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.

LM7171J Total Dose Radiation Test Summary

Summary:

This report presents characteristics of twelve parameters for LM7171J, high speed operational amplifier. This report concentrates on the parameters that were tested with +/-5V supply. All 15 V supply parameters were tested but only two (Input Offset Voltage and current) are presented in this report. Their data is available upon request. Since only DC parameters were tested, AC parameters (Slew Rate and Gain-Bandwidth) are not a part of this report. Data shows that all parameters remained inside the MDS sub group 1 limits throughout the test. Comparison of pre rad and post 200k rad data shows that overall changes in the parameter values were very small and all devices were functional after 200k rad exposure.

Following table shows a summary of average changes after 200krad exposure for each of the twelve parameters presented in this report.

Parameter	Avg. Post 200k Change
Supply Current	-0.52mA
Input Offset Voltage	-0.111mV
Positive Input Bias Current	-0.144uA
Negative Input Bias Current	0.141uA
Input Offset Current	0.002uA
CMRR (V_{CM} = +/-2.5V)	-3.7dB
Positive Output Swing	-0.042V
Negative Output Swing	0.042V
PSRR (V_S = +/-15V to +/-5V)	-0.485dB
Voltage Gain	-0.301dB
Input Offset Voltage (V = +/-15V)	-0.079mV
Input Offset Current (V = +/-15V)	0.003uA

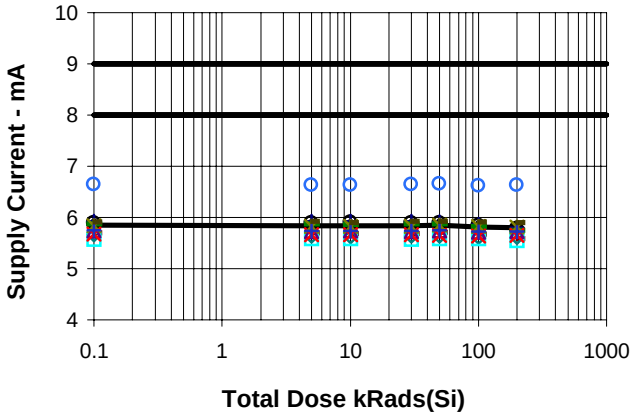
LM7171J Total Dose Radiation Test Summary

Test Details:

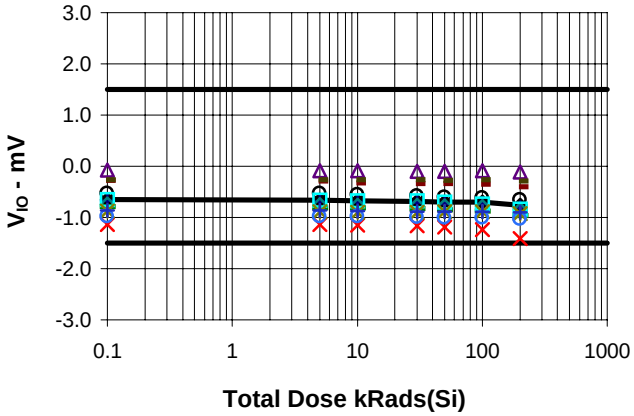
	Samples		
	1-4	5-8	9-12
Samples Size:	12		
Lot #:	STM52071	STM53832	STM58812
Die Run#:	A004CE36	A005B440	A005C665
Date Code:	S4D9502	S5C9539	S5C9541
Test Date:	8/16/96		
Dose Rate:	100.01 Rads(Si)/sec		
MDS #:	MNLM7171AM-X-0A0		
Bias Circuit #:	5885HR A3		
Test Program Number:	QR7171XRD		

LM7171J
Total Dose Radiation Test Characteristics (N=12)

