



Radiation Lot Acceptance Testing (RLAT) Radiation Testing of the RH137H-Negative Adjustable Regulator for Linear Technology

Customer: Linear Technology (PO# 55334L)

RAD Job Number: 10-096

Part Type Tested: Linear Technology RH137H Negative Adjustable Regulator

Commercial Part Number: RH137H

Traceability Information: Fab Lot# W10641855.1, Wafer 2, Assembly Lot# 509700.1. Information obtained from Linear Technology PO#55334L. Date code marking on the package is 0903A, see Appendix A for a photograph of the device and part markings.

Quantity of Units: 12 units total, 5 units for biased irradiation, 5 units for unbiased irradiation and 2 control units. Serial numbers 791 to 795 were biased during irradiation, serial numbers 796 to 800 were unbiased during irradiation and serial numbers 802 and 803 were used as controls. See Appendix B for the radiation bias connection table.

Pre-Irradiation Burn-In: Burn-In performed by Linear Technology prior to receipt by RAD.

TID Dose Rate and Test Increments: 50-300rad(Si)/s with readings at pre-irradiation, 20, 50, 100, and 200krad(Si).

TID Overtest and Post-Irradiation Anneal: No overttest or anneal.

TID Test Standard: MIL-STD-883G, Method 1019.7, Condition A

TID Electrical Test Conditions: Pre-irradiation, and within one hour following each radiation exposure.

Test Programs: RH137HK.SR6

Test Hardware: LTS2020 Tester, 2101 Family Board, 0606 Fixture and RH137 BGSS-961018 DUT Board

Facility and Radiation Source: Radiation Assured Devices Longmire Laboratories, Colorado Springs, CO using the JLSA 81-24 high dose rate Co60 source. Dosimetry performed by CaF₂ TLDs traceable to NIST. RAD's dosimetry has been audited by DSCC and RAD has been awarded Laboratory Suitability for MIL-STD-750 TM 1019.5

Irradiation and Test Temperature: Ambient room temperature for irradiation and test controlled to 24°C ± 6°C per MIL-STD-883.

RLAT Result: PASSED the RLAT to maximum dose level of 200krad(Si) with only moderate degradation to the reference voltage parameters and no significant degradation to any other measured parameter

An ISO 9001:2008 and DSCC Certified Company



1.0. Overview and Background

It is well known that total dose ionizing radiation can cause parametric degradation and ultimately functional failure in electronic devices. The damage occurs via electron-hole pair production, transport and trapping in the dielectric and interface regions. In discrete devices the bulk of the damage is frequently manifested as a reduction in the gain and/or breakdown voltage of the device. The damage will usually anneal with time following the end of the radiation exposure. Due to this annealing, and to ensure a worst-case test condition MIL-STD-883 TM1019.7 calls out a dose rate of 50 to 300rad(Si)/s as Condition A and further specifies that the time from the end of an incremental radiation exposure and electrical testing shall be 1-hour or less and the total time from the end of one incremental irradiation to the beginning of the next incremental radiation step should be 2-hours or less. The work described in this report was performed to meet MIL-STD-883 TM1019.7 Condition A.

2.0. Radiation Test Apparatus

The total ionizing dose testing described in this final report was performed using the facilities at Radiation Assured Devices' Longmire Laboratories in Colorado Springs, CO. The high dose rate total ionizing dose (TID) source is a JLSA 84-21 irradiator modified to provide a panoramic exposure. The Co-60 rods are held in the base of the irradiator heavily shielded by lead, during the radiation exposures the rod is raised by an electronic timer/controller and the exposure is performed in air. The dose rate for this irradiator in this configuration ranges from <1rad(Si)/s to a maximum of approximately 120rad(Si)/s, determined by the distance from the source. For high-dose rate experiments the bias boards are placed in a radial fashion equidistant from the raised Co-60 rods with the distance adjusted to provide the required dose rate. The irradiator calibration is maintained by Radiation Assured Devices Longmire Laboratories using thermoluminescent dosimeters (TLDs)) traceable to the National Institute of Standards and Technology (NIST). Figure 2.1 shows a photograph of the JLSA 81-24 Co-60 irradiator at RAD's Longmire Laboratory facility.

RAD is currently certified by the Defense Supply Center Columbus (DSCC) for Laboratory Suitability under MIL STD 750. Additional details regarding Radiation Assured Devices dosimetry for TM1019 Condition A testing are available in RAD's report to DSCC entitled: "Dose Rate Mapping of the J.L. Shepherd and Associates Model 81 Irradiator Installed by Radiation Assured Devices"



Figure 2.1. Radiation Assured Devices' high dose rate Co-60 irradiator. The dose rate is obtained by positioning the device-under-test at a fixed distance from the gamma cell. The dose rate for this irradiator varies from approximately 120rad(Si)/s close to the rods down to 1rad(Si)/s at a distance of approximately 2-feet.



3.0. Radiation Test Conditions

The RH137H-Negative Adjustable Regulator described in this final report were irradiated using a split 15V supply and with all pins tied to ground, that is biased and unbiased. See the TID Bias Table in Appendix B for the full bias circuits. In our opinion, these bias circuits satisfy the requirements of MIL-STD-883G TM1019.7 Section 3.9.3 Bias and Loading Conditions which states “The bias applied to the test devices shall be selected to produce the greatest radiation induced damage or the worst-case damage for the intended application, if known. While maximum voltage is often worst case some bipolar linear device parameters (e.g. input bias current or maximum output load current) exhibit more degradation with 0 V bias.” Note that the determination of pass / fail for this lot is based on the response of the biased units only.

The devices were irradiated to a maximum total ionizing dose level of 200krad(Si) with incremental readings at 20, 50, 100 and 200krad(Si). Electrical testing occurred within one hour following the end of each irradiation segment. For intermediate irradiations, the parts were tested and returned to total dose exposure within two hours from the end of the previous radiation increment.

The TID bias board was positioned in the Co-60 cell to provide the required minimum of 50rad(Si)/s and was located inside a lead-aluminum enclosure. The lead-aluminum enclosure is required under MIL-STD-883G TM1019.7 Section 3.4 that reads as follows: “Lead/Aluminum (Pb/Al) container. Test specimens shall be enclosed in a Pb/Al container to minimize dose enhancement effects caused by low-energy, scattered radiation. A minimum of 1.5 mm Pb, surrounding an inner shield of at least 0.7 mm Al, is required. This Pb/Al container produces an approximate charged particle equilibrium for Si and for TLDs such as CaF₂. The radiation field intensity shall be measured inside the Pb/Al container (1) initially, (2) when the source is changed, or (3) when the orientation or configuration of the source, container, or test-fixture is changed. This measurement shall be performed by placing a dosimeter (e.g., a TLD) in the device-irradiation container at the approximate test-device position. If it can be demonstrated that low energy scattered radiation is small enough that it will not cause dosimetry errors due to dose enhancement, the Pb/Al container may be omitted”.

The final dose rate within the high dose rate lead-aluminum enclosure was determined based on TLD dosimetry measurements (see previous section). The final dose rate for this work was 74.9rad(Si)/s with a precision of $\pm 5\%$.



4.0. Tested Parameters

During the radiation lot acceptance testing the following pre- and post-irradiation electrical parameters were measured:

1. Reference Voltage
2. Line Regulation
3. Load Regulation $V_{OUT} \leq 5V$
4. Load Regulation $V_{OUT} \geq 5V$
5. Adjust Pin Current
6. Adjust Pin Current Change
7. Minimum Load Current
8. Current Limit $V_{DIFF} \leq 15V$
9. Current Limit $V_{DIFF} = 30V$

Appendix C details the measured parameters, test conditions, pre-irradiation specification and measurement resolution for each of the measurements.

The parametric data was obtained as read and record and all the raw data plus an attributes summary are contained in a separate Excel file. The attributes data contains the average, standard deviation and the average with the KTL values applied. The KTL value used in this work is 2.742 per MIL-HDBK-814 using one sided tolerance limits of 90/90 and a 5-piece sample size. The 90/90 KTL values were selected to match the statistical levels specified in the MIL-PRF-38535 sampling plan for the qualification of a radiation hardness assured (RHA) component. Note that the following criteria must be met for a device to pass the RLAT: following the radiation exposure each of the 5 pieces irradiated under electrical bias shall pass the specification value. The units irradiated without electrical bias and the KTL statistics are included in this report for reference only. If any of the 5 pieces irradiated under electrical bias exceed the datasheet specifications, then the lot could be logged as a failure.



5.0. Total Ionizing Dose Test Results

Based on this criterion the RH137H Negative Adjustable Regulator (from the lot date code/traceability information identified on the first page of this test report) PASSED the RLAT to the maximum dose level of 200krad(Si) with only moderate degradation to the reference voltage parameters and no significant degradation to any other measured parameter. Note that the data for the units-under-test irradiated in the unbiased condition and the KTL statistics presented in this report are for reference only and are not used for the determination of “PASS/FAIL” for the lot. Figures 5.1 through 5.17 show plots of all the measured parameters versus total ionizing dose while Tables 5.1 – 5.17 show the corresponding raw data for each of these parameters.

In the data plots the solid diamonds are the average of the measured data points for the sample irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the units irradiated with all pins tied to ground. The black lines (solid or dashed) are the average of the data points after application of the KTL statistics on the sample irradiated in the biased condition while the shaded lines (solid or dashed) are the average of the data points after application of the KTL statistics on the sample irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.

The control units, as expected, show no significant changes to any of the parameters. Therefore we can conclude that the electrical testing remained in control throughout the duration of the tests and the observed degradation was due to the radiation exposure.

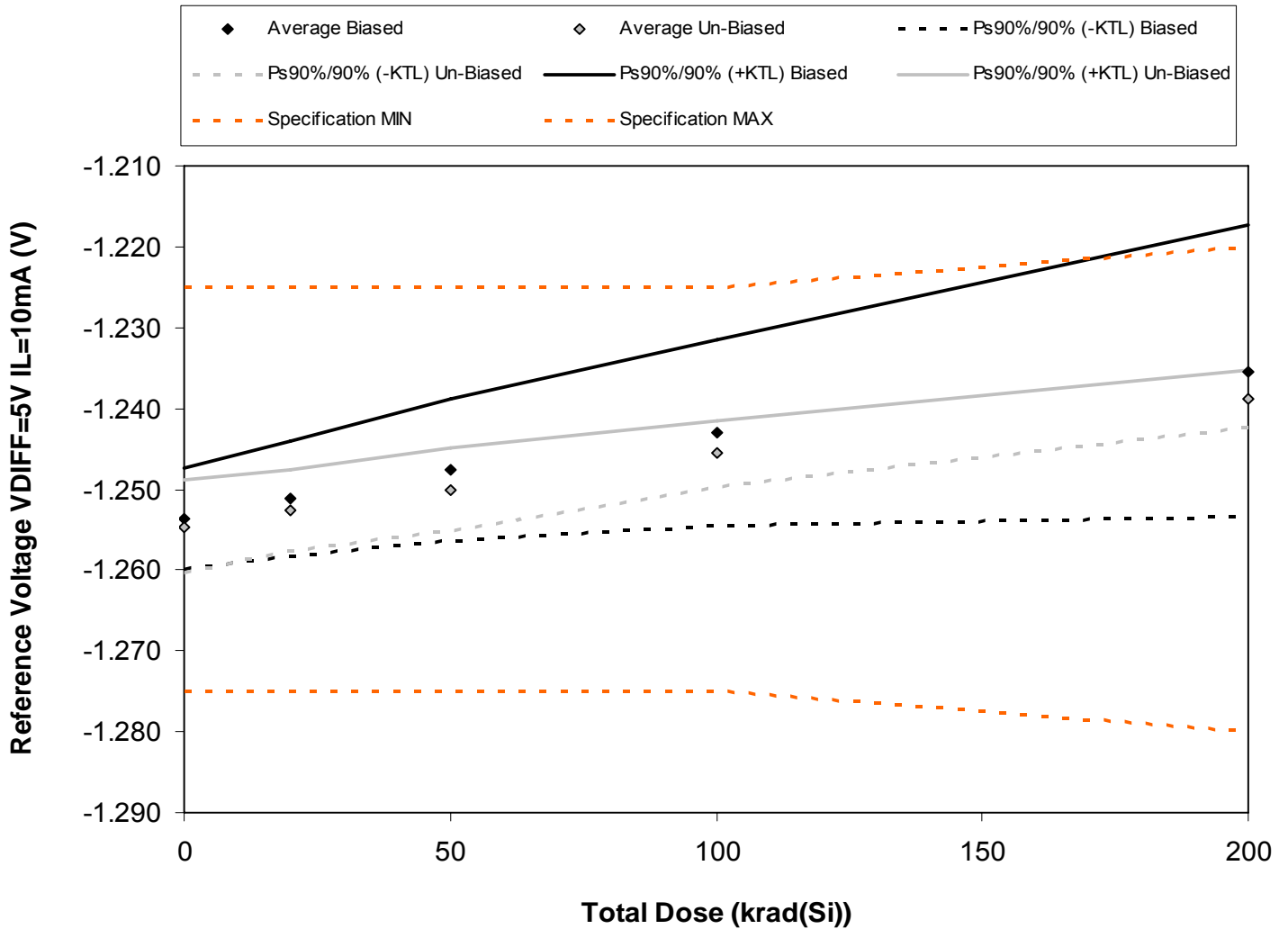


Figure 5.1. Plot of Reference Voltage VDIFF=5V IL=10mA (V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.1. Raw data for Reference Voltage VDIFF=5V IL=10mA (V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Reference Voltage VDIFF=5V IL=10mA (V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device	0	20	50	100	200
791	-1.254	-1.251	-1.248	-1.244	-1.236
792	-1.251	-1.248	-1.245	-1.241	-1.234
793	-1.254	-1.252	-1.249	-1.245	-1.240
794	-1.252	-1.250	-1.244	-1.237	-1.225
795	-1.257	-1.255	-1.252	-1.248	-1.242
796	-1.253	-1.252	-1.248	-1.244	-1.237
797	-1.257	-1.255	-1.252	-1.247	-1.240
798	-1.256	-1.253	-1.251	-1.246	-1.239
799	-1.255	-1.253	-1.251	-1.247	-1.240
800	-1.252	-1.250	-1.248	-1.244	-1.238
802	-1.257	-1.256	-1.256	-1.256	-1.256
803	-1.259	-1.259	-1.259	-1.259	-1.259
Biased Statistics					
Average Biased	-1.254	-1.251	-1.248	-1.243	-1.235
Std Dev Biased	2.30E-03	2.59E-03	3.21E-03	4.18E-03	6.62E-03
Ps90%/90% (+KTL) Biased	-1.247	-1.244	-1.239	-1.232	-1.217
Ps90%/90% (-KTL) Biased	-1.260	-1.258	-1.256	-1.254	-1.254
Un-Biased Statistics					
Average Un-Biased	-1.255	-1.253	-1.250	-1.246	-1.239
Std Dev Un-Biased	2.07E-03	1.82E-03	1.87E-03	1.52E-03	1.30E-03
Ps90%/90% (+KTL) Un-Biased	-1.249	-1.248	-1.245	-1.241	-1.235
Ps90%/90% (-KTL) Un-Biased	-1.260	-1.258	-1.255	-1.250	-1.242
Specification MIN	-1.275	-1.275	-1.275	-1.275	-1.280
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	-1.225	-1.225	-1.225	-1.225	-1.220
Status	PASS	PASS	PASS	PASS	PASS

