International
IOR Rectifier

IRUH33P253B1M

Neutron Test Report

AUGUST 2005

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

List of devices covered by this report include:

IRUH33P183B1MP
IRUH33P183B1MK
IRUH33P183A1MP
IRUH33P183A1MK
IRUH33P253B1MP
IRUH33P253B1MK
IRUH33P253A1MP
IRUH33P253A1MK
IRUH33PA13B1MP
IRUH33PA13B1MK
IRUH33PA13A1MP
IRUH33PA13A1MK
IRUH50PA23B1MP
IRUH50PA23B1MK
IRUH50PA23A1MP
IRUH50PA23A1MK
IRUH50P253B1MP
IRUH50P253B1MK
IRUH50P253A1MP
IRUH50P253A1MK
IRUH50P333B1MP
IRUH50P333B1MK
IRUH50P333A1MP
IRUH50P333A1MK

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INTRODUCTION

This test report covers the neutron fluence tests performed on the IRUH33P253B1M Ultra Low Dropout linear regulator in a hermetic package. The neutron fluence test was performed to determine the effects displacement damage had on the device performance. On August 25th, 2005 International Rectifier characterized this device for neutron hardness at the University of Massachusetts, Nuclear Research Facility using their Fast Neutron Irradiator.

SUMMARY OF RESULTS

All of the test samples passed the post radiation test requirements for fluence levels of 1E11 and 1E12 n/cm^2. The results show a significant degradation in the device's Dropout Voltage characteristic after exposure to neutron irradiation of 1E13 n/cm^2 but the devices are still functional at this level.

TEST METHOD

The test method used in the development of the Test Plan was MIL-PRF-883, method 1017 Neutron Irradiation. This method established the basic requirements for the performance and execution of the tests.

TEST PLAN

The samples were exposed to neutron irradiation in an un-biased state with all of the device leads open. 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 devices were tested on August 25th, 2005 for post exposure affects for the 1E11 and 1E12 n/cm^2 fluence levels. The devices were exposed to a fluence level of 1E13 n/cm^2 but not tested until August 30th, 2005 for post exposure affects for the fluence level.

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 establish Neutron effects for the IRUH33P253B1M, Low Dropout Voltage Regulator. 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 necessary Neutron beam and energy. University of Massachusetts Research Reactor (UMRR) shall provide adequate dosimetry for verification of the neutron beam parameters.

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-STD-883, method 1017. The sample size for this test is 10 devices and one device for a control sample.

4.0 Test Device

4.0 The following device is planned for Neutron characterization:
IRUH33P253B1M
4.2 All devices shall be subjected to 320hrs of burn-in and verified for correct electrical performance prior to arrival at UMRR.
4.3 The device leads will be left open during this test and all parts shall be contained inside a conductive ESD bag during irradiation.

5.0 Test Method

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

6.0 Neutron Source

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.

7.0 Record Keeping

The Reactor facility shall provide dosimetry data for the FNI. 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 Method 1017. IR's design engineering department shall be responsible for selecting the neutron fluence level the product is exposed to.

The facility personnel shall be responsible for loading and moving the device container.

Exposure levels shall be 1E11 n/cm^2, 1E12 n/cm^2, and 1E13 n/cm^2.

Test Procedure - Table 1

Step	Description	Conditions
1	Pre test all devices prior to radiation exposure.	Per T090067G
2	Place all devices in ESD safe bag all device pins are open	
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	See exposure levels
6	Remove devices at completion of exposure time	Facilities personnel
7	Allow devices to decay to safe level	Facilities personnel

8	Test devices after post irradiation	Per T090067G
9	End test. Read and Record data	

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

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.

