



IRUH33PA13B20K

Total Ionizing Dose Test Report

December 2005

International Rectifier currently does not have a DSCC approved Radiation Hardness Assurance Program for MIL-PRF-38534.

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INTRODUCTION

This test report covers the total ionizing dose tests performed on the IRUH33PA13B20K Adjustable Low Dropout linear regulator in a hermetic package. The total ionizing dose 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 December 21, 2005 International Rectifier tested this device for total ionizing dose 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 200K RAD(Si). The results show more degradation on the off-bias state devices for all tests parameters as a function of radiation, but never fell out of the specification limits. The "ON" biased samples passed the post radiation test requirements for all of the required dose levels as well.

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 A. 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 on December 21, 2005 for post radiation effects for dose levels up to 200K Rad(Si).

ON Biased serial numbers: 80, 75, 102, 81, 115
OFF Biased serial numbers: 100, 106, 91, 92, 73
Control Samples: 71 and 107. 71 used for this test.

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 Total Ionizing Dose 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 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 A 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 (When 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 Figures 1 thru 10. 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 200K 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.

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

T#1	VOUT							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	2.506	2.512	2.505	2.509	2.513	2.375	2.625	V
75	2.498	2.509	2.523	2.552	2.593	2.375	2.625	V
80	2.501	2.515	2.529	2.558	2.602	2.375	2.625	V
81	2.499	2.514	2.529	2.563	2.609	2.375	2.625	V
102	2.495	2.511	2.527	2.56	2.603	2.375	2.625	V
115	2.499	2.513	2.529	2.562	2.606	2.375	2.625	V
Max	2.501	2.515	2.529	2.563	2.609	2.375	2.625	V
Avg	2.498	2.512	2.527	2.559	2.602	2.375	2.625	V
Min	2.495	2.509	2.523	2.552	2.593	2.375	2.625	V

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

T#1	VOUT							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	2.506	2.512	2.505	2.509	2.513	2.375	2.625	V
73	2.497	2.513	2.529	2.564	2.618	2.375	2.625	V
91	2.496	2.514	2.53	2.564	2.617	2.375	2.625	V
92	2.502	2.519	2.533	2.564	2.612	2.375	2.625	V
100	2.496	2.514	2.529	2.561	2.611	2.375	2.625	V
106	2.498	2.516	2.532	2.565	2.615	2.375	2.625	V
Max	2.502	2.519	2.533	2.565	2.618	2.375	2.625	V
Avg	2.498	2.515	2.531	2.564	2.615	2.375	2.625	V
Min	2.496	2.513	2.529	2.561	2.611	2.375	2.625	V

Figure 3 "ON" Biased Samples, VDROD, IOU=3A

T#8	VDROD							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	0.194	0.203	0.195	0.199	0.204	0	0.4	V
75	0.187	0.233	0.221	0.241	0.230	0	0.4	V
80	0.194	0.225	0.229	0.252	0.230	0	0.4	V
81	0.191	0.225	0.225	0.248	0.264	0	0.4	V
102	0.194	0.229	0.229	0.252	0.230	0	0.4	V
115	0.194	0.233	0.240	0.259	0.238	0	0.4	V
Max	0.194	0.233	0.240	0.259	0.264	0	0.4	V
Avg	0.192	0.229	0.229	0.250	0.238	0	0.4	V
Min	0.187	0.225	0.221	0.241	0.230	0	0.4	V

Figure 4 "OFF" Biased Samples, VDROD, IOU=3A

T#8	VDROD							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	0.194	0.203	0.195	0.199	0.204	0	0.4	V
73	0.187	0.233	0.229	0.248	0.226	0	0.4	V
91	0.187	0.225	0.229	0.252	0.234	0	0.4	V
92	0.194	0.233	0.229	0.252	0.234	0	0.4	V
100	0.194	0.233	0.229	0.256	0.234	0	0.4	V
106	0.198	0.233	0.236	0.263	0.241	0	0.4	V
Max	0.198	0.233	0.236	0.263	0.241	0	0.4	V
Avg	0.192	0.231	0.230	0.254	0.234	0	0.4	V
Min	0.187	0.225	0.229	0.248	0.226	0	0.4	V

