-0.0010	0.0010	-.0003	4E-5	-.0002	9E-6	.00007	E-4	.00004	2E-4	.00005	5E-5	.0004	5E-4	.0005	3E-4	.0011	4E-4
22	PSR_D	%	-0.0010	0.0010	-.0004	6E-5	-.0003	5E-5	.00008	4E-4	.0012	4E-4	.0012	4E-4	.0059	8E-4	.0059	9E-4	.0116	6E-4
23	INL_A	lsb	-0.25	0.25	0	0.03	0	0.04	-0.04	0	-0.04	0.01	-0.04	0	-0.07	0.05	-0.07	0.05	-0.09	0.20
24	DNL_A	lsb	-5	5	0.04	0	0.04	0.01	0.04	0	0.05	0.01	0.05	0.01	0.09	0.06	0.09	0.06	0.18	0.11
25	INL_B	lsb	-0.25	0.25	0.004	0.04	0.03	0.01	0.04	0.01	-0.06	0.01	-0.06	0	-0.21	0.01	-0.21	0.01	-0.38	0.05
26	DNL_B	lsb	-5	5	0.04	0	0.04	0	0.06	0	0.09	0.01	0.09	0.01	0.26	0.01	0.27	0.02	0.46	0.05
27	INL_C	lsb	-0.25	0.25	0.03	0.01	0.03	0.01	0.01	0.03	0.05	0.16	-0.04	0.01	-0.06	0.04	-0.06	0.04	-0.12	0.07
28	DNL_C	lsb	-5	5	0.04	0	0.04	0	0.04	0.01	0.13	0.11	0.05	0.02	0.09	0.08	0.09	0.07	0.19	0.13
29	INL_D	lsb	-0.25	0.25	0.003	0.05	0.01	0.05	0.02	0.06	-0.03	0.07	-0.07	0.01	-0.21	0.04	-0.2	0.04	-0.39	0.04
30	DNL_D	lsb	-5	5	0.05	0.02	0.05	0.01	0.07	0.01	0.10	0.02	0.11	0.02	0.25	0.04	0.25	0.04	0.47	0.05

Notes:

1/ The mean and standard deviation values were calculated over the three parts irradiated in this testing. The control 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/ In this table, some test parameters have been combined for clarity. Complete results for all test parameters are available on request.

Radiation-sensitive parameters: Icc, Voh, GFSE, PSR, INL and DNL.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DAC8408A /1