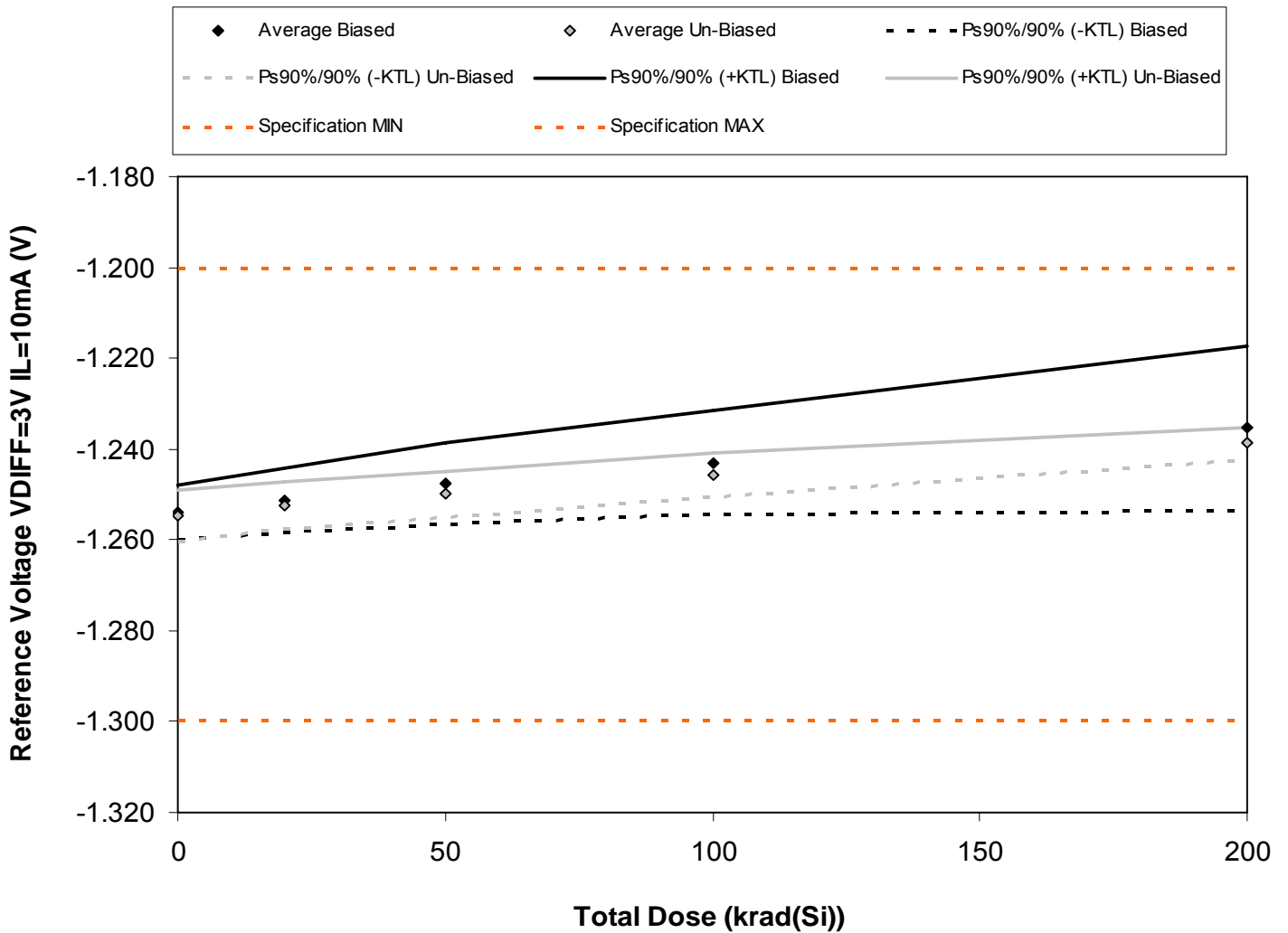


Figure 5.2. Plot of Reference Voltage VDIFF=3V IL=10mA (V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.2. Raw data for Reference Voltage VDIFF=3V IL=10mA (V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Reference Voltage VDIFF=3V IL=10mA (V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device	0	20	50	100	200
791	-1.254	-1.251	-1.248	-1.244	-1.236
792	-1.251	-1.248	-1.245	-1.241	-1.234
793	-1.254	-1.252	-1.249	-1.245	-1.240
794	-1.253	-1.250	-1.244	-1.237	-1.225
795	-1.257	-1.255	-1.252	-1.248	-1.242
796	-1.253	-1.251	-1.248	-1.244	-1.237
797	-1.257	-1.255	-1.252	-1.248	-1.240
798	-1.256	-1.253	-1.251	-1.246	-1.239
799	-1.255	-1.253	-1.251	-1.247	-1.240
800	-1.252	-1.250	-1.248	-1.244	-1.238
802	-1.256	-1.256	-1.256	-1.256	-1.256
803	-1.259	-1.259	-1.259	-1.259	-1.259
Biased Statistics					
Average Biased	-1.254	-1.251	-1.248	-1.243	-1.235
Std Dev Biased	2.17E-03	2.59E-03	3.21E-03	4.18E-03	6.62E-03
Ps90%/90% (+KTL) Biased	-1.248	-1.244	-1.239	-1.232	-1.217
Ps90%/90% (-KTL) Biased	-1.260	-1.258	-1.256	-1.254	-1.254
Un-Biased Statistics					
Average Un-Biased	-1.255	-1.252	-1.250	-1.246	-1.239
Std Dev Un-Biased	2.07E-03	1.95E-03	1.87E-03	1.79E-03	1.30E-03
Ps90%/90% (+KTL) Un-Biased	-1.249	-1.247	-1.245	-1.241	-1.235
Ps90%/90% (-KTL) Un-Biased	-1.260	-1.258	-1.255	-1.251	-1.242
Specification MIN	-1.300	-1.300	-1.300	-1.300	-1.300
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	-1.200	-1.200	-1.200	-1.200	-1.200
Status	PASS	PASS	PASS	PASS	PASS

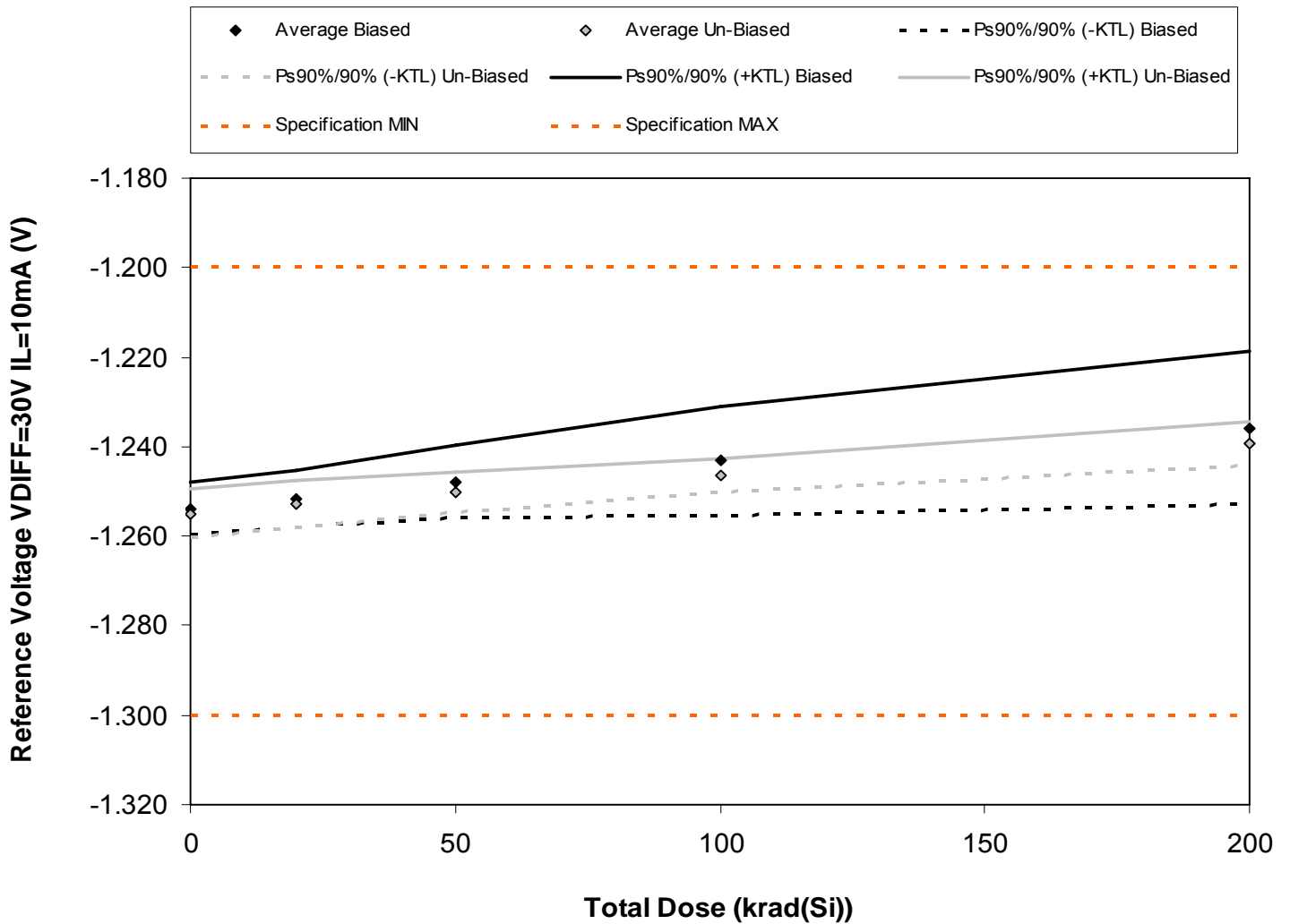


Figure 5.3. Plot of Reference Voltage VDIFF=30V IL=10mA (V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.3. Raw data for Reference Voltage VDIFF=30V IL=10mA (V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Reference Voltage VDIFF=30V IL=10mA (V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device	0	20	50	100	200
791	-1.254	-1.252	-1.248	-1.244	-1.237
792	-1.251	-1.249	-1.245	-1.241	-1.234
793	-1.254	-1.252	-1.249	-1.245	-1.240
794	-1.253	-1.250	-1.245	-1.237	-1.226
795	-1.257	-1.255	-1.252	-1.249	-1.242
796	-1.254	-1.252	-1.249	-1.245	-1.237
797	-1.257	-1.255	-1.252	-1.248	-1.241
798	-1.256	-1.254	-1.251	-1.247	-1.239
799	-1.256	-1.253	-1.251	-1.247	-1.241
800	-1.252	-1.250	-1.248	-1.245	-1.238
802	-1.257	-1.256	-1.256	-1.256	-1.256
803	-1.259	-1.259	-1.259	-1.260	-1.259
Biased Statistics					
Average Biased	-1.254	-1.252	-1.248	-1.243	-1.236
Std Dev Biased	2.17E-03	2.30E-03	2.95E-03	4.49E-03	6.26E-03
Ps90%/90% (+KTL) Biased	-1.248	-1.245	-1.240	-1.231	-1.219
Ps90%/90% (-KTL) Biased	-1.260	-1.258	-1.256	-1.256	-1.253
Un-Biased Statistics					
Average Un-Biased	-1.255	-1.253	-1.250	-1.246	-1.239
Std Dev Un-Biased	2.00E-03	1.92E-03	1.64E-03	1.34E-03	1.79E-03
Ps90%/90% (+KTL) Un-Biased	-1.250	-1.248	-1.246	-1.243	-1.234
Ps90%/90% (-KTL) Un-Biased	-1.260	-1.258	-1.255	-1.250	-1.244
Specification MIN	-1.300	-1.300	-1.300	-1.300	-1.300
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	-1.200	-1.200	-1.200	-1.200	-1.200
Status	PASS	PASS	PASS	PASS	PASS

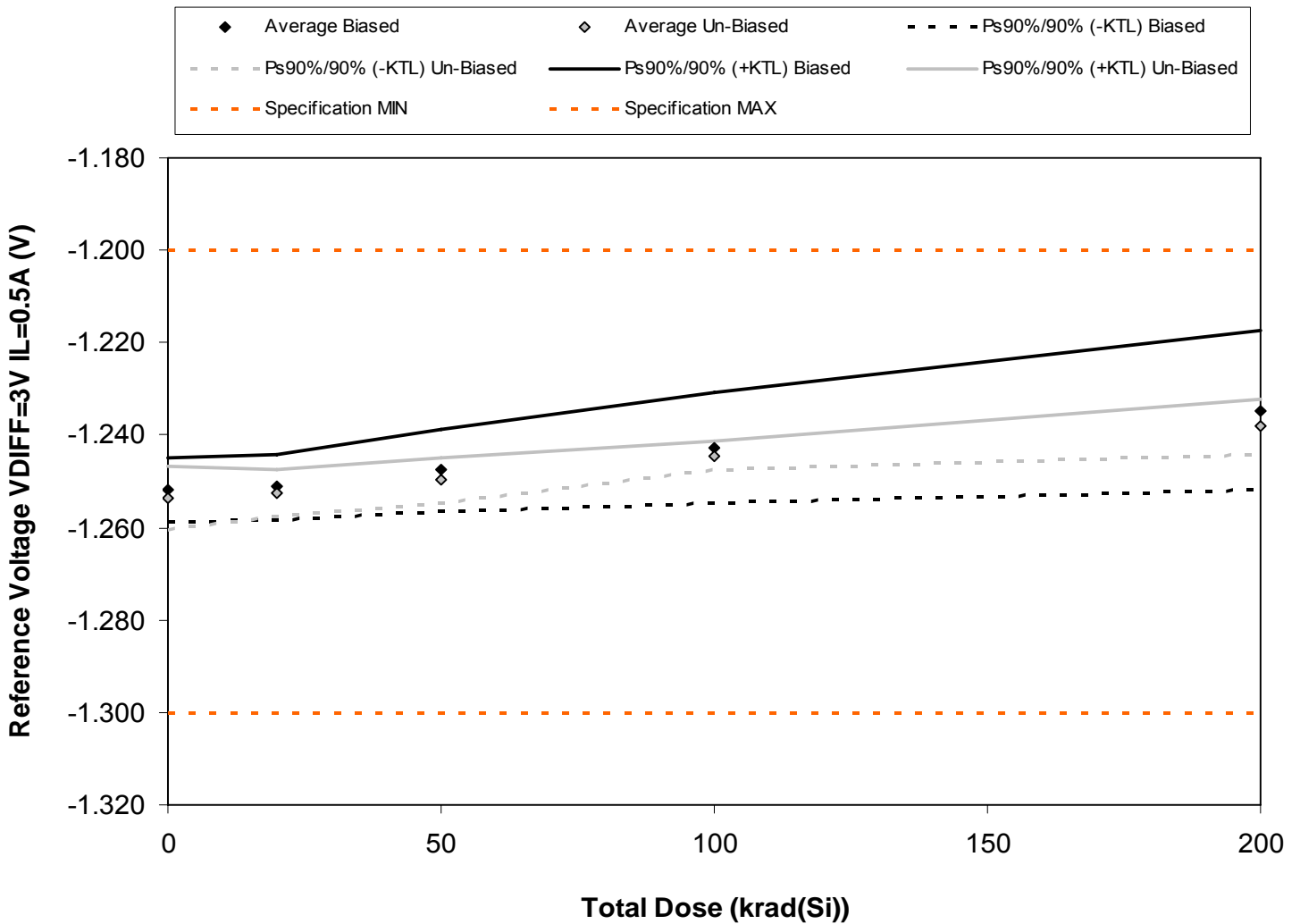


Figure 5.4. Plot of Reference Voltage $V_{DIFF}=3V$ $I_L=0.5A$ (V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.4. Raw data for Reference Voltage VDIFF=3V IL=0.5A (V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Reference Voltage VDIFF=3V IL=0.5A (V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device	0	20	50	100	200
791	-1.254	-1.252	-1.248	-1.244	-1.236
792	-1.248	-1.248	-1.245	-1.240	-1.232
793	-1.252	-1.251	-1.249	-1.245	-1.240
794	-1.251	-1.250	-1.244	-1.237	-1.225
795	-1.254	-1.255	-1.252	-1.248	-1.240
796	-1.252	-1.252	-1.248	-1.244	-1.237
797	-1.255	-1.255	-1.252	-1.245	-1.240
798	-1.256	-1.253	-1.250	-1.244	-1.239
799	-1.255	-1.253	-1.251	-1.246	-1.240
800	-1.250	-1.250	-1.248	-1.243	-1.235
802	-1.256	-1.256	-1.256	-1.254	-1.256
803	-1.257	-1.259	-1.256	-1.257	-1.257
Biased Statistics					
Average Biased	-1.252	-1.251	-1.248	-1.243	-1.235
Std Dev Biased	2.49E-03	2.59E-03	3.21E-03	4.32E-03	6.31E-03
Ps90%/90% (+KTL) Biased	-1.245	-1.244	-1.239	-1.231	-1.217
Ps90%/90% (-KTL) Biased	-1.259	-1.258	-1.256	-1.255	-1.252
Un-Biased Statistics					
Average Un-Biased	-1.254	-1.253	-1.250	-1.244	-1.238
Std Dev Un-Biased	2.51E-03	1.82E-03	1.79E-03	1.14E-03	2.17E-03
Ps90%/90% (+KTL) Un-Biased	-1.247	-1.248	-1.245	-1.241	-1.232
Ps90%/90% (-KTL) Un-Biased	-1.260	-1.258	-1.255	-1.248	-1.244
Specification MIN	-1.300	-1.300	-1.300	-1.300	-1.300
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	-1.200	-1.200	-1.200	-1.200	-1.200
Status	PASS	PASS	PASS	PASS	PASS

