Preliminary Total Dose Radiation Test Report

MSK5065RH
RAD Hard 3A Switching Regulator

Test Date: April, 9, 2025

IC Lot: #1

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TTM Technologies – MSK Products

I. Introduction:

The total dose radiation test plan for the MSK5065RH was developed to qualify the devices as Radiation Hardened to 100 kRAD(Si). The testing was performed beyond 100 kRAD(Si) to show trends in device performance as a function of total dose. The test does not classify maximum radiation tolerance of the device, but simply offers designers insight to the critical parameter-shifts up to the specified total dose level.

MIL-STD-883 Method 1019.7 and ASTM F1892-06 were used as guidelines in the development and implementation of the total dose test plan for the MSK5065RH.

II. Radiation Source:

Total dose was performed at the University of Massachusetts, Lowell MA, using a Cobalt 60 radiation source. The dose rate was determined to be 75.24RAD(Si)/sec. The total dose schedule can be found in Table I.

III. Test Setup:

All test samples were subjected to Group A Electrical Test at 25°C in accordance with the device data sheet. In addition, all devices, with exception of the control devices, received 160 hours of burn-in per MIL-STD-883 Method 1015. For test platform verification, two control devices were tested at 25°C. Ten devices were then tested at 25°C, prior to irradiation, and were found to be within parameter limits.

The devices were vertically aligned with the radiation source and enclosed in a lead/aluminum container during irradiation. Five devices were biased during irradiation. Nominal operating voltage of 12V was used for the bias condition. Five devices had all leads grounded during irradiation for the unbiased condition.

After each irradiation, the device leads were shorted together and transported to the electrical test platform and tested IAW the device data sheet. Testing was performed on irradiated devices, as well as two control devices, at each total dose level. All electrical tests were completed within one hour of irradiation. Each subsequent dose was performed within two hours of the previous irradiation.

IV. Data:

All performance curves are averaged from the test results of the biased and unbiased devices, respectively. If required, full test data can be obtained by contacting TTM Technologies – MSK Products.

V. Summary:

Devices are currently undergoing room-temperature-anneal testing in accordance with MIL-STD-883 Method 1019.9 and results are preliminary pending the conclusion of this testing, on or before 8/2/2025.

All parameters remain within specification at 150kRAD(si) TID and pass 0.99/0.90 statistical analysis at 100kRAD(si) TID, with the exception of Output Voltage Precision, Standby Bias Current Vin=12 EN=1, and Output Current Limit.

For these 3 parameters an explanation is provided along with the charts on pages 11, 12, and 13 respectively.