Figure 5 "ON" Biased Samples, CURRENT LIMIT, VIN=3.3

T#9	CURRENT LIMIT							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	8.502	9.128	8.759	8.982	9.143	3	10	A
75	8.477	8.629	8.532	8.483	8.507	3	10	A
80	8.432	8.492	8.214	8.392	8.371	3	10	A
81	8.387	8.447	8.486	8.165	8.462	3	10	A
102	8.477	8.810	8.532	8.528	8.462	3	10	A
115	8.387	8.447	8.168	8.483	8.507	3	10	A
Max	8.477	8.810	8.532	8.528	8.507	3	10	A
Avg	8.432	8.565	8.386	8.410	8.462	3	10	A
Min	8.387	8.447	8.168	8.165	8.371	3	10	A

Figure 6 "OFF" Biased Samples, CURRENT LIMIT, VIN=3.3

T#9	CURRENT LIMIT							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	8.502	9.128	8.759	8.982	9.143	3	10	A
73	8.114	8.447	8.123	8.029	8.507	3	10	A
91	8.432	8.765	8.395	8.437	8.144	3	10	A
92	8.114	8.447	8.486	8.483	8.371	3	10	A
100	8.114	8.447	8.259	8.210	8.507	3	10	A
106	8.069	8.447	8.077	8.165	8.189	3	10	A
Max	8.432	8.765	8.486	8.483	8.507	3	10	A
Avg	8.169	8.511	8.268	8.265	8.344	3	10	A
Min	8.069	8.447	8.077	8.029	8.144	3	10	A

Figure 7 "ON" Biased Samples, RIPPLE REJECTION = 120Hz.

T#10	RIPPLE REJECTION ¹							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	54.771	98.054	98.690	98.094	99.189	40		dB
75	97.132	98.624	99.850	97.597	88.063	40		dB
80	54.720	100.427	101.902	95.511	87.004	40		dB
81	101.123	100.384	102.772	94.403	63.243	40		dB
102	98.141	100.427	101.944	93.802	63.286	40		dB
115	98.098	99.184	100.493	94.787	63.286	40		dB
Max	101.123	100.427	102.772	97.597	88.063	40		dB
Avg	89.843	99.809	101.392	95.220	72.976	40		dB
Min	54.720	98.624	99.850	93.802	63.243	40		dB

Figure 8 "OFF" Biased Samples, RIPPLE REJECTION = 120Hz

T#10	RIPPLE REJECTION ¹							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	54.771	98.054	98.690	98.094	99.189	40		dB
73	98.624	100.427	101.189	91.619	61.990	40		dB
91	99.784	100.427	100.451	92.375	61.990	40		dB
92	98.141	98.624	98.690	95.511	63.286	40		dB
100	98.624	98.097	99.250	96.301	61.947	40		dB
106	98.624	98.097	100.493	92.375	61.862	40		dB
Max	99.784	100.427	101.189	96.301	63.286	40		dB
Avg	98.759	99.134	100.015	93.636	62.215	40		dB
Min	98.141	98.097	98.690	91.619	61.862	40		dB

¹ A test equipment anomaly caused the low reading for Ripple Rejection at the OK test step for serial 80 and the CNTRL1 sample. The problem was fixed prior to the completion of the 30K RAD(Si) dose step.

Figure 9 “ON” Biased Samples, VOLTAGE SHUTDOWN

T#11	VSHDN							
Serial #	KRAD LEVEL					Limits		U/M
	1	30	50	100	200	Min	Max	
CNTRL1	1.353	1.322	1.318	1.337	1.339	1	1.7	V
75	1.367	1.343	1.401	1.505	1.631	1	1.7	V
80	1.325	1.343	1.381	1.505	1.610	1	1.7	V
81	1.325	1.343	1.401	1.505	1.631	1	1.7	V
102	1.346	1.343	1.401	1.547	1.631	1	1.7	V
115	1.325	1.363	1.422	1.547	1.631	1	1.7	V
Max	1.367	1.363	1.422	1.547	1.631	1	1.7	V
Avg	1.338	1.347	1.401	1.522	1.627	1	1.7	V
Min	1.325	1.343	1.381	1.505	1.610	1	1.7	V

