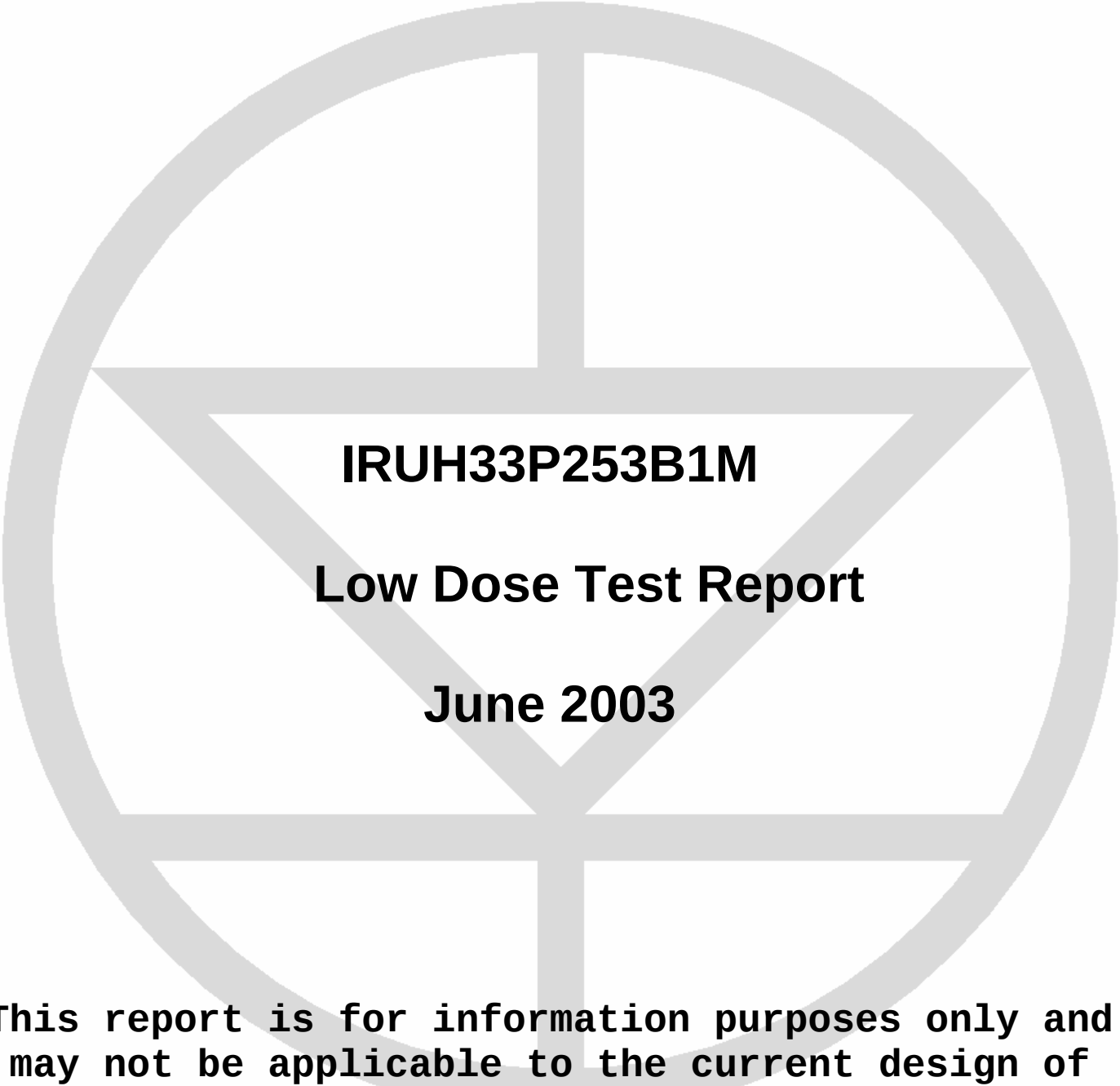




IRUH33P253B1M

Low Dose Test Report

June 2003

**This report is for information purposes only and
may not be applicable to the current design of
the product**

Low Dose (TID) testing

The IRUH33P253B1M (formally identified as the OMR9601SCK) was chosen as the test device for the series of regulators using the same components. The module has been tested in accordance with MIL-STD-883, method 1019, condition C. The Radiation Hardness Assurance Group of International Rectifier conducted this test at the University of Massachusetts Research Nuclear Reactor in Lowell, Mass. This facility has been granted lab suitability by the Defense Supply Center Columbus (DSCC). Pre and post radiation testing was performed at the reactor site in Umass, Lowell. All other tests including electrical performance, QCI screening, burn-in and aging are conducted at International Rectifier in Leominster, Mass. The test plan for conducting the radiation testing is included in Appendix A, herein.