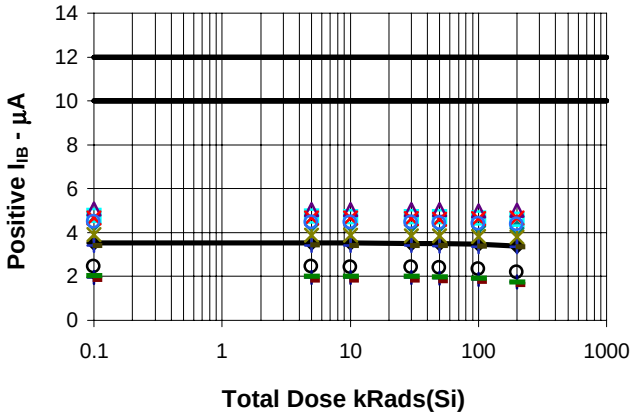
Supply Current vs Total Dose



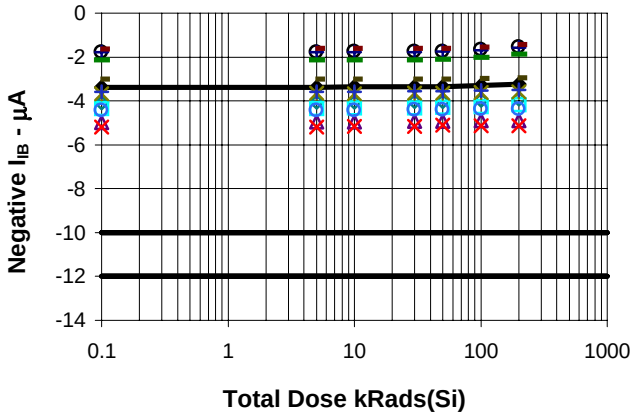
Input Offset Voltage vs Total Dose



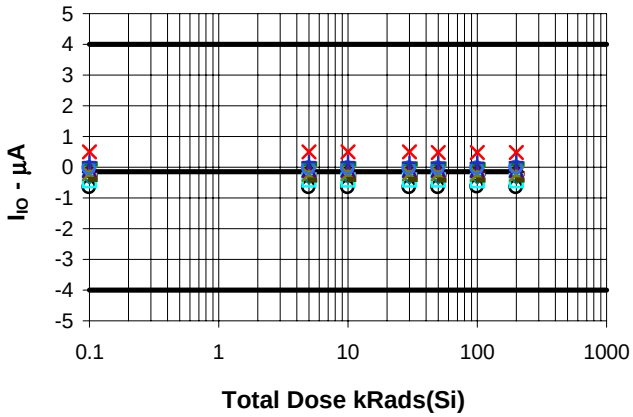
Positive Input Bias Current vs Total Dose



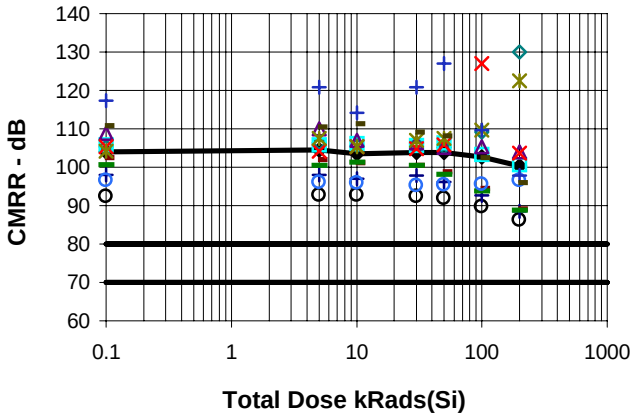
Negative Input Bias Current vs Total Dose



Input Offset Current vs Total Dose



CMRR vs Total Dose (V_{CM} = +/- 2.5V)



Dose Rate = 100.08 Rads(Si)/sec, V+ = +5V, V- = -5V, V_{CM} = 0V and R_L = 1kΩ unless specified otherwise.