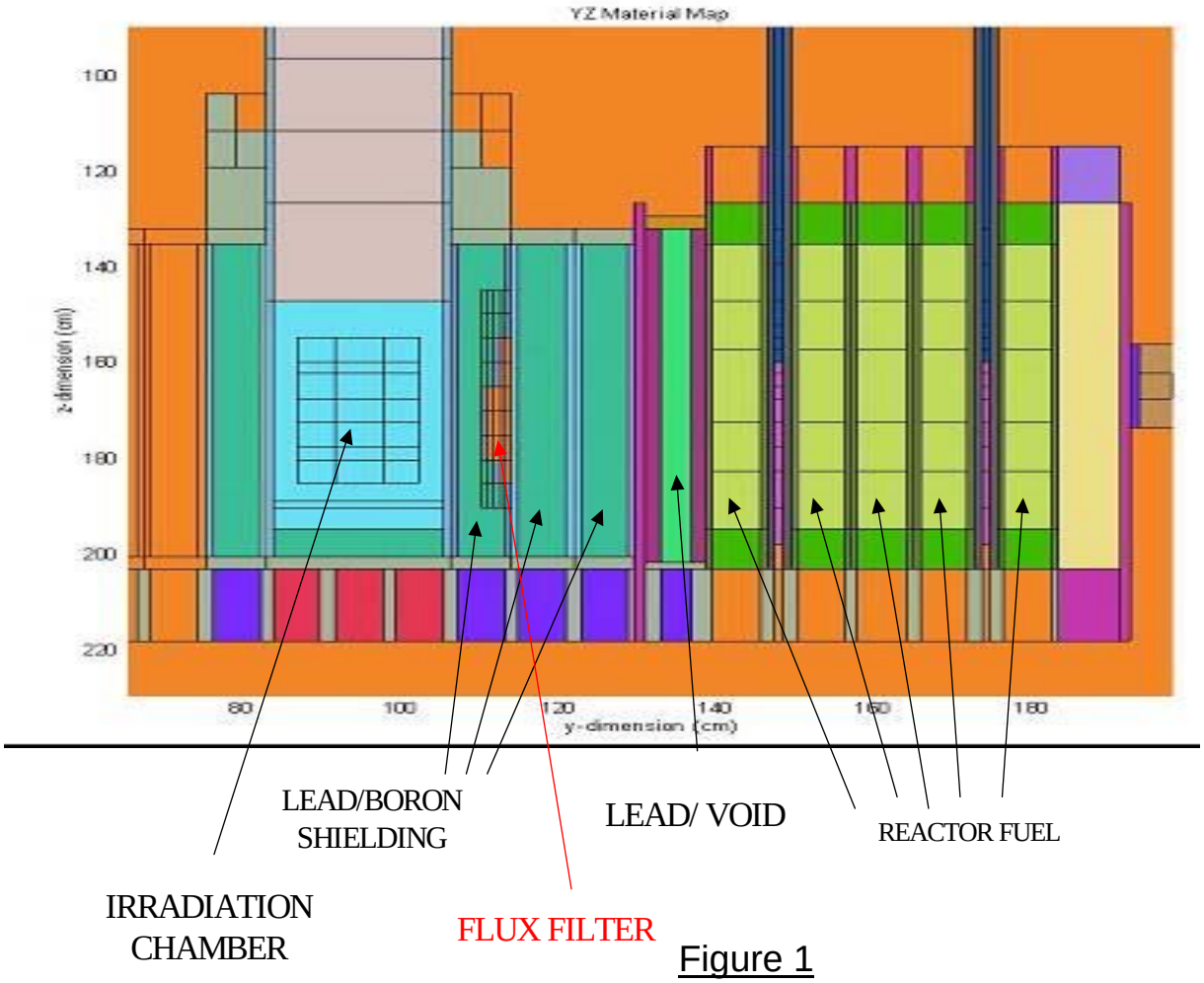


Figure 1

Test Results

The key pre and post radiation test results are shown graphically in Figures 2 thru 9. As outlined in the Test Plan, ten devices were exposed to neutron irradiation at fluence levels of 1E11, 1E12, and 1E13 n/cm^2. The devices were tested after completion of radiation exposure and radioactive decay recovery. The data is displayed in the following graphs with the Average, Minimum, and Maximum for all the device samples shown. The Control sample results are shown with its own curve on each graph. The radiation exposure had minimal affect on the samples up to a fluence level of 1E12 n/cm^2 but significant degradation occurred during the final exposure to 1E13 n/cm^2. The parameter most affected by the exposure was the Dropout Voltage (Figure 7), which increased by as much as 265%. The Output Voltage (Figure 4) test with the input set at 3.135V with a 3.0A load was out of specification as well but this was a symptom of the Dropout Voltage increase. There were no catastrophic failures for any device. All other parameters were within the post radiation limits for the device.