Radiation testing was comprised of the following conditions; biased, with 3.3V_{in} and a low dose rate (.100 rad/sec(Si)), ambient temp - 25°C

Schematic of the IRUH33P253B1M (OMR9601SCK) Regulator is shown in Figure 1.

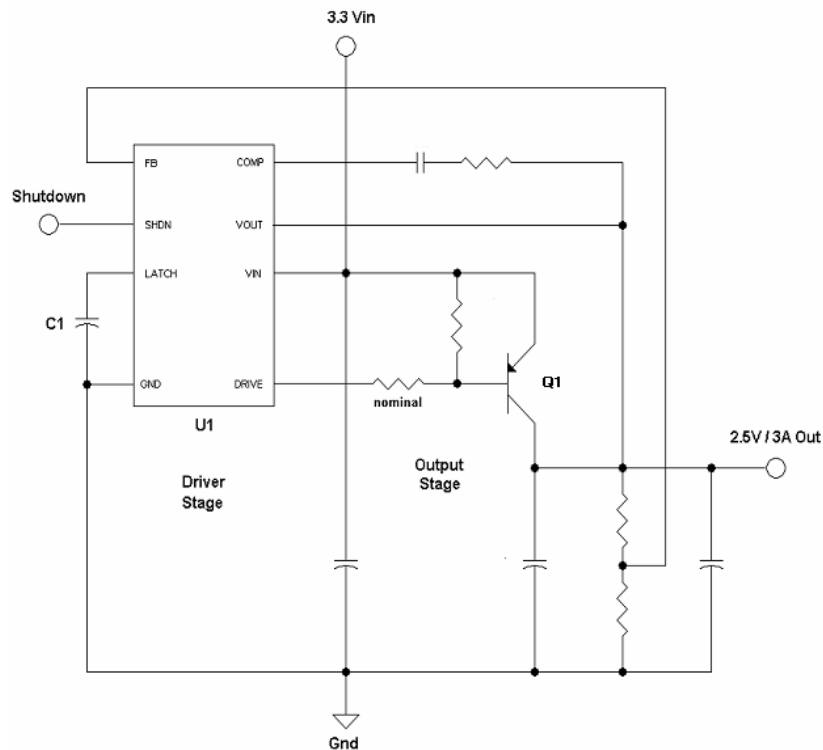


FIGURE 1 – IRUH33P253B1M Schematic

Test Results

Low Dose Rate bias conditions are shown in Figure 2. Bias was applied to all devices during irradiation. Devices tested at pre-irradiation were within specification limits. All devices were tested at each irradiation step in accordance to Mil-Std-883, Method 1019, condition C. The electrical test results are provided in Appendix B, herein.

Four devices were irradiated to 1.5 M Rad (Si) at a dose rate of 0.1 Rad (Si)/sec. Analysis of the data indicated a rise in output voltage up to approximately 170krads at which time the output voltage began to shift toward its nominal level, refer to Figure 3. This phenomena can be attributed to several factors within the regulator. Degradation of the drive circuits (NPN) output transistors and the reference source, along with the output (PNP) Pass transistor attribute to this effect. This data is shown graphically in figures 3 thru 7 below.

One device serial #189 indicated an alarm for Load Regulation at 1.2 M Rad (Si). Subsequent testing of serial #189 did not indicate any problems, thus it was concluded that the test data was acquired incorrectly.

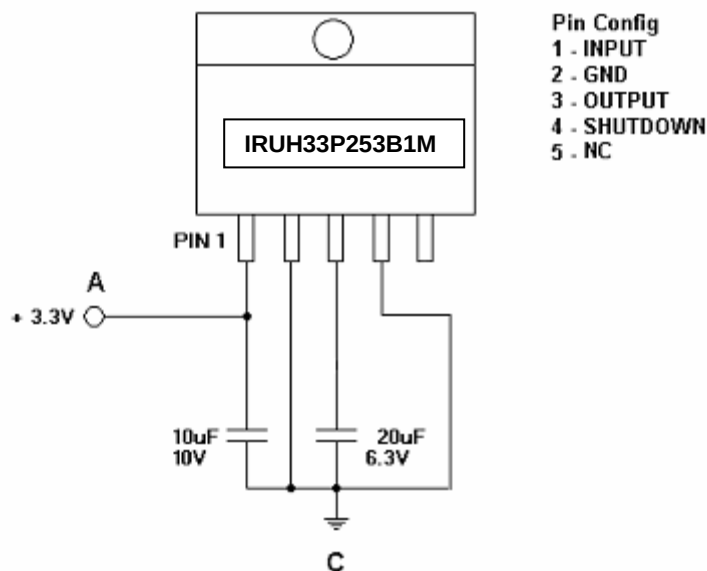


FIGURE 2 TID Bias (Low Dose Rate)

Table 1 below shows the mean value of key parameters for each test point at the low dose rate.

