# 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.

# LM136AH-5.0 Total Dose Radiation Test Summary

Summary:

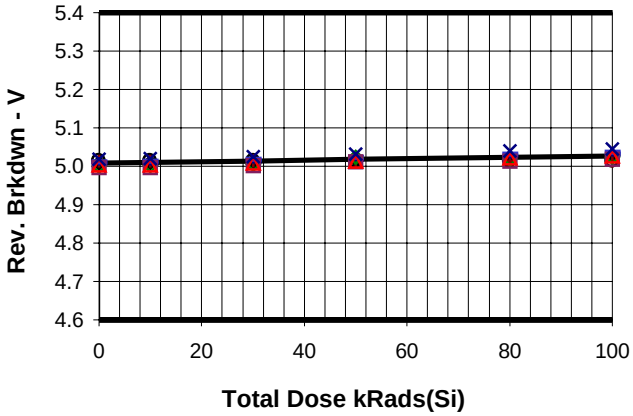
The LM136AH-5.0 is a precision 5.0V shunt regulator diode. This monolithic IC voltage reference operates as a low temperature coefficient 5.0V zener with 0.6ohms dynamic impedance. A third terminal on the LM136AH-5.0 allows the reference voltage and temperature coefficient to be trimmed easily. This report presents characteristics of nine parameters of the LM136AH-5.0. All parameters except for the Reverse Breakdown Voltage stayed within the spec to 100k. After 100k Rads(Si) exposure, four of the six samples had drifted out of the Reverse Breakdown Voltage pre radiation spec of 5.029V. The average of the six samples for Reverse Breakdown Voltage which started at 5.015V at Pre Rad test drifted to 5.033V after 100k Rads(Si) exposure.

Following table shows a summary of average changes after 100krad exposure for each of the nine parameters presented in this report. The attached pages document readings at pre rad, and post 10k, 30k, 50k, 80k and 100k Rads(Si).

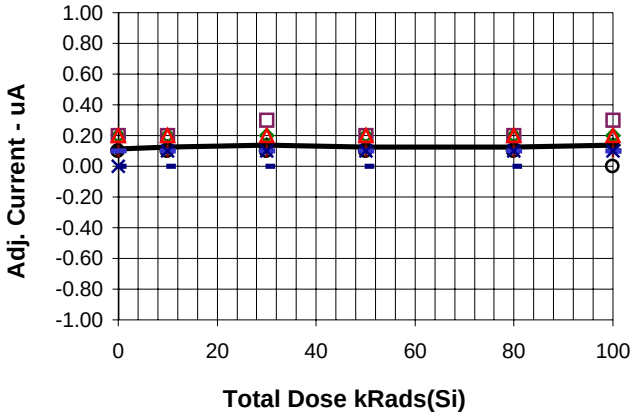
| Parameter | Avg. Post 100k Change |
|---|---|
| Reverse Breakdown Voltage (Vadj = 2.5V) | .018V |
| Adjust Current (Vadj = 2.5V) | .025uA |
| Reverse Breakdown Voltage (Vadj = 1.5V) | .016V |
| Adjust Current (Vadj = 1.5V) | .225uA |
| Reverse Breakdown Voltage (Vadj = 3.5V) | .018V |
| Adjust Current (Vadj = 3.5V) | -0.213uA |
| Reverse Breakdown Change w/Current (.6mA<=Ir<=15mA | 3.79mV |
| Reverse Breakdown Voltage (Vadj = open) | .018V |
| Forward Voltage (IR = -10mA) | -0.022V |

# LM136AH-5.0
# Total Dose Radiation Test Characteristics

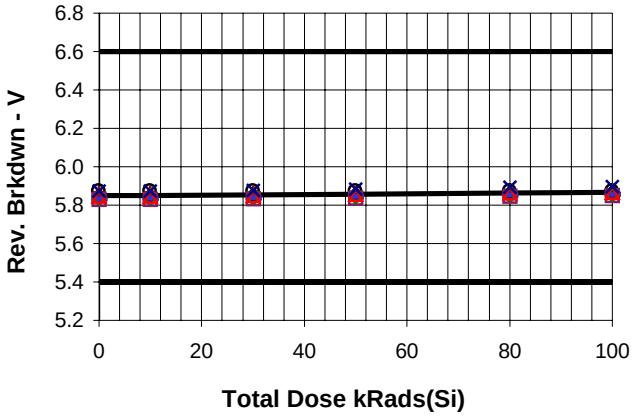
**Reverse Breakdown Voltage vs Total Dose (Vadj = 2.5V)**



