



IRUH33PA13B20K

ELDRS Test Report

FEBRUARY 2006

Revision A

Table of Contents

| | |
|---|---|
| Introduction | 3 |
| Summary of Results | 3 |
| Test Method | 3 |
| Test Plan | 3 |
| Test Facility | 4 |
| Test Results | 5 |
| Conclusion | 9 |
| Appendix A – Electrical Data | |
| Appendix B – Radiation Test Specification | |

INTRODUCTION

This test report covers the total ionizing dose tests performed on the IRUH33PA13B20K Adjustable Low Dropout linear regulator in a hermetic package. The ELDRS test was performed on ten samples of the device from production lot H903185, which had completed MIL-PRF-38534 "H" level assembly and screening. On January 19, 2006 International Rectifier tested this device for ELDRS hardness at the University of Massachusetts, Nuclear Research Facility using their CO⁶⁰ source.

SUMMARY OF RESULTS

All of the test samples passed the post radiation test requirements for total ionizing dose levels up to 44.6K RAD(Si). The results show more degradation on the off-bias devices for all tests parameters as a function of radiation. The "ON" biased samples passed the post radiation test requirements for all of the required dose levels.

TEST METHOD

The test method used as a guide in the development of the Test Plan was MIL-STD-883, Method 1019 Ionizing Radiation, Condition C. This method establishes the basic requirements for the performance and execution of the tests.

TEST PLAN

The samples were exposed to CO⁶⁰ irradiation in both an "ON" and "OFF" biased state per the requirements of the test plan and the radiation test specification. Post radiation testing of the devices occurred at the UMass facility after each dose step was complete. The devices were tested starting on January 20, 2006 for post radiation effects for dose levels up to 100K Rad(Si) at a dose rate of 0.065 Rad(Si)/sec.

ON Biased serial numbers: 111, 114, 89, 67, 96
OFF Biased serial numbers: 94, 93, 85, 117, 76
Control Samples: 71 and 107.

The Radiation Test Specification is included in Appendix B. The testing occurred in the following manner:

1.0 Purpose

The purpose of this test is to characterize and qualify the ELDRS effects for International Rectifier's hybrid low dropout regulator devices. The data resulting from the tests may be incorporated in the IR data sheet for the product.

2.0 Test Responsibility

International Rectifier shall be responsible for conducting the tests, which shall be performed at the University of Massachusetts Research Reactor facility. International Rectifier shall be responsible for the final Test Report.

3.0 Test Facility

3.1 Nuclear Reactor

The University of Massachusetts Research Reactor shall be used to provide the source for Gamma radiation. UMRR will also provide information on dose rate, total dose, irradiation test times and dosimetry for this evaluation.

3.2 Test Equipment

The necessary test equipment including interface board, cables, power supplies, measurement system, etc. shall be provided by International Rectifier.

3.3 Sample Size

Sample size shall be determined based on device type, characterization parameters. As a minimum, the sample size shall meet the requirements of Mil- PRF-38534. Sample size for this TID evaluation equals 12 devices. Five of the samples shall be biased with the worst-case input voltage of 6.8 volts and five samples shall be biased "in-circuit" with the power supply turned off. Two samples shall be maintained as controls of which one shall be tested at each dose step.

4.0 Test Devices

4.1 The following device is planned for Total Ionizing Dose characterization:

- a. IRUH33PA13B20K

4.2 All devices shall be subjected to a minimum of 160hrs of burn-in and electrically tested over the entire operating range prior to radiation exposure.

4.3 All devices shall be tested after each radiation exposure per T090104G within 1 hour and placed back on to radiation exposure within 2 hours.

5.0 Test Method

MIL-STD-883, Method 1019 Condition C shall be used to establish the procedure for all testing described herein.

6.0 Record Keeping

The Reactor facility shall provide dosimetry data for the CO⁶⁰ source. Each exposure run shall be cataloged with the appropriate number in order to maintain correlation to the appropriate data set. IR will be responsible for collecting and compiling the test data.

7.0 Test Report

The Test Report shall include the following information:

- a. Device type(s), serial numbers, wafer lot identification (per active component)
- b. Test dates
- c. Facility, source type
- d. Bias conditions
- e. Comments and observations
- f. Pre and Post Electrical data
- g. Summary descriptive including graphs (if applicable)

TEST FACILITY

The University of Massachusetts, Lowell, Nuclear Research Reactor is a 1 Mega-Watt, Uranium²³⁵ enhanced core reactor. The UMass Lowell Radiation Laboratory provides controlled radiation environments and analytical measurement services to government organizations and to industry. The laboratory provides facilities for proton, neutron, and gamma environments. The Gamma Cave is an irradiation room inside this facility having an equi-dimensional volume of 512 cubic feet. A wide range of dose rates, 1Gray (100 rad) per hour to 10,000 Gray (1 Mrad) per hour, is available. Several small ports penetrate one shielding wall to provide access for instrumentation cables.

Test Results

The key pre and post radiation test results are shown in Tables 1 thru 10. In Figures 1-6, the parametric shifts are shown graphically for all exposed devices. The raw test data for all the parameters tested is shown in Appendix A. As outlined in the Test Plan, five of the devices exposed to total ionizing dose irradiation were biased “ON” with the maximum input voltage and five samples were placed in the bias circuit with the power supply off or biased “OFF”. All samples passed the post radiation test requirements up to 44.6K RAD(Si). The parameters affected the most by the ionizing radiation were Output Voltage, Ripple Rejection, and Shutdown Threshold Voltage with the worst-case condition being the “OFF” bias.

The output voltage shift over radiation exposure with a 1.5A load current was +6.2% for the “OFF” biased samples and + 3.7% for the “ON” biased samples after exposure 100K RAD(Si). The shift at 44.6K RAD(Si) exposure was +4.7% for the “OFF” biased samples and + 3.2% for the “ON” biased samples.

Table 1 “ON” Biased Samples, VOUT, VIN=3.3V @1.5A

| T#1 | VOUT | | | | | | | |
|----------|------------|-------|-------|-------|-------|--------|-------|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 2.510 | 2.510 | 2.505 | 2.508 | 2.509 | 2.375 | 2.625 | V |
| 107 | 2.494 | 2.495 | 2.495 | 2.493 | 2.492 | 2.375 | 2.625 | V |
| 111 | 2.497 | 2.510 | 2.545 | 2.572 | 2.587 | 2.375 | 2.625 | V |
| 114 | 2.509 | 2.520 | 2.550 | 2.579 | 2.595 | 2.375 | 2.625 | V |
| 89 | 2.506 | 2.520 | 2.554 | 2.588 | 2.601 | 2.375 | 2.625 | V |
| 67 | 2.503 | 2.515 | 2.549 | 2.580 | 2.597 | 2.375 | 2.625 | V |
| 96 | 2.506 | 2.524 | 2.566 | 2.588 | 2.602 | 2.375 | 2.625 | V |
| Min | 2.497 | 2.510 | 2.545 | 2.572 | 2.587 | 2.375 | 2.625 | V |
| Avg | 2.504 | 2.518 | 2.553 | 2.581 | 2.596 | 2.375 | 2.625 | V |
| Max | 2.509 | 2.524 | 2.566 | 2.588 | 2.602 | 2.375 | 2.625 | V |

