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Unisys

DATE: October 17, 1997 PPM-97-045
TO: J.Ellis/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: SD5000A
Project: EOS-AM
Job #: M78301
Project part #: SD5000A

cc: B.Silva/300.1
E. Shultz/SWRC
K. LaBel/735
A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on SD5000A (16 Pin DIP) 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 one part was used as a control sample. The total dose radiation levels were 2.5, 5.0, 6.0, and 7.5 kRads.* The dose rate was between 0.025 and 0.062 kRads/hour (0.007 to 0.017 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 5.0 kRad exposure, the parts were annealed for 168 hours at 25°C. After the 7.5 kRad exposure, the parts were annealed for 216 hours at 25°C. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

Initial electrical measurements were made on 5 samples. Four samples (SN's 6, 8, 9, and 10) were used as radiation samples while SN 4 was used as a control sample. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 2.5 kRads.

After the 5.0 kRad irradiation, all parts fell below the specification limit of 0.1V for VGSth with readings in the range of 0.03 to 0.08V. **All parts passed all other tests.**

After the annealing the parts for 168 hours at 25°C, all parts recovered in VGSth with readings in the range of 0.26 to 0.30V. All parts passed all tests.

After the 6.0 kRad irradiation, all parts passed all tests.

After the 7.5 kRad irradiation, all parts failed VGSth with readings of 0.002V. **All parts passed all other tests.**

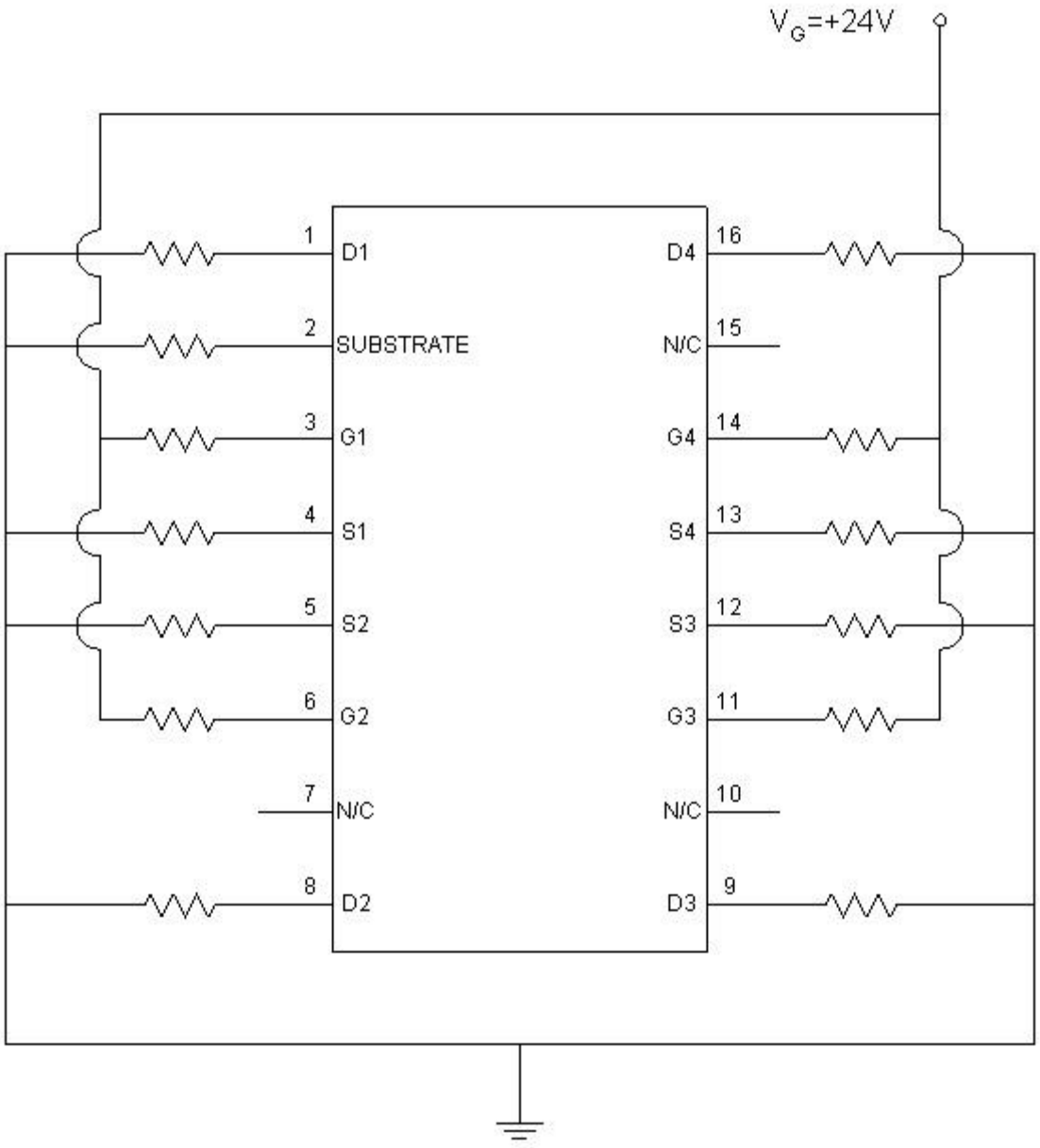
After the annealing the parts for 216 hours at 25°C, all parts recovered in VGSth with readings in the range of 0.11 to 0.15V. All parts passed all tests.

