Government Systems Group

Unisys Corporation
4700 Boston Way
Lanham MD 20706

Telephone
301 731 8600

UNISYS

DATE: April 12, 1994
TO: J. Lohr/311.1
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on Cassini/GCMS
Part No. LM139
Control No. 10456

PPM-94-008

cc: A. Sharma/311
L. Frost/915.3
Library/300.1

A radiation evaluation was performed on LM139 (Quad Voltage Comparator) 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 and 56 krads*. The dose rate was between 0.05 and 0.45 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 56 krad irradiation, the parts were annealed for 168 hours at 25°C, after which the parts were annealed for 168 hours at 100°C. 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. At the 5 krad irradiation level, two parts (S/N 6 and 8) exceeded the lower specification limit of -100 nA for P_IIB_5V, N_IIB_5V, P_IIB_30V and N_IIB_30V, with readings ranging from -102 to -110 nA. At the 10 krad level, all eight irradiated parts exceeded the lower specification limit for these parameters, with readings ranging from -155 to -263 nA. The same failures continued at the 15 krad level, with readings ranging from -234 to -400 nA, and at the 20 krad level, with readings ranging from -315 to -535 nA. In addition, at the 20 krad level, one section of one part (S/N 6) failed to meet the minimum specification limit for 6.00 mA for I_SINK, with a reading of 5.75 mA.

At the 30 krad level, all eight irradiated parts continued to exceed the lower specification limit for P_IIB_5V, N_IIB_5V, P_IIB_30V and N_IIB_30V, with readings ranging from -457 to -754 nA. At least one section of all eight irradiated parts also failed to meet the minimum specification limit for I_SINK, with readings ranging from 4.39 to 5.93 mA, and at least one section of all eight irradiated parts also failed to meet the minimum specification limit of 50 V/mV for AOL, with readings ranging from 35 to 49 V/mV.

At the 50 krad level, all eight irradiated parts exceeded the maximum specification limit of 400 mV for V_SAT, with readings ranging from 660.4 to 1000.4 mV. These failures indicate functional failures of the part. The failures observed in P_IIB_5V, N_IIB_5V, P_IIB_30V and N_IIB_30V continued, with readings about twice the values at the 30 krad level. Also, all sections of all eight irradiated parts failed to meet the minimum specification limits for AOL and I_SINK, with readings ranging from 16 to 30 V/mV, and 2.9 to 4.1

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
**These are manufacturer's non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

mA. In addition, at least one section of two parts (S/N 3 and 7) exceeded the specification range of ±25.00 nA for both IIOS_5V and IIOS_30V and one section of one part (S/N 10) exceeded the specification range for IIOS_30V. Absolute values of readings ranged from 27.04 to 38.99 nA. After 56 krads irradiation, no significant changes were observed.

After annealing for 168 hours at 25°C, no significant changes were observed in any parameter. After annealing for 168 hours at 100°C, no rebound effects were observed.

Table IV provides the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps. Mean and standard deviation values for all parameters except Icc_5V and Icc_30V are given only for section 3 of the parts since, in general, this was the worst case. Values for other sections are available on request.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

TABLE I. Part Information

Generic Part Number:	LM139
Cassini/GCMS Part Number:	LM139*
Cassini/GCMS Control Number:	10456
Charge Number:	C42946
Manufacturer:	National Semiconductor
Lot Date Code:	9313
Quantity Tested:	10
Serial Number of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	3, 4, 5, 6, 7, 8, 9, 10
Part Function:	Quad Voltage Comparator
Part Technology:	Bipolar
Package Style:	14-pin DIP
Test Equipment:	A540
Test Engineer:	T. Mondy

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

TABLE II. Radiation Schedule for LM139

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	03/07/94
2) 5 KRAD IRRADIATION (0.12 KRADS/HOUR)	03/08/94
POST-5 KRAD ELECTRICAL MEASUREMENT	03/10/94
3) 10 KRAD IRRADIATION (0.05 KRADS/HOUR)	03/11/94
POST-10 KRAD ELECTRICAL MEASUREMENT	03/14/94
4) 15 KRAD IRRADIATION (0.11 KRADS/HOUR)	03/14/94
POST-15 KRAD ELECTRICAL MEASUREMENT	03/16/94
5) 20 KRAD IRRADIATION (0.11 KRADS/HOUR)	03/16/94
POST-20 KRAD ELECTRICAL MEASUREMENT	03/18/94
6) 30 KRAD IRRADIATION (0.15 KRADS/HOUR)	03/18/94
POST-30 KRAD ELECTRICAL MEASUREMENT	03/21/94
7) 50 KRAD IRRADIATION (0.45 KRADS/HOUR)	03/21/94
POST-50 KRAD ELECTRICAL MEASUREMENT	03/24/94
8) 56 KRAD IRRADIATION (0.27 KRADS/HOUR)	03/25/94
POST-56 KRAD ELECTRICAL MEASUREMENT	03/28/94
9) 168-HOUR ANNEALING @25°C	03/28/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	04/04/94
10) 168-HOUR ANNEALING @100°C*	04/04/94
POST-168 HOUR ELECTRICAL MEASUREMENT	04/11/94

