

Total Ionization Dose (TID) Test Results of the RH1086MH 0.5A Low Dropout Positive Adjustable Regulator @ High Dose Rate (HDR)

HDR = 50 rads(Si)/s

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Acknowledgements

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TID HDR Testing of the RH1086MH 0.5A Low Dropout Positive Adjustable Regulator

Part Type Tested: RH1086MH 0.5A Low Dropout Positive Adjustable Regulator

Traceability Information: Fab Lot # W1231270.1; Assembly Lot # 719601.1; Wafer # 4; Date Code 1328A. See photograph of unit under test in Appendix A.

Quantity of Units: 42 units received, 2 units for control, 20 units for biased irradiation, and 20 units for unbiased irradiation. Serial numbers 620-624, 630-634, 640-644, and 650-654, and had all pins tied to ground during irradiation. Serial numbers 625-629, 635-639, 645-649, and 655-659 were biased during irradiation. Serial numbers 660 and 661 were used as control. See Appendix B for the radiation bias connection tables.

Radiation and Electrical Test Increments: 40 samples were divided into four groups of 10 each. Serial numbers 620-629 of group 1 were irradiated to 10 Krads(Si). Serial numbers 630-639 of group 2 were irradiated to 30 Krads(Si). Serial numbers 640-649 of group 3 were irradiated to 50 Krads(Si). Serial numbers 650-659 of group 4 were irradiated to 100 Krads(Si).

Radiation dose: 50 rads(Si)/sec.

Radiation Test Standard: MIL-STD-883 TM1019.9 Condition A.

Test Hardware and Software: LTX pre- and post-irradiation test program EFCR1086H.02.

Facility and Radiation Source: Defense Micro Electronic Activity (DMEA) and Cobalt-60.

Irradiation and Test Temperature: Room temperature controlled to $24^{\circ}\text{C}\pm 6^{\circ}\text{C}$ per MIL-STD-883 and MIL-STD-750.

SUMMARY

ALL 42 PARTS PASSED THE ELECTRICAL TEST LIMITS AS SPECIFIED IN THE DATASHEET AFTER EACH IRRADIATION INCREMENT. ADDITIONAL INFORMATION CAN BE PROVIDED PER REQUEST.

1.0 Overview and Background

Among other radiation effects, Total Ionizing Dose (TID) may affect electrical characteristics, causing parametric and/or functional failures in integrated circuits. During gamma-irradiations, TID-induced and transported electron-hole pairs may result in charge trapping in a transistor's dielectrics and interface regions, affecting the device's basic features. Such effects warrant testing and monitoring of circuits to TID, after which annealing and/or Time Dependent Effects (TDE) may take place, depending on the circuit's design and process technology. Hence the requirement per Condition A (for high-dose rates ranging from 50 and 300 rads(Si)/sec) in TM1019, MIL-STD-883 is to not exceed the allowed time from the end of an incremented irradiation and an electrical test to more than one hour. Additionally, the total time from the end of one incremental irradiation to the start of the next incremental step should be less than two hours.

2.0 Radiation Facility and Test Equipment

The samples were irradiated at Defense Micro-Electronics Activity (DMEA) facility in Sacramento, California. DMEA utilizes J.L. Shepherd model 81-22/484 to provide the dose-rate of 50 rads(Si)/s. A special design screw-driven automatic cart inside the exposure tunnel positions the Device-Under-Test (DUT) precisely and repeatedly from the source to attain optimal rate verified by ion chamber detectors. See Appendix C for the certificate of dosimetry.

3.0 Test Conditions

The 40 test samples and two control units were electrically tested at 25°C prior to irradiation. The parts were then placed in a lead/aluminum container and aligned with the radiation source, Cobalt-60, at DMEA facility in Sacramento, California. During irradiation, five units of six separate groups were biased at +/- 15V and other five of similar groups had all pads grounded. Ten units of group 1 were irradiated to 10 Krads(Si); group 2 to 30 Krads(Si); group 3 to 50 Krads(Si); and group 4 to 100 Krads(Si). After irradiation, the samples were transported in dry ice to Linear Technology testing facility. Testing was performed on the two control units to confirm the operation of the test system prior to the electrical testing of the 42 units (40 irradiated and 2 control).

The criteria to pass the high dose-rate test is that five samples in each corresponding dose group irradiated under electrical bias must pass the datasheet limits. If any of the tested parameters of these five units do not meet the required limits then a failure-analysis of the part should be conducted and if valid the lot will be scrapped.

4.0 Tested Parameters

The following parameters were measured pre- and post-irradiations:

- V_{REF} (V) @ $10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$, $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$
- Line Regulation (%) @ $I_{LOAD} = 10\text{mA}$, $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$
- Load Regulation (%) @ $(V_{IN} - V_{OUT}) = 3\text{V}$, $10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$
- Dropout Voltage (V) @ $I_{OUT} = 0.5\text{A}$, $\Delta V_{REF} = 1\%$
- Current Limit (A) @ $(V_{IN} - V_{OUT}) = 5\text{V}$
- Current Limit (A) @ $(V_{IN} - V_{OUT}) = 25\text{V}$
- Minimum Load Current (mA) @ $(V_{IN} - V_{OUT}) = 25\text{V}$
- Adjust Pin Current (μA)
- Delta Adjust Current (μA) @ $10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$, $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$

Appendix D details the test conditions, minimum and maximum values at different accumulated doses.

5.0 Test Results

All 40 samples passed the post-irradiation electrical tests. All measurements of the nine listed parameters in section 4.0 are within the specification limits.

The used statistics in this report are based on the tolerance limits, which are bounds to gage the quality of the manufactured products. It assumes that if the quality of the items is normally distributed with known mean and known standard deviation, the two-sided tolerance limits can be calculated as follows:

$$+K_{TL} = \text{mean} + (K_{TL}) (\text{standard deviation})$$

$$-K_{TL} = \text{mean} - (K_{TL}) (\text{standard deviation})$$

Where $+K_{TL}$ is the upper tolerance limit and $-K_{TL}$ is the lower tolerance limit. These tolerance limits are defined in a table of inverse normal probability distribution.

However, in most cases, mean and standard deviations are unknown and therefore it is practical to estimate both of them from a sample. Hence the tolerance limit depends greatly on the sample size. The $P_{90\%/90\%}$ K_{TL} factor for a lot quality P of 0.9, confidence C of 0.9 with a sample size of 5, can be found from the tabulated table (MIL-HDBK-814, page 94, table IX-B). The K_{TL} factor in this report is 2.742.

In the plots, the dotted lines with diamond markers are the average of the measured data points of five samples irradiated under electrical bias while the dashed lines with X-markers are the average of measured data points of five units irradiated with all pins tied to ground. The solid lines with triangle markers are the average of the data points after the calculation of the K_{TL} statistics on the sample irradiated in the biased setup. The solid lines with square symbols are the average of the measured points after the application of the K_{TL} statistics on the five samples irradiated with all pins grounded. The orange solid lines with circle markers are the specification limits.

The 30 Krads(Si) test limits are using Linear Technology datasheet 20 Krads(Si) specification limits.

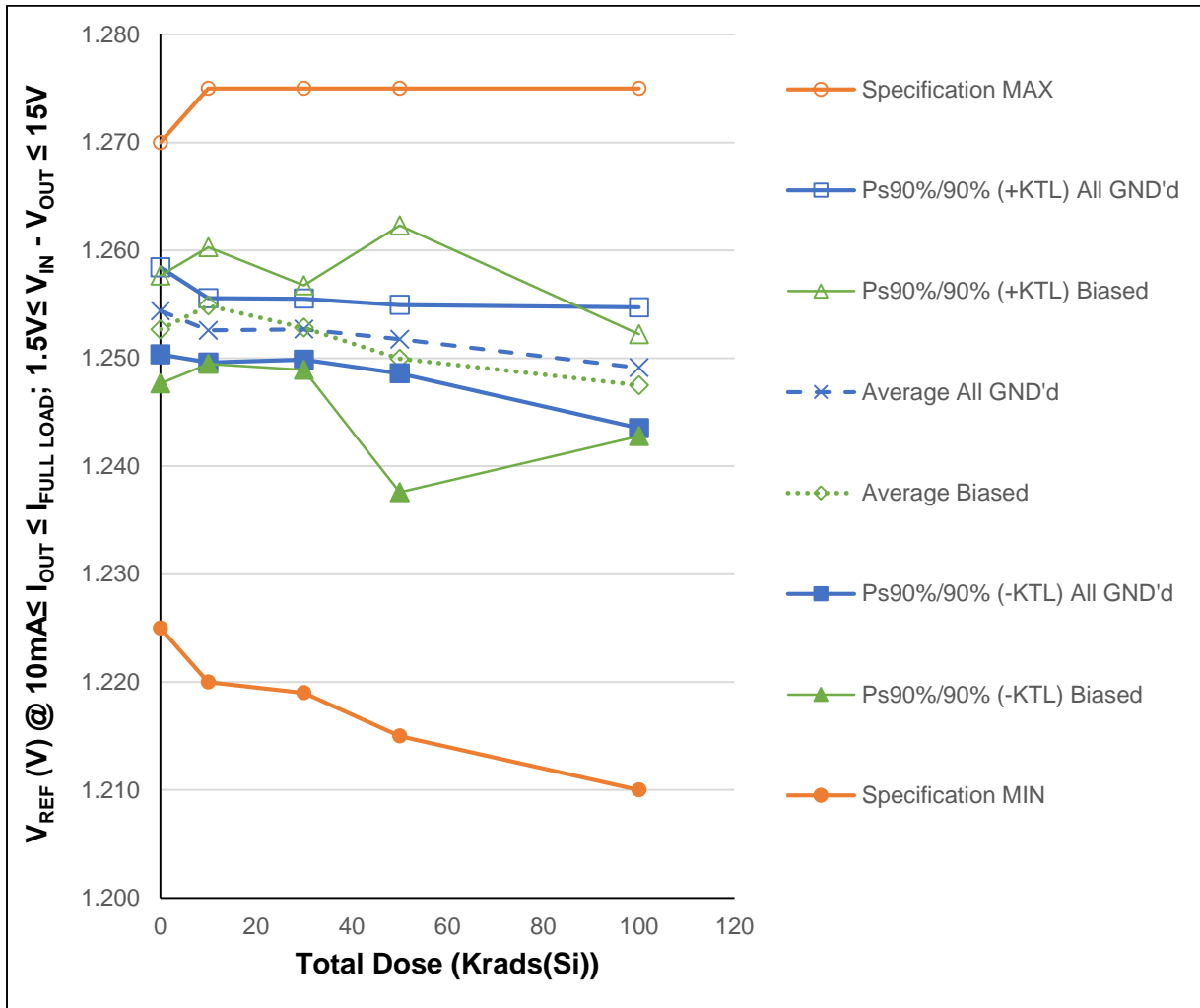


Figure 5.1 Plot of V_{REF} versus Total Dose

Table 5.1: Raw data for reference voltage versus total dose including the statistical calculations, minimum specification, maximum specification, and the status of the test (PASS/FAIL) under the orange headers)