Table 2 “OFF” Biased Samples, VOUT, VIN=3.3V @1.5A

| T#1 | VOUT | | | | | | | |
|----------|------------|-------|-------|-------|--------------|--------|-------|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 2.510 | 2.510 | 2.505 | 2.508 | 2.509 | 2.375 | 2.625 | V |
| 107 | 2.494 | 2.495 | 2.495 | 2.493 | 2.492 | 2.375 | 2.625 | V |
| 94 | 2.505 | 2.516 | 2.569 | 2.608 | 2.665 | 2.375 | 2.625 | V |
| 93 | 2.499 | 2.517 | 2.563 | 2.610 | 2.655 | 2.375 | 2.625 | V |
| 85 | 2.500 | 2.514 | 2.561 | 2.604 | 2.651 | 2.375 | 2.625 | V |
| 117 | 2.510 | 2.529 | 2.570 | 2.612 | 2.661 | 2.375 | 2.625 | V |
| 76 | 2.499 | 2.515 | 2.556 | 2.600 | 2.651 | 2.375 | 2.625 | V |
| Min | 2.499 | 2.514 | 2.556 | 2.600 | 2.651 | 2.375 | 2.625 | V |
| Avg | 2.503 | 2.518 | 2.564 | 2.607 | 2.657 | 2.375 | 2.625 | V |
| Max | 2.510 | 2.529 | 2.570 | 2.612 | 2.665 | 2.375 | 2.625 | V |

Table 3 “ON” Biased Samples, VDROD, IOU=3A

| T#8 | VDROD | | | | | | | |
|----------|------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 0.20 | 0.20 | 0.19 | 0.19 | 0.20 | 0 | 0.4 | V |
| 107 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0 | 0.4 | V |
| 111 | 0.20 | 0.21 | 0.22 | 0.23 | 0.24 | 0 | 0.4 | V |
| 114 | 0.20 | 0.21 | 0.22 | 0.23 | 0.24 | 0 | 0.4 | V |
| 89 | 0.19 | 0.20 | 0.22 | 0.23 | 0.24 | 0 | 0.4 | V |
| 67 | 0.19 | 0.21 | 0.22 | 0.23 | 0.25 | 0 | 0.4 | V |
| 96 | 0.20 | 0.20 | 0.22 | 0.23 | 0.25 | 0 | 0.4 | V |
| Min | 0.192 | 0.197 | 0.215 | 0.227 | 0.239 | 0 | 0.4 | V |
| Avg | 0.195 | 0.206 | 0.217 | 0.231 | 0.244 | 0 | 0.4 | V |
| Max | 0.199 | 0.212 | 0.219 | 0.234 | 0.250 | 0 | 0.4 | V |

Table 4 “OFF” Biased Samples, VDROD, IOU=3A

| T#8 | VDROD | | | | | | | |
|----------|------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 0.20 | 0.20 | 0.19 | 0.19 | 0.20 | 0 | 0.4 | V |
| 107 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0 | 0.4 | V |
| 94 | 0.20 | 0.20 | 0.22 | 0.22 | 0.25 | 0 | 0.4 | V |
| 93 | 0.19 | 0.20 | 0.22 | 0.23 | 0.25 | 0 | 0.4 | V |
| 85 | 0.21 | 0.22 | 0.23 | 0.25 | 0.23 | 0 | 0.4 | V |
| 117 | 0.20 | 0.22 | 0.22 | 0.24 | 0.27 | 0 | 0.4 | V |
| 76 | 0.20 | 0.21 | 0.22 | 0.24 | 0.25 | 0 | 0.4 | V |
| Min | 0.192 | 0.204 | 0.215 | 0.223 | 0.232 | 0 | 0.4 | V |
| Avg | 0.199 | 0.212 | 0.222 | 0.237 | 0.252 | 0 | 0.4 | V |
| Max | 0.210 | 0.223 | 0.230 | 0.249 | 0.265 | 0 | 0.4 | V |

Table 5 “ON” Biased Samples, CURRENT LIMIT, VIN=3.3

| T#9 | CURRENT LIMIT | | | | | | | |
|----------|---------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 9.2 | 9.2 | 9.2 | 9.1 | 8.9 | 3 | 10 | A |
| 107 | 8.9 | 9.2 | 9.3 | 9.1 | 9.1 | 3 | 10 | A |
| 111 | 8.8 | 9.1 | 9.3 | 9.1 | 8.8 | 3 | 10 | A |
| 114 | 8.8 | 9.1 | 9.3 | 8.9 | 8.9 | 3 | 10 | A |
| 89 | 8.8 | 9.1 | 9.3 | 9.1 | 8.9 | 3 | 10 | A |
| 67 | 9.1 | 9.0 | 8.9 | 8.9 | 8.5 | 3 | 10 | A |
| 96 | 8.9 | 8.8 | 9.1 | 9.1 | 8.8 | 3 | 10 | A |
| Min | 8.795 | 8.845 | 8.935 | 8.868 | 8.511 | 3 | 10 | A |
| Avg | 8.890 | 9.026 | 9.161 | 8.986 | 8.783 | 3 | 10 | A |
| Max | 9.112 | 9.117 | 9.252 | 9.095 | 8.874 | 3 | 10 | A |

Table 6 “OFF” Biased Samples, CURRENT LIMIT, VIN=3.3

| T#9 | CURRENT LIMIT | | | | | | | |
|------------|---------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 9.2 | 9.2 | 9.2 | 9.1 | 8.9 | 3 | 10 | A |
| 107 | 8.9 | 9.2 | 9.3 | 9.1 | 9.1 | 3 | 10 | A |
| 94 | 8.7 | 8.8 | 8.8 | 9.1 | 9.1 | 3 | 10 | A |
| 93 | 8.7 | 8.8 | 9.1 | 9.5 | 8.8 | 3 | 10 | A |
| 85 | 8.5 | 8.5 | 8.8 | 8.5 | 8.5 | 3 | 10 | A |
| 117 | 8.9 | 9.1 | 9.1 | 9.1 | 8.9 | 3 | 10 | A |
| 76 | 8.5 | 9.1 | 9.1 | 9.1 | 8.9 | 3 | 10 | A |
| Min | 8.477 | 8.481 | 8.798 | 8.505 | 8.511 | 3 | 10 | A |
| Avg | 8.649 | 8.861 | 8.980 | 9.040 | 8.838 | 3 | 10 | A |
| Max | 8.885 | 9.117 | 9.116 | 9.459 | 9.101 | 3 | 10 | A |

Table 7 “ON” Biased Samples, RIPPLE REJECTION = 120Hz.