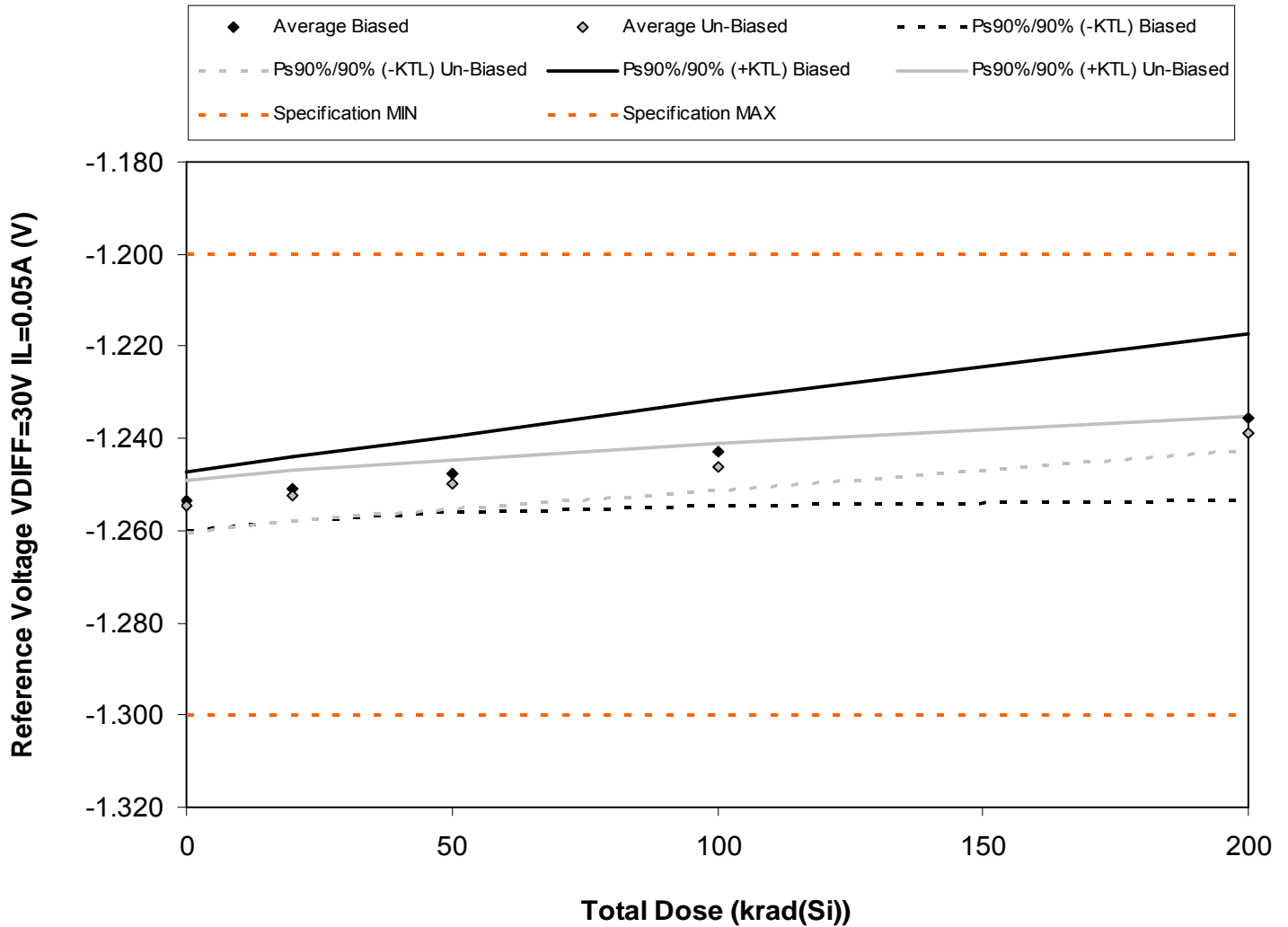


Figure 5.5. Plot of Reference Voltage VDIFF=30V IL=0.05A (V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.5. Raw data for Reference Voltage VDIFF=30V IL=0.05A (V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Reference Voltage VDIFF=30V IL=0.05A (V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-1.254	-1.251	-1.248	-1.244	-1.236
792	-1.251	-1.248	-1.245	-1.241	-1.234
793	-1.254	-1.251	-1.249	-1.245	-1.240
794	-1.252	-1.250	-1.245	-1.237	-1.225
795	-1.257	-1.255	-1.252	-1.248	-1.242
796	-1.253	-1.251	-1.248	-1.244	-1.237
797	-1.257	-1.255	-1.252	-1.248	-1.240
798	-1.256	-1.253	-1.251	-1.247	-1.239
799	-1.255	-1.253	-1.251	-1.247	-1.240
800	-1.252	-1.250	-1.248	-1.244	-1.238
802	-1.257	-1.256	-1.256	-1.256	-1.256
803	-1.259	-1.259	-1.259	-1.259	-1.259
Biased Statistics					
Average Biased	-1.254	-1.251	-1.248	-1.243	-1.235
Std Dev Biased	2.30E-03	2.55E-03	2.95E-03	4.18E-03	6.62E-03
Ps90%/90% (+KTL) Biased	-1.247	-1.244	-1.240	-1.232	-1.217
Ps90%/90% (-KTL) Biased	-1.260	-1.258	-1.256	-1.254	-1.254
Un-Biased Statistics					
Average Un-Biased	-1.255	-1.252	-1.250	-1.246	-1.239
Std Dev Un-Biased	2.07E-03	1.95E-03	1.87E-03	1.87E-03	1.30E-03
Ps90%/90% (+KTL) Un-Biased	-1.249	-1.247	-1.245	-1.241	-1.235
Ps90%/90% (-KTL) Un-Biased	-1.260	-1.258	-1.255	-1.251	-1.242
Specification MIN	-1.300	-1.300	-1.300	-1.300	-1.300
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	-1.200	-1.200	-1.200	-1.200	-1.200
Status	PASS	PASS	PASS	PASS	PASS

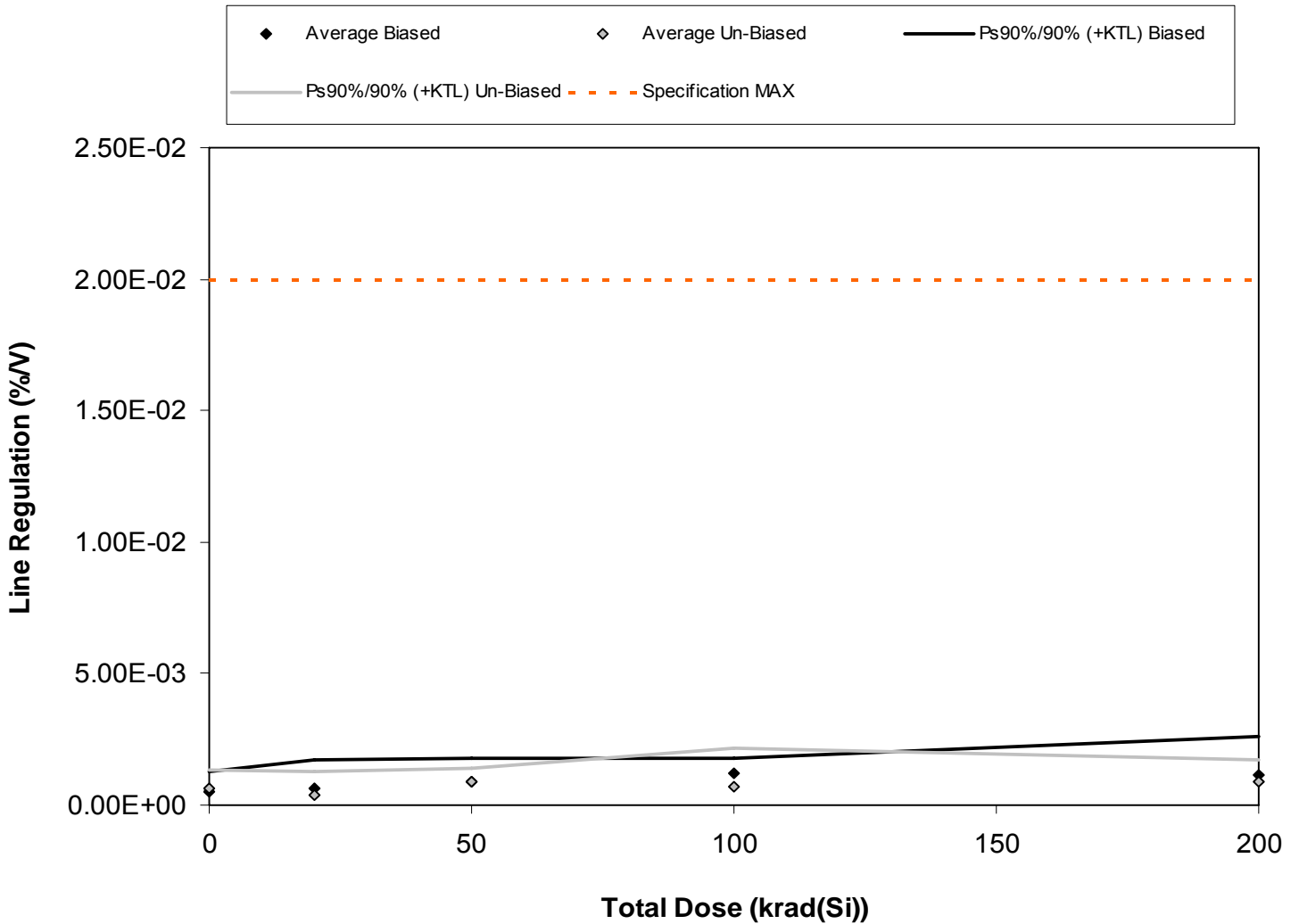


Figure 5.6. Plot of Line Regulation (%/V) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.6. Raw data for Line Regulation (%V) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Line Regulation (%V)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	5.00E-04	1.10E-03	1.00E-03	1.20E-03	9.00E-04
792	8.00E-04	3.00E-04	6.00E-04	1.50E-03	4.00E-04
793	8.00E-04	5.00E-04	9.00E-04	1.00E-03	1.60E-03
794	2.00E-04	1.00E-03	1.40E-03	1.30E-03	1.70E-03
795	3.00E-04	2.00E-04	6.00E-04	1.00E-03	1.10E-03
796	9.00E-04	3.00E-04	1.00E-03	4.00E-04	1.30E-03
797	9.00E-04	0.00E+00	9.00E-04	8.00E-04	1.00E-03
798	4.00E-04	3.00E-04	7.00E-04	4.00E-04	5.00E-04
799	4.00E-04	8.00E-04	1.10E-03	4.00E-04	9.00E-04
800	7.00E-04	6.00E-04	7.00E-04	1.60E-03	8.00E-04
802	4.00E-04	9.00E-04	5.00E-04	7.00E-04	6.00E-04
803	0.00E+00	0.00E+00	5.00E-04	2.00E-04	0.00E+00
Biased Statistics					
Average Biased	5.20E-04	6.20E-04	9.00E-04	1.20E-03	1.14E-03
Std Dev Biased	2.77E-04	4.09E-04	3.32E-04	2.12E-04	5.32E-04
Ps90%/90% (+KTL) Biased	1.28E-03	1.74E-03	1.81E-03	1.78E-03	2.60E-03
Ps90%/90% (-KTL) Biased	-2.41E-04	-5.01E-04	-9.42E-06	6.18E-04	-3.19E-04
Un-Biased Statistics					
Average Un-Biased	6.60E-04	4.00E-04	8.80E-04	7.20E-04	9.00E-04
Std Dev Un-Biased	2.51E-04	3.08E-04	1.79E-04	5.22E-04	2.92E-04
Ps90%/90% (+KTL) Un-Biased	1.35E-03	1.25E-03	1.37E-03	2.15E-03	1.70E-03
Ps90%/90% (-KTL) Un-Biased	-2.82E-05	-4.45E-04	3.89E-04	-7.10E-04	1.01E-04
Specification MAX	2.00E-02	2.00E-02	2.00E-02	2.00E-02	2.00E-02
Status	PASS	PASS	PASS	PASS	PASS