Parameter	Vref @ 10mA ≤ I _{OUT} ≤ I _{FULL LOAD} ; 1.5V ≤ V _{IN} - V _{OUT} ≤ 15V	Total Dose (Krad(Si)) @ 50rad(Si)/s				
Units	(V)	0	10	30	50	100
620	All GND'd Irradiation	1.25510	1.25185			
621	All GND'd Irradiation	1.25510	1.25183			
622	All GND'd Irradiation	1.25212	1.25443			
623	All GND'd Irradiation	1.25586	1.25215			
624	All GND'd Irradiation	1.25379	1.25264			
625	Biased Irradiation	1.25571	1.25322			
626	Biased Irradiation	1.25112	1.25615			
627	Biased Irradiation	1.25146	1.25661			
628	Biased Irradiation	1.25223	1.25230			
629	Biased Irradiation	1.25284	1.25611			
630	All GND'd Irradiation	1.24976		1.25291		
631	All GND'd Irradiation	1.24610		1.25093		
632	All GND'd Irradiation	1.25311		1.25294		
633	All GND'd Irradiation	1.25345		1.25298		
634	All GND'd Irradiation	1.25143		1.25367		
635	Biased Irradiation	1.24915		1.25141		
636	Biased Irradiation	1.24488		1.25447		
637	Biased Irradiation	1.25304		1.25291		
638	Biased Irradiation	1.25511		1.25139		
639	Biased Irradiation	1.25192		1.25398		
640	All GND'd Irradiation	1.24610			1.25227	
641	All GND'd Irradiation	1.25410			1.25288	
642	All GND'd Irradiation	1.24804			1.25244	
643	All GND'd Irradiation	1.24983			1.25122	
644	All GND'd Irradiation	1.25471			1.25000	
645	Biased Irradiation	1.25373			1.25183	
646	Biased Irradiation	1.25349			1.24251	
647	Biased Irradiation	1.24499			1.25414	
648	Biased Irradiation	1.24990			1.25201	
649	Biased Irradiation	1.24999			1.24925	
650	All GND'd Irradiation	1.25182				1.24878
651	All GND'd Irradiation	1.25196				1.24687
652	All GND'd Irradiation	1.25471				1.24806
653	All GND'd Irradiation	1.25318				1.25230
654	All GND'd Irradiation	1.25440				1.24962
655	Biased Irradiation	1.25449				1.24478
656	Biased Irradiation	1.24480				1.24849
657	Biased Irradiation	1.25192				1.24707
658	Biased Irradiation	1.25478				1.24928
659	Biased Irradiation	1.25129				1.24790
660	Control Unit	1.25617	1.25528	1.25528	1.25528	1.25528
661	Control Unit	1.25674	1.25646	1.25646	1.25646	1.25646
All GND'd Irradiation Statistics						
Average All GND'd		1.25439	1.25258	1.25269	1.25176	1.24912
Std Dev All GND'd		0.00147	0.00109	0.00103	0.00116	0.00204
Ps90%/90% (+KTL) All GND'd		1.25843	1.25556	1.25551	1.25493	1.25472
Ps90%/90% (-KTL) All GND'd		1.25036	1.24960	1.24986	1.24859	1.24353
Biased Irradiation Statistics						
Average Biased		1.25267	1.25488	1.25283	1.24995	1.24750
Std Dev Biased		0.00182	0.00197	0.00143	0.00450	0.00172
Ps90%/90% (+KTL) Biased		1.25767	1.26028	1.25674	1.26230	1.25223
Ps90%/90% (-KTL) Biased		1.24767	1.24947	1.24892	1.23760	1.24278
Specification MIN		1.225	1.220	1.219	1.215	1.210
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS
Specification MAX		1.270	1.275	1.275	1.275	1.275
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS

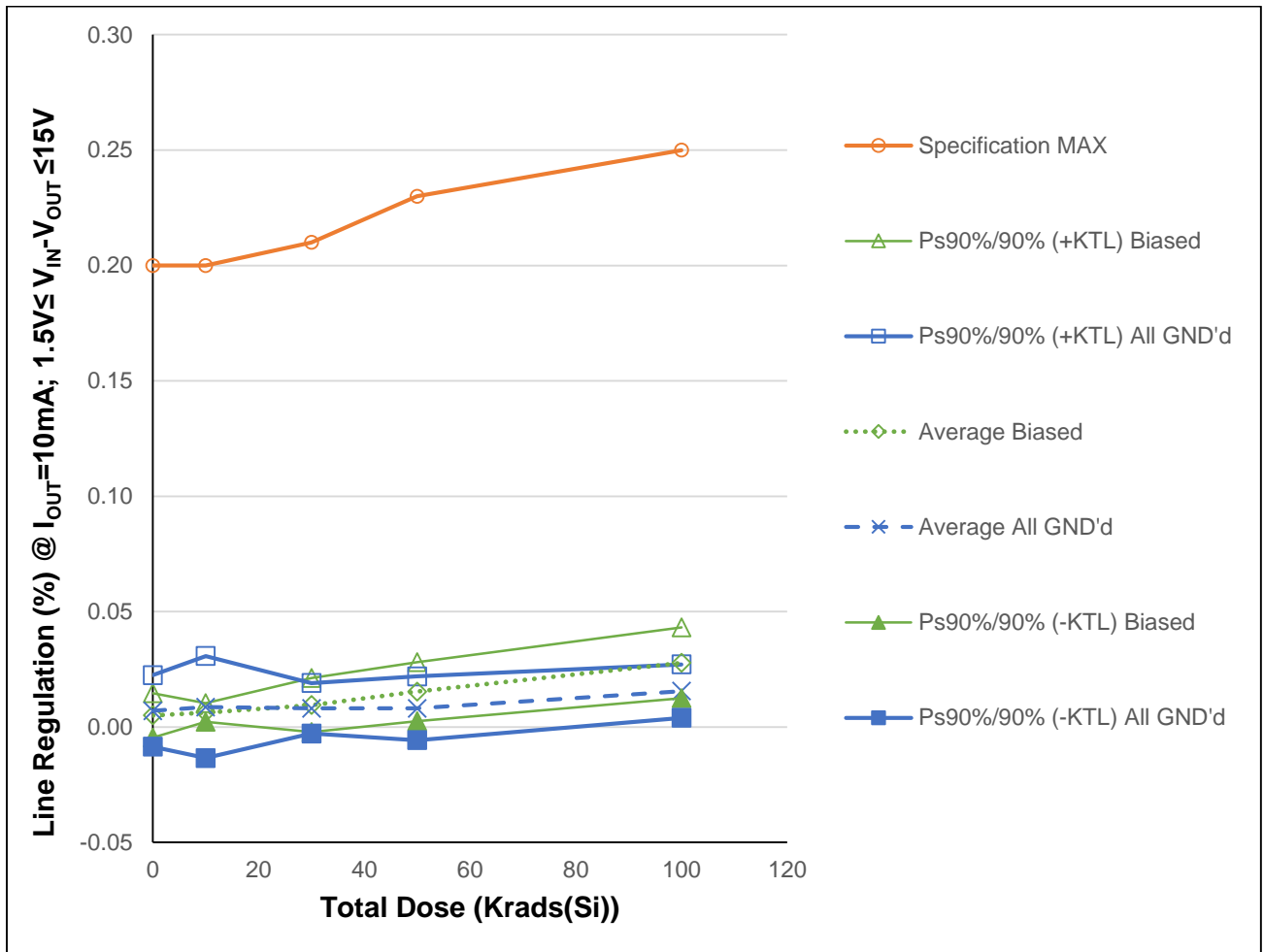


Figure 5.2: Plot of Line Regulation versus Total Dose

Table 5.2: Raw data for line regulation versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL under the second orange header)

Parameter Units	Line Reg @ I _{OUT} =10mA; 1.5V≤V _{IN} -V _{OUT} ≤15V (%)	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
620	All GND'd Irradiation	0.01290	0.00076			
621	All GND'd Irradiation	0.00304	0.00769			
622	All GND'd Irradiation	0.00076	0.00692			
623	All GND'd Irradiation	0.01299	0.00564			
624	All GND'd Irradiation	0.00532	0.02223			
625	Biased Irradiation	0.00304	0.00464			
626	Biased Irradiation	0.00305	0.00531			
627	Biased Irradiation	0.01074	0.00691			
628	Biased Irradiation	0.00228	0.00617			
629	Biased Irradiation	0.00609	0.00843			
630	All GND'd Irradiation	0.00687		0.01050		
631	All GND'd Irradiation	0.00612		0.00869		
632	All GND'd Irradiation	0.00532		0.00304		
633	All GND'd Irradiation	0.01215		0.00533		
634	All GND'd Irradiation	0.00685		0.01301		
635	Biased Irradiation	0.01152		0.00838		
636	Biased Irradiation	-0.00023		0.00608		
637	Biased Irradiation	0.00684		0.01256		
638	Biased Irradiation	0.00213		0.00533		
639	Biased Irradiation	0.00533		0.01529		
640	All GND'd Irradiation	0.01155			0.01378	
641	All GND'd Irradiation	0.00540			0.01225	
642	All GND'd Irradiation	0.01230			0.00381	
643	All GND'd Irradiation	0.00610			0.00846	
644	All GND'd Irradiation	0.00608			0.00229	
645	Biased Irradiation	0.00661			0.01897	
646	Biased Irradiation	0.00532			0.01543	
647	Biased Irradiation	0.00994			0.00768	
648	Biased Irradiation	0.00663			0.01919	
649	Biased Irradiation	0.00663			0.01542	
650	All GND'd Irradiation	0.00015				0.01771
651	All GND'd Irradiation	0.00685				0.00841
652	All GND'd Irradiation	0.00228				0.01719
653	All GND'd Irradiation	0.00768				0.01919
654	All GND'd Irradiation	0.00000				0.01534
655	Biased Irradiation	0.00661				0.01953
656	Biased Irradiation	0.00076				0.03025
657	Biased Irradiation	0.00822				0.03487
658	Biased Irradiation	0.00684				0.02687
659	Biased Irradiation	0.00000				0.02766
660	Control Unit	0.01291	0.00691	0.00691	0.00691	0.00691
661	Control Unit	0.00531	0.01093	0.01093	0.01093	0.01093
All GND'd Irradiation Statistics						
Average All GND'd		0.00700	0.00865	0.00811	0.00812	0.01557
Std Dev All GND'd		0.00566	0.00806	0.00398	0.00505	0.00423
Ps90%/90% (+KTL) All GND'd		0.02252	0.03074	0.01903	0.02196	0.02717
Ps90%/90% (-KTL) All GND'd		-0.00852	-0.01345	-0.00281	-0.00572	0.00397
Biased Irradiation Statistics						
Average Biased		0.00504	0.00629	0.00953	0.01534	0.02783
Std Dev Biased		0.00351	0.00147	0.00428	0.00466	0.00559
Ps90%/90% (+KTL) Biased		0.01466	0.01032	0.02125	0.02810	0.04317
Ps90%/90% (-KTL) Biased		-0.00458	0.00226	-0.00220	0.00257	0.01250
Specification MIN						
Status (Measurements) All GND'd						
Status (Measurements) Biased						
Specification MAX		0.20	0.20	0.21	0.23	0.25
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd						
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased						
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS

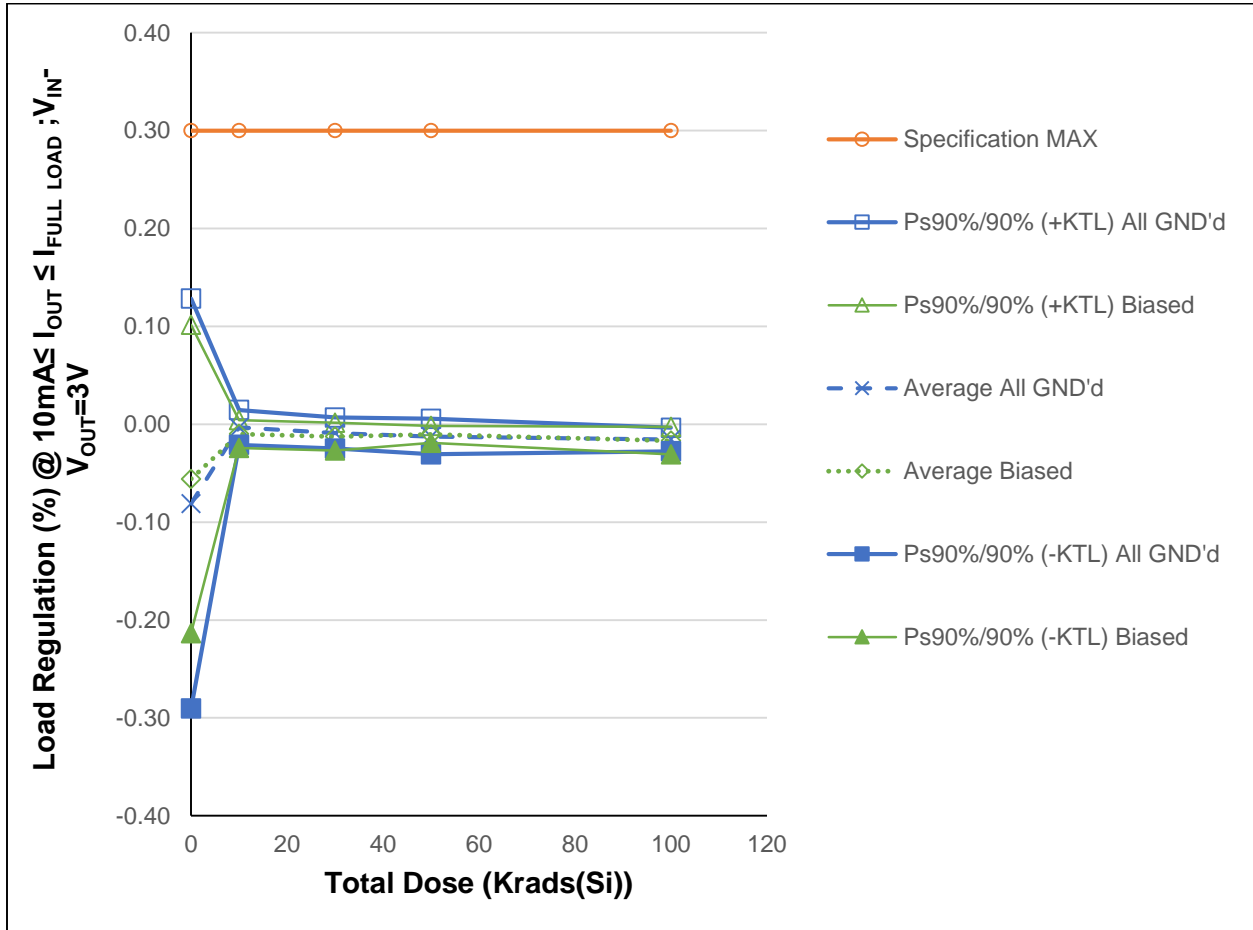


Figure 5.3: Plot of Load Regulation versus Total Dose

All measured post-irradiation data points are within the datasheet specification limits.

Table 5.3: Raw data for load regulation versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL).

Parameter	Load Reg @ 10mA ≤ I _{OUT} ≤ I _{FULL LOAD} , V _{IN} - V _{OUT} = 3V	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
Units	(%)					
620	All GND'd Irradiation	-0.11310	-0.00609			
621	All GND'd Irradiation	-0.00091	-0.01074			
622	All GND'd Irradiation	-0.14147	0.00616			
623	All GND'd Irradiation	0.00311	-0.00541			
624	All GND'd Irradiation	-0.15264	0.00000			
625	Biased Irradiation	-0.03493	-0.01301			
626	Biased Irradiation	-0.09207	-0.01222			
627	Biased Irradiation	-0.03679	-0.00311			
628	Biased Irradiation	-0.13234	-0.00609			
629	Biased Irradiation	0.01667	-0.01556			
630	All GND'd Irradiation	0.00008		-0.00228		
631	All GND'd Irradiation	-0.10391		-0.01532		
632	All GND'd Irradiation	-0.09291		-0.01454		
633	All GND'd Irradiation	-0.17628		-0.00533		
634	All GND'd Irradiation	-0.16518		-0.00685		
635	Biased Irradiation	-0.09237		-0.01234		
636	Biased Irradiation	-0.05512		-0.00844		
637	Biased Irradiation	-0.10865		-0.01378		
638	Biased Irradiation	-0.02294		-0.02065		
639	Biased Irradiation	-0.03808		-0.00768		
640	All GND'd Irradiation	-0.07334			-0.01074	
641	All GND'd Irradiation	-0.03261			-0.01096	
642	All GND'd Irradiation	-0.01849			-0.01919	
643	All GND'd Irradiation	-0.02822			-0.00305	
644	All GND'd Irradiation	-0.05470			-0.01846	
645	Biased Irradiation	-0.14660			-0.01280	
646	Biased Irradiation	-0.02198			-0.01159	
647	Biased Irradiation	-0.14151			-0.00540	
648	Biased Irradiation	-0.15374			-0.00922	
649	Biased Irradiation	-0.04652			-0.01305	
650	All GND'd Irradiation	-0.09142				-0.01077
651	All GND'd Irradiation	-0.13237				-0.01231
652	All GND'd Irradiation	-0.03495				-0.02147
653	All GND'd Irradiation	-0.05477				-0.01477
654	All GND'd Irradiation	-0.05934				-0.01847
655	Biased Irradiation	-0.08880				-0.02336
656	Biased Irradiation	-0.14688				-0.01588
657	Biased Irradiation	-0.08684				-0.01667
658	Biased Irradiation	-0.05849				-0.00924
659	Biased Irradiation	-0.06786				-0.01849
660	Control Unit	0.00008	-0.00615	-0.00615	-0.00615	-0.00615
661	Control Unit	-0.02360	-0.00683	-0.00683	-0.00683	-0.00683
	All GND'd Irradiation Statistics					
	Average All GND'd	-0.08100	-0.00322	-0.00886	-0.01248	-0.01556
	Std Dev All GND'd	0.07634	0.00648	0.00578	0.00661	0.00440
	Ps90%/90% (+KTL) All GND'd	0.12831	0.01455	0.00699	0.00566	-0.00349
	Ps90%/90% (-KTL) All GND'd	-0.29031	-0.02098	-0.02472	-0.03062	-0.02763
	Biased Irradiation Statistics					
	Average Biased	-0.05589	-0.01000	-0.01258	-0.01041	-0.01673
	Std Dev Biased	0.05749	0.00519	0.00519	0.00319	0.00510
	Ps90%/90% (+KTL) Biased	0.10176	0.00423	0.00165	-0.00167	-0.00275
	Ps90%/90% (-KTL) Biased	-0.21354	-0.02423	-0.02681	-0.01915	-0.03070
	Specification MIN					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Specification MAX	0.3	0.3	0.3	0.3	0.3
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd					
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased					
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS

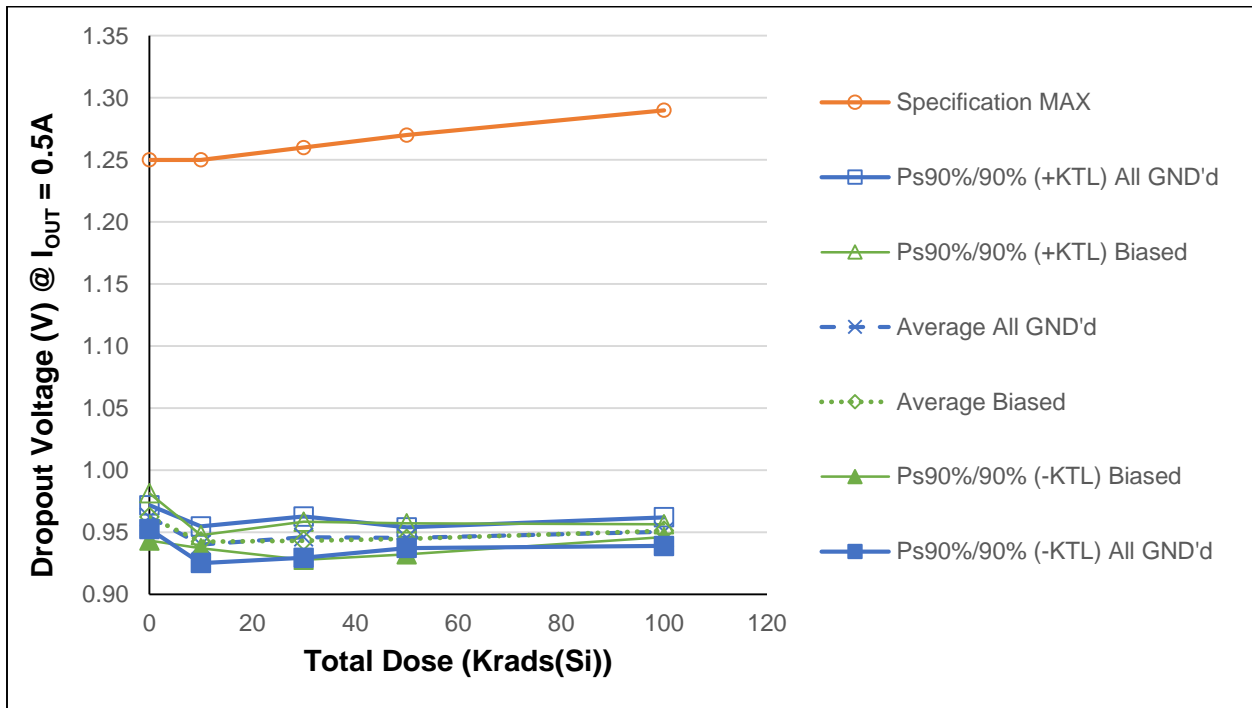


Figure 5.4: Plot of Dropout Voltage versus Total Dose

All measured data points are within datasheet specification limits.

Table 5.4: Raw data for dropout voltage versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL).

Parameter Units	Dropout Voltage @ I _{OUT} = 0.5A (V)	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
620	All GND'd Irradiation	0.96293	0.94423			
621	All GND'd Irradiation	0.95758	0.93093			
622	All GND'd Irradiation	0.95966	0.93952			
623	All GND'd Irradiation	0.96621	0.94217			
624	All GND'd Irradiation	0.96445	0.94332			
625	Biased Irradiation	0.97341	0.94222			
626	Biased Irradiation	0.96194	0.94541			
627	Biased Irradiation	0.95476	0.94013			
628	Biased Irradiation	0.96281	0.94300			
629	Biased Irradiation	0.95866	0.94156			
630	All GND'd Irradiation	0.94645		0.95461		
631	All GND'd Irradiation	0.97062		0.94880		
632	All GND'd Irradiation	0.96073		0.93843		
633	All GND'd Irradiation	0.96476		0.94517		
634	All GND'd Irradiation	0.96612		0.94343		
635	Biased Irradiation	0.95400		0.94498		
636	Biased Irradiation	0.96537		0.94956		
637	Biased Irradiation	0.96377		0.94144		
638	Biased Irradiation	0.96239		0.93466		
639	Biased Irradiation	0.95462		0.94567		
640	All GND'd Irradiation	0.97017			0.94811	
641	All GND'd Irradiation	0.96307			0.94423	
642	All GND'd Irradiation	0.94797			0.94896	
643	All GND'd Irradiation	0.95052			0.94522	
644	All GND'd Irradiation	0.96502			0.94145	
645	Biased Irradiation	0.96262			0.93799	
646	Biased Irradiation	0.95835			0.94766	
647	Biased Irradiation	0.97222			0.94938	
648	Biased Irradiation	0.95622			0.94628	
649	Biased Irradiation	0.95200			0.94240	
650	All GND'd Irradiation	0.95543				0.95472
651	All GND'd Irradiation	0.95872				0.94801
652	All GND'd Irradiation	0.97162				0.94505
653	All GND'd Irradiation	0.96415				0.95469
654	All GND'd Irradiation	0.96120				0.95018
655	Biased Irradiation	0.96223				0.94903
656	Biased Irradiation	0.97764				0.94980
657	Biased Irradiation	0.96101				0.95353
658	Biased Irradiation	0.96941				0.95239
659	Biased Irradiation	0.95159				0.95171
660	Control Unit	0.96246	0.90696	0.90696	0.90696	0.90696
661	Control Unit	0.96399	0.93826	0.93826	0.93826	0.93826
	All GND'd Irradiation Statistics					
	Average All GND'd	0.96216	0.94003	0.94609	0.94559	0.95053
	Std Dev All GND'd	0.00352	0.00538	0.00605	0.00303	0.00422
	Ps90%/90% (+KTL) All GND'd	0.97181	0.95480	0.96268	0.95391	0.96211
	Ps90%/90% (-KTL) All GND'd	0.95252	0.92527	0.92949	0.93728	0.93895
	Biased Irradiation Statistics					
	Average Biased	0.96231	0.94246	0.94326	0.94474	0.95129
	Std Dev Biased	0.00696	0.00196	0.00561	0.00457	0.00185
	Ps90%/90% (+KTL) Biased	0.98141	0.94783	0.95863	0.95727	0.95637
	Ps90%/90% (-KTL) Biased	0.94322	0.93710	0.92789	0.93221	0.94621
	Specification MIN					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Specification MAX	1.25	1.25	1.26	1.27	1.29
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd					
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased					
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS

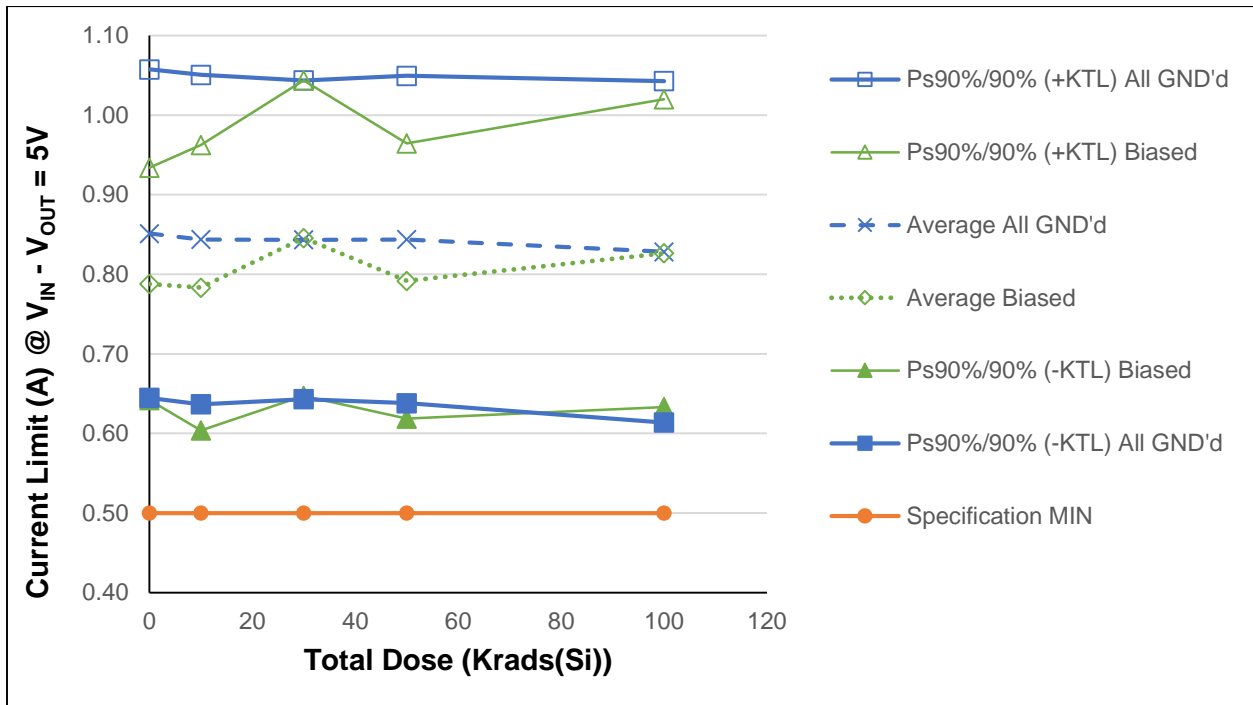


Figure 5.5: Plot of Current Limit versus Total Dose

The measured post-irradiation average data points are within datasheet specification limits.

Table 5.5: Raw data for current limit versus total dose including the statistical calculations, minimum specification, maximum specification, and the status of the test (PASS/FAIL)

Parameter Units	Current Limit @ $V_{IN} - V_{OUT} = 5V$ (A)	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
620	All GND'd Irradiation	0.89874	0.75688			
621	All GND'd Irradiation	0.91618	0.90786			
622	All GND'd Irradiation	0.77254	0.89656			
623	All GND'd Irradiation	0.76552	0.76588			
624	All GND'd Irradiation	0.90259	0.89149			
625	Biased Irradiation	0.76734	0.89938			
626	Biased Irradiation	0.75959	0.75097			
627	Biased Irradiation	0.76175	0.75553			
628	Biased Irradiation	0.88284	0.76501			
629	Biased Irradiation	0.76782	0.74490			
630	All GND'd Irradiation	0.76624		0.76305		
631	All GND'd Irradiation	0.76370		0.76371		
632	All GND'd Irradiation	0.76926		0.89970		
633	All GND'd Irradiation	0.90391		0.89434		
634	All GND'd Irradiation	0.89760		0.89582		
635	Biased Irradiation	0.76423		0.90207		
636	Biased Irradiation	0.89398		0.76415		
637	Biased Irradiation	0.75873		0.76857		
638	Biased Irradiation	0.89065		0.89827		
639	Biased Irradiation	0.90394		0.89444		
640	All GND'd Irradiation	0.75965			0.89225	
641	All GND'd Irradiation	0.89989			0.89776	
642	All GND'd Irradiation	0.91130			0.76655	
643	All GND'd Irradiation	0.90524			0.75709	
644	All GND'd Irradiation	0.75477			0.90518	
645	Biased Irradiation	0.75730			0.77670	
646	Biased Irradiation	0.88780			0.75517	
647	Biased Irradiation	0.90085			0.75688	
648	Biased Irradiation	0.76694			0.90336	
649	Biased Irradiation	0.90639			0.76621	
650	All GND'd Irradiation	0.90571				0.92112
651	All GND'd Irradiation	0.77458				0.77665
652	All GND'd Irradiation	0.90312				0.76358
653	All GND'd Irradiation	0.75988				0.90590
654	All GND'd Irradiation	0.90203				0.77369
655	Biased Irradiation	0.89635				0.77161
656	Biased Irradiation	0.75684				0.78104
657	Biased Irradiation	0.77037				0.77248
658	Biased Irradiation	0.76202				0.90354
659	Biased Irradiation	0.89654				0.90366
660	Control Unit	0.75971	0.87387	0.87387	0.87387	0.87387
661	Control Unit	0.89711	0.89484	0.89484	0.89484	0.89484
	All GND'd Irradiation Statistics					
	Average All GND'd	0.85112	0.84373	0.84332	0.84377	0.82819
	Std Dev All GND'd	0.07525	0.07548	0.07301	0.07502	0.07822
	Ps90%/90% (+KTL) All GND'd	1.05746	1.05070	1.04351	1.04948	1.04268
	Ps90%/90% (-KTL) All GND'd	0.64477	0.63677	0.64314	0.63805	0.61370
	Biased Irradiation Statistics					
	Average Biased	0.78787	0.78316	0.84550	0.79166	0.82646
	Std Dev Biased	0.05321	0.06538	0.07231	0.06303	0.07051
	Ps90%/90% (+KTL) Biased	0.93376	0.96243	1.04378	0.96449	1.01980
	Ps90%/90% (-KTL) Biased	0.64197	0.60388	0.64722	0.61884	0.63312
	Specification MIN	0.5	0.5	0.5	0.5	0.5
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Specification MAX					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Status (-KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) All GND'd					
	Status (-KTL) Biased	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) Biased					

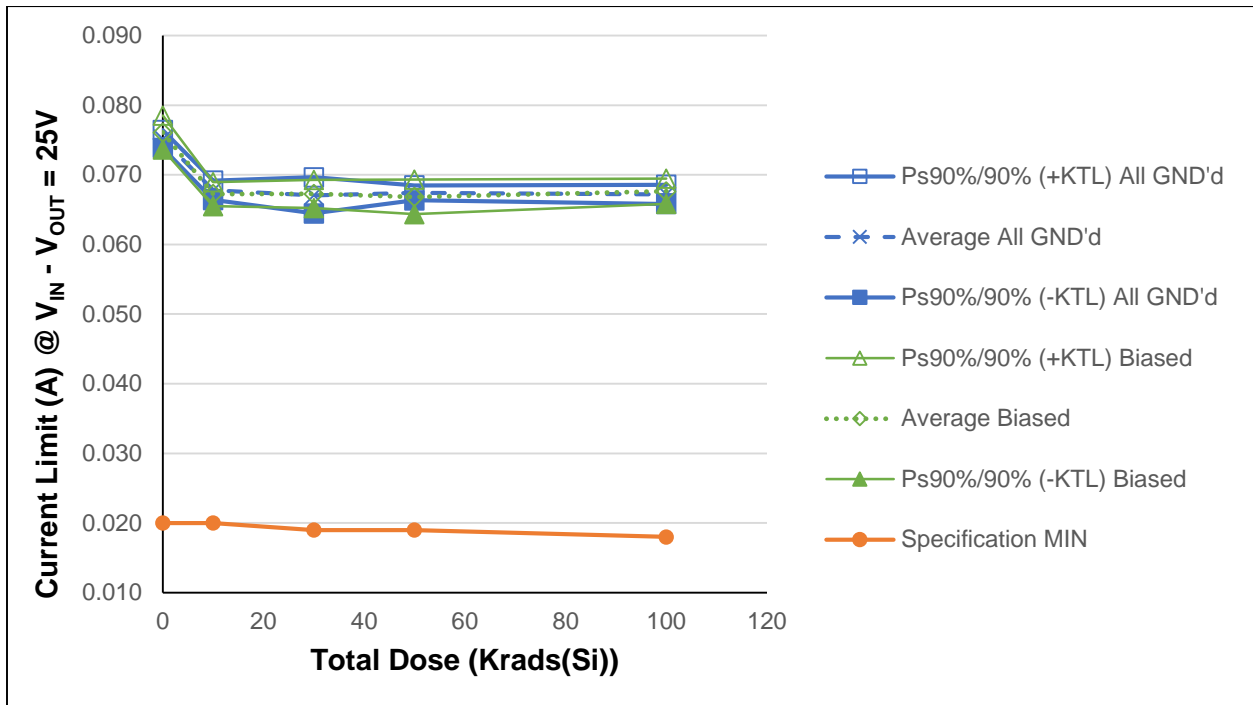


Figure 5.6: Plot of Current Limit versus Total Dose

All measured average data points are within datasheet specification limits.