| T#10 | RIPPLE REJECTION | | | | | | | |
|------------|------------------|---------|---------|--------|--------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 97.2 | 97.2 | 99.2 | 99.2 | 98.2 | 40 | 200 | dB |
| 107 | 98.2 | 98.1 | 98.2 | 99.2 | 99.8 | 40 | 200 | dB |
| 111 | 98.6 | 100.4 | 98.6 | 89.5 | 61.9 | 40 | 200 | dB |
| 114 | 97.6 | 99.2 | 100.4 | 91.8 | 61.9 | 40 | 200 | dB |
| 89 | 99.8 | 100.5 | 98.7 | 89.5 | 60.7 | 40 | 200 | dB |
| 67 | 100.4 | 101.2 | 99.2 | 89.6 | 60.8 | 40 | 200 | dB |
| 96 | 97.6 | 99.8 | 101.1 | 89.5 | 61.9 | 40 | 200 | dB |
| Min | 97.600 | 99.230 | 98.630 | 89.450 | 60.740 | 40 | 200 | dB |
| Avg | 98.810 | 100.224 | 99.590 | 89.970 | 61.460 | 40 | 200 | dB |
| Max | 100.400 | 101.200 | 101.100 | 91.820 | 61.940 | 40 | 200 | dB |

Table 8 “OFF” Biased Samples, RIPPLE REJECTION = 120Hz

| T#10 | RIPPLE REJECTION | | | | | | | |
|------------|------------------|---------|--------|--------|--------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 97.2 | 97.2 | 99.2 | 99.2 | 98.2 | 40 | 200 | dB |
| 107 | 98.2 | 98.1 | 98.2 | 99.2 | 99.8 | 40 | 200 | dB |
| 94 | 98.1 | 99.8 | 95.1 | 63.3 | 58.0 | 40 | 200 | dB |
| 93 | 99.2 | 99.2 | 96.3 | 64.9 | 59.7 | 40 | 200 | dB |
| 85 | 98.1 | 100.5 | 95.9 | 61.9 | 59.7 | 40 | 200 | dB |
| 117 | 98.1 | 99.2 | 95.5 | 64.8 | 59.7 | 40 | 200 | dB |
| 76 | 99.7 | 98.6 | 95.9 | 64.9 | 59.7 | 40 | 200 | dB |
| Min | 98.060 | 98.630 | 95.110 | 61.900 | 58.020 | 40 | 200 | dB |
| Avg | 98.622 | 99.468 | 95.744 | 63.946 | 59.370 | 40 | 200 | dB |
| Max | 99.740 | 100.500 | 96.310 | 64.860 | 59.720 | 40 | 200 | dB |

Table 9 “ON” Biased Samples, VOLTAGE SHUTDOWN

| T#11 | VSHDN | | | | | | | |
|----------|------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 1.38 | 1.38 | 1.37 | 1.35 | 1.36 | 1 | 1.7 | V |
| 107 | 1.32 | 1.34 | 1.31 | 1.35 | 1.36 | 1 | 1.7 | V |
| 111 | 1.34 | 1.36 | 1.45 | 1.51 | 1.53 | 1 | 1.7 | V |
| 114 | 1.36 | 1.38 | 1.45 | 1.47 | 1.53 | 1 | 1.7 | V |
| 89 | 1.36 | 1.38 | 1.45 | 1.51 | 1.53 | 1 | 1.7 | V |
| 67 | 1.32 | 1.34 | 1.43 | 1.45 | 1.51 | 1 | 1.7 | V |
| 96 | 1.34 | 1.38 | 1.51 | 1.53 | 1.55 | 1 | 1.7 | V |
| Min | 1.319 | 1.338 | 1.432 | 1.447 | 1.507 | 1 | 1.7 | V |
| Avg | 1.344 | 1.367 | 1.459 | 1.493 | 1.527 | 1 | 1.7 | V |
| Max | 1.360 | 1.380 | 1.505 | 1.530 | 1.548 | 1 | 1.7 | V |

Table 10 “OFF” Biased Samples, VOLTAGE SHUTDOWN

| T#11 | VSHDN | | | | | | | |
|----------|------------|-------|-------|-------|-------|--------|-----|-----|
| Serial # | KRAD LEVEL | | | | | Limits | | U/M |
| | 0 | 6 | 22 | 45 | 100 | Min | Max | |
| 71 | 1.38 | 1.38 | 1.37 | 1.35 | 1.36 | 1 | 1.7 | V |
| 107 | 1.32 | 1.34 | 1.31 | 1.35 | 1.36 | 1 | 1.7 | V |
| 94 | 1.32 | 1.38 | 1.47 | 1.50 | 1.47 | 1 | 1.7 | V |
| 93 | 1.34 | 1.34 | 1.45 | 1.49 | 1.47 | 1 | 1.7 | V |
| 85 | 1.32 | 1.36 | 1.43 | 1.47 | 1.44 | 1 | 1.7 | V |
| 117 | 1.34 | 1.40 | 1.47 | 1.49 | 1.47 | 1 | 1.7 | V |
| 76 | 1.32 | 1.36 | 1.41 | 1.45 | 1.44 | 1 | 1.7 | V |
| Min | 1.319 | 1.338 | 1.411 | 1.447 | 1.444 | 1 | 1.7 | V |
| Avg | 1.327 | 1.367 | 1.449 | 1.478 | 1.457 | 1 | 1.7 | V |
| Max | 1.339 | 1.401 | 1.474 | 1.499 | 1.465 | 1 | 1.7 | V |

