RDHA701CD10A2NK

Neutron and Total Ionizing Dose Test Report

October 2009

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 neutron fluence and ionizing radiation tests performed on the RDHA701CD10A2NK which is a dual 1 amp Solid-State-Relay in a hermetic package.

Neutron fluence and Total Ionizing Dose tests were performed to determine the effects displacement damage and ionizing radiation had on the device performance. On October 14 2009, International Rectifier characterized this device for ionizing radiation hardness and on October 23, 2009 International Rectifier characterized this device for neutron radiation hardness at the University of Massachusetts, Nuclear Reactor Laboratory Facility using their Fast Neutron Irradiator and Gamma Cave facilities.

SUMMARY OF RESULTS

All of the test samples passed the post radiation test requirements for fluence levels up to 1.0E12 n/cm^2 and 100K Rad(Si). The results show a 50% average increase in the device's turn on propagation delay and a 15% average decrease in the device's turn off propagation delay after exposure to total ionizing dose and neutron radiation. No other significant changes in device performance were noted for either neutron or total ionizing radiation exposure.

TEST METHOD

The test methods used in the development of the Test Plan was MIL-STD-883, Methods 1017 Neutron Irradiation and 1019 Ionizing Radiation. These methods established the basic requirements for the performance and execution of the tests.

TEST PLAN

On October 14, 2009 two samples (serial numbers 237 and 252) were exposed to Total Ionizing Dose radiation under an "ON" biased condition and two samples (serial numbers 231 and 248) were exposed to Total Ionizing Dose radiation under an "OFF" biased condition. Serial number 256 was maintained as a control sample and was not exposed to any radiation.

The same four samples (serial numbers 231, 237, 248, and 252) were exposed to neutron radiation on October 23, 2009 in an un-biased state with all device leads shorted in conductive foam and contained in a conductive bag. Post radiation testing of the devices occurred after the decay of radioactivity of the devices reached an acceptable safe level determined by the facilities personnel. The rate of decay was dependent on the amount of exposure to neutrons and the package materials. The devices were contained in a 20 +/- 10C environment to minimize the effects due to annealing.

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

Test Plan Outline

1.0 Purpose

The purpose of this test is to characterize and establish displacement damage and total ionizing dose radiation effects for International Rectifier's dual solid state relay devices.

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

3.1.1 The University of Massachusetts Research Reactor shall be used to provide the necessary Neutron beam and energy. University of Massachusetts Research Reactor (UMRR) shall provide adequate dosimetry for verification of the neutron beam parameters.

3.1.2 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

Five samples shall be randomly selected. One of which shall be maintained as a control. The samples used for the Total Ionizing Dose radiation exposure shall also be subjected to Neutron radiation exposure.

4.0 Test Device

4.1 The following device is planned for this characterization:

a. RDHA701CD10A2NK

4.2 All devices shall be subjected to a minimum of 96hrs of burn-in and verified for correct electrical performance prior to arrival at UMRR.

4.3 One device shall be biased in the "ON" state and one device shall be biased in the "OFF" state during the Total Ionizing Dose irradiation.

4.4 The device leads will be shorted in conductive foam and all parts shall be contained inside a conductive ESD bag during Neutron irradiation.

5.0 Test Method

5.1 MIL-STD-883, Method 1017 shall be used to establish procedure for all Neutron testing described herein.

5.2 MIL-STD-883, Method 1019 shall be used to establish procedure for all Total Ionizing Dose testing described herein.

6.0 Radiation Source

6.1 The nuclear reactor at Lowell, Mass is capable of providing fast neutron flux level $\geq 10^{11}$ n/cm^2 – s with relatively low thermal fluence and gamma irradiation. The Fast Neutron Irradiator (FNI) offers near uniform spectrum over a large cross-sectional area (12" x 12" x 6"). The dosimetry system used to verify the radiation exposure was P-32, ASTM E-265.

6.2 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 with the CO^{60} source. Several small ports penetrate one shielding wall to provide access for instrumentation cables.

7.0 Record Keeping

7.1 The Reactor facility shall provide dosimetry data for the Fast Neutron Irradiator. IR will be responsible for collecting and compiling the test data.

7.2 The Reactor facility shall provide dosimetry data for the CO^{60}. Each exposure run shall be cataloged with the appropriate lot number in order to maintain correlation to the appropriate data set. IR will be responsible for collecting and compiling the test data.

8.0 Test Procedure

International Rectifier shall control the following test procedure, based on Test Methods 1017 and 1019. The neutron fluence and total ionizing dose levels the product is exposed to shall be per this test plan.

The facility personnel shall be responsible for loading and moving the device container in the Fast Neutron Irradiator. They shall also be responsible for loading, unloading, and moving the Cobalt source for the Total Ionizing Dose exposures.

The Total Ionizing Dose exposure levels shall be 50K, 100K, and 150K Rad(Si).