MSK5065RH Biased/Unbiased Dose Rate Schedule

Dosimetry Equipment
ESR5000

Irradiation Date
04/09/2025

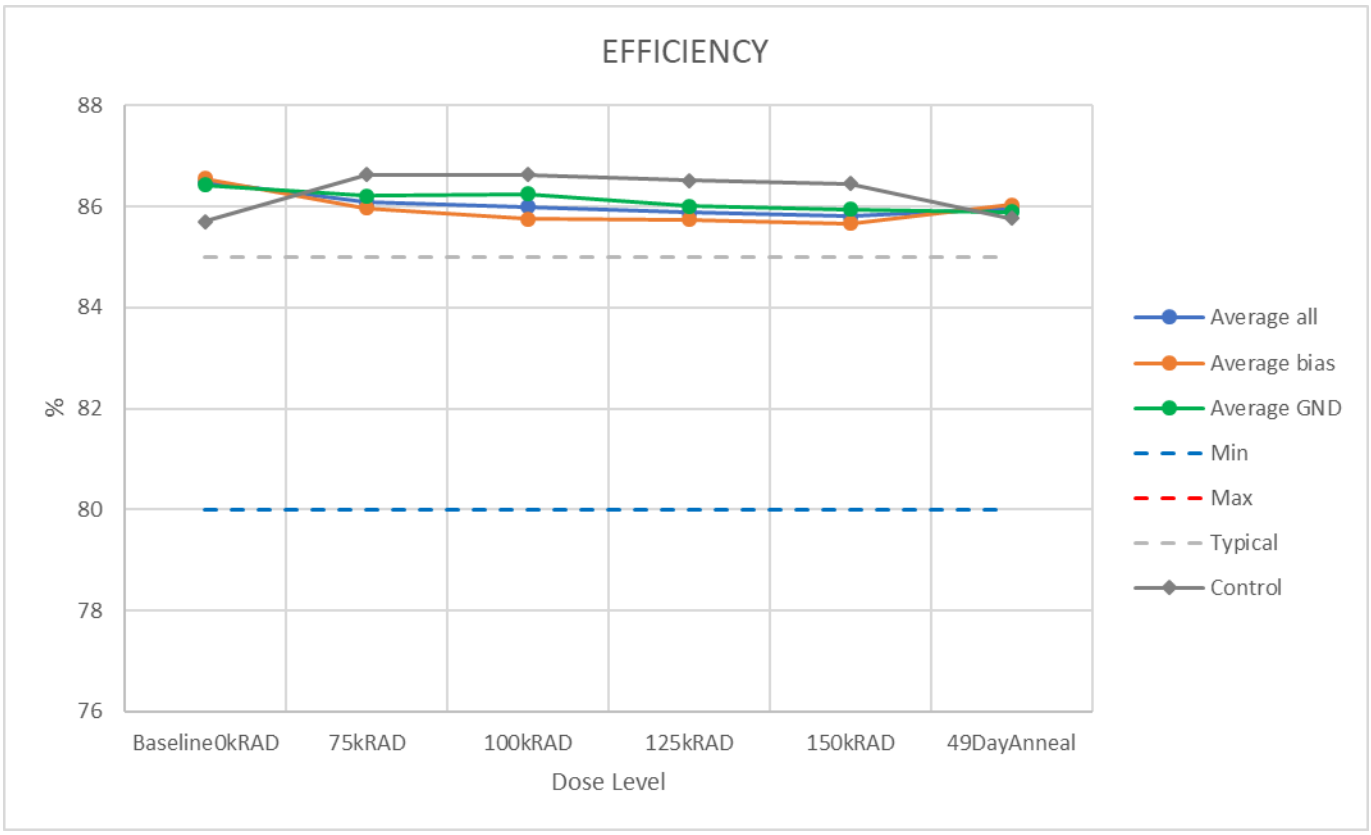
Exposure Length (min:sec)	Incremental Dose RAD(Si)	Cumulative Dose RAD(Si)
17:07	77,300	77,300
4:51	25,800	103,000
4:51	25,800	129,000
4:51	25,800	155,000