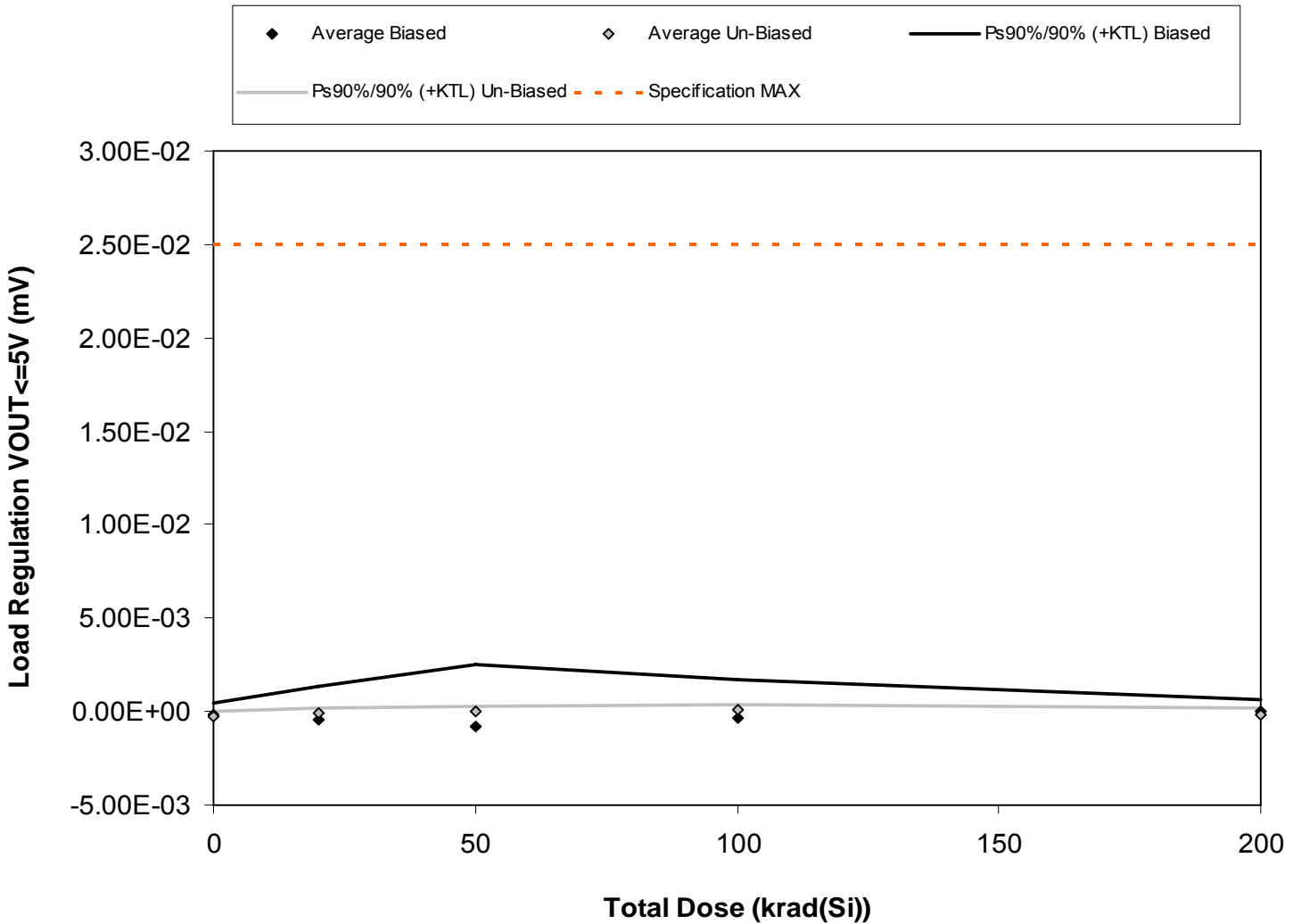


Figure 5.7. Plot of Load Regulation $V_{OUT} \leq 5V$ (mV) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.7. Raw data for Load Regulation $V_{OUT} \leq 5V$ (mV) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Load Regulation $V_{OUT} \leq 5V$ (mV)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-3.03E-04	-1.55E-03	-2.26E-03	-1.70E-03	-3.40E-05
792	-2.02E-04	-3.40E-05	-1.92E-03	-1.18E-04	3.40E-05
793	2.53E-04	-4.88E-04	-1.35E-04	-3.40E-05	-1.35E-04
794	-3.03E-04	1.70E-05	1.85E-04	2.02E-04	4.04E-04
795	-2.02E-04	-1.68E-04	1.68E-04	-1.85E-04	0.00E+00
796	-1.52E-04	-5.10E-05	0.00E+00	2.53E-04	-1.52E-04
797	-2.86E-04	6.70E-05	-2.02E-04	1.52E-04	-6.70E-05
798	-2.70E-04	-5.10E-05	0.00E+00	8.40E-05	-1.68E-04
799	-1.35E-04	-1.85E-04	-1.70E-05	0.00E+00	3.40E-05
800	-2.70E-04	-6.70E-05	8.40E-05	-1.70E-05	-2.70E-04
802	-1.18E-04	-4.88E-04	-1.68E-04	-1.52E-04	1.35E-04
803	-2.86E-04	-1.01E-04	1.68E-04	-1.70E-05	-1.01E-04
Biased Statistics					
Average Biased	-1.51E-04	-4.45E-04	-7.92E-04	-3.67E-04	5.38E-05
Std Dev Biased	2.32E-04	6.48E-04	1.20E-03	7.60E-04	2.06E-04
Ps90%/90% (+KTL) Biased	4.84E-04	1.33E-03	2.49E-03	1.72E-03	6.18E-04
Ps90%/90% (-KTL) Biased	-7.87E-04	-2.22E-03	-4.07E-03	-2.45E-03	-5.10E-04
Un-Biased Statistics					
Average Un-Biased	-2.23E-04	-5.74E-05	-2.70E-05	9.44E-05	-1.25E-04
Std Dev Un-Biased	7.28E-05	8.93E-05	1.05E-04	1.12E-04	1.14E-04
Ps90%/90% (+KTL) Un-Biased	-2.31E-05	1.88E-04	2.62E-04	4.01E-04	1.89E-04
Ps90%/90% (-KTL) Un-Biased	-4.22E-04	-3.02E-04	-3.16E-04	-2.12E-04	-4.38E-04
Specification MAX	2.50E-02	2.50E-02	2.50E-02	2.50E-02	2.50E-02
Status	PASS	PASS	PASS	PASS	PASS

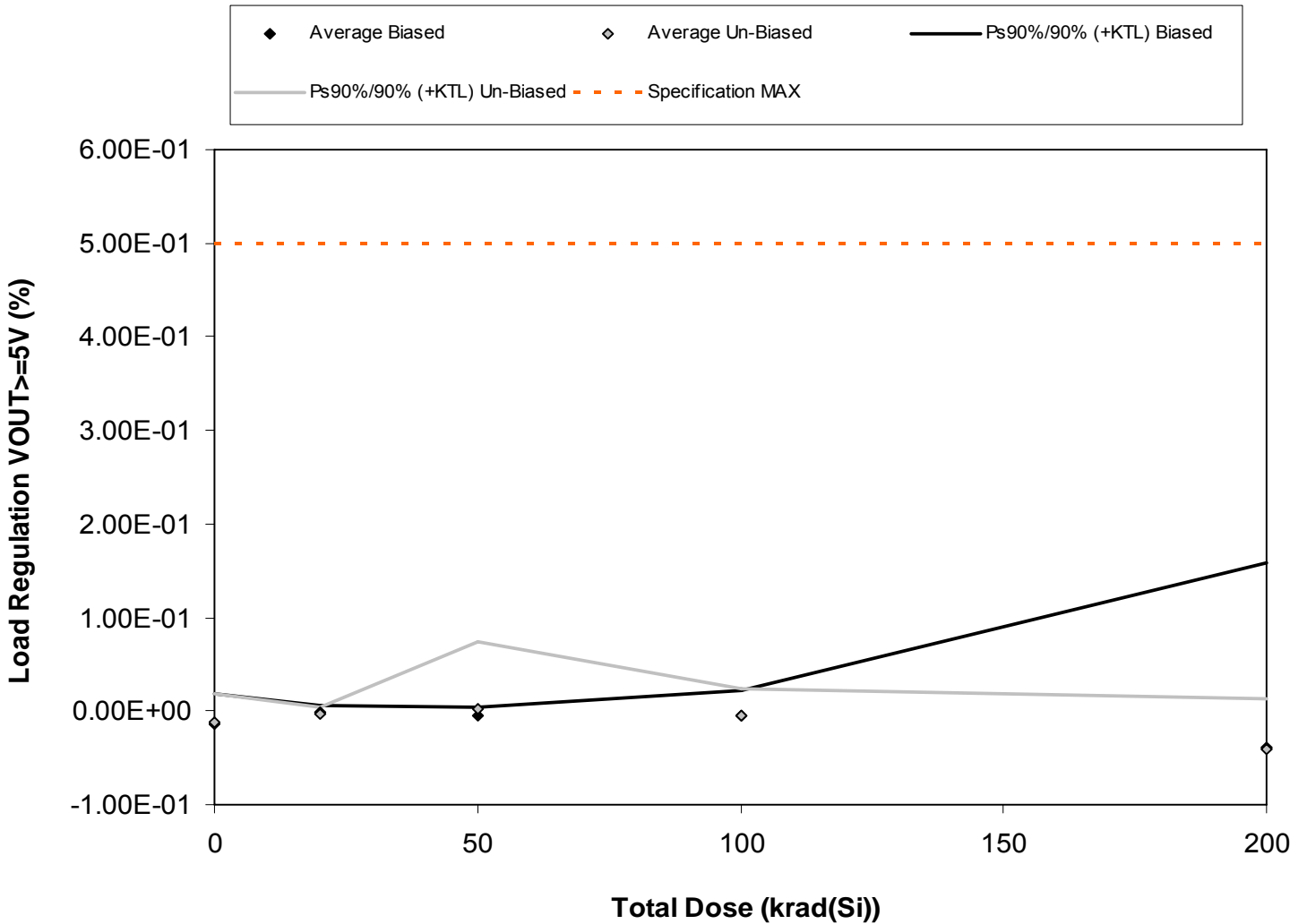


Figure 5.8. Plot of Load Regulation VOUT >= 5V (%) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.8. Raw data for Load Regulation $V_{OUT} \geq 5V$ (%) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Load Regulation $V_{OUT} \geq 5V$ (%)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-3.00E-03	-3.00E-03	-6.00E-03	5.00E-03	-1.90E-02
792	-6.00E-03	-4.00E-03	-5.00E-03	-1.00E-02	-4.00E-03
793	-8.00E-03	-5.00E-03	-3.00E-03	-4.00E-03	0.00E+00
794	-3.00E-02	2.00E-03	-1.00E-02	2.00E-03	-7.00E-03
795	-2.10E-02	0.00E+00	-2.00E-03	-2.10E-02	-1.68E-01
796	-3.00E-03	-6.00E-03	4.10E-02	5.00E-03	-1.40E-02
797	-3.00E-02	-3.00E-03	-1.70E-02	-2.30E-02	-6.60E-02
798	-7.00E-03	-5.00E-03	-1.00E-03	0.00E+00	-3.60E-02
799	-5.00E-03	-2.00E-03	1.10E-02	-5.00E-03	-3.50E-02
800	-1.70E-02	0.00E+00	-2.60E-02	-2.00E-03	-5.30E-02
802	0.00E+00	0.00E+00	-3.10E-02	1.06E-01	-3.00E-02
803	-3.00E-02	-6.00E-03	-7.00E-03	0.00E+00	-1.74E-01
Biased Statistics					
Average Biased	-1.36E-02	-2.00E-03	-5.20E-03	-5.60E-03	-3.96E-02
Std Dev Biased	1.15E-02	2.92E-03	3.11E-03	1.04E-02	7.21E-02
Ps90%/90% (+KTL) Biased	1.78E-02	5.99E-03	3.34E-03	2.28E-02	1.58E-01
Ps90%/90% (-KTL) Biased	-4.50E-02	-9.99E-03	-1.37E-02	-3.40E-02	-2.37E-01
Un-Biased Statistics					
Average Un-Biased	-1.24E-02	-3.20E-03	1.60E-03	-5.00E-03	-4.08E-02
Std Dev Un-Biased	1.12E-02	2.39E-03	2.62E-02	1.07E-02	1.97E-02
Ps90%/90% (+KTL) Un-Biased	1.84E-02	3.35E-03	7.36E-02	2.43E-02	1.33E-02
Ps90%/90% (-KTL) Un-Biased	-4.32E-02	-9.75E-03	-7.04E-02	-3.43E-02	-9.49E-02
Specification MAX	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01
Status	PASS	PASS	PASS	PASS	PASS

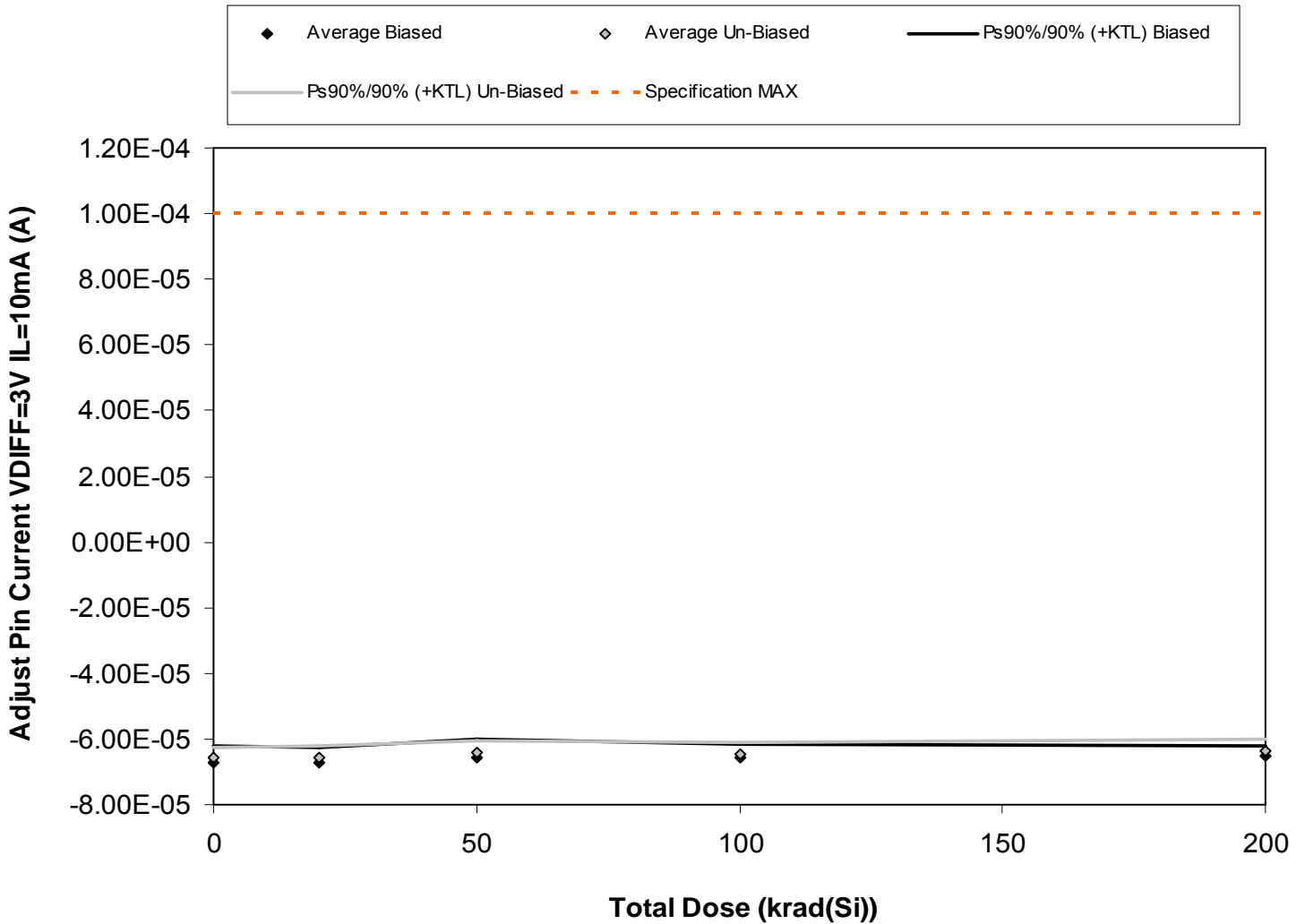


Figure 5.9. Plot of Adjust Pin Current VDIFF=3V IL=10mA (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.9. Raw data for Adjust Pin Current VDIFF=3V IL=10mA (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Adjust Pin Current VDIFF=3V IL=10mA (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-6.77E-05	-6.76E-05	-6.70E-05	-6.66E-05	-6.57E-05
792	-6.54E-05	-6.55E-05	-6.39E-05	-6.43E-05	-6.41E-05
793	-6.78E-05	-6.78E-05	-6.75E-05	-6.69E-05	-6.61E-05
794	-6.95E-05	-6.92E-05	-6.65E-05	-6.74E-05	-6.59E-05
795	-6.52E-05	-6.56E-05	-6.32E-05	-6.39E-05	-6.39E-05
796	-6.43E-05	-6.41E-05	-6.22E-05	-6.33E-05	-6.24E-05
797	-6.64E-05	-6.60E-05	-6.40E-05	-6.51E-05	-6.42E-05
798	-6.53E-05	-6.53E-05	-6.36E-05	-6.43E-05	-6.35E-05
799	-6.73E-05	-6.76E-05	-6.57E-05	-6.66E-05	-6.59E-05
800	-6.52E-05	-6.49E-05	-6.45E-05	-6.37E-05	-6.33E-05
802	-6.51E-05	-6.49E-05	-6.49E-05	-6.47E-05	-6.57E-05
803	-6.46E-05	-6.46E-05	-6.47E-05	-6.50E-05	-6.59E-05
Biased Statistics					
Average Biased	-6.71E-05	-6.71E-05	-6.56E-05	-6.58E-05	-6.51E-05
Std Dev Biased	1.81E-06	1.58E-06	1.94E-06	1.59E-06	1.06E-06
Ps90%/90% (+KTL) Biased	-6.22E-05	-6.28E-05	-6.03E-05	-6.15E-05	-6.22E-05
Ps90%/90% (-KTL) Biased	-7.21E-05	-7.15E-05	-7.09E-05	-7.02E-05	-6.80E-05
Un-Biased Statistics					
Average Un-Biased	-6.57E-05	-6.56E-05	-6.40E-05	-6.46E-05	-6.39E-05
Std Dev Un-Biased	1.14E-06	1.32E-06	1.30E-06	1.29E-06	1.31E-06
Ps90%/90% (+KTL) Un-Biased	-6.26E-05	-6.19E-05	-6.04E-05	-6.10E-05	-6.03E-05
Ps90%/90% (-KTL) Un-Biased	-6.88E-05	-6.92E-05	-6.76E-05	-6.81E-05	-6.75E-05
Specification MAX	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Status	PASS	PASS	PASS	PASS	PASS