Total Ionizing Dose Test Procedure – Table 1

Step	Description	Conditions
1	Pre test all devices prior to radiation exposure.	
2	Perform empty board continuity and leakage verification on radiation bias board.	
3	Load one device in the “ON” bias socket and one device in the “OFF” bias socket on the radiation bias board.	
4	Place radiation bias board in the test rack in the Gamma Cave.	
5	Turn on the bias power supplies and measure the signals at the DUT sites for proper levels.	
6	Secure the chamber and expose the samples to the specified dose.	Facilities personnel 50K Rad(Si) exposure step
7	Remove devices at completion of exposure time	Facilities personnel
8	Test devices – Read and Record data – within 1 hour of removal from the chamber	
9	Repeat steps 2 thru 7 for exposure level 2 This exposure must start within 2 hours of the completion of the last exposure	50K Rad(Si) exposure step
10	Repeat steps 2 thru 7 for exposure level 2 This exposure must start within 2 hours of the completion of the last exposure	50K Rad(Si) exposure step
11	Place the “ON” bias sample back on the radiation bias board under the same bias for a minimum of 24 hours at 24C +/-6C. Place the “OFF” bias sample back on the radiation bias board under the same bias for a minimum of 24 hours at 24C +/-6C.	If the devices fail post exposure test they must be subject to extended room temperature anneal per Method 1019, 3.11
12	Test devices – Read and Record data – within 4 hours of removal of the bias	
13	Place the “ON” bias sample back on the radiation bias board under the same bias for 168 hours +/-12 hours at 100C +5/-0C. Place the “OFF” bias sample back on the radiation bias board under the same bias for 168 hours	Subject the devices to MOS accelerated anneal per Method 1019, 3.12

	+/-12 hours at 100C +5/-0C.	
14	Test devices – Read and Record data – within 4 hours of removal of the bias	

Please note the Total Ionizing Dose exposure steps are considered cumulative.

The Neutron fluence total exposure levels shall be 1E11 n/cm^2, 6E11 n/cm^2, and 1E12 n/cm^2.

Neutron Test Procedure - Table 2

Step	Description	Conditions
1	Pre test all devices prior to radiation exposure.	
2	Place all devices in ESD safe bag all device pins are placed in conductive foam.	
3	Place devices into the shielded container	Unbiased
4	Lower the container into the irradiation chamber	Facilities personnel
5	Expose the devices to pre-determined level	1E11 n/cm^2 exposure step
6	Remove devices at completion of exposure time	Facilities personnel
7	Allow devices to decay to safe level	Facilities personnel
8	Test devices - Read and Record data	
9	If product fails catastrophic stop, select new samples and select a lower exposure step.	
9	Repeat steps 2 thru 9 for exposure level 2	5E11 n/cm^2 exposure step
10	Repeat steps 2 thru 9 for exposure level 3	4E11 n/cm^2 exposure step

Please note the Neutron exposure steps are considered cumulative.

9.0 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. Fluence
e. Certificate of Exposure
f. Bias conditions
g. Comments and observations
h. Pre and Post Electrical data
i. Summary descriptive including graphs

TEST FACILITY

The University of Massachusetts, Lowell, Nuclear Research Reactor is a 1 Mega-Watt, Uranium^{235} enhanced core reactor. The Fast Neutron Irradiation (FNI) chamber (see Figure 1) is designed to give a fast flux level from 10^{10} to 10^{16} n/cm^2-s with relatively low thermal fluence and gamma dose rates. It is also designed to provide a 1MeV equivalent flux over the effective range.

