

Total Ionization Dose (TID) Test Results of the RH1028MW Ultralow Low Noise Precision High Speed Operational Amplifiers @ High Dose Rate (HDR)

HDR= 50 rads/sec

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Duc Nguyen, Sana Rezgui

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TID HDR Test Results of the RH1028MW Ultralow Noise Precision High Speed Operational Amplifiers

Part Type Tested: RH1028MW Ultralow Noise Precision High Speed Operational Amplifiers

Traceability Information: Fab Lot #: W1117814.1, Wafer #: 5, Assembly Lot #: 675617.1. Date Code: 1228A. See photograph of unit under test in Appendix A.

Quantity of Units: 52 units received, 2 control units, 25 units for biased irradiation, and 25 units for unbiased irradiation. Serial numbers 335, 337-340, 352, 353, 355-357, 380, 382, 384-386, 396-400, and 419-423 had all pins tied to ground during irradiation. Serial numbers 138, 140-143, 144, 145, 147-149, 157, 159, 161-163, 341, 343, 344, 347, 348, 424, 425, and 428-430 were biased during irradiation. Serial numbers 350 and 351 were used as control. Refer to Appendix B for the radiation bias connection tables.

Radiation and Electrical Test Increments: 50 samples were divided into 5 groups of 10 each. Group 1 with serial numbers 138, 140-143, 352, 353, and 355-357 were irradiated up to 10 Krads(Si). Serial numbers 144, 145, 147-149, 335, 337, and 338-340 were used for 20 Krads(Si) group. The following serial numbers 157, 159, 161-163, 380, 383, and 384-386 were irradiated up to 50 Krads(Si). The 100 Krads(Si) group consisted of serial numbers 341, 343, 344, 347, 348, and 396-400. The last group with serial numbers 419-423, 424, 425, and 428-430 were exposed to 200 Krads(Si). All 52 samples were electrically tested pre- and post-irradiation.

Radiation dose: 50rads/sec.

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

Test Hardware and Software: LTX test program EQBRH1028.02.

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

FIFTY TWO PARTS PASSED THE ELECTRICAL TEST LIMITS AS SPECIFIED IN THE DATASHEET AFTER EACH IRRADIATION INCREMENT UP TO 200 KRADS(SI). 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 exposed 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 50rads/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.

The electrical measurements were performed with the Automated Test Equipment LTX, test program EQBRH1028.02.

3.0. Test Conditions

The 50 samples and two control units were electrically test at 25°C prior to irradiation. The parts then were placed in a lead/aluminum container and aligned with the radiation source, ⁶⁰Cobalt, at DMEA facility in Sacramento, California. Five units of six separate groups were biased and five others of the same six group were unbiased during irradiation. Ten units of group 1 were irradiated to 10 Krads(Si); group 2 to 30 Krads(Si); group 3 to 50 Krads(Si), group 4 to 100 Krads(Si), and group 5 to 200 Krads(Si). After irradiation the samples were transported in dry ice to Linear Technology testing facility. Testing was performed on the 2 control units to confirm the operation of the test system prior to the electrical testing of 50 irradiated units.

The criteria to pass the high dose-rate test is that the samples in each corresponding dose group irradiated under electrical bias must pass the datasheet limits. If any of the tested parameters of these 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-irradiation at $V_S = \pm 15V$, $V_{CM} = 0V$ unless otherwise noted:

- Input Offset Voltage V_{OS} (V)
- Input Offset Current I_{OS} (nA)
- Positive Bias Current $+I_B$ (nA)
- Negative Bias Current $-I_B$ (nA)
- Positive Slew Rate (V/uS)
- Negative Slew Rate (V/uS)
- Common Mode Rejection Ratio CMRR (dB)
- Power Supply Rejection Ratio PSRR (dB)
- Large-Signal Voltage Gain A_{VOL} (V/mV)
- Positive Output Voltage Swing (V) at $R_L = 2k\Omega$
- Negative Output Voltage Swing (V) at $R_L = 2k\Omega$
- Positive Output Voltage Swing (V) at $R_L = 600\Omega$
- Negative Output Voltage Swing (V) at $R_L = 600\Omega$

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

5.0. Test Results

Fifty samples passed the post-irradiation electrical tests. All measurements of the thirteen 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 deviation are unknown and therefore it is practice to estimate both of them from a sample. Hence the tolerance limit depends upon the outcome of the sample. For the lot quality P of 0.9, confidence c of 0.9 with a sample size of 5, the $Ps90\%/90\%$ K_{TL} factor can be found from the tabulated table (MIL-HDBK-814, page 94, table IX-B). The K_{TL} factor 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 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 samples 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 tied to ground. 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.

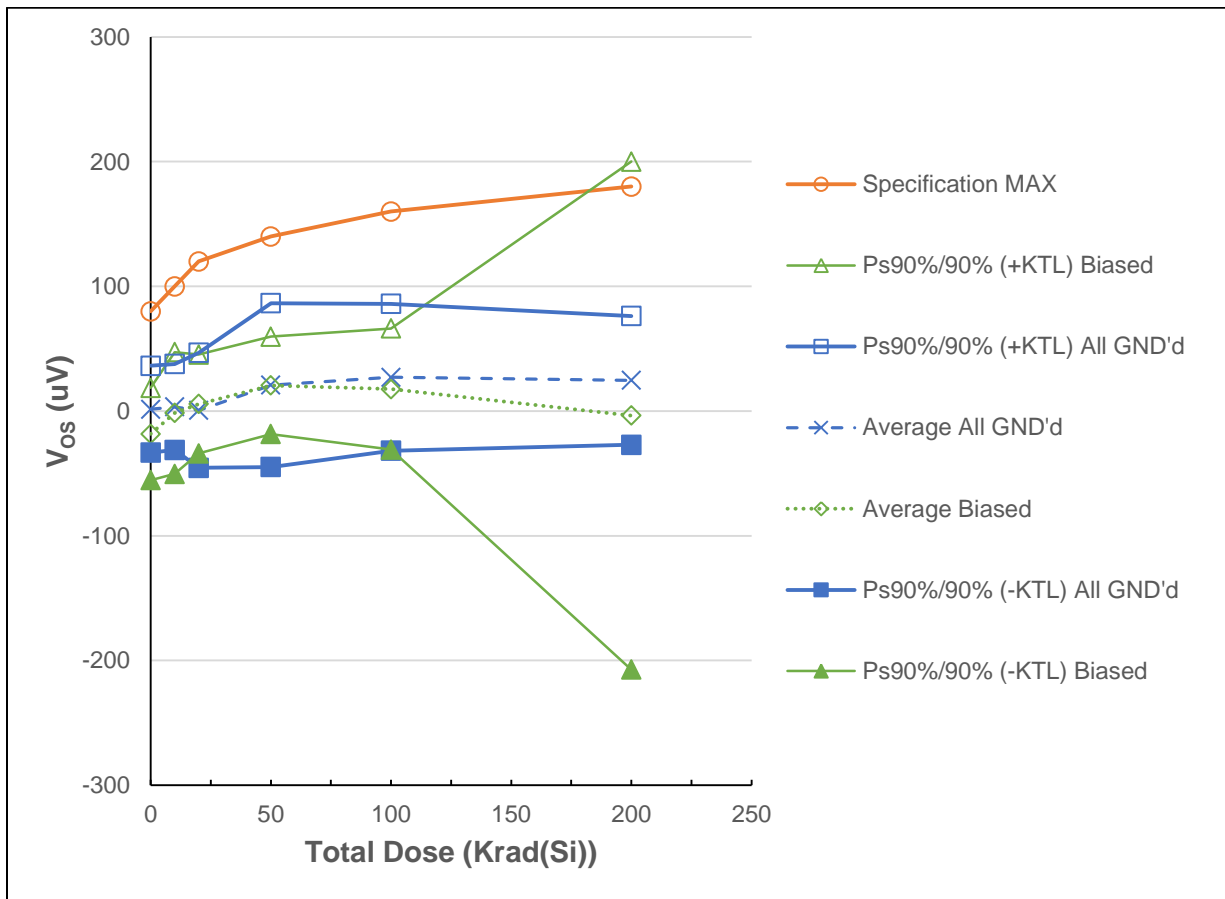


Figure 5.1: Plot of Input Offset Voltage V_{OS} versus Total Dose.

The averages of biased irradiation measurements are shown in the dotted green line with diamond markers. The averages of all ground-connection irradiation measurements are shown in the dashed blue line with X markers. The data are well under the specification maximum limit.

Table 5.1: Raw data for input offset voltage versus total dose.

Parameter Units	VOS (μ V)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	-5.54	-6.56				
353	All GND'd Irradiation	-9.81	-6.78				
355	All GND'd Irradiation	18.10	19.90				
356	All GND'd Irradiation	12.10	13.70				
357	All GND'd Irradiation	-7.43	-3.65				
138	Biased-Irradiation	2.75	28.50				
140	Biased-Irradiation	-25.46	-10.23				
141	Biased-Irradiation	-17.67	-4.57				
142	Biased-Irradiation	-17.62	-3.17				
143	Biased-Irradiation	-33.60	-18.29				
335	All GND'd Irradiation	-13.93		-3.02			
337	All GND'd Irradiation	19.42		30.00			
338	All GND'd Irradiation	-24.18		-12.10			
339	All GND'd Irradiation	-20.50		-8.11			
340	All GND'd Irradiation	-15.36		-3.74			
144	Biased-Irradiation	-25.59		-2.60			
145	Biased-Irradiation	-7.54		16.73			
147	Biased-Irradiation	-1.39		17.00			
148	Biased-Irradiation	-8.30		13.04			
149	Biased-Irradiation	-38.11		-15.86			
380	All GND'd Irradiation	31.50			44.90		
382	All GND'd Irradiation	28.80			38.70		
384	All GND'd Irradiation	2.46			18.50		
385	All GND'd Irradiation	4.25			18.30		
386	All GND'd Irradiation	-26.60			-16.40		
157	Biased-Irradiation	18.88			42.61		
159	Biased-Irradiation	-3.56			21.81		
161	Biased-Irradiation	-17.19			8.08		
162	Biased-Irradiation	-1.60			22.78		
163	Biased-Irradiation	-13.18			7.84		
396	All GND'd Irradiation	26.20				44.20	
397	All GND'd Irradiation	30.70				51.10	
398	All GND'd Irradiation	5.65				26.10	
399	All GND'd Irradiation	-1.44				16.10	
400	All GND'd Irradiation	-21.10				-2.14	
341	Biased-Irradiation	17.94				47.50	
343	Biased-Irradiation	-17.08				5.40	
344	Biased-Irradiation	-14.97				3.71	
347	Biased-Irradiation	-5.95				13.30	
348	Biased-Irradiation	-0.59				18.40	
419	All GND'd Irradiation	38.30					28.21
420	All GND'd Irradiation	-5.95					-0.83
421	All GND'd Irradiation	-2.74					19.59
422	All GND'd Irradiation	-34.10					51.66
423	All GND'd Irradiation	6.11					24.41
424	Biased-Irradiation	25.10					41.03
425	Biased-Irradiation	-8.76					27.05
428	Biased-Irradiation	14.80					35.87
429	Biased-Irradiation	0.27					-135.10
430	Biased-Irradiation	22.60					13.24
350	Control Unit	-27.40	-29.60	-29.60	-29.60	-29.60	-29.60
351	Control Unit	-6.72	-17.10	-17.10	-17.10	-17.10	-17.10
All GND'd Irradiation Statistics							
Average All GND'd		1.48	3.32	0.61	20.80	27.07	24.61
Std Dev All GND'd		12.70	12.56	16.83	23.96	21.48	18.82
Ps90%/90% (+KTL) All GND'd		36.31	37.76	46.76	86.50	85.97	76.22
Ps90%/90% (-KTL) All GND'd		-33.34	-31.11	-45.55	-44.90	-31.82	-27.00
Biased-Irradiation Statistics							
Average Biased		-18.32	-1.55	5.66	20.62	17.66	-3.58
Std Dev Biased		13.50	17.82	14.46	14.23	17.71	74.27
Ps90%/90% (+KTL) Biased		18.70	47.31	45.32	59.64	66.23	200.08
Ps90%/90% (-KTL) Biased		-55.34	-50.42	-33.99	-18.40	-30.90	-207.24
Specification MIN							
Status (Measurements) All GND'd							
Status (Measurements) Biased							
Specification MAX		80	100	120	140	160	180
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd							
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased							
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS	FAIL

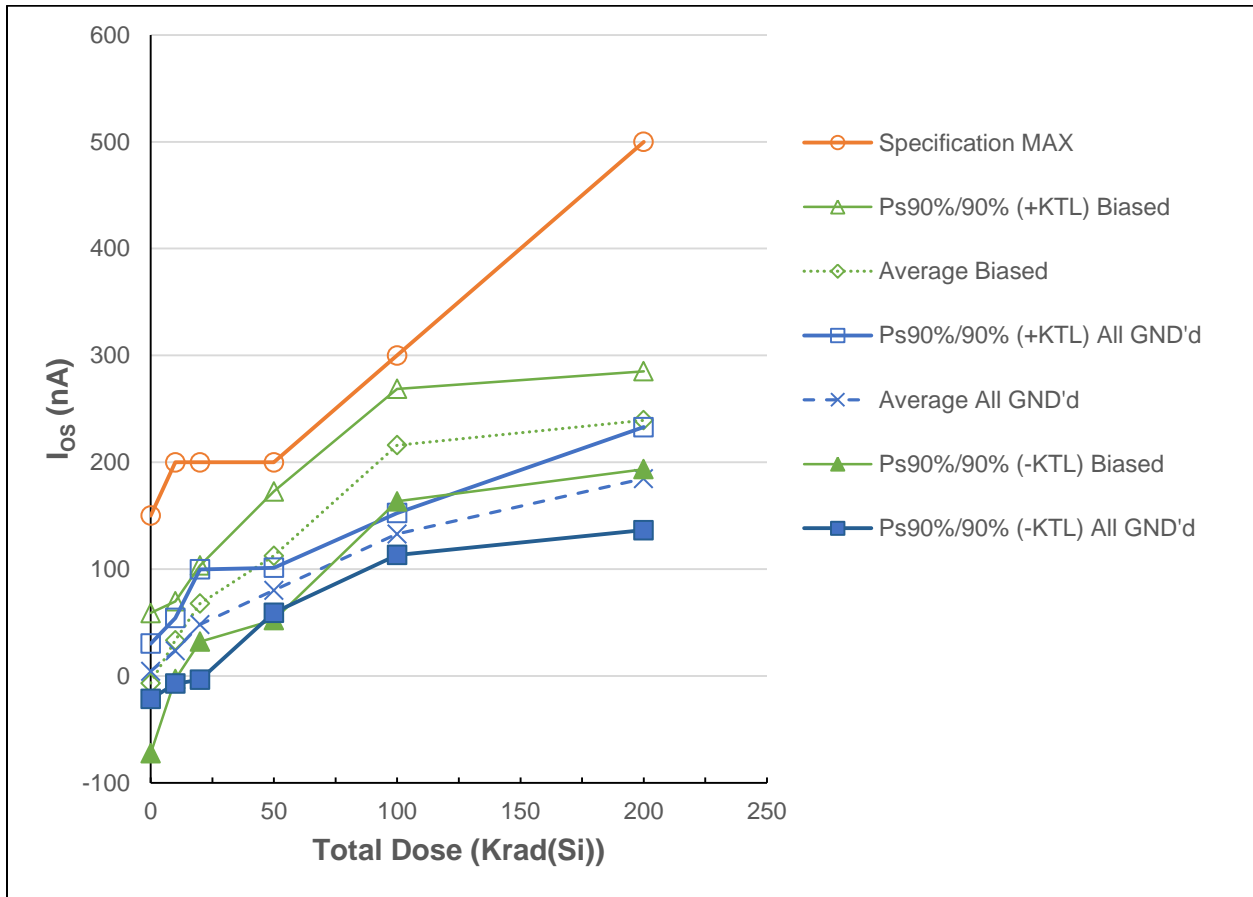


Figure 5.2: Plot of Input Offset Current I_{OS} versus Total Dose

The averages of biased irradiation measurements are shown in the dotted green line with diamond markers. The averages of all ground-connection irradiation measurements are shown in the dashed blue line with X markers. The measured values of all samples are within datasheet maximum limits.

