

**UNISYS**

DATE: August 17, 1994

TO: T. Mecum/311.1

FROM: K. Sahu/300.1 *KS*

SUBJECT: Radiation Report on FUSE  
Part No. EL2243C  
Control No. 11024

PPM-94-018

cc: A. Sharma/311  
Library/300.1

A radiation evaluation was performed on EL2243C (Dual Operational Amplifier) 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 cobalt-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 total dose radiation levels were 5, 10, 15, 20, 30, 50, 75 and 100 krad\*. The dose rate was between 0.075 and 1.5 krad/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits\*\* listed in Table III.

At initial electrical measurements the +PSRR2 and -PSRR2 reading for four parts, S/N 33, S/N 36, S/N 37, and S/N 38, read less than the minimum specification limit of 80 dB, with values in the range of 75 dB to 79.8 dB. From the 5 krad irradiation level up to and including the 15 krad irradiation level, three of the parts continued to read less than the minimum specification limit for +PSRR2 and -PSRR2, with values in the same range. S/N 8 recovered to within specification limits at the 10 krad irradiation level.

After the 20 krad irradiation level, the same failures continued for +PSRR2 and -PSRR2 and S/N 32 exceeded the maximum specification limit of  $\pm 5$  mV for  $V_{IO1}$ , with a reading of 5.1 mV.

At the 30, 50 and 75 krad levels, the same failures continued with the parts reading the same values. At the 100 krad irradiation level, the same parts continued to read less than the minimum specification limit for +PSRR2 and -PSRR2, with readings in the range of 75dB to 77 dB respectively, and S/N 32 continued to exceed the maximum specification limit for  $V_{IO1}$  with a reading of 5.5 mV.

After annealing for 168 hours at 25°C, S/N 33, S/N 36 and S/N 37 continued to read less than the minimum specification limit for +PSRR2 and -PSRR2, with readings in the range of 75dB to 78 dB respectively, and S/N 32 continued to exceed the maximum specification limit for  $V_{IO1}$  with a reading of 5.4 mV.

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

\*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

\*\*These are manufacturer's non-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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:	EL2243C
FUSE	
Part Number:	EL2243C
FUSE	
Control Number:	11024
Charge Number:	C44430
Manufacturer:	Elantec
Lot Date Code:	9332C
Quantity Tested:	10
Serial Number of Control Sample:	30, 31
Serial Numbers of Radiation Sample:	32, 33, 34, 35, 36, 37, 38, 39
Part Function:	Dual Op-Amp
Part Technology:	Linear
Package Style:	8 Pin DIP
Test Equipment:	A540
Test Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for EL2243C

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/23/94
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	06/23/94 06/24/94
3) 10 KRAD IRRADIATION (0.075 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	06/24/94 06/27/94
4) 15 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	06/27/94 06/28/94
5) 20 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	06/28/94 06/29/94
6) 30 KRAD IRRADIATION (0.5 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	06/29/94 06/30/94
7) 50 KRAD IRRADIATION (0.6 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT (Power outage occurred after 29 hours. Parts annealed at room temperature under bias for 2.5 days. Dose rate was then adjusted to complete irradiation within 23 hours.)	07/01/94 07/06/94
8) 75 KRAD IRRADIATION (1.25 KRADS/HOUR) POST-75 KRAD ELECTRICAL MEASUREMENT	07/06/94 07/07/94
9) 100 KRAD IRRADIATION (1.5 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	07/07/94 07/08/94
10) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/08/94 07/15/94
11) 168-HOUR ANNEALING @100°C* POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/14/94 07/21/94

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

\*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-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of EL2243C

TEST CONDITIONS: VSS= +/- 15V unless otherwise noted;

Test temperature : 25oC

tst #	Test name	Min	Max
1	I <sub>dd</sub>	0.0 ma	10.0 ma
2	I <sub>ss</sub>	-10.00 ma	0.00 ma
3	V <sub>oh1</sub>	12.0 v	
4	V <sub>oh2</sub>	12.0 v	
5	V <sub>ol1</sub>		-12.0 v
6	V <sub>ol2</sub>		-12.0 v
7	v <sub>io</sub> 1		5.0 mv
8	v <sub>io</sub> 2		5.0 mv
9	+i <sub>bias</sub> 1		700.0 na
10	+i <sub>bias</sub> 2		700.0 na
11	-i <sub>bias</sub> 1		700.0 na
12	-i <sub>bias</sub> 2		700.0 na
13	i <sub>io</sub> 1	-100.0 na	100.0 na
14	i <sub>io</sub> 2	-100.0 na	100.0 na
15	+A <sub>vs</sub> 1 (V/mv)	250.0	
16	+A <sub>vs</sub> 2 (V/mv)	250.0	
17	cm <sub>rr</sub> 1	80.0 db	
18	cm <sub>rr</sub> 2	80.0 db	
19	+p <sub>srr</sub> 1	80.0 db	
20	+p <sub>srr</sub> 2	80.0 db	
21	-p <sub>srr</sub> 1	80.0 db	
22	-p <sub>srr</sub> 2	80.0 db	
23	+I <sub>out</sub>	-50.00 ma	0.00 ma
24	+I <sub>out</sub>	-50.00 ma	0.00 ma
25	-I <sub>out</sub>	0.00 ma	50.00 ma
26	-I <sub>out</sub>	0.00 ma	50.00 ma

