Government Systems Group

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Unisys Corporation
4700 Boston Way
Lanham MD 20706

Telephone
301 731 8600

UNISYS

PPM-95-149

DATE: May 1, 1995
TO: J. Lohr/311
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on: OP 07A
Project: CASSINI/CIRS
Control #: 12097
Job #: EE56288
Project part #: JM38510/13501SGX

cc: B. Posey/300.1
A. Sharma/311.0
OFA Library/300.1

A radiation evaluation was performed on OP 07A (OP AMP) 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 ^{60}Co gamma ray source. During the radiation testing, four 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, 10, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.04 and 1.47 krads/hour (see Table II for radiation schedule). After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits** listed in Table III.

All parts passed initial electrical measurements. All irradiated parts passed all parametric tests up to and including the 2.5 krad irradiation level. After the 5 krad irradiation, S/N 62, 63, 64, 66 and 67 exceeded the maximum specification limit of 2.00 nA for N_IIB_0V, with readings ranging from 2.08 to 3.17 nA, and S/N 62, 63 and 66 exceeded the maximum specification limit of 2.00 nA for P_IIB_0V, with readings ranging from 2.02 to 4.14 nA.

At the 10 krad irradiation level, all irradiated parts exceeded the maximum specification limit for both N_IIB_0V and P_IIB_0V, with readings ranging from 2.75 to 4.31 nA for P_IIB_0V and 2.87 to 3.75 nA for N_IIB_0V. At the 15 and 20 krad levels, the same degradation in N_IIB_0V and P_IIB_0V continued, with readings ranging from 3.02 to 6.06 nA at 15 krads and from 4.91 to 8.07 nA at 20 krads.

At the 30 krad level, the same degradation in N_IIB_0V and P_IIB_0V continued. In addition, S/N 62, 63, 64, 65, 67 and 69 exceeded the specification limit of ±25.00 µV for VOS_0V, with readings ranging from -26.0 to +56.9 µV.

At the 50 krad level, all iradiated parts continued to exceed the maximum specification limit for N_IIB_0V and P_IIB_0V, with readings ranging from 22.6 to 36.2 nA. In addition, all irradiated parts exceeded the maximum specification limit for VOS_0V, with readings ranging from -71.0 to 160 µV. S/N 62, 63, 65, 66 and 68 fell below the minimum specification limit of 300.0 V/mV for N_AOL, with readings ranging from 191 to 248 V/mV. No valid readings could be obtained for S/N 64 for P_AOL and N_AOL at this level. S/N 62 also exceeded the maximum specification limit of 2.00 nA for IIOS_0V, with a reading of 2.16 nA.

At the 75 krad level, the same degradation continued, with slightly increasing values. S/N 64 fell below the minimum specification limit for N_AOL, with a reading of 173 V/mV and passed P_AOL.

* 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.

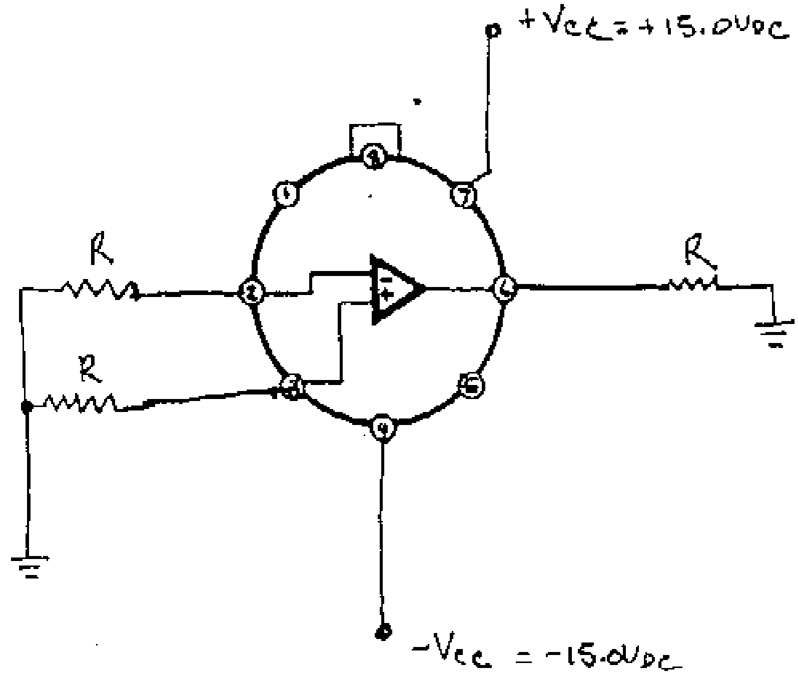
At the 100 krad level, the same degradation continued. S/N 64 and 67 marginally fell below the minimum specification limit of 110.0dB for CMRR, with readings of 102 and 105 dB, respectively. In addition, S/N 64 marginally fell below the minimum specification limit of -10.0 µV/V for +/-_PSRR, with a reading of -10.9 µV/V.