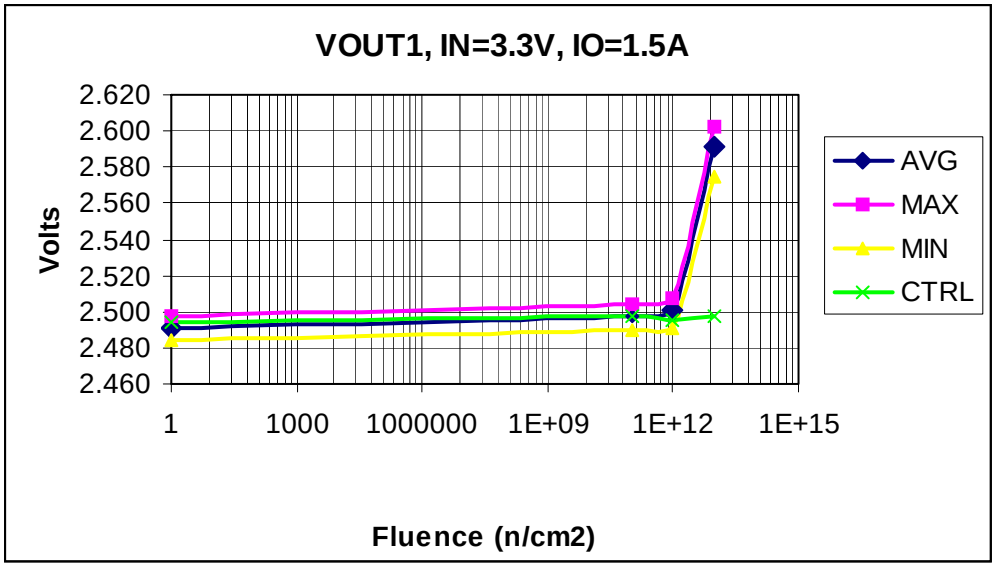


Figure 2

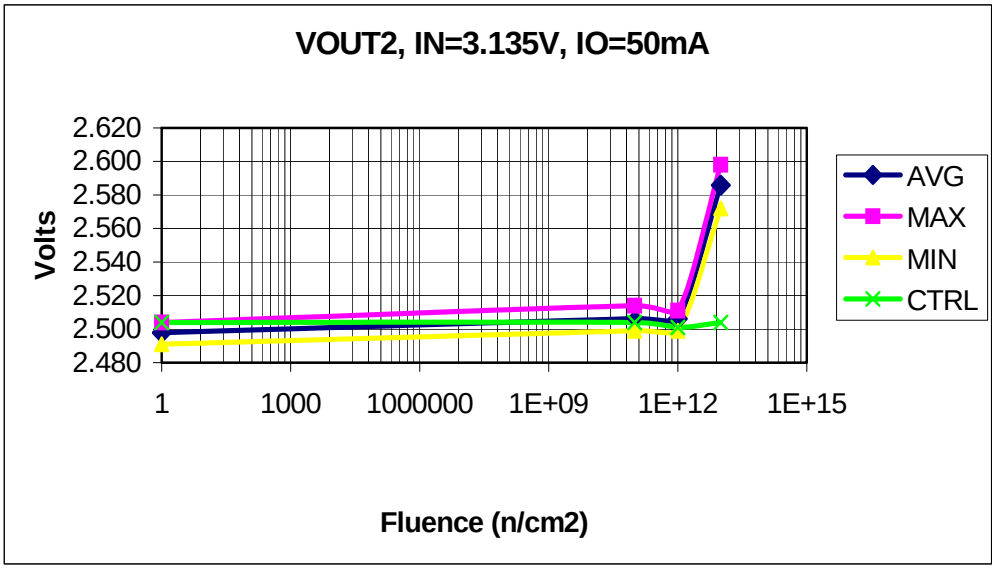


Figure 3

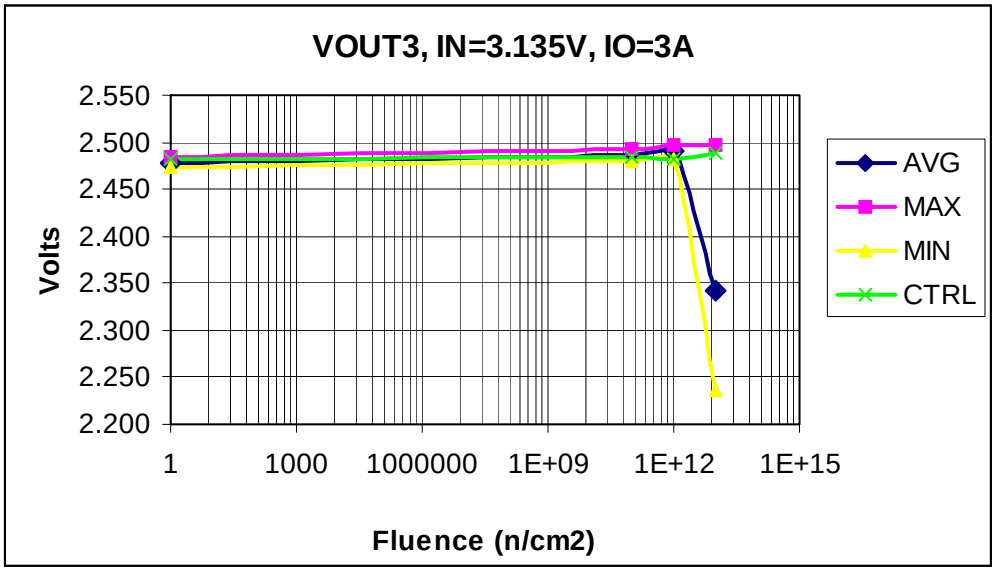


Figure 4

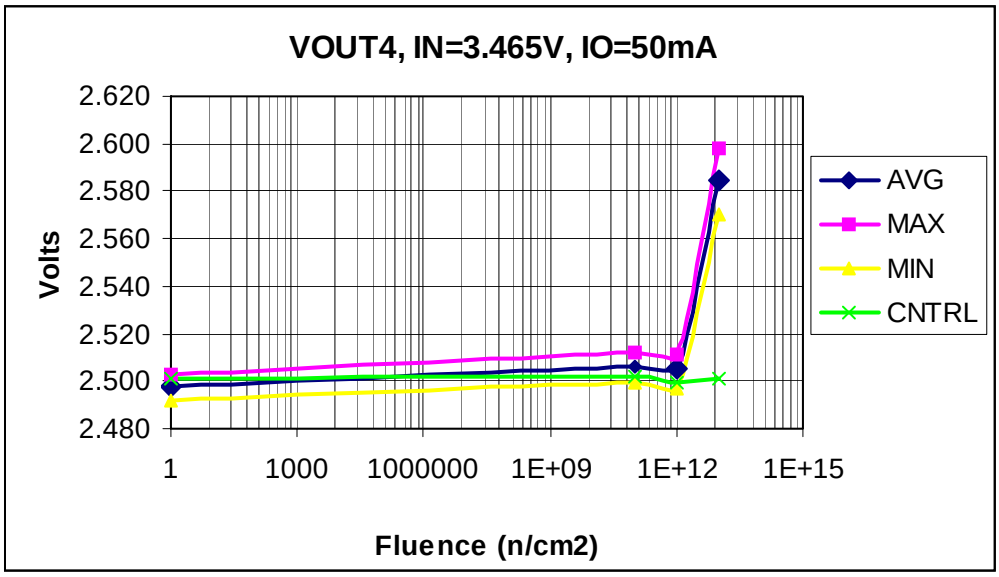


Figure 5

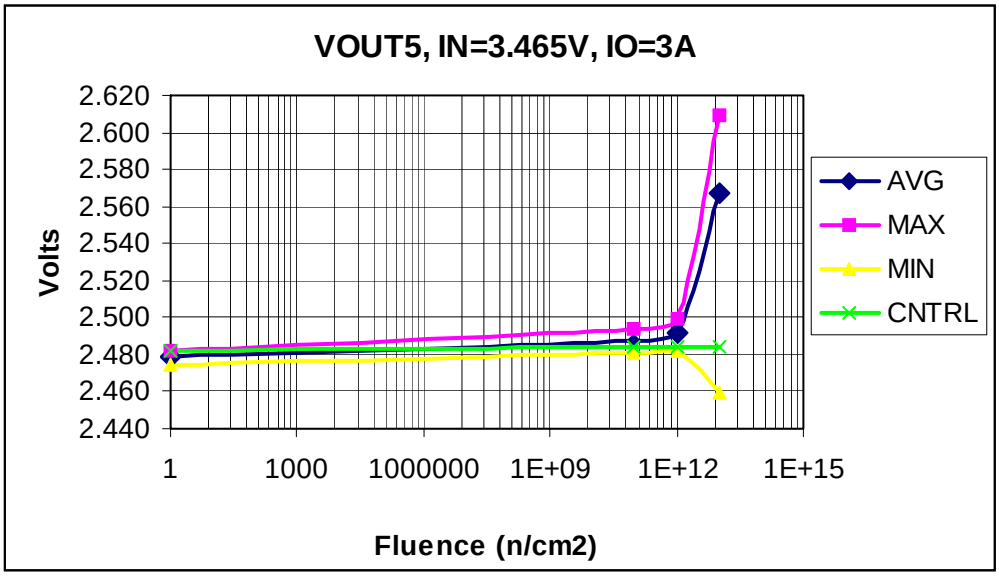


Figure 6

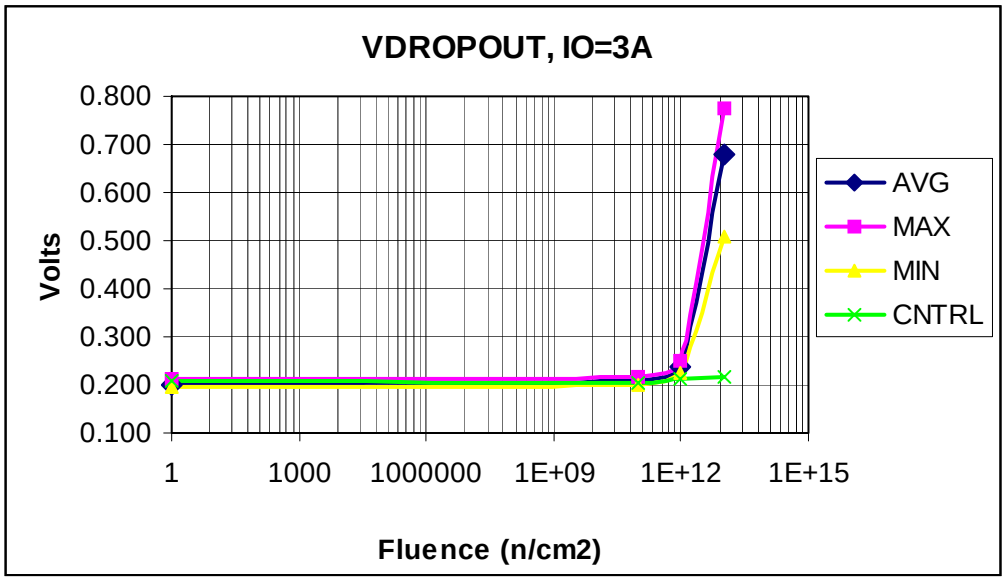


Figure 7

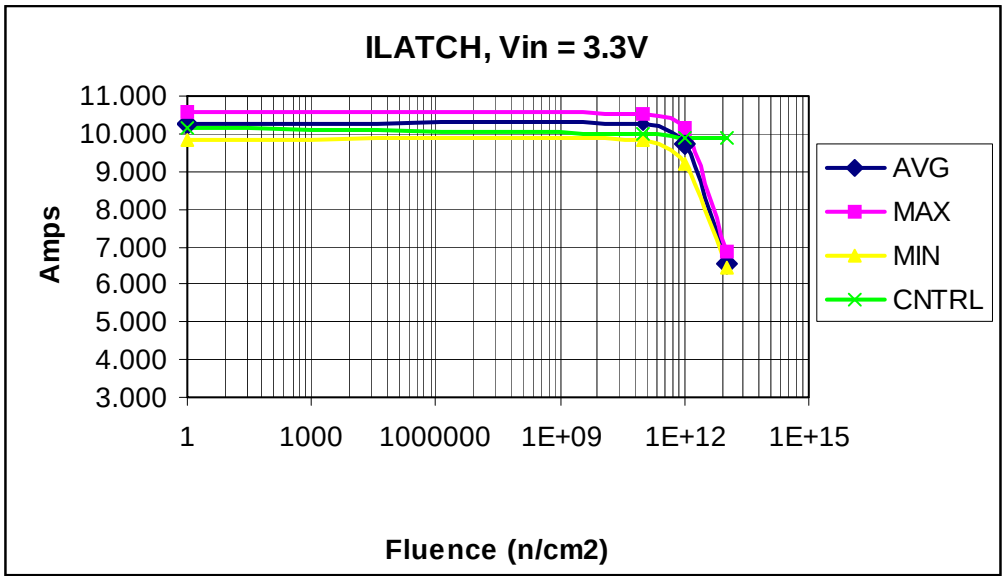


Figure 8

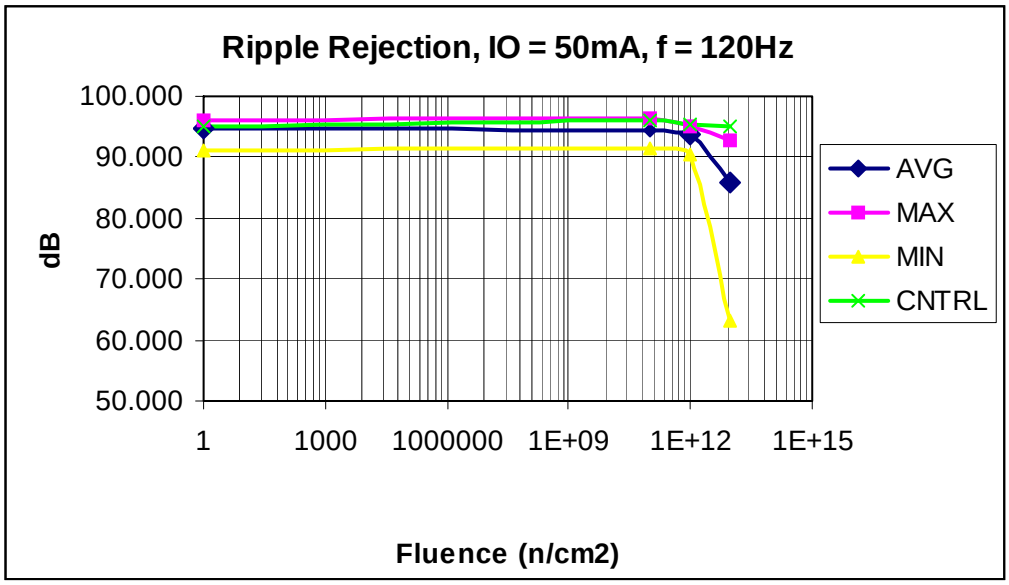


Figure 9

CONCLUSION

The IRUH33P253B1M has demonstrated hardness to neutron radiation exposure to a fluence level of 1E12 n/cm^2 with no affect on its overall performance and the results show it to meet all the post radiation test requirements. The results of this testing also show this device to be fully functional at a fluence level of 1E13 n/cm^2 for input voltages at or above 3.3 volts with the maximum load applied. All devices tested proved to be immune to any catastrophic events up to a fluence level of 1E13 n/cm^2.

Appendix A

Electrical Data

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Electrical Test Data (Pre-radiation)

Wednesday, August 24, 2005, 4:37 PM

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Vdrop	Ilatch	Ripple Rej	Vshdn	Vshdn	Ishdn*
