



DATE: November 9, 1995
 TO: J. Lohr/311.1
 FROM: K. Sahu/300.1 *K. Sahu*
 SUBJECT: Radiation Report on: DAC08
 Project: CASSINI/CIRS
 Control #: 14225
 Job #: EP61741
 Project part #: M38510/H13025EA

PPM-95-185

cc: J. Plante/300.1
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A radiation evaluation was performed on DAC08 (8-BIT DAC) 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, five parts were irradiated under bias (see Figure 1 for bias configuration) and one part was used as a control sample. The total dose radiation levels were 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 krad^{*}. The dose rate was between 0.06 and 0.29 krad/hour (see Table II for radiation schedule). After the 10 krad exposure, the parts were annealed for 168 hours at 25°C, after which the parts were annealed for 168 hours at 100°C. After each radiation exposure, 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 throughout all irradiation steps up to and including the 4 krad irradiation level.

After the 5 krad irradiation, S/N 2, 3 and 6 fell below the minimum specification limit of -3.00 μA for I_{ref} , with readings of -3.17, -3.14 and -3.11 μA , respectively. All irradiated parts passed all other electrical tests at this irradiation level.

After the 6 krad irradiation, all irradiated parts fell below the minimum specification limit for I_{ref} , with readings ranging from -3.05 to -3.41 μA . All irradiated parts passed all other electrical tests at this irradiation level.

The same degradation in I_{ref} continued to be observed, with gradually increasing readings, up to the 10 krad level. At 10 krad, readings ranged from -3.80 to -4.48 μA . All irradiated parts passed all other electrical tests up to and including this irradiation level.

After annealing for 168 hours at 25°C, no recovery was observed.

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

A radiation test of the same part type, with Lot Date Code 9335, manufactured by PMI/Analog Devices Inc., was performed in December, 1994, for CASSINI/CIRS (Report no. PPM-95-103). The radiation test levels in this test were 2.5, 5, 10, 15, 20, 30 and 50 krad, and the dose rate ranged between 0.04 and 0.31 krad/hour. In this test,

* 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.

Iref also proved to be the most sensitive parameter, with all irradiated parts exceeding specification limits after 5 krad. In the same test, the parts also showed marginal degradation in +NI. after 10 krad and in fil after 20 krad.

Table IV provides a summary of the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

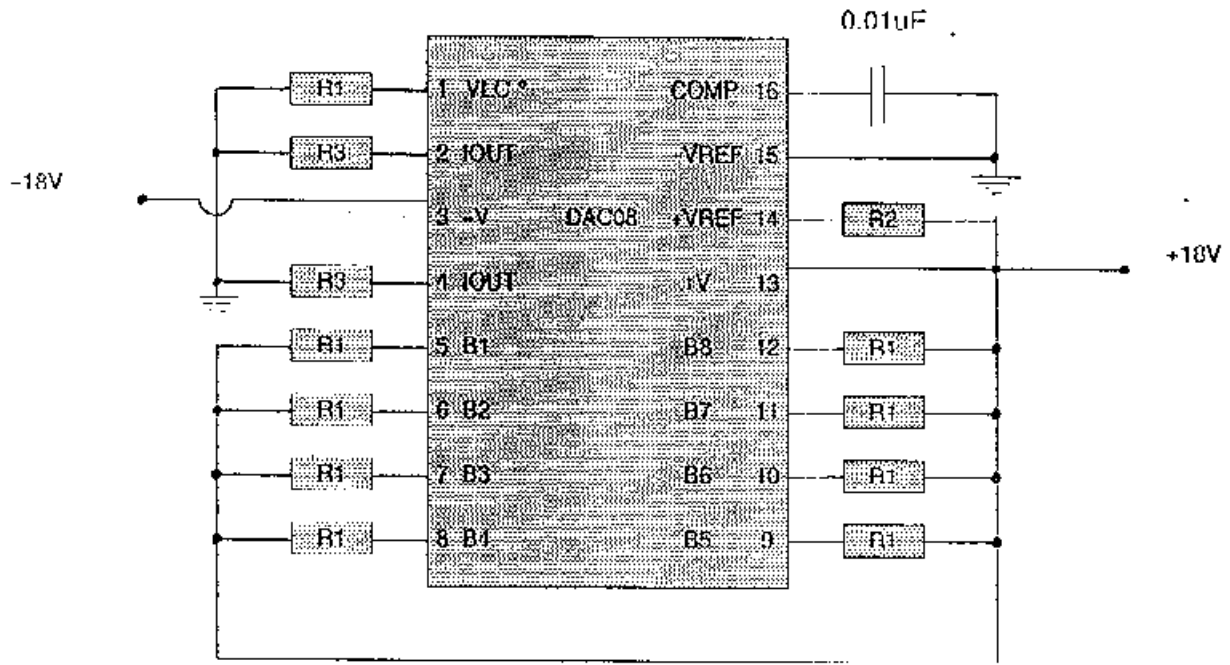
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for DAC08