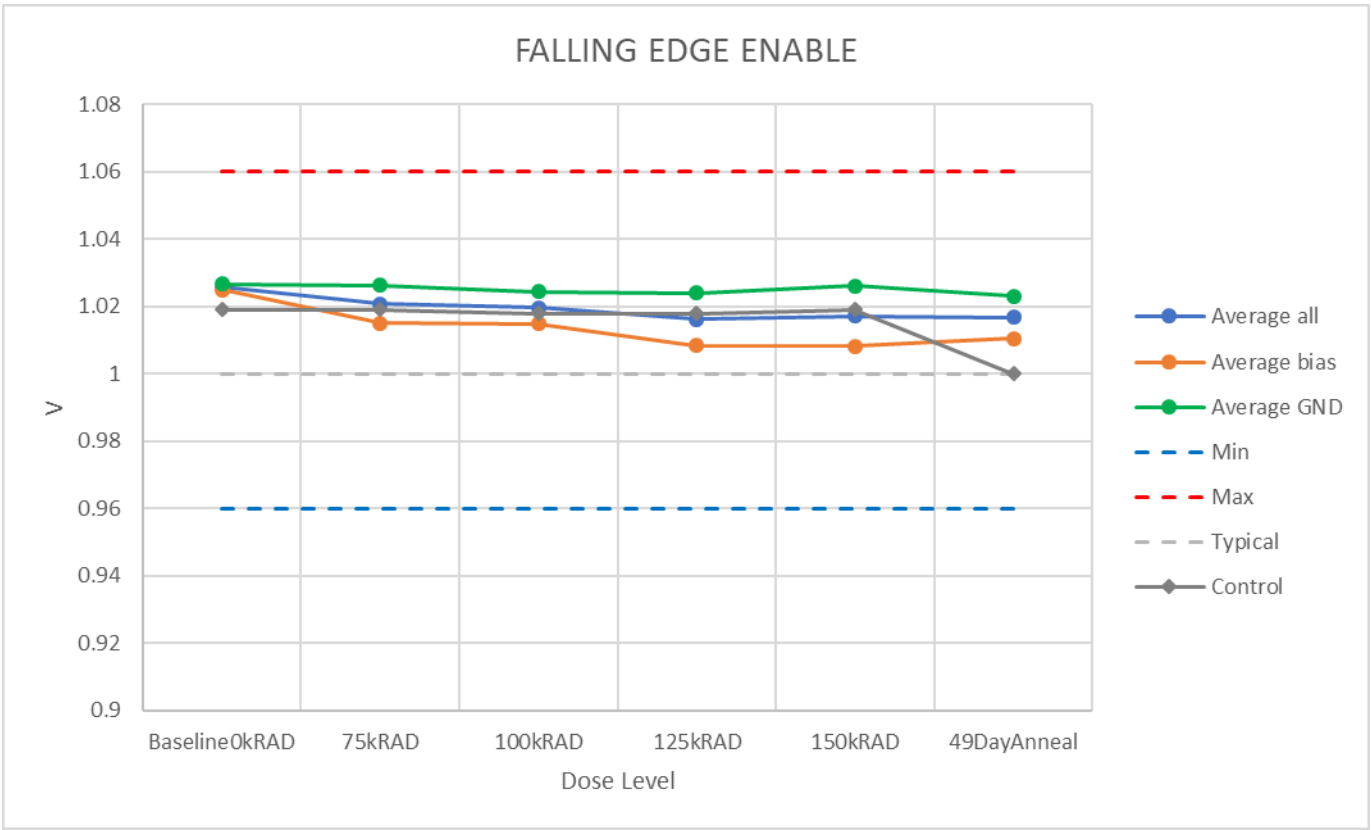
Biased S/N – 2,3,4,6,7

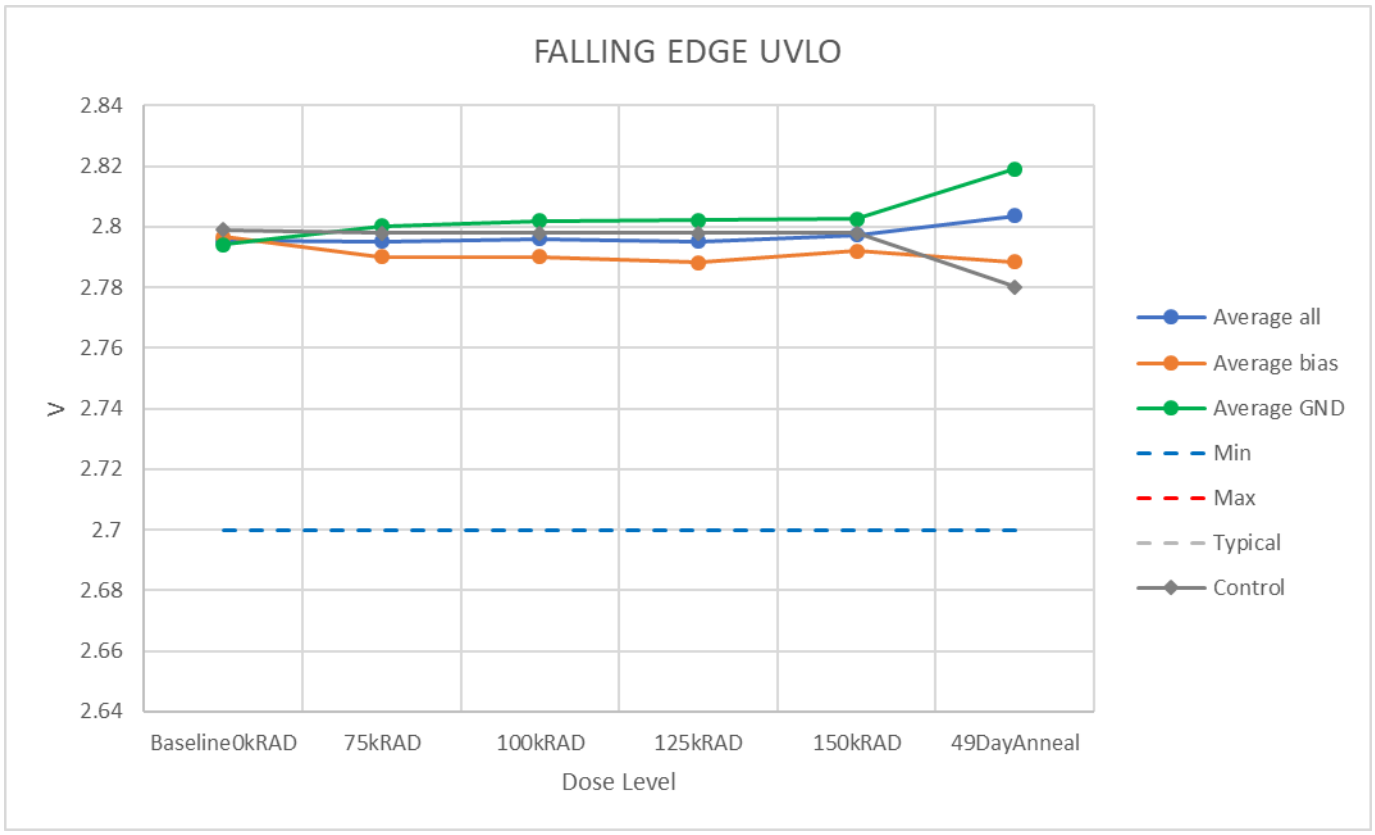
