Federal Systems

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PPM-95-184

DATE: October 27, 1995
TO: J. Lohr/311.1
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: SP9380
Project: XDS/ACHE
Control #: 13762
Job #: EE61728
Project part #: SP9380B-18

cc: J. Plante/300.1
A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on SP9380 (18-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, four 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 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12.5, 15, 20 and 30 krads*. The dose rate was between 0.06 and 0.29 krads/hour (see Table II for radiation schedule). After the 100 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.

After the 1 krad irradiation, S/N 5 fell below the minimum specification limit of -1.00 µA for Iil DB8, with a reading of -2.30 µA. The same degradation in Iil DB8 continued to be seen in S/N 5 throughout all subsequent irradiation and annealing steps, with approximately the same reading. All other irradiated parts continued to pass all other electrical measurements up to and including the 5 krad level.

After the 6 krad irradiation, S/N 2 fell below the minimum specification limit of 9.999 V for Vref, with a reading of 9.989 V. The same degradation in Vref continued to be observed in S/N 2 throughout all subsequent irradiation and annealing steps, with approximately the same reading. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

After the 9 krad irradiation, S/N 2 exceeded the maximum specification limit of 0.00040 % for INL, with a reading of 0.00053 %. The same degradation in INL continued to be observed in S/N 2 throughout all subsequent irradiation and annealing steps, with approximately the same reading. In addition, S/N 5 read -2.58 µA for Iih DB8, against a maximum specification limit of 1.00 µA. The same degradation in Iih DB8 continued to be observed in S/N 5 throughout all subsequent irradiation and annealing steps, with approximately the same reading. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

After the 10 krad irradiation, S/N 4 read below the minimum specification limit for Vref, with a reading of 9.986 V. The same degradation in Vref continued to be observed in S/N 4 throughout all subsequent irradiation and annealing steps, with approximately the same reading. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

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* 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 12.5 krad irradiation, S/N 3 and 4 exceeded the maximum specification limit for INL, with readings of 0.00060 and 0.00041, respectively. The same degradation in INL continued to be observed in S/N 3 and 4 throughout all subsequent irradiation and annealing steps, with approximately the same reading for S/N 3, and increasing to 0.00060 for S/N 4. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

After the 15 krad irradiation, S/N 3 exceeded the maximum specification limit of 0.00040 for DNL, with a reading of 0.00046. The same degradation in DNL continued to be observed in S/N 3 up to and including the 168 hour anneal at 25°C, with readings increasing to 0.00136 V. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

After the 20 krad irradiation, S/N 2, 4 and 5 exceeded the maximum specification limit for DNL, with readings of 0.00083, 0.00079 and 0.00056, respectively. The same degradation in DNL continued to be observed in S/N 2, 4 and 5 up to and including the 168 hour anneal at 25°C, with readings increasing to 0.00126, 0.00121 and 0.00091, respectively. All other irradiated parts passed all other electrical tests at this level, except for those previously noted.

After the 30 krad irradiation, no additional parameters showed degradation. The same degradation in the parameters as previously noted continued.

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.

Table IV provides a summary of the functional test results and 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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TABLE I. Part Information

Generic Part Number:	SP9380*
XDS/ACHE Part Number	SP9380B-18
XDS/ACHE Control Number:	13762
Charge Number:	EE61728
Manufacturer:	Sipex
Lot Date Code (LDC):	9509
Quantity Tested:	5
Serial Number of Control Samples:	1
Serial Numbers of Radiation Samples:	2, 3, 4, 5
Part Function:	18-BIT DAC
Part Technology:	Hybrid
Package Style:	32-pin Flatpack
Test Equipment:	A540
Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for SP9380