Parametric Shifts as a Function of ELDRS Radiation

Figure 1

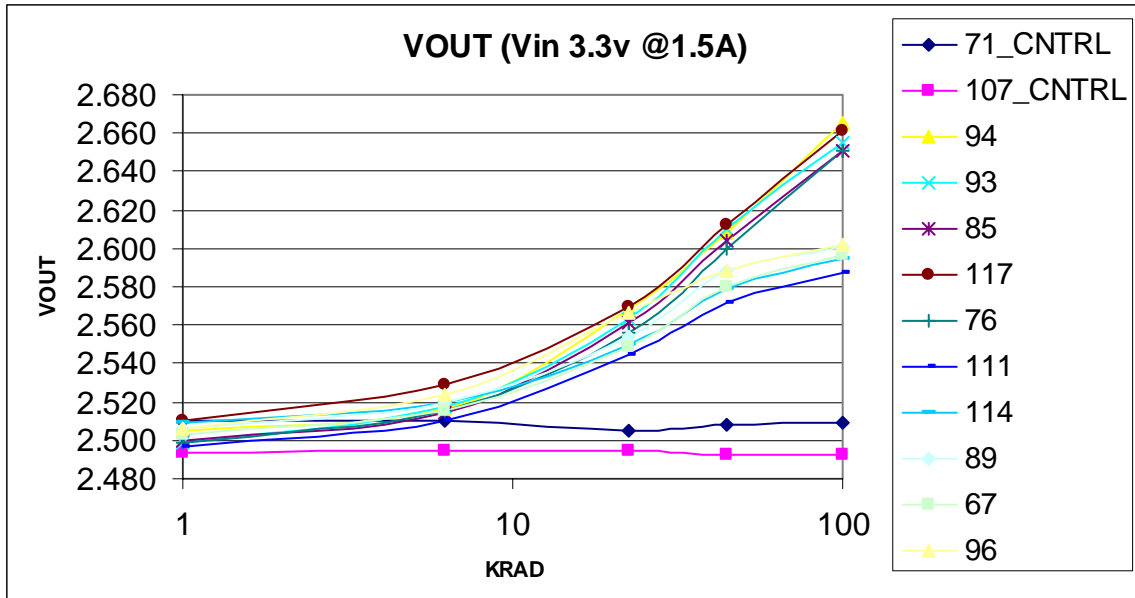


Figure 2

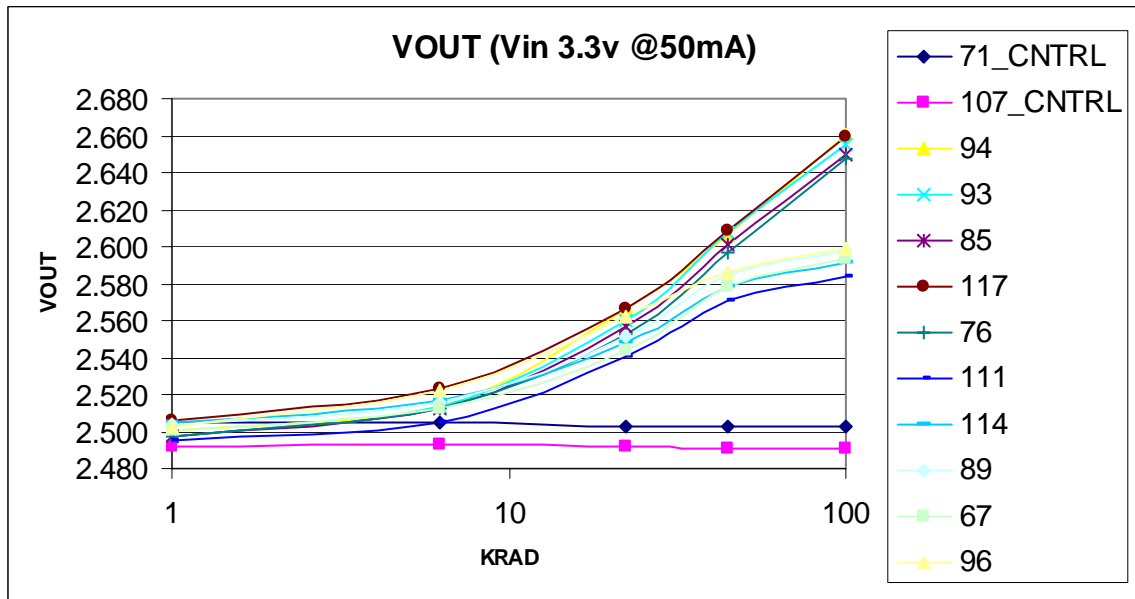


Figure 3

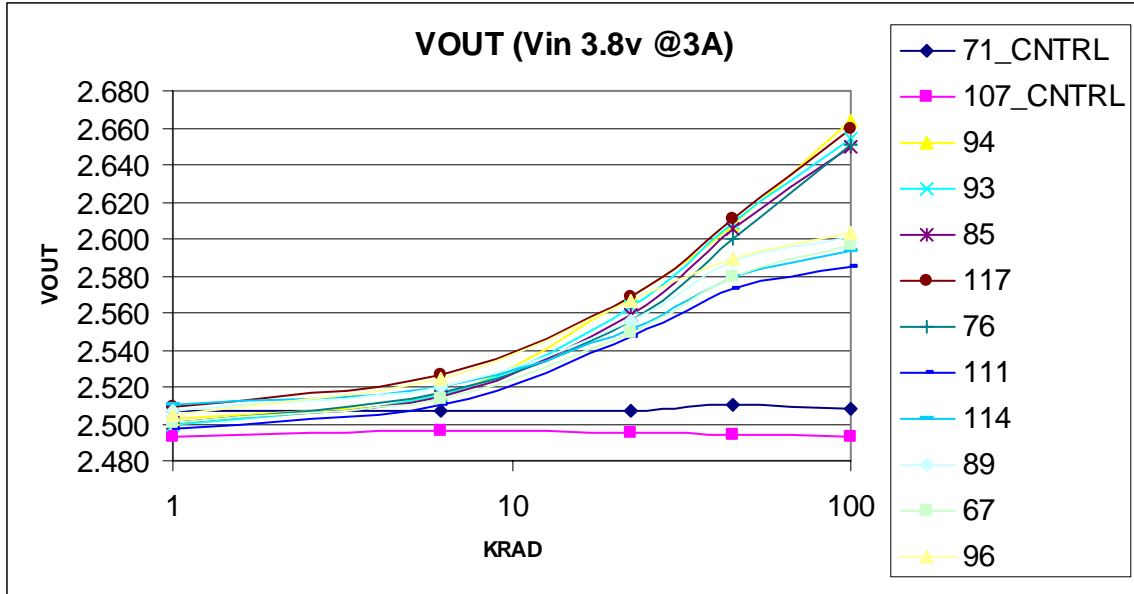


Figure 4

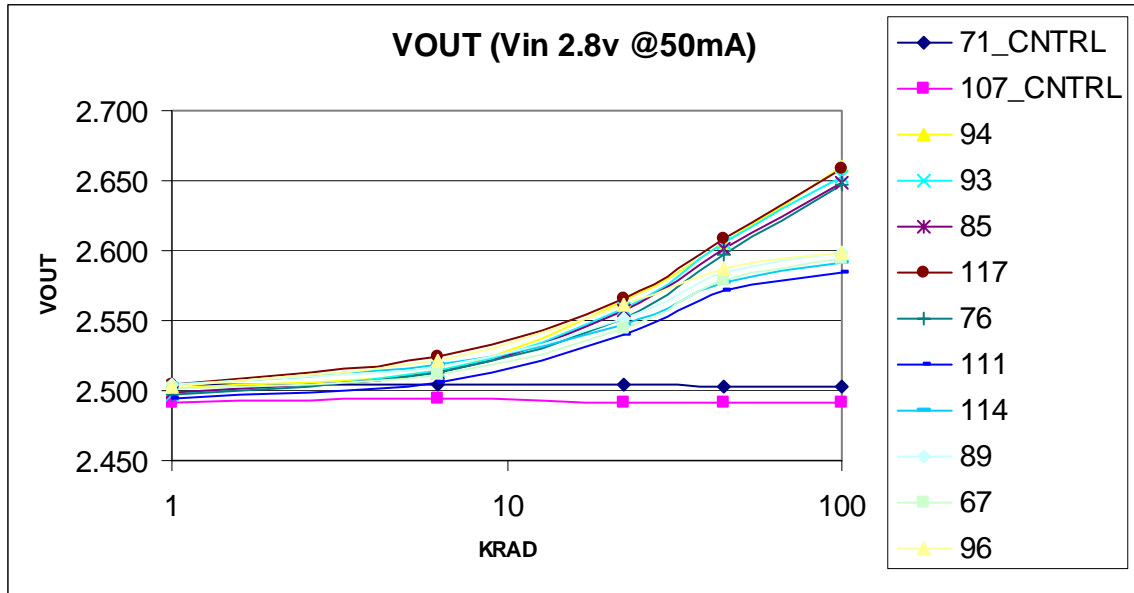


Figure 5

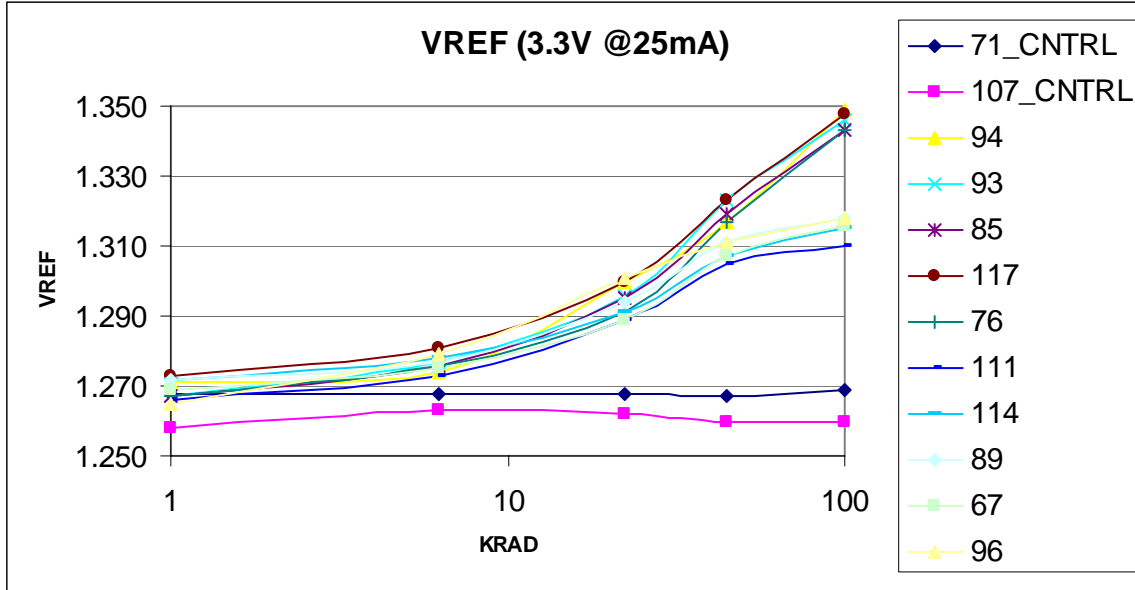
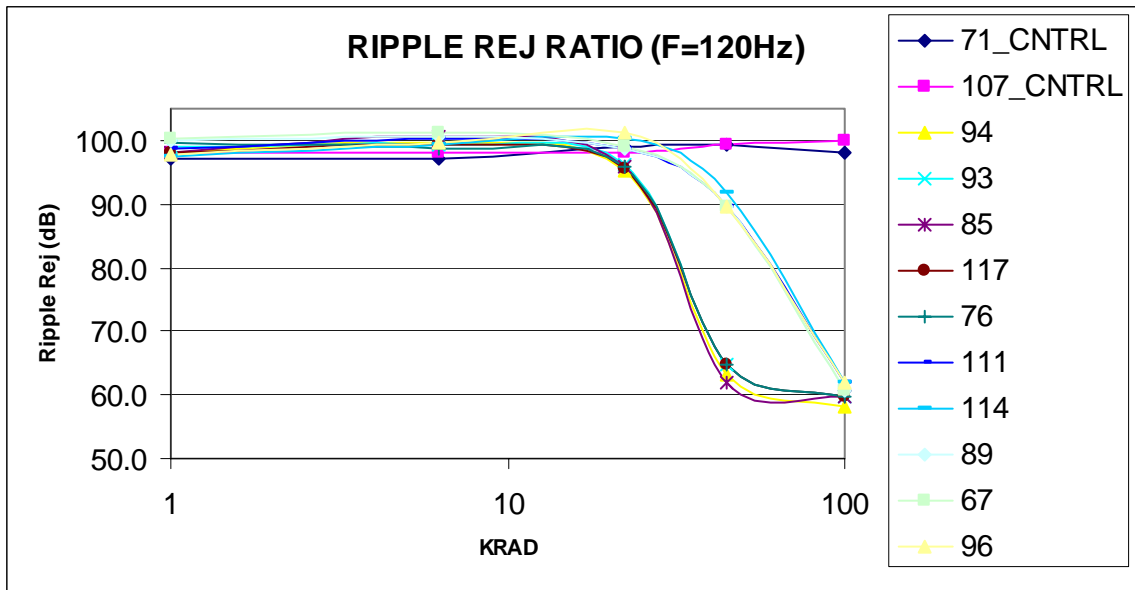


Figure 6



CONCLUSION

The IRUH33PA13B20K has demonstrated hardness to ELDRS radiation exposure up to 44.6 KRAD(Si) at dose rate of 0.065 Rad (Si)/sec with no parametric failures when device is in the "ON" or "OFF" bias condition and the results show it to meet all the post radiation test requirements. There are parametric shifts for Output Voltage, Dropout Voltage, Ripple Rejection, and Shutdown Threshold Voltage, which need to be considered in designs where tight tolerances over the life of the product need to be maintained.

Appendix A

Electrical Data

Electrical Test Data (Pre-radiation)