Unbiased S/N – 8,9,10,12,14

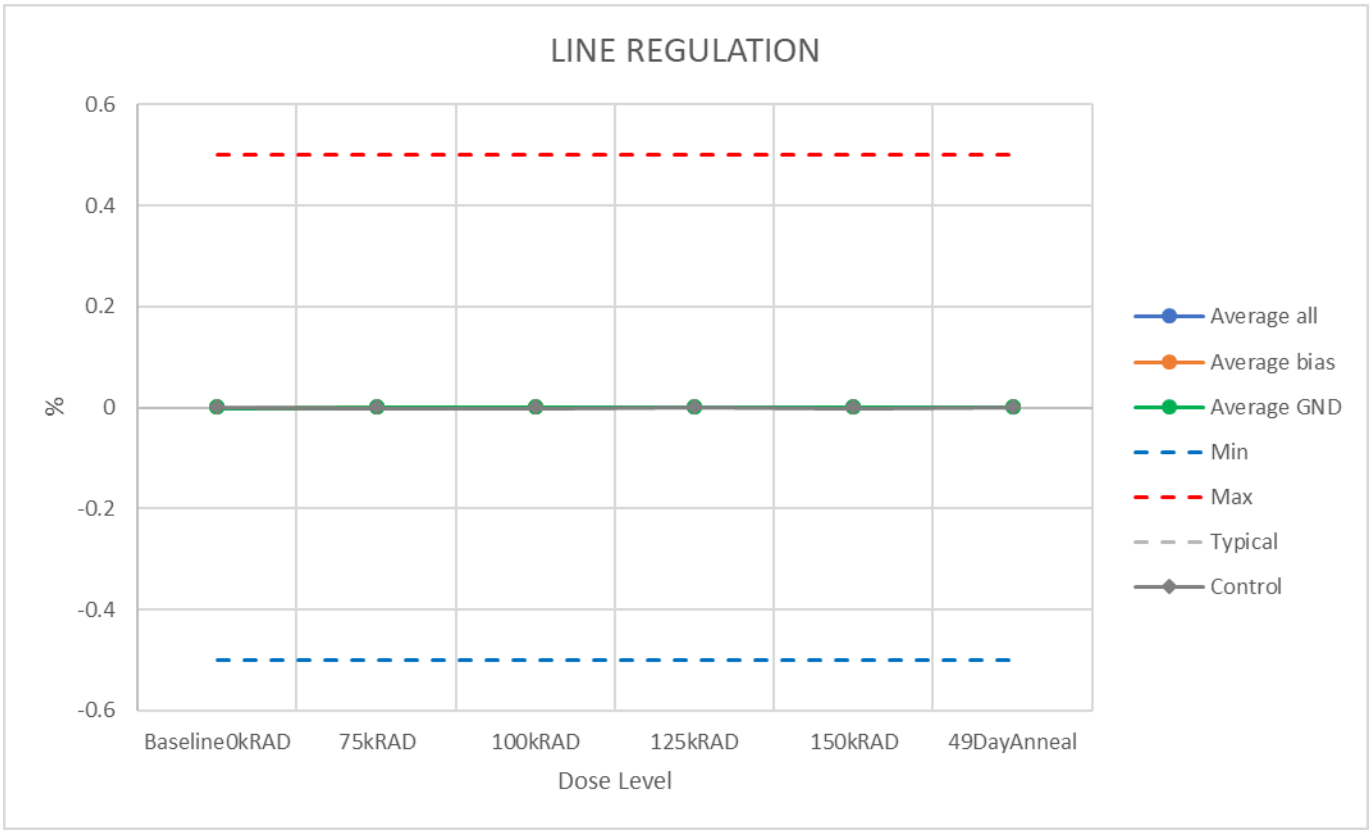
Table 1

