

UNISYS

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FROM: K. Sahu/300.1
SUBJECT: Radiation Report on CASSINI/CIRS
Part No.OP27A
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A radiation evaluation was performed on OP27A (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 ⁶⁰Co 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, 10, 15, 20, 30 50 and 100 krad*. The dose rate was between 0.15 and 2.94 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.

All parts passed initial electrical measurements. All parts passed all electrical tests up to and including the 5 krad irradiation level. At the 10 krad irradiation level, S/N 53 marginally exceeded the maximum specification limit of 40nA for both +ibias and -ibias, with readings of 41.2 and 43.0nA, respectively. At the 15 krad irradiation level, the same part continued to exceed the maximum specification limit for ibias with a maximum reading of 56.4nA. At the 20 krad irradiation level, the same part continued to exceed the maximum specification limit for ibias with a reading of 72.1nA. In addition S/N55 exceeded the maximum specification for ibias with a reading of 49.1nA.

At the 30 krad irradiation level, all parts exceeded the maximum specification limit for ibias with readings ranging from 45.7nA to 125.4nA. In addition all parts except S/N55 fell below the minimum specification limit of -25uV for vio with readings ranging from -32uV to -36.5uV. At the 50 krad irradiation level, all parts continued to exceed the maximum specification for ibias with readings ranging from 92.8nA to 212.9nA, and the same parts continued to fall below the minimum specification limit for vio with readings ranging from -42.8uV to -252.3uV. At the 100 krad irradiation level, the same degradation continued in ibias and vio with readings ranging from 346.2nA to 806.5nA and -35uV to -320.3uV, respectively. In addition all parts exceeded the maximum specification limit of -35nA for iio with readings ranging from 106.4nA to 135.9nA. In addition all parts except S/N55 fell below the minimum specification limit of 100dB for psrr with readings ranging from 88.4dB to 98.5dB and all parts fell below the minimum specification limit of 1.7V for SR with readings ranging from 1.51V to 1.65V.

After annealing for 168 hours at 25°C, all parts continued to exceed the maximum specification limit for ibias and all parts fell below the minimum specification limit for SR with readings ranging from 282.8nA to 489.9nA and from 1.57V to 1.68V, respectively.

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

*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.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures 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:	OP27A
CASSINI/CIRS Part Number:	M38510/13503SGA
CASSINI/CIRS Control Number:	12098
Charge Number:	EE56096
Manufacturer:	Linear Technology Corp
Lot Date Code:	9109
Quantity Tested:	5
Serial Number of Control Samples:	51
Serial Numbers of Radiation Samples:	52, 53, 54, 55
Part Function:	Operational Amplifier
Part Technology:	CMOS
Package Style:	8 pin can
Test Equipment:	A540
Test Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for OP27A

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	01/11/95
2) 2.5 KRAD IRRADIATION (0.147 KRADS/HOUR) POST-2.5 KRAD ELECTRICAL MEASUREMENT	01/30/95 01/31/95
3) 5 KRAD IRRADIATION (0.147 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	01/31/95 02/01/95
4) 10 KRAD IRRADIATION (0.294 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	02/01/95 02/02/95
5) 15 KRAD IRRADIATION (0.294 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	02/02/95 02/03/95
6) 20 KRAD IRRADIATION (0.294 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	02/06/95 02/07/95
7) 30 KRAD IRRADIATION (0.588 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	02/07/95 02/08/95
8) 50 KRAD IRRADIATION (1.176 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	02/08/95 02/09/95
9) 100 KRAD IRRADIATION (2.941 KRADS/HOUR) POST-100 KRAD ELECTRICAL MEASUREMENT	02/09/95 02/10/95
10) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/10/95 02/17/95
11) 168-HOUR ANNEALING @100°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/17/95 02/24/95

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

Table III. Electrical Characteristics of OP27A

TEST CONDITIONS: VS= +/- 15V unless otherwise noted;
 Test temperature : 25°C

tst	Test name	Min	Max	Condition
1	I _{dd_15v}	0.00 ma	5.00 ma	
2	I _{ss_15v}	-5.00 ma	0.00 ma	
3	+V _{o_600}	10.0 v		R1 = 600 ohms
4	+V _{o_2K}	11.5 v		R1 = 2 Kohms
5	-V _{o_600}		-10.0 v	R1 = 600 ohms
6	-V _{o_2k}		-11.5 v	R1 = 2 Kohms
7	v _{io}	-25.0 uv	25.0 uv	
8	+i _{bias}	-40.00 na	40.00 na	
9	-i _{bias}	-40.00 na	40.00 na	
10	i _{io}	-35.00 na	35.00 na	
11	A _{vs_2k (V/mv)}	1000.0		
12	cm _{rr}	114.0 db		R1 = 2 Kohms
13	+p _{srr}	100.0 db		cm = +/- 11v
14	-p _{srr}	100.0 db		V _{dd} = +5v to +18v
15	+i _{os}	-70.00 ma	0.00 ma	V _{ss} = -5v to -18v
16	-i _{os}	0.00 ma	70.00 ma	
17	+SR	1.70 v		
18	-SR	1.70 v		