LM7171J
Total Dose Radiation Test Characteristics (N=12)

Supply Current vs Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	5.847	5.572	6.647	0.276	0
5	5.842	5.584	6.634	0.275	0
10	5.839	5.584	6.634	0.276	0
30	5.841	5.572	6.647	0.280	0
50	5.847	5.584	6.659	0.281	0
100	5.818	5.584	6.622	0.275	0
200	5.795	5.550	6.638	0.285	0
300					
1000					

Input Offset Voltage vs Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-0.653	-1.140	-0.075	0.317	0
5	-0.664	-1.143	-0.093	0.315	0
10	-0.673	-1.152	-0.093	0.314	0
30	-0.684	-1.161	-0.096	0.314	0
50	-0.694	-1.188	-0.096	0.319	0
100	-0.706	-1.239	-0.087	0.329	0
200	-0.764	-1.407	-0.108	0.355	0
300					
1000					

Positive Input Bias Current vs Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	3.536	1.854	5.079	1.199	0
5	3.528	1.851	5.058	1.193	0
10	3.515	1.839	5.049	1.189	0
30	3.505	1.833	5.049	1.188	0
50	3.497	1.815	5.037	1.191	0
100	3.457	1.767	4.992	1.205	0
200	3.392	1.644	5.004	1.256	0
300					
1000					

Negative Input Bias Current vs Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-3.384	-5.181	-1.620	1.294	0
5	-3.376	-5.181	-1.617	1.290	0
10	-3.369	-5.157	-1.608	1.288	0
30	-3.357	-5.148	-1.602	1.285	0
50	-3.346	-5.103	-1.596	1.281	0
100	-3.303	-5.121	-1.554	1.298	0
200	-3.243	-5.145	-1.431	1.353	0
300					
1000					

Input Offset Current vs Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-0.152	-0.663	0.501	0.307	0
5	-0.152	-0.666	0.510	0.312	0
10	-0.146	-0.660	0.501	0.306	0
30	-0.148	-0.672	0.507	0.307	0
50	-0.151	-0.666	0.483	0.304	0
100	-0.154	-0.654	0.483	0.302	0
200	-0.150	-0.663	0.483	0.307	0
300					
1000					

CMRR vs Total Dose (V_{CM} = +/- 2.5V)

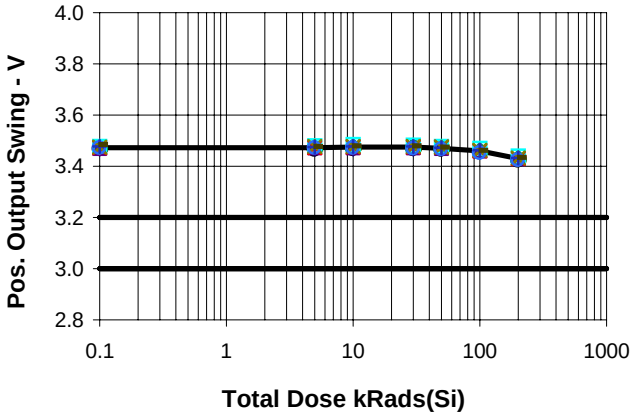
Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	104.0	92.3	117.4	6.7	0
5	104.5	92.7	120.9	7.5	0
10	103.6	92.6	114.2	6.3	0
30	103.9	92.4	120.9	7.5	0
50	103.8	91.9	126.9	9.1	0
100	102.7	89.6	126.9	10.5	0
200	100.3	86.2	130.0	13.6	0
300					
1000					

Dose Rate = 100.08 Rads(Si)/sec, V+ = +5V, V- = -5V, V_{CM} = 0V and R_L = 1kΩ unless specified otherwise.