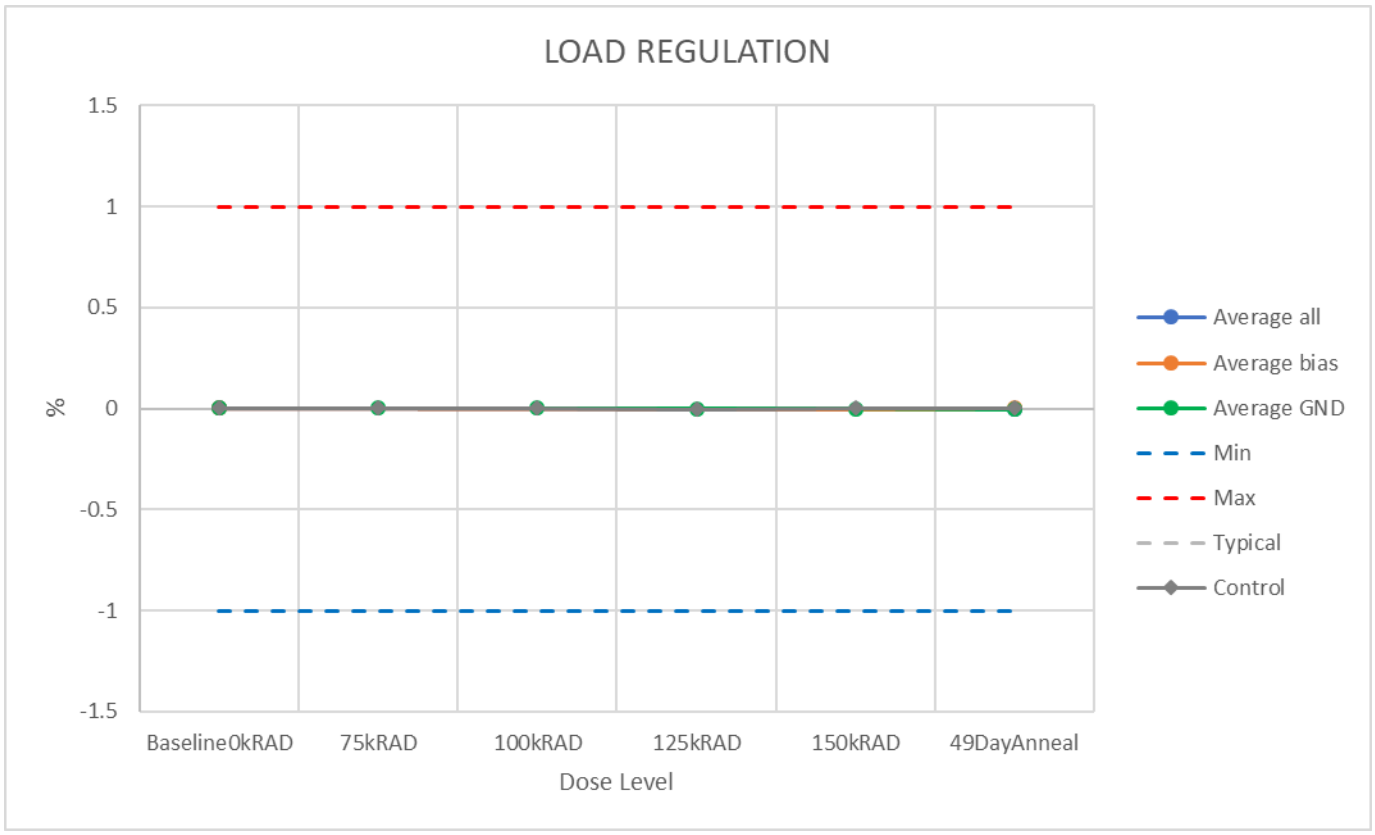
Dose Time, Incremental Dose and Total Cumulative Dose