Table 5.2: Raw data for input offset current versus total dose.

Parameter Units	IOS (nA)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	-7.69	7.35				
353	All GND'd Irradiation	13.20	30.10				
355	All GND'd Irradiation	-3.30	20.20				
356	All GND'd Irradiation	6.59	22.80				
357	All GND'd Irradiation	12.80	37.10				
138	Biased-Irradiation	8.43	42.43				
140	Biased-Irradiation	1.10	35.12				
141	Biased-Irradiation	-1.10	16.83				
142	Biased-Irradiation	6.60	39.14				
143	Biased-Irradiation	-49.10	-8.05				
335	All GND'd Irradiation	-17.59		20.20			
337	All GND'd Irradiation	-4.40		52.50			
338	All GND'd Irradiation	18.69		48.40			
339	All GND'd Irradiation	28.58		73.00			
340	All GND'd Irradiation	9.89		46.20			
144	Biased-Irradiation	8.79		68.40			
145	Biased-Irradiation	2.20		59.62			
147	Biased-Irradiation	26.02		88.52			
148	Biased-Irradiation	6.96		67.31			
149	Biased-Irradiation	-8.06		54.50			
380	All GND'd Irradiation	9.89			73.20		
382	All GND'd Irradiation	13.50			92.30		
384	All GND'd Irradiation	6.59			82.00		
385	All GND'd Irradiation	0.37			79.00		
386	All GND'd Irradiation	1.10			74.30		
157	Biased-Irradiation	7.33			103.52		
159	Biased-Irradiation	-13.92			99.50		
161	Biased-Irradiation	0.73			106.45		
162	Biased-Irradiation	31.88			140.46		
163	Biased-Irradiation	7.69			105.71		
396	All GND'd Irradiation	0.37				123.00	
397	All GND'd Irradiation	-2.93				129.00	
398	All GND'd Irradiation	20.50				142.00	
399	All GND'd Irradiation	5.13				135.00	
400	All GND'd Irradiation	2.20				135.00	
341	Biased-Irradiation	-18.68				193.00	
343	Biased-Irradiation	-16.49				212.00	
344	Biased-Irradiation	2.20				232.00	
347	Biased-Irradiation	1.47				204.00	
348	Biased-Irradiation	16.85				239.00	
419	All GND'd Irradiation	6.59					171.31
420	All GND'd Irradiation	4.03					163.59
421	All GND'd Irradiation	6.59					199.24
422	All GND'd Irradiation	6.59					204.76
423	All GND'd Irradiation	-7.69					184.17
424	Biased-Irradiation	15.70					241.15
425	Biased-Irradiation	22.30					265.05
428	Biased-Irradiation	6.59					241.15
429	Biased-Irradiation	27.10					227.18
430	Biased-Irradiation	24.20					222.04
350	Control Unit	-33.00	-33.50	-33.50	-33.50	-33.50	-33.50
351	Control Unit	-8.06	-2.57	-2.57	-2.57	-2.57	-2.57
All GND'd Irradiation Statistics							
Average All GND'd		4.32	23.51	48.06	80.16	132.80	184.61
Std Dev All GND'd		9.46	11.19	18.85	7.66	7.16	17.60
Ps90%/90% (+KTL) All GND'd		30.27	54.19	99.75	101.17	152.42	232.88
Ps90%/90% (-KTL) All GND'd		-21.63	-7.17	-3.63	59.15	113.18	136.35
Biased-Irradiation Statistics							
Average Biased		-6.82	33.38	67.67	112.48	216.00	239.31
Std Dev Biased		23.96	11.43	12.98	18.87	19.20	16.69
Ps90%/90% (+KTL) Biased		58.87	69.83	103.25	172.64	268.64	285.09
Ps90%/90% (-KTL) Biased		-72.50	-3.07	32.09	52.32	163.36	193.54
Specification MIN							
Status (Measurements) All GND'd							
Status (Measurements) Biased							
Specification MAX		150	200	200	200	300	500
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd							
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased							
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS

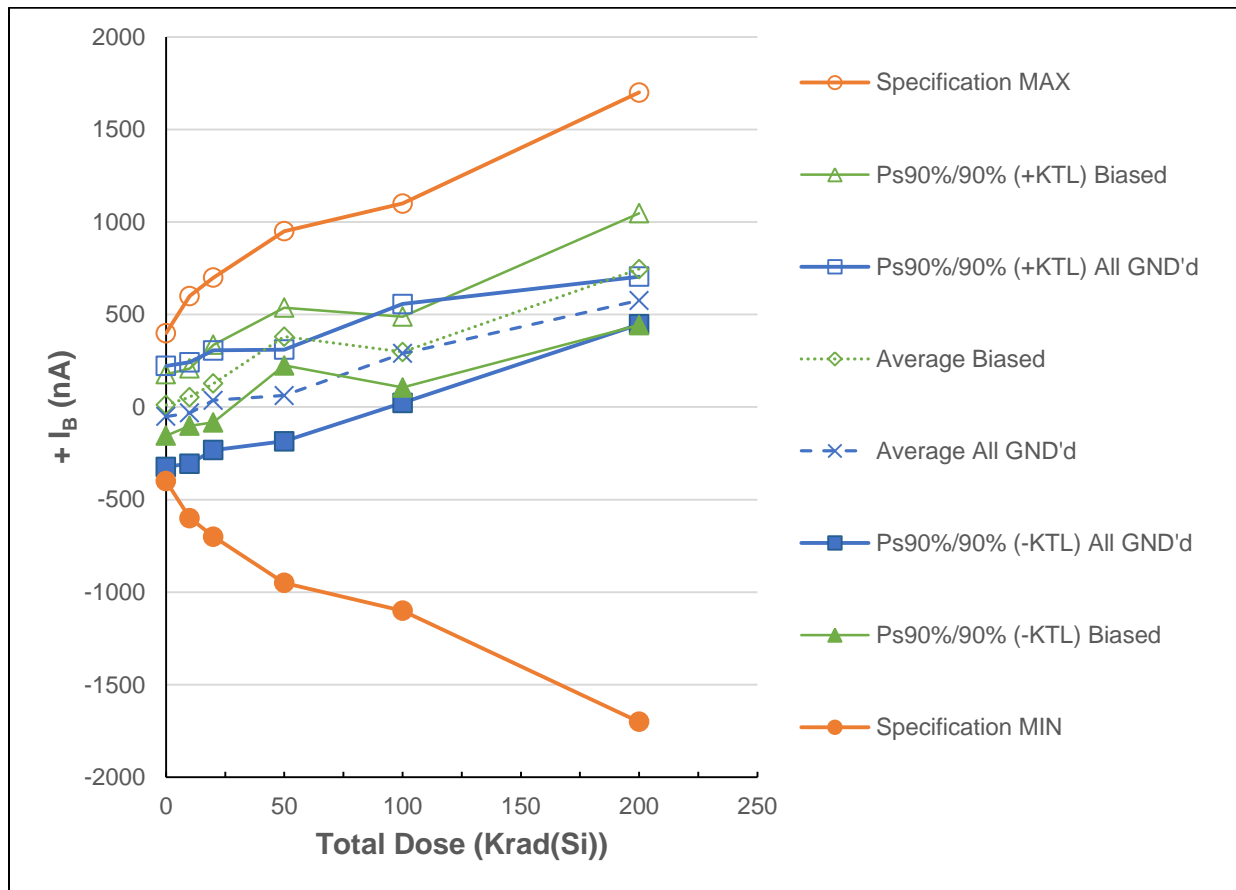


Figure 5.3: Plot of Positive Input Bias Current I_{OS} versus Total Dose

The averages of biased irradiation measurements are shown in the dotted green line with diamond markers. The averages of all ground-connection irradiation measurements are shown in the dashed blue line with X markers. The average measured values of all samples are within datasheet maximum limits.

Table 5.3: Raw data for Positive Input Bias Current I_B .

Parameter Units	Positive I_B (nA)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	79.30	81.60				
353	All GND'd Irradiation	7.69	38.40				
355	All GND'd Irradiation	-51.30	-18.40				
356	All GND'd Irradiation	-114.00	-94.80				
357	All GND'd Irradiation	-174.00	-166.00				
138	Biased-Irradiation	-78.08	-35.32				
140	Biased-Irradiation	-15.40	38.25				
141	Biased-Irradiation	54.62	90.03				
142	Biased-Irradiation	23.64	67.34				
143	Biased-Irradiation	74.04	109.06				
335	All GND'd Irradiation	47.10		26.10			
337	All GND'd Irradiation	147.90		123.00			
338	All GND'd Irradiation	-74.04		-118.00			
339	All GND'd Irradiation	169.35		121.00			
340	All GND'd Irradiation	43.62		32.80			
144	Biased-Irradiation	125.36		191.77			
145	Biased-Irradiation	-34.46		47.94			
147	Biased-Irradiation	-10.63		62.95			
148	Biased-Irradiation	37.39		112.17			
149	Biased-Irradiation	87.79		220.14			
380	All GND'd Irradiation	16.10			139.00		
382	All GND'd Irradiation	3.48			143.00		
384	All GND'd Irradiation	-42.30			96.30		
385	All GND'd Irradiation	-111.00			-6.62		
386	All GND'd Irradiation	-178.00			-57.20		
157	Biased-Irradiation	82.84			390.14		
159	Biased-Irradiation	68.18			396.54		
161	Biased-Irradiation	34.46			346.95		
162	Biased-Irradiation	104.10			461.14		
163	Biased-Irradiation	3.48			310.35		
396	All GND'd Irradiation	76.40				312.00	
397	All GND'd Irradiation	22.30				352.00	
398	All GND'd Irradiation	-136.00				118.00	
399	All GND'd Irradiation	49.80				326.00	
400	All GND'd Irradiation	108.00				342.00	
341	Biased-Irradiation	58.58				371.00	
343	Biased-Irradiation	128.87				371.00	
344	Biased-Irradiation	-160.72				223.00	
347	Biased-Irradiation	22.33				277.00	
348	Biased-Irradiation	-51.26				245.00	
419	All GND'd Irradiation	-60.10					560.01
420	All GND'd Irradiation	18.00					619.38
421	All GND'd Irradiation	-0.55					629.85
422	All GND'd Irradiation	43.60					553.21
423	All GND'd Irradiation	-37.60					518.84
424	Biased-Irradiation	49.80					569.75
425	Biased-Irradiation	87.90					748.76
428	Biased-Irradiation	-50.60					755.01
429	Biased-Irradiation	-131.00					779.27
430	Biased-Irradiation	-195.00					873.56
350	Control Unit	151.00	161.00	161.00	161.00	161.00	161.00
351	Control Unit	21.40	18.40	18.40	18.40	18.40	18.40
All GND'd Irradiation Statistics							
	Average All GND'd	-50.46	-31.84	36.98	62.90	290.00	576.26
	Std Dev All GND'd	99.40	99.93	98.25	90.25	97.36	46.97
	Ps90%/90% (+KTL) All GND'd	222.09	242.17	306.39	310.36	556.95	705.04
	Ps90%/90% (-KTL) All GND'd	-323.01	-305.85	-232.43	-184.57	23.05	447.48
Biased-Irradiation Statistics							
	Average Biased	11.77	53.87	127.00	381.02	297.40	745.27
	Std Dev Biased	60.55	56.42	76.55	56.78	69.88	110.15
	Ps90%/90% (+KTL) Biased	177.79	208.58	336.91	536.72	489.00	1047.29
	Ps90%/90% (-KTL) Biased	-154.26	-100.84	-82.92	225.32	105.80	443.25
	Specification MIN	-400	-600	-700	-950	-1100	-1700
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS	PASS
	Specification MAX	400	600	700	950	1100	1700
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
	Status (-KTL) Biased	PASS	PASS	PASS	PASS	PASS	PASS
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS	PASS

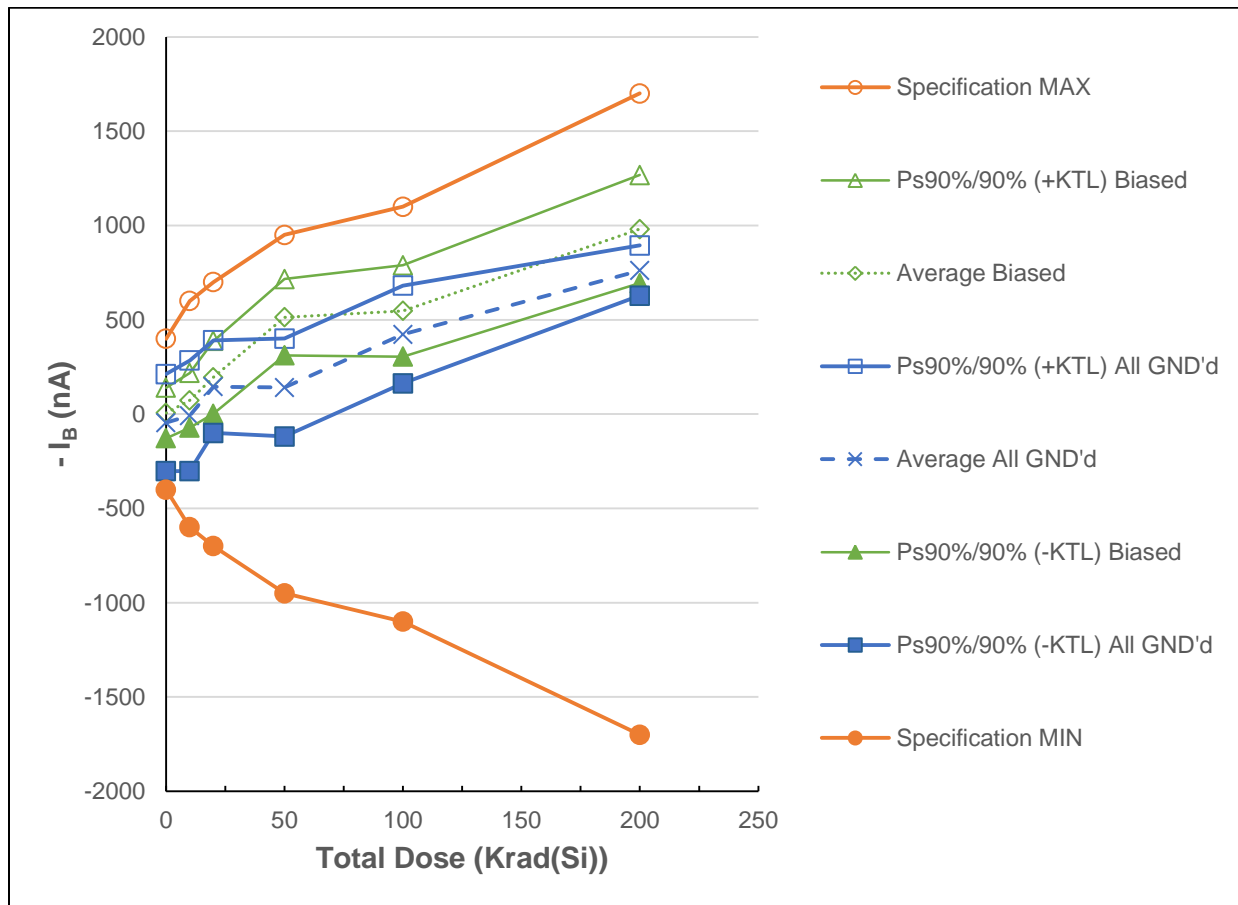


Figure 5.4: Plot of Negative Input Bias versus Total Dose

All measured data points are well under datasheet upper limits.