Table 5.6: Raw data for current limit versus total dose including the statistical calculations, minimum specification, and the status of the test (PASS/FAIL)

Parameter	Current Limit @ $V_{IN} - V_{OUT} = 25V$	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
Units	(A)					
620	All GND'd Irradiation	0.07453	0.06780			
621	All GND'd Irradiation	0.07515	0.06863			
622	All GND'd Irradiation	0.07580	0.06758			
623	All GND'd Irradiation	0.07493	0.06746			
624	All GND'd Irradiation	0.07532	0.06737			
625	Biased Irradiation	0.07491	0.06808			
626	Biased Irradiation	0.07642	0.06756			
627	Biased Irradiation	0.07723	0.06704			
628	Biased Irradiation	0.07556	0.06707			
629	Biased Irradiation	0.07634	0.06641			
630	All GND'd Irradiation	0.07672		0.06734		
631	All GND'd Irradiation	0.07459		0.06791		
632	All GND'd Irradiation	0.07508		0.06668		
633	All GND'd Irradiation	0.07583		0.06777		
634	All GND'd Irradiation	0.07541		0.06559		
635	Biased Irradiation	0.07683		0.06779		
636	Biased Irradiation	0.07423		0.06748		
637	Biased Irradiation	0.07522		0.06711		
638	Biased Irradiation	0.07413		0.06788		
639	Biased Irradiation	0.07625		0.06607		
640	All GND'd Irradiation	0.07498			0.06694	
641	All GND'd Irradiation	0.07442			0.06757	
642	All GND'd Irradiation	0.07626			0.06705	
643	All GND'd Irradiation	0.07682			0.06773	
644	All GND'd Irradiation	0.07449			0.06777	
645	Biased Irradiation	0.07567			0.06597	
646	Biased Irradiation	0.07460			0.06614	
647	Biased Irradiation	0.07447			0.06773	
648	Biased Irradiation	0.07661			0.06645	
649	Biased Irradiation	0.07639			0.06788	
650	All GND'd Irradiation	0.07606				0.06721
651	All GND'd Irradiation	0.07637				0.06690
652	All GND'd Irradiation	0.07461				0.06777
653	All GND'd Irradiation	0.07526				0.06651
654	All GND'd Irradiation	0.07508				0.06754
655	Biased Irradiation	0.07520				0.06827
656	Biased Irradiation	0.07493				0.06747
657	Biased Irradiation	0.07578				0.06836
658	Biased Irradiation	0.07444				0.06730
659	Biased Irradiation	0.07650				0.06679
660	Control Unit	0.07456	0.05975	0.05975	0.05975	0.05975
661	Control Unit	0.07399	0.06724	0.06724	0.06724	0.06724
	All GND'd Irradiation Statistics					
	Average All GND'd	0.07515	0.06777	0.06706	0.06741	0.06719
	Std Dev All GND'd	0.00047	0.00051	0.00095	0.00039	0.00050
	Ps90%/90% (+KTL) All GND'd	0.07644	0.06916	0.06966	0.06848	0.06856
	Ps90%/90% (-KTL) All GND'd	0.07386	0.06638	0.06445	0.06634	0.06581
	Biased Irradiation Statistics					
	Average Biased	0.07609	0.06723	0.06726	0.06683	0.06764
	Std Dev Biased	0.00089	0.00063	0.00073	0.00090	0.00067
	Ps90%/90% (+KTL) Biased	0.07852	0.06895	0.06928	0.06931	0.06947
	Ps90%/90% (-KTL) Biased	0.07366	0.06552	0.06525	0.06435	0.06581
	Specification MIN	0.02	0.02	0.019	0.019	0.018
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Specification MAX					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Status (-KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) All GND'd					
	Status (-KTL) Biased	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) Biased					

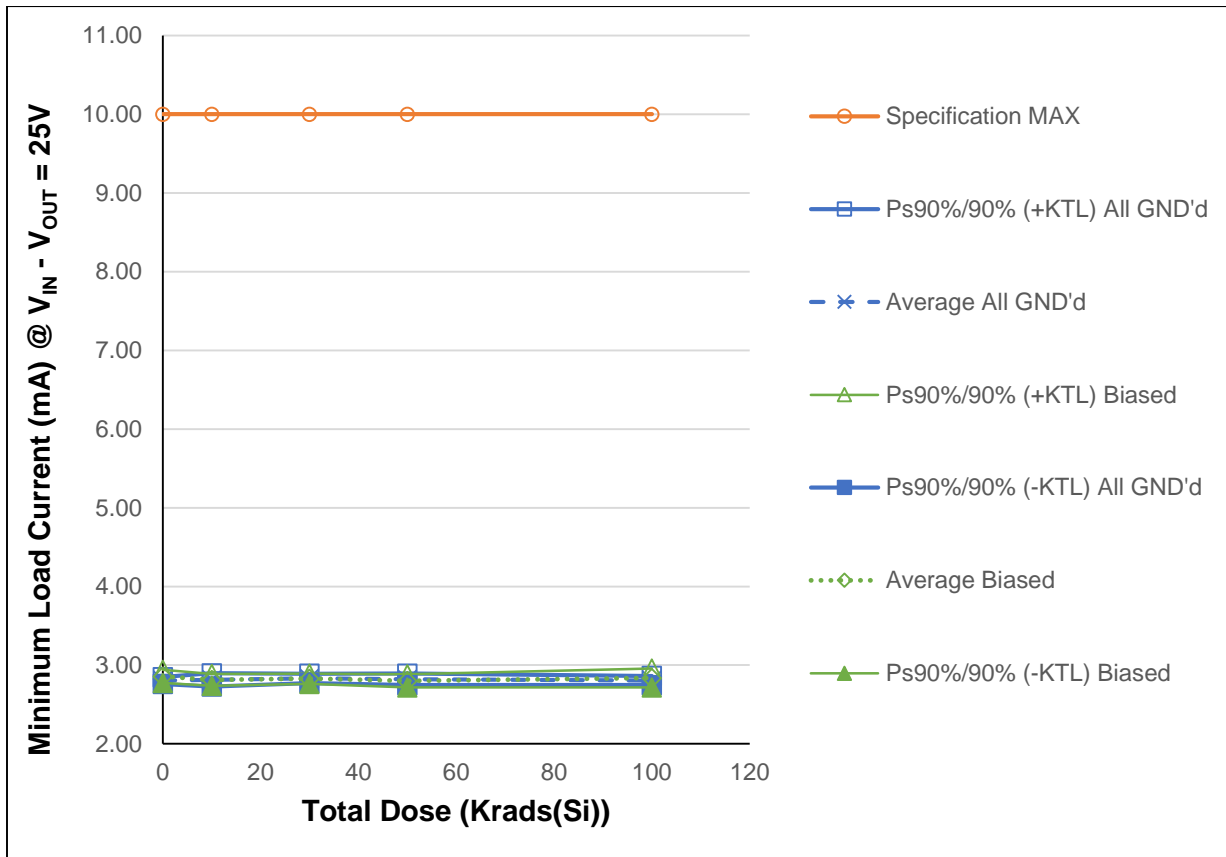


Figure 5.7: Plot of Minimum Load Current versus Total Dose

The average measured values of all samples pass the datasheet specification maximum limit.

Table 5.7: Raw data table for minimum load current versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL)

Parameter Units	Minimum Load Current @ $V_{IN} - V_{OUT} = 25V$ (mA)	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
620	All GND'd Irradiation	2.78890	2.81004			
621	All GND'd Irradiation	2.80192	2.83628			
622	All GND'd Irradiation	2.80620	2.85265			
623	All GND'd Irradiation	2.79835	2.77874			
624	All GND'd Irradiation	2.83120	2.79081			
625	Biased Irradiation	2.82847	2.83406			
626	Biased Irradiation	2.86177	2.81782			
627	Biased Irradiation	2.88914	2.83997			
628	Biased Irradiation	2.82320	2.79204			
629	Biased Irradiation	2.88129	2.77544			
630	All GND'd Irradiation	2.85020		2.82150		
631	All GND'd Irradiation	2.80246		2.81851		
632	All GND'd Irradiation	2.78371		2.84119		
633	All GND'd Irradiation	2.84279		2.86528		
634	All GND'd Irradiation	2.80322		2.81311		
635	Biased Irradiation	2.88313		2.83866		
636	Biased Irradiation	2.78562		2.83357		
637	Biased Irradiation	2.79278		2.79112		
638	Biased Irradiation	2.77815		2.85327		
639	Biased Irradiation	2.83915		2.82273		
640	All GND'd Irradiation	2.80376			2.78590	
641	All GND'd Irradiation	2.78212			2.85350	
642	All GND'd Irradiation	2.88213			2.82651	
643	All GND'd Irradiation	2.83983			2.80212	
644	All GND'd Irradiation	2.77509			2.83444	
645	Biased Irradiation	2.82274			2.80273	
646	Biased Irradiation	2.78172			2.78560	
647	Biased Irradiation	2.80613			2.83258	
648	Biased Irradiation	2.88771			2.75749	
649	Biased Irradiation	2.86598			2.82273	
650	All GND'd Irradiation	2.85874				2.83743
651	All GND'd Irradiation	2.82633				2.79728
652	All GND'd Irradiation	2.82198				2.81575
653	All GND'd Irradiation	2.80254				2.78959
654	All GND'd Irradiation	2.80895				2.78644
655	Biased Irradiation	2.81482				2.84843
656	Biased Irradiation	2.84226				2.79258
657	Biased Irradiation	2.85446				2.88413
658	Biased Irradiation	2.79530				2.86897
659	Biased Irradiation	2.85408				2.79158
660	Control Unit	2.78371	2.92352	2.92352	2.92352	2.92352
661	Control Unit	2.78890	2.85188	2.85188	2.85188	2.85188
	All GND'd Irradiation Statistics					
	Average All GND'd	2.80532	2.81371	2.83192	2.82049	2.80530
	Std Dev All GND'd	0.01581	0.03077	0.02145	0.02671	0.02126
	Ps90%/90% (+KTL) All GND'd	2.84867	2.89807	2.89075	2.89374	2.86360
	Ps90%/90% (-KTL) All GND'd	2.76196	2.72934	2.77309	2.74725	2.74699
	Biased Irradiation Statistics					
	Average Biased	2.85677	2.81186	2.82787	2.80022	2.83714
	Std Dev Biased	0.03001	0.02756	0.02330	0.03000	0.04304
	Ps90%/90% (+KTL) Biased	2.93906	2.88742	2.89175	2.88248	2.95515
	Ps90%/90% (-KTL) Biased	2.77449	2.73631	2.76399	2.71797	2.71912
	Specification MIN					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Specification MAX	10	10	10	10	10
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd					
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased					
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS

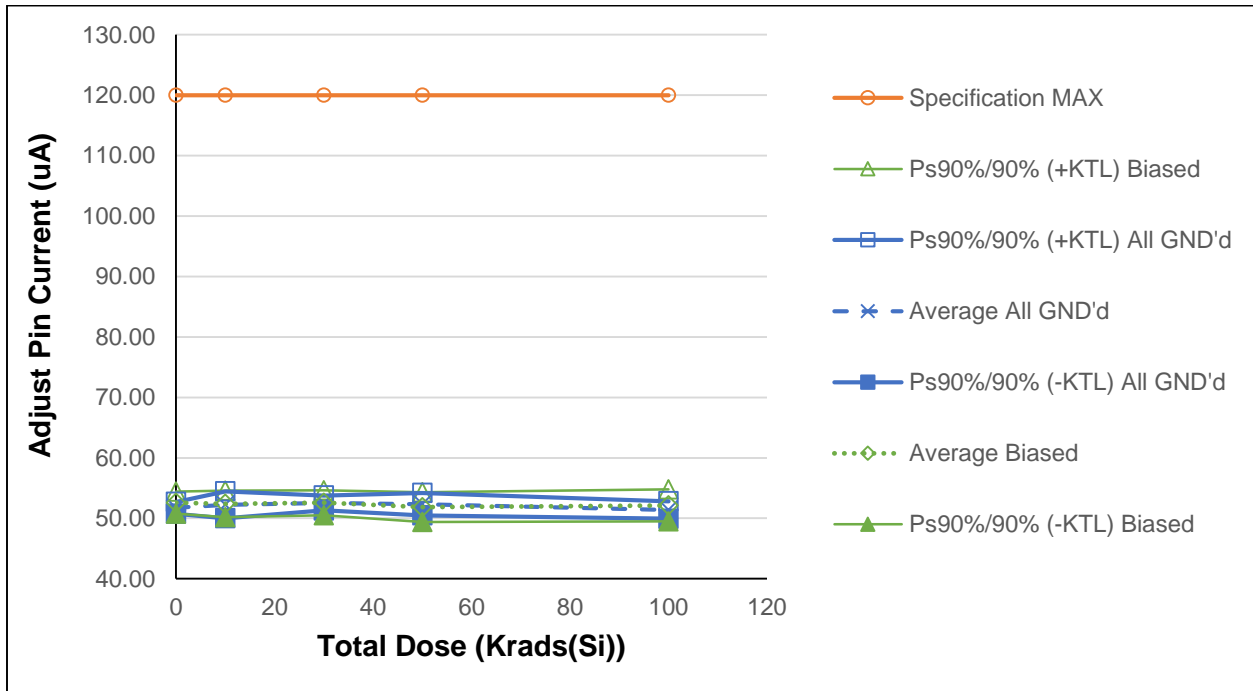


Figure 5.8: Plot of Adjust Pin Current versus Total Dose

Table 5.8: Raw data table for adjust pin current versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL)

