

UNISYS

DATE: May 16, 1995
 TO: M. Gates/735
 FROM: K. Sahu/300.1 *KS*
 SUBJECT: Radiation Report on: IBM0116400AJ3
 Project: LANDSAT
 Control #: 12327
 Job #: EE56129
 Project part #: TP0116400AJ3B-70

PPM-95-153

A. Sharma/311
 OFA Library/300.1

A radiation evaluation was performed on IBM0116400AJ3 (4M X 4 16Mb DRAM) 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 two parts were used as control samples. The total dose radiation levels were 1.5, 3, 4.5, 6, 9, 12, 15, 20, 30, 50, 75 and 100 krad*. The dose rate was between 0.02 and 1.47 krad/hour (see Table II for radiation schedule). After each radiation exposure and annealing step, parts were electrically tested according to the test conditions and the specification limits** listed in Table III. These tests included six functional tests at 5.0 Mhz, with Vcc = 5.0 V. For details of the functional tests, refer to Table III.

All parts passed all initial functional tests and electrical measurements.

After the 1.5 krad irradiation, S/N 155 exceeded the maximum specification limit of 2.0 mA for ICC7, with a reading of 2.2 mA. All irradiated parts passed all other electrical tests up to and including the 30 krad irradiation.

After the 50 krad irradiation, S/N 152, 154 and 155 exceeded the maximum specification limit of 2.4 V for VIH_MIN_4.5V and VIH_MIN_5.5V with readings of 4.6 and 5.6 V, respectively. The same parts also fell below the minimum specification limit of 0 V for VIL_MAX_4.5V and VIL_MAX_5.5V, with readings of -100 mV. S/N 152 and 154 also exceeded the maximum specification limit of 2.0 mA for ICC7, with readings of 3.04 and 2.84 mA, respectively. All irradiated parts continued to pass all other functional and parametric tests.

At the 75 krad irradiation level, S/N 152, 153, 154 and 155 exceeded the specification limits for VIH_MIN_5.5V, VIL_MAX_4.5V and VIL_MAX_5.5V, with readings of 5.6 V, -100 mV and -100 mV, respectively and exceeded the specification limit for ICC7, with readings ranging from 2.4 to 2.5 mA for S/N 153, 154 and 155, and a reading of 8.6 mA for S/N 152. In addition, S/N 152 also exceeded the maximum specification limit of 2.4 V for VIH_MIN_4.5V, with a reading of 4.6 V, and exceeded the maximum specification limit of 10.0 µA for I1H, I1L and IOZH, with readings of >100 mA, >100 mA and 3.1 mA, respectively. S/N 152 also marginally exceeded the maximum specification limit of 1.0 mA for ICC5, with a reading of 1.01 mA. All irradiated parts continued to pass all other functional and parametric tests.

At the 100 krad irradiation level, all irradiated parts exceeded the maximum specification limits for VIH_MIN_4.5V, VIH_MIN_5.5V, VIL_MAX_4.5V and VIL_MAX_5.5V, with readings of 4.6 V, 5.6 V, -100 mV and -100 mV, respectively. All irradiated parts also exceeded the specification limits for I1H and IOZH, with readings of >100 mA, and all irradiated parts exceeded the maximum specification limits of 2.0 mA for ICC2, 1.0 mA for ICC5 and 2.0 mA for ICC7, with readings ranging from 4.6 to 11.9 mA for ICC2, 4.5 to 119. mA for ICC5

* 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.

and 2.9 to 11.8 mA for ICC7. S/N 152, 153 and 154 also exceeded the specification limit for IIL, with a reading of >100 mA. S/N 152 exceeded the maximum specification limit of 35.0 ns for TAA_LH and TAA_HL, with a reading of 1.0 ms. All irradiated parts continued to pass all other functional and parametric tests.

After annealing for 168 hours at 25°C, S/N 152 failed Functional Test # 2, 3, 4 and 5. All irradiated parts recovered to within specification limits for VIH_MIN_4.5V, VIH_MIN_5.5V, VIL_MAX_4.5V, VIL_MAX_5.5V, TAA_LH and TAA_HL. All irradiated parts except S/N 152 also recovered to within specification limits for IIH, IIL and IOZH, as well as ICC2 and ICC5.

After annealing for 168 hours at 100°C, S/N 152 passed all six functional tests, however, S/N 155 failed Functional Tests # 3, 4 and 6. No rebound effects were observed.