| TEST | Vout1 | Vout2 | Vout3 | Vout4 | Vout5 | Line Reg | Load Reg | Vdrop | Current Limit | Ripple Rej. | Vshdn | Vout @shdn | Ishdn* |
|-----------|-------|-------|-------|-------|-------|----------|----------|-------|---------------|-------------|-------|------------|--------|
| Max Limit | 2.525 | 2.625 | 2.625 | 2.625 | 2.625 | 6.25 | 73.8 | 0.4 | 10 | 200 | 1.6 | 100 | ---- |
| Min Limit | 2.475 | 2.375 | 2.375 | 2.375 | 2.375 | -6.25 | -73.8 | 0 | 3 | 65 | 1.0 | -100 | ---- |
| Serial # | (V) | (V) | (V) | (V) | (V) | (mV) | (mV) | (V) | (A) | (dB) | (V) | (mV) | (uA) |
| 71 | 2.510 | 2.505 | 2.507 | 2.504 | 1.268 | -0.678 | 4.370 | 0.201 | 9.152 | 97.18 | 1.378 | -1.967 | 0.151 |
| 107 | 2.494 | 2.492 | 2.493 | 2.492 | 1.258 | 0.181 | 4.541 | 0.193 | 8.907 | 98.18 | 1.319 | -1.059 | 0.147 |
| 94 | 2.505 | 2.501 | 2.503 | 2.502 | 1.271 | -1.718 | 3.237 | 0.195 | 8.658 | 98.06 | 1.319 | -1.033 | 0.145 |
| 93 | 2.499 | 2.497 | 2.500 | 2.497 | 1.267 | -0.407 | 2.402 | 0.192 | 8.749 | 99.15 | 1.339 | -1.133 | 0.145 |
| 85 | 2.500 | 2.497 | 2.501 | 2.498 | 1.267 | -0.407 | 4.260 | 0.210 | 8.477 | 98.06 | 1.319 | -1.119 | 0.144 |
| 117 | 2.510 | 2.506 | 2.509 | 2.505 | 1.273 | 0.090 | 2.834 | 0.203 | 8.885 | 98.10 | 1.339 | -0.975 | 0.151 |
| 76 | 2.499 | 2.497 | 2.501 | 2.497 | 1.267 | -0.904 | 4.157 | 0.195 | 8.477 | 99.74 | 1.319 | -1.018 | 0.149 |
| 111 | 2.497 | 2.495 | 2.497 | 2.494 | 1.266 | 0.045 | 3.010 | 0.195 | 8.840 | 98.58 | 1.339 | -1.248 | 0.146 |
| 114 | 2.509 | 2.505 | 2.510 | 2.505 | 1.272 | -0.542 | 4.206 | 0.199 | 8.840 | 97.60 | 1.360 | -1.578 | 0.150 |
| 89 | 2.506 | 2.504 | 2.507 | 2.505 | 1.272 | 0.090 | 3.547 | 0.192 | 8.795 | 99.83 | 1.360 | -1.535 | 0.145 |
| 67 | 2.503 | 2.501 | 2.501 | 2.501 | 1.269 | -0.136 | 2.428 | 0.192 | 9.112 | 100.40 | 1.319 | -2.338 | 0.151 |
| 96 | 2.506 | 2.503 | 2.505 | 2.503 | 1.265 | -0.949 | 3.199 | 0.197 | 8.862 | 97.64 | 1.340 | -1.332 | 0.146 |

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 6K RAD(Si))

| TEST | Vout1 | Vout2 | Vout3 | Vout4 | Vout5 | Line Reg | Load Reg | Vdrop | Current Limit | Ripple Rej. | Vshdn | Vout @shdn | Ishdn* |
|-----------|-------|-------|-------|-------|-------|----------|----------|-------|---------------|-------------|-------|------------|--------|
| Max Limit | 2.625 | 2.625 | 2.625 | 2.625 | 2.625 | 12.5 | 147.6 | 0.4 | 10 | 200 | 1.7 | 100 | ---- |
| Min Limit | 2.375 | 2.375 | 2.375 | 2.375 | 2.375 | -12.5 | -147.6 | 0 | 3 | 65 | 1.0 | -100 | ---- |
| Serial # | (V) | (V) | (V) | (V) | (V) | (mV) | (mV) | (V) | (A) | (dB) | (V) | (mV) | (uA) |
| 71 | 2.510 | 2.505 | 2.507 | 2.504 | 1.268 | -0.677 | 4.37 | 0.201 | 9.152 | 97.18 | 1.378 | -1.967 | 0.1514 |
| 107 | 2.495 | 2.493 | 2.496 | 2.494 | 1.263 | -0.225 | 4.297 | 0.189 | 9.198 | 98.14 | 1.336 | -1.034 | 0.146 |
| 94 | 2.516 | 2.513 | 2.516 | 2.514 | 1.274 | -1.31 | 4.468 | 0.204 | 8.790 | 99.79 | 1.378 | -1.034 | 0.1427 |
| 93 | 2.517 | 2.514 | 2.516 | 2.514 | 1.277 | -0.993 | 4.023 | 0.204 | 8.845 | 99.23 | 1.338 | -1.277 | 0.1474 |
| 85 | 2.514 | 2.512 | 2.515 | 2.513 | 1.276 | -0.722 | 2.932 | 0.223 | 8.481 | 100.50 | 1.359 | -1.233 | 0.1413 |
| 117 | 2.529 | 2.523 | 2.526 | 2.524 | 1.281 | -0.406 | 3.008 | 0.219 | 9.072 | 99.19 | 1.401 | -0.557 | 0.1464 |
| 76 | 2.515 | 2.512 | 2.517 | 2.513 | 1.276 | 0.1355 | 4.805 | 0.208 | 9.117 | 98.63 | 1.359 | -2.111 | 0.1435 |
| 111 | 2.510 | 2.505 | 2.510 | 2.506 | 1.273 | -0.180 | 3.21 | 0.212 | 9.072 | 100.40 | 1.359 | -2.212 | 0.1444 |
| 114 | 2.520 | 2.517 | 2.520 | 2.519 | 1.278 | 0.6777 | 5.719 | 0.212 | 9.072 | 99.23 | 1.380 | -2.457 | 0.1462 |
| 89 | 2.520 | 2.516 | 2.520 | 2.517 | 1.277 | -0.180 | 3.026 | 0.197 | 9.117 | 100.50 | 1.380 | -0.859 | 0.1445 |
| 67 | 2.515 | 2.512 | 2.514 | 2.512 | 1.275 | 0.3614 | 3.396 | 0.208 | 9.026 | 101.20 | 1.338 | -2.338 | 0.1512 |
| 96 | 2.524 | 2.522 | 2.524 | 2.522 | 1.279 | 0.4969 | 2.368 | 0.204 | 8.845 | 99.79 | 1.380 | -1.332 | 0.1461 |

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 22K RAD(Si))