Table 5.4: Raw data for negative input bias current versus total dose.

Parameter Units	Negative I_b (nA)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	71.80	88.00				
353	All GND'd Irradiation	22.30	65.80				
355	All GND'd Irradiation	-54.20	4.41				
356	All GND'd Irradiation	-107.00	-72.00				
357	All GND'd Irradiation	-160.00	-130.00				
138	Biased-Irradiation	-70.38	8.23				
140	Biased-Irradiation	-13.01	74.66				
141	Biased-Irradiation	53.70	105.04				
142	Biased-Irradiation	31.52	104.12				
143	Biased-Irradiation	27.12	101.01				
335	All GND'd Irradiation	31.89		118.00			
337	All GND'd Irradiation	145.16		216.00			
338	All GND'd Irradiation	-54.62		22.80			
339	All GND'd Irradiation	197.94		249.00			
340	All GND'd Irradiation	54.98		121.00			
144	Biased-Irradiation	136.72		257.65			
145	Biased-Irradiation	-31.71		108.88			
147	Biased-Irradiation	14.66		152.25			
148	Biased-Irradiation	43.80		181.34			
149	Biased-Irradiation	80.28		275.40			
380	All GND'd Irradiation	26.40			218.00		
382	All GND'd Irradiation	18.10			229.00		
384	All GND'd Irradiation	-36.10			173.00		
385	All GND'd Irradiation	-113.00			70.60		
386	All GND'd Irradiation	-175.00			13.80		
157	Biased-Irradiation	93.10			495.17		
159	Biased-Irradiation	57.18			498.47		
161	Biased-Irradiation	35.19			456.74		
162	Biased-Irradiation	135.44			604.60		
163	Biased-Irradiation	14.85			418.32		
396	All GND'd Irradiation	77.30				434.00	
397	All GND'd Irradiation	20.30				478.00	
398	All GND'd Irradiation	-115.00				256.00	
399	All GND'd Irradiation	54.20				466.00	
400	All GND'd Irradiation	111.00				477.00	
341	Biased-Irradiation	39.54				606.00	
343	Biased-Irradiation	110.93				663.00	
344	Biased-Irradiation	-158.89				440.00	
347	Biased-Irradiation	24.90				528.00	
348	Biased-Irradiation	-33.68				498.00	
419	All GND'd Irradiation	-52.80					732.96
420	All GND'd Irradiation	24.20					782.77
421	All GND'd Irradiation	2.93					827.80
422	All GND'd Irradiation	51.30					760.90
423	All GND'd Irradiation	-45.40					699.88
424	Biased-Irradiation	65.90					807.21
425	Biased-Irradiation	112.00					1009.01
428	Biased-Irradiation	-42.50					991.19
429	Biased-Irradiation	-104.00					1007.91
430	Biased-Irradiation	-169.00					1090.25
350	Control Unit	120.00	125.00	125.00	125.00	125.00	125.00
351	Control Unit	15.80	13.20	13.20	13.20	13.20	13.20
All GND'd Irradiation Statistics							
Average All GND'd		-45.42	-8.76	145.36	140.88	422.20	760.86
Std Dev All GND'd		93.97	91.92	89.57	94.65	94.60	48.63
Ps90%/90% (+KTL) All GND'd		212.26	284.27	390.97	400.40	681.59	894.19
Ps90%/90% (-KTL) All GND'd		-303.10	-301.78	-100.25	-118.64	162.81	627.53
Biased-Irradiation Statistics							
Average Biased		5.79	73.01	195.10	513.75	547.00	981.11
Std Dev Biased		48.91	45.43	70.39	63.46	88.24	104.58
Ps90%/90% (+KTL) Biased		139.90	217.85	388.12	716.06	788.96	1267.88
Ps90%/90% (-KTL) Biased		-128.31	-71.82	2.09	311.43	305.04	694.35
Specification MIN		-400	-600	-700	-950	-1100	-1700
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Specification MAX		400	600	700	950	1100	1700
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS

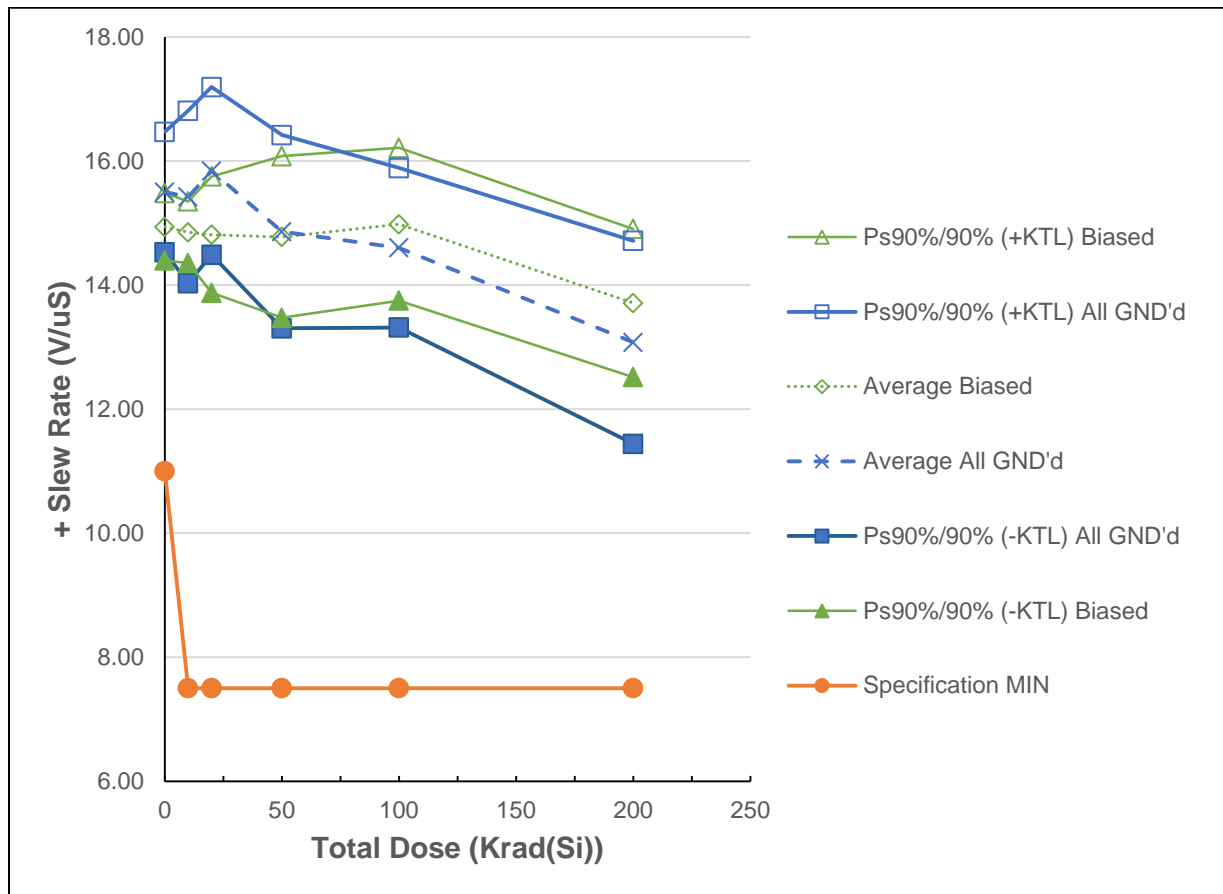


Figure 5.5: Plot of versus Positive Slew Rate versus Total Dose

The measured parameters are within the specification maximum limits.

Table 5.5: Raw data for positive slew rate versus total dose.

Parameter Units	Positive Slew Rate (V/uS)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	15.50	15.90				
353	All GND'd Irradiation	16.00	15.90				
355	All GND'd Irradiation	15.00	14.70				
356	All GND'd Irradiation	15.50	15.40				
357	All GND'd Irradiation	15.50	15.20				
138	Biased-Irradiation	14.81	14.59				
140	Biased-Irradiation	15.25	15.03				
141	Biased-Irradiation	15.03	15.03				
142	Biased-Irradiation	14.81	14.81				
143	Biased-Irradiation	14.81	14.81				
335	All GND'd Irradiation	14.39		15.20			
337	All GND'd Irradiation	14.81		15.50			
338	All GND'd Irradiation	15.25		15.90			
339	All GND'd Irradiation	15.73		16.20			
340	All GND'd Irradiation	15.97		16.40			
144	Biased-Irradiation	15.25		15.03			
145	Biased-Irradiation	14.81		14.81			
147	Biased-Irradiation	14.81		14.59			
148	Biased-Irradiation	14.39		14.39			
149	Biased-Irradiation	15.03		15.25			
380	All GND'd Irradiation	15.50			14.90		
382	All GND'd Irradiation	15.70			15.20		
384	All GND'd Irradiation	14.80			14.30		
385	All GND'd Irradiation	16.20			15.60		
386	All GND'd Irradiation	14.80			14.30		
157	Biased-Irradiation	15.03			15.03		
159	Biased-Irradiation	14.81			14.39		
161	Biased-Irradiation	14.81			14.39		
162	Biased-Irradiation	15.73			15.48		
163	Biased-Irradiation	15.03			14.59		
396	All GND'd Irradiation	16.00				15.20	
397	All GND'd Irradiation	15.00				13.90	
398	All GND'd Irradiation	15.50				14.50	
399	All GND'd Irradiation	15.70				14.70	
400	All GND'd Irradiation	15.70				14.70	
341	Biased-Irradiation	14.81				14.60	
343	Biased-Irradiation	15.25				15.00	
344	Biased-Irradiation	15.03				14.60	
347	Biased-Irradiation	15.72				15.70	
348	Biased-Irradiation	15.25				15.00	
419	All GND'd Irradiation	16.00					12.82
420	All GND'd Irradiation	15.30					13.51
421	All GND'd Irradiation	15.00					12.66
422	All GND'd Irradiation	15.70					12.50
423	All GND'd Irradiation	15.00					13.89
424	Biased-Irradiation	15.70					13.16
425	Biased-Irradiation	14.80					13.89
428	Biased-Irradiation	16.20					13.33
429	Biased-Irradiation	14.60					14.08
430	Biased-Irradiation	15.50					14.08
350	Control Unit	15.30	15.20	15.20	15.20	15.20	15.20
351	Control Unit	16.20	15.90	15.90	15.90	15.90	15.90
All GND'd Irradiation Statistics							
Average All GND'd		15.50	15.42	15.84	14.86	14.60	13.08
Std Dev All GND'd		0.35	0.51	0.49	0.57	0.47	0.60
Ps90%/90% (+KTL) All GND'd		16.47	16.81	17.19	16.42	15.89	14.71
Ps90%/90% (-KTL) All GND'd		14.53	14.03	14.49	13.30	13.31	11.44
Biased-Irradiation Statistics							
Average Biased		14.94	14.85	14.81	14.77	14.98	13.71
Std Dev Biased		0.20	0.18	0.34	0.48	0.45	0.44
Ps90%/90% (+KTL) Biased		15.48	15.35	15.75	16.08	16.21	14.90
Ps90%/90% (-KTL) Biased		14.39	14.35	13.87	13.47	13.75	12.52
Specification MIN		11.0	7.5	7.5	7.5	7.5	7.5
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

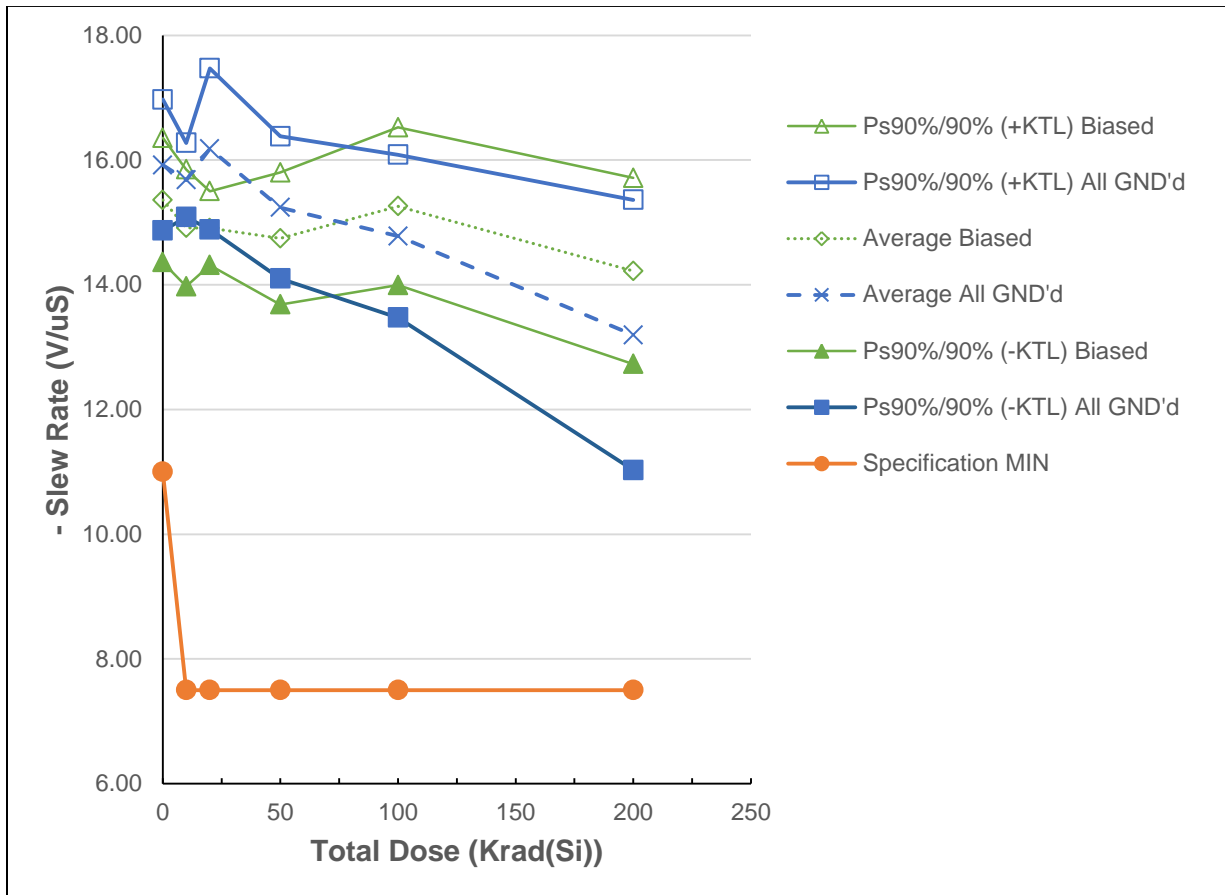


Figure 5.6: Plot of Negative Slew Rate versus Total Dose

The maximum limits at different accumulated doses of the parameter are at 100 ppm/mA and the measured values are in the 2.5-3.0 ppm/mA range.