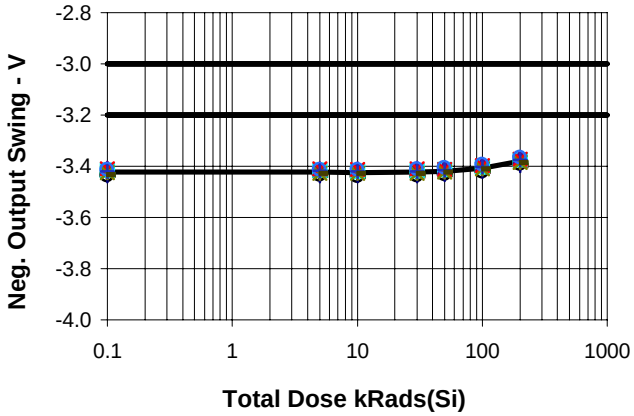
Note 1: Number of devices that were outside MDS sub group 1 limits.

LM7171J
Total Dose Radiation Test Charateristics (N=12)

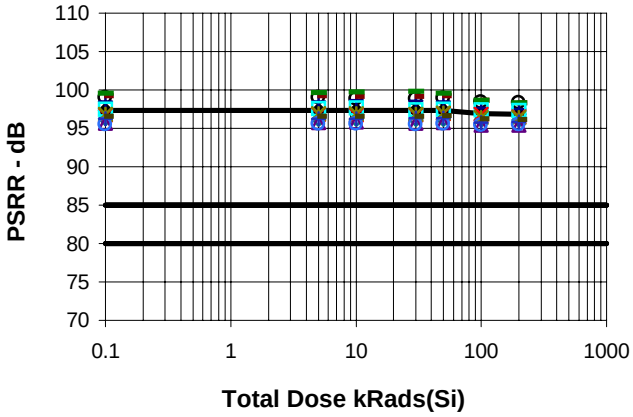
Positive Output Swing vs Total Dose (R_L = 1kΩ)



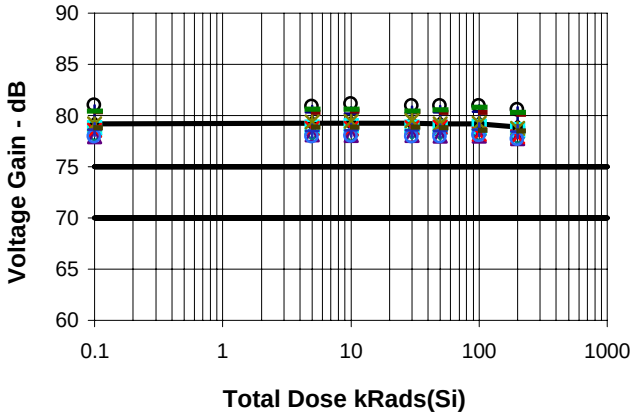
Negative Output Swing vs Total Dose (R_L = 1kΩ)



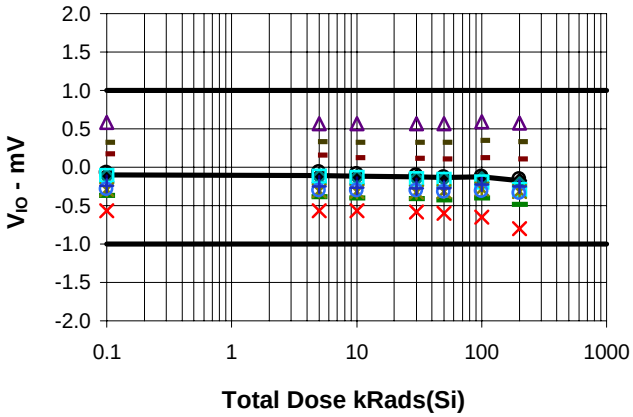
PSRR vs Total Dose (V_S = +/-15V to +/-5V)