After annealing for 168 hours at 25°C, all irradiated parts read within specification limits for IIOS_0V, CMRR and +/-_PSRR. No other recovery was noted.

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter for both biased and unbiased parts after each irradiation exposure.

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 OP 07A



R = 10kΩ, ½W

TABLE I. Part Information

Generic Part Number:	OP 07A*
CASSINI/CIRS Part Number	JM38510/13501SGX
CASSINI/CIRS Control Number:	12097
Charge Number:	EE56288
Manufacturer:	PMI
Lot Date Code (LDC):	9416
Quantity Tested:	10
Serial Number of Control Samples:	60, 61
Serial Numbers of Biased Radiation Samples:	62, 63, 64, 65, 66, 67, 68, 69
Part Function:	Op Amp
Part Technology:	CMOS
Package Style:	8-pin TOx Can
Test Equipment:	A540
Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for OP 07A

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	04/07/95
2) 2.5 KRAD IRRADIATION (0.04 KRADS/HOUR)	04/07/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	04/10/95
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR)	04/10/95
POST-5 KRAD ELECTRICAL MEASUREMENT	04/11/95
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	04/11/95
POST-10 KRAD ELECTRICAL MEASUREMENT	04/12/95
5) 15 KRAD IRRADIATION (0.29 KRADS/HOUR)	04/12/95
POST-15 KRAD ELECTRICAL MEASUREMENT	04/13/95
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR)	04/13/95
POST-20 KRAD ELECTRICAL MEASUREMENT	04/14/95
7) 30 KRAD IRRADIATION (0.15 KRADS/HOUR)	04/14/95
POST-30 KRAD ELECTRICAL MEASUREMENT	04/17/95
8) 50 KRAD IRRADIATION (1.18 KRADS/HOUR)	04/18/95
POST-50 KRAD ELECTRICAL MEASUREMENT	04/19/95
9) 75 KRAD IRRADIATION (1.47 KRADS/HOUR)	04/19/95
POST-75 KRAD ELECTRICAL MEASUREMENT	04/20/95
10) 100 KRAD IRRADIATION (1.47 KRADS/HOUR)	04/20/95
POST-100 KRAD ELECTRICAL MEASUREMENT	04/21/95

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

Table III. Electrical Characteristics of OP 07A

Unless Otherwise Specified: T_A =25°C, VCC = +/- 15Vdc, V_{OUT}=0v

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
		SUPPLY CURRENT		
Plus Icc	Icc	V_{OUT} = 0V *(SEE NOTE 1)*		4.0mA
Minus Icc	Icc	V_{OUT} = 0V *(SEE NOTE 1)*	-4.0mA	
		INPUT OFFSET TESTS		
VOS 0V	V_{IO}	V_{OUT} = 0V *(SEE NOTE 1)*	-25uV	25uV
P IIB 0V	$+I_{IB}$	V_{OUT} = 0V *(SEE NOTE 1)*	-2nA	2nA
N IIB 0V	$-I_{IB}$	V_{OUT} = 0V *(SEE NOTE 1)*	-2nA	2nA
IIOS 0V	I_{IO}	V_{OUT} = 0V *(SEE NOTE 1)*	-2nA	2nA
CMRR	CMRR	V_{CM} = +/- 13V	110dB	
Plus PSRR	+PSRR	+Vcc =20V, 5V	-10uV/V	10uV/V
Minus PSRR	-PSRR	-Vcc = -20V, -5V	-10uV/V	10uV/V
PSRR	±PSRR	+Vcc =(4.5, 20)V, -Vcc = (-4.5, -20)V	-10uV/V	10uV/V
		AMPLIFIER OUTPUT TESTS		
P VOUT 600	V_{OP}	R_L=600Ω	10.0V	
P VOUT 2K	V_{OP}	R_L=2KΩ	12.0V	
N VOUT 600	V_{OP}	R_L=600Ω		-10.0V
N VOUT 2K	V_{OP}	R_L=2KΩ		-12.0V
P AOL V/mV	A_{VS}	VOUT = (0V to 10V), R_L=2KΩ	300 V/mV	
N AOL V/mV	A_{VS}	VOUT = (0V to -10V), R_L=2KΩ	300 V/mV	
		OUTPUT SHORT CIRCUIT CURRENT		
Pluse ISC	$I_{OS(+)}$	Vout = +15V	-65mA	
MINUS ISC	$I_{OS(-)}$	Vout = -15V		65mA

Note:

1. The Test Specification condition of V_{CM} = 0V, has been replaced with the condition of V_{OUT} = 0V.
2. R_L=600Ω was substitued for R_L=1KΩ due to tester limitation.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for OP 07A /1