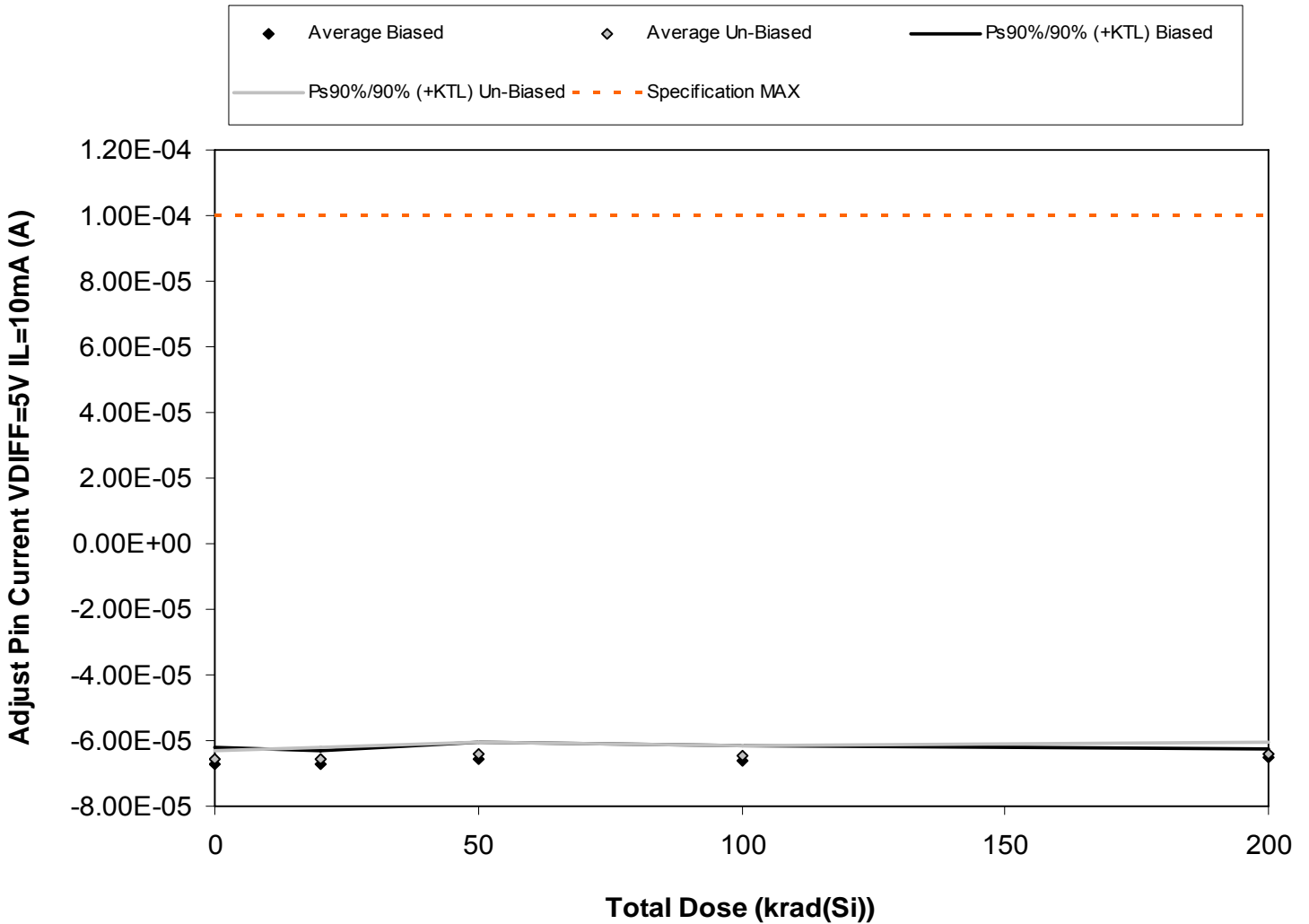


Figure 5.10. Plot of Adjust Pin Current VDIFF=5V IL=10mA (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.10. Raw data for Adjust Pin Current VDIFF=5V IL=10mA (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Adjust Pin Current VDIFF=5V IL=10mA (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-6.76E-05	-6.76E-05	-6.68E-05	-6.67E-05	-6.56E-05
792	-6.52E-05	-6.56E-05	-6.39E-05	-6.43E-05	-6.42E-05
793	-6.77E-05	-6.76E-05	-6.75E-05	-6.71E-05	-6.60E-05
794	-6.97E-05	-6.92E-05	-6.64E-05	-6.74E-05	-6.59E-05
795	-6.52E-05	-6.56E-05	-6.32E-05	-6.41E-05	-6.38E-05
796	-6.48E-05	-6.42E-05	-6.22E-05	-6.33E-05	-6.26E-05
797	-6.64E-05	-6.60E-05	-6.39E-05	-6.50E-05	-6.47E-05
798	-6.53E-05	-6.55E-05	-6.34E-05	-6.42E-05	-6.37E-05
799	-6.72E-05	-6.77E-05	-6.57E-05	-6.63E-05	-6.58E-05
800	-6.51E-05	-6.49E-05	-6.47E-05	-6.38E-05	-6.30E-05
802	-6.50E-05	-6.49E-05	-6.49E-05	-6.47E-05	-6.56E-05
803	-6.50E-05	-6.47E-05	-6.48E-05	-6.49E-05	-6.57E-05
Biased Statistics					
Average Biased	-6.71E-05	-6.71E-05	-6.56E-05	-6.59E-05	-6.51E-05
Std Dev Biased	1.89E-06	1.56E-06	1.92E-06	1.55E-06	1.01E-06
Ps90%/90% (+KTL) Biased	-6.19E-05	-6.28E-05	-6.03E-05	-6.17E-05	-6.23E-05
Ps90%/90% (-KTL) Biased	-7.23E-05	-7.14E-05	-7.08E-05	-7.01E-05	-6.79E-05
Un-Biased Statistics					
Average Un-Biased	-6.57E-05	-6.57E-05	-6.40E-05	-6.45E-05	-6.40E-05
Std Dev Un-Biased	1.01E-06	1.31E-06	1.35E-06	1.18E-06	1.31E-06
Ps90%/90% (+KTL) Un-Biased	-6.30E-05	-6.21E-05	-6.03E-05	-6.13E-05	-6.04E-05
Ps90%/90% (-KTL) Un-Biased	-6.85E-05	-6.92E-05	-6.77E-05	-6.78E-05	-6.76E-05
Specification MAX	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Status	PASS	PASS	PASS	PASS	PASS

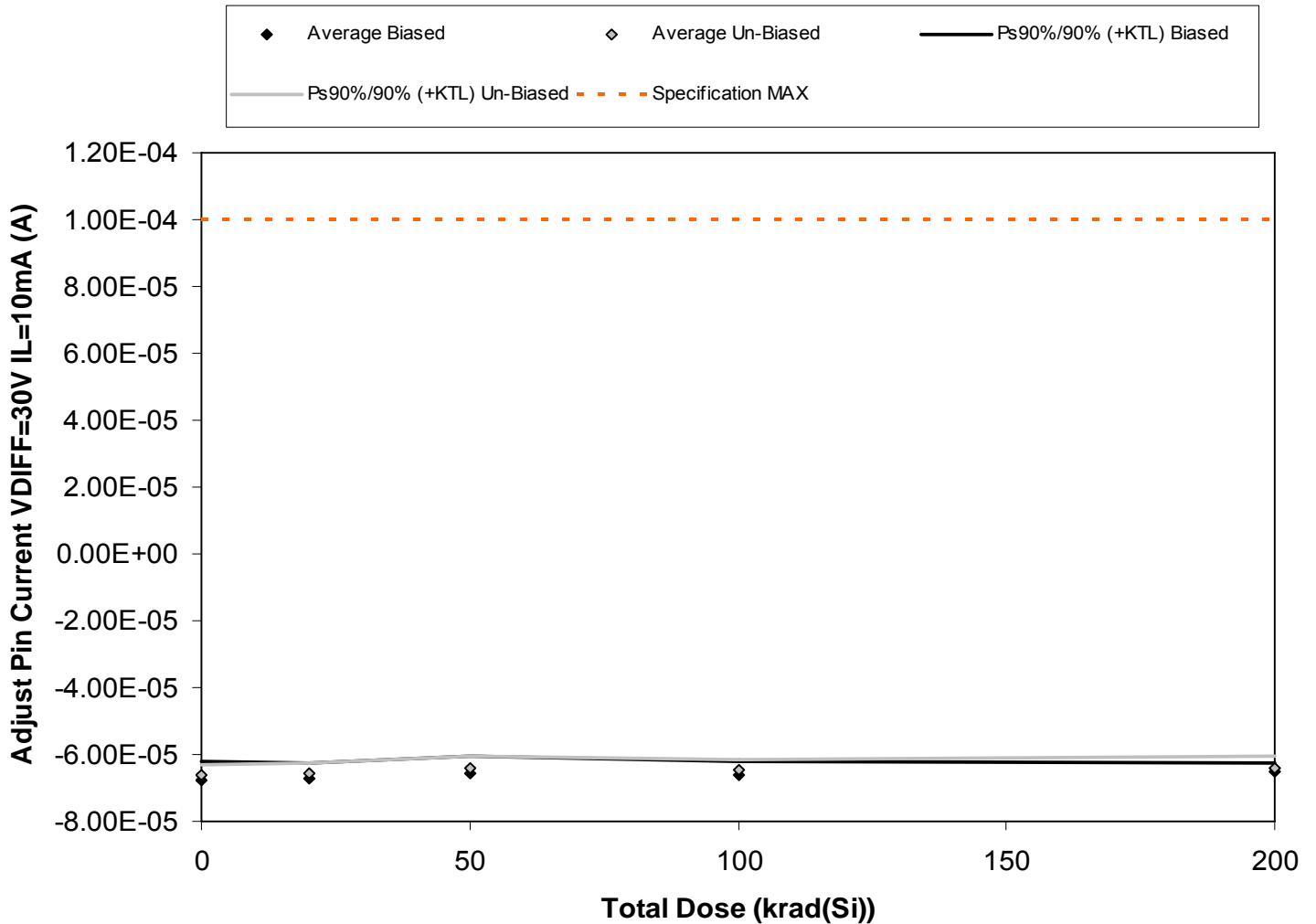


Figure 5.11. Plot of Adjust Pin Current VDIFF=30V IL=10mA (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.11. Raw data for Adjust Pin Current VDIFF=30V IL=10mA (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Adjust Pin Current VDIFF=30V IL=10mA (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-6.81E-05	-6.74E-05	-6.72E-05	-6.67E-05	-6.58E-05
792	-6.57E-05	-6.55E-05	-6.39E-05	-6.45E-05	-6.44E-05
793	-6.83E-05	-6.80E-05	-6.75E-05	-6.69E-05	-6.65E-05
794	-6.99E-05	-6.94E-05	-6.69E-05	-6.75E-05	-6.60E-05
795	-6.53E-05	-6.57E-05	-6.36E-05	-6.43E-05	-6.40E-05
796	-6.49E-05	-6.45E-05	-6.22E-05	-6.36E-05	-6.28E-05
797	-6.64E-05	-6.60E-05	-6.39E-05	-6.53E-05	-6.47E-05
798	-6.56E-05	-6.57E-05	-6.38E-05	-6.47E-05	-6.40E-05
799	-6.74E-05	-6.78E-05	-6.57E-05	-6.67E-05	-6.59E-05
800	-6.52E-05	-6.51E-05	-6.49E-05	-6.38E-05	-6.33E-05
802	-6.51E-05	-6.49E-05	-6.53E-05	-6.49E-05	-6.57E-05
803	-6.51E-05	-6.47E-05	-6.47E-05	-6.52E-05	-6.60E-05
Biased Statistics					
Average Biased	-6.74E-05	-6.72E-05	-6.58E-05	-6.60E-05	-6.54E-05
Std Dev Biased	1.93E-06	1.63E-06	1.88E-06	1.49E-06	1.06E-06
Ps90%/90% (+KTL) Biased	-6.22E-05	-6.27E-05	-6.07E-05	-6.19E-05	-6.25E-05
Ps90%/90% (-KTL) Biased	-7.27E-05	-7.17E-05	-7.10E-05	-7.00E-05	-6.82E-05
Un-Biased Statistics					
Average Un-Biased	-6.59E-05	-6.58E-05	-6.41E-05	-6.48E-05	-6.41E-05
Std Dev Un-Biased	1.02E-06	1.24E-06	1.33E-06	1.27E-06	1.23E-06
Ps90%/90% (+KTL) Un-Biased	-6.31E-05	-6.24E-05	-6.04E-05	-6.14E-05	-6.07E-05
Ps90%/90% (-KTL) Un-Biased	-6.87E-05	-6.92E-05	-6.77E-05	-6.83E-05	-6.75E-05
Specification MAX	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Status	PASS	PASS	PASS	PASS	PASS

