TOTAL DOSE RADIATION TEST

I. INTRODUCTION

Total dose radiation tests are designed to characterize changes in device performance due to total dose radiation. These tests are not intended to classify maximum radiation tolerance of any particular device, rather, they simply show trends in the critical parameters as a function of total dose. Whether a device meets tolerance requirements is left up to the designer. In many occasions, designers have the ability to circumvent radiation effects by adding appropriate shielding or compensating for the variations in performance.

MIL-STD-883 method 1019 is used as a guideline for these tests. National's gamma radiation source is kept in compliance with method 1019 and radiation test samples are irradiated under dose rate condition A, which tests for total-dose effects. Samples are kept biased while irradiating. Dose rate is maintained between 50 - 300 Rads(Si)/sec and all samples are exposed to a total dose of 200 kRads(Si).

II. RADIATION SOURCE

A. Type

Atomic Energy of Canada Limited cobalt 60 irradiation unit model Gammacell 220 is used to irradiate the devices under test. The Gammacell 220 produces gamma radiation photons approximately 1.25MeV in energy. Dose rate in the gammacell is maintained between 50 and 300 Rads(Si)/sec with an accuracy of +/- 10%.

B. Dosimetery

Thermoluminescence Dosimetery is performed according to MIL-STD-883 method 1019. Actual dose rate for individual test is calculated from the exponential decay approximation of the dosimetery data.

III. TEST SETUP AND PROCEDURE

A. Pre-radiation Electrical Test

All test samples are verified to be functionally and parameterically working prior to irradiation. They are subject to group A qualification test including burn in. Samples are also verified to be within room temperature acceptance limits.

B. Test Environment

Samples are enclosed in a lead/aluminum container vertically aligned with the source of radiation while being irradiated. Ambient temperature throughout the test is approximately 25^{o}C.

C. Biasing

All devices under test are kept biased during irradiation. Bias circuit used for burn-in is also used for irradiation.

C. Electrical Test

Remote electrical tests are performed on the irradiated devices at several total dose levels. All samples are short circuited while transporting to the automatic electrical tester. Electrical tests are completed within two hours of each irradiation step.

IV. DATA PRESENTATION

A Test Summary sheet provides details on the origins of test samples, dose rate, list of parameters tested and total variation in those parameters. Details of the test consists of select device parameter plotted and tabulated as a function of total dose. Test conditions for each parameter are also specified. Acceptance limits specified in RETS or MDS are also plotted on the graph for reference purpose.

This RHA report is supplied only as a guideline to demonstrate the characteristics of our product in a Total Dose Radiation environment. The results reported are representative only of the lot tested in this specific sample and should not be used as generic RHA qualification data. National Semiconductor uses different process flows for different product qualification levels, and National Semiconductor will not guarantee the RHA performance of any product unless National Semiconductor has tested and certified the specific manufacturing lot. At each radiation exposure level, minimum and maximum shows a plausible variation in the parameter values. It is important to remember that this variation includes variation due to radiation exposure as well as variation between lots and variation between wafers. Measurement variation is assumed insignificant. Whenever possible, radiation test reports will provide an estimate of the percentage of total variation that can be attributed to radiation exposure. This estimate is calculated by analysis of variance (ANOVA) or similar statistical method.

