UNISYS

DATE: April 7, 1997
TO: J.Ellis/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on: SD5000
Project: EO-1
Job #: EV78053
Project part #: SD5000

PPM-97-009

cc: B.Silva/300.1
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A radiation evaluation was performed on SD5000 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 two parts were used as control samples. The total dose radiation levels were 2.5, 5.0, 5.9, and 7.5 krads.* The dose rate was between 0.04 and 0.06 krads/hour (see Table II for radiation schedule). Between the 5.0 and 5.9 krad exposures, the parts were annealed for 264 hours at 25°C. After the final radiation exposure, all parts were annealed for 288 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 8 samples. Four parts (SN's 225, 228, 229 and 230) passed all tests. However, SNs 226, 231, 232, and 233, exceed the specification limit of 10 nA for ISDoff with readings in the range of 80-933 nA. The ISDoff readings were highest for SN 231. This part was submitted for DPA and removed from any further radiation testing. Five samples (SN's 225, 226, 228, 229, and 232) were used as radiation samples while SN's 230 and 233 were used as control samples. The ISDoff readings for the irradiated samples ranged from 3-90 nA. All parts passed all other tests during initial electrical measurements.

After the 2.5 krad irradiation, all irradiated parts showed significant degradation in Vgsth, but all parts still met the minimum specification limit of 0.1 V for this parameter. All irradiated parts also showed some degradation in ISDoff. All irradiated parts continued to pass all other tests at this level.

After the 5.0 krad irradiation, all irradiated parts showed increased degradation in Vgsth, and four parts failed to meet the minimum specification limit of 0.1 V for this parameter. Only one part, SN 229, passed all tests at this radiation level. All irradiated parts also showed some increase in ISDoff, with the readings in the range of 17-325 nA. All irradiated parts continued to pass all other tests at this level.

The parts were annealed at 25°C to determine if the parts will show any significant recovery. Electrical measurements were made after 48, 96 and 264 hours to monitor any recovery in Vgsth. After 264 hours of annealing, all parts met the minimum specification limit of 0.1 V.

After 5.9 krads all parts except SN 226 still met the minimum specification limit for Vgsth.

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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 7.5 krads, all parts failed to meet the specification limit for Vgsth with readings in the range of 0.001-0.1 V against the minimum specification limit of 0.10 V. The readings for ISDoff ranged from 40-750 nA. All irradiated parts continued to pass all other tests at this level.

After annealing the parts for 144 hours at 25°C, parts again showed some recovery in Vgsth with readings in the range of 0.002-0.25 V. Following 288 hours of annealing at 25°C, further recovery was observed in Vgsth with all parts except SN 226 and SN 236 meeting the minimum specification limit of 0.1V. The Vgsth readings for SN 226 were in the range of 0.002-0.06 V, while the readings for SN 232 were in the range of 0.09-0.96 V. Parts also showed some recovery in ISDoff.

