

UNISYS

DATE: December 22, 1994

PPM-95-109

TO: B. Fafaul/311
FROM: K. Sahu/300.1 *KS*
SUBJECT: Radiation Report on HST/CAL
Part No. TL074
Control No. 11134cc: A. Sharma/311.0
R. Williams/300.1
OFA Library/300.1

A radiation evaluation was performed on TL074 (Quad 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 ⁶⁰Co 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 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krad*. The dose rate was between 0.08 and 1.47 krads/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 irradiated parts passed all electrical tests up to and including the 10 krad level.

At the 15 krad irradiation level, all irradiated parts exceeded the maximum specification limit of ±200.0 pA for P_IIB_AMP1 - 4 and N_IIB_AMP1 - 4 (eight tests total), with readings ranging from 211 to 424 pA. In addition, S/N 66 marginally exceeded the maximum specification limit of ±100.0 pA for IIOS_AMP3, with a reading of 104 pA, and S/N 67 exceeded the maximum specification limit of ±100 pA for IIOS_AMP2 and IIOS_AMP3, with readings of 108 and 130 pA, respectively.

At the 20 krad level, All irradiated parts except S/N 69 exceeded specification limits for all P_IIB and N_IIB tests (S/N 69 passed N_IIB_AMP3 and N_IIB_AMP4), with readings ranging from 218 to 431 pA, and all irradiated parts exceeded specification limits for IIOS_AMP2 and IIOS_AMP3, with readings ranging from 109 to 187 pA.

At the 30 krad level, all irradiated parts exceeded specification limits for all P_IIB and N_IIB tests, with readings ranging from 344 to 950 pA. All irradiated parts except S/N 62 exceeded specification limits for at least one IIOS test, with readings ranging from -368 to 254 pA.

At the 50 krad level, all irradiated parts exceeded specification limits for all P_IIB and N_IIB tests, with readings ranging from 552 to 1006 pA, and all irradiated parts exceeded specification limits for IIOS_AMP2 - 4, with readings ranging from 173 to 408 pA. In addition, S/N 65 and 67 exceeded the maximum specification limit of ±9.00 mV for VOS_AMP_2, with a reading of -10.25 mV.

*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 75 krad level, all parts exceeded specification limits for all P_IIB, N_IIB and IIOS_AMP2 - 4 tests, with readings approximately the same as at the 50 krad level. All irradiated parts read within specification limits for all other parameters.

At the 100 krad level, all parts exceeded specification limits for all P_IIB and N_IIB tests, with readings approximately the same as at the 75 krad level. All irradiated parts read within specification limits for all other parameters.

After annealing for 168 hours at 25°C, no significant recovery was observed.

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

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:	TL074
HST/CAL Part Number:	TL074MWB
HST/CAL Control Number:	11134
Charge Number:	ES56002
Manufacturer:	Texas Instruments
Lot Date Code:	9403
Quantity Tested:	8
Serial Number of Control Sample:	60, 61
Serial Numbers of Radiation Sample:	62, 63, 64, 65, 66, 67, 68, 69
Part Function:	Quad Op Amp
Part Technology:	JFET
Package Style:	14 Pin Flat Pack
Test Equipment:	A540
Test Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for TL074

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	10/25/94
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	10/26/94
POST-2.5 KRAD ELECTRICAL MEASUREMENT	10/27/94
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR)	10/27/94
POST-5 KRAD ELECTRICAL MEASUREMENT	10/28/94
4) 10 KRAD IRRADIATION (0.08 KRADS/HOUR)	10/28/94
POST-10 KRAD ELECTRICAL MEASUREMENT	10/31/94
5) 15 KRAD IRRADIATION (0.29 KRADS/HOUR)	10/31/94
POST-15 KRAD ELECTRICAL MEASUREMENT	11/01/94
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR)	11/01/94
POST-20 KRAD ELECTRICAL MEASUREMENT	11/02/94
7) 30 KRAD IRRADIATION (0.59 KRADS/HOUR)	11/02/94
POST-30 KRAD ELECTRICAL MEASUREMENT	11/03/94
8) 50 KRAD IRRADIATION (0.59 KRADS/HOUR)	11/03/94
POST-50 KRAD ELECTRICAL MEASUREMENT	11/05/94
9) 75 KRAD IRRADIATION (1.47 KRADS/HOUR)	11/07/94
POST-75 KRAD ELECTRICAL MEASUREMENT	11/08/94
10) 100 KRAD IRRADIATION (1.47 KRADS/HOUR)	11/13/94
POST-100 KRAD ELECTRICAL MEASUREMENT	11/14/94
11) 168-HOUR ANNEALING @25°C	11/14/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/21/94
12) 168-HOUR ANNEALING @100°C*	11/21/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	12/01/94