Table 5.6: Raw data for Negative Slew Rate

Parameter Units	Negative Slew Rate (V/us)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	16.30	15.90				
353	All GND'd Irradiation	16.30	15.90				
355	All GND'd Irradiation	15.40	15.40				
356	All GND'd Irradiation	15.80	15.60				
357	All GND'd Irradiation	15.80	15.60				
138	Biased-Irradiation	14.91	14.49				
140	Biased-Irradiation	15.83	15.13				
141	Biased-Irradiation	15.58	15.35				
142	Biased-Irradiation	15.35	14.91				
143	Biased-Irradiation	15.13	14.69				
335	All GND'd Irradiation	14.91		15.60			
337	All GND'd Irradiation	15.35		16.00			
338	All GND'd Irradiation	15.58		16.00			
339	All GND'd Irradiation	16.07		16.50			
340	All GND'd Irradiation	16.07		16.80			
144	Biased-Irradiation	15.35		15.13			
145	Biased-Irradiation	15.58		14.91			
147	Biased-Irradiation	15.13		14.69			
148	Biased-Irradiation	15.13		14.69			
149	Biased-Irradiation	15.58		15.13			
380	All GND'd Irradiation	15.80			15.60		
382	All GND'd Irradiation	16.10			15.40		
384	All GND'd Irradiation	14.90			14.70		
385	All GND'd Irradiation	16.30			15.60		
386	All GND'd Irradiation	15.40			14.90		
157	Biased-Irradiation	15.58			14.91		
159	Biased-Irradiation	15.35			14.49		
161	Biased-Irradiation	15.35			14.49		
162	Biased-Irradiation	16.07			15.35		
163	Biased-Irradiation	15.35			14.49		
396	All GND'd Irradiation	16.30				15.20	
397	All GND'd Irradiation	15.10				14.10	
398	All GND'd Irradiation	15.80				14.50	
399	All GND'd Irradiation	15.80				14.90	
400	All GND'd Irradiation	16.10				15.20	
341	Biased-Irradiation	15.13				14.90	
343	Biased-Irradiation	15.58				15.60	
344	Biased-Irradiation	15.13				14.70	
347	Biased-Irradiation	15.82				15.80	
348	Biased-Irradiation	15.82				15.30	
419	All GND'd Irradiation	16.30					12.99
420	All GND'd Irradiation	15.60					13.70
421	All GND'd Irradiation	15.40					12.35
422	All GND'd Irradiation	15.80					12.66
423	All GND'd Irradiation	15.60					14.29
424	Biased-Irradiation	15.80					13.51
425	Biased-Irradiation	15.10					14.29
428	Biased-Irradiation	16.30					13.89
429	Biased-Irradiation	14.90					14.93
430	Biased-Irradiation	15.80					14.49
350	Control Unit	15.40	15.60	15.60	15.60	15.60	15.60
351	Control Unit	16.30	16.40	16.40	16.40	16.40	16.40
All GND'd Irradiation Statistics							
Average All GND'd		15.92	15.68	16.18	15.24	14.78	13.20
Std Dev All GND'd		0.38	0.22	0.47	0.42	0.48	0.79
Ps90%/90% (+KTL) All GND'd		16.97	16.27	17.47	16.38	16.09	15.36
Ps90%/90% (-KTL) All GND'd		14.87	15.09	14.89	14.10	13.47	11.03
Biased-Irradiation Statistics							
Average Biased		15.36	14.91	14.91	14.74	15.26	14.22
Std Dev Biased		0.36	0.34	0.22	0.39	0.46	0.54
Ps90%/90% (+KTL) Biased		16.35	15.85	15.50	15.80	16.53	15.71
Ps90%/90% (-KTL) Biased		14.36	13.97	14.32	13.68	13.99	12.73
Specification MIN		11.0	7.5	7.5	7.5	7.5	7.5
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

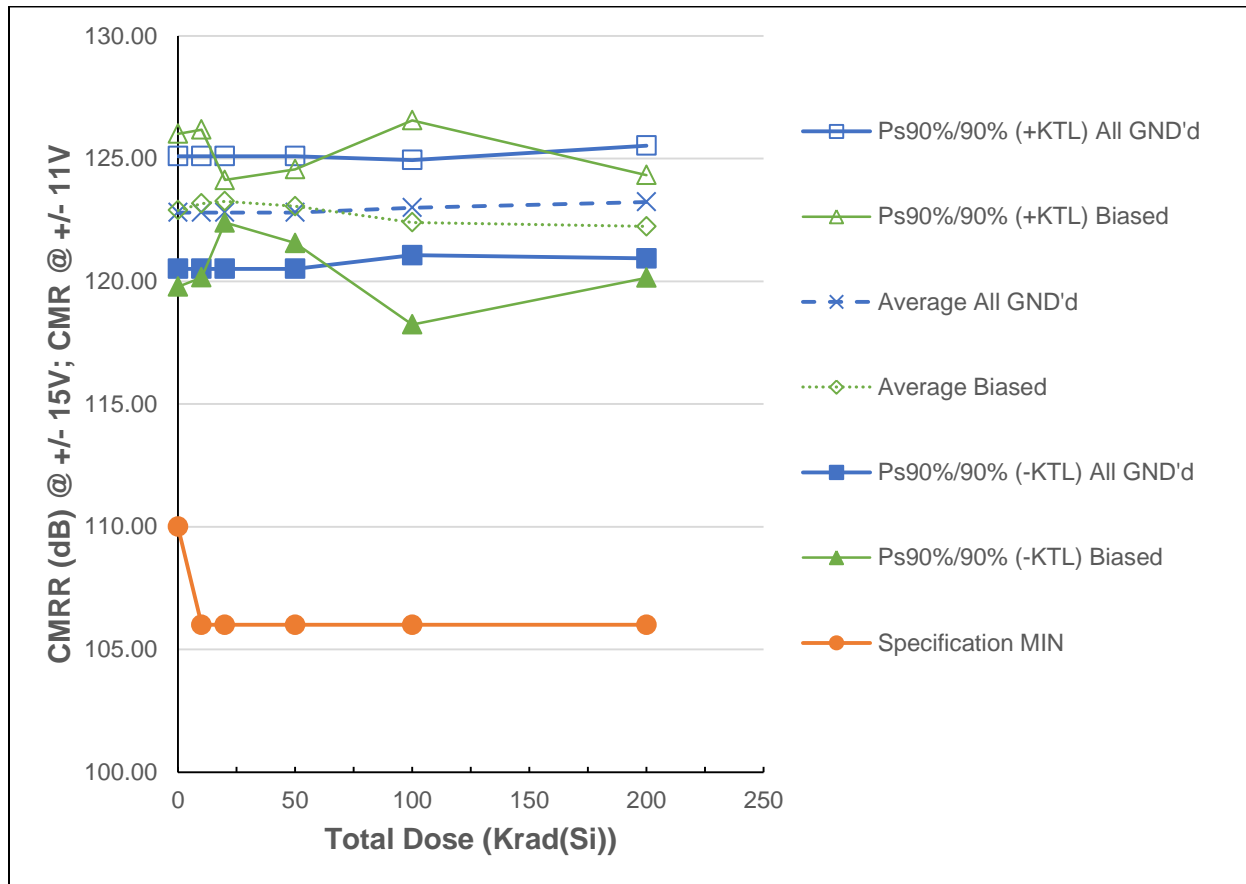


Figure 5.7: Plot of Common Mode Rejection Ratio versus Total Dose

Table 5.7: Raw data for CMRR

Parameter Units	CMRR @ +/- 15V, CMR @ +/- 11V (dB)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	122.00	122.00				
353	All GND'd Irradiation	123.00	123.00				
355	All GND'd Irradiation	123.00	123.00				
356	All GND'd Irradiation	124.00	124.00				
357	All GND'd Irradiation	122.00	122.00				
138	Biased-Irradiation	124.90	125.12				
140	Biased-Irradiation	122.67	122.84				
141	Biased-Irradiation	122.19	122.68				
142	Biased-Irradiation	122.35	122.51				
143	Biased-Irradiation	122.35	122.68				
335	All GND'd Irradiation	122.84		123.00			
337	All GND'd Irradiation	121.74		122.00			
338	All GND'd Irradiation	123.90		124.00			
339	All GND'd Irradiation	122.67		122.00			
340	All GND'd Irradiation	123.01		123.00			
144	Biased-Irradiation	122.84		122.84			
145	Biased-Irradiation	123.35		123.54			
147	Biased-Irradiation	122.67		123.01			
148	Biased-Irradiation	123.01		123.36			
149	Biased-Irradiation	123.01		123.54			
380	All GND'd Irradiation	123.00			123.00		
382	All GND'd Irradiation	124.00			124.00		
384	All GND'd Irradiation	123.00			123.00		
385	All GND'd Irradiation	123.00			122.00		
386	All GND'd Irradiation	122.00			122.00		
157	Biased-Irradiation	123.01			123.01		
159	Biased-Irradiation	121.89			122.20		
161	Biased-Irradiation	122.84			123.01		
162	Biased-Irradiation	123.35			123.54		
163	Biased-Irradiation	123.18			123.54		
396	All GND'd Irradiation	123.00				123.00	
397	All GND'd Irradiation	123.00				122.00	
398	All GND'd Irradiation	123.00				124.00	
399	All GND'd Irradiation	122.00				123.00	
400	All GND'd Irradiation	123.00				123.00	
341	Biased-Irradiation	121.60				121.00	
343	Biased-Irradiation	122.68				122.00	
344	Biased-Irradiation	124.70				125.00	
347	Biased-Irradiation	122.36				122.00	
348	Biased-Irradiation	122.36				122.00	
419	All GND'd Irradiation	123.00					122.20
420	All GND'd Irradiation	123.00					124.08
421	All GND'd Irradiation	124.00					124.10
422	All GND'd Irradiation	124.00					122.99
423	All GND'd Irradiation	122.00					122.78
424	Biased-Irradiation	122.00					121.58
425	Biased-Irradiation	123.00					122.11
428	Biased-Irradiation	122.00					122.04
429	Biased-Irradiation	123.00					121.89
430	Biased-Irradiation	125.00					123.55
350	Control Unit	122.00	122.00	122.00	122.00	122.00	122.00
351	Control Unit	123.00	123.00	123.00	123.00	123.00	123.00
All GND'd Irradiation Statistics							
Average All GND'd		122.80	122.80	122.80	122.80	123.00	123.23
Std Dev All GND'd		0.84	0.84	0.84	0.84	0.71	0.84
Ps90%/90% (+KTL) All GND'd		125.09	125.09	125.09	125.09	124.94	125.53
Ps90%/90% (-KTL) All GND'd		120.51	120.51	120.51	120.51	121.06	120.93
Biased-Irradiation Statistics							
Average Biased		122.89	123.17	123.26	123.06	122.40	122.24
Std Dev Biased		1.14	1.10	0.32	0.55	1.52	0.76
Ps90%/90% (+KTL) Biased		126.01	126.18	124.12	124.56	126.56	124.33
Ps90%/90% (-KTL) Biased		119.78	120.15	122.39	121.56	118.24	120.14
Specification MIN		110	106	106	106	106	106
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