Table 1 – Mean Parameters per Test Point (***Biased***)

Biased Devices		Pre Rad Data	Post Rad Data											
Test	Krads	1	33	79	169	246	355	443	481	557	1050	1214	1417	1476
Vout1	(V)	2.50	2.53	2.56	2.57	2.56	2.54	2.53	2.52	2.52	2.50	2.50	2.50	2.50
Vout2	(V)	2.49	2.52	2.54	2.56	2.54	2.53	2.52	2.51	2.51	2.49	2.49	2.49	2.49
Vout3	(V)	2.50	2.53	2.56	2.57	2.55	2.54	2.53	2.52	2.51	2.50	2.49	2.50	2.50
Vout4	(V)	2.48	2.52	2.54	2.56	2.54	2.52	2.51	2.51	2.50	2.49	2.48	2.48	2.48
Line Reg	(mV)	-1.42	0.21	0.38	-0.38	-0.45	-0.71	0.26	0.37	-0.13	1.86	3.48	3.76	4.78
Load Reg	(mV)	9.58	9.34	9.14	9.92	10.36	10.13	9.20	9.63	9.51	8.98	4.48	4.56	3.44
Ibias	(mA)	-1.43	1.42	1.85	1.17	4.37	1.34	1.34	1.51	-1.35	-2.38	5.48	-0.18	-0.19
Short Ckt	(A)	4.29	4.20	4.10	3.30	3.17	3.08	3.27	3.03	3.53	3.18	3.76	4.04	3.86
Enable	(V)	2.50	2.53	2.56	2.57	2.56	2.54	2.53	2.52	2.51	2.50	2.50	2.50	2.50
Disable	(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enable	(V)	2.50	2.53	2.56	2.57	2.56	2.54	2.53	2.52	2.51	2.50	2.50	2.50	2.50