Figure 10 “OFF” Biased Samples, VOLTAGE SHUTDOWN

T#11	VSHDN							
Serial #	KRAD LEVEL					Limits		U/M
	0	30	50	100	200	Min	Max	
CNTRL1	1.353	1.322	1.318	1.337	1.339	1	1.7	V
73	1.325	1.322	1.381	1.526	1.589	1	1.7	V
91	1.325	1.343	1.381	1.505	1.610	1	1.7	V
92	1.346	1.363	1.422	1.505	1.631	1	1.7	V
100	1.325	1.343	1.422	1.526	1.610	1	1.7	V
106	1.325	1.363	1.401	1.526	1.631	1	1.7	V
Max	1.346	1.363	1.422	1.526	1.631	1	1.7	V
Avg	1.329	1.347	1.401	1.518	1.614	1	1.7	V
Min	1.325	1.322	1.381	1.505	1.589	1	1.7	V

CONCLUSION

The IRUH33PA13B20K has demonstrated hardness to high dose rate ionizing radiation exposure up to 200 KRAD(Si) 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**
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(mA)
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.6	0.1	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	65	1	-0.1	----
CNTRL	2.506	2.506	2.507	2.507	1.269	-0.904	1.183	0.194	8.502	54.77	1.353	-0.716	0.147
75	2.498	2.496	2.500	2.497	1.263	-0.451	6.043	0.187	8.477	97.13	1.367	-1.407	0.149
80	2.501	2.502	2.502	2.502	1.269	-0.722	-1.76	0.194	8.432	54.72	1.325	-0.201	0.146
81	2.499	2.501	2.503	2.501	1.267	-0.09	3.996	0.191	8.387	101.12	1.325	-0.010	0.145
91	2.496	2.497	2.498	2.498	1.264	-1.852	3.321	0.187	8.432	99.78	1.325	1.29	0.146
92	2.502	2.500	2.503	2.503	1.267	-1.175	2.067	0.194	8.114	98.14	1.346	-0.79	0.147
100	2.496	2.496	2.498	2.497	1.265	-0.497	1.5	0.194	8.114	98.62	1.325	-0.46	0.145
102	2.495	2.495	2.497	2.496	1.265	-0.361	1.795	0.194	8.477	98.14	1.346	0.3	0.148
106	2.498	2.497	2.499	2.497	1.263	-0.135	4.791	0.198	8.069	98.62	1.325	-0.962	0.15
73	2.497	2.494	2.499	2.496	1.265	-0.407	7.235	0.187	8.114	98.62	1.325	-0.704	0.148
115	2.499	2.497	2.502	2.497	1.265	-1.039	6.42	0.194	8.387	98.09	1.325	-0.919	0.146

** A test equipment anomaly caused the low reading for Ripple Rejection at the 0K test step for serial 80 and the CNTRL1 sample. The problem was fixed prior to the completion of the 30K RAD(Si) dose step.

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

Electrical Test Data (Post radiation – 30K 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)	(mA)
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	0.1	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1	-0.1	----
CNTRL	2.512	2.505	2.512	2.505	1.269	-0.316	7.963	0.203	9.128	98.05	1.322	-2.179	0.149
75	2.509	2.507	2.511	2.508	1.269	-1.22	0.517	0.233	8.629	98.62	1.343	-1.777	0.144
80	2.515	2.512	2.516	2.513	1.272	0.09	0.382	0.225	8.492	100.42	1.343	-1.748	0.142
81	2.514	2.513	2.517	2.512	1.272	-0.135	0.317	0.225	8.447	100.38	1.343	-1.834	0.138
91	2.514	2.512	2.514	2.512	1.272	-0.225	0.317	0.225	8.765	100.42	1.343	-1.23	0.144
92	2.519	2.516	2.519	2.516	1.274	-1.988	0.389	0.233	8.447	98.62	1.363	-2.539	0.143
100	2.514	2.512	2.515	2.512	1.273	0.451	0.219	0.233	8.447	98.09	1.343	-0.482	0.142
102	2.511	2.510	2.512	2.511	1.270	-1.039	0.329	0.229	8.810	100.42	1.343	-2.338	0.141
106	2.516	2.514	2.519	2.514	1.272	-1.446	0.586	0.233	8.447	98.09	1.363	-1.518	0.144
73	2.513	2.511	2.513	2.510	1.270	-0.723	4.778	0.233	8.447	100.43	1.322	-1.072	0.144
115	2.513	2.510	2.513	2.511	1.271	-1.581	0.444	0.233	8.447	99.18	1.363	-1.777	0.142