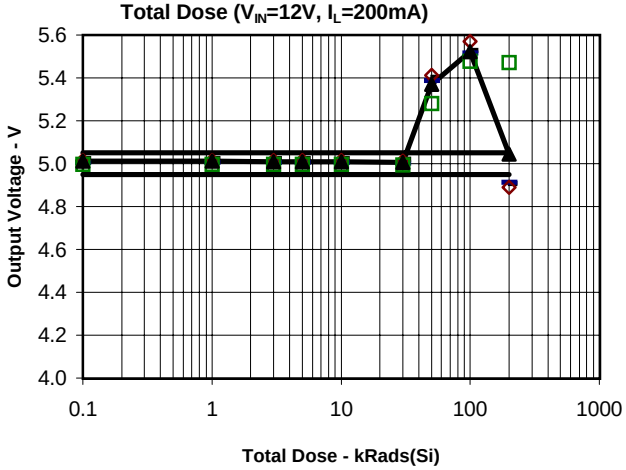
Parameter[1]	Symbol	Test #	%Δ Post 200k Rad (Si)
Output Voltage	V_{OUT}	44	0.70
Output Voltage 0.2A <= I_{LOAD} <= 1A, 8V <= V_{IN} <= 40V	V_{OUT}	45	-0.13
Output Voltage 0.2A <= I_{LOAD} <= 1A, 8V <= V_{IN} <= 40V	V_{OUT}	46	-0.27
Output Voltage 0.2A <= I_{LOAD} <= 1A, 8V <= V_{IN} <= 40V	V_{OUT}	47	2.47
Output Voltage 0.2A <= I_{LOAD} <= 1A, 8V <= V_{IN} <= 40V	V_{OUT}	48	2.52
Saturation Voltage I_{OUT} = 1A	V_{SAT}	43	2.53
Output leakage Current V_{IN} = 35V, V_{OUT} = 0V	I_L	8	162.2
Output leakage Current V_{IN} = 35V, V_{OUT} = -1V	I_L	9	20.1
Quiescent Current	I_Q	10	117.91
Standby Quiescent Current ON/OFF Pin = OFF	I_{STBY}	11	2984.93
Max Duty Cycle (ON)	DC	42	1.76
ON/OFF Pin Threshold Voltage[2] V_{OUT} = 0V	V_{IH}	55	N/A
ON/OFF Pin Threshold Voltage[2] V_{OUT} = 5V	V_{IL}	54	N/A
ON/OFF Pin Input Current On/OFF Pin = OFF	I_{IH}	57	-68.2
ON/OFF Pin Input Current On/OFF Pin = ON	I_{IL}	56	0.0

Note 1: V_{IN} = 12V, I_{LOAD} = 200mA unless otherwise specified

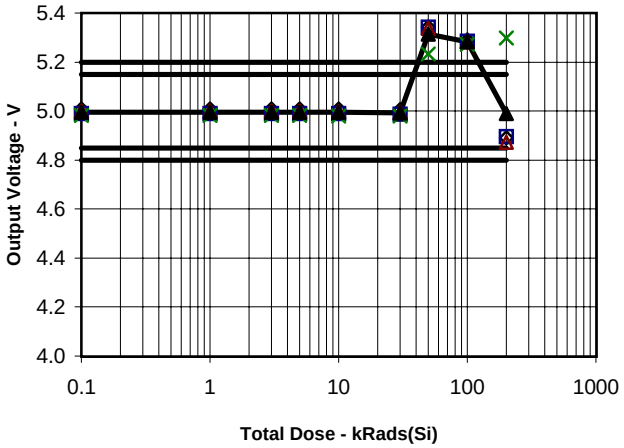
Note 2: Indirect tests, no failures were seen throughout the test

LM1575J-5.0
Device Parameter Characteristics

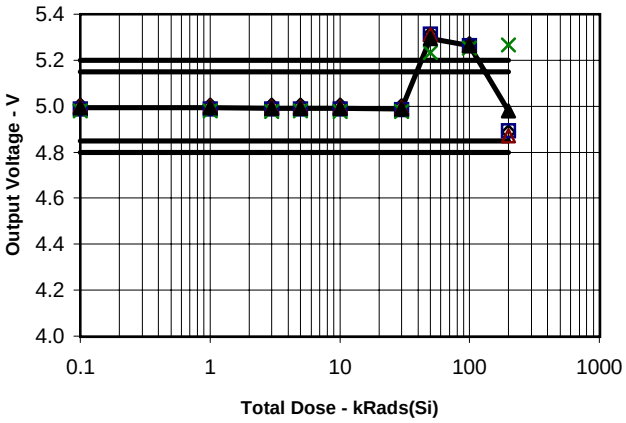
Output Voltage vs
Total Dose (V_{IN}=12V, I_L=200mA)



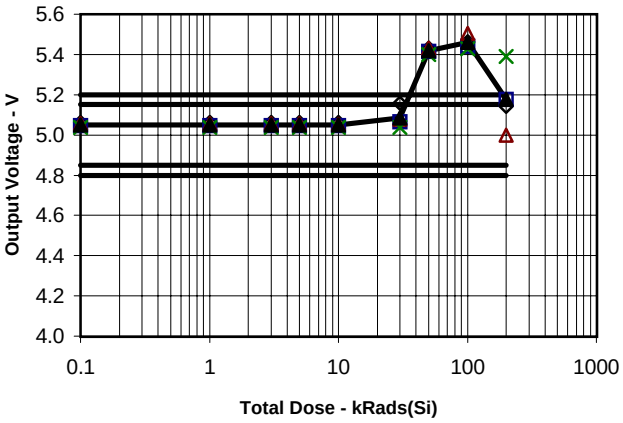
Output Voltage vs
Total Dose (V_{IN}=8V, I_L=200mA)