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 TL074

Test Name	Conditions	Limits	
		Min	Max
Plus_ICC	Vout=0V		10.000 mA
Minus_ICC	Vout=0V	-10.000 mA	
VOS	Vout=0V	-9.00 mV	9.00 mV
P_IIB	Vout=0V	-200.00 pA	200.0 pA
N_IIB	Vout=0V	-200.00 pA	200.00 pA
IIOS	Vout=0V	-100.00 pA	100.00 pA
CMRR	Vcm=±11V, Vout=0V	80.0 dB	
+PSRR	+Vcc=(15, 9)V, -Vcc=-15V, Vout=0V	80.0 dB	
-PSRR	-Vcc=(-15, -9)V, +Vcc=15V, Vout=0V	80.0 dB	
PSRR	+Vcc=(15,9)V, -Vcc=(-15, -9)V, Vout=0V	80.0 dB	
AOL	RI=2kΩ, Vout=(10,0)V	35 V/mV	
+VOUT	RI=10kΩ	12.00 V	
-VOUT	RI=10kΩ		-12.00 V/mV

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for TL074 /1

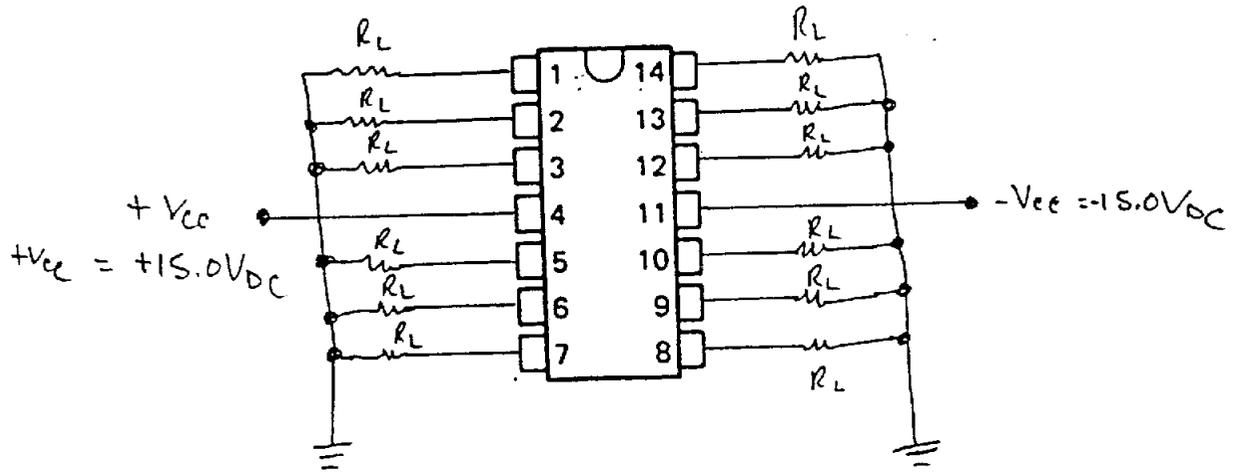
Test #	Parameters	Units	Spec. Lim./2		Total Dose Exposure (krads)										Annealing											
			min	max	2.5		5		10		15		20		30		50		75		100		168 hrs @25°C		168 hrs @100°C	
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	Plus ICC	mA	-10.000	10.000	8.25	.16	8.25	.10	8.24	.11	7.93	.14	7.66	.11	7.55	.10	7.27	.13	6.96	.09	6.93	.13	7.21	.13	7.89	.14
2	Minus ICC	mA	-10.000	10.000	-8.50	.16	-8.23	.10	-8.22	.11	-7.92	.14	-7.65	.11	-7.54	.10	-7.27	.12	-6.95	.09	-6.92	.13	-7.20	.13	-7.88	.14
3	VOS AMP 1	mV	-9.00	9.00	3.05	2.1	0.29	2.1	0.32	2.1	0.33	2.1	0.33	2.0	0.38	2.0	0.39	6.3	0.57	1.9	0.05	2.0	-0.12	2.0	-0.57	2.3
4	VOS AMP 2	mV	-9.00	9.00	0.56	1.9	0.55	1.9	0.44	1.7	0.45	1.6	0.41	1.7	0.45	1.6	0.46	1.6	1.92	5.4	0.57	1.8	1.07	1.9	1.56	1.8
5	VOS AMP 3	mV	-9.00	9.00	-0.83	1.0	-0.85	1.0	-0.73	.99	-0.63	.95	-0.58	.94	-0.53	.94	-0.43	.91	-0.25	.90	-0.30	.90	-0.58	0.89	-1.71	.72
6	VOS AMP 4	mV	-9.00	9.00	0.01	1.6	0.01	1.5	0.02	1.5	0.01	1.5	0.01	1.5	0.01	1.5	0.01	1.5	0.04	1.7	-0.40	1.7	-0.43	1.7	-0.38	1.5
7	F_HIB AMP1	PA	-200.00	200.00	44.7	6.7	66.6	10	94.4	5.1	177	48	335	46	360	30	553	209	919	6.6	851	28	970	8.2	334	34
8	F_HIB AMP2	PA	-200.00	200.00	46.5	5.5	73.1	11	98.6	5.5	185	51	354	48	387	32	563	230	962	6.3	848	29	973	9.3	338	34
9	F_HIB AMP3	PA	-200.00	200.00	45.6	5.2	73.0	12	98.6	5.3	182	52	350	48	384	30	576	173	965	7.2	848	29	969	8.8	334	34
10	F_HIB AMP4	PA	-200.00	200.00	46.1	5.1	74.5	12	101	5.2	185	53	355	50	391	29	743	168	996	7.2	871	28	999	8.3	342	35
11	N_HIB AMP1	PA	-200.00	200.00	45.7	5.2	73.0	12	97.4	5.5	180	51	346	43	379	30	755	151	966	7.3	851	27	970	8.0	333	34