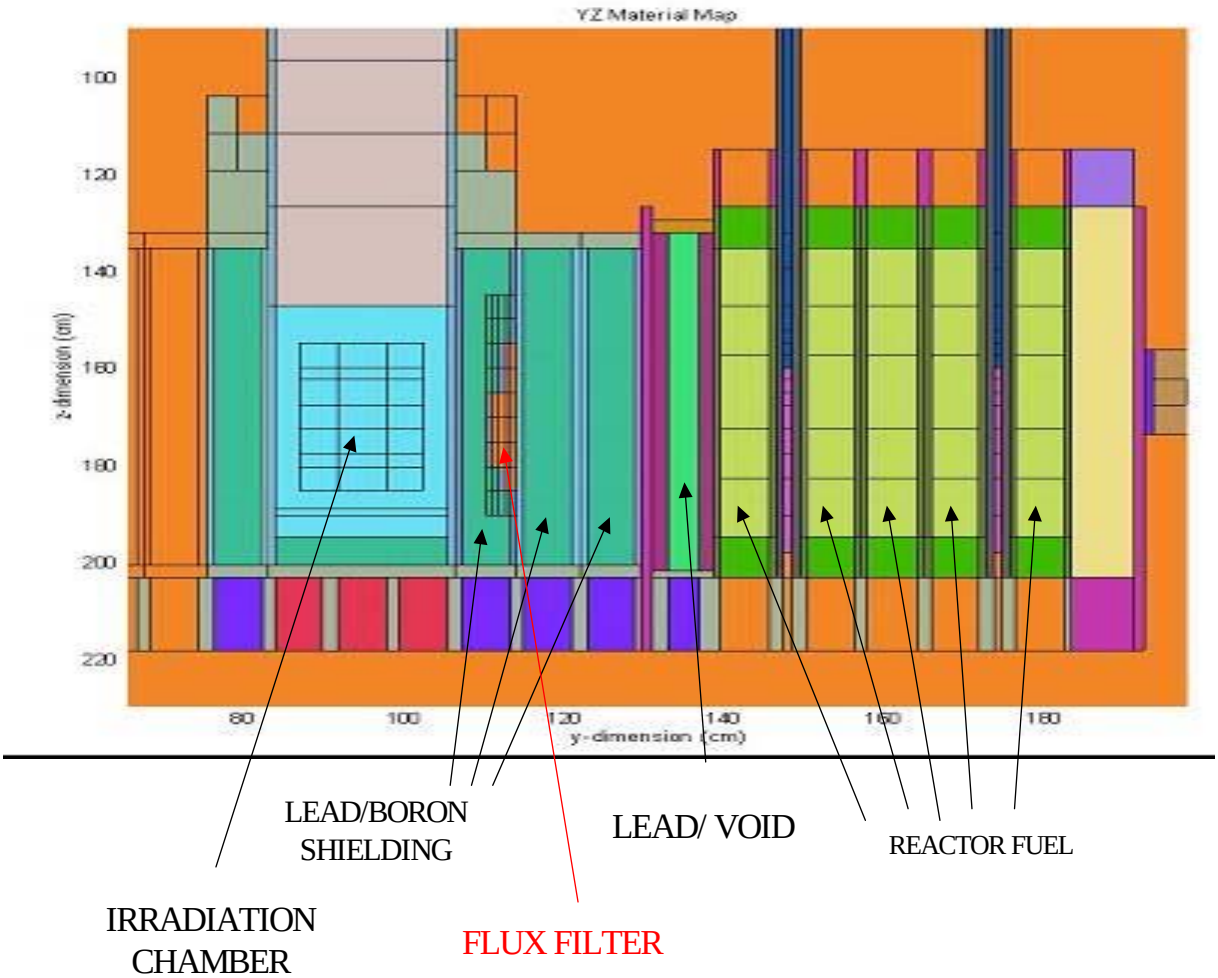

Figure 1

Test Results

The pre and post radiation test results are shown graphically in Figures 2 thru 5. As outlined in the Test Plan, four devices (serial numbers 231, 237, 248, and 252) were exposed to total ionizing dose and then neutron radiation. The devices were tested after the completion of each radiation exposure. The average of the results for each selected parameter is displayed in the following graphs for the exposed parts and the unexposed part (control sample). There were no catastrophic failures for any device.

Output Leakage Current:
The graph displays the results of all the radiation exposures in the order they were preformed. The radiation exposures the device was subject to had minimal effect on the device output leakage current.