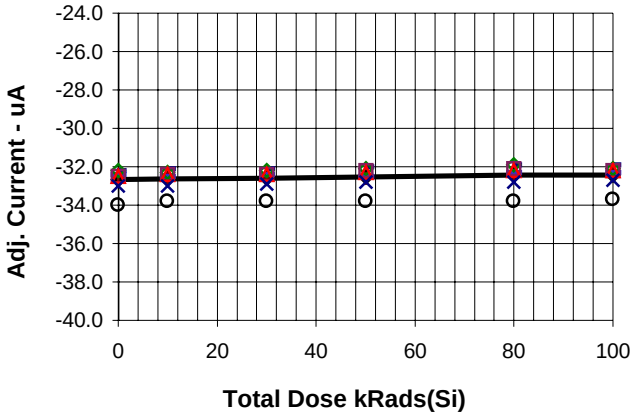

**Adjust Current vs Total Dose (Vadj = 2.5V)**



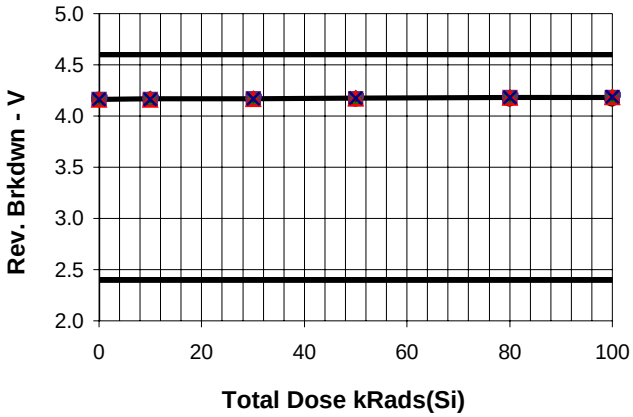

**Reverse Breakdown Voltage vs Total Dose (Vadj = 1.5V)**



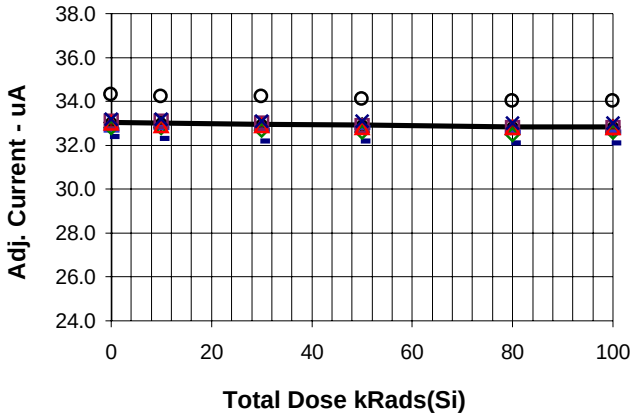

**Adjust Current vs Total Dose (Vadj = 1.5V)**




**Reverse Breakdown Voltage vs Total Dose (Vadj = 3.5V)**




**Adjust Current vs Total Dose (Vadj = 3.5V)**




Total Dose: 55.902 Rads(Si)/sec, Ir = 1mA unless specified otherwise.