- (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. $\pm 5\%$

TABLE I. Part Information

Generic Part Number:	DAC08*
CASSINI/CIRS Part Number	M38510/113025EA
CASSINI/CIRS Control Number:	14225
Charge Number:	EE61741
Manufacturer:	PMI/Analog Devices
Lot Date Code (LDC):	9435
Quantity Tested:	6
Serial Number of Control Sample:	1
Serial Numbers of Radiation Samples:	2, 3, 4, 5, 6
Part Function:	8-bit DAC
Part Technology:	Bipolar
Package Style:	16-pin DIP
Test Equipment:	A540
Engineer:	C. Nguyen

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

TABLE II Radiation Schedule for DAC08

EVENT.....	DATE.....
1) INITIAL ELECTRICAL MEASUREMENTS.....	10/04/95
2) 1 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/04/95
POST-1 KRAD ELECTRICAL MEASUREMENT.....	10/05/95
3) 2 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/05/95
POST-25 KRAD ELECTRICAL MEASUREMENT.....	10/06/95
4) 3 KRAD IRRADIATION (0.17 KRADS/HOUR).....	10/06/95
POST-3 KRAD ELECTRICAL MEASUREMENT.....	10/10/95
5) 4 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/10/95
POST-4 KRAD ELECTRICAL MEASUREMENT.....	10/11/95
6) 5 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/11/95
POST-5 KRAD ELECTRICAL MEASUREMENT.....	10/12/95
7) 6 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/12/95
POST-6 KRAD ELECTRICAL MEASUREMENT.....	10/13/95
8) 7 KRAD IRRADIATION (0.10 KRADS/HOUR).....	10/13/95
POST-7 KRAD ELECTRICAL MEASUREMENT.....	10/16/95
9) 8 KRAD IRRADIATION (0.10 KRADS/HOUR).....	10/16/95
POST-8 KRAD ELECTRICAL MEASUREMENT.....	10/17/95
10) 9 KRAD IRRADIATION (0.06 KRADS/HOUR).....	10/17/95
POST-9 KRAD ELECTRICAL MEASUREMENT.....	10/18/95
11) 10 KRAD IRRADIATION (0.29 KRADS/HOUR).....	10/18/95
POST-10 KRAD ELECTRICAL MEASUREMENT.....	10/19/95
12) 168-HOUR ANNEALING @25°C.....	10/18/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	10/26/95
13) 168-HOUR ANNEALING @100°C*.....	10/26/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	11/03/95

*High temperature annealing is performed to accelerate long term time dependent effects (TDF), 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 8830, Method 1019, Para. 3.10.1.

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

Table III. Electrical Characteristics of DAC08

TEST CONDITIONS: VCC = 15V, VSS = -15V; IRRIP = 2mA unless otherwise noted;

Test temperature : 25oC

Sequencer: vdd_5v

tst	Test name	Min	Max	Condition
1	Icc	0.40 ma	3.80 ma	all inputs = 15v
2	Iss	-7.80 ma	-0.80 ma	all inputs = 15v
3	Iref	-3.00ua	0.00 ua	
4	+IFS	1.984 ma	2.000 ma	all inputs = 15v
5	+IIS	-1.00 ua	1.00 ua	all inputs = 0v
6	-IFS	1.984 ma	2.000 ma	all inputs = 0v
7	-IIS	-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

Electrical parameters are tested GO/no GO :