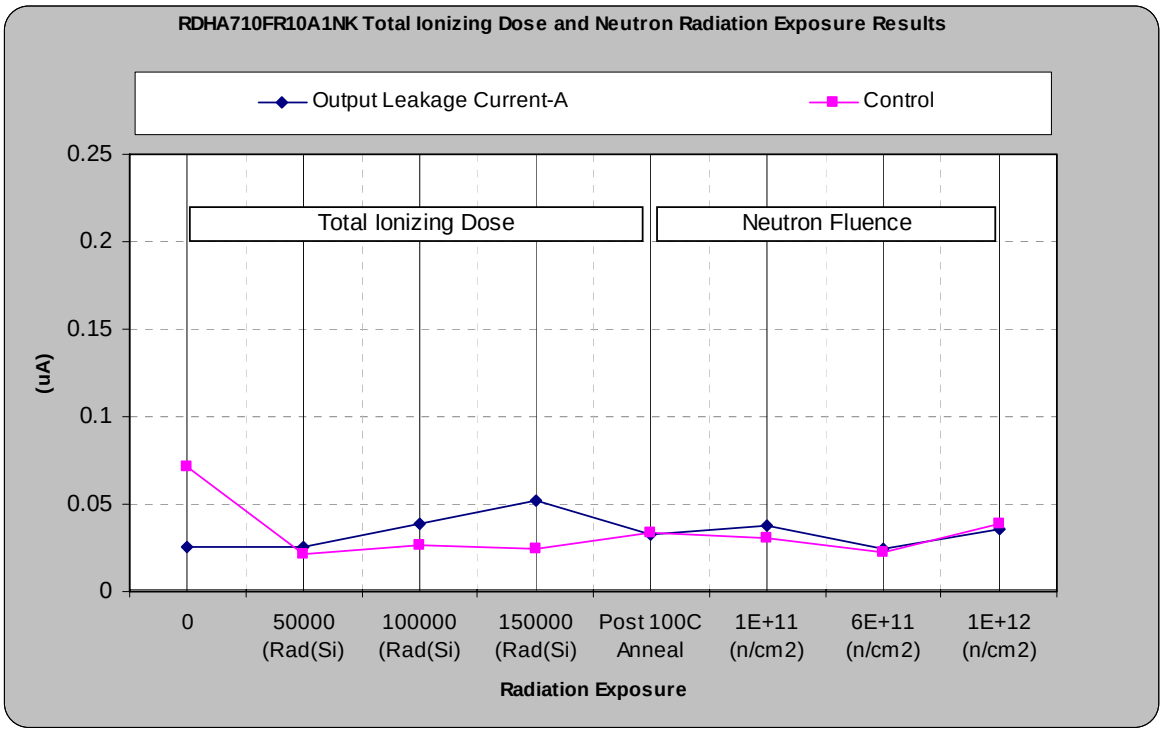

Figure 2

Turn On Delay:

The graph displays the results of all the radiation exposures in the order they were preformed. The total ionizing dose exposure caused a 50% increase in the turn on delay for the device. The subsequent 100C anneal test shifted this parameter back down by 25%. The neutron exposures at 6e+11 and 1e+12 n/cm^2 caused this parameter to increase back to the same level it was at after the 150K total dose exposure. The product is still well within the 4ms maximum limits for this parameter after all the exposures were complete.

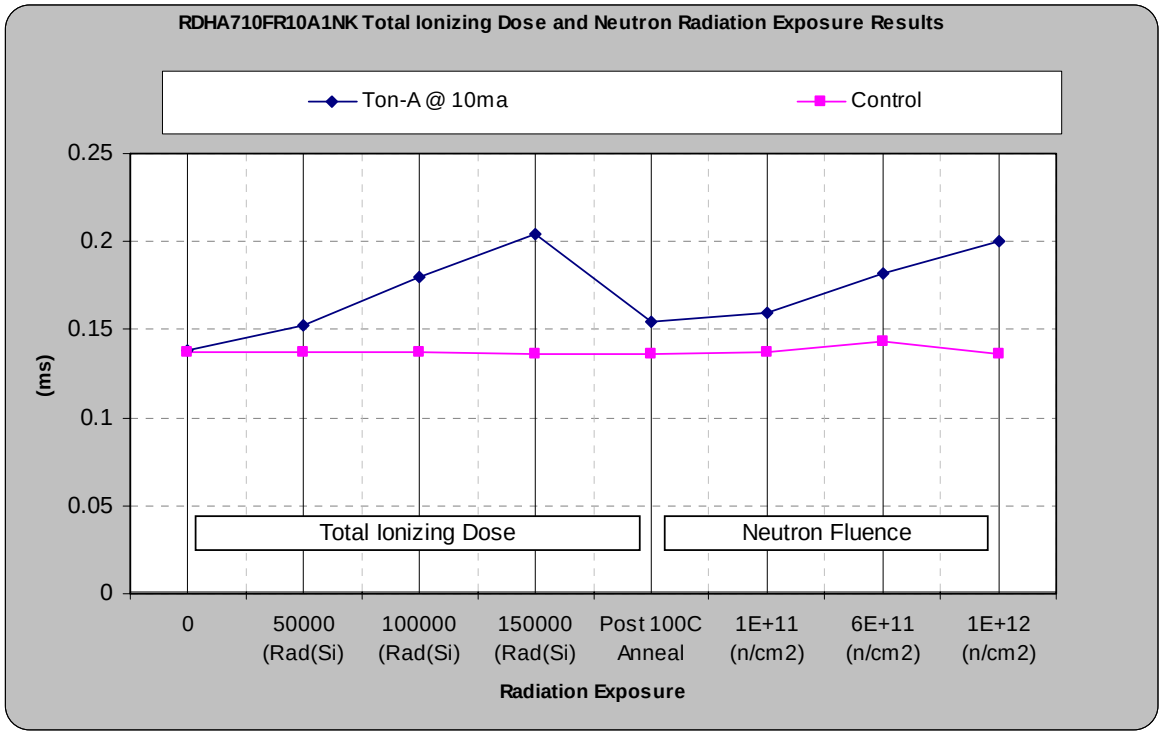

Figure 3

Turn Off Delay:

The graph displays the results of all the radiation exposures in the order they were preformed. The radiation exposure caused a 15% decrease in the turn off delay for the device.