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP27A /1

Test #	Parameter	Unit	Spec. Lim./2		Total Dose Exposure (krads)																Annealing					
					Initial		2.5		5		10		15		20		30		50		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
1	I _{dd} 15v	mA	0	5	3.06	0.12	3.02	0.11	3.0	0.11	2.97	0.11	2.93	0.09	2.89	0.08	2.79	0.07	2.64	0.03	2.38	0.03	2.46	0.05	2.33	0.05
2	I _{ss} 15v	mA	-5	0	-3.05	0.12	-3.02	0.12	-3.0	0.11	-2.97	0.11	-2.93	0.10	-2.88	0.09	-2.79	0.07	-2.63	0.03	-2.38	0.03	-2.46	0.05	-2.32	0.05
3	+V _o 600	V	10	-	13.8	0.01	13.8	0.01	13.8	0.01	13.8	0.0	13.8	0.01	13.8	0.0	13.8	0.0	13.8	0.01	13.8	0.02	13.8	0.0	13.8	0.07
4	+V _o 2k	V	11.5	-	13.9	0.01	13.9	0.01	13.9	0.01	13.9	0.0	13.9	0.0	13.9	0.0	13.9	0.0	13.8	0.01	14.0	0.01	14.0	0.0	14.0	0.02
5	-V _o 600	V	-	-10	-14.0	0.06	-14.0	0.06	-14.0	0.06	-14.0	0.05	-14.0	0.06	-14.0	0.03	-14.0	0.05	-14.0	0.01	-14.0	0.02	-14.0	0.01	-14.0	0.06
6	-V _o 2k	V	-	-11.5	-14.1	0.06	-14.1	0.07	-14.2	0.06	-14.2	0.06	-14.2	0.06	-14.2	0.05	-14.2	0.04	-14.2	0.02	-14.0	0.02	-14.0	0.01	-14.0	0.06
7	v _{io}	uV	-25	25	7	6	7	5	6	7	6	6	7	4	7	25	17	145	86	184	130	2	15	-10	19	
8	+i _{bias}	nA	-40	40	15.1	5.83	16.8	7.17	22.4	8.45	26.1	11.2	34.9	15.2	46.3	18.7	82.9	33.1	172	47.7	645	155	391	91.9	263	79.7
9	-i _{bias}	nA	-40	40	11.4	5.54	13.7	7.06	19.8	9.44	23.2	13.9	30.8	17.7	41.2	22.7	74.8	37.3	158	61.2	820	159	378	91.9	243	81.6
10	i _{io}	nA	-35	35	1.67	2.57	3.04	2.48	2.54	2.41	2.87	3.63	4.12	2.93	5.19	4.17	8.06	4.95	13.9	13.5	125	12.9	13.2	5.15	19.9	6.22
11	A _{vs} 2k/3	V/mv	1000	-	10823	3449	23677	14883	13605	3667	11561	3467	9078	563	14755	5689	21319	1273	2843	459	1137	390	4229	1461	3625	732
12	emrr	db	114	-	134	3.69	134	3.29	133	2.86	134	3.36	134	2.99	134	3.08	837	3.30	135	4.52	136	8.09	135	5.78	136	4.95
13	+psrr	db	100	-	118	9.46	116	7.06	118	7.87	121	13.1	118	6.92	119	8.44	468	4.99	106	5.12	98.3	6.82	113	5.33	112	10.7
14	-psrr	db	100	-	117	5.16	115	4.43	116	4.94	120	8.09	123	11.1	123	16.3	490	10.8	107	5.39	97.3	7.41	114	5.48	115	13.2
15	i _{ios}	mA	-70	0	35	0.60	35.5	0.5	35	0.59	35	0.54	35	0.50	34.7	0.45	135	0.36	31.6	1.18	23.4	1.68	26.7	0.78	27.9	0.51
16	-i _{os}	mA	0	70	40	0.89	39.4	0.97	39	1.18	38.8	1.23	38.7	1.34	37.9	1.24	36.9	1.05	36.4	0.82	37.1	0.97	36.8	0.91	36.3	0.84
17	+SR	V	1.70	-	2.10	0.09	2.07	0.09	2.07	0.08	2.03	0.06	1.99	0.06	1.94	0.04	1.87	0.05	1.74	0.02	1.53	0.02	1.49	0.04	1.53	0.03
18	-SR	V	1.70	-	2.13	0.15	2.14	0.15	2.19	0.10	2.13	0.12	2.10	0.06	2.19	0.06	2.09	0.11	1.88	0.04	1.69	0.06	1.70	0.08	1.61	0.04

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/ After the initial radiation exposure the mean and standard deviation values for A_{vs}_2k are calculated over only three parts, because a meaningful value for S/N 53 could not be obtained.

Radiation-sensitive parameters: v_{io}, +i_{bias}, -i_{bias}, i_{io}, +psrr, -psrr and +SR.

Figure 1. Radiation Bias Circuit for OP27A

Bias conditions

$$T_A = 100^\circ \text{C}$$

$$+V_{CC} = 15V_{DC} \pm 0.5V_{DC}$$

$$-V_{CC} = -15V_{DC} \pm 0.5V_{DC}$$

$$R_L = 2K\Omega, 1/2 \text{ W @ } \pm 10\%$$