Parameter Units	Adjust Pin Current (uA)	Total Dose (Krad(Si)) @ 50rad(Si)/s				
		0	10	30	50	100
620	All GND'd Irradiation	51.66626	52.35584			
621	All GND'd Irradiation	51.67128	52.79287			
622	All GND'd Irradiation	51.50335	53.14195			
623	All GND'd Irradiation	51.44524	51.12804			
624	All GND'd Irradiation	52.33411	51.73420			
625	Biased Irradiation	52.05342	52.64637			
626	Biased Irradiation	52.61404	52.98154			
627	Biased Irradiation	53.47535	53.15586			
628	Biased Irradiation	51.81253	51.20387			
629	Biased Irradiation	52.94736	51.97979			
630	All GND'd Irradiation	52.28404		52.33471		
631	All GND'd Irradiation	52.05799		52.03568		
632	All GND'd Irradiation	50.48202		53.02933		
633	All GND'd Irradiation	52.78799		52.98154		
634	All GND'd Irradiation	51.41187		52.28917		
635	Biased Irradiation	52.95969		53.00289		
636	Biased Irradiation	51.15160		52.87756		
637	Biased Irradiation	50.99628		51.28181		
638	Biased Irradiation	50.75951		52.51974		
639	Biased Irradiation	51.90482		53.13737		
640	All GND'd Irradiation	51.79536			51.46272	
641	All GND'd Irradiation	50.88761			52.80159	
642	All GND'd Irradiation	52.30337			52.77596	
643	All GND'd Irradiation	52.12768			51.73455	
644	All GND'd Irradiation	50.79623			52.89007	
645	Biased Irradiation	51.96527			52.11939	
646	Biased Irradiation	50.59139			51.19154	
647	Biased Irradiation	51.64664			53.15346	
648	Biased Irradiation	53.09697			50.84679	
649	Biased Irradiation	52.03653			51.87455	
650	All GND'd Irradiation	52.67594				52.25869
651	All GND'd Irradiation	52.16105				51.02570
652	All GND'd Irradiation	51.98091				51.44152
653	All GND'd Irradiation	51.47708				51.20605
654	All GND'd Irradiation	51.96169				50.95098
655	Biased Irradiation	52.14954				52.54912
656	Biased Irradiation	52.41154				51.16724
657	Biased Irradiation	53.09016				52.90524
658	Biased Irradiation	51.75587				53.02453
659	Biased Irradiation	52.53522				51.04490
660	Control Unit	51.05544	58.47776	58.47776	58.47776	58.47776
661	Control Unit	51.39640	53.44619	53.44619	53.44619	53.44619
	All GND'd Irradiation Statistics					
	Average All GND'd	51.72405	52.23058	52.53409	52.33298	51.37659
	Std Dev All GND'd	0.35523	0.81001	0.44543	0.67854	0.52813
	Ps90%/90% (+KTL) All GND'd	52.69808	54.45162	53.75545	54.19352	52.82471
	Ps90%/90% (-KTL) All GND'd	50.75002	50.00954	51.31272	50.47243	49.92847
	Biased Irradiation Statistics					
	Average Biased	52.58054	52.39349	52.56387	51.83715	52.13821
	Std Dev Biased	0.67158	0.80270	0.75261	0.89601	0.95928
	Ps90%/90% (+KTL) Biased	54.42200	54.59449	54.62752	54.29401	54.76855
	Ps90%/90% (-KTL) Biased	50.73908	50.19249	50.50023	49.38028	49.50787
	Specification MIN					
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Specification MAX	120	120	120	120	120
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS

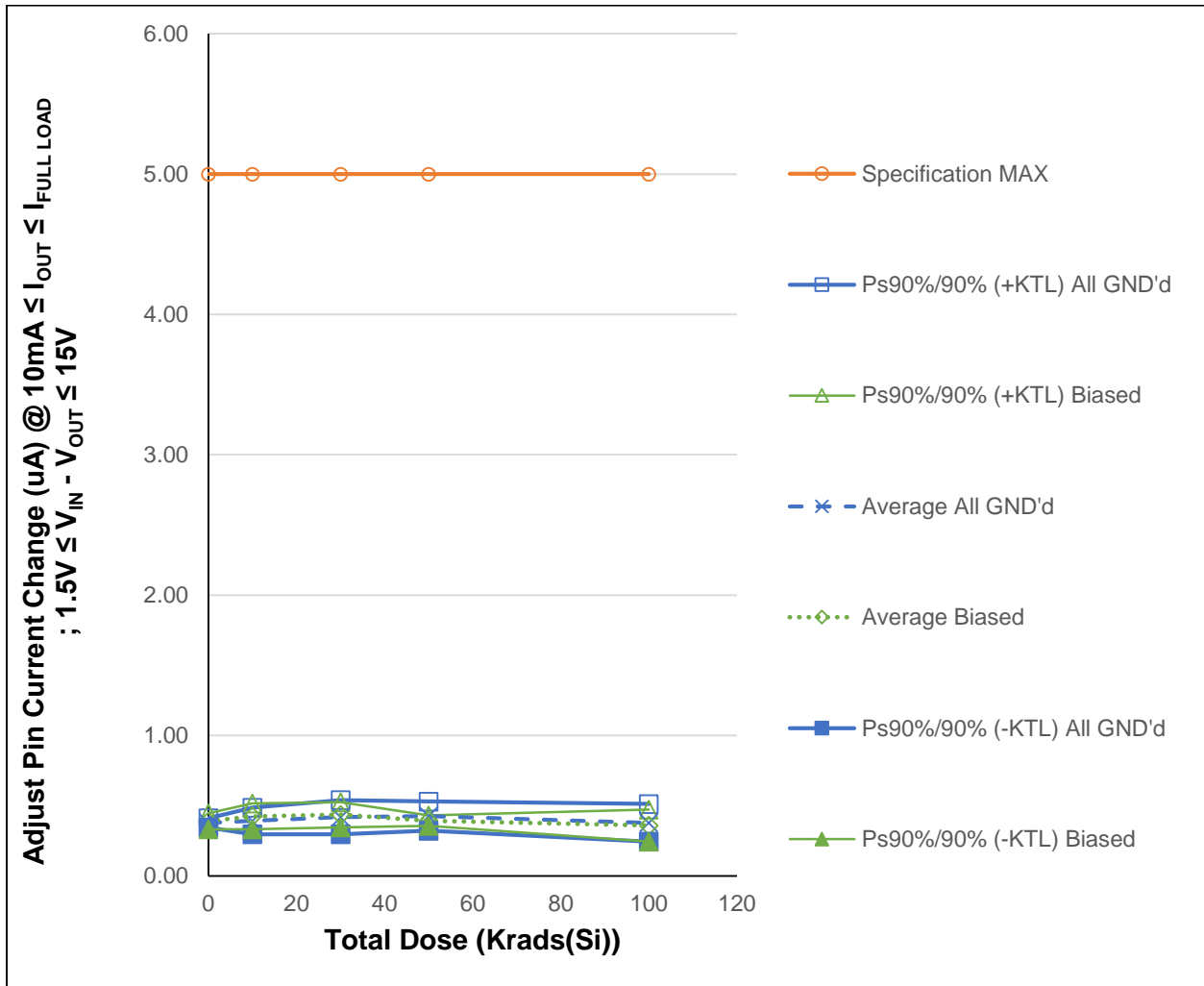


Figure 5.9: Plot of Adjust Pin Current Change versus Total Dose

Table 5.9: Raw data table for adjust pin current change versus total dose including the statistical calculations, maximum specification, and the status of the test (PASS/FAIL)

Parameter	Adj Pin I Change @ 10mA _{≤I_{OUT}≤I_{FULL LOAD}} ; 1.5V _{≤V_{IN}-V_{OUT}≤15V}	Total Dose (Krad(Si)) @ 50rad(Si)/s				
Units	(uA)	0	10	30	50	100
620	All GND'd Irradiation	0.37633	0.44718			
621	All GND'd Irradiation	0.36847	0.40006			
622	All GND'd Irradiation	0.37215	0.38091			
623	All GND'd Irradiation	0.37212	0.36623			
624	All GND'd Irradiation	0.39874	0.36211			
625	Biased Irradiation	0.37470	0.47706			
626	Biased Irradiation	0.42288	0.39581			
627	Biased Irradiation	0.39859	0.40395			
628	Biased Irradiation	0.37749	0.40600			
629	Biased Irradiation	0.37599	0.43548			
630	All GND'd Irradiation	0.35862		0.37698		
631	All GND'd Irradiation	0.47815		0.41506		
632	All GND'd Irradiation	0.35499		0.45737		
633	All GND'd Irradiation	0.43571		0.37263		
634	All GND'd Irradiation	0.34353		0.46834		
635	Biased Irradiation	0.40396		0.42281		
636	Biased Irradiation	0.36421		0.42979		
637	Biased Irradiation	0.36659		0.40185		
638	Biased Irradiation	0.37877		0.43417		
639	Biased Irradiation	0.40948		0.48979		
640	All GND'd Irradiation	0.43471			0.38615	
641	All GND'd Irradiation	0.41866			0.43875	
642	All GND'd Irradiation	0.35742			0.47652	
643	All GND'd Irradiation	0.43986			0.43593	
644	All GND'd Irradiation	0.39826			0.38907	
645	Biased Irradiation	0.44284			0.40898	
646	Biased Irradiation	0.44743			0.37174	
647	Biased Irradiation	0.37267			0.39302	
648	Biased Irradiation	0.43679			0.39990	
649	Biased Irradiation	0.38998			0.39293	
650	All GND'd Irradiation	0.41713				0.40115
651	All GND'd Irradiation	0.43488				0.35143
652	All GND'd Irradiation	0.41457				0.45236
653	All GND'd Irradiation	0.38717				0.33127
654	All GND'd Irradiation	0.41105				0.35342
655	Biased Irradiation	0.41066				0.35402
656	Biased Irradiation	0.35757				0.36678
657	Biased Irradiation	0.37704				0.32425
658	Biased Irradiation	0.40067				0.32365
659	Biased Irradiation	0.45000				0.42489
660	Control Unit	0.39923	0.40051	0.40051	0.40051	0.40051
661	Control Unit	0.44066	0.44693	0.44693	0.44693	0.44693
	All GND'd Irradiation Statistics					
	Average All GND'd	0.37756	0.39130	0.41808	0.42529	0.37793
	Std Dev All GND'd	0.01216	0.03460	0.04425	0.03795	0.04888
	Ps90%/90% (+KTL) All GND'd	0.41090	0.48616	0.53942	0.52936	0.51197
	Ps90%/90% (-KTL) All GND'd	0.34422	0.29643	0.29674	0.32121	0.24389
	Biased Irradiation Statistics					
	Average Biased	0.38993	0.42366	0.43568	0.39331	0.35872
	Std Dev Biased	0.02087	0.03342	0.03269	0.01373	0.04148
	Ps90%/90% (+KTL) Biased	0.44715	0.51529	0.52532	0.43097	0.47246
	Ps90%/90% (-KTL) Biased	0.33271	0.33203	0.34604	0.35566	0.24497
	Specification MIN					
	Status (Measurements) All GND'd					
	Status (Measurements) Biased					
	Specification MAX	5	5	5	5	5
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd					
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased					
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS