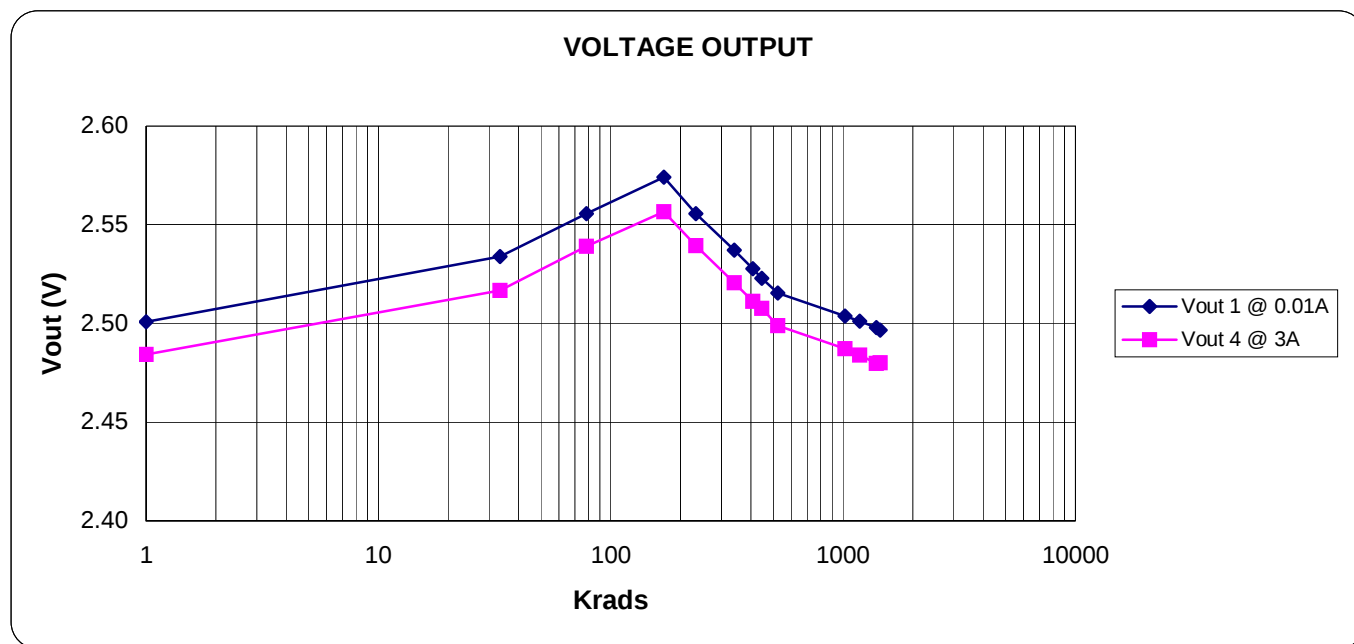


FIGURE 3

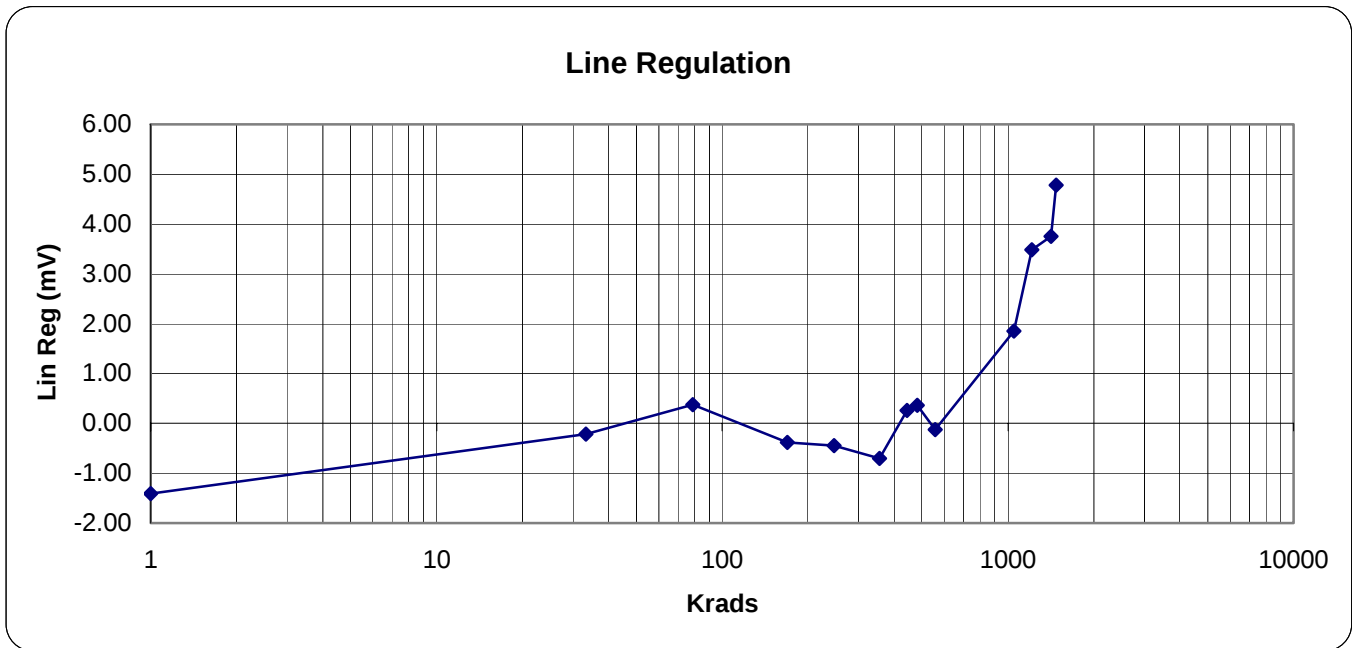


FIGURE 4

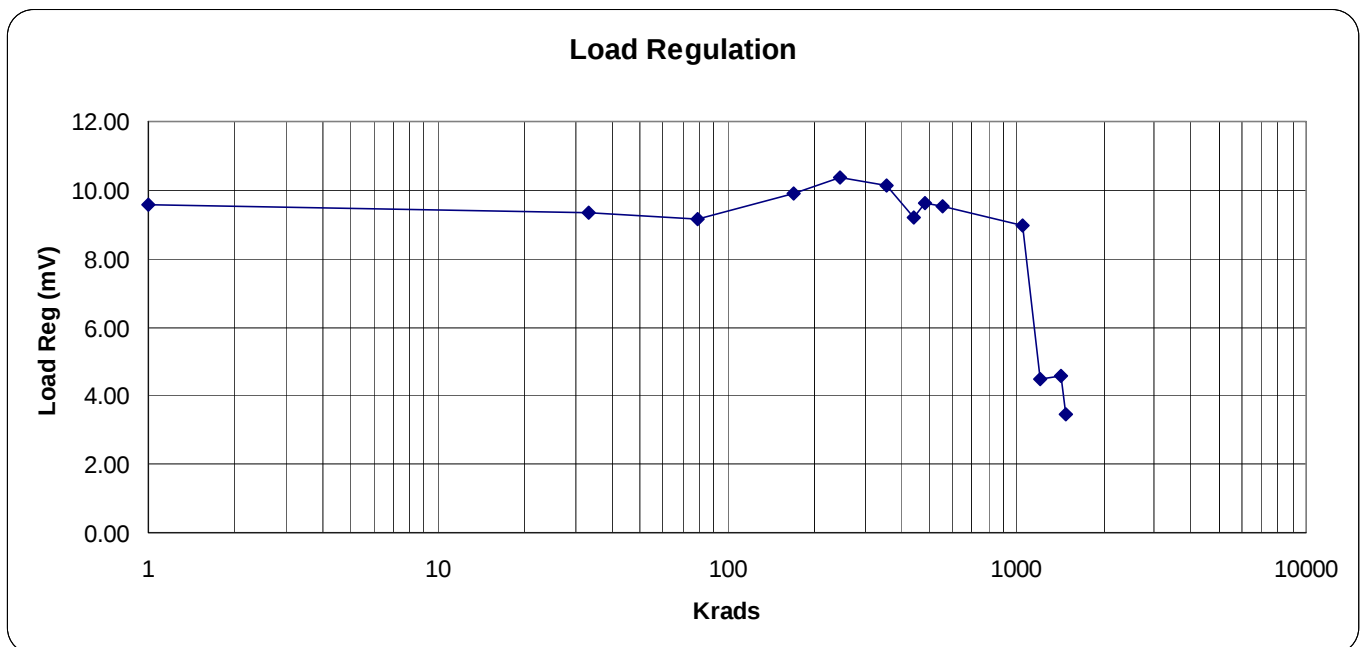


FIGURE 5

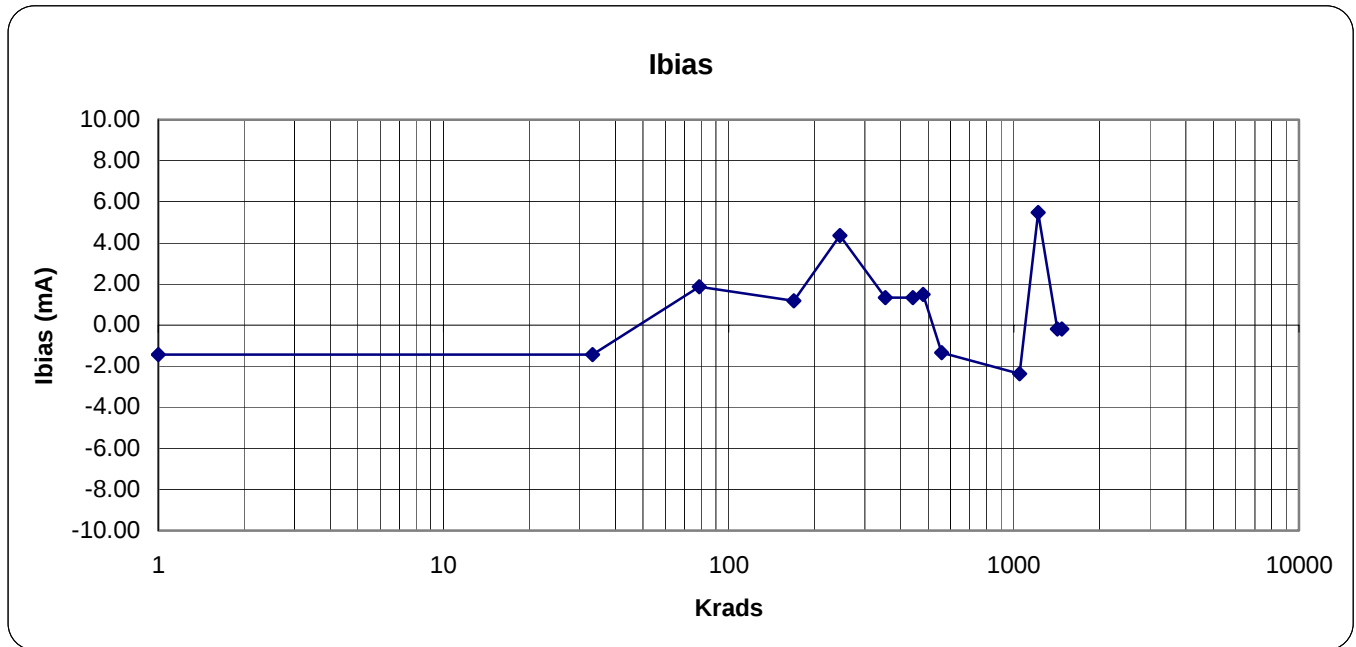


FIGURE 6

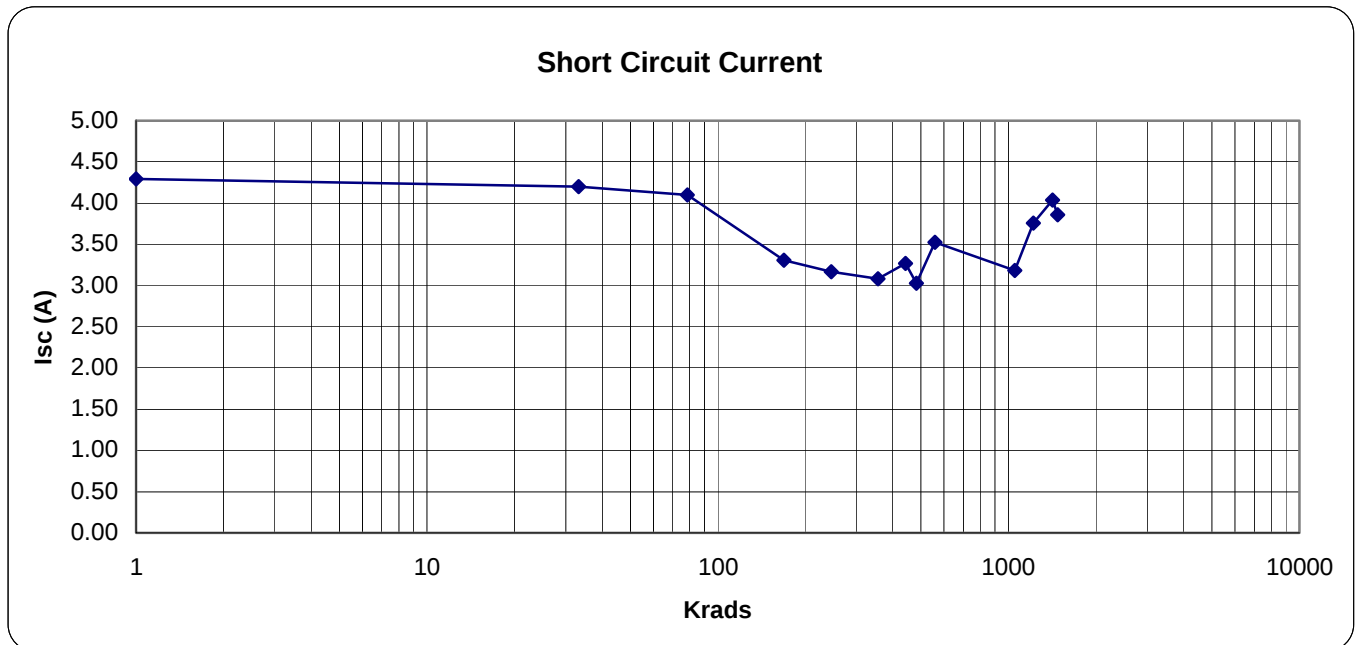


FIGURE 7

Summary

The biased devices performed extremely well to the total accumulated rate of exposure of 1.5M Rad (Si). Degradation of the internal reference source is noticeable at 30K Rad (Si) (see Figure 3). This anomaly continues up to 170Krad at which time the gains of the drive and output transistors begin to have an opposing effect to the radiation. The result is a shift of the output voltage towards its nominal value.

Conclusion

Low dose irradiation indicates an enhanced low dose rate sensitivity (ELDRS) effect as shown in the graphs and data. Response to the low dose radiation is very robust. In accordance to Method 1019, condition C, the devices can be rated at > 500K Rad (Si) (2X) at low dose rate of 0.100 Rad (Si)/sec".