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

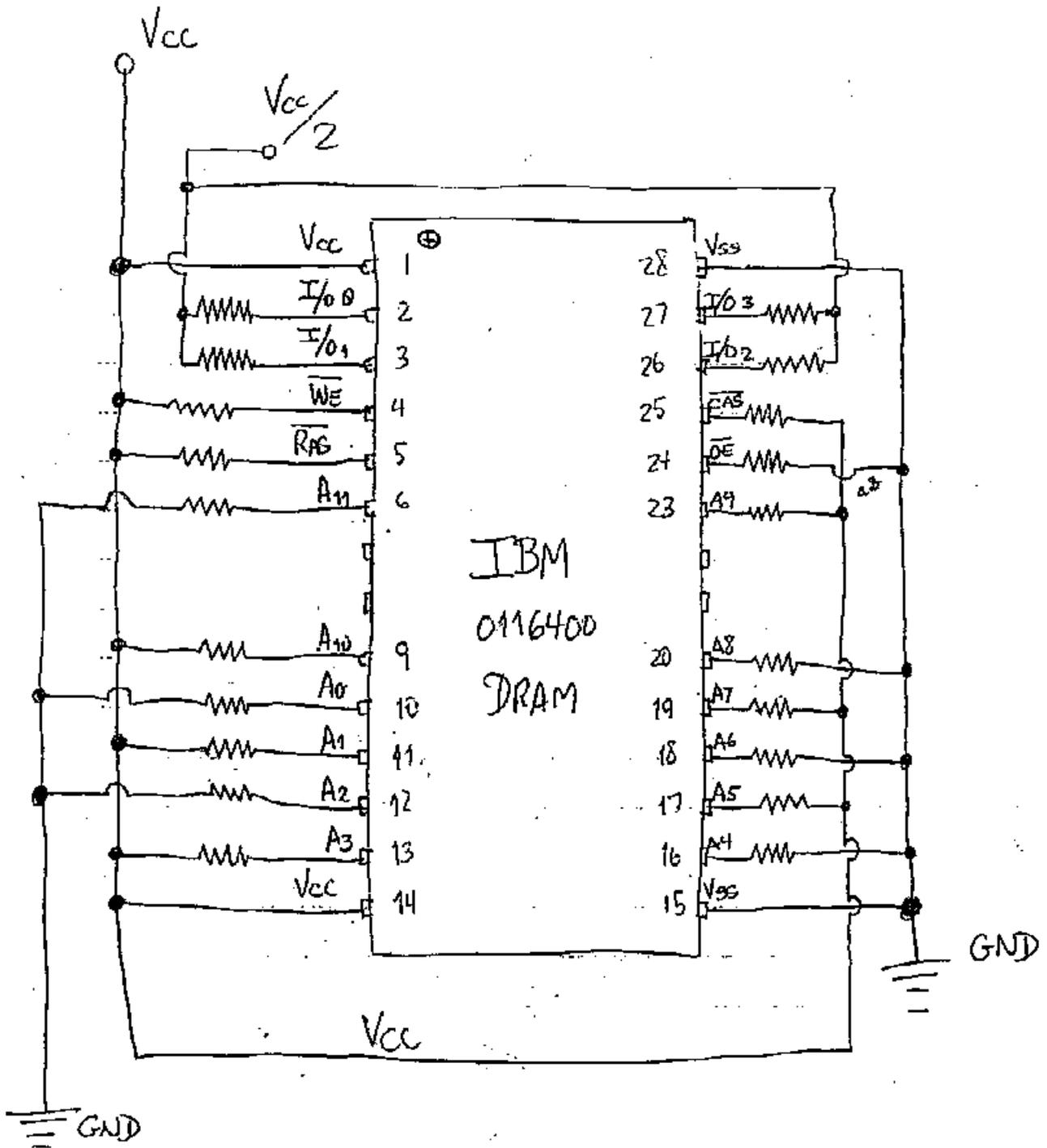
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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 IBM0116400AJ3



Vcc = +5.0 V ± 0.1 V
 Vcc/2 = +2.5 V ± 0.1 V
 R = 2K Ω ± 10%

TABLE I. Part Information

Generic Part Number:	IBM0116400AJ3*
LANDSAT Part Number	TP0116400AJ3B-70
LANDSAT Control Number:	12327
Charge Number:	EE56129
Manufacturer:	IBM
Lot Date Code (LDC):	9314
Quantity Tested:	6
Serial Number of Control Samples:	150, 151
Serial Numbers of Radiation Samples:	152, 153, 154, 155
Part Function:	4M X 4 16Mb DRAM
Part Technology:	CMOS
Package Style:	28-pin SOJ
Test Equipment:	S-50
Engineer:	J. Lander

