Government Systems Group

CAREPORTS\267.DOC

Unisys Corporation
4700 Boston Way
Lanham MD 20706

Telephone
301 731 8600

UNISYS

DATE: July 7, 1995 PPM-95-160
TO: J. Lohr/311
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on: LM158
Project: CASSINI/CIRS
Control #: 11817
Job #: EE56326
Project part #: LM158

cc: B. Posey/300.1
A. Sharma/311
OFA Library/300.1

A radiation evaluation was performed on LM158 (Dual 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 Co^{60} 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, 75 and 100 krads*. The dose rate was between 0.08 and 1.47 krads/hour (see Table II for radiation schedule). After the 100 krad exposure, 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 step, 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 throughout all irradiation steps up to and including the 30 krad irradiation level.

After the 50 krad irradiation, S/N 59 fell below the minimum specification limit of -50.00 nA for P_IIB_AMP1, P_IIB_AMP2, N_IIB_AMP1 and N_IID_AMP2, with readings of -57.90, -58.21, -57.02 and -57.24 nA, respectively. All other irradiated parts continued to pass all electrical tests at this level.

After the 75 krad irradiation, all irradiated parts exceeded specification limits for the same tests, with readings ranging from -51.68 to -62.32 nA.

After the 100 krad irradiation, degradation in the same parameters continued to be observed, with readings ranging from -57.13 to -67.91 nA. In addition, S/N 56 and 59 marginally fell below the minimum specification limit of -2.00 mV for VOS_A1 Vcm=28, with readings of -2.01 and -2.05 mV, respectively.

After annealing for 168 hours at 25°C, no 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 each irradiation exposure 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.

* 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.

ADVISORY ON THE USE OF THIS DOCUMENT

The information contained in this document has been developed solely for the purpose of providing general guidance to employees of the Goddard Space Flight Center (GSFC). This document may be distributed outside GSFC only as a courtesy to other government agencies and contractors. Any distribution of this document, or application or use of the information contained herein, is expressly conditional upon, and is subject to, the following understandings and limitations:

(a) The information was developed for general guidance only and is subject to change at any time;

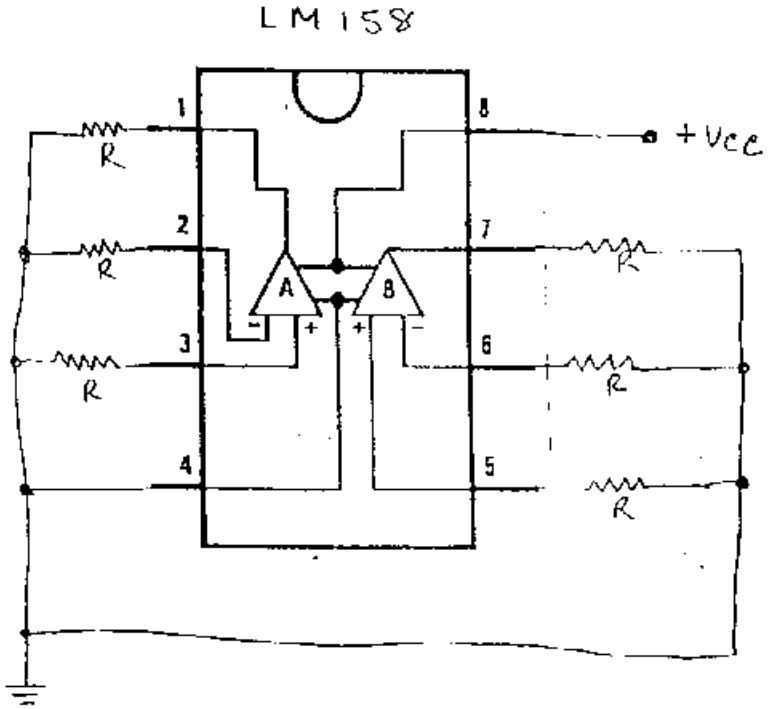
(b) The information was developed under unique GSFC laboratory conditions which may differ substantially from outside conditions;

(c) GSFC does not warrant the accuracy of the information when applied or used under other than unique GSFC laboratory conditions;

(d) The information should not be construed as a representation of product performance by either GSFC or the manufacturer;

(e) Neither the United States government nor any person acting on behalf of the United States government assumes any liability resulting from the application or use of the information.