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/11/95
2) 1 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/12/95
POST-1 KRAD ELECTRICAL MEASUREMENT	09/13/95
3) 2 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/13/95
POST-25 KRAD ELECTRICAL MEASUREMENT	09/14/95
4) 3 KRAD IRRADIATION (0.11 KRADS/HOUR)	09/14/95
POST-3 KRAD ELECTRICAL MEASUREMENT	07/15/95
5) 4 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/17/95
POST-4 KRAD ELECTRICAL MEASUREMENT	09/18/95
6) 5 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/18/95
POST-5 KRAD ELECTRICAL MEASUREMENT	09/19/95
7) 6 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/19/95
POST-6 KRAD ELECTRICAL MEASUREMENT	09/20/95
8) 7 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/20/95
POST-7 KRAD ELECTRICAL MEASUREMENT	09/21/95
9) 8 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/21/95
POST-8 KRAD ELECTRICAL MEASUREMENT	09/22/95
10) 9 KRAD IRRADIATION (0.11 KRADS/HOUR)	09/25/95
POST-9 KRAD ELECTRICAL MEASUREMENT	09/25/95
11) 10 KRAD IRRADIATION (0.59 KRADS/HOUR)	09/25/95
POST-10 KRAD ELECTRICAL MEASUREMENT	09/26/95
12) 12.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	09/26/95
POST-12.5 KRAD ELECTRICAL MEASUREMENT	09/27/95
13) 15 KRAD IRRADIATION (0.18 KRADS/HOUR)	09/27/95
POST-15 KRAD ELECTRICAL MEASUREMENT	09/28/95
14) 20 KRAD IRRADIATION (0.29 KRADS/HOUR)	09/28/95
POST-20 KRAD ELECTRICAL MEASUREMENT	09/29/95
15) 30 KRAD IRRADIATION (0.15 KRADS/HOUR)	09/29/95
POST-30 KRAD ELECTRICAL MEASUREMENT	10/02/95
16) 168-HOUR ANNEALING @25°C	10/02/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/10/95
17) 168-HOUR ANNEALING @100°C*	10/10/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/17/95

*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-8830, Method 1019, Para. 3.10.1.

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

Table III. Electrical Characteristics of SP9380

TEST CONDITIONS: VCC = 15V, VEE = -15V Vout = +10v (1)
unless otherwise noted;

Test temperature : 25oC

tst	Test name	Min	Max	Condition
1	ICC		30.00 ma	
2	IEE	20.00 ma		
3	PD		600.0 mw	
4	Iih DB17		1.000 ua	Vih=3.2v
5	Iih DB16		1.000 ua	Vih=3.2v
6	Iih DB15		1.000 ua	Vih=3.2v
7	Iih DB14		1.000 ua	Vih=3.2v
8	Iih DB13		1.000 ua	Vih=3.2v
9	Iih DB12		1.000 ua	Vih=3.2v
10	Iih DB11		1.000 ua	Vih=3.2v
11	Iih DB10		1.000 ua	Vih=3.2v
12	Iih DB9		1.000 ua	Vih=3.2v
13	Iih DB8		1.000 ua	Vih=3.2v
14	Iih DB7		1.000 ua	Vih=3.2v
15	Iih DB6		1.000 ua	Vih=3.2v
16	Iih DB5		1.000 ua	Vih=3.2v
17	Iih DB4		1.000 ua	Vih=3.2v
18	Iih DB3		1.000 ua	Vih=3.2v
19	Iih DB2		1.000 ua	Vih=3.2v
20	Iih DB1		1.000 ua	Vih=3.2v
21	Iih DB0		1.000 ua	Vih=3.2v
22	Iih LEN		1.000 ua	Vih=3.2v
23	Iih HEN		1.000 ua	Vih=3.2v
24	Iil DB17	-1.000 ua		Vil=0.4v
25	Iil DB16	-1.000 ua		Vil=0.4v
26	Iil DB15	-1.000 ua		Vil=0.4v
27	Iil DB14	-1.000 ua		Vil=0.4v
28	Iil DB13	-1.000 ua		Vil=0.4v
29	Iil DB12	-1.000 ua		Vil=0.4v
30	Iil DB11	-1.000 ua		Vil=0.4v
31	Iil DB10	-1.000 ua		Vil=0.4v
32	Iil DB9	-1.000 ua		Vil=0.4v
33	Iil DB8	-1.000 ua		Vil=0.4v
34	Iil DB7	-1.000 ua		Vil=0.4v
35	Iil DB6	-1.000 ua		Vil=0.4v
36	Iil DB5	-1.000 ua		Vil=0.4v
37	Iil DB4	-1.000 ua		Vil=0.4v
38	Iil DB3	-1.000 ua		Vil=0.4v
39	Iil DB2	-1.000 ua		Vil=0.4v
40	Iil DB1	-1.000 ua		Vil=0.4v
41	Iil DB0	-1.000 ua		Vil=0.4v
42	Iil LEN	-1.000 ua		Vil=0.4v
43	Iil HEN	-1.000 ua		Vil=0.4v
44	Vref	9.999000v		internal
45	+Pssr	-0.00010 %	0.00010 %	
46	-Pssr	-0.00010 %	0.00010 %	
48	INL	-0.00040 %	0.00040 %	
49	DNL	-0.00040 %	0.00040 %	