Appendix A



Figure A1: Top View showing ID and Date Code

Appendix B

Radiation Bias Connection Tables

Table B1: Biased Conditions

PIN	FUNCTION	CONNECTION / BIAS
1	INPUT	+ 15V
2	ADJUST	-15V To Pin 3 via 150Ω resistor
3 CASE	OUTPUT	To pin 2 via 150Ω resistor to - 15V

Table B2: All GND'd

PIN	FUNCTION	CONNECTION / BIAS
1	INPUT	Ground
2	ADJUST	Ground
3	OUTPUT	Ground

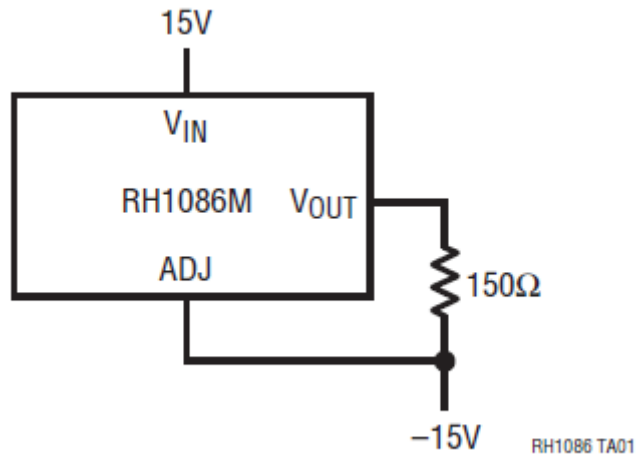


Figure B1: Total Dose Bias Circuit

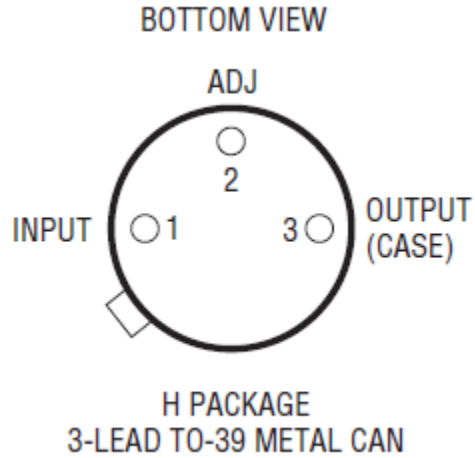


Figure B2: Pin-Out



Figure B3: Bias Board (top view)

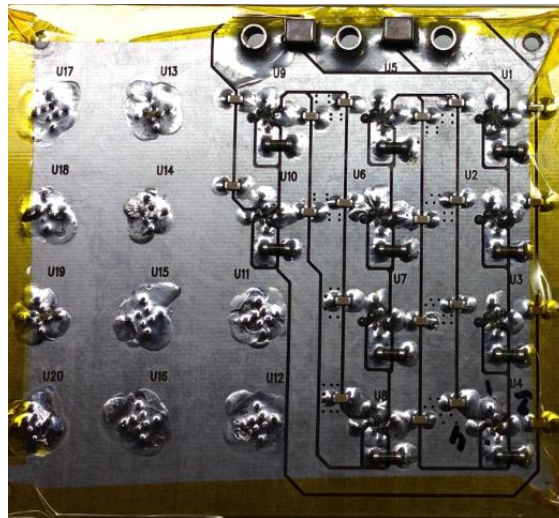


Figure B4: Bias Board (bottom view)

Appendix C

TEST CERTIFICATE

Defense Microelectronics Activity
Science and Engineering Gamma Irradiation Test Facility
DMEA/MEBC
4234 54th Street
McClellan, CA 95652



Testing Certificate Number: 1691.01

This laboratory is accredited by the American Association for Laboratory Accreditation (A2LA) and the dosimetry reported in this test certificate has been determined in accordance with the laboratory's terms of accreditation. The results contained herein relate only to the items tested. This certificate may not be reproduced, except in full, without the approval of this laboratory.

Date: 2014-02-26

Test Certificate #: 2014-NRC-024

Total Pages (except cover): 2

WARNING - This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U.S.C., Sec 2751, et seq.) or the Export Administration Act of 1979 (Title 50, U.S.C., App. 2401 et seq.), as amended. Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of DoD Directive 5230.25.

REQUEST FOR AND RESULTS OF TESTS				PAGE NO. 1	NO. OF PAGES 2				
SECTION A - REQUEST FOR TEST									
1. TO: (Include ZIP Code) Defense Microelectronics Activity Science and Engineering Gamma Irradiation Test Facility 4234 54th Street McClellan, CA 95652-2100			2. FROM: (Include ZIP Code) Dr. Sana Rezgui Linear Technology Corp. 1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408) 432-1900 Email: srezgui@linear.com						
3. PRIME CONTRACTOR AND ADDRESS (Include ZIP Code) Same as block 2 CONTRACT NUMBER CRADA CR-08-17			4. MANUFACTURING PLANT NAME AND ADDRESS (Include ZIP Code) Linear Technology Corp. 1630 McCarthy Blvd. Milpitas, CA 95035 P.O. NUMBER TBD						
5. END ITEM AND/OR PROJECT N/A		6. SAMPLE NUMBER N/A	7. LOT NO. See below	8. REASON FOR SUBMITTAL Total Ionizing Dose (TID) Testing	9. DATE SUBMITTED 2014-02-24				
10. MATERIAL TO BE TESTED Various biased/unbiased devices - see below	10a. QUANTITY SUBMITTED See below	11. QUANTITY REPRESENTED N/A	12. SPEC. & AMEND AND/OR DRAWING NO. & REV. FOR SAMPLE & DATE N/A						
13. PURCHASED FROM OR SOURCE Linear Technology Corp.		14. SHIPMENT METHOD Hand carry	15. DATE SAMPLED AND SUBMITTED BY 2014-02-25 by Tom Shepherd						
16. REMARKS AND/OR SPECIAL INSTRUCTIONS AND/OR WAIVERS. Dose Rate: 3000 ±10% rad/(SiO ₂)/min Irradiation Steps: 22 Type of Test: Customer-Performed Total Dose: see below ±10% krad/(SiO ₂) Requested Test Start Date: 2014-02-25 Dimensions: various Security Requirements, Safety or Handling Precautions: Customer to perform pre- and post-irradiation electrical testing. Parts may be packed by customer in dry ice for transport. Irradiation portion of testing to be conducted per MIL-STD-883H, Test Method 1019.8, Condition A. Customer reserves right to modify parameters, devices, etc. to suit test requirements. Description of parts to be irradiated is as follows: MSK196RH (6RH6105BK#1B*01), fab lot #WDS4907E.1, ass'y lot #N/A, WFR #2: 10, 30, 50, 100 and 200 krad/(SiO ₂), 10 devices per dose level, biased/GND'd RH1086MH (6RH1086BHK), fab lot #W1231270.1, ass'y lot #719601.1, WFR #4: 10, 30, 50 and 100 krad/(SiO ₂), 10 devices per dose level, biased/GND'd RH1084MK-CS, fab lot #WD41450E.1, ass'y lot #N/A, WFR #5: 10, 30, 50, 100 and 200 krad/(SiO ₂), 10 devices per dose level, biased/GND'd RH1021BMH-10 (6RH1021-10K*14), fab lot #W1245822.1, ass'y lot #724755.1, WFR #1: 10, 30, 50 and 100 krad/(SiO ₂), 10 devices per dose level, biased/GND'd RH1021CMH-5450289 (RH1021-5K*08), fab lot #10214210.1, ass'y lot #697997.1, WFR #10: 10, 30, 50 and 100 krad/(SiO ₂), 10 devices per dose level, biased/GND'd									
Experiment #: 2014-NRC-024		DMEA Approval:		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="font-size: 8px;">SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500</td> <td style="font-size: 8px;">SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500</td> <td style="font-size: 8px;">ARSHAD, MOHAMMAD MAD 1231956693 Date: 2014-02-26 14:04:00 -0500</td> <td style="font-size: 8px;">MELINE CARY W.1231854033 Date: 2014-02-26 14:04:00 -0500</td> </tr> </table>		SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500	SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500	ARSHAD, MOHAMMAD MAD 1231956693 Date: 2014-02-26 14:04:00 -0500	MELINE CARY W.1231854033 Date: 2014-02-26 14:04:00 -0500
SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500	SHEPHERD, THOMAS J. AD J 1255235946 Date: 2014-02-26 10:40:01 -0500	ARSHAD, MOHAMMAD MAD 1231956693 Date: 2014-02-26 14:04:00 -0500	MELINE CARY W.1231854033 Date: 2014-02-26 14:04:00 -0500						
17. SEND REPORT OF TEST TO Individual identified in Block 2									
SECTION B - RESULTS OF TEST (Continue on plain white paper if more space is required)									
1. DATE SAMPLE RECEIVED 2014-02-25		2. DATE RESULTS REPORTED 2014-02-26		3. LAB REPORT NUMBER N/A					
4. TEST PERFORMED		RESULTS OF TEST	SAMPLE RESULT	REQUIREMENTS					
		Please see next page.							
DATE	TYPED NAME AND TITLE OF PERSON CONDUCTING TEST		SIGNATURE						
2014-02-26	Thomas J. Shepherd, SEGIT Technical Manager		SHEPHERD, THOMAS J. 1255235946 6						
2014-02-26	Mohammad Arshad, Alt. SEGIT Facility Supervisor		ARSHAD, MOHAMMAD. 1231956693						

DD FORM 1222, FEB 62 (EF)

REPLACES DD FORM 1222, 1 JUL 58, WHICH IS OBSOLETE.