Figure 1. Radiation Bias Circuit for LM158



BIAS CONDITIONS:

R = 10KΩ @ ½ W

+Vcc = 30VDC ± 0.5V ad

T_A = 100°C

TABLE I. Part Information

Generic Part Number:	LM158*
CASSINI/CIRS Part Number	LM158
CASSINI/CIRS Control Number:	11817
Charge Number:	EE56326
Manufacturer:	NSI
Lot Date Code (LDC):	9433A
Quantity Tested:	5
Serial Number of Control Sample:	55
Serial Numbers of Radiation Samples:	56, 57, 58, 59
Part Function:	Dual Op Amp
Part Technology:	Bipolar
Package Style:	8-pin DIP
Test Equipment:	A540
Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for LM158

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	04/25/95
2) 2.5 KRAD IRRADIATION (0.15 KRADS/HOUR)	04/25/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	04/26/95
3) 5.0 KRAD IRRADIATION (0.15 KRADS/HOUR)	04/26/95
POST-5.0 KRAD ELECTRICAL MEASUREMENT	04/27/95
4) 10.0 KRAD IRRADIATION (0.29 KRADS/HOUR)	04/27/95
POST-10.0 KRAD ELECTRICAL MEASUREMENT	04/28/95
5) 15.0 KRAD IRRADIATION (0.77 KRADS/HOUR)	04/28/95
POST-15.0 KRAD ELECTRICAL MEASUREMENT	05/01/95
6) 20 KRAD IRRADIATION (0.29 KRADS/HOUR)	05/01/95
POST-20 KRAD ELECTRICAL MEASUREMENT	05/02/95
7) 30 KRAD IRRADIATION (0.59 KRADS/HOUR)	05/02/95
POST-30 KRAD ELECTRICAL MEASUREMENT	05/03/95
8) 50 KRAD IRRADIATION (1.18 KRADS/HOUR)	05/03/95
POST-50 KRAD ELECTRICAL MEASUREMENT	05/04/95
9) 75 KRAD IRRADIATION (1.47 KRADS/HOUR)	05/04/95
POST-75 KRAD ELECTRICAL MEASUREMENT	05/05/95
10) 100 KRAD IRRADIATION (0.39 KRADS/HOUR)	05/05/95
POST-100 KRAD ELECTRICAL MEASUREMENT	05/08/95
11) 168-HOUR ANNEALING @ 25°C	05/08/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/15/95
12) 168-HOUR ANNEALING @ 100°C	05/15/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/24/95