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for SP9380 /1

Test #	Parameters/3,	Units	Spec. Lim./2 min	Spec. Lim./2 max	Total Dose Exposure (krads) Initial mean	Initial sd	1 mean	1 sd	2 mean	2 sd	3 mean	3 sd	4 mean	4 sd	5 mean	5 sd	6 mean	6 sd	7 mean	7 sd	8 mean	8 sd
1	Icc	mA	-	30.00	20.6	.12	20.6	.11	20.5	.11	20.5	.11	20.4	.11	20.4	.11			20.0	.16	20.2	.17
2	IEE	mA	-20.00	-	-12.0	.14	-12.1	.13	-12.0	.13	-11.9	.13	-11.9	.13	-11.9	.13	20.3	.11	-11.7	.15	-11.7	.14
4-21	Iih DB17-DB	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	-11.8	.11	0	0	0	0
22	Iih LEN	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Iih HEN	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-41	Iil DB17-DB0	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Iil LEN	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Iil HEN	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	-0	0	0	0	0	0	0
44	Vref	V	9.999000	-	10.0008	0	10.0010	0	10.0011	0	10.0010	0	10.0008	0	10.0009	0	9.9955	.01	9.9987	.01	9.9986	.10
45	+Pssr	%	-0.00010	0.00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	-Pssr	%	-0.00010	0.00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	INL	%	-0.00040	0.00040	.0002	0	.0002	0	.0002	0	.0002	0	.0002	0	.0002	0	.0001	0	.0001	0	.0001	0
49	DNL	%	-0.00040	0.00040	.0001	0	.0001	0	.0001	0	.0001	0	.0001	0	.0001	0	.0001	0	.0001	0	.0001	0

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control sample remained constant throughout the testing and is 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, the Iih and Iil test parameters have been combined for clarity. Complete results for all test parameters are available on request.

4/ Data for S/N 5 are not included in the Iih and Iil statistics. Refer to the discussion on pages 1 and 2.

Radiation-sensitive parameters: Iih DB8, Iil DB8, Vref, INL, DNL

TABLE IV (Cont'd.): Summary of Electrical Measurements after Total Dose Exposures and Annealing for SP9380 /1

Test #	Parameters/3,	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	Total Dose Exposure (krads) 9 mean	9 sd	10 mean	10 sd	12.5 mean	12.5 sd	15 mean	15 sd	20 mean	20 sd	30 mean	30 sd	Annealing 168 hrs @25°C mean	168 hrs @25°C sd	168 hrs @100°C mean	168 hrs @100°C sd
1	Icc	mA	-	30.00	20.6	.12	20.2	.11	20.1	.22	19.6	.12	19.6	.09	19.4	.11	19.2	.08	19.4	.09	19.8	.08
2	IEE	mA	-20.00	-	-12.0	.14	-11.7	.12	-11.6	.25	-11.1	.15	-11.1	.10	-10.9	.12	-10.7	.10	-10.9	.11	-11.4	.10
4-21	Iih DB17-DB	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Iih LEN	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Iih HEN	uA	-	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24-41	Iil DB17-DB0	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Iil LEN	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Iil HEN	uA	-1.00	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Vref	V	9.999000	-	10.0008	0	9.9987	.01	9.9912	.01	9.9956	.01	9.9955	.01	9.9954	.01	9.9955	.01	9.9957	.01	9.9973	.01
45	+Pssr	%	-0.00010	0.00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	-Pssr	%	-0.00010	0.00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	INL	%	-0.00040	0.00040	.0002	0	.0003	0	.0004	0	.0005	0	.0012	0	.0027	0	.0046	0	.0042	0	.0005	0
49	DNL	%	-0.00040	0.00040	.0001	0	.0001	0	.0001	0	.0002	0	.0004	0	.0008	0	.0013	0	.0012	0	.0001	0

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control sample remained constant throughout the testing and is 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, the Iih and Iil test parameters have been combined for clarity. Complete results for all test parameters are available on request.

4/ Data for S/N 5 are not included in the Iih and Iil statistics. Refer to the discussion on pages 1 and 2.

Radiation-sensitive parameters: Iih DB8, Iil DB8, Vref, INL, DNL