Continuation of DD Form 1222

Experiment #: 2014-NRC-024 Page 2 of 2

4.	Test Performed	Results of Test	Sample Result	Requirements	Step No.
	20140225 10:12:30 to 20140225 10:15:44	1.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1086MH (6RH1086BHK), WFR #4, S/Ns 620-629: 10 krad TD	1
	20140225 10:12:30 to 20140225 10:15:44	1.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021BMH-10 (6RH1021-10K*14), WFR #1, S/Ns 93-97, 99-103: 10 krad TD	1
	20140225 10:12:30 to 20140225 10:15:44	1.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021CMH-5#50289 (RH1021-5K*08), WFR #10, S/Ns 267-276: 10 krad TD	1
	20140225 10:44:00 to 20140225 10:53:43	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1086MH (6RH1086BHK), WFR #4, S/Ns 630-639: 30 krad TD	2
	20140225 10:44:00 to 20140225 10:53:43	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021BMH-10 (6RH1021-10K*14), WFR #1, S/Ns 105-109: 30 krad TD	2
	20140225 10:44:00 to 20140225 10:53:43	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021CMH-5#50289 (RH1021-5K*08), WFR #10, S/Ns 277-286: 30 krad TD	2
	20140225 11:09:00 to 20140225 11:18:43	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021BMH-10 (6RH1021-10K*14), WFR #1, S/Ns 110-114: 30 krad TD	3
	20140225 11:34:00 to 20140225 11:50:12	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1086MH (6RH1086BHK), WFR #4, S/Ns 640-649: 50 krad TD	4
	20140225 11:34:00 to 20140225 11:50:12	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021BMH-10 (6RH1021-10K*14), WFR #1, S/Ns 116, 118-120, 180, 182-186: 50 krad TD	4
	20140225 11:34:00 to 20140225 11:50:12	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021CMH-5#50289 (RH1021-5K*08), WFR #10, S/Ns 287-296: 50 krad TD	4
	20140225 12:07:00 to 20140225 12:39:25	1.000E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #4, S/Ns 650-659: 100 krad TD	5
	20140225 12:07:00 to 20140225 12:39:25	1.000E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021BMH-10 (6RH1021-10K*14), WFR #1, S/Ns 187-193, 196-198: 100 krad TD	5
	20140225 12:07:00 to 20140225 12:39:25	1.000E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1021CMH-5#50289 (RH1021-5K*08), WFR #10, S/Ns 297-300, 316-317, 319-322: 100 krad TD	5
	20140225 14:46:00 to 20140225 14:49:14	1.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #2, S/Ns 1020-1027, 1029-1030: 10 krad TD	6
	20140225 14:46:00 to 20140225 14:49:14	1.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 13-22: 10 krad TD	6
	20140225 15:00:20 to 20140225 15:10:03	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #2, S/Ns 1031, 1042-1050: 30 krad TD	7
	20140225 15:00:20 to 20140225 15:10:03	3.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 23-32: 30 krad TD	7
	20140225 15:19:40 to 20140225 15:35:52	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #2, S/Ns 1051-1056, 1058-1059, 1061-1062: 50 krad TD	8
	20140225 15:19:40 to 20140225 15:35:52	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 33, 35-37, 39-44: 50 krad TD	8
	20140225 15:45:10 to 20140225 16:17:35	1.000E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #2, S/Ns 1064-1065, 1067-1074: 100 krad TD	9
	20140225 15:45:10 to 20140225 16:17:35	1.000E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 45-47, 49-55: 100 krad TD	9
	20140225 16:27:20 to 20140225 17:15:57	1.500E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	MSK196RH (6RH6105BK#IB*01), WFR #2, S/Ns 1075-1084: 150 krad TD	10
	20140225 16:27:20 to 20140225 17:15:57	1.500E+05 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 56-60, 62, 64-67: 150 krad SD, 150 krad TD	10
	20140225 17:22:20 to 20140225 17:38:32	5.000E+04 rad(SiO2) at 3.085E+03	rad(SiO2)/min	RH1084MK-CS, WFR #5, S/Ns 56-60, 62, 64-67: 50 krad SD, 200 krad TD	11

Uncertainty: Total Doses reported are ± 16.02%

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2.

//

NOTES:

- ASTM = American Society for Testing and Materials.
- DUT = Device Under Test.
- S/N = Serial Number.
- SD = Step Dose.
- TD = Total Dose.
- Dose rate uniformity across target area: ± 9.76%
- All irradiation steps met the requirements of MIL-STD-883H, Test Method 1019.8, Condition A.
- After the original Test Request (DD Form 1222) was approved, the following changes were made:
 - Total number of irradiation steps was 11 instead of 22. The board configuration allowed the irradiation of 2 boards simultaneously.
 - The MSK196RH (6RH6105BK#IB*01) highest TD level was incorrect on the original Test Request; it should have been 150 krad(SiO2) instead of 200 krad(SiO2). The 150 krad(SiO2) TD was executed correctly during Step No. 10.
- Latitude to change test parameters to suit customer requirements was included in the original Test Request; no Customer Order Change Request (SEGIT Form QP03-4, Rev. 5) was required/issued.
- Source information:
 - Irradiator = J.L. Shepherd & Associates Model 81-22/484 self-contained irradiation facility, S/Ns 7125/50016.
 - Source selection = two large Co-60 sources.
- Dosimeter system:
 - Radcal Model No. 9010 Radiation Monitor Controller, S/N 90-1313.
 - Radcal Model No. 90X5-018 Electrometer/Ion Chamber, S/Ns 95-0478/9771.
 - This dosimeter system was calibrated per ISO/IEC 17025:2005 by University of Wisconsin Medical Radiation Research Center on 3 Feb 2014 (Report No. ION14426). This calibration is effective for two years.
- Irradiation geometry: in accordance with section 7.3.2 of ASTM E1249-00 (2005), the DUT's semiconductor chip plane was perpendicular to the incident radiation beam.
- Filter box: a DMEA Dose Enhancement Chamber (DEC) was used for all testing/dosimetry involved with this experiment. The DEC's Pb and Al layers are compliant with section 7.2.2 of ASTM E1249-00 (2005) with respect to thickness and geometry.

Appendix D

Table D1: Pre-Irradiation Electrical Characteristics of Device-Under-Test

PARAMETER	CONDITIONS	NOTES	$T_A = 25^\circ\text{C}$			SUB-GROUP	$-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$			SUB-GROUP	UNITS
			MIN	TYP	MAX		MIN	TYP	MAX		
Reference Voltage	$I_{\text{OUT}} = 10\text{mA}$, $(V_{\text{IN}} - V_{\text{OUT}}) = 3\text{V}$ (K)		1.238	1.262		1					V
	$10\text{mA} \leq I_{\text{OUT}} \leq I_{\text{FULL LOAD}}$, $1.5\text{V} \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 25\text{V}$	6	1.225	1.270			1.225	1.270	2,3		V
Line Regulation	$I_{\text{LOAD}} = 10\text{mA}$, $1.5\text{V} \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 15\text{V}$	2, 3		0.2		1		0.2	2,3		%
Load Regulation	$(V_{\text{IN}} - V_{\text{OUT}}) = 3\text{V}$, $10\text{mA} \leq I_{\text{OUT}} \leq I_{\text{FULL LOAD}}$	2, 3, 6		0.3		1		0.4	2,3		%
Dropout Voltage	$\Delta V_{\text{REF}} = 1\%$, $I_{\text{OUT}} = 1.5\text{A}$ (K)	4		1.5		1		1.5	2,3		V
	$\Delta V_{\text{REF}} = 1\%$, $I_{\text{OUT}} = 0.5\text{A}$ (H)	4		1.25		1		1.25	2,3		V
Current Limit	$(V_{\text{IN}} - V_{\text{OUT}}) = 5\text{V}$ (K)		1.5			1	1.5		2,3		A
	$(V_{\text{IN}} - V_{\text{OUT}}) = 5\text{V}$ (H)		0.5			1	0.5		2,3		A
	$(V_{\text{IN}} - V_{\text{OUT}}) = 25\text{V}$ (K)		0.05			1	0.05		2,3		A
	$(V_{\text{IN}} - V_{\text{OUT}}) = 25\text{V}$ (H)		0.020			1	0.020		2,3		A
Minimum Load Current	$(V_{\text{IN}} - V_{\text{OUT}}) = 25\text{V}$			10		1		10	2,3		mA
Thermal Regulation	$T_A = 25^\circ\text{C}$, 30ms Pulse			0.04		4					%/W
Ripple Rejection	$f = 120\text{Hz}$, $C_{\text{ADJ}} = 25\mu\text{F}$, $C_{\text{OUT}} = 25\mu\text{F}$ Tantalum, $I_{\text{OUT}} = I_{\text{FULL LOAD}}$, $(V_{\text{IN}} - V_{\text{OUT}}) = 3\text{V}$	6	60			4	60		5,6		dB
Adjust Pin Current	$T_J = 25^\circ\text{C}$			55	120	1		120	2,3		μA
Adjust Pin Current Change	$10\text{mA} \leq I_{\text{OUT}} \leq I_{\text{FULL LOAD}}$, $1.5\text{V} \leq (V_{\text{IN}} - V_{\text{OUT}}) \leq 15\text{V}$	6		5		1		5	2,3		μA
Temperature Stability				0.5				0.5			%
Long Term Stability	$T_A = 125^\circ\text{C}$, 1000 Hours	5		0.3							%
RMS Output Noise (% of V_{OUT})	$10\text{Hz} \leq f \leq 10\text{kHz}$			0.003							%
Thermal Resistance Junction-to-Case	Control Circuitry (K)	5		1.7							$^\circ\text{C}/\text{W}$
	Control Circuitry (H)	5		15.0							$^\circ\text{C}/\text{W}$
	Power Transistor (K)	5		4.0							$^\circ\text{C}/\text{W}$
	Power Transistor (H)	5		20.0							$^\circ\text{C}/\text{W}$

Table D2: Post-Irradiation Electrical Characteristics of Device-Under-Test

PARAMETER	CONDITIONS	10KRAD (Si)		20KRAD (Si)		50KRAD (Si)		100KRAD (Si)		200KRAD (Si)		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Reference Voltage (Note 6)	$I_{OUT} = 10\text{mA}$ ($V_{IN} - V_{OUT} = 3\text{V}$ (K))	1.234	1.262	1.230	1.262	1.225	1.262	1.220	1.262	1.205	1.262	V
	$10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$ $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$	1.220	1.275	1.219	1.275	1.215	1.275	1.210	1.275	1.20	1.275	V
Line Regulation (Notes 2, 3)	$I_{OUT} = 10\text{mA}$ $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$		0.2		0.21		0.23		0.25		0.3	%
Load Regulation (Notes 2, 3, 6)	$(V_{IN} - V_{OUT}) = 3\text{V}$ $10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$		0.3		0.3		0.3		0.3		0.3	%
Dropout Voltage (Note 4)	$\Delta V_{REF} = 1\%$, $I_{OUT} = 1.5\text{A}$ (K)		1.5		1.51		1.52		1.55		1.575	V
	$\Delta V_{REF} = 1\%$, $I_{OUT} = 0.5\text{A}$ (H)		1.25		1.26		1.27		1.29		1.32	V
Current Limit	$(V_{IN} - V_{OUT}) = 5\text{V}$ (K)	1.5		1.5		1.5		1.5		1.5		A
	$(V_{IN} - V_{OUT}) = 25\text{V}$ (K)	0.05		0.049		0.048		0.047		0.045		A
	$(V_{IN} - V_{OUT}) = 5\text{V}$ (H)	0.5		0.5		0.5		0.5		0.5		A
	$(V_{IN} - V_{OUT}) = 25\text{V}$ (H)	0.020		0.019		0.019		0.018		0.017		A
Minimum Load Current	$(V_{IN} - V_{OUT}) = 25\text{V}$		10		10		10		10		10	mA
Adjust Pin Current			120		120		120		120		120	μA
Adjust Pin Current Change (Note 6)	$10\text{mA} \leq I_{OUT} \leq I_{FULL\ LOAD}$ $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 15\text{V}$		5		5		5		5		5	μA

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: See thermal regulation specifications for changes in output voltage due to heating effects. Line and load regulation are measured at a constant junction temperature by low duty cycle pulse testing.

Note 3: Line and load regulation are guaranteed up to the maximum power dissipation of 15W for RH1086MK and 3W for the RH1086MH. Power dissipation is determined by the input/output differential voltage and the output current. Guaranteed maximum power dissipation will not be available over the full input/output voltage range.

Note 4: Dropout voltage is specified over the full output current range of the device. Test points and limits are shown on the Dropout Voltage curve in the LT[®]1086 data sheet.

Note 5: Guaranteed by design, characterization, or correlation to other tested parameters.

Note 6: $I_{FULL\ LOAD}$ is defined in the Current Limit curves in the standard data sheet. For compliance with 883 revision C current density specifications, the RH1086MK is derated to 1A.