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

Electrical Test Data (Post radiation – 50K 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	0.1	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1	-0.1	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(mA)
CNTRL	2.505	2.503	2.505	2.503	1.267	-0.045	1.433	0.195	8.759	98.69	1.318	-0.301	0.146
75	2.529	2.526	2.529	2.525	1.278	-0.813	4.386	0.229	8.123	101.18	1.381	-0.790	0.140
80	2.523	2.521	2.525	2.522	1.277	-0.09	3.635	0.221	8.532	99.85	1.401	-0.258	0.141
81	2.529	2.527	2.529	2.527	1.280	-0.813	3.004	0.229	8.214	101.9	1.381	0.030	0.139
91	2.529	2.529	2.530	2.528	1.280	-0.316	2.556	0.225	8.486	102.77	1.401	-0.661	0.136
92	2.530	2.528	2.530	2.528	1.279	-0.948	2.162	0.229	8.395	100.45	1.381	-1.639	0.140
100	2.533	2.530	2.534	2.530	1.281	0.135	3.502	0.229	8.486	98.69	1.422	-0.388	0.141
102	2.529	2.528	2.529	2.526	1.280	-1.129	3.396	0.229	8.259	99.25	1.422	-0.603	0.141
106	2.527	2.525	2.528	2.524	1.279	-0.09	2.504	0.229	8.532	101.94	1.401	-1.294	0.139
73	2.529	2.526	2.529	2.525	1.278	-0.813	4.386	0.229	8.123	101.19	1.381	-0.790	0.140
115	2.498	2.495	2.496	2.494	1.263	-0.090	1.919	0.180	9.167	98.16	1.297	-2.387	0.149

* 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*
Max Limit	2.625	2.625	2.625	2.625	2.625	12.5	147.6	0.4	10	200	1.7	0.1	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1	-0.1	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(mA)
CNTRL	2.509	2.504	2.507	2.504	1.268	0.497	3.466	0.199	8.982	98.09	1.337	-1.840	0.150
75	2.564	2.559	2.561	2.558	1.293	-0.226	2.500	0.248	8.029	91.62	1.526	-2.733	0.133
80	2.552	2.550	2.554	2.550	1.290	0.271	5.296	0.241	8.483	97.60	1.505	-2.445	0.137
81	2.558	2.556	2.558	2.557	1.293	-0.135	1.878	0.252	8.392	95.51	1.505	-1.452	0.133
91	2.563	2.561	2.563	2.560	1.298	0.316	1.520	0.248	8.165	94.40	1.505	-1.034	0.133
92	2.564	2.560	2.562	2.560	1.295	-1.445	1.159	0.252	8.437	92.38	1.505	-2.157	0.136
100	2.564	2.561	2.562	2.560	1.294	-0.452	1.748	0.252	8.483	95.51	1.505	-2.085	0.136
102	2.561	2.557	2.559	2.556	1.293	0.181	2.895	0.256	8.210	96.30	1.526	-1.380	0.132
106	2.560	2.558	2.561	2.559	1.295	-0.181	2.520	0.252	8.528	93.80	1.547	-0.963	0.134
73	2.564	2.559	2.561	2.558	1.293	-0.226	2.500	0.248	8.029	91.62	1.526	-2.733	0.133
115	2.495	2.494	2.494	2.492	1.261	0.000	1.577	0.188	9.073	98.66	1.316	-1.178	0.148