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

TABLE II. Radiation Schedule for IBM0116400AJ3

EVENT.....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	03/01/95
2) 1.5 KRAD IRRADIATION (0.02 KRADS/HOUR).....	03/17/95
POST-1.5 KRAD ELECTRICAL MEASUREMENT.....	03/20/95
3) 3 KRAD IRRADIATION (0.09 KRADS/HOUR).....	03/20/95
POST-3 KRAD ELECTRICAL MEASUREMENT.....	03/21/95
4) 4.5 KRAD IRRADIATION (0.09 KRADS/HOUR).....	03/21/95
POST-4.5 KRAD ELECTRICAL MEASUREMENT.....	03/22/95
5) 6 KRAD IRRADIATION (0.35 KRADS/HOUR).....	03/22/95
POST-6 KRAD ELECTRICAL MEASUREMENT.....	03/23/95
6) 9 KRAD IRRADIATION (0.18 KRADS/HOUR).....	03/23/95
POST-9 KRAD ELECTRICAL MEASUREMENT.....	03/24/95
7) 12 KRAD IRRADIATION (0.47 KRADS/HOUR).....	03/24/95
POST-12 KRAD ELECTRICAL MEASUREMENT.....	03/27/95
8) 15 KRAD IRRADIATION (0.19 KRADS/HOUR).....	03/27/95
POST-15 KRAD ELECTRICAL MEASUREMENT.....	03/28/95
9) 20 KRAD IRRADIATION (0.29 KRADS/HOUR).....	03/28/95
POST-20 KRAD ELECTRICAL MEASUREMENT.....	03/29/95
10) 30 KRAD IRRADIATION (0.61 KRADS/HOUR).....	03/29/95
POST-30 KRAD ELECTRICAL MEASUREMENT.....	03/30/95
11) 50 KRAD IRRADIATION (1.25 KRADS/HOUR).....	03/30/95
POST-50 KRAD ELECTRICAL MEASUREMENT.....	03/31/95
12) 75 KRAD IRRADIATION (0.39 KRADS/HOUR).....	03/31/95
POST-75 KRAD ELECTRICAL MEASUREMENT.....	04/03/95
13) 100 KRAD IRRADIATION (1.47 KRADS/HOUR).....	04/03/95
POST-100 KRAD ELECTRICAL MEASUREMENT.....	04/04/95
14) 168-HOUR ANNEALING @25°C.....	04/04/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	04/11/95
15) 168-HOUR ANNEALING @ 100°C.....	04/11/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	04/24/95

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

Table III. Electrical Characteristics of IBM0116400AJ3

FUNCTIONAL TESTS							
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C	
FUNCT # 1	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V
FUNCT # 2	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V
FUNCT # 3	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V
FUNCT # 4	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V
FUNCT # 5	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V
FUNCT # 6	5.0V	0.0V	5.0V	FREQ = 5.000MHZ	ALL I/O	VOL < 1.0V	VOH > 2.0V

(1) FUNCTIONAL TESTS ARE PERFORMED AT VCC = 5.0V ONLY

(2) FUNCTIONAL TESTS CONSIST OF THE FOLLOWING PATTERNS :

- 1 - SIMPLE FUNCTIONAL TEST
- 2 - ALL ONES
- 3 - ALL ZEROS
- 4 - CHECKERBOARD & INVERSE CHECKERBOARD
- 5 - COL ADDRESS
- 6 - SURROUND

DC PARAMETRIC TESTS							
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C	
VIH_4.5V*	4.5V	0.0V	0.8V	FREQ = 5MHZ	INS	> +0.0V	< +2.4V
VIH_5.5V*	5.5V	0.0V	0.8V	FREQ = 5MHZ	INS	> +0.0V	< +2.4V
VIL_4.5V*	4.5V	2.4V	4.5V	FREQ = 5MHZ	INS	> +0.8V	< +4.5V
VIL_5.5V*	5.5V	2.4V	5.5V	FREQ = 5MHZ	INS	> +0.8V	< +5.5V
IIL	5.5V	0.0V	5.8V	VIH = 5.8V	INS	> -10.0UA	< +10.0UA
IIL	5.5V	0.0V	5.5V	VIH = 0.0V	INS	> -10.0UA	< +10.0UA
IOZH	5.5V	0.0V	5.5V	VOUT = 5.5V	OUTS	> -10.0UA	< +10.0UA
IOZL	5.5V	0.0V	5.5V	VOUT = 0.0V	OUTS	> -10.0UA	< +10.0UA
ICC1	5.5V	0.0V	5.5V	FRQ = 1/TRC MIN	VCC	> 0.0MA	< +75.0MA
ICC2	5.5V	0.0V	5.5V	STAND-BY	VCC	> 0.0MA	< +2.0MA
ICC3	5.5V	0.0V	5.5V	FRQ = 1/TRC MIN	VCC	> 0.0MA	< +75.0MA
ICC4	5.5V	0.0V	5.5V	FRQ = 1/TRC MIN	VCC	> 0.0MA	< +65.0MA
ICC5	5.5V	0.0V	5.5V	STAND-BY	VCC	> 0.0MA	< +1.0MA
ICC6	5.5V	0.0V	5.5V	FRQ = 1/TRC MIN	VCC	> 0.0MA	< +75.0MA
ICC7	5.5V	0.2V	5.3V	FRQ = 1/TRAS MIN	VCC	> 0.0MA	< +2.0MA