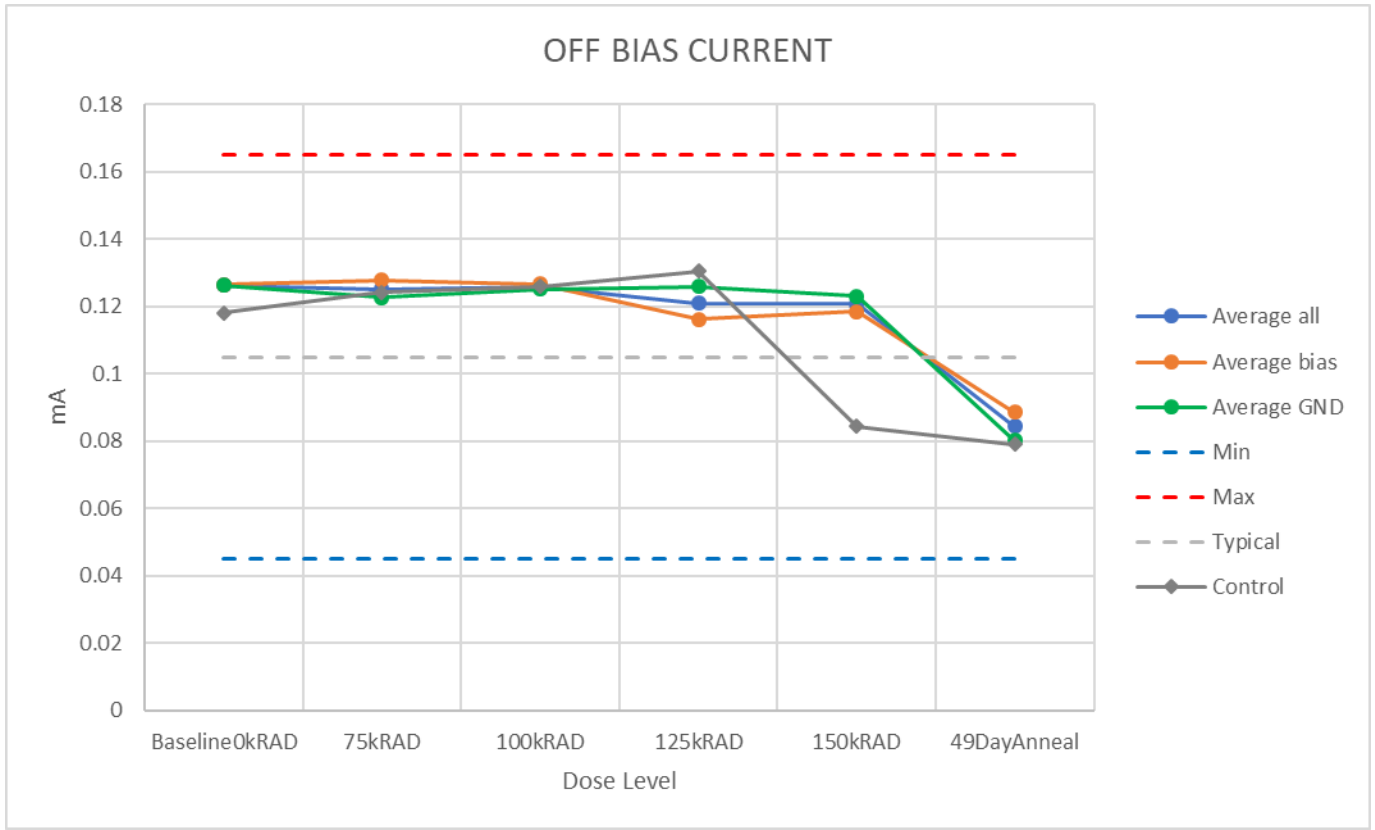

EFFICIENCY
88
86
84
82
80
78
76
%
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