Max Limit	2.525	2.625	2.625	2.625	2.625	0.400	----	200	1.6	100	----
Min Limit	2.475	2.375	2.375	2.375	2.375	----	3	65	1.0	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(V)	(A)	(dB)	(V)	(mV)	(uA)
1703	2.494	2.504	2.482	2.501	2.482	0.209	10.127	95.161	1.384	-1.180	149.578
1691	2.488	2.496	2.478	2.496	2.477	0.212	9.854	95.488	1.342	-1.968	147.989
1694	2.488	2.497	2.477	2.494	2.477	0.209	10.263	93.181	1.384	-1.180	156.299
1712	2.498	2.502	2.484	2.503	2.481	0.201	9.900	94.424	1.384	-1.495	148.997
1731	2.495	2.502	2.482	2.502	2.482	0.201	10.218	95.531	1.363	-1.381	144.648
1740	2.490	2.497	2.477	2.499	2.478	0.201	10.218	95.917	1.342	-1.510	146.287
1750	2.485	2.494	2.473	2.493	2.474	0.197	10.536	94.764	1.363	0.741	153.843
1765	2.484	2.491	2.474	2.492	2.474	0.205	10.218	95.875	1.342	-0.936	147.686
1776	2.496	2.504	2.481	2.502	2.482	0.197	10.581	94.466	1.342	-1.782	152.727
1786	2.491	2.496	2.476	2.496	2.478	0.197	10.536	91.170	1.405	-2.169	159.414
1789	2.492	2.500	2.481	2.499	2.481	0.197	10.263	95.917	1.363	-1.940	148.471

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

Electrical Test Data (Post 1e11 n/cm^2 exposure)