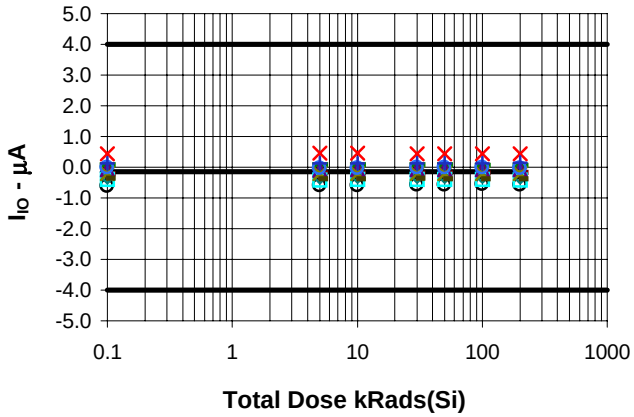
Voltage Gain vs Total Dose



Input Offset Voltage vs Total Dose (V = +/-15V)



Input Offset Current vs Total Dose (V = +/-15V)



Dose Rate = 100.08 Rads(Si)/sec, V+ = +5V, V- = -5V, V_{CM} = 0V and R_L = 1kΩ unless specified otherwise.

LM7171J
Total Dose Radiation Test Charateristics (N=12)

Positive Output Swing vs
Total Dose (R_L = 1kΩ)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	3.473	3.466	3.485	0.006	0
5	3.473	3.466	3.480	0.005	0
10	3.475	3.469	3.485	0.005	0
30	3.475	3.468	3.484	0.006	0
50	3.471	3.465	3.479	0.005	0
100	3.459	3.453	3.469	0.005	0
200	3.431	3.423	3.440	0.005	0
300					
1000					

Negative Output Swing vs
Total Dose (R_L = 1kΩ)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-3.423	-3.436	-3.407	0.011	0
5	-3.423	-3.437	-3.409	0.010	0
10	-3.425	-3.439	-3.409	0.010	0
30	-3.423	-3.438	-3.408	0.011	0
50	-3.419	-3.433	-3.404	0.010	0
100	-3.407	-3.421	-3.391	0.010	0
200	-3.381	-3.398	-3.364	0.011	0
300					
1000					

PSRR vs Total Dose
(V_S = +/-15V to +/-5V)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	97.303	95.494	99.576	1.426	0
5	97.337	95.611	99.639	1.418	0
10	97.347	95.572	99.764	1.426	0
30	97.314	95.494	99.828	1.445	0
50	97.335	95.572	99.576	1.401	0
100	96.918	95.417	98.692	1.224	0
200	96.818	95.417	98.362	1.108	0
300					
1000					

Voltage Gain vs
Total Dose

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	79.196	77.967	81.024	1.081	0
5	79.226	77.941	80.879	1.044	0
10	79.261	77.993	81.135	1.089	0
30	79.251	77.941	80.951	1.020	0
50	79.214	77.941	80.915	1.042	0
100	79.177	77.993	80.915	1.132	0
200	78.895	77.713	80.561	1.092	0
300					
1000					

Input Offset Voltage vs
Total Dose (V = +/-15V)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-0.097	-0.564	0.585	0.319	0
5	-0.106	-0.567	0.567	0.319	0
10	-0.118	-0.570	0.564	0.318	0
30	-0.128	-0.585	0.564	0.321	0
50	-0.137	-0.603	0.564	0.326	0
100	-0.124	-0.654	0.591	0.336	0
200	-0.176	-0.804	0.576	0.365	0
300					
1000					

Input Offset Current vs
Total Dose (V = +/-15V)

Dose	Avg.	Min.	Max.	S. Dev.	Fail[1]
0.1	-0.141	-0.615	0.447	0.279	0
5	-0.143	-0.612	0.456	0.282	0
10	-0.141	-0.597	0.453	0.276	0
30	-0.138	-0.591	0.447	0.274	0
50	-0.138	-0.588	0.447	0.274	0
100	-0.139	-0.567	0.435	0.269	0
200	-0.138	-0.576	0.444	0.273	0
300					
1000					

Dose Rate = 100.08 Rads(Si)/sec, V+ = +5V, V- = -5V, V_{CM} = 0V and R_L = 1kΩ unless specified otherwise.

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