*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-8830, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of LM139

Unless Otherwise Specified: T_A =25°C

TEST NAME	SYMBOL	CONDITIONS	LIMITS	
			MIN	MAX
		SUPPLY CURRENT		
5V	Icc	+Vcc = 5V, V_{OUT} = 0V	0.000mA	3.000mA
30V	Icc	+Vcc = 30V, V_{OUT} = 0V	0.000mA	3.000mA
		INPUT OFFSET TESTS		
VOS_5V	V_{IO}	+Vcc = 5V, V_{OUT} = 1.4V	-5.00mV	5.00mV
VOS_30V	V_{IO}	+Vcc = 30V, V_{OUT} = 15V (Note: 1)	-5.00mV	5.00mV
PSRR	PSRR	+Vcc = (5V, 30V), V_{OUT} = 1.4V	70dB	
P_IIB_5V	$+I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V (Note: 1)	-100.00nA	-1.000nA
N_IIB_5V	$-I_{IB}$	+Vcc = 5V, V_{OUT} = 1.4V (Note: 1)	-100.00nA	-1.000nA
IIOS_5V	I_{IO}	+Vcc = 5V, V_{OUT} = 1.4V (Note: 1)	-25.00nA	25.00nA
P_IIB_30V	$+I_{IB}$	+Vcc = 30V, V_{OUT} = 15V (Note: 1)	-100.00nA	-1.000nA
N_IIB_30V	$-I_{IB}$	+Vcc = 30V, V_{OUT} = 15V (Note: 1)	-100.00nA	-1.000nA
IIOS_30V	I_{IO}	+Vcc = 30V, V_{OUT} = 15V (Note: 1)	-25.00nA	25.00nA
AOL		+Vcc = 5V, V_{OUT} = (11V, 1V)	50 V/mV	
I_SINK		+Vcc = 5V, V_{OUT} = 1.5V (Note: 2)	6.00mA	
V_SAT		+Vcc = 5V, I_{OUT} = 4.0mA (Note: 2)		400.0mV
I_LEAK		+Vcc = 30V, V_{OUT} = 30V		0.500uA

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LM139 /1

				Total Dose Exposure (krads)														Annealing			
		Spec. Lim. /3		Initial		5		10		15		20		30		50		56		168 hrs @25øC		168 hrs @100øC	
Parameters /2		min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Icc_5V	mA	0	3.0	0.86	.01	0.73	.02	0.60	.02	0.50	.02	0.36	.02	0.50	.02	0.42	.02	0.43	.01	0.44	.01	0.57	.01
Icc_30V	mA	0	3.0	0.92	.02	0.89	.02	0.81	.02	0.76	.02	0.71	.02	0.64	.02	0.55	.02	0.56	.02	0.57	.02	0.73	.02
VOS_5V	mV	-5.0	5.0	0.78	.30	0.81	.34	0.82	.39	0.54	.42	0.86	.43	0.89	.44	1.04	.47	0.97	.40	0.94	.38	0.50	.37
VOS_30V	mV	-5.0	5.0	0.73	.35	0.71	.39	0.70	.43	0.70	.47	0.75	.46	0.66	.46	0.65	.49	0.56	.42	0.58	.40	0.40	.28
PSRR	dB	70		113	5.8	114	13	106	4.2	102	2.9	99.4	2.3	95.2	1.9	89.3	1.5	89.7	1.4	90.6	1.4	98.3	1.9
P_IIB_5V	nA	-100	-1.0	-13.8	.43	-61.6	13	-190	32	-286	46	-369	57	-537	66	-762	63	-724	51	-737	46	-506	21
N_IIB_5V	nA	-100	-1.0	-13.7	.42	-64.7	13	-192	32	-288	46	-382	55	-541	65	-771	62	-761	51	-744	46	-507	20
IIOS_5V	nA	-25	25	0.27	.17	3.10	1.5	2.95	2.6	4.26	3.8	5.24	5.2	6.75	7.1	9.92	9.4	8.62	8.3	7.52	7.6	2.44	3.6
P_IIB_30V	nA	-100	-1.0	-14.3	.46	-86.2	14	-207	37	-318	54	-431	68	-624	82	-821	82	-918	67	-869	60	-568	26
N_IIB_30V	nA	-100	-1.0	-14.2	.44	-89.6	14	-209	36	-320	53	-435	66	-631	80	-830	80	-945	66	-896	59	-587	25
IIOS_30V	nA	-25	25	3.32	.18	3.44	1.6	3.53	3.0	4.93	4.3	6.20	6.0	8.17	8.4	8.90	13	10.1	9.3	8.59	8.9	2.81	4.3
AOL	V/mV	50		1201	324	310	22	176	16	118	14	84.4	13	50.8	8.2	24.1	3.9	25.0	3.5	38.5	3.9	85.8	9.2
I_SINK	mA	6.0		11.4	.22	11.5	.27	9.53	.43	8.13	.50	7.02	.53	5.49	.50	3.75	.37	3.83	.33	4.10	.34	7.33	.45
V_SAT	mV		400	217	6.1	224	6.9	236	8.1	245	9.1	256	11	283	18	866	255	692	253	637	332	254	8.2
I_LEAK	µA		0.5	0.06	0	0.10	0	0.07	.03	0.05	0	0.21	0	0.11	.03	0.21	0	0.21	0	0.20	.02	0.10	0