Thursday, August 25, 2005, 11:32 AM

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Vdrop*	Ilatch	Ripple Rej	Vshdn*	Vshdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	----	----	200	----	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	----	3	40	----	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(V)	(A)	(dB)	(V)	(mV)	(uA)
1703	2.498	2.504	2.485	2.502	2.484	0.206	9.993	95.916	1.363	-3.356	148.864
1691	2.496	2.507	2.484	2.503	2.485	0.213	9.860	95.476	1.386	-0.679	146.095
1694	2.495	2.505	2.483	2.506	2.485	0.209	10.541	92.884	1.386	-1.439	155.155
1712	2.504	2.514	2.493	2.512	2.494	0.213	9.905	94.752	1.428	-1.310	147.914
1731	2.502	2.509	2.490	2.510	2.492	0.205	10.087	95.476	1.386	-1.482	145.026
1740	2.497	2.506	2.485	2.505	2.485	0.217	10.359	95.863	1.365	-0.507	146.565
1750	2.492	2.501	2.481	2.501	2.482	0.202	10.450	94.084	1.386	-3.058	153.279
1765	2.490	2.499	2.481	2.499	2.481	0.213	10.223	96.224	1.365	-3.015	149.467
1776	2.504	2.508	2.491	2.510	2.492	0.202	10.541	94.084	1.386	1.012	153.137
1786	2.497	2.506	2.485	2.505	2.485	0.209	10.405	91.304	1.386	-1.453	159.569
1789	2.500	2.508	2.488	2.507	2.488	0.205	10.450	95.519	1.386	-1.424	146.860