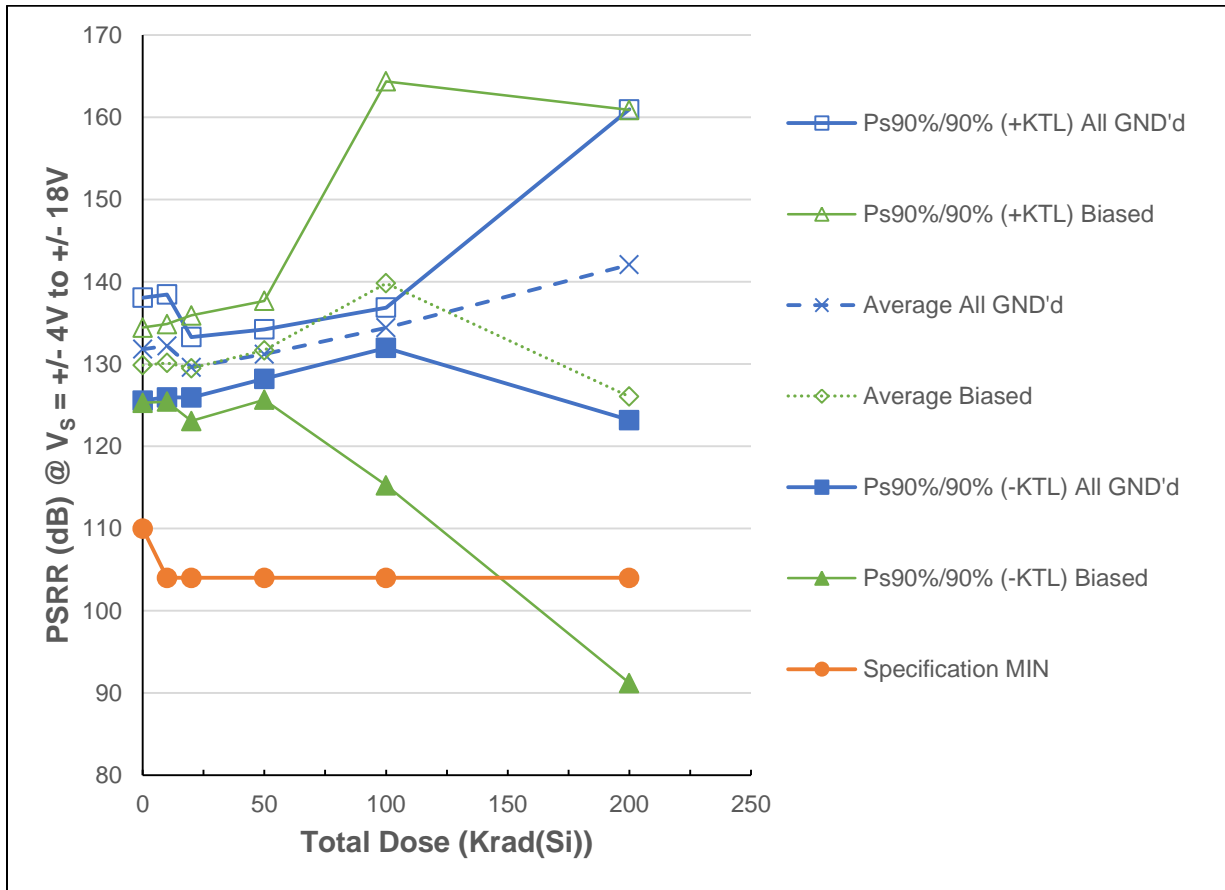


Figure 5.8: Plot of Power Supply Rejection Ratio (PSRR) versus Total Dose

Table 5.8: Raw data for PSRR

Parameter Units	PSRR @ $V_s = \pm 4V$ to $\pm 18V$ (dB)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	129.00	130.00				
353	All GND'd Irradiation	134.00	135.00				
355	All GND'd Irradiation	132.00	132.00				
356	All GND'd Irradiation	134.00	134.00				
357	All GND'd Irradiation	130.00	130.00				
138	Biased-Irradiation	132.60	132.56				
140	Biased-Irradiation	129.67	129.79				
141	Biased-Irradiation	128.56	128.44				
142	Biased-Irradiation	128.50	128.72				
143	Biased-Irradiation	129.89	131.13				
335	All GND'd Irradiation	128.82		129.00			
337	All GND'd Irradiation	128.47		129.00			
338	All GND'd Irradiation	129.50		129.00			
339	All GND'd Irradiation	128.72		129.00			
340	All GND'd Irradiation	131.04		132.00			
144	Biased-Irradiation	129.60		130.35			
145	Biased-Irradiation	127.77		128.60			
147	Biased-Irradiation	133.02		133.13			
148	Biased-Irradiation	127.16		128.22			
149	Biased-Irradiation	127.00		127.14			
380	All GND'd Irradiation	133.00			133.00		
382	All GND'd Irradiation	131.00			131.00		
384	All GND'd Irradiation	130.00			131.00		
385	All GND'd Irradiation	130.00			130.00		
386	All GND'd Irradiation	130.00			131.00		
157	Biased-Irradiation	130.91			132.71		
159	Biased-Irradiation	127.49			129.12		
161	Biased-Irradiation	129.67			131.04		
162	Biased-Irradiation	129.67			130.59		
163	Biased-Irradiation	132.02			134.84		
396	All GND'd Irradiation	132.00				135.00	
397	All GND'd Irradiation	131.00				134.00	
398	All GND'd Irradiation	132.00				135.00	
399	All GND'd Irradiation	133.00				135.00	
400	All GND'd Irradiation	131.00				133.00	
341	Biased-Irradiation	128.57				130.00	
343	Biased-Irradiation	129.09				136.00	
344	Biased-Irradiation	132.22				146.00	
347	Biased-Irradiation	130.51				135.00	
348	Biased-Irradiation	131.61				152.00	
419	All GND'd Irradiation	132.00					135.54
420	All GND'd Irradiation	135.00					139.12
421	All GND'd Irradiation	129.00					136.71
422	All GND'd Irradiation	131.00					149.75
423	All GND'd Irradiation	128.00					149.19
424	Biased-Irradiation	132.00					128.31
425	Biased-Irradiation	137.00					140.72
428	Biased-Irradiation	132.00					131.58
429	Biased-Irradiation	129.00					106.39
430	Biased-Irradiation	130.00					123.17
350	Control Unit	131.00	132.00	132.00	132.00	132.00	132.00
351	Control Unit	131.00	131.00	131.00	131.00	131.00	131.00
All GND'd Irradiation Statistics							
Average All GND'd		131.80	132.20	129.60	131.20	134.40	142.06
Std Dev All GND'd		2.28	2.28	1.34	1.10	0.89	6.89
Ps90%/90% (+KTL) All GND'd		138.05	138.45	133.28	134.20	136.85	160.95
Ps90%/90% (-KTL) All GND'd		125.55	125.95	125.92	128.20	131.95	123.17
Biased-Irradiation Statistics							
Average Biased		129.85	130.13	129.49	131.66	139.80	126.03
Std Dev Biased		1.67	1.72	2.34	2.19	8.96	12.70
Ps90%/90% (+KTL) Biased		134.42	134.85	135.91	137.67	164.36	160.87
Ps90%/90% (-KTL) Biased		125.28	125.41	123.07	125.65	115.24	91.20
Specification MIN		110	104	104	104	104	104
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	FAIL
Status (+KTL) Biased							

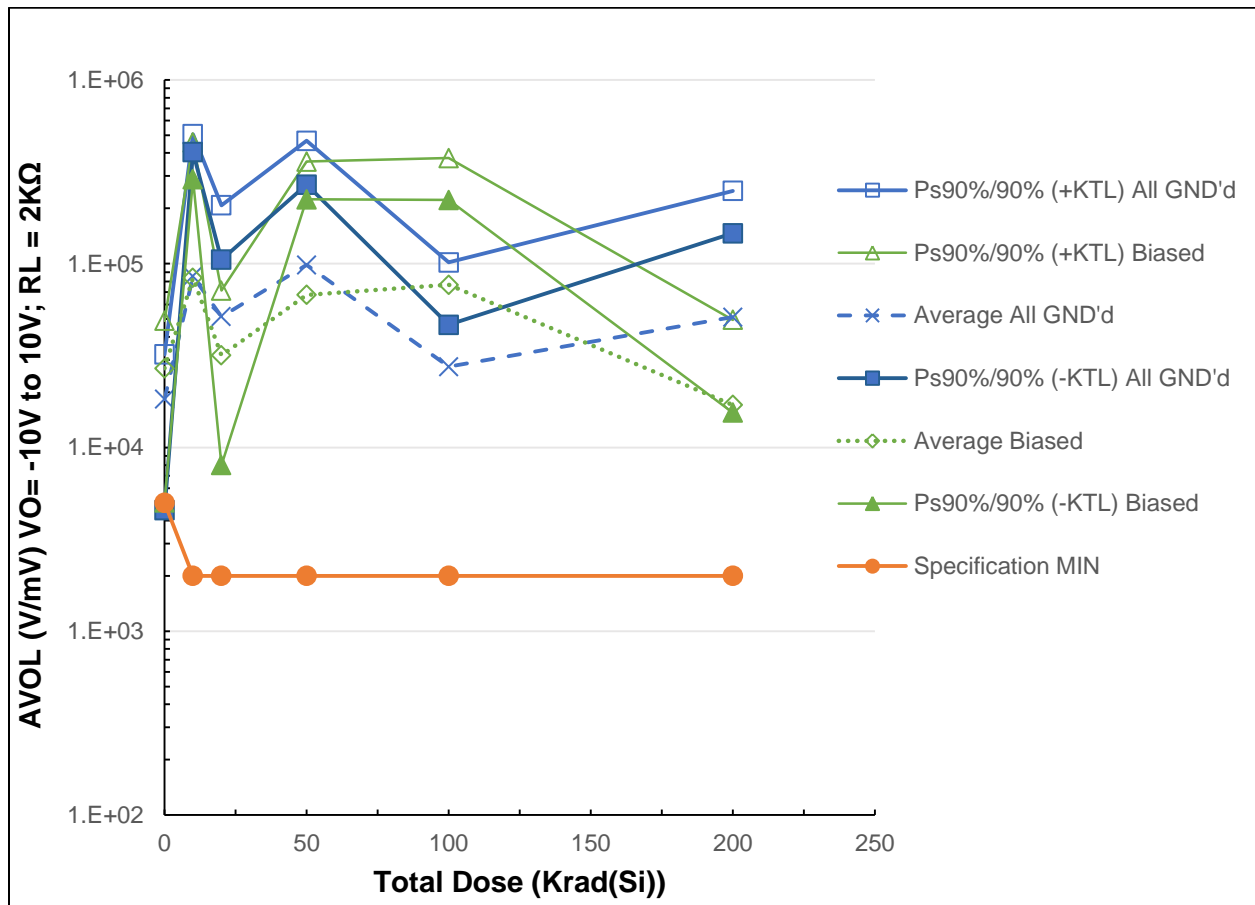


Figure 5.9: Plot of Large Signal Voltage Gain versus Total Dose

Table 5.9: Raw data for large signal voltage gain Avol

Parameter Units	Avol @ V _O = -10V to 10V; R _L = 2K Ω (V/mV)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	1.97E+04	2.05E+04				
353	All GND'd Irradiation	1.40E+04	1.17E+04				
355	All GND'd Irradiation	2.19E+04	2.32E+04				
356	All GND'd Irradiation	1.22E+04	1.14E+04				
357	All GND'd Irradiation	2.38E+04	3.60E+05				
138	Biased-Irradiation	1.57E+04	1.56E+04				
140	Biased-Irradiation	2.48E+04	2.06E+04				
141	Biased-Irradiation	3.23E+04	3.60E+04				
142	Biased-Irradiation	3.66E+04	4.08E+04				
143	Biased-Irradiation	2.54E+04	2.92E+04				
335	All GND'd Irradiation	3.13E+04		1.14E+05			
337	All GND'd Irradiation	3.00E+04		1.20E+04			
338	All GND'd Irradiation	2.04E+04		7.47E+03			
339	All GND'd Irradiation	2.43E+04		1.14E+05			
340	All GND'd Irradiation	1.74E+04		9.95E+03			
144	Biased-Irradiation	2.81E+04		2.43E+04			
145	Biased-Irradiation	3.66E+04		2.92E+04			
147	Biased-Irradiation	2.08E+04		1.54E+04			
148	Biased-Irradiation	3.93E+04		5.40E+04			
149	Biased-Irradiation	3.27E+04		3.54E+04			
380	All GND'd Irradiation	1.51E+04			1.30E+04		
382	All GND'd Irradiation	1.88E+04			2.42E+04		
384	All GND'd Irradiation	2.14E+04			1.86E+04		
385	All GND'd Irradiation	2.85E+04			1.66E+05		
386	All GND'd Irradiation	4.16E+04			2.70E+05		
157	Biased-Irradiation	3.09E+04			3.49E+04		
159	Biased-Irradiation	4.91E+04			2.40E+05		
161	Biased-Irradiation	3.09E+04			3.00E+04		
162	Biased-Irradiation	1.77E+04			1.63E+04		
163	Biased-Irradiation	1.62E+04			1.72E+04		
396	All GND'd Irradiation	1.43E+04				2.22E+04	
397	All GND'd Irradiation	1.93E+04				7.44E+04	
398	All GND'd Irradiation	1.83E+04				1.12E+04	
399	All GND'd Irradiation	1.85E+04				7.71E+03	
400	All GND'd Irradiation	1.52E+04				2.20E+04	
341	Biased-Irradiation	3.05E+04				2.45E+04	
343	Biased-Irradiation	2.30E+04				3.60E+04	
344	Biased-Irradiation	1.68E+04				7.47E+03	
347	Biased-Irradiation	2.51E+04				2.70E+05	
348	Biased-Irradiation	2.46E+04				4.59E+04	
419	All GND'd Irradiation	1.49E+04					2.70E+04
420	All GND'd Irradiation	1.77E+04					1.96E+04
421	All GND'd Irradiation	1.97E+04					1.66E+04
422	All GND'd Irradiation	1.55E+04					1.31E+04
423	All GND'd Irradiation	2.74E+04					1.80E+05
424	Biased-Irradiation	1.61E+04					7.41E+03
425	Biased-Irradiation	1.40E+04					2.96E+04
428	Biased-Irradiation	2.02E+04					2.96E+04
429	Biased-Irradiation	3.28E+04					5.10E+03
430	Biased-Irradiation	2.19E+04					1.35E+04
350	Control Unit	2.40E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04	1.61E+04
351	Control Unit	1.95E+04	2.60E+04	2.60E+04	2.60E+04	2.60E+04	2.60E+04
All GND'd Irradiation Statistics							
Average All GND'd		1.83E+04	8.54E+04	5.15E+04	9.84E+04	2.75E+04	5.12E+04
Std Dev All GND'd (VOS)		5.02E+03	1.54E+05	5.71E+04	1.15E+05	2.70E+04	7.21E+04
Ps90%/90% (+KTL) All GND'd		3.21E+04	5.07E+05	2.08E+05	4.66E+05	1.02E+05	2.49E+05
Ps90%/90% (-KTL) All GND'd		4.55E+03	4.04E+05	1.05E+05	2.69E+05	4.65E+04	1.46E+05
Biased-Irradiation Statistics							
Average Biased		2.70E+04	8.37E+04	3.17E+04	6.77E+04	7.68E+04	1.70E+04
Sdtatus (Measurements) All GND'		8.00E+03	1.36E+05	1.45E+04	1.06E+05	1.09E+05	1.18E+04
Ps90%/90% (+KTL) Biased		4.89E+04	4.56E+05	7.14E+04	3.59E+05	3.76E+05	4.95E+04
Ps90%/90% (-KTL) Biased		5.02E+03	2.88E+05	8.02E+03	2.24E+05	2.22E+05	1.55E+04
Specification MIN		5.00E+03	2.00E+03	2.00E+03	2.00E+03	2.00E+03	2.00E+03
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Specification MAX							
Status (Measurements) All GND'd							
Status (Measurements) Biased							
Status (-KTL) All GND'd		FAIL	PASS	PASS	PASS	PASS	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

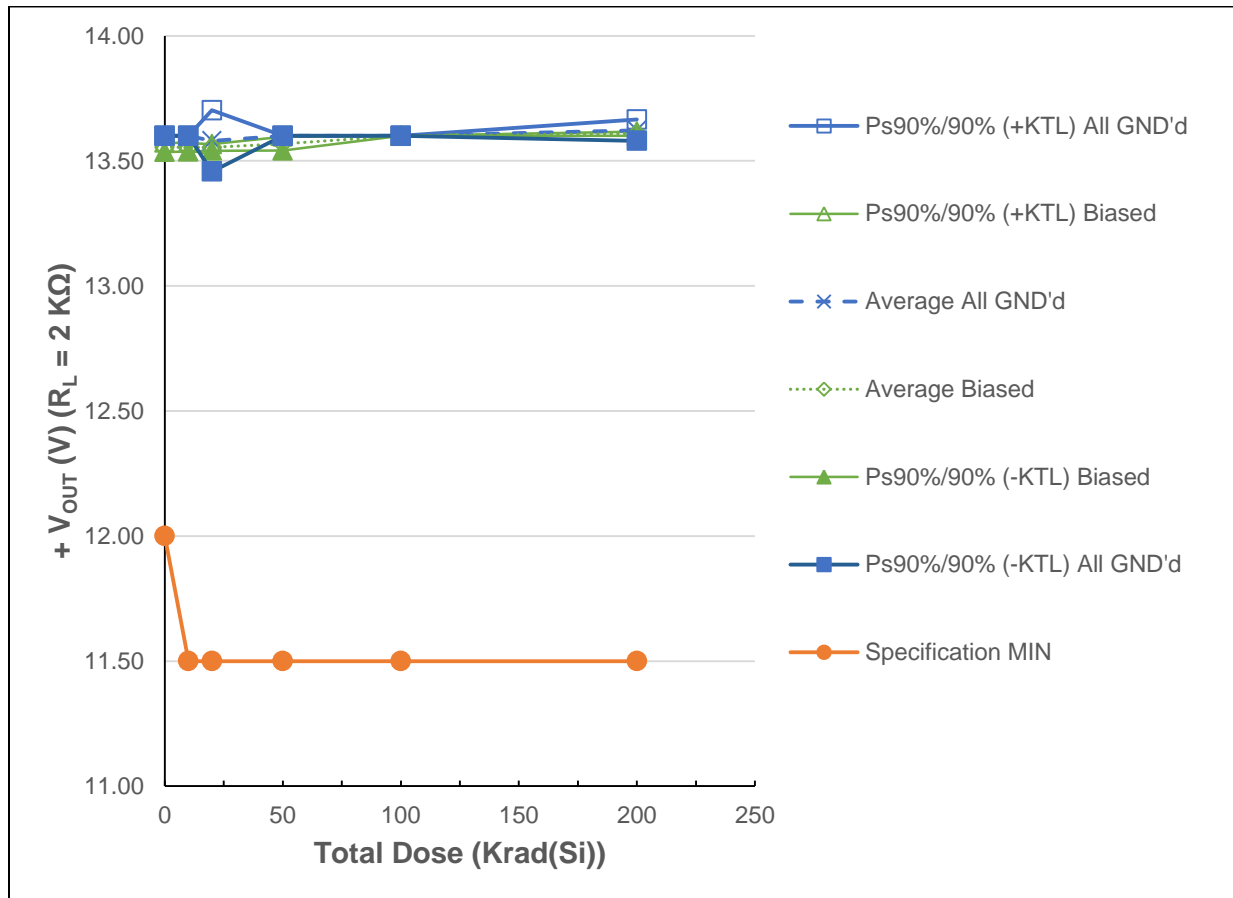


Figure 5.10: Plot of Positive Voltage Output Swing ($R_L = 2K\Omega$) versus Total Dose

Table 5.10: Raw data for positive voltage output swing at $R_L = 2K\Omega$.

