Unisys

DATE: January 15, 1999 PPM-99-012
TO: S Hull/562
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SUBJECT: Radiation Report on **DG412 (Maxim) (LDC 9829)**
PROJECT: IRAC

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A radiation evaluation was performed on **DG412 (5962-9073102MEA) Precision Monolithic Quad SPST CMOS Analog Switch (Maxim)** to determine the total ionizing dose (TID) tolerance of these parts. The TID testing was performed using a Co^{60} gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The TID radiation levels were 2.5, 5.0, 7.5, 10.0, and 15.0kRads.[1] The dose rate was 0.023kRads/hour (0.006Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 2.5, 5.0 and 15.0kRad irradiation, the parts were annealed under bias at 25°C and tested after 72, 96, and 168 hours respectively.[2] After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III.

An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step. For detailed information, refer to Tables I through IV and Figure 1.

All parts passed all initial electrical tests. All parts passed the functional test upon irradiation from 2.5 to 15kRads. However, all parts showed significant degradation in many parameters from 2.5 to 10kRads including IDD, ISS, Iil, Iih, Idoff, and Isoff. After annealing the parts for 72 hours at 25℃ after the 2.5kRad irradiation and 96 hours at 25℃ after the 5.0kRad irradiation, some recovery was observed in a few of the sensitive parameters. Upon continued irradiation to 15kRads, the parts showed continued degradation in Iil, Iih, Idoff, and Isoff, but showed a decrease in IDD and ISS. After annealing the parts for 168 hours at 25℃ after 15.0kRads, the parts showed no significant change in any parameter.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 52, 53, 54, 55, 56, 57, 58, and 59) were used as radiation samples while SN's 50 and 51 were used as control samples.

All parts were within the specification limits For IDD, ISS and Rds. However, for Iil, Iih, Idoff, Isoff, Idon, and Ison, the parts initially exceeded the specification limits of 0.50, 0.50, 0.25, 0.25, 0.4, and 0.4nA, respectively. This is because the open socket leakage itself was above the specification limits due to the noise in the power supplies and the load boards for the ATE. For these parts, it will be necessary to observe the net increase or decrease in these values to determine if the part is degrading or not.

After the 2.5kRad irradiation, the parts showed significant degradation in IDD_vil with all readings greater than 5µA and ISS_vil with all readings less than -5µA with a specification limit of ±1.0µA for both. All parts showed significant degradation in IN1-4_Iih with readings greater than 5000nA with a specification limit of ±0.5nA. All parts showed an increase in the current readings for IN_Iih, Idoff1, Isoff1, Isoff2, and Idon2. **All parts passed all other tests including the functional test.**

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After annealing the parts for 72 hours at 25°C, the parts showed only modest recovery in Iih, Idoff1 and Isoff1, with no significant change in any other parameter.

After the 5.0kRad irradiation, the parts showed significant degradation in IDD_vil with all readings greater than 100µA and ISS_vil with all readings less than -100µA with a specification limit of ±1.0µA for both. One part exceeded the specification limit of 1.0µA for IDD_vih with a reading of 5µA and fell below the specification limit of -1.0µA for ISS_vih with a reading of -5µA. All parts showed very significant degradation in IN1-4_Iih with readings greater than 41µA with a specification limit of ±0.5nA. All parts showed significant degradation in Idoff1, Isoff1, Isoff2, and Idon2. **All parts passed all other tests including the functional test.**

After annealing the parts for 96 hours at 25°C, the parts showed no significant change in any parameter.

After the 7.5kRad to 15kRad irradiations, the parts showed significant degradation in IDD_vil and IDD_vih with all readings greater than 100µA and ISS_vil and ISS_vih with all readings less than -100µA with a specification limit of ±1.0µA for both at 7.5 and 10kRads. However, after 15kRads, all parts fell to within specification limits for all four parameters. All parts showed significant degradation in Iil, Iih, Idoff1, Idoff2, Isoff1, Isoff2, Idon1, and Idon2. **All parts passed all other tests including the functional test.**

After annealing the parts for 168 hours at 25°C, the parts showed no significant change in any parameter.

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 us at (301) 731-8954.