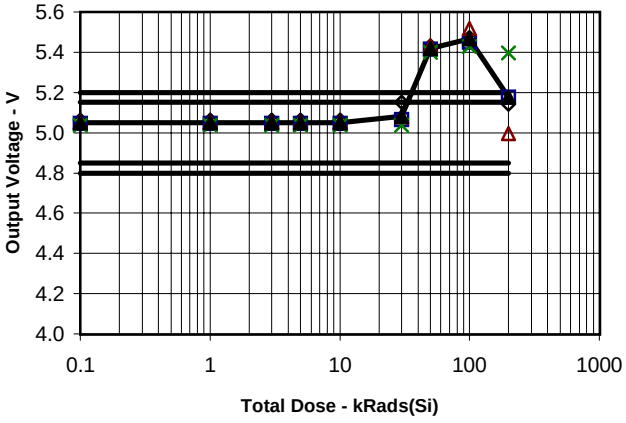
Output Voltage vs
Total Dose (V_{IN}=8V, I_L=1A)



Output Voltage vs
Total Dose (V_{IN}=40V, I_L=200mA)



Output Voltage vs
Total Dose (V_{IN}=40V, I_L=1A)



LM1575J-5.0/XXX
Device Parameter Characteristics

Output Voltage - V (V_{IN}=12V, I_L=200mA)

MDS Limits: 4.95V - 5.05V (SG1)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	5.011	4.997	5.024	0.012	0
1	5.011	4.997	5.024	0.012	0
3	5.010	4.997	5.024	0.012	0
5	5.010	4.997	5.023	0.011	0
10	5.009	4.996	5.023	0.011	0
30	5.007	4.994	5.022	0.012	0
50	5.371	5.282	5.411	0.060	4
100	5.523	5.477	5.571	0.039	4
200	5.046	4.891	5.472	0.284	4

Output Voltage - V (V_{IN}=8V, I_L=200mA)

MDS Limits: 4.85V - 5.15V (SG1); 4.8V - 5.2V (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	4.996	4.982	5.009	0.012	0
1	4.995	4.982	5.009	0.012	0
3	4.995	4.981	5.009	0.012	0
5	4.995	4.981	5.008	0.012	0
10	4.994	4.981	5.007	0.011	0
30	4.992	4.979	5.006	0.012	0
50	5.314	5.233	5.342	0.054	4
100	5.283	5.273	5.292	0.008	4
200	4.989	4.874	5.299	0.207	1

Output Voltage - V (V_{IN}=8V, I_L=1A)

MDS Limits: 4.85V - 5.15V (SG1); 4.8V - 5.2V (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	4.993	4.979	5.006	0.012	0
1	4.993	4.979	5.006	0.012	0
3	4.992	4.978	5.006	0.012	0
5	4.992	4.979	5.005	0.012	0
10	4.992	4.978	5.004	0.011	0
30	4.989	4.976	5.003	0.012	0
50	5.294	5.234	5.315	0.040	4
100	5.262	5.252	5.271	0.008	4
200	4.979	4.871	5.266	0.191	1

Output Voltage - V (V_{IN}=40V, I_L=200mA)

MDS Limits: 4.85V - 5.15V (SG1); 4.8V - 5.2V (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	5.051	5.039	5.064	0.011	0
1	5.051	5.039	5.064	0.011	0
3	5.051	5.038	5.064	0.011	0
5	5.051	5.038	5.063	0.011	0
10	5.050	5.037	5.063	0.011	0
30	5.086	5.038	5.159	0.052	1
50	5.418	5.398	5.430	0.015	4
100	5.460	5.429	5.506	0.034	4
200	5.176	4.998	5.389	0.162	3

Output Voltage - V (V_{IN}=40V, I_L=1A)

MDS Limits: 4.85V - 5.15V (SG1); 4.8V - 5.2V (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	5.050	5.038	5.063	0.011	0
1	5.050	5.038	5.063	0.011	0
3	5.050	5.037	5.063	0.011	0
5	5.050	5.037	5.063	0.011	0
10	5.049	5.036	5.062	0.011	0
30	5.083	5.037	5.151	0.049	1
50	5.419	5.399	5.431	0.015	4
100	5.467	5.429	5.516	0.037	4
200	5.177	4.994	5.398	0.167	2

Note 1: Number of devices that were outside MDS sub group 1 limits.