Parameter Units	Vout (+) @ $R_L=2K\Omega$ (V)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	13.60	13.60				
353	All GND'd Irradiation	13.60	13.60				
355	All GND'd Irradiation	13.60	13.60				
356	All GND'd Irradiation	13.60	13.60				
357	All GND'd Irradiation	13.60	13.60				
138	Biased-Irradiation	13.55	13.55				
140	Biased-Irradiation	13.55	13.55				
141	Biased-Irradiation	13.56	13.56				
142	Biased-Irradiation	13.56	13.56				
143	Biased-Irradiation	13.54	13.54				
335	All GND'd Irradiation	13.56		13.60			
337	All GND'd Irradiation	13.54		13.50			
338	All GND'd Irradiation	13.55		13.60			
339	All GND'd Irradiation	13.56		13.60			
340	All GND'd Irradiation	13.56		13.60			
144	Biased-Irradiation	13.55		13.56			
145	Biased-Irradiation	13.55		13.56			
147	Biased-Irradiation	13.54		13.55			
148	Biased-Irradiation	13.55		13.55			
149	Biased-Irradiation	13.55		13.55			
380	All GND'd Irradiation	13.60			13.60		
382	All GND'd Irradiation	13.60			13.60		
384	All GND'd Irradiation	13.50			13.60		
385	All GND'd Irradiation	13.60			13.60		
386	All GND'd Irradiation	13.60			13.60		
157	Biased-Irradiation	13.56			13.58		
159	Biased-Irradiation	13.54			13.55		
161	Biased-Irradiation	13.55			13.56		
162	Biased-Irradiation	13.56			13.58		
163	Biased-Irradiation	13.56			13.57		
396	All GND'd Irradiation	13.60				13.60	
397	All GND'd Irradiation	13.50				13.60	
398	All GND'd Irradiation	13.60				13.60	
399	All GND'd Irradiation	13.60				13.60	
400	All GND'd Irradiation	13.60				13.60	
341	Biased-Irradiation	13.54				13.60	
343	Biased-Irradiation	13.56				13.60	
344	Biased-Irradiation	13.54				13.60	
347	Biased-Irradiation	13.56				13.60	
348	Biased-Irradiation	13.55				13.60	
419	All GND'd Irradiation	13.60					13.61
420	All GND'd Irradiation	13.60					13.64
421	All GND'd Irradiation	13.60					13.62
422	All GND'd Irradiation	13.60					13.61
423	All GND'd Irradiation	13.50					13.64
424	Biased-Irradiation	13.60					13.60
425	Biased-Irradiation	13.60					13.61
428	Biased-Irradiation	13.60					13.61
429	Biased-Irradiation	13.50					13.61
430	Biased-Irradiation	13.60					13.61
350	Control Unit	13.50	13.50	13.50	13.50	13.50	13.50
351	Control Unit	13.60	13.60	13.60	13.60	13.60	13.60
All GND'd Irradiation Statistics							
Average All GND'd		13.60	13.60	13.58	13.60	13.60	13.62
Std Dev All GND'd		0.00	0.00	0.04	0.00	0.00	0.02
Ps90%/90% (+KTL) All GND'd		13.60	13.60	13.70	13.60	13.60	13.67
Ps90%/90% (-KTL) All GND'd		13.60	13.60	13.46	13.60	13.60	13.58
Biased-Irradiation Statistics							
Average Biased		13.55	13.55	13.55	13.57	13.60	13.61
Std Dev Biased		0.01	0.01	0.00	0.01	0.00	0.00
Ps90%/90% (+KTL) Biased		13.57	13.57	13.57	13.60	13.60	13.62
Ps90%/90% (-KTL) Biased		13.54	13.54	13.54	13.54	13.60	13.60
Specification MIN		12.0	11.5	11.5	11.5	11.5	11.5
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

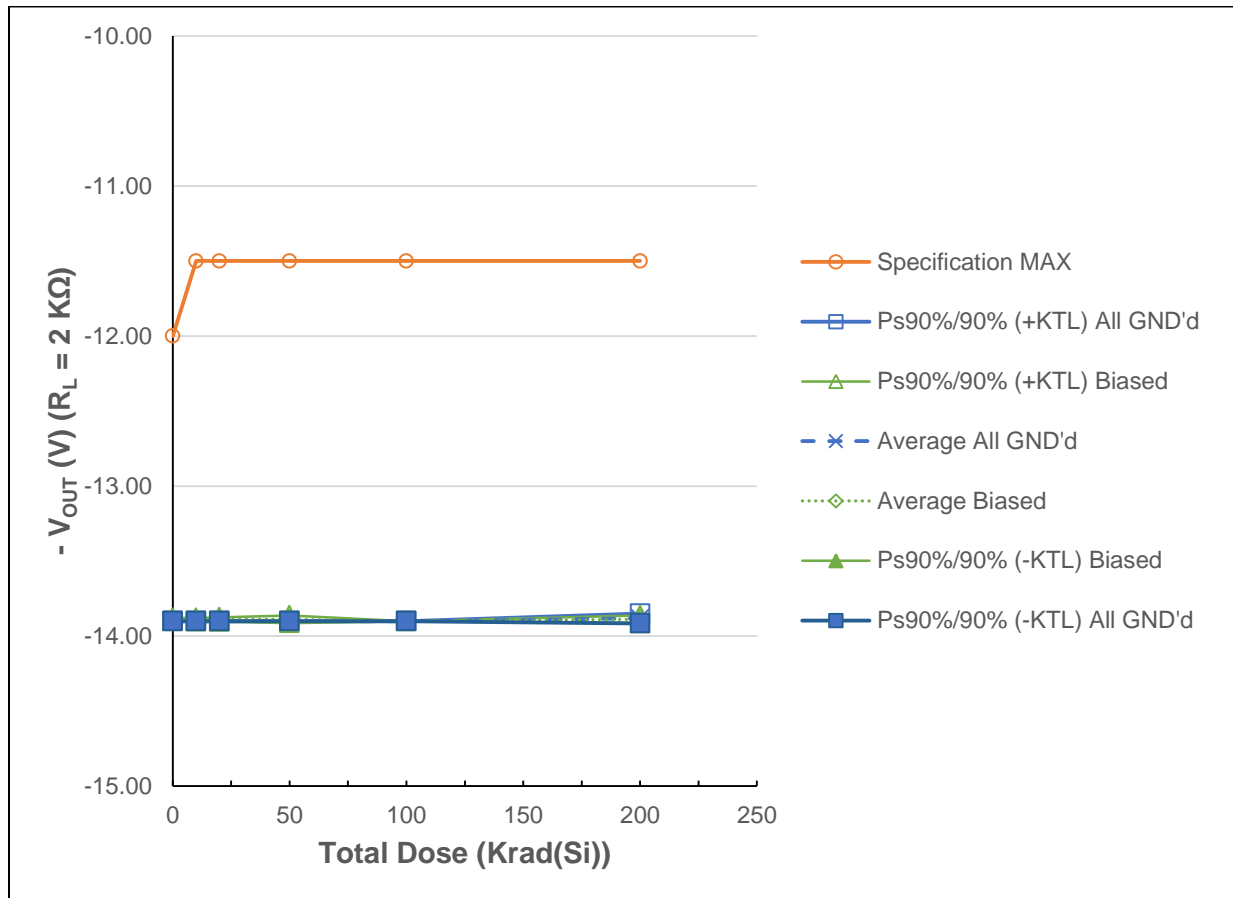


Figure 5.10: Plot of Negative Voltage Output Swing ($R_L = 2K\Omega$) versus Total

Table 5.11: Raw data for negative voltage output swing at $R_L = 2K\Omega$.

Parameter Units	Vout (-) @ $R_L = 2K\Omega$ (V)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	-13.90	-13.90				
353	All GND'd Irradiation	-13.90	-13.90				
355	All GND'd Irradiation	-13.90	-13.90				
356	All GND'd Irradiation	-13.90	-13.90				
357	All GND'd Irradiation	-13.90	-13.90				
138	Biased-Irradiation	-13.89	-13.89				
140	Biased-Irradiation	-13.89	-13.89				
141	Biased-Irradiation	-13.89	-13.89				
142	Biased-Irradiation	-13.90	-13.90				
143	Biased-Irradiation	-13.89	-13.89				
335	All GND'd Irradiation	-13.89		-13.90			
337	All GND'd Irradiation	-13.89		-13.90			
338	All GND'd Irradiation	-13.89		-13.90			
339	All GND'd Irradiation	-13.90		-13.90			
340	All GND'd Irradiation	-13.90		-13.90			
144	Biased-Irradiation	-13.90		-13.90			
145	Biased-Irradiation	-13.89		-13.89			
147	Biased-Irradiation	-13.89		-13.89			
148	Biased-Irradiation	-13.88		-13.88			
149	Biased-Irradiation	-13.89		-13.89			
380	All GND'd Irradiation	-13.90			-13.90		
382	All GND'd Irradiation	-13.90			-13.90		
384	All GND'd Irradiation	-13.90			-13.90		
385	All GND'd Irradiation	-13.90			-13.90		
386	All GND'd Irradiation	-13.90			-13.90		
157	Biased-Irradiation	-13.89			-13.89		
159	Biased-Irradiation	-13.88			-13.88		
161	Biased-Irradiation	-13.89			-13.89		
162	Biased-Irradiation	-13.90			-13.90		
163	Biased-Irradiation	-13.89			-13.89		
396	All GND'd Irradiation	-13.90				-13.90	
397	All GND'd Irradiation	-13.90				-13.90	
398	All GND'd Irradiation	-13.90				-13.90	
399	All GND'd Irradiation	-13.90				-13.90	
400	All GND'd Irradiation	-13.90				-13.90	
341	Biased-Irradiation	-13.88				-13.90	
343	Biased-Irradiation	-13.90				-13.90	
344	Biased-Irradiation	-13.88				-13.90	
347	Biased-Irradiation	-13.90				-13.90	
348	Biased-Irradiation	-13.88				-13.90	
419	All GND'd Irradiation	-13.90					-13.87
420	All GND'd Irradiation	-13.90					-13.89
421	All GND'd Irradiation	-13.90					-13.87
422	All GND'd Irradiation	-13.90					-13.88
423	All GND'd Irradiation	-13.90					-13.90
424	Biased-Irradiation	-13.90					-13.88
425	Biased-Irradiation	-13.90					-13.90
428	Biased-Irradiation	-13.90					-13.88
429	Biased-Irradiation	-13.90					-13.89
430	Biased-Irradiation	-13.90					-13.89
350	Control Unit	-13.90	-13.90	-13.90	-13.90	-13.90	-13.90
351	Control Unit	-13.90	-13.90	-13.90	-13.90	-13.90	-13.90
All GND'd Irradiation Statistics							
Average All GND'd		-13.90	-13.90	-13.90	-13.90	-13.90	-13.88
Std Dev All GND'd		0.00	0.00	0.00	0.00	0.00	0.01
Ps90%/90% (+KTL) All GND'd		-13.90	-13.90	-13.90	-13.90	-13.90	-13.85
Ps90%/90% (-KTL) All GND'd		-13.90	-13.90	-13.90	-13.90	-13.90	-13.92
Biased-Irradiation Statistics							
Average Biased		-13.89	-13.89	-13.89	-13.89	-13.90	-13.89
Std Dev Biased		0.00	0.00	0.01	0.01	0.00	0.01
Ps90%/90% (+KTL) Biased		-13.88	-13.88	-13.87	-13.86	-13.90	-13.86
Ps90%/90% (-KTL) Biased		-13.90	-13.90	-13.90	-13.91	-13.90	-13.91
Specification MIN							
Status (Measurements) All GND'd							
Status (Measurements) Biased							
Specification MAX		-12.0	-11.5	-11.5	-11.5	-11.5	-11.5
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd							
Status (+KTL) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased							
Status (+KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS

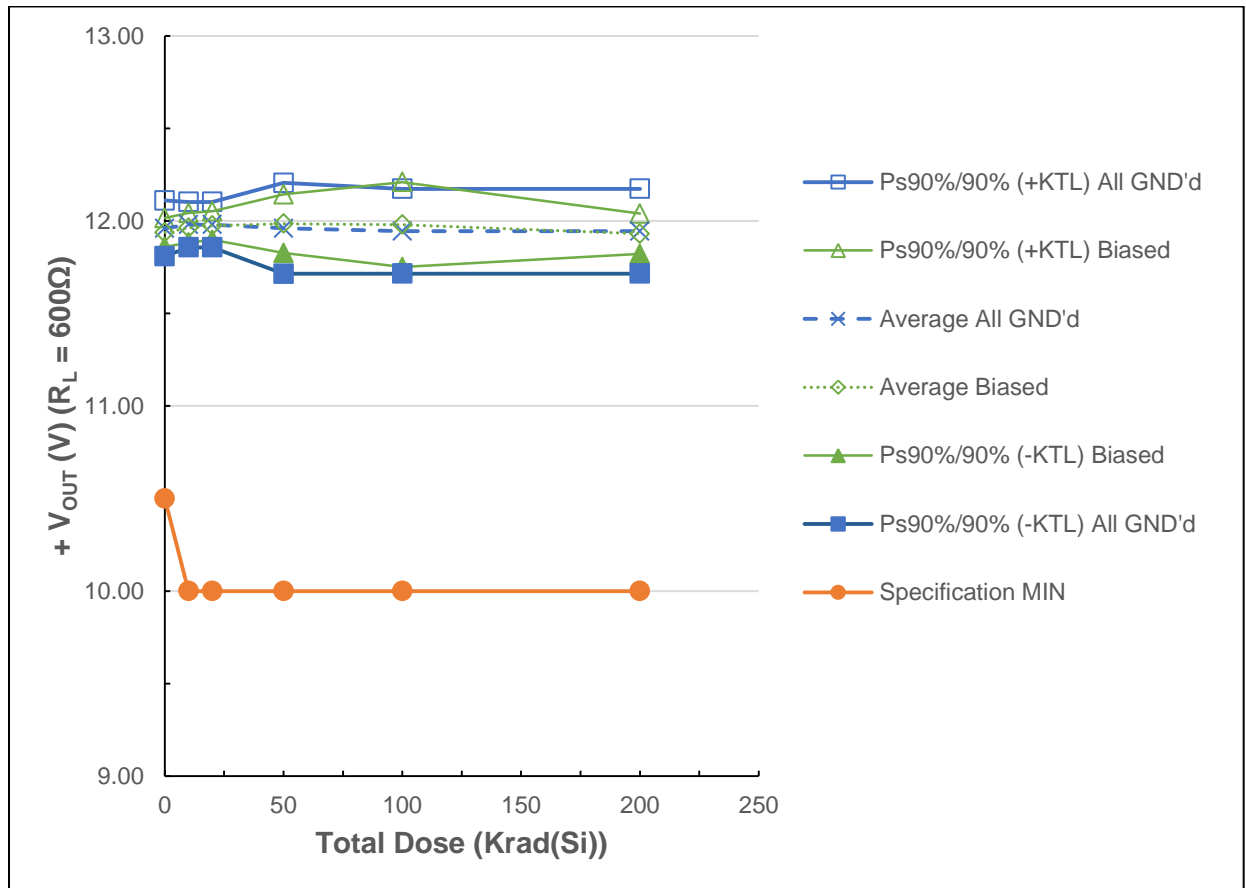


Figure 5.12: Plot of Positive Voltage Output Swing ($R_L = 600\Omega$) versus Total Dose

Table 5.12: Raw data for positive voltage output swing at $R_L = 600\Omega$.