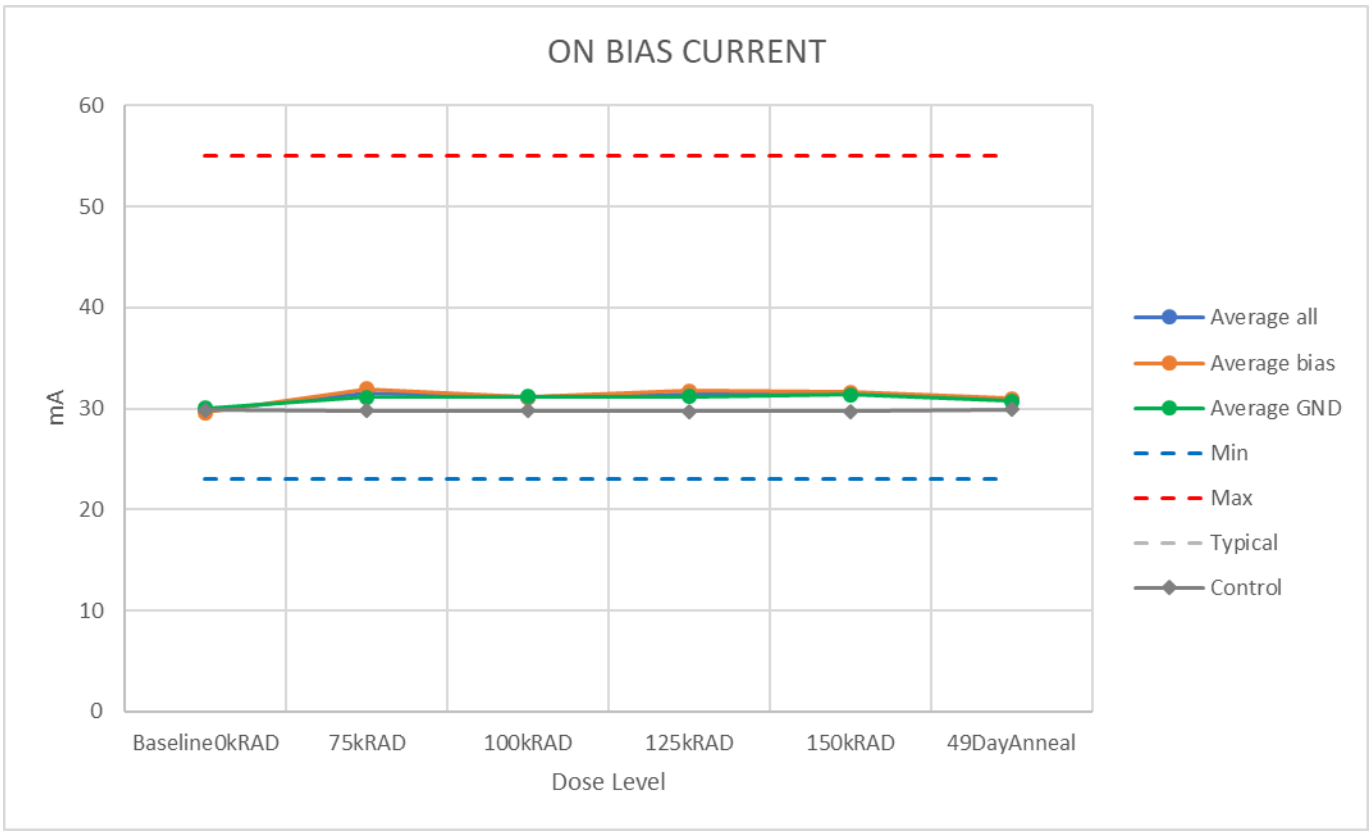

FALLING EDGE ENABLE
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
V
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