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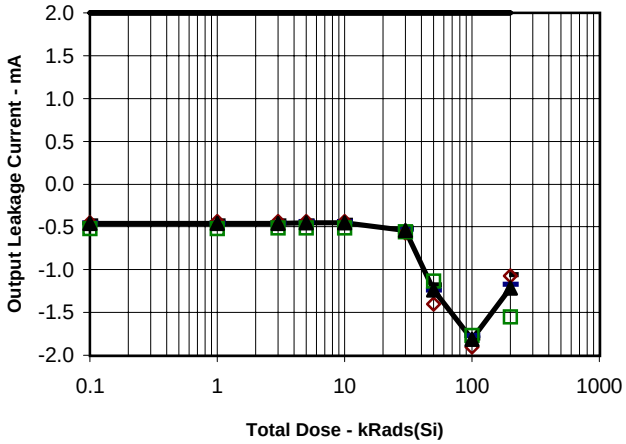
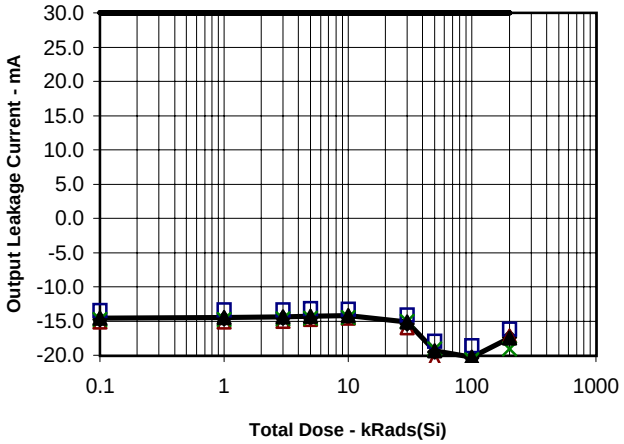
Device Parameter Characteristics

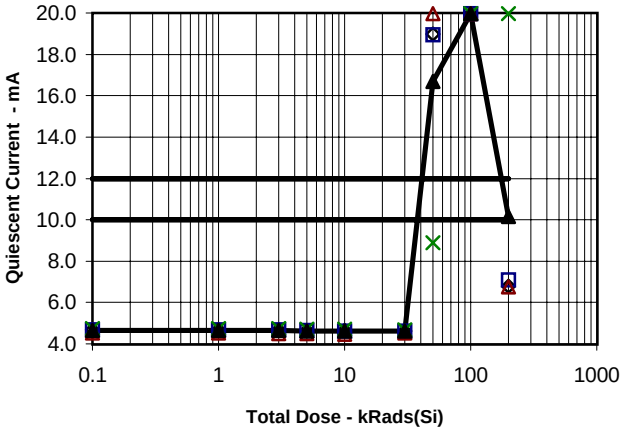
Output Leakage Current vs
Total Dose (V_{IN}=40V, V_{out}=0V)



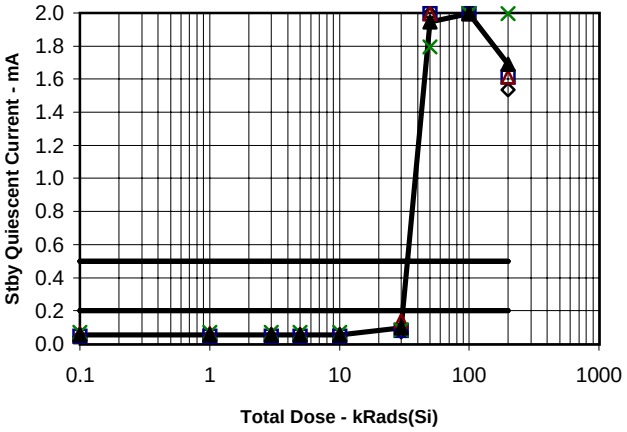
Output Leakage Current vs
Total Dose (V_{IN}=40V, V_{OUT}=-1V)



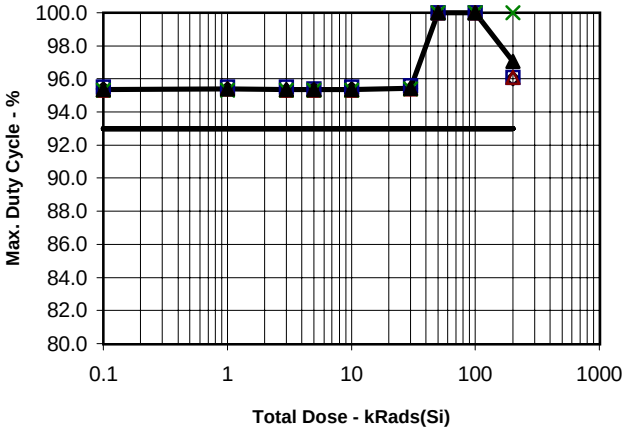
Quiescent Current vs
Total Dose (V_{IN}=12V, I_L=200mA)