AC PARAMETRIC TESTS							
PARAMETER	VCC	VIL	VIH	CONDITIONS	OUTPINS	LIMITS 25C	
TAA_LH	4.5V	0.0V	3.0V	F=5.0MHZ, VCOMP=1.5V	OUTS	> 0NS	< 35NS
TAA_HL	4.5V	0.0V	3.0V	F=5.0MHZ, VCOMP=1.5V	OUTS	> 0NS	< 35NS

* VIH_4.5V and VIH_5.5V are shown in the text and in Table IV as VIH_MIN_4.5V and VIH_MIN_5.5V, respectively, to indicate that they are a measurement of the minimum value of VIH necessary to produce the correct output. Similarly, VIL_4.5V and VIL_5.5V are shown as VIL_MAX_4.5V and VIL_MAX_5.5V, respectively, to indicate that they are a measurement of the maximum value of VIL above which the correct output is not seen.

TABLE IV: Summary of Functional Tests after Total Dose Exposures and Annealing for IBM0116400AJ3 /1

# Functional Tests (2/3)	Total Dose Exposure (krads)															
	Initial		1.5		3.0		4.5		6.0		9.0		12		15	
1 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	
2 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	
3 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	
4 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	
5 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	
6 Vcc=5.0V,VB=0.0V,VD=5.0V,Freq=5MHz	P		P		P		P		P		P		P		P	

# Parameters	Units	Spec. Lim.A		Total Dose Exposure (krads)															
		min	max	Initial		1.5		3.0		4.5		6.0		9.0		12		15	
1 VIH_MIN_4.5V	V	0	2.4	1.70	0	1.68	.04	1.70	0	1.70	0	1.70	0	1.70	0	1.70	0	1.70	0
2 VIH_MIN_5.5V	V	0	2.4	1.90	0	1.90	0	1.90	0	1.90	0	1.90	0	1.93	.04	1.95	.05	2.00	0
3 VIL_MAX_4.5V	V	0.8	4.5	1.05	.09	1.10	.07	1.10	.07	1.10	.07	1.20	0	1.18	.04	1.15	.05	1.15	.05
4 VIL_MAX_5.5V	V	0.8	5.5	1.20	.07	1.30	0	1.30	0	1.30	0	1.30	.12	1.18	.08	1.18	.08	1.15	.05
5 IIH	µA	-10.0	10.0	0.0	.09	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0
6 IIL	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 IOZH	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 IOZL	µA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 ICC1	mA	0	75.0	43.0	5.1	51.0	.13	50.0	.31	51.2	.45	51.8	.30	52.1	.43	52.2	.39	52.3	.23
10 ICC2	mA	0	2.0	0.15	.09	0.15	.09	0.15	.10	0.15	.09	0.15	.09	0.16	.09	0.15	.09	0.15	.09
11 ICC3	mA	0	75.0	34.0	.29	34.0	.24	34.2	.33	34.3	.28	34.7	.29	35.1	.24	35.3	.25	35.6	.29
12 ICC4	mA	0	65.0	4.54	.39	4.57	.41	4.53	.34	4.57	.39	4.51	.16	4.54	.11	4.56	.08	4.59	.09
13 ICC5	mA	0	1.0	0.15	.09	0.15	.09	0.15	.09	0.15	.09	0.15	.09	0.15	.09	0.15	.09	0.15	.09
14 ICC6	mA	0	75.0	44.9	4.8	40.9	.47	50.9	.30	50.8	.21	51.4	.51	51.1	.24	51.6	.33	51.8	.12
15 ICC7	mA	0	2.0	0.47	.26	1.14	.64	0.49	.39	0.53	.26	0.15	.09	0.74	.24	0.37	.37	0.30	.65
16 TAA_LH	ns	0	35.0	24.4	1.8	14.1	2.7	15.2	2.0	13.4	1.0	13.2	.18	13.4	.20	13.5	.19	14.2	1.9
17 TAA_HL	ns	0	35.0	24.7	.54	14.8	.33	15.3	.24	15.4	.51	15.7	2.6	11.9	2.6	11.9	2.5	12.1	2.7

Notes:

- 1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.
- 3/ No reliable measurements could be obtained for this test at this level.
- 4/ 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.