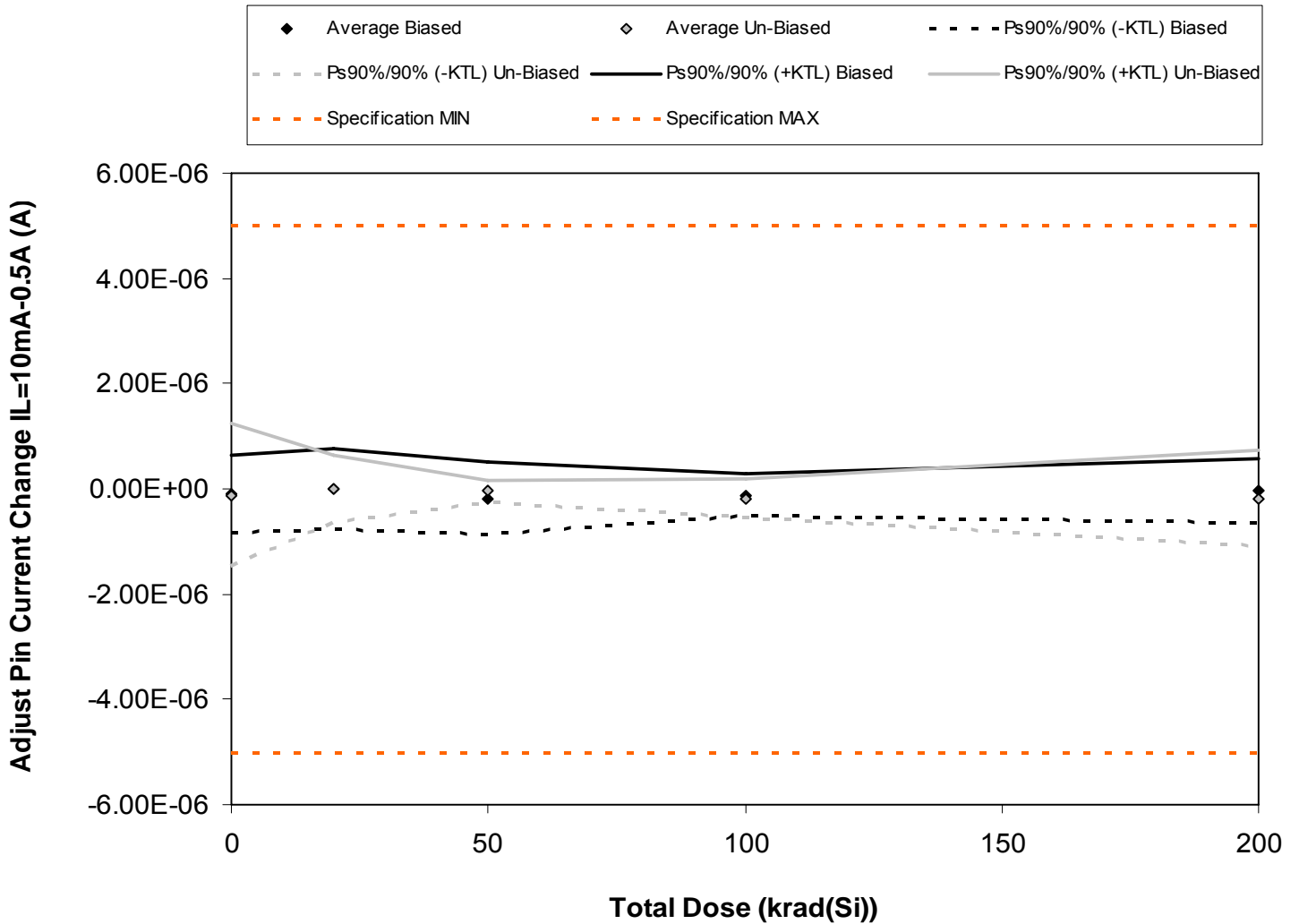


Figure 5.12. Plot of Adjust Pin Current Change IL=10mA-0.5A (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.12. Raw data for Adjust Pin Current Change IL=10mA-0.5A (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Adjust Pin Current Change IL=10mA-0.5A (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-3.60E-07	2.70E-07	-4.50E-07	0.00E+00	1.60E-07
792	-3.10E-07	-3.80E-07	-2.00E-08	-1.80E-07	-2.90E-07
793	3.10E-07	2.50E-07	0.00E+00	-3.30E-07	2.20E-07
794	-9.00E-08	-1.80E-07	4.00E-08	2.00E-08	0.00E+00
795	0.00E+00	0.00E+00	-4.50E-07	-9.00E-08	-2.00E-07
796	-5.10E-07	1.30E-07	0.00E+00	0.00E+00	-9.00E-08
797	-3.60E-07	3.10E-07	0.00E+00	-2.50E-07	-5.80E-07
798	-4.00E-07	-1.10E-07	-7.00E-08	-7.00E-08	-4.70E-07
799	7.10E-07	-2.90E-07	0.00E+00	-2.70E-07	2.00E-08
800	0.00E+00	-7.00E-08	-1.60E-07	-3.10E-07	2.00E-07
802	-4.50E-07	-7.00E-08	-2.00E-08	2.20E-07	-1.10E-07
803	-1.60E-07	-3.10E-07	-2.70E-07	-3.60E-07	0.00E+00
Biased Statistics					
Average Biased	-9.00E-08	-8.00E-09	-1.76E-07	-1.16E-07	-2.20E-08
Std Dev Biased	2.69E-07	2.79E-07	2.51E-07	1.44E-07	2.21E-07
Ps90%/90% (+KTL) Biased	6.48E-07	7.58E-07	5.12E-07	2.78E-07	5.84E-07
Ps90%/90% (-KTL) Biased	-8.28E-07	-7.74E-07	-8.64E-07	-5.10E-07	-6.28E-07
Un-Biased Statistics					
Average Un-Biased	-1.12E-07	-6.00E-09	-4.60E-08	-1.80E-07	-1.84E-07
Std Dev Un-Biased	4.98E-07	2.31E-07	7.06E-08	1.36E-07	3.30E-07
Ps90%/90% (+KTL) Un-Biased	1.25E-06	6.28E-07	1.48E-07	1.94E-07	7.22E-07
Ps90%/90% (-KTL) Un-Biased	-1.48E-06	-6.40E-07	-2.40E-07	-5.54E-07	-1.09E-06
Specification MIN	-5.00E-06	-5.00E-06	-5.00E-06	-5.00E-06	-5.00E-06
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06
Status	PASS	PASS	PASS	PASS	PASS

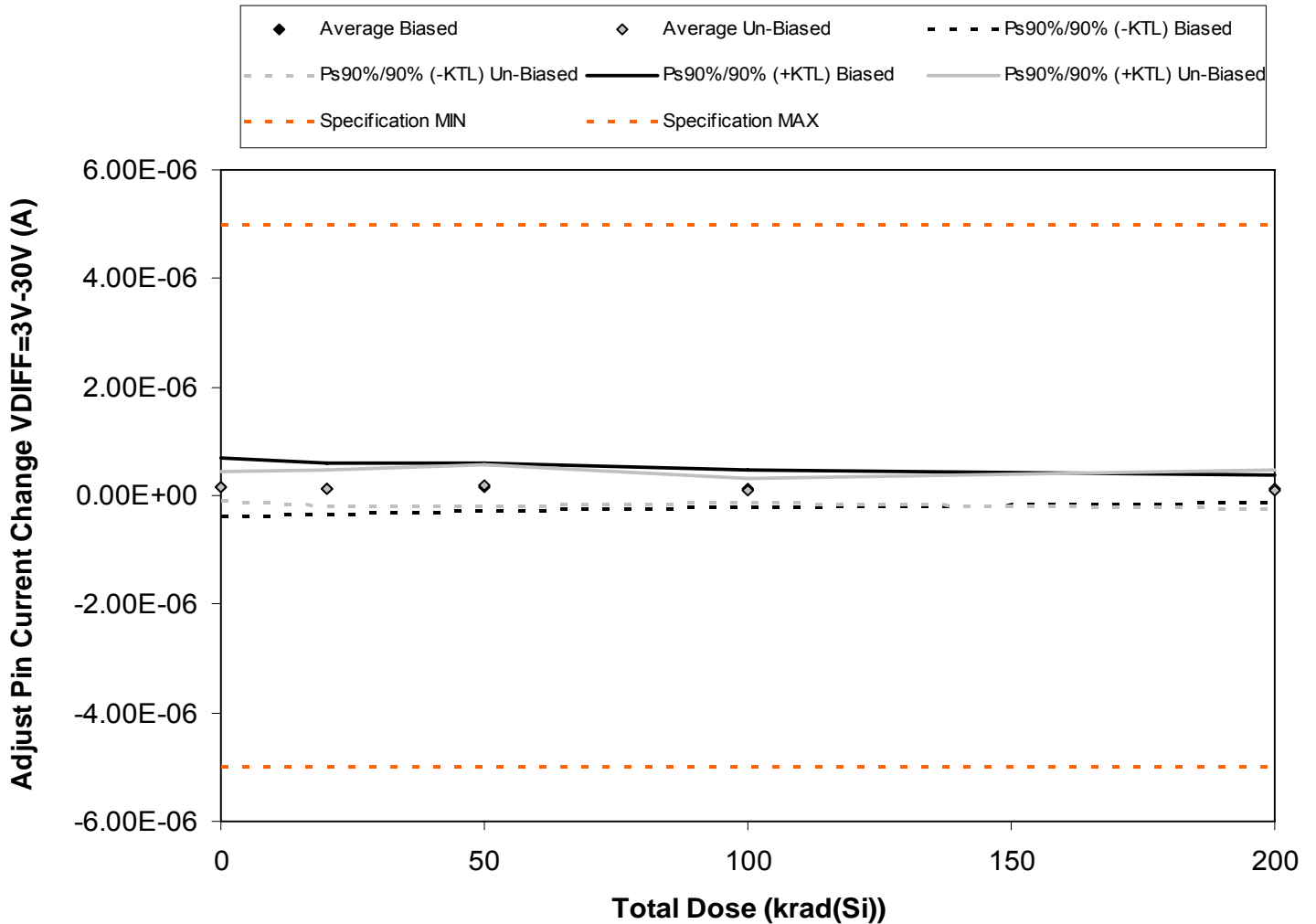


Figure 5.13. Plot of Adjust Pin Current Change VDIFF=3V-30V (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.13. Raw data for Adjust Pin Current Change VDIFF=3V-30V (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Adjust Pin Current Change VDIFF=3V-30V (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	3.80E-07	4.00E-07	1.10E-07	4.00E-08	9.00E-08
792	2.20E-07	1.60E-07	1.30E-07	2.70E-07	4.00E-08
793	1.30E-07	-7.00E-08	-2.00E-08	2.70E-07	2.50E-07
794	2.20E-07	2.00E-08	4.20E-07	4.00E-08	1.80E-07
795	-1.60E-07	1.10E-07	1.60E-07	2.00E-08	4.00E-08
796	2.20E-07	2.20E-07	0.00E+00	4.00E-08	2.70E-07
797	2.70E-07	4.00E-08	3.10E-07	9.00E-08	2.20E-07
798	1.80E-07	0.00E+00	3.10E-07	1.80E-07	4.00E-08
799	0.00E+00	2.70E-07	9.00E-08	0.00E+00	-2.00E-08
800	1.80E-07	1.80E-07	2.20E-07	1.80E-07	4.00E-08
802	1.80E-07	1.80E-07	3.30E-07	9.00E-08	2.20E-07
803	4.00E-08	4.50E-07	2.00E-07	2.50E-07	4.00E-08
Biased Statistics					
Average Biased	1.58E-07	1.24E-07	1.60E-07	1.28E-07	1.20E-07
Std Dev Biased	1.99E-07	1.78E-07	1.61E-07	1.30E-07	9.25E-08
Ps90%/90% (+KTL) Biased	7.04E-07	6.11E-07	6.01E-07	4.84E-07	3.74E-07
Ps90%/90% (-KTL) Biased	-3.88E-07	-3.63E-07	-2.81E-07	-2.28E-07	-1.34E-07
Un-Biased Statistics					
Average Un-Biased	1.70E-07	1.42E-07	1.86E-07	9.80E-08	1.10E-07
Std Dev Un-Biased	1.02E-07	1.17E-07	1.38E-07	8.14E-08	1.27E-07
Ps90%/90% (+KTL) Un-Biased	4.50E-07	4.62E-07	5.63E-07	3.21E-07	4.58E-07
Ps90%/90% (-KTL) Un-Biased	-1.10E-07	-1.78E-07	-1.91E-07	-1.25E-07	-2.38E-07
Specification MIN	-5.00E-06	-5.00E-06	-5.00E-06	-5.00E-06	-5.00E-06
Status	PASS	PASS	PASS	PASS	PASS
Specification MAX	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06
Status	PASS	PASS	PASS	PASS	PASS

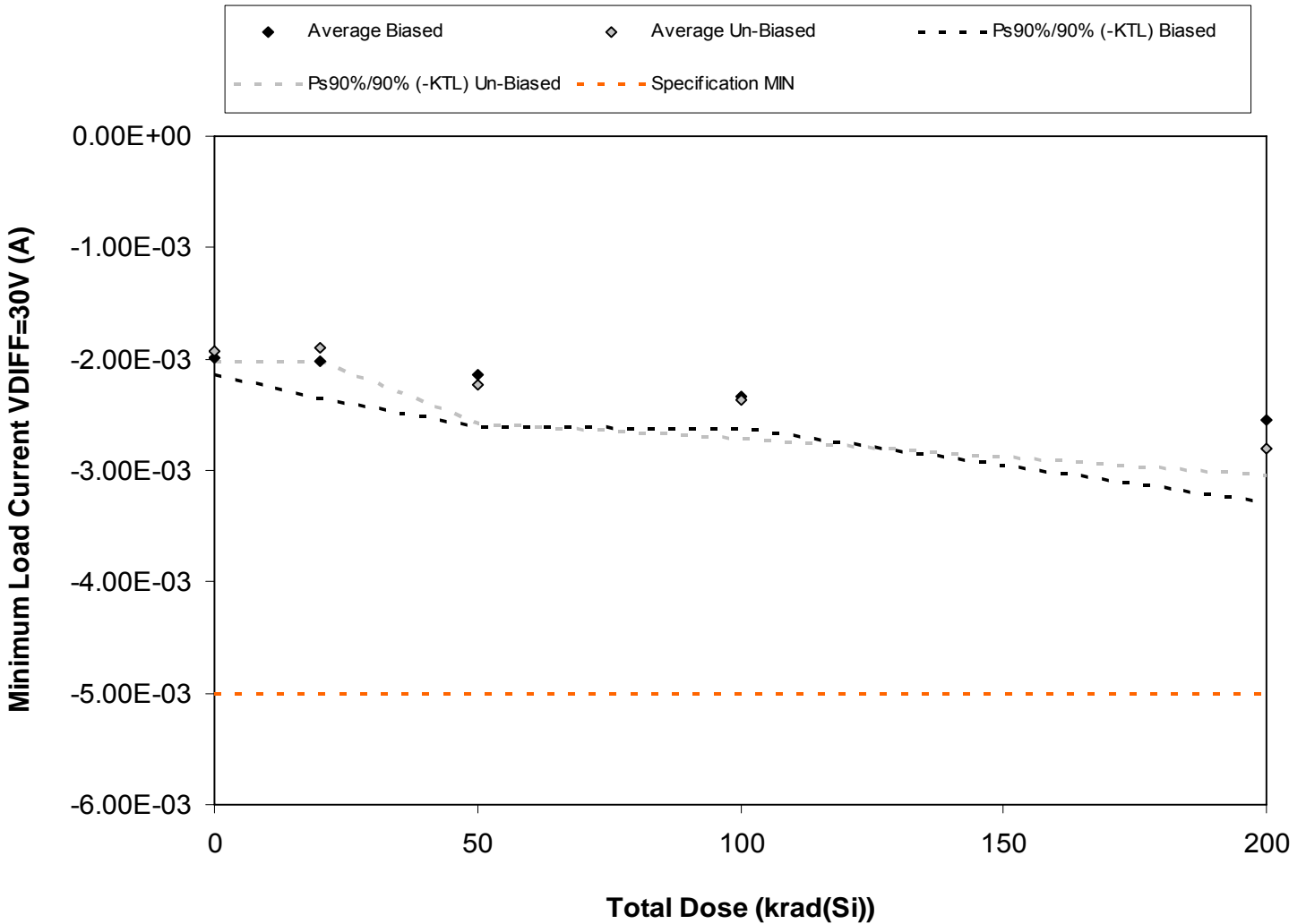


Figure 5.14. Plot of Minimum Load Current VDIFF=30V (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.14. Raw data for Minimum Load Current VDIFF=30V (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Minimum Load Current VDIFF=30V (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-2.02E-03	-1.96E-03	-1.98E-03	-2.41E-03	-2.53E-03
792	-1.96E-03	-2.08E-03	-2.06E-03	-2.33E-03	-2.16E-03
793	-1.98E-03	-2.20E-03	-2.04E-03	-2.22E-03	-2.69E-03
794	-2.06E-03	-1.96E-03	-2.41E-03	-2.47E-03	-2.49E-03
795	-1.93E-03	-1.88E-03	-2.18E-03	-2.26E-03	-2.88E-03
796	-1.91E-03	-1.82E-03	-2.30E-03	-2.18E-03	-2.84E-03
797	-1.93E-03	-1.93E-03	-2.43E-03	-2.32E-03	-2.67E-03
798	-1.93E-03	-1.93E-03	-2.16E-03	-2.49E-03	-2.80E-03
799	-1.98E-03	-1.93E-03	-2.16E-03	-2.47E-03	-2.80E-03
800	-1.94E-03	-1.88E-03	-2.14E-03	-2.39E-03	-2.90E-03
802	-1.93E-03	-1.86E-03	-2.08E-03	-2.39E-03	-2.57E-03
803	-1.87E-03	-1.79E-03	-2.08E-03	-2.28E-03	-2.78E-03
Biased Statistics					
Average Biased	-1.99E-03	-2.02E-03	-2.13E-03	-2.34E-03	-2.55E-03
Std Dev Biased	5.25E-05	1.22E-04	1.71E-04	1.06E-04	2.67E-04
Ps90%/90% (+KTL) Biased	-1.85E-03	-1.68E-03	-1.67E-03	-2.05E-03	-1.82E-03
Ps90%/90% (-KTL) Biased	-2.13E-03	-2.35E-03	-2.60E-03	-2.63E-03	-3.28E-03
Un-Biased Statistics					
Average Un-Biased	-1.94E-03	-1.90E-03	-2.24E-03	-2.37E-03	-2.80E-03
Std Dev Un-Biased	2.83E-05	4.45E-05	1.25E-04	1.27E-04	8.67E-05
Ps90%/90% (+KTL) Un-Biased	-1.86E-03	-1.77E-03	-1.89E-03	-2.02E-03	-2.56E-03
Ps90%/90% (-KTL) Un-Biased	-2.01E-03	-2.02E-03	-2.58E-03	-2.72E-03	-3.04E-03
Specification MIN	-5.00E-03	-5.00E-03	-5.00E-03	-5.00E-03	-5.00E-03
Status	PASS	PASS	PASS	PASS	PASS