 Input Voltage VIH, VIL

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

Test #	Parameters	Units	Spec. Lim.3		Total Dose Exposure (TDE) (krads)/2												Annealing			
					Initials		2		4		5		8		10		165 hrs @25°C		168 hrs @100°C	
					min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Icc	mA	0.4	3.8	2.58	.03	2.57	.03	2.56	.03	2.57	.03	2.58	.03	2.58	.03	2.55	.03	2.56	.03
2	Iss	mA	-7.8	-0.8	-6.78	.03	-6.77	.03	-6.77	.03	-6.77	.03	-6.78	.03	-6.77	.03	-6.78	.03	-6.76	.03
3	Iref	uA	-3.00	0	-2.00	.09	-2.00	.11	-3.00	.12	-3.00	.14	-4.00	.22	-4.00	.28	-4.00	.22	-3.00	.13
4	+IFS	mA	1.984	2.000	2.00	0	2.00	0	2.00	0	2.00	0	1.99	0	1.99	0	1.99	0	1.99	0
5	-IFS	uA	-1.00	1.00	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	+IFS	mA	1.984	2.000	2.00	0	2.00	0	2.00	0	1.99	0	1.99	0	1.99	0	1.99	0	1.99	0
7	-IFS	uA	-1.00	1.00	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	+Pss_Ifs1/4	uA	-4.00	4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Iih B1	uA	-10.00	10.00	-0.62	.13	-0.60	.15	-0.81	.04	-0.63	.18	-0.50	.12	-0.90	.23	-0.80	.14	-0.81	.01
17	Iih B2	uA	-10.00	10.00	-1.00	.15	-1.00	.16	-0.79	.14	-1.00	.18	-0.80	.13	-0.70	.07	-1.00	.09	-0.90	.12
18	Iih B3	uA	-10.00	10.00	-1.00	.15	-1.00	.33	-0.80	.24	-1.00	.27	-0.90	.24	-0.92	.09	-0.83	.20	-0.90	.15
19	Iih B4	uA	-10.00	10.00	-1.00	.14	-1.00	.20	-0.70	.08	-1.00	.29	-0.74	.13	-0.69	.07	-1.00	.15	-0.86	.27
20	Iih B5	uA	-10.00	10.00	-1.00	.18	-1.00	.24	-1.00	.33	-1.00	.30	-0.77	.13	-0.78	.12	-0.92	.17	-0.86	.19
21	Iih B6	uA	-10.00	10.00	-1.00	.13	-1.00	.31	-0.52	.05	-1.00	.20	-0.90	.13	-0.74	.07	-0.94	.25	-0.54	.13
22	Iih B7	uA	-10.00	10.00	-1.00	.05	-1.00	.35	-0.50	.14	-1.00	.23	-0.90	.22	-0.90	.14	-1.00	.13	-0.89	.19
23	Iih B8	uA	-10.00	10.00	-1.00	.09	-0.90	.23	-0.90	.06	-1.00	.15	-0.87	.27	-0.80	.11	-1.00	.27	-0.75	.11
24	Iil B1	uA	-10.00	0.05	-3.00	.10	-3.00	.14	-4.00	.08	-4.00	.07	-5.00	.21	-6.00	.33	-6.00	.32	-5.00	.16
25	Iil B2	uA	-10.00	0.05	-3.00	.25	-4.00	.17	-4.00	.15	-4.00	.27	-5.00	.26	-6.00	.28	-6.00	.33	-5.00	.20
26	Iil B3	uA	-10.00	0.05	-3.00	.20	-4.00	.24	-4.00	.18	-4.00	.24	-5.00	.29	-6.00	.31	-6.00	.34	-5.00	.14
27	Iil B4	uA	-10.00	0.05	-3.00	.25	-4.00	.36	-4.00	.26	-4.00	.06	-5.00	.19	-6.00	.08	-6.00	.33	-5.00	.24
28	Iil B5	uA	-10.00	0.05	-3.00	.19	-4.00	.17	-4.00	.09	-4.00	.12	-5.00	.22	-6.00	.36	-6.00	.23	-4.00	.07
29	Iil B6	uA	-10.00	0.05	-3.00	.24	-4.00	.32	-4.00	.16	-4.00	.17	-5.00	.27	-6.00	.32	-6.00	.23	-5.00	.15
30	Iil B7	uA	-10.00	0.05	-3.00	.08	-4.00	.30	-4.00	.21	-4.00	.16	-5.00	.28	-6.00	.19	-6.00	.42	-5.00	.23
31	Iil B8	uA	-10.00	0.05	-3.00	.15	-4.00	.35	-4.00	.21	-4.00	.19	-5.00	.36	-6.00	.30	-6.00	.31	-5.00	.16
32	+NL	%	-0.10	0.10	-0.02	.03	-0.11	.04	-0.01	.04	-0.02	.04	-0.01	.04	-0.01	.05	-0.01	.05	-0.04	.01
33	-NL	%	-0.10	0.10	-0.02	.03	-0.01	.04	-0.01	.04	-0.02	.04	-0.01	.05	-0.01	.05	-0.01	.05	-0.04	.01
34	dNL	%	-0.30	0.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	-Monotonicity	uA	0.00	16.00	0.17	.06	0.18	.04	0.20	.06	0.22	.06	0.24	.07	0.26	.07	0.25	.08	0.24	.06
36	-Monotonicity	uA	0.00	16.00	0.17	.06	0.18	.04	0.20	.06	0.22	.06	0.24	.07	0.26	.07	0.25	.08	0.24	.06
37	dMonotonicity	uA	-4.00	4.00	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 five parts irradiated in this testing. The control sample remained constant throughout the testing and is not included in this table.
- 2/ Since the parametric test values changed very slowly during the irradiation steps, TDE steps 1, 3, 6, 7 and 9 krad are omitted in this table for clarity. Data are available on request.
- 3/ 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.
- 4/ Values for mean and standard deviation for -Pss_Ifs1-4 and -Pss_Ifs1-4 were all zero throughout all irradiation and annealing steps, consequently, the values are shown only for +Pss_Ifs1.

Radiation-sensitive parameters: Iref