TABLE IV (Cont'd.): Summary of Functional Tests after Total Dose Exposures and Annealing for IBM0116400AJ3 /1

# Functional Tests /2 /3	Total Dose Exposure (krads)										Annealing						
			20		30		50		75		100		168 hrs@25°C		168 hrs@100°C		
	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	
1	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		P		P	
2	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		3P1F		P	
3	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		3P1F		3P1F	
4	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		3P1F		3P1F	
5	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		3P1F		P	
6	V _{cc} =5.0V, V _i =0.0V, V _o =5.0V, Freq=5MHz	P		P		P		P		P		P		P		3P1F	

# Parameters	Units	Spec. Lim.4	min	max	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
					1	V _{IH_MIN_4.5V}	V	0	2.4	1.75	.05	1.70	0	3.38	1.3	2.43	1.2	4.50
2	V _{IH_MIN_5.5V}	V	0	2.4	2.03	.04	2.00	0	4.73	1.5	3.60	0	5.50	0	3.90	1.8	5.50	0
3	V _{IL_MAX_4.5V}	V	0.8	4.5	1.10	.12	1.05	.04	0.20	.52	-0.10	0	-0.10	0	0.90	.50	-0.10	0
4	V _{IL_MAX_5.5V}	V	0.8	5.5	1.15	.09	1.13	.08	0.16	.48	-0.10	0	-0.10	0	0.55	.65	-0.10	0
5	I _{IH}	µA	-10.0	10.0	0	0	0	0	-0.20	.45	3.5E4	4.3E4	0.1E4	2.0E4	2.5E4	4.3E4	0	.01
6	I _{IL}	µA	-10.0	10.0	0	0	0	0	-0.02	.06	1.1E4	3.2E4	3.0E4	4.6E4	1.3E4	3.2E4	-0.65	.07
7	I _{OZH}	µA	-10.0	10.0	0	0	0	0	0.35	.35	790	1344	3302	339	377	652	0	0
8	I _{OZL}	µA	-10.0	10.0	0	0	0	0	0	0	-0.08	.13	-0.16	.20	0	0	0	0
9	I _{CC1}	mA	0	75.0	34.1	.70	52.7	.25	65.4	.23	60.1	3.9	57.5	26	39.9	7.1	54.3	3.9
10	I _{CC2}	mA	0	2.0	0.15	.09	0.15	.08	0.13	.08	0.63	.20	7.82	2.6	0.93	.55	0.17	.08
11	I _{CC3}	mA	0	75.0	36.5	.43	36.3	.50	42.0	.83	50.8	4.0	35.1	25	61.2	8.6	41.3	5.1
12	I _{CC4}	mA	0	65.0	4.50	.27	4.55	.05	5.11	.59	5.74	.56	11.3	1.4	7.17	1.1	4.51	.58
13	I _{CC5}	mA	0	1.0	0.18	.09	0.16	.09	0.18	.09	0.67	.20	7.78	2.6	0.93	.55	0.18	.07
14	I _{CC6}	mA	0	75.0	12.1	11	34.3	25	35.4	.30	60.4	3.9	57.6	26	37.6	2.8	52.5	.93
15	I _{CC7}	mA	0	2.0	0.78	.22	0.39	.37	1.38	.97	4.01	2.7	5.34	3.7	8.92	8.9	1.46	.56
16	TAA_LH	ns	0	35.0	13.3	.29	14.7	1.8	15.3	.71	15.0	.59	1.9E3	3.9E3	14.5	1.0	15.7	.51
17	TAA_HL	ns	0	35.0	11.0	3.5	11.9	4.3	10.6	2.6	10.5	2.8	1.3E3	3.3E3	11.9	3.7	10.5	3.0

Notes:

- 1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing. The control samples remained constant throughout the testing are are not included in this table.
- 2/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.
- 3/ No reliable measurements could be obtained for this test at this level.
- 4/ 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.