Appendix A

Electrical Test Results

Table 4 – Electrical Test Results – Pre-Irradiation

Biased Devices		Pre-Irradiation Data				
Test	Ser #	173	189	181	186	LIMITS
Vout1	(V)	2.50	2.50	2.51	2.50	[2.4 TO 2.6 V]
Vout2	(V)	2.49	2.49	2.50	2.49	[2.4 TO 2.6 V]
Vout3	(V)	2.50	2.50	2.51	2.50	[2.4 TO 2.6 V]
Vout4	(V)	2.48	2.48	2.49	2.48	[2.4 TO 2.6 V]
Line Reg	(mV)	-1.42	-1.32	-1.27	-1.65	[-100 TO 100 MV]
Load Reg	(mV)	11.30	9.30	9.81	7.92	[-20 TO 20 MV]
Ibias	(mA)	2.62	-13.59	2.66	2.62	[-10 TO 10 MA]
Short Ckt	(A)	4.35	4.27	4.27	4.27	[3 TO 9A]
Enable	(V)	2.50	2.50	2.51	2.50	[2.4 TO 2.6 V]
Disable	(V)	0.00	0.00	0.00	0.00	[-0.1 TO 0.1 V]
Enable	(V)	2.50	2.50	2.51	2.50	[2.4 TO 2.6 V]

Table 5 – Electrical Test Results – Post-Irradiation

SN:	173														
	Date:	5/30/02	6/4/02	6/11/02	6/25/02	7/5/02	7/22/02	8/2/02	8/8/02	8/20/02	11/13/02	12/10/02	1/13/03	1/23/03	
Tests	Krads:	1	33	79	169	246	355	443	481	557	1050	1214	1417	1476	Limits
Vout1	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.53	2.52	2.51	2.50	2.47	2.50	2.50	[2.4 TO 2.6 V]
Vout2	(V)	2.49	2.52	2.54	2.56	2.54	2.52	2.51	2.51	2.50	2.49	2.48	2.49	2.49	[2.4 TO 2.6 V]
Vout3	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.53	2.52	2.51	2.50	2.47	2.50	2.50	[2.4 TO 2.6 V]
Vout4	(V)	2.48	2.51	2.53	2.55	2.53	2.51	2.51	2.50	2.49	2.48	2.61	2.47	2.47	[2.4 TO 2.6 V]
Line Reg	(mV)	-1.42	-0.28	0.68	-0.35	-0.35	-0.69	-0.01	0.39	-0.29	2.01	4.60	3.60	4.55	[-100 TO 100 MV]
Load Reg	(mV)	11.30	10.79	10.21	11.98	11.98	12.14	11.46	11.92	11.75	11.49	21.26	8.94	7.62	[-20 TO 20 MV]
Ibias	(mA)	2.62	2.70	5.27	4.62	4.62	4.36	4.15	4.68	2.68	1.79	1.00	2.44	1.75	[-10 TO 10 MA]
Short Ckt	(A)	4.35	4.27	4.15	3.29	3.29	3.05	3.25	3.06	3.54	3.15	3.76	4.09	3.92	[3 TO 9A]
Enable	(V)	2.50	2.53	2.55	2.57	2.57	2.53	2.53	2.52	2.51	2.50	2.49	2.50	2.50	[2.4 TO 2.6 V]
Disable	(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[-0.1 TO 0.1 V]
Enable	(V)	2.50	2.53	2.55	2.57	2.57	2.53	2.53	2.52	2.51	2.50	2.50	2.50	2.50	[2.4 TO 2.6 V]

SN:	189														
	Date:	5/30/02	6/4/02	6/11/02	6/25/02	7/5/02	7/22/02	8/2/02	8/8/02	8/20/02	11/13/02	12/10/02	1/13/03	1/23/03	
Tests	Krads:	1	33	79	169	246	355	443	481	557	1050	1214	1417	1476	Limits
Vout1	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.48	2.49	2.49	[2.4 TO 2.6 V]
Vout2	(V)	2.49	2.52	2.54	2.56	2.54	2.52	2.51	2.51	2.50	2.49	2.48	2.48	2.49	[2.4 TO 2.6 V]
Vout3	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.48	2.49	2.49	[2.4 TO 2.6 V]
Vout4	(V)	2.48	2.51	2.53	2.55	2.54	2.52	2.51	2.51	2.49	2.48	2.47	2.48	2.48	[2.4 TO 2.6 V]
Line Reg	(mV)	-1.32	-0.06	0.55	-0.33	-0.19	-0.46	0.54	0.53	0.01	1.93****		4.15	5.10	[-100 TO 100 MV]
Load Reg	(mV)	9.30	9.07	9.24	9.52	10.61	10.60	10.25	8.77	9.63	8.18	7.05	3.44	0.34	[-20 TO 20 MV]
(load)	(mA)	-13.59	-13.84	-4.65	0.00	5.63	-5.75	-6.24	-5.75	-13.47	-14.43	-9.44	-8.09	-7.60	[-10 TO 10 MA]
Short Ckt	(A)	4.27	4.23	4.11	3.34	3.13	3.09	3.25	3.05	3.50	3.19	3.76	4.01	3.84	[3 TO 9A]
Enable	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.48	2.49	2.49	[2.4 TO 2.6 V]
Disable	(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[-0.1 TO 0.1 V]
Enable	(V)	2.50	2.53	2.55	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.48	2.49	2.49	[2.4 TO 2.6 V]