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

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Electrical Test Data (Post 1e12 n/cm^2 exposure)

Thursday, August 25, 2005, 2:49 PM

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Vdrop*	Ilatch	Ripple Rej	Vshdn*	Vshdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	----	----	200	----	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	----	3	40	----	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(V)	(A)	(dB)	(V)	(mV)	(uA)
1703	2.495	2.501	2.482	2.499	2.484	0.214	9.900	95.530	1.367	-1.557	148.957
1765	2.491	2.499	2.483	2.497	2.482	0.237	9.810	95.161	1.325	-0.681	145.204
1731	2.505	2.511	2.495	2.511	2.496	0.248	9.719	94.138	1.388	0.095	146.515
1740	2.501	2.507	2.491	2.506	2.491	0.240	9.537	94.806	1.346	-1.112	146.955
1694	2.497	2.504	2.489	2.501	2.488	0.240	9.810	92.662	1.388	-0.954	155.473
1750	2.495	2.501	2.484	2.499	2.485	0.233	9.855	93.822	1.388	-0.968	151.396
1691	2.501	2.508	2.491	2.508	2.492	0.244	9.492	95.203	1.367	-1.241	145.545
1712	2.507	2.509	2.497	2.510	2.499	0.240	9.219	93.822	1.388	-1.299	147.869
1789	2.503	2.508	2.494	2.508	2.494	0.237	9.810	94.138	1.346	-1.615	146.342
1776	2.501	2.505	2.491	2.508	2.493	0.225	10.173	93.223	1.388	-0.781	151.365
1786	2.505	2.510	2.494	2.509	2.493	0.243	9.779	90.458	1.410	-3.194	161.566

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

Electrical Test Data (Post 1e13 n/cm^2 exposure)

Tuesday, August 30, 2005, 1:30 PM

TEST	Vout1	Vout2	Vout3	Vout4	Vout5	Vdrop*	Ilatch	Ripple Rej	Vshdn*	Vshdn	Ishdn*
Max Limit	2.625	2.625	2.625	2.625	2.625	----	----	200	----	100	----
Min Limit	2.375	2.375	2.375	2.375	2.375	----	3	40	----	-100	----
Serial #	(V)	(V)	(V)	(V)	(V)	(V)	(A)	(dB)	(V)	(mV)	(uA)
1703	2.497	2.504	2.488	2.501	2.484	0.215	9.887	95.146	1.348	-3.188	149.578
1765	2.591	2.583	**2.271**	2.583	2.520	**0.718**	6.434	92.121	1.432	-0.818	146.865
1750	2.589	2.585	2.497	2.584	2.592	**0.508**	6.889	90.667	1.432	-0.588	153.512
1740	2.602	2.593	**2.305**	2.590	2.601	**0.737**	6.525	92.380	1.432	0.115	148.804
1694	2.580	2.575	**2.339**	2.573	2.585	**0.655**	6.434	64.781	1.474	-1.378	156.402
1789	2.602	2.598	**2.351**	2.598	2.609	**0.678**	6.525	92.881	1.453	1.867	148.467
1786	2.575	2.572	**2.373**	2.570	2.581	**0.654**	6.525	63.240	1.453	-0.948	162.854
1691	2.596	2.588	**2.237**	2.585	2.459	**0.773**	6.434	92.338	1.432	-1.206	150.236
1712	2.599	2.591	**2.243**	2.592	2.539	**0.777**	6.434	90.495	1.453	1.480	149.591
1731	2.600	2.594	**2.315**	2.595	2.601	**0.726**	6.434	90.929	1.432	-0.488	149.042
1776	2.583	2.579	2.486	2.578	2.590	**0.556**	6.889	89.309	1.432	1.408	153.850

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

Appendix B

Radiation Test Specification

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PRODUCT DISCRIPTION: 2.5V LOW DROPOUT VOLTAGE REGULATOR

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

Table 1: Pre Radiation Tests, 25C tests only

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 = 3.135 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V out	Vin = 3.135 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
A	Output Voltage	V out	Vin = 3.465 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 50 mA					
A	Output Voltage	V out	Vin = 3.465 Vdc	Pre Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
A	Dropout Voltage	Vdrop	Iout = 3.0 A	Pre Rad		0	0.40	Vdc
A	Current Limit	I limit	Vin = 3.3 Vdc	Pre Rad		3.0	---	A
A	Ripple Rejection	Rrej	F= 120 Hz	Pre Rad		65	200	dB
			Iout = 50 mA					
A	Shutdown	Vshutdown	Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to	Pre Rad		1.0	1.6	V
	Threshold		4.8V, output monitored for 100mV drop					
A	Output voltage	Vout shdn	Vin = 3.3 Vdc	Pre Rad		-0.1	+0.1	V
	At Shutdown		Iout = 50 mA					
			Vshdn = +5 Vdc					
A	Shutdown	Ishutdown	Vin = 3.3 Vdc	Pre Rad	1	---	---	uA
	Pin Current		Iout = 50 mA					
			Vshdn = +5 Vdc					