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

Electrical Test Data (Post radiation – 200K 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	0.1	----
Min Limit	2.375	2.375	2.375	2.375	2.375	-12.5	-147.6	0	3	40	1	-0.1	----
Serial #	(V)	(V)	(V)	(V)	(V)	(mV)	(mV)	(V)	(A)	(dB)	(V)	(mV)	(mA)
CNTRL	2.513	2.511	2.513	2.511	1.276	0.994	4.007	0.204	9.143	99.189	1.339	-2.652	0.149
75	2.593	2.592	2.592	2.590	1.315	0.63	2.10	0.230	8.507	88.06	1.631	-1.348	0.131
80	2.602	2.601	2.600	2.600	1.319	-0.81	0.42	0.230	8.371	87.00	1.610	-1.276	0.129
81	2.609	2.607	2.608	2.608	1.322	0.23	1.36	0.264	8.462	63.24	1.631	-1.090	0.126
91	2.617	2.613	2.611	2.609	1.323	-0.68	0.70	0.234	8.144	61.99	1.610	-1.391	0.130
92	2.612	2.607	2.606	2.605	1.321	-1.18	0.06	0.234	8.371	63.29	1.631	-0.732	0.129
100	2.611	2.605	2.603	2.602	1.320	-1.22	-0.41	0.234	8.507	61.95	1.610	-1.319	0.129
102	2.603	2.602	2.602	2.602	1.320	-1.22	-1.05	0.230	8.462	63.29	1.631	-1.606	0.128
106	2.615	2.611	2.609	2.607	1.322	-1.13	0.45	0.241	8.189	61.86	1.631	-0.861	0.128
73	2.618	2.613	2.613	2.610	1.324	-0.723	2.942	0.226	8.507	61.99	1.589	-1.735	0.130
115	2.606	2.605	2.604	2.603	1.322	-0.63	-0.29	0.238	8.507	63.29	1.631	-0.646	0.125

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

Appendix B

Radiation Test Specification

Specification #	T090104G	Revision: A	ECN #	Date:
IR Base Part No.	IRRUH33PA13B20K			

PRODUCT DISCRIPTION: ADJUSTABLE LOW DROPOUT VOLTAGE REGULATOR

Automatic Test Tester: PXI TEST CONSOLE 04-134-TC

Table 1: Pre Radiation Tests, 25C tests only ¹

Prog. Ref.	Test	Symbol	Test Conditions	Rad Level:	Notes	MIN	MAX	Units
A	Output Voltage	V out	Vin = 3.30 Vdc	Pre Rad		2.475	2.525	Vdc
			Iout = 1.5 A					
A	Output Voltage	V out	Vin = 3.3 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V out	Vin = 3.8 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
A	Output Voltage	V out	Vin = 2.8 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V ref	Vin = 3.3 Vdc	Pre Rad		1.225	1.305	Vdc
			Iout = 25mA					
A	Line Regulation	Vrline	2.9V < Vin < 3.8V	Pre Rad		-6.25	6.25	mVdc
			Iout = 50 mA					
A	Load Regulation	Vrload	Vin = 3.3V	Pre Rad		-73.8	73.8	mVdc
			50mA < Io < 3.0A					
A	Dropout Voltage	Vdrop	Iout = 3A	Pre Rad		0	0.40	Vdc
A	Current Limit	I limit	Vin = 3.3 Vdc	Pre Rad		3.0	10.0	A
A	Ripple Rejection	Rrej	F= 120 Hz	Pre Rad		65	200	dB
			Iout = 50 mA					
A	Shutdown Threshold	Vshutdown	Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to 4.8V, output monitored for 100mV drop below	Pre Rad		1.0	1.6	V
A	Output voltage At Shutdown	Vout shdn	Vin = 3.3 Vdc	Pre Rad		-0.1	+0.1	V
			Iout = 50 mA					
			Vshdn = +5 Vdc					
A	Shutdown Pin Current	Ishutdown	Vin = 3.3 Vdc	Pre 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.

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					
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.

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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