Parameter Units	Vout (+) @ $R_L = 600\Omega$ (V)	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
		0	10	20	50	100	200
352	All GND'd Irradiation	11.90	12.00				
353	All GND'd Irradiation	12.00	12.00				
355	All GND'd Irradiation	11.90	11.90				
356	All GND'd Irradiation	12.00	12.00				
357	All GND'd Irradiation	12.00	12.00				
138	Biased-Irradiation	11.92	11.94				
140	Biased-Irradiation	11.95	11.98				
141	Biased-Irradiation	11.95	11.97				
142	Biased-Irradiation	11.97	12.00				
143	Biased-Irradiation	11.90	11.92				
335	All GND'd Irradiation	11.95		12.00			
337	All GND'd Irradiation	11.88		11.90			
338	All GND'd Irradiation	11.96		12.00			
339	All GND'd Irradiation	11.94		12.00			
340	All GND'd Irradiation	11.97		12.00			
144	Biased-Irradiation	11.99		12.01			
145	Biased-Irradiation	11.96		11.98			
147	Biased-Irradiation	11.93		11.94			
148	Biased-Irradiation	11.92		11.95			
149	Biased-Irradiation	11.96		11.99			
380	All GND'd Irradiation	11.90			11.90		
382	All GND'd Irradiation	12.00			12.00		
384	All GND'd Irradiation	11.90			11.90		
385	All GND'd Irradiation	12.10			12.10		
386	All GND'd Irradiation	11.90			11.90		
157	Biased-Irradiation	12.00			12.02		
159	Biased-Irradiation	11.88			11.92		
161	Biased-Irradiation	11.90			11.93		
162	Biased-Irradiation	12.01			12.04		
163	Biased-Irradiation	11.99			12.01		
396	All GND'd Irradiation	12.00				11.86	
397	All GND'd Irradiation	11.90				12.00	
398	All GND'd Irradiation	12.00				11.90	
399	All GND'd Irradiation	12.00				11.90	
400	All GND'd Irradiation	12.00				12.06	
341	Biased-Irradiation	11.89				11.90	
343	Biased-Irradiation	11.94				11.90	
344	Biased-Irradiation	11.95				12.00	
347	Biased-Irradiation	12.07				12.10	
348	Biased-Irradiation	11.96				12.00	
419	All GND'd Irradiation	12.00					11.86
420	All GND'd Irradiation	12.00					12.00
421	All GND'd Irradiation	12.00					11.90
422	All GND'd Irradiation	12.00					11.90
423	All GND'd Irradiation	12.00					12.06
424	Biased-Irradiation	12.00					11.89
425	Biased-Irradiation	11.90					11.97
428	Biased-Irradiation	12.00					11.91
429	Biased-Irradiation	11.90					11.92
430	Biased-Irradiation	12.00					11.98
350	Control Unit	11.90	11.90	11.90	11.90	11.90	11.90
351	Control Unit	12.00	12.00	12.00	12.00	12.00	12.00
All GND'd Irradiation Statistics							
Average All GND'd		11.96	11.98	11.98	11.96	11.94	11.94
Std Dev All GND'd		0.05	0.04	0.04	0.09	0.08	0.08
Ps90%/90% (+KTL) All GND'd		12.11	12.10	12.10	12.21	12.17	12.17
Ps90%/90% (-KTL) All GND'd		11.81	11.86	11.86	11.71	11.71	11.71
Biased-Irradiation Statistics							
Average Biased		11.94	11.96	11.97	11.98	11.98	11.93
Std Dev Biased		0.03	0.03	0.03	0.06	0.08	0.04
Ps90%/90% (+KTL) Biased		12.02	12.04	12.05	12.14	12.21	12.04
Ps90%/90% (-KTL) Biased		11.86	11.88	11.90	11.83	11.75	11.82
Specification MIN		10.5	10.0	10.0	10.0	10.0	10.0
Status (Measurements) All GND'd		PASS	PASS	PASS	PASS	PASS	PASS
Status (Measurements) Biased		PASS	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	PASS
Status (+KTL) All GND'd							
Status (-KTL) Biased		PASS	PASS	PASS	PASS	PASS	PASS
Status (+KTL) Biased							

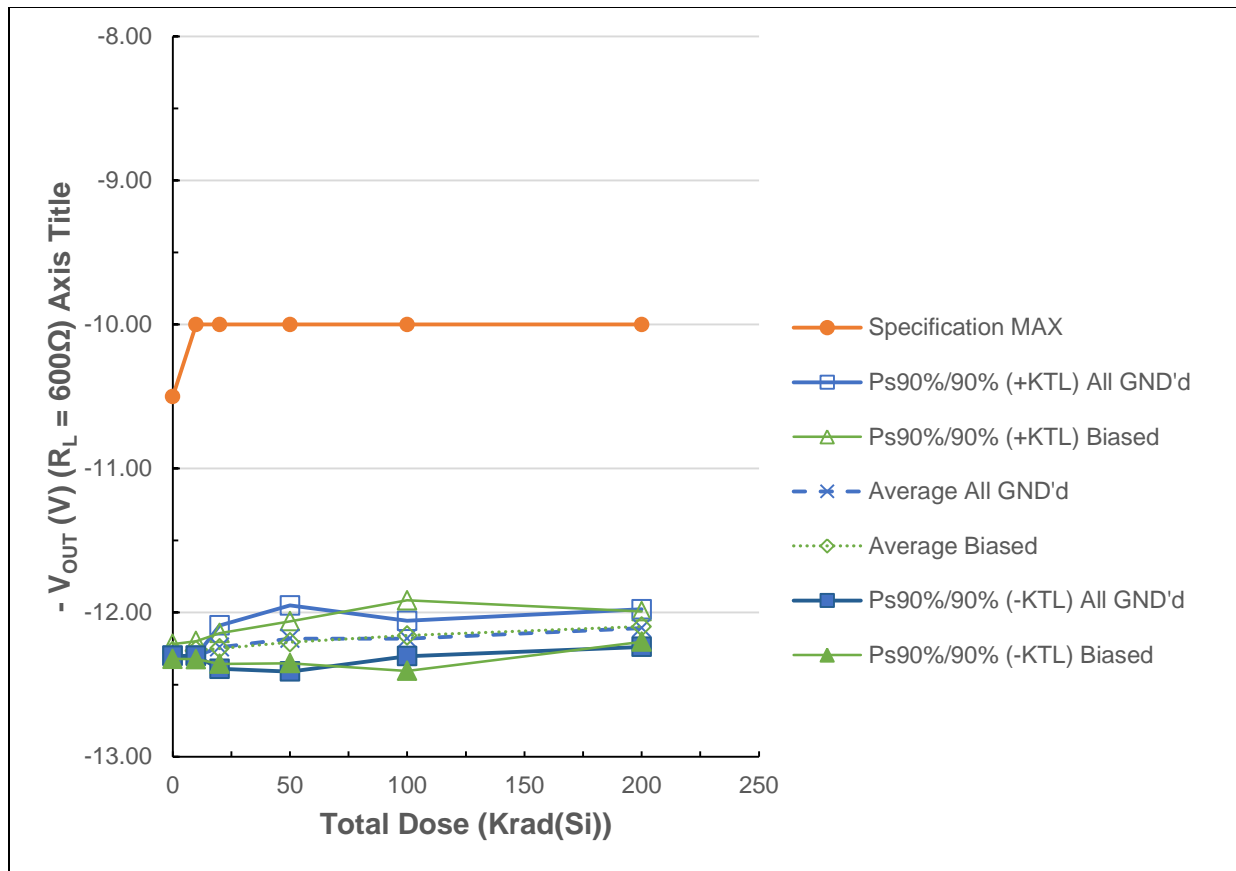


Figure 5.13: Plot of Negative Voltage Output Swing ($R_L = 600\Omega$) versus Total Dose

Table 5.13: Raw data for negative voltage output swing at $R_L = 600\Omega$.

Parameter	Vout (-) @ $R_L = 600\Omega$	Total Dose (Krad(Si)) @ 50 rads(Si)/s					
Units	(V)	0	10	20	50	100	200
352	All GND'd Irradiation	-12.300	-12.300				
353	All GND'd Irradiation	-12.300	-12.300				
355	All GND'd Irradiation	-12.300	-12.300				
356	All GND'd Irradiation	-12.300	-12.300				
357	All GND'd Irradiation	-12.300	-12.300				
138	Biased-Irradiation	-12.250	-12.235				
140	Biased-Irradiation	-12.269	-12.257				
141	Biased-Irradiation	-12.280	-12.274				
142	Biased-Irradiation	-12.296	-12.294				
143	Biased-Irradiation	-12.254	-12.248				
335	All GND'd Irradiation	-12.276		-12.200			
337	All GND'd Irradiation	-12.245		-12.200			
338	All GND'd Irradiation	-12.283		-12.200			
339	All GND'd Irradiation	-12.331		-12.300			
340	All GND'd Irradiation	-12.345		-12.300			
144	Biased-Irradiation	-12.322		-12.304			
145	Biased-Irradiation	-12.296		-12.254			
147	Biased-Irradiation	-12.259		-12.224			
148	Biased-Irradiation	-12.248		-12.203			
149	Biased-Irradiation	-12.291		-12.265			
380	All GND'd Irradiation	-12.300			-12.200		
382	All GND'd Irradiation	-12.300			-12.200		
384	All GND'd Irradiation	-12.200			-12.100		
385	All GND'd Irradiation	-12.400			-12.300		
386	All GND'd Irradiation	-12.200			-12.100		
157	Biased-Irradiation	-12.298			-12.210		
159	Biased-Irradiation	-12.232			-12.146		
161	Biased-Irradiation	-12.263			-12.183		
162	Biased-Irradiation	-12.341			-12.290		
163	Biased-Irradiation	-12.289			-12.203		
396	All GND'd Irradiation	-12.300				-12.200	
397	All GND'd Irradiation	-12.300				-12.100	
398	All GND'd Irradiation	-12.300				-12.200	
399	All GND'd Irradiation	-12.300				-12.200	
400	All GND'd Irradiation	-12.300				-12.200	
341	Biased-Irradiation	-12.25				-12.10	
343	Biased-Irradiation	-12.32				-12.20	
344	Biased-Irradiation	-12.29				-12.10	
347	Biased-Irradiation	-12.38				-12.30	
348	Biased-Irradiation	-12.29				-12.10	
419	All GND'd Irradiation	-12.300					-12.065
420	All GND'd Irradiation	-12.300					-12.133
421	All GND'd Irradiation	-12.300					-12.085
422	All GND'd Irradiation	-12.300					-12.076
423	All GND'd Irradiation	-12.300					-12.179
424	Biased-Irradiation	-12.300					-12.058
425	Biased-Irradiation	-12.300					-12.140
428	Biased-Irradiation	-12.400					-12.056
429	Biased-Irradiation	-12.200					-12.110
430	Biased-Irradiation	-12.300					-12.124
350	Control Unit	-12.200	-12.300	-12.300	-12.300	-12.300	-12.300
351	Control Unit	-12.300	-12.400	-12.400	-12.400	-12.400	-12.400
All GND'd Irradiation Statistics							
	Average All GND'd	-12.300	-12.300	-12.240	-12.180	-12.180	-12.108
	Std Dev All GND'd	0.000	0.000	0.055	0.084	0.045	0.048
	Ps90%/90% (+KTL) All GND'd	-12.300	-12.300	-12.090	-11.951	-12.057	-11.977
	Ps90%/90% (-KTL) All GND'd	-12.300	-12.300	-12.390	-12.409	-12.303	-12.238
Biased-Irradiation Statistics							
	Average Biased	-12.270	-12.261	-12.250	-12.206	-12.160	-12.098
	Std Dev Biased	0.019	0.023	0.039	0.053	0.089	0.038
	Ps90%/90% (+KTL) Biased	-12.218	-12.198	-12.143	-12.061	-11.915	-11.992
	Ps90%/90% (-KTL) Biased	-12.321	-12.324	-12.356	-12.352	-12.405	-12.203
Specification MIN							
	Status (Measurements) All GND'd						
	Status (Measurements) Biased						
Specification MAX							
	Status (Measurements) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
	Status (Measurements) Biased	PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) All GND'd							
	Status (+KTL) All GND'd	PASS	PASS	PASS	PASS	PASS	PASS
Status (-KTL) Biased							
	Status (+KTL) Biased	PASS	PASS	PASS	PASS	PASS	PASS

Appendix A

Picture of one among ten samples used in the test. The date code and related identification numbers should be correlated with the provided information in the second page of this report.