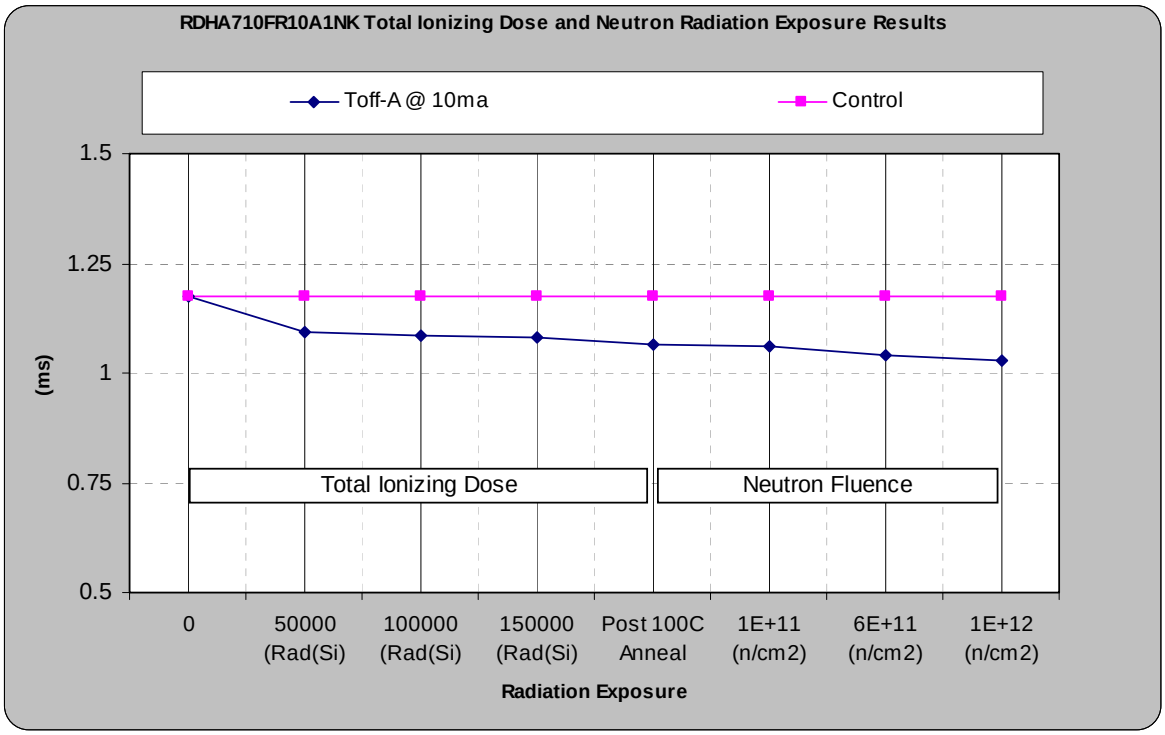

Figure 4

RDS(on):

The graph displays the results of all the radiation exposures in the order they were preformed. No significant shifts in this parameter were recorded after any of the radiation exposures.