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for EL2243C /1

Parameters	Spec. Lim./2 min max	Total Dose Exposure (TDE) (krads)														Annealing									
		Initials		5		10		15		20		30		50		75		100		168 hrs @25°C		168 hrs @100°C			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
I <sub>di</sub>	μA	0	10	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2	8.2	0.2
I <sub>ss</sub>	mA	-10	0	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13	8.2	0.13
V <sub>oh1</sub>	V	12		13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11
V <sub>oh2</sub>	V	12	-12	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11	13.4	0.11
V <sub>o11</sub>	V		-12	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08
V <sub>o12</sub>	V			14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08	14.2	0.08
V <sub>io1</sub>	mV	-5	5	2.7	1.5	2.73	2.3	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6	2.73	2.6
V <sub>io2</sub>	mV	-5	5	2.5	2.5	2.5	2.4	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
+ibias1	nA		700	388	12.9	388	12.6	388	12.4	388	11.9	388	13.2	388	13.4	405	12.6	415	12.9	436	12.8	432	12.5	410	12.6
+ibias2	nA		700	386	12.4	387	12.4	388	12.5	395	12.8	399	13.1	392	12.8	400	12.5	410	13.6	435	12.2	435	12.6	415	12.8
-ibias1	nA		700	388	12.2	382	12.3	388	12.3	388	12.3	388	12.6	394	12.5	407	12.9	412	12.4	429	11.9	429	12.9	412	12.9
-ibias2	nA		700	384	12.6	384	12.1	386	12.1	385	11.9	392	12.3	401	13.3	412	13.8	419	13.8	434	11.8	435	13.9	419	12.8
i <sub>ic1</sub>	nA	-100	100	0.78	4.1	1.2	0.3	5.32	6.6	1.3	4.1	0.2	4.4	5.5	3.4	0.23	3.3	1.8	4.01	0.6	2.6	0.78	4.1	0.78	3.5
i <sub>ic2</sub>	nA	-100	100	0.12	3.1	4.3	10.4	0.06	3.6	2.2	0.6	2.2	3.9	0.52	6.8	1	3.9	1	4.9	3.1	6.5	2.9	0.7	2.7	6.1
A <sub>vs1</sub>	V/mV	250		592	117	559	170	519	64	533	84	478	67.5	563	149	450	27.3	455	27.1	395	63.2	450	50.2	420	61.3
A <sub>vs2</sub>	V/mV	250		590	115	565	174	525	89	560	89	560	229	537	143	510	110	525	115	479	45.7	424	52	45.5	53.2
c <sub>arr1</sub>	dB	80		114	1.7	115	2.5	115	2.5	114	2.5	113	2.1	114	2.2	114	2.2	114	2.1	112	1.8	113	2.2	116	2.6
c <sub>arr2</sub>	dB	80		113	1.6	114	2.3	114	2.3	115	2.3	112	2.1	113	2.31	113	2.1	114	2.3	113	1.9	114	2.4	114	2.3
+psrr1	dB	80		115	9.4	116	9.8	116	12.4	113	15.7	114	9.4	112	7.5	109	7.8	110	7.7	108	7.7	111	9.2	111	6.5
-psrr2	dB	80		82	6.1	83.8	7.7	83	11.5	82.2	5.5	82.1	5.5	82	5.6	82	5.5	81.8	4.9	82	5.4	84.2	7.8	81.8	5.2
-psrr1	dB	80		100	4.2	101	4.3	101	4.6	101	4.2	100	4.5	101	4.9	101	5.6	101	5.7	100	5.0	100	4.2	101	4.5
-psrr2	dB	80		82.2	5.5	82.2	4.9	82	4.8	82	4.6	81.6	4.9	82.1	5.9	81.9	4.8	81.6	4.7	82	4.9	81.6	4.8	84	7.8
+I <sub>out1</sub>	mA	-50	0	41.8	0.69	41.2	0.68	41	0.6	42	0.71	41.5	0.79	41.2	0.73	41.2	0.73	41.8	0.79	41.2	0.58	41.2	0.71	41	0.6
+I <sub>out2</sub>	mA	-50	0	42	0.71	40.5	0.77	39	0.7	41.9	0.69	42.1	0.75	40.9	0.69	42.8	0.69	38.9	0.79	40.5	0.77	41.8	0.69	41	0.6
-I <sub>out1</sub>	mA	0	50	41.4	0.7	42.2	0.79	40	0.68	39.9	0.82	42.1	0.69	43.2	0.81	42.3	0.79	42.1	0.81	43.2	0.79	41.2	0.82	41	0.6
-I <sub>out2</sub>	mA	0	50	42.4	0.8	41.2	0.83	42	0.8	41.2	0.81	41.9	0.81	43.5	0.79	43.1	0.81	41.9	0.65	42.2	0.83	42.3	0.81	41	0.7

- 1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and is not included in this table.
- 2/ 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.
- 3/ The radiation sensitive parameters were V<sub>io1</sub>, +psrr2 and -psrr2.

Figure 1. Radiation Bias Circuit for EL2243C