# LM136AH-5.0
# Total Dose Radiation Test Characteristics

Reverse Breakdown Voltage vs
Total Dose (Vadj = 2.5V)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 5.008 | 4.996 | 5.019 | 0.008 | 0 |
| 10 | 5.009 | 4.997 | 5.020 | 0.008 | 0 |
| 30 | 5.013 | 5.001 | 5.025 | 0.008 | 0 |
| 50 | 5.019 | 5.011 | 5.032 | 0.007 | 0 |
| 80 | 5.023 | 5.014 | 5.040 | 0.010 | 0 |
| 100 | 5.026 | 5.014 | 5.045 | 0.011 | 0 |

Adjust Current vs Total
Dose (Vadj = 2.5V)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 0.113 | 0.0 | 0.2 | 0.083 | 0 |
| 10 | 0.125 | 0.0 | 0.2 | 0.071 | 0 |
| 30 | 0.138 | 0.0 | 0.3 | 0.092 | 0 |
| 50 | 0.125 | 0.0 | 0.2 | 0.071 | 0 |
| 80 | 0.125 | 0.0 | 0.2 | 0.071 | 0 |
| 100 | 0.138 | 0.0 | 0.3 | 0.092 | 0 |

Reverse Breakdown Voltage vs
Total Dose (Vadj = 1.5V)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 5.849 | 5.829 | 5.873 | 0.019 | 0 |
| 10 | 5.849 | 5.829 | 5.874 | 0.019 | 0 |
| 30 | 5.852 | 5.833 | 5.878 | 0.018 | 0 |
| 50 | 5.856 | 5.838 | 5.884 | 0.017 | 0 |
| 80 | 5.862 | 5.846 | 5.893 | 0.016 | 0 |
| 100 | 5.865 | 5.851 | 5.898 | 0.015 | 0 |

Adjust Current vs Total
Dose (Vadj = 1.5V)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | -32.663 | -34.0 | -32.2 | 0.595 | 0 |
| 10 | -32.638 | -33.8 | -32.1 | 0.537 | 0 |
| 30 | -32.600 | -33.8 | -32.1 | 0.542 | 0 |
| 50 | -32.538 | -33.8 | -32.0 | 0.576 | 0 |
| 80 | -32.438 | -33.8 | -31.9 | 0.628 | 0 |
| 100 | -32.438 | -33.7 | -31.9 | 0.560 | 0 |

Reverse Breakdown Voltage vs
Total Dose (Vadj = 3.5V)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 4.166 | 4.155 | 4.187 | 0.012 | 0 |
| 10 | 4.167 | 4.155 | 4.189 | 0.012 | 0 |
| 30 | 4.170 | 4.155 | 4.194 | 0.013 | 0 |
| 50 | 4.175 | 4.155 | 4.199 | 0.015 | 0 |
| 80 | 4.181 | 4.155 | 4.207 | 0.018 | 0 |
| 100 | 4.184 | 4.155 | 4.212 | 0.020 | 0 |

Adjust Current vs Total
Dose (Vadj = 3.5V)

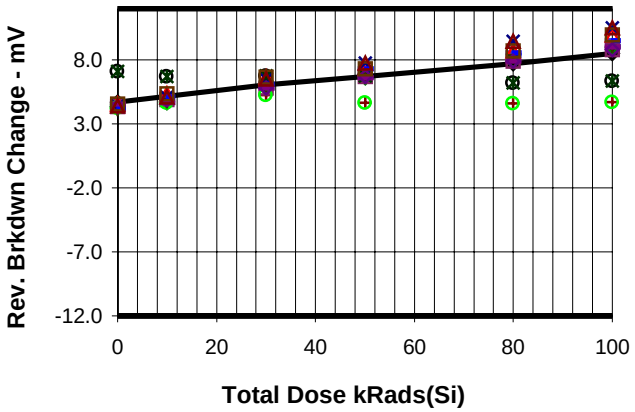
| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 33.038 | 32.4 | 34.3 | 0.568 | 0 |
| 10 | 33.025 | 32.3 | 34.2 | 0.544 | 0 |
| 30 | 32.963 | 32.2 | 34.2 | 0.571 | 0 |
| 50 | 32.925 | 32.2 | 34.1 | 0.544 | 0 |
| 80 | 32.825 | 32.1 | 34.0 | 0.547 | 0 |
| 100 | 32.825 | 32.1 | 34.0 | 0.542 | 0 |

Total Dose: 55.902 Rads(Si)/sec, Ir = 1mA unless specified otherwise.