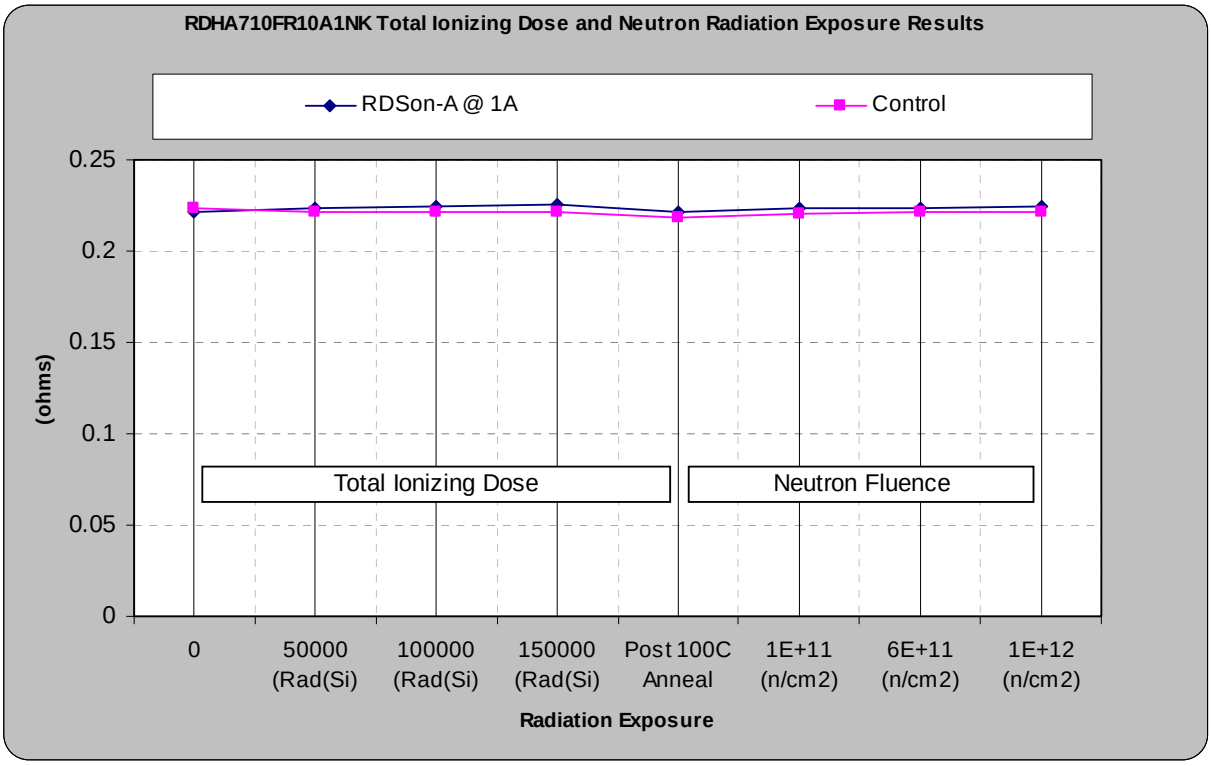

Figure 5

CONCLUSION

The radiation tests performed on the RDHA701CD10A2NK demonstrate hardness to a combined total dose ionizing radiation exposure of 100K Rad(Si) and neutron radiation exposure of 1.0E12 n/cm^2 with minimal effect on its overall performance and the results show it to meet all the post radiation test requirements.

Appendix A

Electrical Data

Electrical Test Data (Pre-radiation) – 10/13/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.038	13.262	1.301	1.36	0.143	1.169	0.222	0.105	13.445	1.306	1.364	0.131	1.181	0.224
231	0.004	12.825	1.296	1.359	0.145	1.175	0.221	0.021	13.43	1.3	1.353	0.138	1.179	0.224
237	0.019	12.241	1.29	1.348	0.141	1.157	0.22	0.07	13.342	1.283	1.338	0.14	1.167	0.221
248	0.008	14.702	1.295	1.352	0.139	1.164	0.219	0.031	13.851	1.294	1.348	0.132	1.181	0.222
252	0.046	13.466	1.315	1.382	0.134	1.181	0.22	0.004	13.53	1.303	1.367	0.139	1.181	0.222

Electrical Test Data (Post 50K Rad(Si) exposure) – 10/14/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.035	13.236	1.311	1.377	0.142	1.17	0.22	0.007	13.467	1.311	1.371	0.132	1.182	0.222
231	0.028	12.815	1.294	1.355	0.155	1.104	0.223	0.006	13.361	1.302	1.357	0.144	1.11	0.226
237	0.005	12.242	1.29	1.349	0.161	1.071	0.222	0.033	13.374	1.286	1.343	0.163	1.071	0.223
248	0.026	14.734	1.297	1.356	0.143	1.103	0.222	0.016	13.855	1.292	1.343	0.141	1.111	0.225
252	0.042	13.475	1.316	1.385	0.152	1.082	0.223	0.052	13.541	1.304	1.369	0.157	1.086	0.225

Electrical Test Data (Post 100K Rad(Si) exposure) – 10/14/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.018	13.267	1.304	1.363	0.142	1.171	0.22	0.035	13.469	1.307	1.363	0.132	1.182	0.222
231	0.032	12.808	1.289	1.345	0.183	1.091	0.224	0.036	13.243	1.3	1.352	0.168	1.099	0.227
237	0.011	12.239	1.29	1.347	0.192	1.065	0.222	0.068	13.375	1.283	1.336	0.197	1.066	0.224
248	0.057	14.725	1.295	1.352	0.164	1.093	0.223	0.022	14.126	1.294	1.347	0.164	1.1	0.226
252	0.037	13.5	1.316	1.384	0.181	1.084	0.223	0.05	13.483	1.303	1.367	0.188	1.085	0.225

Electrical Test Data (Post 150K Rad(Si) exposure) – 10/14/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.037	13.064	1.302	1.359	0.142	1.17	0.22	0.011	13.472	1.308	1.365	0.131	1.182	0.222
231	0.008	12.794	1.29	1.346	0.209	1.079	0.225	0.088	13.284	1.3	1.352	0.19	1.088	0.228
237	0.076	12.234	1.291	1.348	0.219	1.064	0.223	0.049	13.245	1.283	1.336	0.226	1.064	0.225
248	0.016	14.733	1.293	1.347	0.186	1.08	0.224	0.061	14.122	1.292	1.343	0.186	1.088	0.227
252	0.006	13.493	1.315	1.383	0.205	1.086	0.224	0.112	13.557	1.304	1.367	0.215	1.086	0.226