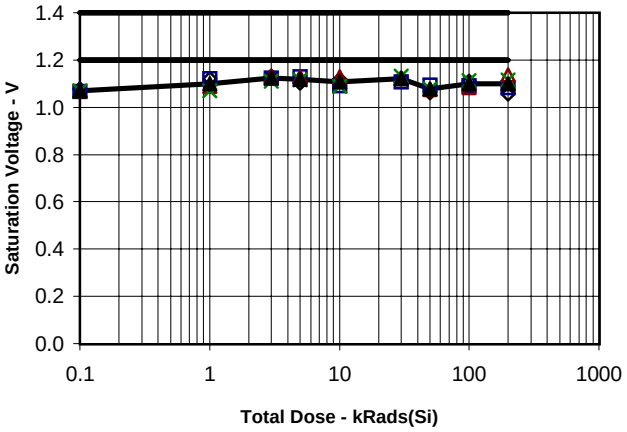
Standby Quiescent Current vs
Total Dose (V_{IN}=12V, I_L=200mA, Dev - OFF)



Max. Duty Cycle vs
Total Dose (V_{IN}=12V, I_L=200mA)



Saturation Voltage vs
Total Dose (I_{OUT}=1A)



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Device Parameter Characteristics

Output Leakage Current - mA (V_{IN}=40V, V_{OUT}=0V)

MDS Limits: 2 mA (SG1)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-0.463	-0.520	-0.430	0.039	0
1	-0.460	-0.520	-0.430	0.041	0
3	-0.458	-0.510	-0.430	0.036	0
5	-0.455	-0.510	-0.430	0.037	0
10	-0.453	-0.510	-0.420	0.039	0
30	-0.543	-0.570	-0.510	0.028	0
50	-1.238	-1.400	-1.130	0.117	0
100	-1.810	-1.900	-1.770	0.062	0
200	-1.213	-1.550	-1.060	0.230	0

Output Leakage Current - mA (V_{IN}=40V, V_{OUT}=-1V)

MDS Limits: 30 mA (SG1)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-14.550	-15.100	-13.500	0.714	0
1	-14.500	-15.100	-13.400	0.753	0
3	-14.425	-15.000	-13.400	0.704	0
5	-14.300	-14.800	-13.200	0.739	0
10	-14.225	-14.600	-13.300	0.618	0
30	-15.125	-16.000	-14.100	0.797	0
50	-19.300	-20.700	-17.900	1.155	0
100	-20.325	-21.600	-18.600	1.258	0
200	-17.475	-19.100	-16.200	1.204	0

Quiescent Current - mA (V_{IN}=12V, I_L=200mA)

MDS Limits: 10mA (SG1); 12mA (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	4.663	4.520	4.750	0.099	0
1	4.660	4.520	4.750	0.098	0
3	4.648	4.500	4.740	0.103	0
5	4.628	4.480	4.720	0.103	0
10	4.608	4.460	4.700	0.103	0
30	4.613	4.520	4.680	0.067	0
50	16.703	8.900	19.980	5.224	3
100	19.980	19.980	19.980	0.000	4
200	10.160	6.760	19.980	6.549	1

Standby Quiescent Current - mA

V_{IN}=12V, I_L=200mA, Dev - OFF

MDS Limits: 0.2mA(SG1); 0.5mA (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	0.055	0.043	0.071	0.013	0
1	0.055	0.043	0.071	0.013	0
3	0.054	0.042	0.071	0.013	0
5	0.054	0.042	0.071	0.013	0
10	0.054	0.042	0.070	0.013	0
30	0.096	0.075	0.139	0.029	0
50	1.947	1.795	1.998	0.102	4
100	1.998	1.998	1.998	0.000	4
200	1.689	1.534	1.998	0.209	4

Max. Duty Cycle - % (V_{IN}=12V, I_L=200mA)