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

Table III. Electrical Characteristics of LM158

Unless Otherwise Specified: T_A =25°C, -Vcc = 0V

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
ICC_5V	Icc	+Vcc = 5V, V_{OUT} = 1.4V, R_L = 10KΩ (Note: 1)		1.2mA
ICC_30V	Icc	+Vcc = 30V, V_{OUT} = 1.4V, R_L = 10KΩ (Note: 1)		3.0mA
VOS_AMP1_30V	V_{IO}	+Vcc = 30V, V_{OUT} = 1.4V, Vcm = 0V	-2.0mV	2.0mV
VOS_AMP2_30V	V_{IO}	+Vcc = 30V, V_{OUT} = 1.4V, Vcm = 0V	-2.0mV	2.0mV
VOS_A1_Vcm30V	V_{IO}	+Vcc = 30V, V_{OUT} = 1.4V, Vcm = 30V	-2.0mV	2.0mV
VOS_A2_Vcm30V	V_{IO}	+Vcc = 30V, V_{OUT} = 1.4V, Vcm = 30V	-2.0mV	2.0mV
VOS_AMP1_5V	V_{IO}	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-2.0mV	2.0mV
VOS_AMP2_5V	V_{IO}	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-2.0mV	2.0mV
P_IIB_AMP2	$+I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-50.0nA	-1.0nA
P_IIB_AMP2	$+I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-50.0nA	-1.0nA
N_IIB_AMP2	$-I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-50.0nA	-1.0nA
N_IIB_AMP2	$-I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-50.0nA	-1.0nA
IIOS_AMP1	I_{IO}	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-10.0nA	10.0nA
IIOS_AMP2	I_{IO}	+Vcc = 5V, V_{OUT} = 1.4V, Vcm = 0V	-10.0nA	10.0nA
CMRR_AMP1	CMRR	+Vcc = 30V, V_{OUT} = 1.4V, Vin = (0,28)V	70dB	
CMRR_AMP2	CMRR	+Vcc = 30V, V_{OUT} = 1.4V, Vin = (0,28)V	70dB	
+PSRR_AMP1	PSRR	+Vcc = (5,30)V, V_{OUT} = 1.4V, Vcm = 0V	65dB	
+PSRR_AMP2	PSRR	+Vcc = (5,30)V, V_{OUT} = 1.4V, Vcm = 0V	65dB	
AOL_AMP1	A_{VS}	+Vcc = 15V, R_L = 2KΩ, V_{OUT} = (1,11)V	50V/mV	
AOL_AMP2	A_{VS}	+Vcc = 15V, R_L = 2KΩ, V_{OUT} = (1,11)V	50V/mV	
VOH_AMP1	V_{OH}	+Vcc = 30V, R_L = 2KΩ	26V	
VOH_AMP1	V_{OH}	+Vcc = 30V, R_L = 2KΩ	26V	
VOL_AMP1	V_{OL}	+Vcc = 30V, R_L = 10KΩ		40.0mV
VOL_AMP2	V_{OL}	+Vcc = 30V, R_L = 10KΩ		40.0mV
VOL_AMP1 @1uA	V_{OL}	+Vcc = 30V, Isink = 1uA		40.0mV
VOL_AMP2 @1uA	V_{OL}	+Vcc = 30V, Isink = 1uA		40.0mV
I_{SINK} A1 @ .2V	I_{SINK}	+Vcc = 15V, V_{OUT} = 0.2V (Note: 2)	12.0uA	
I_{SINK} A2 @ .2V	I_{SINK}	+Vcc = 15V, V_{OUT} = 0.2V (Note: 2)	12.0uA	
I_{SINK} A1 @ 2V	I_{SINK}	+Vcc = 15V, V_{OUT} = 2V (Note: 3)	10.0mA	
I_{SINK} A2 @ 2V	I_{SINK}	+Vcc = 15V, V_{OUT} = 2V (Note: 3)	10.0mA	
I_{SOURCE} A1 @ 2V	I_{SOURCE}	+Vcc = 15V, V_{OUT} = 2V (Note: 3)		-20.0mA
I_{SOURCE} A2 @ 2V	I_{SOURCE}	+Vcc = 15V, V_{OUT} = 2V (Note: 3)		-20.0mA

Notes: Tests Not Performed - Short Circuit Current and Differential Input Voltage.

1. R_L = 10KΩ is substituted for R_L = 100KΩ in the Icc test.
2. For the I_{SINK} test Vout is driven towards 0V while the Output is held at 0.2V and 2.0V.
3. For the I_{SOURCE} Test Vout is driven towards 15V while the Output is held at 2.0V.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LM158 /1