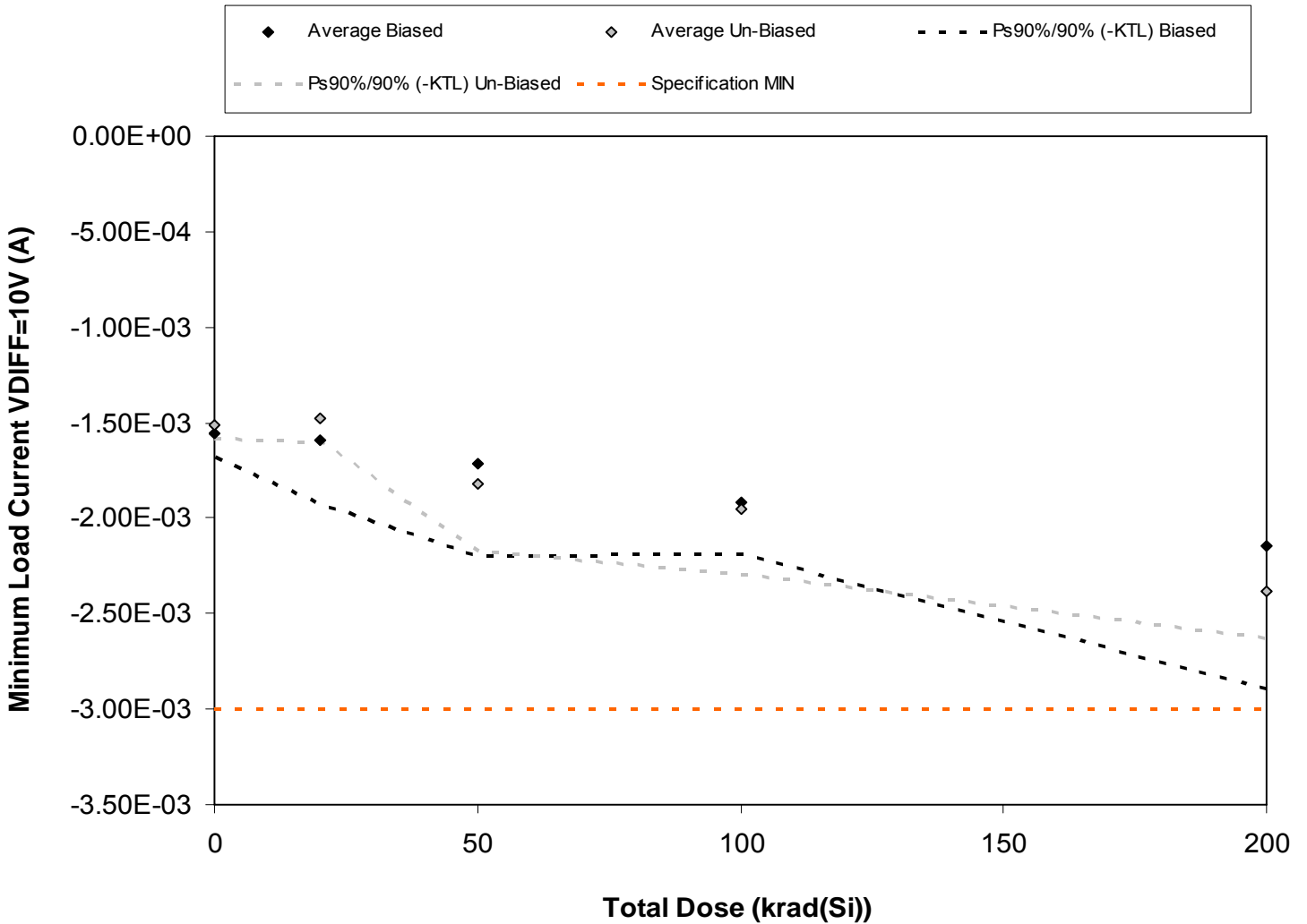


Figure 5.15. Plot of Minimum Load Current VDIFF=10V (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.15. Raw data for Minimum Load Current VDIFF=10V (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Minimum Load Current VDIFF=10V (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-1.59E-03	-1.53E-03	-1.56E-03	-1.98E-03	-2.12E-03
792	-1.55E-03	-1.67E-03	-1.65E-03	-1.93E-03	-1.75E-03
793	-1.55E-03	-1.77E-03	-1.61E-03	-1.79E-03	-2.28E-03
794	-1.61E-03	-1.53E-03	-2.00E-03	-2.04E-03	-2.08E-03
795	-1.50E-03	-1.48E-03	-1.77E-03	-1.84E-03	-2.49E-03
796	-1.50E-03	-1.40E-03	-1.88E-03	-1.77E-03	-2.43E-03
797	-1.50E-03	-1.50E-03	-2.02E-03	-1.88E-03	-2.24E-03
798	-1.50E-03	-1.52E-03	-1.75E-03	-2.08E-03	-2.39E-03
799	-1.55E-03	-1.50E-03	-1.73E-03	-2.04E-03	-2.39E-03
800	-1.53E-03	-1.48E-03	-1.73E-03	-1.98E-03	-2.47E-03
802	-1.50E-03	-1.46E-03	-1.65E-03	-1.97E-03	-2.14E-03
803	-1.46E-03	-1.36E-03	-1.67E-03	-1.86E-03	-2.37E-03
Biased Statistics					
Average Biased	-1.56E-03	-1.60E-03	-1.72E-03	-1.92E-03	-2.14E-03
Std Dev Biased	4.33E-05	1.21E-04	1.77E-04	1.01E-04	2.73E-04
Ps90%/90% (+KTL) Biased	-1.44E-03	-1.26E-03	-1.23E-03	-1.64E-03	-1.39E-03
Ps90%/90% (-KTL) Biased	-1.68E-03	-1.93E-03	-2.20E-03	-2.19E-03	-2.89E-03
Un-Biased Statistics					
Average Un-Biased	-1.51E-03	-1.48E-03	-1.82E-03	-1.95E-03	-2.38E-03
Std Dev Un-Biased	2.56E-05	4.68E-05	1.28E-04	1.26E-04	8.87E-05
Ps90%/90% (+KTL) Un-Biased	-1.44E-03	-1.35E-03	-1.47E-03	-1.61E-03	-2.14E-03
Ps90%/90% (-KTL) Un-Biased	-1.58E-03	-1.60E-03	-2.17E-03	-2.29E-03	-2.63E-03
Specification MIN	-3.00E-03	-3.00E-03	-3.00E-03	-3.00E-03	-3.00E-03
Status	PASS	PASS	PASS	PASS	PASS

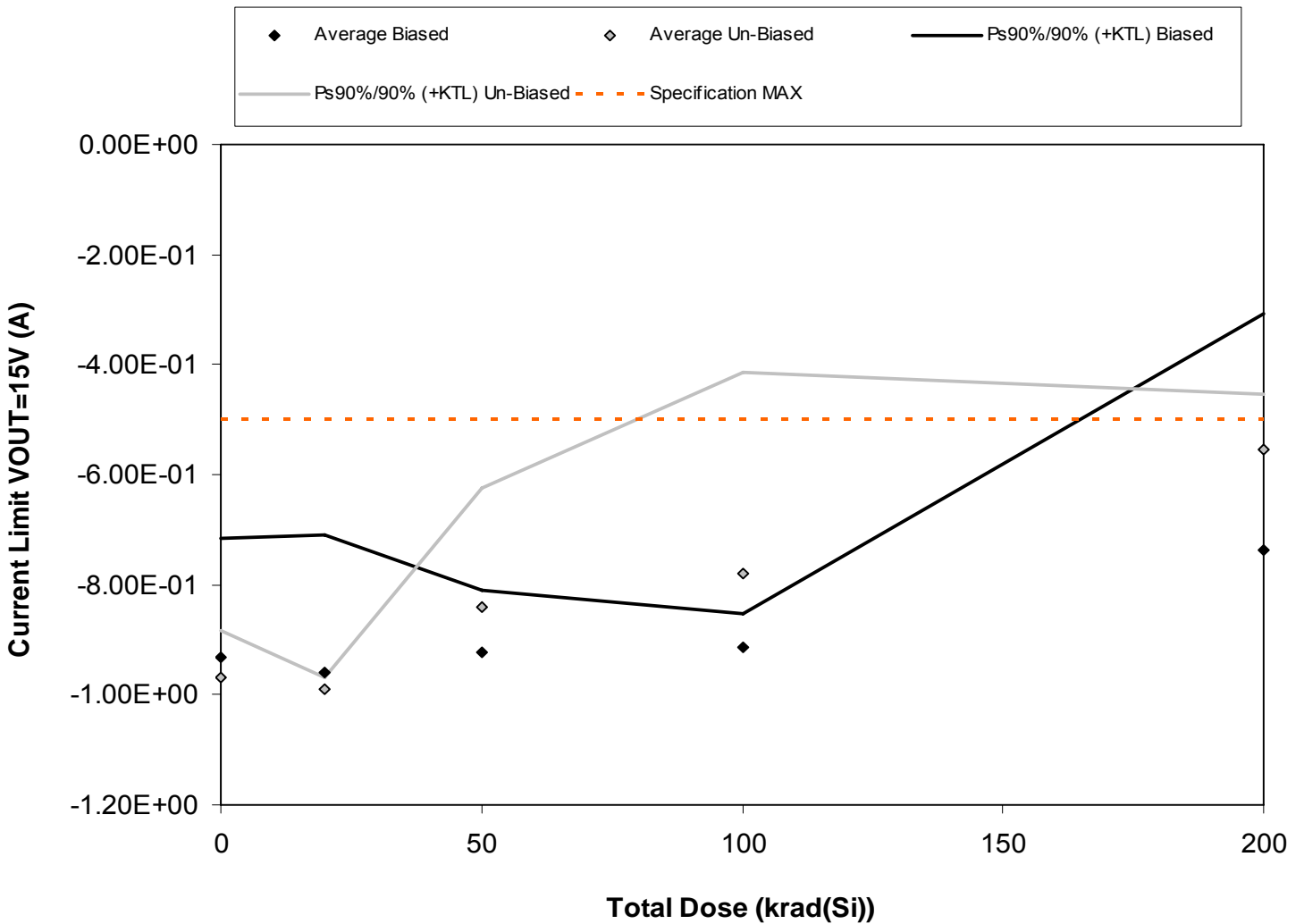


Figure 5.16. Plot of Current Limit VOUT=15V (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.16. Raw data for Current Limit VOUT=15V (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Current Limit VOUT=15V (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-8.19E-01	-9.42E-01	-9.74E-01	-9.13E-01	-7.08E-01
792	-9.30E-01	-8.42E-01	-9.19E-01	-9.13E-01	-9.19E-01
793	-9.75E-01	-9.08E-01	-9.47E-01	-9.41E-01	-6.13E-01
794	-9.08E-01	-1.05E+00	-8.63E-01	-8.80E-01	-8.80E-01
795	-1.03E+00	-1.05E+00	-9.13E-01	-9.19E-01	-5.69E-01
796	-9.42E-01	-9.97E-01	-8.97E-01	-8.97E-01	-5.41E-01
797	-9.97E-01	-1.00E+00	-7.35E-01	-9.08E-01	-6.02E-01
798	-9.30E-01	-9.85E-01	-9.13E-01	-6.63E-01	-5.08E-01
799	-9.86E-01	-9.85E-01	-7.80E-01	-6.19E-01	-5.80E-01
800	-9.92E-01	-9.85E-01	-8.85E-01	-8.19E-01	-5.41E-01
802	-9.69E-01	-9.85E-01	-9.35E-01	-8.19E-01	-6.80E-01
803	-1.05E+00	-1.05E+00	-9.08E-01	-8.74E-01	-6.08E-01
Biased Statistics					
Average Biased	-9.32E-01	-9.58E-01	-9.23E-01	-9.13E-01	-7.38E-01
Std Dev Biased	7.87E-02	9.10E-02	4.15E-02	2.18E-02	1.57E-01
Ps90%/90% (+KTL) Biased	-7.16E-01	-7.09E-01	-8.09E-01	-8.53E-01	-3.09E-01
Ps90%/90% (-KTL) Biased	-1.15E+00	-1.21E+00	-1.04E+00	-9.73E-01	-1.17E+00
Un-Biased Statistics					
Average Un-Biased	-9.69E-01	-9.91E-01	-8.42E-01	-7.81E-01	-5.54E-01
Std Dev Un-Biased	3.10E-02	8.49E-03	7.94E-02	1.33E-01	3.69E-02
Ps90%/90% (+KTL) Un-Biased	-8.84E-01	-9.68E-01	-6.24E-01	-4.15E-01	-4.53E-01
Ps90%/90% (-KTL) Un-Biased	-1.05E+00	-1.01E+00	-1.06E+00	-1.15E+00	-6.55E-01
Specification MAX	-5.00E-01	-5.00E-01	-5.00E-01	-5.00E-01	-5.00E-01
Status	PASS	PASS	PASS	PASS	PASS