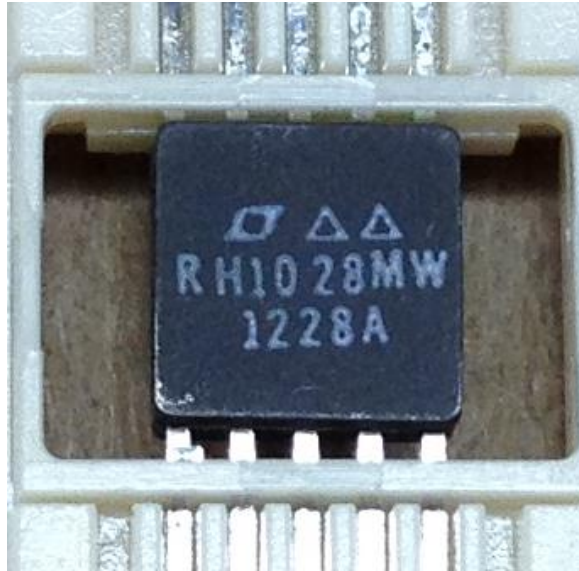


Figure A1: Top View showing date code



Figure A2: Bottom View showing serial number

Appendix B

Radiation Bias Connection Tables

Table B1: Biased Conditions

Pin	Function	Connection / Bias
1	NC	NC
2	V _{OS} TRIM	NC
3	- IN	To 10 K Ω resistor to pin 7
4	+ IN	To 10 K Ω resistor to +8V
5	V ⁻	To - 15V to bypass capacitor
6	Overcomp	NC
7	V _{OUT}	To 10 K Ω resistor to pin 3
8	V ⁺	To + 15V to bypass capacitor
9	V _{OS} TRIM	NC
10	NC	NC

Table B2: All GND'd

Pin	Function	Connection / Bias
1	NC	GND
2	V _{OS} TRIM	GND
3	- IN	GND
4	+ IN	GND
5	V ⁻	GND
6	Overcomp	GND
7	V _{OUT}	GND
8	V ⁺	GND
9	V _{OS} TRIM	GND
10	NC	GND

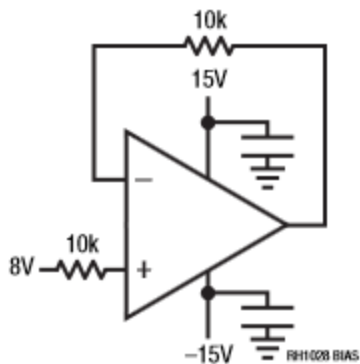


Figure B1: Total Dose Bias Circuit

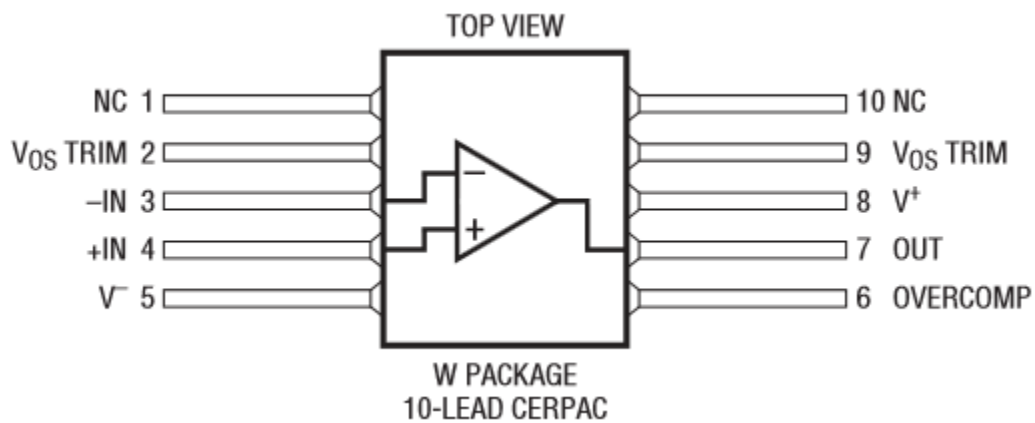


Figure B2: Pin-Out

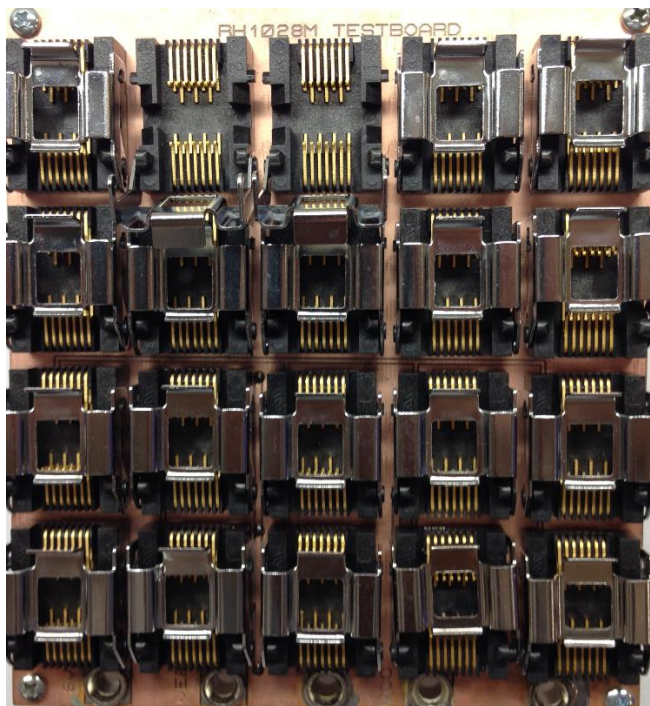


Figure B3: Bias Board (top view)

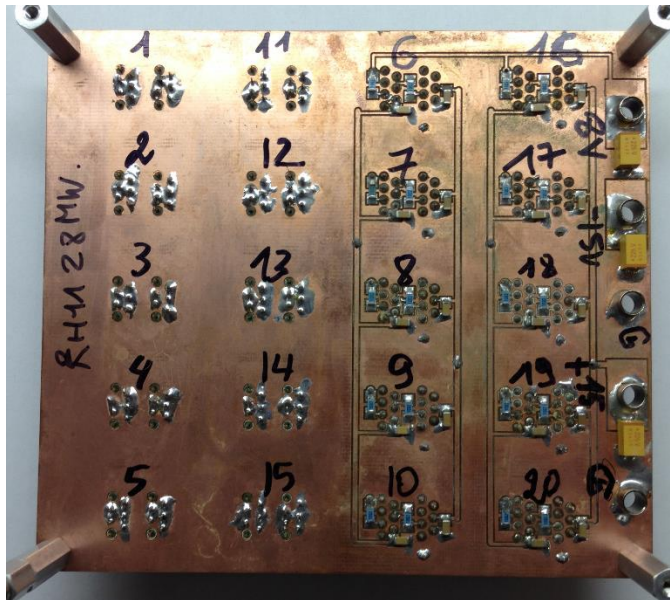


Figure B4: Bias Board (bottom view)

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: 2013-12-05

Test Certificate #: 2014-NRC-005

Total Pages (except cover): 3

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 3
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: sreznui@linear.com		
3. PRIME CONTRACTOR AND ADDRESS (include ZIP Code) Same as block 2				4. MANUFACTURING PLANT NAME AND ADDRESS (include ZIP Code) Linear Technology Corp. 1630 McCarthy Blvd. Milpitas, CA 95035		
CONTRACT NUMBER CRADA CR-08-17				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 2013-12-03
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 2013-12-03 by Tom Shepherd		
16. REMARKS AND/OR SPECIAL INSTRUCTIONS AND/OR WAIVERS. Dose Rate: 3000 ±10% rad(SiO ₂)/min Irradiation Steps: 13 Type of Test: Customer-Performed Total Dose: see below ±10% krad(SiO ₂) Requested Test Start Date: 2013-12-04 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: WQRH1409MW, fab lot #W1040927.1, ass'y lot #715549.2, WFR #19: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1409MW, fab lot #W1403645.3, ass'y lot #734726.2, WFR #6: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1409MW, fab lot #W1403645.3, ass'y lot #734727.2, WFR #7: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1409MW, fab lot #W1403645.3, ass'y lot #734729.2, WFR #13: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1014MW, fab lot #W1213460.1, ass'y lot #739171.2, WFR #11: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1014MW, fab lot #W1213460.1, ass'y lot #739172.2, WFR #12: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1014MW, fab lot #W1213460.1, ass'y lot #739173.2, WFR #13: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased WQRH1014MW, fab lot #W1213460.1, ass'y lot #739174.2, WFR #14: 50 and 200 krad(SiO ₂), 5 devices per dose level, biased RH1028MW, fab lot #W1117814.1, ass'y lot #675617.1, WFR #5: 10, 30, 50, 100, 150, and 200 krad(SiO ₂), 10 devices per dose level, biased BIPC150 Devices, fab lot #BPC201494.1, ass'y lot #G/A, WFR #2: 50, 100, and 200 krad(SiO ₂), TBD devices per dose level, biased (GND)						
Experiment #: 2014-NRC-005		DMEA Approval:  AS J.125523594		 ARSHAD MOHAM MAD.1231956693		 MELINE CARY, W.1231854033
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 2013-12-04		2. DATE RESULTS REPORTED 2013-12-05		3. LAB REPORT NUMBER N/A		
4. TEST PERFORMED		RESULTS OF TEST		SAMPLE RESULT		REQUIREMENTS
		Please see next page.				
DATE 2013-12-05 2013-12-06		TYPED NAME AND TITLE OF PERSON CONDUCTING TEST Thomas J. Shepherd, SEGIT Technical Manager Mohammad Arshad, Alt. SEGIT Facility Supervisor		SIGNATURE SHEPHERD, THOMAS J. 125523594 6 ARSHAD, MOHAMMAD. 1231956693  		

DD FORM 1222, FEB 62 (EF)

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

Continuation of DD Form 1222

4.	Test Performed	Results of Test	Experiment #:	Sample Result	Page 2 of 3	Requirements	Step No.
	20131204 09:38:00 to 20131204 09:54:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min	2014-NRC-005	WQRH1498MW, WFR #19, S/Ns 1-5: 50 krad TD			1
	20131204 09:38:00 to 20131204 09:54:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #13, S/Ns 1-5: 50 krad TD			1
	20131204 09:38:00 to 20131204 09:54:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #10, S/Ns 1-5: 50 krad TD			1
	20131204 09:38:00 to 20131204 09:54:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #7, S/Ns 37-41: 50 krad TD			1
	20131204 10:04:30 to 20131204 11:09:21	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #19, S/Ns 6-10: 200 krad TD			2
	20131204 10:04:30 to 20131204 11:09:21	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #13, S/Ns 6-10: 200 krad TD			2
	20131204 10:04:30 to 20131204 11:09:21	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #10, S/Ns 6-10: 200 krad TD			2
	20131204 10:04:30 to 20131204 11:09:21	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #7, S/Ns 42-46: 200 krad TD			2
	20131204 11:21:30 to 20131204 11:36:49	5.000E+04 rad(SiO ₂) at 3.266E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #6, S/Ns 29-38: 50 krad SD, 50 krad TD			3
	20131204 11:42:00 to 20131204 12:27:56	1.500E+05 rad(SiO ₂) at 3.266E+03 rad(SiO ₂)/min		WQRH1498MW, WFR #6, S/Ns 34-38: 150 krad SD, 200 krad TD			4
	20131204 12:55:00 to 20131204 13:11:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #11, S/Ns 3-7: 50 krad TD			5
	20131204 12:55:00 to 20131204 13:11:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #12, S/Ns 15-19: 50 krad TD			5
	20131204 12:55:00 to 20131204 13:11:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #13, S/Ns 27-31: 50 krad TD			5
	20131204 12:55:00 to 20131204 13:11:13	5.000E+04 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #14, S/Ns 38-42: 50 krad TD			5
	20131204 13:21:35 to 20131204 14:26:26	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #11, S/Ns 8-12: 200 krad TD			6
	20131204 13:21:35 to 20131204 14:26:26	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #12, S/Ns 20-24: 200 krad TD			6
	20131204 13:21:35 to 20131204 14:26:26	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #13, S/Ns 32-36: 200 krad TD			6
	20131204 13:21:35 to 20131204 14:26:26	2.000E+05 rad(SiO ₂) at 3.084E+03 rad(SiO ₂)/min		WQRH1014MW, WFR #14, S/Ns 43-47: 200 krad TD			6

Uncertainty: Total Doses reported are \pm 14.80% (Step Nos. 1-2, 5-6)
 \pm 8.76% (Step Nos. 3-4)

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: \pm 8.56% (Step Nos. 1-2, 5-6)
 \pm 2.52% (Step Nos. 3-4)
- 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 15 instead of 13 per customer request.
 - 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 90-1286.
 - Radcal Model No. 90X5-0.18 Electrometer/Ion Chamber, S/Ns 95-0476/9770.
 - This dosimeter system was calibrated per ISO/IEC 17025:2005 by University of Wisconsin Medical Radiation Research Center on 11 Oct 2012 (Report No. ION13910). 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.



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

NOTES:

1. ASTM = American Society for Testing and Materials.
2. DUT = Device Under Test.
3. S/N = Serial Number.
4. SD = Step Dose.
5. TD = Total Dose.
6. Dose rate uniformity across target area:
 = 4.22% (Step Nos. 7-12)
 = 8.95% (Step Nos. 13-15)
7. All irradiation steps met the requirements of MIL-STD-883H, Test Method 1019.8, Condition A.
8. After the original Test Request (DD Form 1222) was approved, the following changes were made:
 a. BIPC device quantity per dose level was 4 each (was TBD).
 b. Total number of irradiation steps was 15 instead of 13 per customer request.
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.
9. Source information:
 a. Irradiator = J.L. Shepherd & Associates Model 81-22/484 self-contained irradiation facility, S/Ns 7125/50016.
 b. Source selection = two large Co-60 sources.
10. Dosimeter system:
 a. Radcal Model No. 9010 Radiation Monitor Controller, S/N 90-1286.
 b. Radcal Model No. 90X5-0.18 Electrometer/Ion Chamber, S/Ns 95-0476/9770.
 c. This dosimeter system was calibrated per ISO/IEC 17025:2005 by University of Wisconsin Medical Radiation Research Center on 11 Oct 2012 (Report No. ION13910). This calibration is effective for two years.
11. 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.
12. 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: Electrical Characteristics of Device-Under-Test

Parameter	Pre-irradiation MIN MAX	10 Krad(Si) MIN MAX	20 Krad(Si) MIN MAX	50 Krad(Si) MIN MAX	100 Krad(Si) MIN MAX	200 Krad(Si) MIN MAX	Units
Input Offset Voltage	80	100	120	140	160	180	μV
Input Offset Current	150	200	200	200	300	500	nA
+ Input Bias Current	+/-400	+/-600	+/-700	+/-950	+/-1100	+/-1700	nA
- Input Bias Current	+/-400	+/-600	+/-700	+/-950	+/-1100	+/-1700	nA
+ Slew Rate	11	7.5	7.5	7.5	7.5	7.5	V/μS
- Slew Rate	11	7.5	7.5	7.5	7.5	7.5	V/μS
CMRR	110	106	106	106	106	106	dB
PSRR	110	104	104	104	104	104	dB
A_{VOL} ($R_L = 2\text{ K}\Omega$)	5	2	2	2	2	2	V/μV
$V_{OUT (+)}$ ($R_L = 2\text{ K}\Omega$)	12	11.5	11.5	11.5	11.5	11.5	V
$V_{OUT (-)}$ ($R_L = 2\text{ K}\Omega$)	-12	-11.5	-11.5	-11.5	-11.5	-11.5	V
$V_{OUT (+)}$ ($R_L = 600\ \Omega$)	10.5	10	10	10	10	10	V
$V_{OUT (-)}$ ($R_L = 600\ \Omega$)	-10.5	-10	-10	-10	-10	-10	V