| TEST | Vout1 | Vout2 | Vout3 | Vout4 | Vout5 | Line Reg | Load Reg | Vdrop | Current Limit | Ripple Rej. | Vshdn | Vout @shdn | Ishdn* |
|-----------|-------|-------|-------|-------|-------|----------|----------|-------|---------------|-------------|-------|------------|--------|
| Max Limit | 2.625 | 2.625 | 2.625 | 2.625 | 2.625 | 12.5 | 147.6 | 0.4 | 10 | 200 | 1.7 | 100 | ---- |
| Min Limit | 2.375 | 2.375 | 2.375 | 2.375 | 2.375 | -12.5 | -147.6 | 0 | 3 | 40 | 1.0 | -100 | ---- |
| Serial # | (V) | (V) | (V) | (V) | (V) | (mV) | (mV) | (V) | (A) | (dB) | (V) | (mV) | (uA) |
| 71 | 2.505 | 2.503 | 2.507 | 2.504 | 1.268 | 0.4516 | 4.534 | 0.189 | 9.207 | 99.150 | 1.369 | -1.565 | 0.149 |
| 107 | 2.495 | 2.492 | 2.495 | 2.491 | 1.262 | -0.541 | 3.915 | 0.189 | 9.252 | 98.150 | 1.306 | -1.738 | 0.1488 |
| 94 | 2.569 | 2.566 | 2.569 | 2.565 | 1.300 | -0.541 | 4.025 | 0.223 | 8.844 | 95.110 | 1.474 | -2.227 | 0.1388 |
| 93 | 2.563 | 2.560 | 2.563 | 2.558 | 1.296 | -0.271 | 3.761 | 0.219 | 9.071 | 96.310 | 1.453 | -3.149 | 0.1399 |
| 85 | 2.561 | 2.557 | 2.559 | 2.557 | 1.295 | 0 | 3.208 | 0.230 | 8.798 | 95.870 | 1.432 | -3.351 | 0.1387 |
| 117 | 2.570 | 2.567 | 2.569 | 2.566 | 1.300 | 0.7226 | 3.438 | 0.223 | 9.116 | 95.520 | 1.474 | -3.235 | 0.1433 |
| 76 | 2.556 | 2.552 | 2.556 | 2.551 | 1.291 | -0.180 | 4.166 | 0.215 | 9.071 | 95.910 | 1.411 | -3.423 | 0.1417 |
| 111 | 2.545 | 2.541 | 2.547 | 2.540 | 1.289 | 0 | 5.714 | 0.215 | 9.252 | 98.630 | 1.453 | -0.686 | 0.1367 |
| 114 | 2.550 | 2.548 | 2.551 | 2.547 | 1.291 | 0.6774 | 2.704 | 0.219 | 9.252 | 100.400 | 1.453 | -1.162 | 0.1419 |
| 89 | 2.554 | 2.551 | 2.556 | 2.552 | 1.294 | 0.271 | 4.518 | 0.215 | 9.252 | 98.670 | 1.453 | -1.867 | 0.1386 |
| 67 | 2.549 | 2.544 | 2.549 | 2.545 | 1.289 | 0.4968 | 2.37 | 0.219 | 8.935 | 99.150 | 1.432 | -1.507 | 0.1393 |
| 96 | 2.566 | 2.562 | 2.566 | 2.562 | 1.301 | 0.6774 | 4.78 | 0.215 | 9.113 | 101.100 | 1.505 | -2.602 | 0.1421 |

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 44K RAD(Si))

| TEST | Vout1 | Vout2 | Vout3 | Vout4 | Vout5 | Line Reg | Load Reg | Vdrop | Current Limit | Ripple Rej. | Vshdn | Vout @shdn | Ishdn* |
|-----------|-------|-------|-------|-------|-------|----------|----------|-------|---------------|-------------|-------|------------|--------|
| Max Limit | 2.625 | 2.625 | 2.625 | 2.625 | 2.625 | 12.5 | 147.6 | 0.4 | 10 | 200 | 1.7 | 100 | ---- |
| Min Limit | 2.375 | 2.375 | 2.375 | 2.375 | 2.375 | -12.5 | -147.6 | 0 | 3 | 40 | 1.0 | -100 | ---- |
| Serial # | (V) | (V) | (V) | (V) | (V) | (mV) | (mV) | (V) | (A) | (dB) | (V) | (mV) | (uA) |
| 71 | 2.508 | 2.503 | 2.510 | 2.503 | 1.267 | -0.0903 | 7.459 | 0.189 | 9.134 | 99.240 | 1.352 | -0.982 | 0.1478 |
| 107 | 2.493 | 2.491 | 2.494 | 2.491 | 1.260 | -0.0903 | 3.813 | 0.186 | 9.089 | 99.240 | 1.352 | -1.73 | 0.1458 |
| 94 | 2.608 | 2.606 | 2.608 | 2.606 | 1.317 | 1.265 | 2.861 | 0.223 | 9.089 | 63.290 | 1.499 | -1.241 | 0.1384 |
| 93 | 2.610 | 2.608 | 2.609 | 2.606 | 1.323 | -0.0452 | 2.134 | 0.234 | 9.459 | 64.860 | 1.488 | -1.942 | 0.1406 |
| 85 | 2.604 | 2.601 | 2.605 | 2.601 | 1.319 | 2.169 | 3.323 | 0.249 | 8.505 | 61.900 | 1.468 | -2.072 | 0.1381 |
| 117 | 2.612 | 2.609 | 2.611 | 2.609 | 1.323 | 0 | 1.983 | 0.238 | 9.050 | 64.820 | 1.488 | -3.31 | 0.1411 |
| 76 | 2.600 | 2.597 | 2.600 | 2.597 | 1.317 | 0.6327 | 3.439 | 0.238 | 9.095 | 64.860 | 1.447 | -2.417 | 0.1409 |
| 111 | 2.572 | 2.571 | 2.573 | 2.571 | 1.305 | 0.4972 | 1.604 | 0.234 | 9.050 | 89.450 | 1.509 | -2.417 | 0.1376 |
| 114 | 2.579 | 2.578 | 2.579 | 2.577 | 1.307 | 1.085 | 1.54 | 0.227 | 8.868 | 91.820 | 1.468 | -3.152 | 0.1395 |
| 89 | 2.588 | 2.585 | 2.588 | 2.584 | 1.311 | -0.2712 | 2.311 | 0.227 | 9.050 | 89.450 | 1.509 | -3.282 | 0.1361 |
| 67 | 2.580 | 2.578 | 2.580 | 2.578 | 1.307 | 0.0452 | 1.783 | 0.234 | 8.868 | 89.640 | 1.447 | -3.742 | 0.1356 |
| 96 | 2.588 | 2.586 | 2.589 | 2.587 | 1.311 | 0.4972 | 2.485 | 0.231 | 9.095 | 89.490 | 1.530 | -4.074 | 0.1369 |

* Data collected for information purposes only parameter not specified for post radiation.

Electrical Test Data (Post radiation – 100K RAD(Si))