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Electrical Test Data (Post 100C Anneal – 168hrs) – 10/23/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.014	13.1	1.312	1.374	0.141	1.17	0.217	0.053	13.455	1.313	1.371	0.131	1.183	0.219
231	0.006	12.807	1.293	1.351	0.164	1.103	0.222	0.06	13.264	1.302	1.355	0.156	1.112	0.225
237	0.012	12.24	1.294	1.354	0.157	1.022	0.22	0.004	13.342	1.286	1.339	0.157	1.025	0.221
248	0.037	14.708	1.296	1.35	0.151	1.099	0.219	0.06	13.969	1.296	1.349	0.147	1.107	0.222
252	0.059	13.515	1.317	1.383	0.149	1.027	0.221	0.021	13.563	1.305	1.368	0.152	1.038	0.223

Electrical Test Data (Post 1e11 n/cm^2 exposure) – 10/23/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.038	13.235	1.304	1.363	0.142	1.169	0.22	0.023	13.463	1.309	1.366	0.132	1.181	0.221
231	0.036	12.807	1.289	1.344	0.171	1.098	0.223	0.052	13.297	1.301	1.353	0.162	1.106	0.225
237	0.022	12.246	1.291	1.348	0.162	1.015	0.222	0.053	13.336	1.283	1.336	0.161	1.018	0.223
248	0.016	14.725	1.291	1.344	0.156	1.091	0.222	0.019	13.904	1.292	1.343	0.151	1.099	0.225
252	0.052	13.531	1.317	1.385	0.154	1.021	0.223	0.051	13.542	1.303	1.366	0.157	1.031	0.224

Electrical Test Data (Post 6e11 n/cm^2 exposure) – 10/23/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.039	13.233	1.302	1.359	0.141	1.169	0.22	0.005	13.494	1.308	1.364	0.132	1.182	0.222
231	0.027	12.781	1.287	1.342	0.197	1.082	0.223	0.031	13.301	1.299	1.352	0.187	1.092	0.226
237	0.024	12.233	1.289	1.347	0.185	0.996	0.222	0.001	13.38	1.281	1.334	0.183	0.999	0.223
248	0.011	14.743	1.288	1.34	0.176	1.076	0.223	0.033	14.1	1.289	1.34	0.17	1.085	0.226
252	0.025	13.547	1.315	1.382	0.176	1	0.223	0.044	13.572	1.302	1.366	0.178	1.011	0.224

Electrical Test Data (Post 1e12 n/cm^2 exposure) – 10/23/2009

Test Name	Output Leakage Current-A	VR-A @ 10uA	VF-A @ 10mA	VF-A @ 20mA	Ton-A @ 10ma	Toff-A @ 10ma	RDSon-A @ 1A	Output Leakage Current-B	VR-B @ 10uA	VF-B @ 10mA	VF-B @ 20mA	Ton-B @ 10ma	Toff-B @ 10ma	RDSon-B @ 1A
Test Number	1.1	2	3	4	5.1	5.2	6.1	7	8	9	10	11.1	11.2	12.1
Lower Limit	0.001	5	1.1	1.15	0.001	0.001	0	0.001	5	1.1	1.15	0.001	0.001	0
Upper Limit	10	32	1.75	1.8	4	2	0.4	10	32	1.75	1.8	4	2	0.4
Units	uA	V	V	V	ms	ms	ohm	uA	V	V	V	ms	ms	ohm
Serial #														
256	0.026	13.008	1.3	1.355	0.142	1.169	0.22	0.051	13.46	1.307	1.363	0.131	1.182	0.222
231	0.051	12.792	1.285	1.34	0.216	1.07	0.225	0.016	13.352	1.297	1.349	0.206	1.08	0.227
237	0.009	12.242	1.287	1.347	0.204	0.982	0.224	0.003	13.381	1.279	1.331	0.205	0.985	0.224
248	0.032	14.665	1.289	1.343	0.192	1.068	0.222	0.051	14.157	1.289	1.34	0.186	1.076	0.226
252	0.076	13.556	1.313	1.383	0.194	0.986	0.225	0.047	13.56	1.299	1.362	0.2	0.996	0.226

Appendix B

Radiation Test Specification

Automatic Test			**Tester: Eagle ETS-564**					
Table 1: Pre Radiation Tests, 25C only								
Prog. Ref.	Test	Symbol	Test Conditions	Rad Level:	Notes	MIN	MAX	Units
A	Leakage Current Off	IO [leak]	IF=0mA, Vout=100V	Pre Rad	1	---	10.0	uA
A	Input Reverse Voltage	V_R	IR = 10uA	Pre Rad	1	5.0	32.0	V
A	Input Forward Voltage	VF1	IF=10mA	Pre Rad	1	1.10	1.75	V
A	Input Forward Voltage	VF2	IF=20mA	Pre Rad	1	1.15	1.80	V
A	Drain to Source Resistance	Rds(on)	IF = 10mA, Iout = 1A, PW >= 200mS	Pre Rad	1	---	0.40	Ohm
A	Time On	Ton	Vout = 28.0V, Iout = 1A, IF = 0 to 10mA, PW = 15ms	Pre Rad	1	---	4.0	ms
A	Time Off	Toff	Vout = 28.0V, Iout = 1A, IF = 10 to 0mA, PW = 15ms	Pre Rad	1	---	2.0	ms