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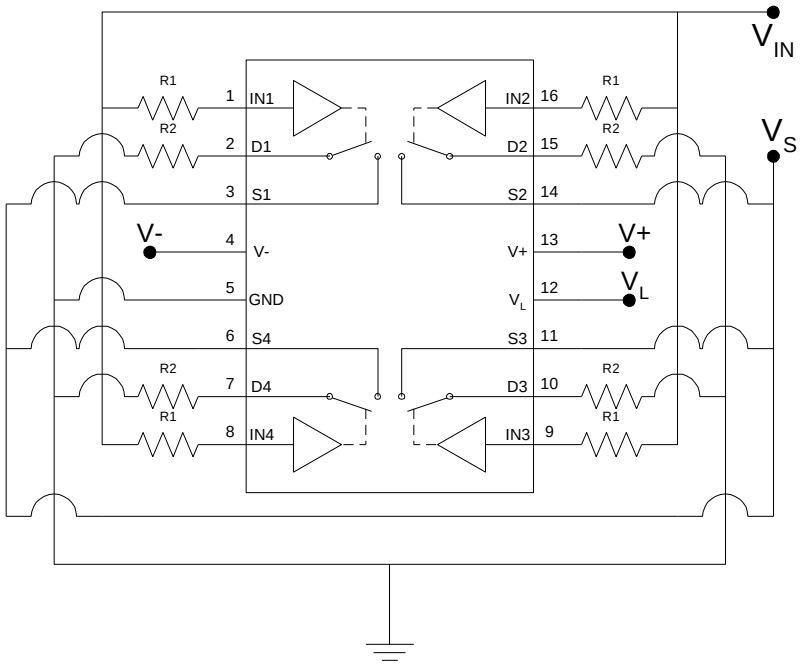
Figure 1. Radiation Bias Circuit for DG412



Notes:
1. V+ = +15.0V ±0.5V, V- = -15.0V ±0.5V, V_L = +5.0V ±0.5V, V_S = +10V ±0.5V, V_{IN} = 2.4V ±0.1V.
2. R_1 = 2kΩ ±5%, ¼W.
3. R_2 = 3kΩ ±5%, ¼W.

TABLE I. Part Information

Generic Part Number:	DG412
IRAC Part Number:	DG412 (5962-9073102MEA)
Charge Number:	M99713
Manufacturer:	Maxim
Lot Date Code (LDC):	9728
Quantity Tested:	10
Serial Number of Control Samples:	51, 52
Serial Numbers of Radiation Samples:	53, 54, 55, 56, 57, 58, 59, and 60
Part Function:	Improved, Quad, SPST Analog Switches
Part Technology:	CMOS
Package Style:	16 Pin DIP
Test Equipment:	A540
Test Engineer:	A. Duvalsaint

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

TABLE II. Radiation Schedule for DG412

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	11/16/98
2) 2.5 KRAD IRRADIATION (0.038 KRADS/HOUR)	11/17/98
POST-2.5 KRAD ELECTRICAL MEASUREMENT	11/20/98
3) 72 HOUR ANNEALING @25°C	11/20/98
POST-72 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/23/98
4) 5.0 KRAD IRRADIATION (0.015 KRADS/HOUR)	11/23/98
POST-5.0 KRAD ELECTRICAL MEASUREMENT	11/30/98
5) 96 HOUR ANNEALING @25°C	11/30/98
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/04/98
6) 7.5 KRAD IRRADIATION (0.038 KRADS/HOUR)	12/04/98
POST-7.5 KRAD ELECTRICAL MEASUREMENT	12/07/98
7) 10.0 KRAD IRRADIATION (0.028 KRADS/HOUR)	12/07/98
POST-10.0 KRAD ELECTRICAL MEASUREMENT	12/11/98
8) 15.0 KRAD IRRADIATION (0.077 KRADS/HOUR)	12/11/98
POST-15.0 KRAD ELECTRICAL MEASUREMENT	12/14/98
9) 168 HOUR ANNEALING @25°C	12/14/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/21/98

Effective Dose Rate = 15,000 RADS/27 DAYS=23.1 RADS/HOUR=0.006 RADS/SEC

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

Table III. Electrical Characteristics of DG412 /1

Test #	Parameter	Units	Test Conditions /2	Spec. Lim. min	Spec. Lim. max
1	Functional Test	P/F	100kHz, V_{IL} = 0.8V, V_{IH} = 2.4V, Load = ±10mA	V_{OH}>3V	V_{OL}<1V
10	IDD_vil	mA	V_{IN} = 0.0V	-1.0	1.0
11	ISS_vil	mA	V_{IN} = 0.0V	-1.0	1.0
12	IDD_vih	mA	V_{IN} = 5.0V	-1.0	1.0
13	ISS_vih	mA	V_{IN} = 5.0V	-1.0	1.0
20-23	IN1-4_iil	nA	V_{IN}1-4 = 0.8V, V_{DD} = 15V, V_{SS} = -15V	-0.5	0.5
24-27	IN1-4_iih	nA	V_{IN}1-4 = 2.4V, V_{DD} = 15V, V_{SS} = -15V	-0.5	0.5
30-33	D1-4_Idoff1	nA	V_{IN}1-4 = 0.8V, V_D = 15V, V_S = -15V	-0.25	0.25
34-37	D1-4_Idoff2	nA	V_{IN}1-4 = 0.8V, V_D = -5V, V_S = 15V	-0.25	0.25
40-43	S1-4_Isoff1	nA	V_{IN}1-4 = 0.8V, V_D = 15V, V_S = -15V	-0.25	0.25
44-47	S1-4_Isoff2	nA	V_{IN}1-4 = 0.8V, V_D = -5V, V_S = 15V	-0.25	0.25
50-53	S1-4_Ison1	nA	V_{IN}1-4 = 2.4V, V_S = 15V	-0.4	0.4
54-57	S1-4_Ison2	nA	V_{IN}1-4 = 2.4V, V_S = -5V	-0.4	0.4
60-63	D1-4_Idon1	nA	V_{IN}1-4 = 2.4V, V_D = 15V	-0.4	0.4
64-67	D1-4_Idon2	nA	V_{IN}1-4 = 2.4V, V_D = -5V	-0.4	0.4
70-73	Rds1-4_+8.5V	W	V_{IN}1-4 = 2.4V, V_D = 8.5V	0	35
74-77	Rds1-4_-8.5V	W	V_{IN}1-4 = 2.4V, V_D = -8.5V	0	35
80-83	Rds1-4_+3.0V	W	V_{IN}1-4 = 2.4V, V_D = 3.0V	0	80
84-87	Rds1-4_+8.0V	W	V_{IN}1-4 = 2.4V, V_D = 8.0V	0	80