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

* 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. The manufacturer provided no post-irradiation limits at the time these tests were performed.

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

Figure 1. Radiation Bias Circuit for SD5000A



Notes:
1. Resistors are 47kΩ ± 5%, ¼ W.
2. V_G = 24.0V ±0.5V DC

TABLE I. Part Information

Generic Part Number:	SD5000A
EOS-AM Part Number	SD5000A
Charge Number:	M78301
Manufacturer:	Cal-Logic
Lot Date Code (LDC):	93-2629W#1
Quantity Tested:	5
Serial Number of Control Sample:	4
Serial Numbers of Radiation Samples:	6, 8, 9, and 10
Part Function:	High-Speed DMOS Quad
Part Technology:	Hybrid
Package Style:	16 Pin DIP
Test Equipment:	Testronics
Test Engineer:	B. Chong

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for SD5000A

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	09/08/97
2) 2.5 KRAD IRRADIATION (0.062 KRADS/HOUR)	09/22/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT	09/24/97
3) 5.0 KRAD IRRADIATION (0.062 KRADS/HOUR)	09/24/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT	09/26/97
4) 168 HOUR ANNEALING @25°C	09/26/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/02/97
5) 6.0 KRAD IRRADIATION (0.025 KRADS/HOUR)	10/02/97
POST-6.0 KRAD ELECTRICAL MEASUREMENT	10/03/97
6) 7.5 KRAD IRRADIATION (0.037 KRADS/HOUR)	10/04/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT	10/06/97
7) 216 HOUR ANNEALING @25°C	10/06/97
POST-216 HOUR ANNEAL ELECTRICAL MEASUREMENT	10/15/97

Effective Dose Rate = 7,500 RADS/15 DAYS=20.8 RADS/HOUR=0.006 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the interim-annealing step.

The interim annealing following the 5.0 kRad step was added due to degradation in the parts. The addition of an interim annealing step better simulates the space environment's lower dose rate for very sensitive devices. This may allow the parts to show satisfactory performance at higher doses or indicate that the part can not be used beyond the previous dose level.

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

Table III. Electrical Characteristics of SD5000A /1

Test #	Parameter	Units	Test Conditions	Spec. min	Lim. max
1-8 A	ID off	nA	V_{GS} = 5V, V_{DS} = 20V		10
1,5,9,13 B	VBR	V	I_R = 1mA	25	
2,6,10,14 B	IR	nA	V_R = 25V		1000
3,7,11,15 B	IR	nA	V_R = 30V		1000
4,8,12,16 B	RDS on	W	I_D = 1mA, V_{GS} = 5V		70
4,10,16,22 C	VGSth	V	V_{DS} = 2.5V, I_D = 1mA	0.1	2.0
7,13,19,25 C	dVGS	V	V_{GS} measured at V_{DS} = 10V, I_D = 16mA and 20mA	-0.43	0.43

Note:

1/ These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for SD5000A /1

Test # /3	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	Initial mean	Initial sd	Total Dose Exposure (kRads) 2.5 mean	2.5 sd	5.0 mean	5.0 sd	Annealing 168 hours @25°C /5 mean	Annealing 168 hours @25°C /5 sd	Total Dose Exposure (kRads) 6.0 mean	6.0 sd	7.5 mean	7.5 sd	Annealing 216 hours @25°C mean	Annealing 216 hours @25°C sd
1-8 A	ID off /4	nA		10	P		P		P		P		P		P		P	
1,5,9,13 B	VBR /4	V	25		P		P		P		P		P		P		P	
2,6,10,14 B	IR	nA		1000	0.7	0.08	0.4	0.15	0.7	0.13	0.5	0.04	0.6	0.02	0.7	0.08	0.4	0.08
3,7,11,15 B	IR	nA		1000	0.5	0.04	0.5	0.15	0.5	0.15	0.4	0.04	0.5	0.11	0.6	0.05	0.4	0.07
4,8,12,16 B	RDS on	W		70	55	0.4	55	0.4	57	0.8	61	0.7	63	0.8	64	0.9	68	0.9
4,10,16,22 C	VGSth	V	0.1	2.0	1.05	0.008	0.50	0.015	0.07	0.017	0.29	0.02	0.28	0.02	0.002	0	0.13	0.02
7,13,19,25 C	dVGS	V	-0.43	0.43	-0.38	0	-0.38	0	-0.40	0.009	-0.40	0.009	-0.41	0.009	-0.42	0.009	-0.42	0.009

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout 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/ Three series of tests were run on the parts. The letter designates which program was run to obtain these measurements.

4/ "P" ("F") indicates that all parts passed (failed) this test at this irradiation level or annelaing step. "nPmF" means that n parts passed and m parts failed this test at this irradiation level or annealing step.

5/ The interim annealing step was added due to significant degradation in the parts at this level. The addition of this interim annealing step better simulates the space environment's lower dose rate for very sensitive devices. This may allow parts to show satisfactory performance at higher doses or indicate that the part can not be used beyond the previous dose level.

Radiation sensitive parameter: VGSth.