Notes:

1. 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								
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 = 3.135 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 50 mA					
B	Output Voltage	V out	Vin = 3.135 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
B	Output Voltage	V out	Vin = 3.465 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 50 mA					
B	Output Voltage	V out	Vin = 3.465 Vdc	Post Rad		2.375	2.625	Vdc
			Iout = 3.0 A					
B	Dropout Voltage	Vdrop	Iout = 3.0 A	Post Rad	1	---	---	Vdc
B	Current Limit	I limit	Vin = 3.3 Vdc	Post Rad		3.0	---	A
B	Ripple Rejection	Rrej	F= 120 Hz	Post Rad		40	200	dB
			Iout = 50 mA					
B	Shutdown	Vshutdown	Vin = 5.0 Vdc, Vshutdown ramp from 0.8V to	Post Rad	1	---	---	V
	Threshold		4.8V, output monitored for 100mV drop					
B	Output voltage	Vout shdn	Vin = 3.3 Vdc	Post Rad		-0.1	+0.1	V
	At Shutdown		Iout = 50 mA					
			Vshdn = +5 Vdc					
B	Shutdown	Ishutdown	Vin = 3.3 Vdc	Post Rad	1	---	---	uA
	Pin Current		Iout = 50 mA					
			Vshdn = +5 Vdc					

Notes:

1. 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 6: Neutron Radiation Requirements [5, 6]	
Fast Neutron Irradiator Facility @ UMass, Lowell	
Bias Conditions	All pins open.
Fluence Step Profile	1.0E+11, 9E+11, 9E+12
Equivalent Fluence	1MeV (neutrons/cm^2)
Test Temperature	20C +/-10C
Test Procedure	T030061G

5. Performed during initial qualification of the device and retested only when specified by Quality Assurance due to a change per MIL-PRF-38534. The sample size for the hybrid qualification is 11 devices; 1 device will not be irradiated and used as a control sample.

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

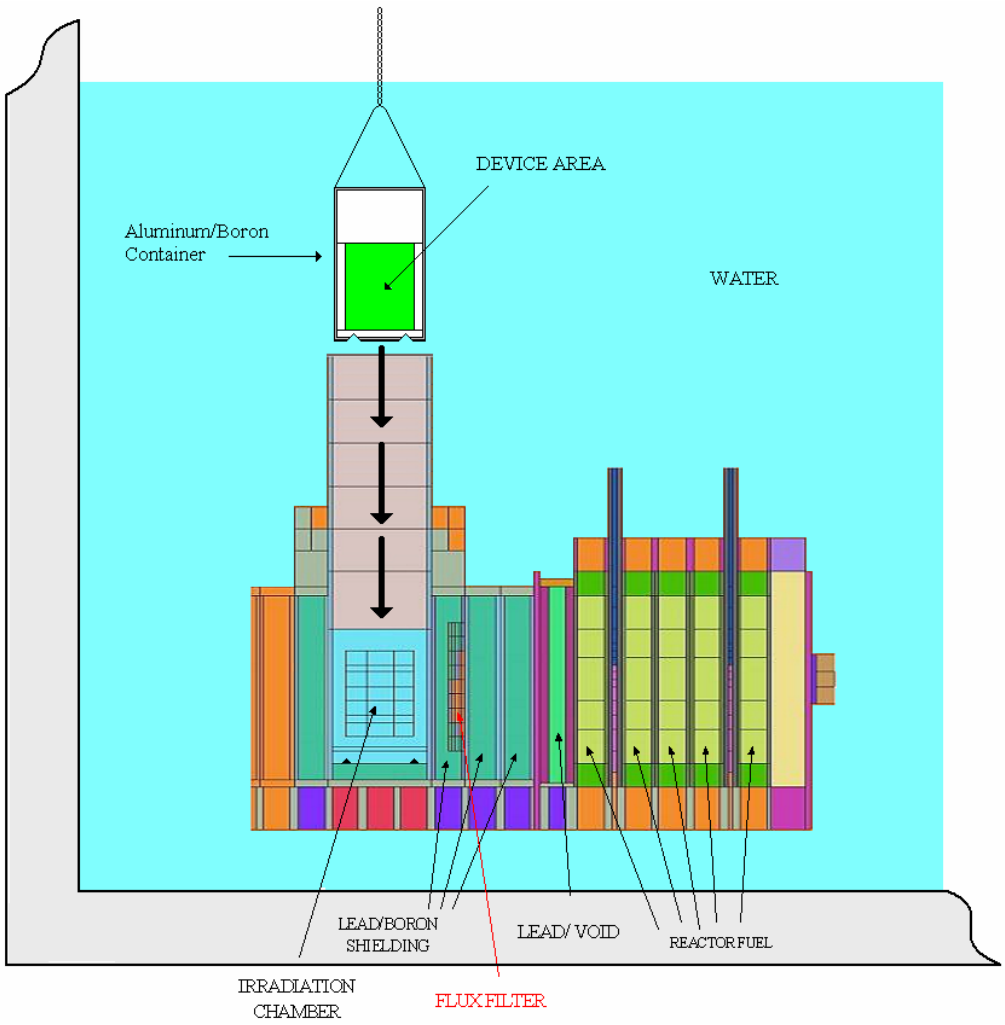
Table 7: Test Hardware		
	Test Fixture	Test System
Pre Radiation Tests	04-135-TF, 04-135-010-TA	PXI 04-134-TC
Post Radiation Tests	04-135-TF, 04-135-010-TA	PXI 04-134-TC

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.