12	N_HIB AMP2	PA	-200.00	200.00	45.4	26	20.5	17	68.3	9.9	162	43	283	39	260	37	610	91	630	1.3	597	21	597	21	597	21
13	N_HIB AMP3	PA	-200.00	200.00	45.6	30	31.1	20	62.3	11	155	43	264	39	233	37	566	91	577	14	552	23	552	23	552	23
14	N_HIB AMP4	PA	-200.00	200.00	49.3	13	49.1	9.9	83.8	5.6	167	44	305	43	313	30	661	136	815	8.5	794	11	867	27	984	7.1
15	IOS AMP1	PA	-100.00	100.00	-0.95	3.6	-6.39	3.1	-2.81	1.5	-3.24	4.4	-10.9	3.0	-18.2	2.6	-20.2	150	-46.8	2.4	-45.5	3.3	-0.22	2.0	0.55	1.6
16	IOS AMP2	PA	-100.00	100.00	18.1	23	52.6	20	31.2	10	22.8	26	71.6	19	127	16	-47.1	183	332	13	326	25	-8.90	2.1	-7.86	1.2
17	IOS AMP3	PA	-100.00	100.00	19.9	28	61.9	24	36.4	12	27.4	32	86.4	23	152	19	110	91	388	15	375	30	-26.1	1.2	-21.4	1.0
18	IOS AMP4	PA	-100.00	100.00	6.74	11	25.4	9.9	16.8	4.8	18.0	14	50.0	11	77.8	7.2	82.3	36	181	5.7	167	12	4.06	1.8	14.8	1.4
19	CMRR AMP1	dB	80.0	80.0	121	7.5	122	5.5	121	6.3	122	7.2	123	8.3	122	5.6	98.5	19	122	4.5	122	3.9	122	3.7	122	3.7
20	CMRR AMP2	dB	80.0	80.0	132	15	136	7.0	137	7.7	130	8.8	136	19	129	8.9	128	5.7	115	18	128	4.8	128	11	129	12
21	CMRR AMP3	dB	80.0	80.0	120	3.8	121	3.5	121	2.9	123	3.7	123	4.0	123	4.0	124	4.4	127	6.7	128	9.0	128	7.3	124	4.0
22	CMRR AMP4	dB	80.0	80.0	126	6.6	127	7.2	128	12	127	7.3	127	6.2	128	12	130	12	128	8.2	108	6.5	127	7.7	128	9.0
23	+PSRR AMP1	dB	80.0	80.0	114	15	132	13	113	12	113	15	110	11	110	11	107	6.2	108	7.1	108	9.9	105	6.5	107	7.5
24	+PSRR AMP2	dB	80.0	80.0	109	7.9	110	10	112	12	110	9.6	108	6.9	108	7.3	107	6.2	108	8.7	99.4	4.0	107	7.1	108	8.4
25	+PSRR AMP3	dB	80.0	80.0	105	8.3	105	8.0	105	8.2	104	7.9	103	6.6	102	5.7	102	5.5	100	4.4	107	11	99.3	3.7	100	4.5
26	+PSRR AMP4	dB	80.0	80.0	108	10	113	24	108	9.5	107	9.3	109	15	108	13	108	14	107	12	107	11	107	13	108	13
27	-PSRR AMP1	dB	80.0	80.0	96.7	12	100	11	100	21	96.0	8.3	95.7	6.6	95.9	6.2	93	101	98.2	7.6	101	11	102	13	99.7	9.0
28	-PSRR AMP2	dB	80.0	80.0	96.8	7.1	96.0	6.4	96.2	6.9	96.0	5.4	95.9	4.6	96.1	4.3	97.2	5.3	98.3	6.3	100	11	104	20	99.4	9.8
29	-PSRR AMP3	dB	80.0	80.0	98.8	14	97.6	9.3	97.6	9.4	97.3	20	99.6	13	97.8	8.5	97.3	7.2	97.3	7.2	98.4	9.5	101	15	97.6	7.3
30	-PSRR AMP4	dB	80.0	80.0	108	14	107	11	107	10	112	20	108	12	106	7.7	105	7.9	105	10	105	9.9	103	7.6	104	9.6