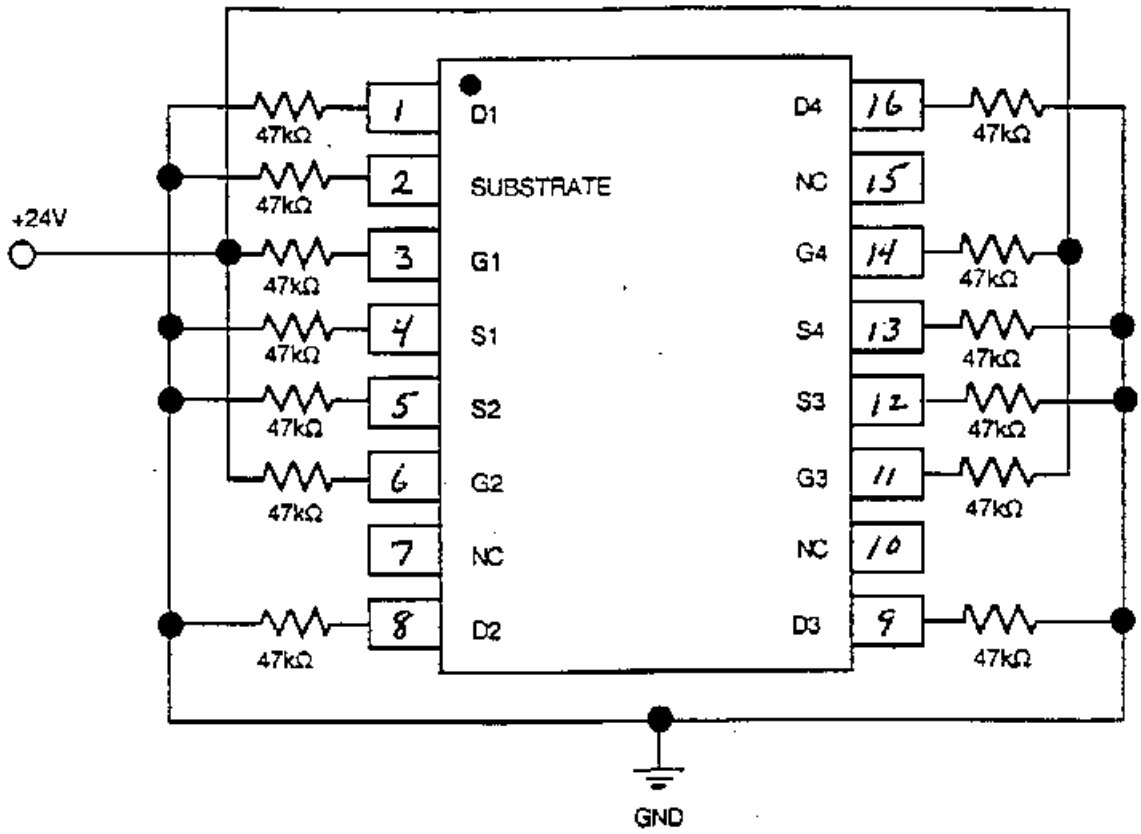
Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

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 SD5000

Job Number: EV78053

Part Number: SD5000



Note:

Resistors are +/-5% , 1/4 W

TABLE I. Part Information

Generic Part Number:	SD5000
EO-1Part Number	SD5000
Charge Number:	EV78053
Manufacturer:	CAL-LOGIC
Lot Date Code (LDC):	9633
Quantity Tested:	8
Serial Number of Control Samples:	230, 233
Serial Numbers of Radiation Samples:	225, 226, 228, 229, 232
Part Function:	Quad-Power Mosfet
Part Technology:	CMOS
Package Style:	16 Pin Flat-pack
Test Equipment:	Tektronics
Tester:	J.Fogle

- No radiation tolerance/hardness was guaranteed by the manufacturer for this part.
- SN 230 was submitted for DPA because of high leakage current readings during Initial electrical measurements.

TABLE II. Radiation Schedule for SD5000

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/03/97
2) 2.5 KRAD IRRADIATION (0.060 KRADS/HOUR)	03/05/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT	03/07/97
3) 5 KRAD IRRADIATION (0.040 KRADS/HOUR)	03/07/97
POST-5 KRAD ELECTRICAL MEASUREMENT	03/10/97
12) 264-HOUR ANNEALING @25°C	03/10/97
POST-264 HOUR ANNEAL ELECTRICAL MEASUREMENT	03/21/97
5)5.9 KRAD IRRADIATION (0.015 KRADS/HOUR)	03/21/97
POST-5.9 KRAD ELECTRICAL MEASUREMENT	03/24/97
6) 7.5 KRAD IRRADIATION (0.040 KRADS/HOUR)	03/24/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT	03/26/97
12) 144-HOUR ANNEALING @25°C	04/01/97
POST-144 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/01/97
12) 288 HOUR ANNEALING @25°C	04/07/97
POST-288 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/07/97