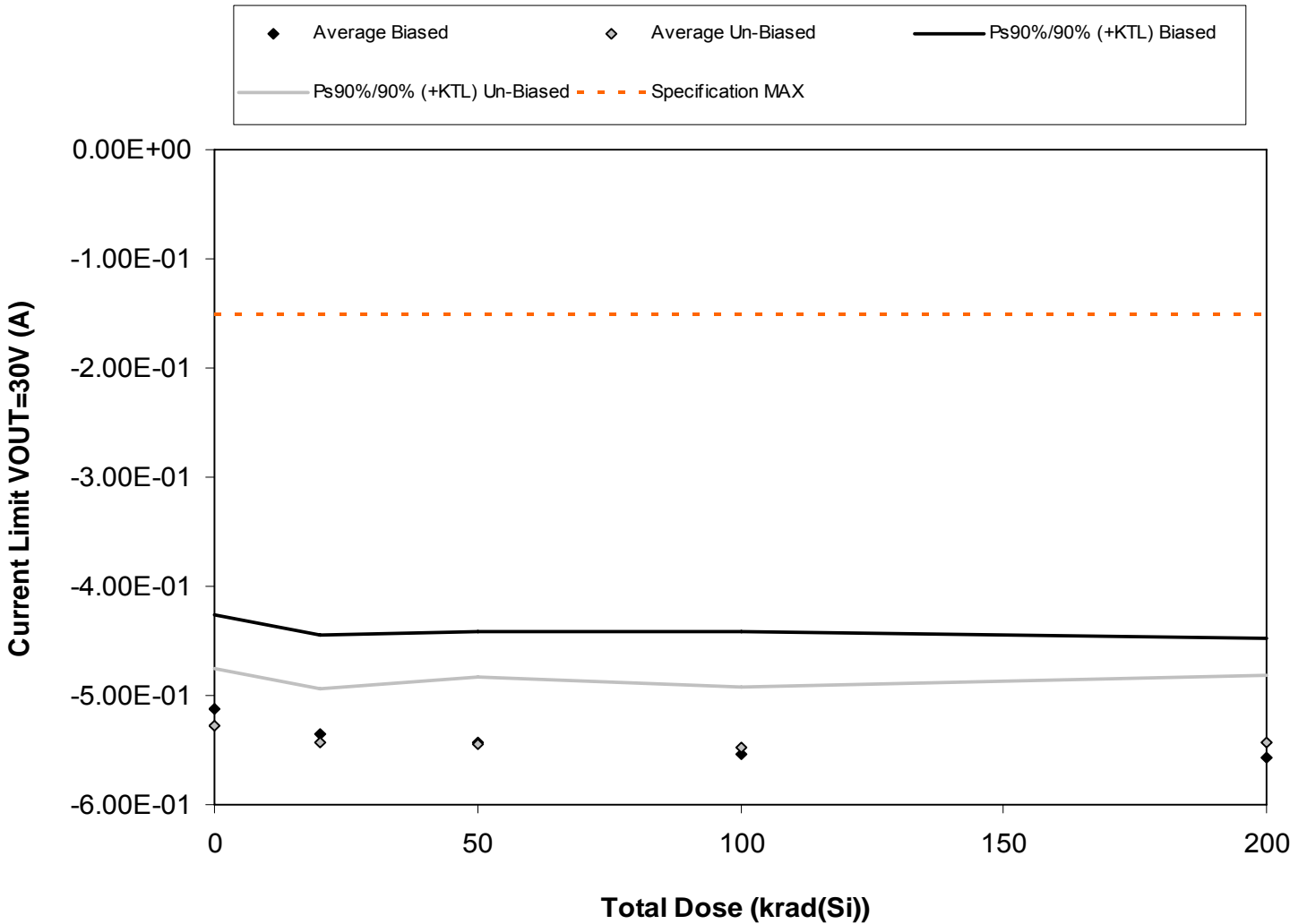


Figure 5.17. Plot of Current Limit VOUT=30V (A) versus total dose. The solid diamonds are the average of the measured data points for the samples irradiated under electrical bias while the shaded diamonds are the average of the measured data points for the samples irradiated with all pins tied to ground. The black lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated under electrical bias while the gray lines (solid and/or dashed) are the average of the data points after application of the KTL statistics on the samples irradiated in the unbiased condition. The red dotted line(s) are the pre- and/or post-irradiation minimum and/or maximum specification value as defined in the datasheet and/or test plan.



Table 5.17. Raw data for Current Limit VOUT=30V (A) versus total dose, including the statistical analysis, specification and the status of the testing (pass/fail).

Current Limit VOUT=30V (A)	Total Dose (krad(Si))				
	0	20	50	100	200
Device					
791	-4.69E-01	-4.86E-01	-4.86E-01	-4.97E-01	-5.02E-01
792	-5.14E-01	-5.25E-01	-5.30E-01	-5.36E-01	-5.41E-01
793	-5.25E-01	-5.47E-01	-5.47E-01	-5.52E-01	-5.52E-01
794	-4.97E-01	-5.42E-01	-5.69E-01	-5.97E-01	-5.96E-01
795	-5.53E-01	-5.75E-01	-5.80E-01	-5.91E-01	-5.96E-01
796	-4.97E-01	-5.14E-01	-5.13E-01	-5.19E-01	-5.13E-01
797	-5.30E-01	-5.42E-01	-5.36E-01	-5.41E-01	-5.35E-01
798	-5.25E-01	-5.47E-01	-5.47E-01	-5.47E-01	-5.41E-01
799	-5.36E-01	-5.52E-01	-5.52E-01	-5.58E-01	-5.52E-01
800	-5.47E-01	-5.63E-01	-5.74E-01	-5.74E-01	-5.74E-01
802	-5.36E-01	-5.41E-01	-5.47E-01	-5.41E-01	-5.52E-01
803	-4.86E-01	-4.80E-01	-4.86E-01	-4.80E-01	-4.91E-01
Biased Statistics					
Average Biased	-5.12E-01	-5.35E-01	-5.42E-01	-5.55E-01	-5.57E-01
Std Dev Biased	3.13E-02	3.28E-02	3.70E-02	4.12E-02	3.98E-02
Ps90%/90% (+KTL) Biased	-4.26E-01	-4.45E-01	-4.41E-01	-4.42E-01	-4.48E-01
Ps90%/90% (-KTL) Biased	-5.98E-01	-6.25E-01	-6.44E-01	-6.68E-01	-6.67E-01
Un-Biased Statistics					
Average Un-Biased	-5.27E-01	-5.44E-01	-5.44E-01	-5.48E-01	-5.43E-01
Std Dev Un-Biased	1.87E-02	1.83E-02	2.23E-02	2.04E-02	2.24E-02
Ps90%/90% (+KTL) Un-Biased	-4.76E-01	-4.93E-01	-4.83E-01	-4.92E-01	-4.82E-01
Ps90%/90% (-KTL) Un-Biased	-5.78E-01	-5.94E-01	-6.06E-01	-6.04E-01	-6.04E-01
Specification MAX	-1.50E-01	-1.50E-01	-1.50E-01	-1.50E-01	-1.50E-01
Status	PASS	PASS	PASS	PASS	PASS



6.0. Summary / Conclusions

The total ionizing dose testing described in this final report was performed using the facilities at Radiation Assured Devices' Longmire Laboratories in Colorado Springs, CO. The high dose rate total ionizing dose (TID) source is a JLSA 84-21 irradiator modified to provide a panoramic exposure. The Co-60 rods are held in the base of the irradiator heavily shielded by lead, during the radiation exposures the rod is raised by an electronic timer/controller and the exposure is performed in air. The dose rate for this irradiator in this configuration ranges from $<1\text{rad}(\text{Si})/\text{s}$ to a maximum of approximately $120\text{rad}(\text{Si})/\text{s}$, determined by the distance from the source.

The parametric data was obtained as read and record and all the raw data plus an attributes summary are contained in a separate Excel file. The attributes data contains the average, standard deviation and the average with the KTL values applied. The KTL value used in this work is 2.742 per MIL-HDBK-814 using one sided tolerance limits of 90/90 and a 5-piece sample size. The 90/90 KTL values were selected to match the statistical levels specified in the MIL-PRF-38535 sampling plan for the qualification of a radiation hardness assured (RHA) component. Note that the following criteria must be met for a device to pass the RLAT: following the radiation exposure each of the 5 pieces irradiated under electrical bias shall pass the specification value. The units irradiated without electrical bias and the KTL statistics are included in this report for reference only. If any of the 5 pieces irradiated under electrical bias exceed the datasheet specifications, then the lot could be logged as a failure.

Based on this criterion the RH137H Negative Adjustable Regulator (from the lot date code/traceability information identified on the first page of this test report) PASSED the RLAT to the maximum dose level of $200\text{krad}(\text{Si})$ with only moderate degradation to the reference voltage parameters and no significant degradation to any other measured parameter. Note that the data for the units-under-test irradiated in the unbiased condition and the KTL statistics presented in this report are for reference only and are not used for the determination of "PASS/FAIL" for the lot.



Appendix A: Photograph of device-under-test to show part markings





Appendix B: TID Bias Connections

Biased Samples:

Pin	Function	Connection / Bias
1	ADJ	2k Ω to +15V
2	VOUT	243 Ω to +15V, 0.1 μ F decoupling from +15V to GND
3/CASE	VIN	To -15V, 0.1 μ F decoupling from -15V to GND

Unbiased Samples:

Pin	Function	Connection / Bias
1	ADJ	GND
2	VOUT	GND
3/CASE	VIN	GND

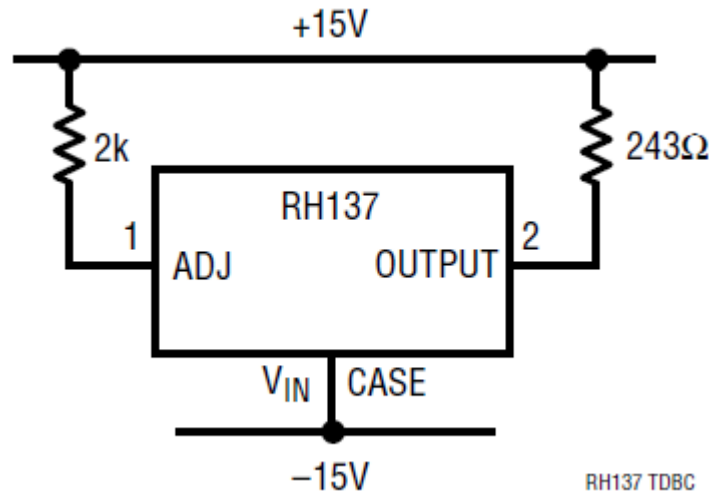


Figure B.1. Irradiation bias drawing for the units to be irradiated under electrical bias. This figure was extracted from LINEAR TECHNOLOGY CORPORATION, RH137 Datasheet.

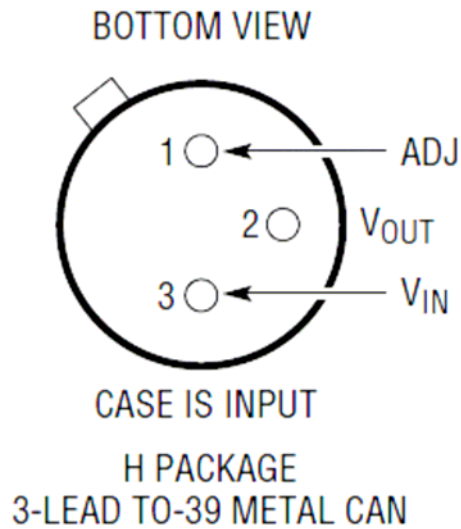


Figure B.2. H package drawing (for reference only). This figure was extracted from the LINEAR TECHNOLOGY CORPORATION RH137 Datasheet.



Appendix C: Electrical Test Parameters and Conditions

All electrical tests for this device are performed on one of Radiation Assured Device's LTS2020 Test Systems. The LTS2020 Test System is a programmable parametric tester that provides parameter measurements for a variety of digital, analog and mixed signal products including voltage regulators, voltage comparators, D to A and A to D converters. The LTS2020 Test System achieves accuracy and sensitivity through the use of software self-calibration and an internal relay matrix with separate family boards and custom personality adapter boards. The tester uses this relay matrix to connect the required test circuits, select the appropriate voltage / current sources and establish the needed measurement loops for all the tests performed. The tests will be conducted using the LTS-2101 Linear Family Board, LTS-0606 Socket Assembly and the RH137 DUT board. The measured parameters and test conditions are shown in Tables C.1.

A listing of the measurement precision/resolution for each parameter is shown in Tables C.2. The precision/resolution values were obtained either from test data or from the DAC resolution of the LTS-2020. To generate the precision/resolution shown in Table C.2, one of the units-under-test was tested repetitively (a total of 10-times with re-insertion between tests) to obtain the average test value and standard deviation. Using this test data MIL-HDBK-814 90/90 KTL statistics were applied to the measured standard deviation to generate the final measurement range. This value encompasses the precision/resolution of all aspects of the test system, including the LTS2020 mainframe, family board, socket assembly and DUT board as well as insertion error. In some cases, the measurement resolution is limited by the internal DACs, which results in a measured standard deviation of zero. In these instances the precision/resolution will be reported back as the LSB of the DAC.

Note that the testing and statistics used in this document are based on an "analysis of variables" technique, which relies on small sample sizes to qualify much larger lot sizes (see MIL-HDBK-814, p. 91 for a discussion of statistical treatments). Not all measured parameters are well suited to this approach due to inherent large variations. If necessary, larger samples sizes could be used to qualify these parameters using an "attributes" approach.



Table C.1. Measured parameters and test conditions RH137H.

TEST DESCRIPTION	TEST CONDITIONS
Reference Voltage	$V_{DIFF}=V_{IN}-V_{OUT}=5V, I_L=10mA$
	$V_{DIFF}=3V, I_L=10mA$
	$V_{DIFF}=30V, I_L=10mA$
	$V_{DIFF}=3V, I_L=0.5A$
	$V_{DIFF}=30V, I_L=0.05A$
Line Regulation	$V_{DIFF}=3V$ to $30V, I_L=10mA$
Load Regulation $V_{OUT} \leq 5V$	$V_{DIFF}=5V, V_{IN}=6.25V, I_L=10mA$ to $0.5A$
Load Regulation $V_{OUT} \geq 5V$	$V_{DIFF}=5V, V_{IN}=11.25V, I_L=10mA$ to $0.5A$
Adjust Pin Current	$V_{DIFF}=3V, I_L=10mA$
	$V_{DIFF}=5V, I_L=10mA$
	$V_{DIFF}=30V, I_L=10mA$
Adjust Pin Current Change	$V_{DIFF}=5V, I_L=10mA$ to $0.5A$
	$V_{DIFF}=3V$ to $30V, I_L=10mA$
Minimum Load Current	$V_{DIFF}=30V$
	$V_{DIFF}=10V$
Current Limit $V_{DIFF} \leq 15V$	$V_{DIFF}=15V$
Current Limit $V_{DIFF}=30V$	$V_{DIFF}=30V$

Table C.2. Measured parameters, pre-irradiation specifications and measurement resolutions for the RH137H.

Measured Parameter	Pre-Irradiation Specification	Measurement Resolution/Precision
Reference Voltage	$1.25V \pm 25mV$ $1.25V \pm 50mV$	$\pm 2.62E-03V$
Line Regulation	0.02%/V MAX	$\pm 6.78E-04\%/V$
Load Regulation $V_{OUT} \leq 5V$	25mV MAX	1.35E-03V
Load Regulation $V_{OUT} \geq 5V$	0.5% MAX	3.80E-02%
Adjust Pin Current	100 μ A MAX	9.83E-07A
Adjust Pin Current Change	$\pm 5\mu$ A MAX	4.39E-07A
Minimum Load Current $V_{DIFF}=30V$	5mA MAX	1.00E-06A
Minimum Load Current $V_{DIFF}=10V$	3mA MAX	1.00E-06A
Current Limit $V_{DIFF} \leq 15V$	0.5A MAX	1.21E-01A
Current Limit $V_{DIFF}=30V$	0.15A MAX	1.42E-02A



Appendix D: List of Figures Used in Section 5 (RLAT Test Results)

- 5.1 Reference Voltage $V_{DIFF}=5V$ $I_L=10mA$ (V)
- 5.2 Reference Voltage $V_{DIFF}=3V$ $I_L=10mA$ (V)
- 5.3 Reference Voltage $V_{DIFF}=30V$ $I_L=10mA$ (V)
- 5.4 Reference Voltage $V_{DIFF}=3V$ $I_L=0.5A$ (V)
- 5.5 Reference Voltage $V_{DIFF}=30V$ $I_L=0.05A$ (V)
- 5.6 Line Regulation (%/V)
- 5.7 Load Regulation $V_{OUT}\leq 5V$ (mV)
- 5.8 Load Regulation $V_{OUT}\geq 5V$ (%)
- 5.9 Adjust Pin Current $V_{DIFF}=3V$ $I_L=10mA$ (A)
- 5.10 Adjust Pin Current $V_{DIFF}=5V$ $I_L=10mA$ (A)
- 5.11 Adjust Pin Current $V_{DIFF}=30V$ $I_L=10mA$ (A)
- 5.12 Adjust Pin Current Change $I_L=10mA-0.5A$ (A)
- 5.13 Adjust Pin Current Change $V_{DIFF}=3V-30V$ (A)
- 5.14 Minimum Load Current $V_{DIFF}=30V$ (A)
- 5.15 Minimum Load Current $V_{DIFF}=10V$ (A)
- 5.16 Current Limit $V_{OUT}=15V$ (A)
- 5.17 Current Limit $V_{OUT}=30V$ (A)