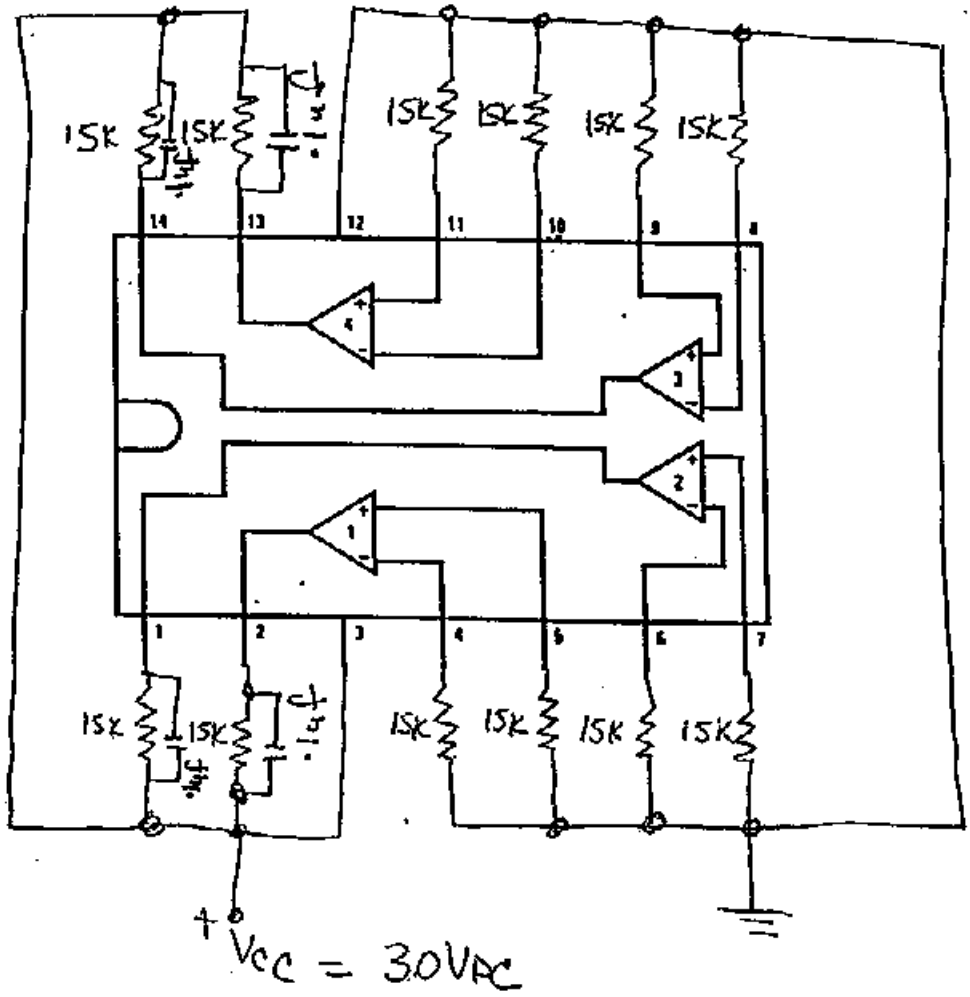
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.

2/ Values for all parameters except Icc_5V and Icc_30V are given only for section 3, which was, in general, the worst case. Values for other sections are available on request. Mean and standard deviation values for VOS and IIOS are computed from absolute values.

3/ These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

Radiation-sensitive parameters were: P_IIB_5V, N_IIB5V, P_IIB_30V, N_IIB_30V, IIOS_5V, IIOS_30V, I_SINK, AOL and V_SAT.

Figure 1. Radiation Bias Circuit for LM139



Conditions:

Vcc = 30.0V±0.5VDC
R = 15kOhms, 1/2W
Ta = 25°C