SN:	181														
	Date:	5/30/02	6/4/02	6/11/02	6/25/02	7/5/02	7/22/02	8/2/02	8/8/02	8/20/02	11/13/02	12/10/02	1/13/03	1/23/03	
Tests	Krads:	1	33	79	169	246	355	443	481	557	1050	1214	1417	1476	Limits
Vout1	(V)	2.51	2.54	2.57	2.59	2.57	2.55	2.54	2.54	2.53	2.52	2.51	2.51	2.51	[2.4 TO 2.6 V]
Vout2	(V)	2.50	2.53	2.55	2.57	2.56	2.54	2.54	2.53	2.52	2.51	2.50	2.50	2.50	[2.4 TO 2.6 V]
Vout3	(V)	2.51	2.54	2.57	2.59	2.57	2.55	2.53	2.54	2.53	2.52	2.51	2.51	2.51	[2.4 TO 2.6 V]
Vout4	(V)	2.49	2.53	2.55	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.50	2.49	2.49	[2.4 TO 2.6 V]
Line Reg	(mV)	-1.27	-0.28	-0.02	-0.48	-0.64	-0.73	0.54	0.32	-0.08	1.59	3.95	3.82	4.83	[-100 TO 100 MV]
Load Reg	(mV)	9.81	9.30	9.41	10.20	10.26	10.14	9.97	9.40	9.57	8.81	6.48	4.13	3.90	[-20 TO 20 MV]
Ibias	(mA)	2.66	2.73	4.10	0.03	4.60	4.28	4.80	4.53	2.70	1.90	2.48	2.45	2.57	[-10 TO 10 MA]
Short Ckt	(A)	4.27	4.19	4.11	3.29	3.13	3.13	3.29	3.05	3.54	3.19	3.76	4.05	3.84	[3 TO 9A]
Enable	(V)	2.51	2.54	2.57	2.58	2.57	2.55	2.53	2.53	2.53	2.52	2.51	2.51	2.51	[2.4 TO 2.6 V]
Disable	(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[-0.1 TO 0.1 V]
Enable	(V)	2.51	2.54	2.57	2.58	2.57	2.55	2.54	2.53	2.53	2.52	2.51	2.51	2.51	[2.4 TO 2.6 V]

SN:	186															
	Date:	5/30/02	6/4/02	6/11/02	6/25/02	7/5/02	7/22/02	8/2/02	8/8/02	8/20/02	11/13/02	12/10/02	1/13/03	1/23/03		
Tests	Krads:	1	33	79	169	246	355	443	481	557	1050	1214	1417	1476	Limits	
Vout1	(V)	2.50	2.54	2.56	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.50	2.50	2.50	[2.4 TO 2.6 V]	
Vout2	(V)	2.49	2.53	2.55	2.56	2.54	2.52	2.52	2.51	2.50	2.49	2.49	2.49	2.49	[2.4 TO 2.6 V]	
Vout3	(V)	2.50	2.54	2.56	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.50	2.50	2.50	[2.4 TO 2.6 V]	
Vout4	(V)	2.48	2.52	2.54	2.55	2.54	2.52	2.51	2.50	2.50	2.49	2.48	2.48	2.48	[2.4 TO 2.6 V]	
Line Reg	(mV)	-1.65	-0.23	0.31	-0.36	-0.60	-0.95	-0.03	0.22	-0.14	1.89	4.11	3.45	4.64	[-100 TO 100 MV]	
Load Reg	(mV)	7.92	8.21	7.69	7.97	8.60	7.62	5.10	8.42	7.10	7.43	4.47	1.72	1.89	[-20 TO 20 MV]	
Ibias	(mA)	2.62	2.73	2.70	0.03	2.65	2.50	2.65	2.58	2.67	2.24	2.44	2.46	2.53	[-10 TO 10 MA]	
Short Ckt	(A)	4.27	4.11	4.03	3.29	3.13	3.05	3.29	3.05	3.54	3.19	3.76	4.01	3.84	[3 TO 9A]	
Enable	(V)	2.50	2.54	2.56	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.50	2.50	2.50	[2.4 TO 2.6 V]	
Disable	(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[-0.1 TO 0.1 V]	
Enable	(V)	2.50	2.54	2.56	2.57	2.55	2.53	2.52	2.52	2.51	2.50	2.50	2.50	2.50	[2.4 TO 2.6 V]	