31	FSRR AMP1	dB	80.0	80.0	101	4.6	101	4.9	101	4.8	102	6.5	104	8.6	106	12	105	8.3	105	8.4	108	15	105	7.0	109	9.3
32	FSRR AMP2	dB	80.0	80.0	102	5.2	102	4.6	103	4.8	103	3.9	103	3.9	104	4.6	106	7.1	109	11	113	14	112	18	108	10
33	FSRR AMP3	dB	80.0	80.0	103	8.1	103	7.0	103	7.1	103	7.0	103	8.5	105	12	104	9.8	106	13	104	11	104	11	105	11
34	FSRR AMP4	dB	80.0	80.0	116	15	120	19	118	17	114	11	112	9.0	112	10	110	7.3	108	8.7	106	6.7	108	9.3	108	8.1
35	AOL AMP1	V/mV	35.00	35.00	354	21	392	6.9	280	9.3	198	8.1	153	7.7	128	5.3	93	7.4	62.7	3.1	52.5	3.7	52.0	4.8	64.4	6.8
36	AOL AMP2	V/mV	35.00	35.00	342	13	485	13	275	11	190	9.1	148	11	124	9.4	93.5	7.4	62.7	2.8	53.6	1.4	51.3	2.8	61.2	5.1
37	AOL AMP3	V/mV	35.00	35.00	198	5.1	181	6.5	175	5.9	139	6.8	114	6.4	98.1	5.9	98.8	2.3	55.4	2.6	47.7	2.3	47.4	3.2	57.6	4.5
38	AOL AMP4	V/mV	35.00	35.00	197	11	175	8.8	171	9.4	134	8.8	111	8.2	95.0	7.5	78.2	5.8	53.4	3.6	45.5	2.3	45.2	2.5	53.9	3.8
39	+VOUT AMP1	V	12.00	12.00	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	0.29	15	13.9	0	13.9	0	13.9	0	13.9	0
40	+VOUT AMP2	V	12.00	12.00	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	0.29	15	13.9	0	13.9	0	13.9	0	13.9	0
41	+VOUT AMP3	V	12.00	12.00	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	0.29	15	13.9	0	13.9	0	13.9	0	13.9	0
42	+VOUT AMP4	V	12.00	12.00	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	13.9	0	0.29	15	13.9	0	13.9	0	13.9	0	13.9	0
43	-VOUT AMP1	V	-12.00	-12.00	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.07	-13.2	0	-13.2	.01	-13.2	.01	-13.2	.01
44	-VOUT AMP2	V	-12.00	-12.00	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.07	-13.2	0	-13.2	.01	-13.2	.01	-13.2	.01
45	-VOUT AMP3	V	-12.00	-12.00	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.07	-13.2	0	-13.2	.01	-13.2	.01	-13.2	.01
46	-VOUT AMP4	V	-12.00	-12.00	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.01	-13.2	.07	-13.2	0	-13.2	.01	-13.2	.01	-13.2	.01

Notes:

- 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 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/ No reliable readings could be obtained at this level.

Radiation-sensitive parameters: P_IIB, N_IIB, IOS and VOL.

Figure 1. Radiation Bias Circuit for TL074



$R_L = 10\text{ k}\Omega, \frac{1}{2}W$