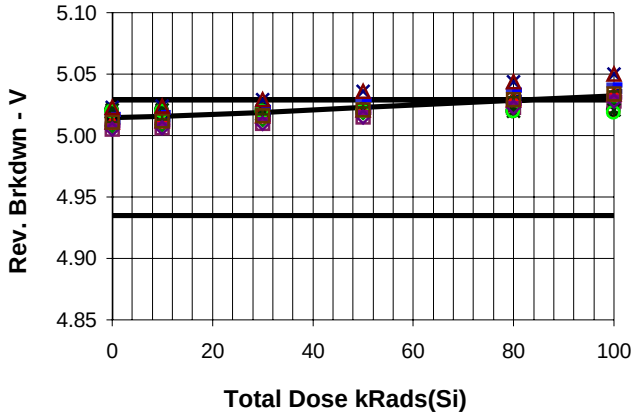
Note 1: Number of devices that were outside MDS sub group 1 limits.

# LM136AH-5.0
# Total Dose Radiation Test Characteristics

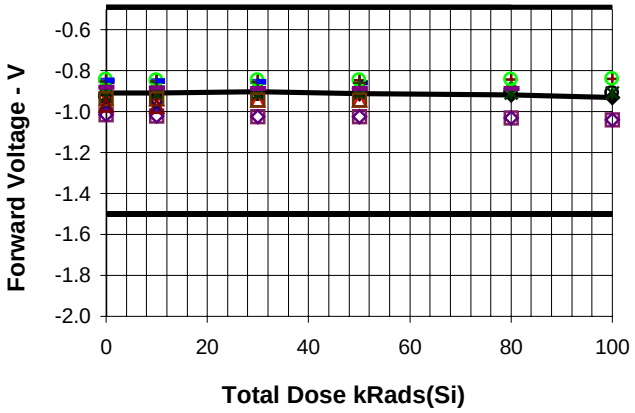
**Reverse Breakdown Change with Current vs Total Dose (.6mA<= Ir <= 15mA)**




**Reverse Breakdown Voltage vs Total Dose (Vadj = Open)**




**Forward Voltage vs Total Dose (Ir = -10mA)**




Total Dose: 55.902 Rads(Si)/sec, Ir = 1mA unless specified otherwise.

# LM136AH-5.0
# Total Dose Radiation Test Characteristics

Reverse Breakdown Change with
Current vs Total Dose (.6mA<= Ir <= 15mA)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 4.693 | 4.120 | 7.100 | 0.983 | 0 |
| 10 | 5.138 | 4.630 | 6.700 | 0.681 | 0 |
| 30 | 6.070 | 5.240 | 6.740 | 0.520 | 0 |
| 50 | 6.714 | 4.630 | 7.750 | 0.936 | 0 |
| 80 | 7.710 | 4.590 | 9.460 | 1.568 | 0 |
| 100 | 8.483 | 4.680 | 10.500 | 1.961 | 0 |

Reverse Breakdown Voltage vs
Total Dose (Vadj = Open)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | 5.015 | 5.0 | 5.0 | 0.007 | 0 |
| 10 | 5.016 | 5.0 | 5.0 | 0.006 | 0 |
| 30 | 5.019 | 5.0 | 5.0 | 0.006 | 0 |
| 50 | 5.023 | 5.0 | 5.0 | 0.007 | 1 |
| 80 | 5.029 | 5.0 | 5.0 | 0.008 | 3 |
| 100 | 5.033 | 5.0 | 5.1 | 0.010 | 5 |

Forward Voltage vs
Total Dose (Ir = -10mA)

| Dose | Avg. | Min. | Max. | S. Dev. | Fail[1] |
|---|---|---|---|---|---|
| 0 | -0.909 | -1.017 | -0.845 | 0.064 | 0 |
| 10 | -0.911 | -1.021 | -0.847 | 0.064 | 0 |
| 30 | -0.904 | -1.026 | -0.848 | 0.065 | 1 |
| 50 | -0.913 | -1.025 | -0.847 | 0.066 | 2 |
| 80 | -0.917 | -1.030 | -0.844 | 0.080 | 4 |
| 100 | -0.931 | -1.041 | -0.842 | 0.101 | 5 |

Total Dose: 55.902 Rads(Si)/sec, Ir = 1mA unless specified otherwise.
Note 1: Number of devices that were outside MDS sub group 1 limits.