Test #	Parameters	Units	Spec Limits 2/ min	Spec Limits 2/ max	Initial mean	Initial sd	Total Dose Exposure (krads) 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	168 hrs@25°C sd	168 hrs@100°C mean	168 hrs@100°C sd
1	ICC_5V	mA	-	1.20	0.92	.01	0.91	.01	0.91	.01	0.91	.01	0.91	.01	0.91	.01	0.93	.01	0.91	.01	1.02	.07	1.05	.10	1.03	.11	0.93	.03
2	ICC_30V	mA	-	1.20	1.39	.02	1.38	.03	1.38	.03	1.37	.03	1.37	.03	1.37	.03	1.40	.03	1.38	.03	1.49	.09	1.51	.11	1.49	.12	1.39	.04
3	VOS_AMP1_30V	mV	-2.00	2.00	0.62	.50	0.33	.04	0.58	.52	0.54	.52	0.54	.51	0.51	.50	0.40	.55	0.24	.57	0.15	.59	0.06	.60	0.06	.61	0.13	.63
4	VOS_AMP2_30V	mV	-2.00	2.00	0.90	.41	0.84	.49	0.85	.40	0.81	.39	0.78	.38	0.75	.39	0.68	.38	0.48	.34	0.43	.36	0.34	.34	0.34	.34	0.39	.33
5	VOS_A1 Vcm=28	mV	-2.00	2.00	-1.05	.53	-1.04	.03	-1.08	.54	-1.12	.55	-1.13	.54	-1.15	.54	-1.26	.58	-1.45	.60	-1.55	.63	-1.64	.64	-1.65	.65	-1.61	.68
6	VOS_A2 Vcm=28	mV	-2.00	2.00	-0.69	.39	-0.71	.47	-0.73	.39	-0.76	.37	-0.88	.29	-0.90	.29	-0.90	.35	-1.14	.31	-1.18	.34	-1.28	.31	-1.29	.30	-1.29	.28
7	VOS_AMP1_5V	mV	-2.00	2.00	0.61	.48	0.33	.02	0.57	.50	0.52	.51	0.53	.49	0.50	.48	0.38	.53	0.21	.56	0.11	.58	0.01	.60	0.02	.60	0.09	.63
8	VOS_AMP2_5V	mV	-2.00	2.00	0.84	.38	0.78	.46	0.79	.38	0.75	.37	0.70	.35	0.68	.36	0.61	.35	0.40	.31	0.34	.34	0.25	.32	0.25	.31	0.29	.31
9	P_IIB_AMP1	nA	-50.0	-1.00	-20.0	3.3	-30.0	4.3	-30.0	3.7	-30.0	3.7	-30.0	2.6	-30.0	3.9	-40.0	4.0	-51.1	4.6	-2.17	4.3	2.23	4.5	-60.0	5.0	-60.0	5.4
10	P_IIB_AMP2	nA	-50.0	-1.00	-24.0	3.1	-26.9	4.1	-28.3	3.6	-31.7	3.5	-31.6	2.6	-33.6	4.0	-41.9	3.9	-51.6	4.4	-56.1	4.2	-61.5	4.3	-62.0	4.8	-60.0	5.3
11	N_IIB_AMP1	nA	-50.0	-1.00	-24.0	3.2	-26.3	4.1	-27.7	3.6	-31.1	3.6	-31.0	2.5	-32.9	3.8	-41.0	3.9	-50.4	4.4	-54.9	4.2	-60.2	4.3	-60.7	4.8	-58.7	5.2
12	N_IIB_AMP2	nA	-50.0	-1.00	-24.2	3.3	-26.4	4.3	-27.5	3.8	-31.2	3.7	-31.0	2.5	-32.9	3.8	-41.0	4.0	-50.4	4.6	-54.5	4.3	-60.2	4.4	-60.7	4.9	-58.4	5.4
13	IIOS_AMP1	nA	-10.0	10.0	-0.20	.12	-0.36	.21	-0.56	.17	-0.38	.17	-0.34	.09	-0.42	.11	-0.50	.12	-0.48	.71	-0.69	.19	-0.70	.22	-0.68	.23	-0.62	.24
14	IIOS_AMP2	nA	-10.0	10.0	0.23	.23	-0.32	.23	-0.85	.19	-0.51	.20	-0.63	.14	-0.71	.19	-0.85	.14	-1.23	.21	-1.26	.19	-1.38	.15	-1.38	.13	-1.53	.21
15	CMRR_AMP1	dB	70.0	-	136	5.6	146	2.4	135	5.0	140	7.2	136	5.6	136	6.2	137	5.5	153	18	149	13	141	8.4	141	7.3	143	9.2