MDS Limits: minimum 93% (SG9)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	95.375	95.300	95.500	0.096	0
1	95.400	95.300	95.500	0.082	0
3	95.350	95.300	95.500	0.100	0
5	95.350	95.300	95.400	0.058	0
10	95.375	95.300	95.500	0.096	0
30	95.450	95.400	95.600	0.100	0
50	100.000	100.000	100.000	0.000	0
100	100.000	100.000	100.000	0.000	0
200	97.050	96.000	100.000	1.967	0

Saturation Voltage - V (I_{OUT}=1A)

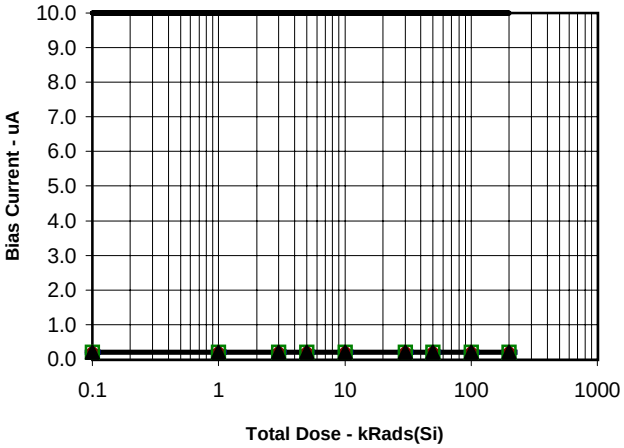
MDS Limits: 1.2V (SG1); 1.4V (SG2,3)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	1.071	1.067	1.078	0.005	0
1	1.100	1.070	1.122	0.025	0
3	1.124	1.111	1.132	0.010	0
5	1.119	1.103	1.129	0.013	0
10	1.108	1.088	1.130	0.021	0
30	1.121	1.108	1.133	0.010	0
50	1.078	1.061	1.095	0.014	0
100	1.100	1.084	1.114	0.014	0
200	1.098	1.056	1.137	0.036	0

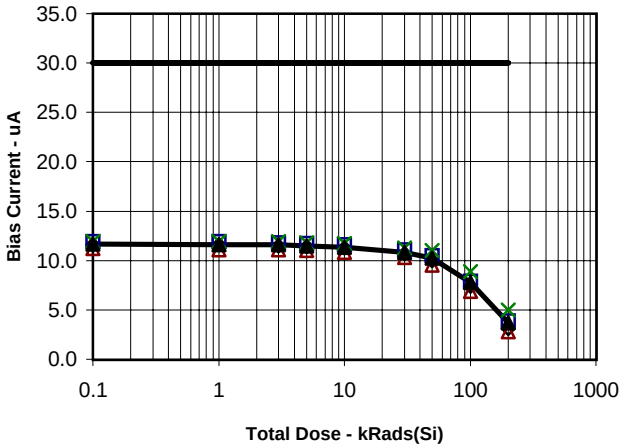
Note 1: Number of devices that were outside MDS sub group 1 limits.

LM1575J-5.0
Device Parameter Characteristics

ON/OFF Pin Bias Current vs
Total Dose (V_{IN}=12V, I_L=200mA, Dev ON)



ON/OFF Pin Bias Current vs
Total Dose (V_{IN}=8V, I_L=200mA, Dev OFF)



LM1575J-5.0
Device Parameter Characteristics

ON/OFF Pin Bias Current - uA

V_{IN}=12V, I_{LOAD}=200mA, Dev ON

MDS Limits:10 uA (SG1)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	0.200	0.200	0.200	0.000	0
1	0.200	0.200	0.200	0.000	0
3	0.200	0.200	0.200	0.000	0
5	0.200	0.200	0.200	0.000	0
10	0.200	0.200	0.200	0.000	0
30	0.200	0.200	0.200	0.000	0
50	0.200	0.200	0.200	0.000	0
100	0.200	0.200	0.200	0.000	0
200	0.200	0.200	0.200	0.000	0

ON/OFF Pin Bias Current - uA

V_{IN}=12V, I_{LOAD}=200mA, Dev OFF

MDS Limits: 30 uA (SG1)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	11.650	11.200	11.900	0.332	0
1	11.625	11.100	11.900	0.377	0
3	11.575	11.100	11.900	0.359	0
5	11.475	11.000	11.800	0.359	0
10	11.350	10.800	11.700	0.404	0
30	10.850	10.300	11.300	0.443	0
50	10.250	9.500	11.000	0.645	0
100	7.775	6.900	8.900	0.854	0
200	3.700	2.800	5.000	0.983	0

Note 1: Number of devices that were outside MDS sub group 1 limits.