Automatic Test			**Tester: Eagle ETS-564**					
Table 2: Post Radiation Tests, 25C only								
Prog. Ref.	Test	Symbol	Test Conditions	Rad Level:	Notes	MIN	MAX	Units
B	Leakage Current Off	IO [leak]	IF=0mA, Vout=100V	Post Rad	1	---	10.0	uA
B	Input Reverse Voltage	V_R	IR = 10uA	Post Rad	1	5.0	32.0	V
B	Input Forward Voltage	VF1	IF=10mA	Post Rad	1	1.10	1.75	V
B	Input Forward Voltage	VF2	IF=20mA	Post Rad	1	1.15	1.80	V
B	Drain to Source Resistance	Rds(on)	IF = 10mA, Iout = 1A, PW >= 200mS	Post Rad	1	---	0.40	Ohm
B	Time On	Ton	Vout = 28.0V, Iout = 1A, IF = 0 to 10mA, PW = 15ms	Post Rad	1	---	4.0	ms
B	Time Off	Toff	Vout = 28.0V, Iout = 1A, IF = 10 to 0mA, PW = 15ms	Post Rad	1	---	2.0	ms

Note 1: All tests are performed on each switch in the product.

Fast Neutron Irradiator Facility @ UMass, Lowell	
Bias Conditions	All pins shorted in conductive foam. Parts inside an ESD conductive bag.
Fluence Step Profile	1.0E+11, 5.0E+11, 4.0E+11
Equivalent Fluence	1MeV (neutrons/cm^2)
Test Temperature	20C +/-10C
Test Procedure	T030061G

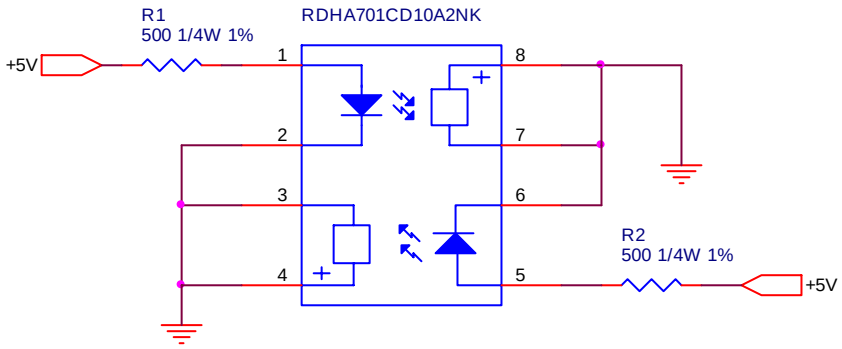
2. Performed on four samples that are exposed to Total Dose. The steps are cumulative.

3. All handling guidelines for neutron irradiated product outlined in T030061G must be followed for this multiple exposure test. Fluence steps are considered cumulative.

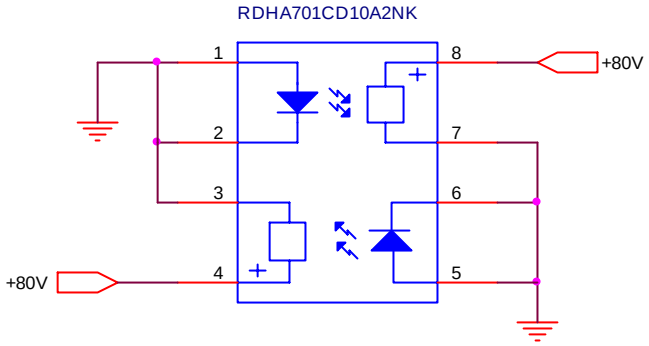
Total Dose Radiation Requirements [4]		
High Dose Rate [4]		
Bias Conditions	IF = 7mA, Vout =0V On Bias	IF = 0mA, Vout=80V Off Bias
Dose Step Profile	50K, 50K, 50K	50K, 50K, 50K
Dose Rate Range	50 to 300 Rad(Si)/Sec	50 to 300 Rad(Si)/Sec
Board Number	09-128-TF	09-128-TF
Program Card Number	N/A	N/A
Chamber	Gamma Cave	Gamma Cave
Test Temperature	25C +/-5C	25C +/-5C

4. 100C Post Radiation Anneal step is required for this product.

ON BIAS



OFF BIAS



Appendix C

Neutron Test Set Up

Neutron Irradiation Set Up

1. Devices are placed into the aluminum / boron container.
2. The container is then lowered into the irradiation chamber.
3. At the completion of the run time, remove container from the radiation chamber.
4. Allow devices to decay (radioactive) to an acceptable safe level before testing.
5. Repeat process as required.