International
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Appendix D

Neutron Exposure Certificate

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RADIATION LABORATORY

August 29, 2005

Chris DiCienzo
International Rectifier Corporation
205 Crawford Street
Leominster, MA 01453

Subject: **Certificate of Neutron Exposure**

Product:	Electronic Devices 050825-1
Irradiation Date:	August 25, 2005
Irradiation Facility:	Reactor Facility- FNI
Irradiation Length:	184 sec @ 5kW
Desired (1MeV Si Eq.)Exposure:	1.0E11 neutrons/cm^2
Dosimetry system:	P-32, ASTM E-265

Neutron Dosimetry Results:

	Front Tablet	Back Tablet
Efficiency	0.1814	0.1765
P-32 Decay Constant	5.63E-07	5.63E-07
Rel. Damage Factor	0.544	0.544
Spectral Avg. X-sect	7.35E-27	7.35E-27
Net Disintegrations	6439.86	5435.02
Activity [1]	6.56E+00	5.54E+00
Saturated Activity [2]	6.34E+04	5.35E+04
Target Atoms [3]	6.40E+21	6.65E+21
Reaction Rate [4]	9.90E-18	8.04E-18
Fluence(>10kev) [5]	2.48E+11	2.01E+11

(1) ASTM E261 (Eq. 1)
(2) ASTM E261 (Eq. 3)
(3) ASTM E261 (Eq. 6)
(4) ASTM E261 (Eq. 5)
(5) ASTM E261 (Eq. 38)

Front Tablet Fluence (1MeV Si Eq.) = 1.35E+11 n/cm^2
Back Tablet Fluence (1MeV Si Eq.) = 1.10E+11 n/cm^2

Average Neutron Fluence (1MeV Si Eq.) = 1.22E+11 n/cm^2

Reviewed by _____
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RADIATION LABORATORY

August 29, 2005

Chris DiCienzo
International Rectifier Corporation
205 Crawford Street
Leominster, MA 01453

Subject: **Certificate of Neutron Exposure**

Product:	Electronic Devices 050825-2
Irradiation Date:	August 25, 2005
Irradiation Facility:	Reactor Facility- FNI
Irradiation Length:	416sec @ 20kW
Desired (1MeV Si Eq.)Exposure:	9.0E11 neutrons/cm^2
Dosimetry system:	P-32, ASTM E-265

Neutron Dosimetry Results:

	Front Tablet	Back Tablet
Efficiency	0.1719	0.1801
P-32 Decay Constant	5.63E-07	5.63E-07
Rel. Damage Factor	0.544	0.544
Spectral Avg. X-sect	7.35E-27	7.35E-27
Net Disintegrations	28998.47	22243.41
Activity [1]	5.86E+01	4.50E+01
Saturated Activity [2]	2.50E+05	1.92E+05
Target Atoms [3]	6.89E+21	6.47E+21
Reaction Rate [4]	3.63E-17	2.97E-17
Fluence(>10kev) [5]	2.06E+12	1.68E+12

(1) ASTM E261 (Eq. 1)
(2) ASTM E261 (Eq. 3)
(3) ASTM E261 (Eq. 6)
(4) ASTM E261 (Eq. 5)
(5) ASTM E261 (Eq. 38)

Front Tablet Fluence (1MeV Si Eq.) = 1.12E+12 n/cm^2
Back Tablet Fluence (1MeV Si Eq.) = 9.12E+11 n/cm^2

Average Neutron Fluence (1MeV Si Eq.) = 1.02E+12 n/cm^2

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RADIATION LABORATORY

August 29, 2005

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International Rectifier Corporation
205 Crawford Street
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Subject: **Certificate of Neutron Exposure**

Product:	Electronic Devices 050825-3
Irradiation Date:	August 25, 2005
Irradiation Facility:	Reactor Facility- FNI
Irradiation Length:	923.4 sec @90kW
Desired (1MeV Si Eq.)Exposure:	9.0E12 neutrons/cm^2
Dosimetry system:	P-32, ASTM E-265

Neutron Dosimetry Results:

	Front Tablet	Back Tablet
Efficiency	0.1748	0.1801
P-32 Decay Constant	5.63E-07	5.63E-07
Rel. Damage Factor	0.544	0.544
Spectral Avg. X-sect	7.35E-27	7.35E-27
Net Disintegrations	53484.36	41457.96
Activity [1]	5.36E+02	4.15E+02
Saturated Activity [2]	1.03E+06	7.99E+05
Target Atoms [3]	6.74E+21	6.47E+21
Reaction Rate [4]	1.53E-16	1.24E-16
Fluence(>10kev) [5]	1.92E+13	1.55E+13

(1) ASTM E261 (Eq. 1)
(2) ASTM E261 (Eq. 3)
(3) ASTM E261 (Eq. 6)
(4) ASTM E261 (Eq. 5)
(5) ASTM E261 (Eq. 38)

Front Tablet Fluence (1MeV Si Eq.) = 1.05E+13 n/cm^2
Back Tablet Fluence (1MeV Si Eq.) = 8.44E+12 n/cm^2

Average Neutron Fluence (1MeV Si Eq.) = 9.45E+12 n/cm^2

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