| TEST | Vout1 | Vout2 | Vout3 | Vout4 | Vout5 | Line Reg | Load Reg | Vdrop | Current Limit | Ripple Rej. | Vshdn | Vout @shdn | Ishdn* |
|-----------|-------|-------|-------|-------|-------|----------|----------|-------|---------------|-------------|-------|------------|--------|
| Serial # | (V) | (V) | (V) | (V) | (V) | (mV) | (mV) | (V) | (A) | (dB) | (V) | (mV) | (uA) |
| Max Limit | 2.625 | 2.625 | 2.625 | 2.625 | 2.625 | 12.5 | 147.6 | 0.4 | 10 | 200 | 1.7 | 100 | ---- |
| Min Limit | 2.375 | 2.375 | 2.375 | 2.375 | 2.375 | -12.5 | -147.6 | 0 | 3 | 40 | 1.0 | -100 | ---- |
| 71 | 2.509 | 2.503 | 2.508 | 2.503 | 1.269 | 0 | 5.659 | 0.197 | 8.855 | 98.150 | 1.357 | -2.027 | 0.1499 |
| 107 | 2.492 | 2.491 | 2.493 | 2.491 | 1.260 | 0 | 4.497 | 0.189 | 9.127 | 99.830 | 1.357 | -0.719 | 0.1475 |
| 94 | 2.665 | 2.661 | 2.664 | 2.660 | 1.349 | -0.677 | 0.7832 | 0.254 | 9.101 | 58.020 | 1.465 | -2.405 | 0.1455 |
| 93 | 2.655 | 2.655 | 2.654 | 2.653 | 1.346 | 1.401 | 0.467 | 0.254 | 8.829 | 59.670 | 1.465 | -0.836 | 0.1408 |
| 85 | 2.651 | 2.650 | 2.650 | 2.649 | 1.343 | 0.4518 | 0.7231 | 0.232 | 8.511 | 59.720 | 1.444 | -1.225 | 0.1418 |
| 117 | 2.661 | 2.659 | 2.660 | 2.658 | 1.348 | -0.858 | 2.436 | 0.265 | 8.874 | 59.720 | 1.465 | -2.045 | 0.145 |
| 76 | 2.651 | 2.648 | 2.651 | 2.647 | 1.343 | 1.446 | 1.91 | 0.254 | 8.874 | 59.720 | 1.444 | -2.75 | 0.1435 |
| 111 | 2.587 | 2.584 | 2.585 | 2.584 | 1.310 | 1.129 | 2.896 | 0.243 | 8.829 | 61.940 | 1.527 | -1.542 | 0.1346 |
| 114 | 2.595 | 2.591 | 2.594 | 2.592 | 1.315 | 0.2259 | 3.316 | 0.243 | 8.874 | 61.900 | 1.527 | -2.16 | 0.1359 |
| 89 | 2.601 | 2.598 | 2.601 | 2.598 | 1.318 | -0.677 | 3.027 | 0.239 | 8.874 | 60.740 | 1.527 | -2.074 | 0.1332 |
| 67 | 2.597 | 2.593 | 2.597 | 2.594 | 1.316 | -0.632 | 3.856 | 0.250 | 8.511 | 60.780 | 1.507 | -4.059 | 0.1339 |
| 96 | 2.602 | 2.599 | 2.603 | 2.599 | 1.318 | 0.5421 | 4.724 | 0.247 | 8.829 | 61.94 | 1.548 | -2.376 | 0.1338 |

* Data collected for information purposes only parameter not specified for pre-radiation.

Appendix B

Radiation Test Specification

| Automatic Test | | Tester: PXI TEST CONSOLE 04-134-TC | | | | | | |
|--|----------------------------|------------------------------------|---|------------|-------|--------|-------|-------|
| Table 2: Post Radiation Tests, 25C tests only ¹ | | | | | | | | |
| Prog. Ref. | Test | Symbol | Test Conditions | Rad Level: | Notes | MIN | MAX | Units |
| B | Output Voltage | V out | Vin = 3.30 Vdc | Post Rad | | 2.375 | 2.625 | Vdc |
| | | | Iout = 1.5 A | | | | | |
| B | Output Voltage | V out | Vin = 3.3 Vdc | Post Rad | | 2.375 | 2.625 | Vdc |
| | | | Iout = 50 mA | | | | | |
| B | Output Voltage | V out | Vin = 3.8 Vdc | Post Rad | | 2.375 | 2.625 | Vdc |
| | | | Iout = 3.0 A | | | | | |
| B | Output Voltage | V out | Vin = 2.8 Vdc | Post Rad | | 2.375 | 2.625 | Vdc |
| | | | Iout = 50 mA | | | | | |
| B | Output Voltage | V ref | Vin = 3.3 Vdc | Post Rad | | 1.202 | 1.328 | Vdc |
| | | | Iout = 25mA | | | | | |
| B | Line Regulation | Vrline | 2.9V < Vin < 3.8V | Post Rad | | -12.5 | 12.5 | mVdc |
| | | | Iout = 50 mA | | | | | |
| B | Load Regulation | Vrload | Vin = 3.3V | Post Rad | | -147.6 | 147.6 | mVdc |
| | | | 50mA < Io < 3.0A | | | | | |
| B | Dropout Voltage | Vdrop | Iout = 3A | Post Rad | | 0 | 0.40 | Vdc |
| | | | | | | | | |
| B | Current Limit | I limit | Vin = 3.3 Vdc | Post Rad | | 3.0 | 10.0 | A |
| | | | | | | | | |
| B | Ripple Rejection | Rrej | F= 120 Hz | Post Rad | | 40 | 200 | dB |
| | | | Iout = 50 mA | | | | | |
| B | Shutdown Threshold | Vshutdown | Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to 4.8V, output | Post Rad | | 1.0 | 1.7 | V |
| | | | | | | | | |
| B | Output voltage At Shutdown | Vout shdn | Vin = 3.3 Vdc | Post Rad | | -0.1 | +0.1 | V |
| | | | Iout = 50 mA | | | | | |
| | | | Vshdn = +5 Vdc | | | | | |
| B | Shutdown Pin Current | Ishutdown | Vin = 3.3 Vdc | Post Rad | 2 | --- | --- | uA |
| | | | Iout = 50 mA | | | | | |
| | | | Vshdn = +5 Vdc | | | | | |

Notes:

1. Regulator shall be biased at a nominal Vout of 2.5V with Radjust set at 976 ohms and tested to the limits specified on the data sheet.
2. These tests are performed for information purposes only.

This is proprietary information of International Rectifier Hi-Rel Products and it is understood that this will not be divulged to a third party or used in any way prejudicial to the interest of International Rectifier Hi-Rel Products.

Table 3: Total Dose Radiation Requirements

| High Dose Rate ³ | | |
|-----------------------------|----------------------------------|--|
| Bias Conditions | Vin = 6.8V, Vout = 2.5V, Io=10mA | Unbiased, in circuit with power supply off |
| Dose Step Profile | 30K, 20K, 50K, 50K, 50K | 30K, 20K, 50K, 50K, 50K |
| Dose Rate Range | 50 to 300 Rad(Si)/sec | 50 to 300 Rad(Si)/sec |
| Board Number | TF-02-011 | TF-02-011 |
| Program Card Number | 05-043-TA | 05-043-TA |
| Chamber | Gamma Cave | Gamma Cave |
| Test Temperature | 25C +/-5C | 25C +/-5C |
| Low Dose Rate ³ | | |
| Bias Conditions | Vin = 6.8V, Vout = 2.5V, Io=10mA | Unbiased, in circuit with power supply off |
| Dose Step Profile | 30K, 20K, 50K, 50K, 50K | 30K, 20K, 50K, 50K, 50K |
| Dose Rate Range | 0.01 to 0.10 Rad(Si)/sec | 0.01 to 0.10 Rad(Si)/sec |
| Board Number | TF-02-008 | TF-02-008 |
| Program Card Number | 05-043-TA | 05-043-TA |
| Chamber | Hot Cell | Hot Cell |
| Test Temperature | 25C +/-5C | 25C +/-5C |

3. Performed at during initial qualification of the device and retested only when specified by Quality Assurance due to a change per MIL-PRF-38534.

Radiation Circuit