Notes:

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.

2/ T_A = 25°C unless otherwise noted.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DG412 /1

							TDE (kRads Si)		Annealing		TDE (kRads Si)		Annealing		Total Dose Exposure (kRads Si)						Annealing	
					Initial		2.5		72 hours @25°C		5.0		96 hours @25°C		7.5		10.0		15.0		168 hours @25°C	
Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Functional Test	P/F			P		P		P		P		P		P		P		P		P	
10	IDD_vil	?A	-1.0	1.0	-0.009	0.006	5		5		>100		>100		>100		>100		0.1	0	0.1	0
11	ISS_vil	?A	-1.0	1.0	-0.002	0.005	<-5		<-5		<-100		<-100		<-100		<-100		-0.4	0	-0.4	0
12	IDD_vih	?A	-1.0	1.0	-0.005	0.010	0.005	0.010	0	3.92	0.62	1.8	0	0	1.9	2.6	>5		0.1	0	0.1	0
13	ISS_vih	?A	-1.0	1.0	0.001	0.009	0.006	0.006	0.002	5.24	-0.62	1.8	0	0	-38	52	<-100		-0.4	0	-0.4	0
20-23	IN1-4_Iil	nA	-0.5	0.5	-0.66	0.04	-0.66	0.04	-0.59	0.27	-0.66	0.04	0	0	0	0	0	0	0	0	0	0
24-27	IN1-4_Iih	nA	-0.5	0.5	0.63	0.02	>5000		1283	2375	>41000		>41000		>41000		>41000		>41000		>41000	
30-33	D1-4_Idoff1	nA	-0.25	0.25	1.97	0.11	8.34	11.74	3.02	2.16	1355	421	703	563	749	1	>48000		>48000		>48000	
34-37	D1-4_Idoff2	nA	-0.25	0.25	-29	0.09	-29	0.08	-29	0.18	-29	0.19	-24	0	<-240		<-240		<-240		<-240	
40-43	S1-4_Isoff1	nA	-0.25	0.25	7.08	0.11	12.1	4.23	7.9	0.8	1264	559	639	347	>47000		>47000		>47000		>47000	
44-47	S1-4_Isoff2	nA	-0.25	0.25	1.64	0.08	2.95	0.95	1.72	0.17	728	351	370	214	<-850		<-850		<-850		<-850	
50-53	S1-4_Ison1	nA	-0.4	0.4	38	0.27	38	0.23	38	0.33	38	0.34	39	0.24	39	0.30	39	0.30	39	0.75	40	0.36
54-57	S1-4_Ison2	nA	-0.4	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60-63	D1-4_Idon1	nA	-0.4	0.4	19	0.36	19	0.19	19	0.20	19	0.1	19	0.3	19	0.4	20	0.8	20	1.0	21	1.1
64-67	D1-4_Idon2	nA	-0.4	0.4	-93	0.20	-94	0.12	-92	0.14	-94	0.22	-95	0.14	-95	0.27	-92	0.26	-92	0.55	-92	0.15
70-73	Rds1-4_+8.5V	?	0	35	23.5	0.2	24.0	0.2	24.1	0.2	23.9	0.1	24.0	0.1	24.1	0.1	23.9	0.1	24.2	0.2	24.5	0.1
74-77	Rds1-4_-8.5V	?	0	35	23.2	0.1	23.6	0.1	23.8	0.2	23.6	0.2	23.7	0.1	23.9	0.1	23.8	0.1	24.2	0.2	24.5	0.2
80-83	Rds1-4_+3.0V	?	0	80	48.9	0.2	47.6	0.2	47.8	0.3	45.8	0.3	46.1	0.3	44.9	0.3	43.5	0.2	41.5	0.2	42.0	0.3
84-87	Rds1-4_+8.0V	?	0	80	48.9	0.2	47.6	0.2	47.7	0.3	45.8	0.3	46.1	0.3	44.9	0.3	43.5	0.2	41.5	0.2	42.0	0.2

Notes:

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

Radiation sensitive parameters: IDD, ISS, Iil, Iih, Idoff, Isoff, Idon, Ison.