16	CMRR_AMP2	dB	70.0	-	133	5.3	131	4.3	134	6.2	132	4.2	133	5.0	133	5.7	136	9.7	137	7.1	149	26	144	7.8	139	5.4	140	9.6
17	+PSRR_AMP1	dB	65.0	-	164	7.8	164	15	174	17	159	5.8	168	4.1	162	6.3	157	3.8	163	14	163	16	161	8.1	161	9.0	157	11
18	+PSRR_AMP2	dB	65.0	-	160	5.0	167	3.5	161	3.2	167	12	161	5.3	154	5.1	158	5.3	170	18	155	2.1	153	3.2	156	3.8	157	6.3
19	AOL_AMP1	V/mV	50.0	-	292	18	291	25	283	19	289	19	287	15	288	16	286	19	278	16	264	19	247	28	246	23	261	10
20	AOL_AMP2	V/mV	50.0	-	224	9.9	219	14	220	10	223	12	231	23	235	23	219	11	215	11	202	16	201	25	201	26	207	13
21	VOH_AMP1	V	26.0	-	28.2	.01	28.2	.01	28.2	.01	28.2	.01	28.2	.02	28.2	.02	28.2	.01	28.2	.01	28.2	.01	28.2	.02	28.2	.01	28.2	.01
22	VOH_AMP2	V	26.0	-	28.2	.01	28.2	.01	28.2	.01	28.2	.01	28.2	.02	28.2	.02	28.2	.01	28.2	.02	28.2	.01	28.2	.01	28.2	.02	28.2	.01
23	VOL_AMP1	mV	-	40.0	0.06	.02	-0.13	.03	0.48	.02	-0.03	.01	0.13	.01	0.53	.90	0.17	.02	0.48	.01	0.18	.01	0.32	.13	0.43	.15	0.76	.01
24	VOL_AMP2	mV	-	40.0	1.02	.01	0.92	.02	1.29	.03	0.93	.01	1.07	.02	1.27	.51	1.12	.04	1.30	.01	1.07	.02	1.12	.03	1.21	.03	1.42	.02
25	VOL_AMP1@1µA	mV	-	40.0	7.91	.97	8.26	1.0	8.11	1.0	8.32	1.0	8.36	1.0	9.07	2.0	8.03	1.0	8.22	1.0	8.03	1.7	8.35	2.0	8.46	1.8	8.89	1.6
26	VOL_AMP2@1µA	mV	-	40.0	7.96	.95	8.29	.99	8.15	1.0	8.35	.97	8.35	.95	9.03	1.8	8.02	.99	8.25	.99	7.80	.98	7.83	.89	8.12	.80	8.66	1.1
27	Isink_A1@0.2V	µA	12.0	-	86.0	4.0	84.0	4.0	84.0	4.0	83.0	4.0	83.0	4.0	84.0	4.0	91.0	4.0	86.2	4.0	90.0	12	88.0	14	88.0	14	85.0	10
28	Isink_A2@0.2V	µA	12.0	-	86.0	3.0	83.0	3.0	84.0	3.0	83.0	3.0	84.0	3.0	84.0	3.0	91.0	4.0	86.3	3.5	98.0	2.0	97.0	7.0	96.0	7.0	89.0	5.0
29	Isink_A1@2.0V	mA	10.0	-	21.1	.83	20.8	.95	20.8	.85	20.7	.91	20.7	.83	20.5	.90	20.4	.97	20.2	.99	19.9	1.0	19.7	1.2	19.7	1.0	19.8	1.1
30	Isink_A1@2.0V	mA	10.0	-	20.9	.84	20.5	.95	20.6	8.5	20.4	.90	20.4	.83	20.3	.90	20.1	.98	20.0	.99	19.6	1.1	19.4	1.1	19.3	1.1	19.6	.99
31	Isrc_A1@2.0V	mA	-	-20.0	-47.8	.50	-47.9	.48	-47.5	.43	-47.8	.48	-47.3	.30	-47.3	.26	-47.5	.42	-47.3	.40	-47.2	.43	-47.4	.48	-47.3	.46	-46.9	.52
32	Isrc_A2@2.0V	mA	-	-20.0	-46.8	.50	-46.9	.53	-46.4	.50	-46.7	.50	-46.5	.46	-46.5	.52	-46.5	.48	-46.3	.45	-46.2	.48	-46.3	.49	-46.3	.50	-45.9	.47

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 these tests were performed.

Radiation-sensitive parameters: P_IIB_AMP1, P_IIB_AMP2, N_IIB_AMP1, N_IIB_AMP2 and VOS_A1 Vcm=28.