Effective Dose Rate = 8.5 RADS/HOUR=.002 RADS/SEC

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

Table III. Electrical Characteristics of SD5000

Test #	Parameters	Units	Test Condition	Spec. Lim. min	Spec. Lim. max
1-4	Vgsth	V	Vds=Vgs=Vgsth, Id=1uA, Vsb=0V	0.1	2.0
5-8	IDSoff	nA	Vgs=Vbs= -5V, Vds=20V		10
9-12	ISDoff	nA	Vgd=Vbd= -5V, Vsd=20V		10
13-16	VBRsb	V	Vgb=0V, Is=1uA, Drain Open	25	
17-20	IDB	nA	Vgb=25V, Source Open		1000
21-24	Igbs	nA	Vdb=Vsb=0V, Vgb=30V		1000
24-28	RDSon	ohm	Vsb=0V, Id=1mA, Vgs=5V		70
29-32	gfs	mho	Vds=10V, Vsb=0V, Id=20mA, f=1kHz	-0.41	0.41

NOTE: SD5000 is a quad power MOSFET. Each of the parameters in Table III was measured for each indiviual MOSFET in the part. However, since Vgsth was the only parameter that was very sensitive to radiation exposure, measurments of this parameter are provided for each of the 4 MOSFETs on the part in Table IV. All other parameters have been combined for simplicity and clarity.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for SD5000 /1

Test# /3			Spec. Lim./2		Initial		Total Dose Exposure (krads) 2.5		5.0		Annealing 264 hrs @25°C		Rad level 5.9		Rad level 7.5		Annealing 144 hrs @25°C		Annealing 288 hrs @25°C	
#	Parameters/3	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Vgsth1	V	0.1	2.0	0.772	0.051	0.340	0.068	0.038	0.055	0.233	0.076	0.162	0.078	0.024	0.049	0.125	0.079	0.150	0.081
2	Vgsth2	V	0.1	2.0	1.008	0.072	0.456	0.045	0.146	0.053	0.311	0.048	0.267	0.047	0.113	0.046	0.194	0.039	0.205	0.047
3	Vgsth3	V	0.1	2.0	0.769	0.059	0.334	0.074	0.028	0.058	0.227	0.088	0.154	0.085	0.023	0.047	0.116	0.087	0.137	0.091
4	Vgsth4	V	0.1	2.0	0.780	0.049	0.346	0.074	0.030	0.062	0.225	0.083	0.156	0.083	0.021	0.042	0.116	0.083	0.129	0.089
5-8	IDSoff	nA		10	0.156	0.040	0.116	0.015	0.074	0.023	0.092	0.004	4/		0.072	0.049	4/		0.034	0.013
9-12	ISDoff	nA		10	26.6	39.2	47.2	63.3	112.5	150.2	98.9	133.1	4/		257.6	335.3	4/		234.1	280.7
13-16	VBRsb	V	25		Pass		Pass		Pass		Pass		4/		Pass		4/		Pass	
17-20	IDB	nA		1000	0.9	0.22	0.9	0.16	1.2	0.19	0.94	0.15	4/		0.94	0.13	4/		0.4	0.2
21-24	Igbs	nA		1000	0.84	0.28	0.74	.021	1.14	0.21	0.78	0.19	4/		0.72	0.15	4/		0.2	0.1
24-28	RDSon	ohm		70	51	0.71	51.6	0.89	54.0	1.0	58.6	1.14	4/		59.6	1.14	4/		63.2	0.91
29-32	gfs	mho	-0.41	0.41	-0.360	0	-0.376	0.009	-0.384	0.009	-0.392	0.11	-0.400	0	-0.416	0.009	-0.420	0	-0.413	0.006

Notes:

1/ The mean and standard deviation values were calculated over the five 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.

4/ These parameters were not measured at these steps to save the test time.

Radiation-sensitive parameters: VGSth and ISDoff.