Test #	Parameters	Units	Spec. Lim./2 min	Spec. Lim./2 max	Initial mean	Initial sd	2.5 mean	2.5 sd	5 mean	5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	30 mean	30 sd	50 mean	50 sd	75 mean	75 sd	100 mean	100 sd	Annealing 168 hrs@25°C mean	Annealing 168 hrs@25°C sd
							Total Dose Exposure (krads)																			
1	Plus_Icc	mA	0	4.0	1.58	.04	1.56	.04	1.53	.04	1.49	.04	1.44	.04	1.41	.04	1.35	.04	1.28	.05	1.23	.05	1.23	.06	1.29	.05
2	Minus_Icc	mA	-4.0	0	-1.57	.04	-1.55	.04	-1.52	.04	-1.48	.04	-1.43	.04	-1.41	.04	-1.34	.04	-1.28	.05	-1.23	.05	-1.22	.06	-1.28	.05
3	VOS_0V	µV	-25.0	25.0	-1.97	7.1	-0.20	8.0	-3.00	12	-2.00	9	-2.00	13	-12.0	11	-18.0	28	80.0	240	-21.0	196	-66.0	202	-27.0	123
4	P_IIB_0V	nA	-2.0	2.0	1.38	.07	1.79	.41	2.26	.76	3.09	.50	4.06	.85	6.13	.98	12.6	2.1	27.4	4.0	42.6	3.8	56.4	8.3	35.7	4.1
5	N_IIB_0V	nA	-2.0	2.0	1.43	.09	1.77	.22	2.19	.40	3.05	.29	4.11	.53	6.06	.83	12.6	1.9	27.3	3.5	42.0	3.3	55.4	8.2	35.3	4.0
6	IIOS_0V	nA	-2.0	2.0	-0.05	.06	0.02	.20	0.06	.37	0.04	.23	-0.06	.39	0.07	.30	-0.05	.61	0.08	.94	0.55	.96	0.98	1.2	0.48	.73
7	CMRR	dB	110.0	-	135	2.1	135	2.5	135	2.1	138	11	143	13	137	4.9	130	8.6	/3		116	8.0	113	6.7	119	7.1
8	Plus_PSRR	µV/V	-10.0	10.0	-0.24	.11	-0.24	.12	-0.22	.12	-0.26	.15	-0.33	.16	-0.32	.19	-0.57	.39	-0.98	1.1	-1.28	.97	-1.23	.99	-0.94	.79
9	Minus_PSRR	µV/V	-10.0	10.0	0.59	.11	0.59	.13	0.60	.13	0.66	.22	0.77	.22	0.69	.30	0.90	.85	2.95	6.2	2.12	5.1	0.24	2.7	1.35	3.1
10	+/-_PSRR	µV/V	-10.0	10.0	-0.60	.17	-0.60	.19	-0.61	.20	-0.68	.25	-0.83	.26	-0.79	.35	-1.15	.85	-3.31	4.4	-2.54	3.7	-1.97	3.8	-1.81	2.5
11	P_VOUT_600	V	10.0	-	11.5	.01	11.5	.01	11.5	.01	11.5	.01	11.5	.01	11.5	.01	11.5	.01	11.5	.01	11.4	.25	11.1	.46	11.5	.06
12	P_VOUT_2K	V	12.0	-	14.0	.01	14.0	0	14.0	0	14.0	.01	14.0	0	14.0	0	14.0	0	14.0	.01	14.0	.01	14.0	.01	14.0	.01
13	N_VOUT_600	V	-	-10.0	-11.2	.02	-11.2	.02	-11.2	.02	-11.2	.02	-11.3	.02	-11.3	.02	-11.3	.02	-11.3	.02	-11.3	.02	-11.3	.03	-11.3	.02
14	N_VOUT_2K	V	-	-12.0	-13.0	.04	-13.0	.03	-12.9	.02	-12.9	.03	-12.9	.02	-12.8	.02	-12.8	.02	-12.7	.03	-12.7	.02	-12.7	.03	-12.7	.03
15	P_AOL /3	V/mV	300.0	-	5003	385	4359	309	3932	179	3434	208	2628	231	2495	159	2285	180	1238	229	1050	456	1305	1062	1590	729
16	N_AOL /3	V/mV	300.0	-	5501	427	4999	527	4748	419	4030	451	2445	796	1755	561	742	194	272	112	174	31	157	39	307	59
17	Plus_ISC	mA	-65.0	-	-27.0	.35	-30.0	.37	-26.7	.38	-26.6	.29	-26.3	.25	-26.3	.33	-25.9	.36	-25.3	.52	-24.9	.70	-24.5	1.1	-25.2	.62
18	Minus_ISC	mA	-	65.0	37.1	.58	37.0	.62	36.4	.69	36.1	.61	35.6	.60	35.5	.76	34.8	.83	33.7	1.1	33.2	.94	32.7	.98	33.2	.90

Notes:

1/ The mean and standard deviation values were calculated over the four biased and two unbiased 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 these tests were performed.

3/ The mean and standard deviation for this parameter at the 50 krad level is calculated for seven samples.

Radiation-sensitive parameters: P_IIB_0V, N_IIB_0V, VOS_0V, P_AOL, N_AOL, IIOS_0V, CMRR and +/-_PSRR.