Test #	Parameters/3	Units	Spec. Lim./2 min	Spec. Lim./2 max	Annealing 24 hrs @25°C mean	Annealing 24 hrs @25°C sd	Rad Level 3 mean	Rad Level 3 sd	Annealing 72 hrs @25°C mean	Annealing 72 hrs @25°C sd	Rad Level 4 mean	Rad Level 4 sd	Rad Level 5 mean	Rad Level 5 sd	Rad Level 6 mean	Rad Level 6 sd	Annealing 72 hrs @25°C mean	Annealing 72 hrs @25°C sd	Rad Level 7 mean	Rad Level 7 sd
1	Icc_0V	uA	-	50	108	19	252	27	239	25	440	41	727	93	920	44	978	43	1273	89
2	Icc_5V	uA	-	50	290	141	592	57	578	55	1014	94	1584	145	2241	115	2255	119	2965	217
3	Icc_vil	mA	-	1	0	0	0.04	0	0.03	0	0.06	0.01	0.14	0.09	0.06	0.11	0.03	0.11	0.03	0.04
4	Icc_vih	mA	-	1	0.64	0.04	0.93	0.06	0.92	0.06	1.33	0.09	1.88	0.15	2.51	0.12	2.53	0.12	3.21	0.21
5	Iih DB	uA	-1	1	-0.2	0.01	-0.2	0.01	-0.2	0.01	-0.2	0.02	-0.2	0.02	-0.2	0.07	-0.2	0.01	-0.2	0.01
6	Iih DS	uA	-1	1	-0.4	0.07	-0.4	0.06	-0.4	0.04	-0.4	0.11	-0.4	0.06	-0.04	0.07	-0.4	0.05	-0.4	0.02
7	Iih AB_	uA	-1	1	-0.2	0.07	-0.3	0.02	-0.3	0.05	-0.3	0.04	-0.3	0.05	-0.3	0.09	-0.3	0.04	-0.2	0.02
8	Iih RW_	uA	-1	1	-0.3	0.02	-0.4	0.03	-0.3	0.08	-0.2	0.10	-0.3	0.09	-0.2	0	-0.3	0.06	-0.3	0.02
9	Iil DB	uA	-1	1	-0.1	0.02	-0.1	0.06	-0.1	0.06	-0.2	0.02	-0.2	0.01	-0.2	0.04	-0.2	0.08	-0.18	0
10	Iil DS	uA	-1	1	-0.2	0.06	-0.2	0	-0.19	0.02	-0.3	0.03	-0.2	0.01	-0.2	0.04	-0.2	0.04	-0.2	0.05
11	Iil AB_	uA	-1	1	-0.2	0.02	-0.2	0.04	-0.2	0.04	-0.2	0.01	-0.3	0	-0.2	0	-0.2	0.02	-0.2	0
12	Iil RW_	uA	-1	1	-0.2	0.04	-0.2	0	-0.2	0.02	-0.2	0.09	-0.2	0.03	-0.25	0.05	-0.2	0.03	-0.2	0.03
13	Voh DB	V	4	-	4.26	0	4.23	0	4.29	0.01	4.16	0.02	4.08	0.02	3.96	0.03	3.96	0.03	3.81	0.04
14	Vol DB	V	-	4	0.09	0	0.09	0.07	0.09	0.01	0.09	0	0.09	0	0.10	0	0.10	0	0.10	0
15	GFSE_A	lsb	-1	1	-0.43	0.19	0.05	0.29	0.07	0.28	0.85	0.39	1.65	0.50	120	116	120	115	204	68
16	GFSE_B	lsb	-1	1	1.07	0.15	1.89	0.17	1.85	0.13	2.84	0.16	3.83	0.29	5.13	0.32	5.16	0.31	6.39	0.32
17	GFSE_C	lsb	-1	1	-0.34	0.17	0.15	0.16	0.15	0.17	0.99	0.14	1.82	0.16	126	123	126	123	167	70.9
18	GFSE_D	lsb	-1	1	1.14	0.03	1.97	0.05	1.9	0.10	2.91	0.07	3.95	0.12	5.22	0.21	5.21	0.21	6.42	0.24
19	PSR_A	%	-0.0010	0.0010	.0015	1.1E-3	.0032	1.8E-3	.0035	1.9E-3	.0058	3.4E-3	.0085	5E-3	.0123	8.1E-3	.0121	8E-3	.0156	1.1E-2
20	PSR_B	%	-0.0010	0.0010	.0134	6E-4	.02	8E-5	.0196	1.5E-3	.0279	1E-3	.0361	2.6E-3	.0501	2.7E-3	.0502	3E-3	.0632	4.1E-3
21	PSR_C	%	-0.0010	0.0010	.0009	7E-4	.0029	3E-4	.0031	3E-4	.0059	1.7E-3	.0091	3.3E-3	.0138	5.4E-3	.0137	6E-3	.0185	7.5E-3
22	PSR_D	%	-0.0010	0.0010	.0121	8E-4	.0183	1E-3	.0179	1.6E-3	.0255	1.2E-3	.0330	2.7E-3	.0459	2.8E-3	.046	3.1E-3	.0582	4.3E-3
23	INL_A	lsb	-0.25	0.25	-0.15	0.13	-0.23	0.09	-0.23	0.08	-0.43	0.11	-0.65	0.15	16.7	31.7	16.2	29.6	-378	294
24	DNL_A	lsb	-5	5	0.17	0.13	0.32	0.16	0.32	0.17	0.54	0.18	0.77	0.24	31.7	51.9	32.2	54.1	358	308
25	INL_B	lsb	-0.25	0.25	-0.42	0.02	-0.62	0.01	-1.40	0.67	-0.85	0.01	-106	0.03	-1.34	0.03	-1.34	0.03	-2.08	0.84
26	DNL_B	lsb	-5	5	0.47	0.01	0.68	0.02	1.12	0.37	0.94	0.02	1.18	0.05	1.47	0.06	1.46	0.03	1.95	0.34
27	INL_C	lsb	-0.25	0.25	-0.12	0.07	-0.16	0.35	-0.29	0.12	-0.48	0.12	-0.75	0.12	-56.9	96.9	-58.5	99.9	-160	95.6
28	DNL_C	lsb	-5	5	0.19	0.13	0.36	0.14	0.33	0.15	0.55	0.15	0.76	0.12	52.1	88.5	68.3	113	108	53.7
29	INL_D	lsb	-0.25	0.25	-0.41	0.03	-0.60	0.04	-0.59	0.04	-0.83	0.05	-1.05	0.07	-1.33	0.07	-1.34	0.07	-1.59	0.07
30	DNL_D	lsb	-5	5	0.48	0.03	0.68	0.04	0.66	0.03	0.91	0.05	1.20	0.07	1.48	0.07	1.46	0.07	1.77	0.08

Notes:

1/ The mean and standard deviation values were calculated over the three parts irradiated in this testing. The control 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/ In this table, some test parameters have been combined for clarity. Complete results for all test parameters are available on request.

Radiation-sensitive parameters: Icc, Voh, GFSE, PSR, INL and DNL.

Figure 1. Radiation Bias Circuit for DAC8408A