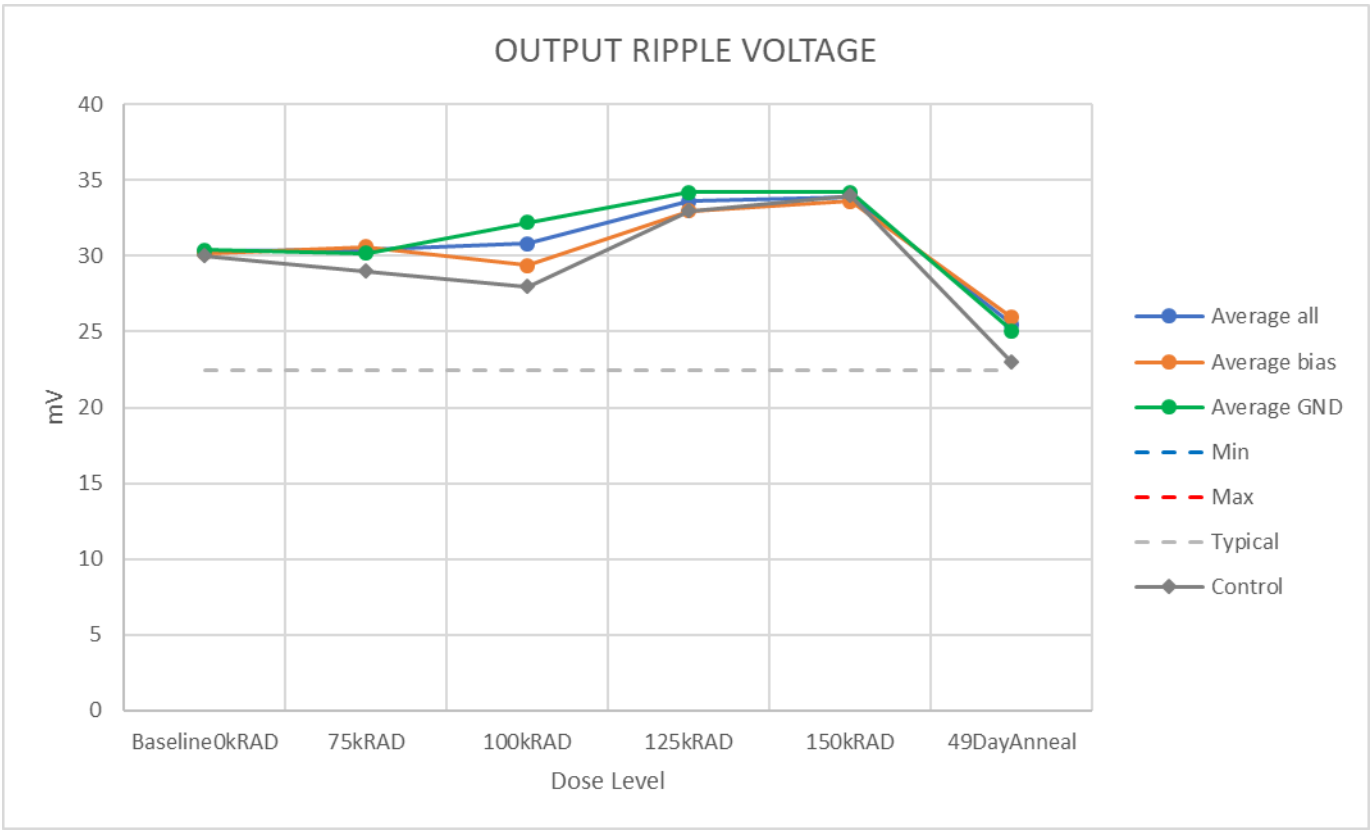

FALLING EDGE UVLO
2.84
2.82
2.8
2.78
2.76
2.74
2.72
2.7
2.68
2.66
2.64
V
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

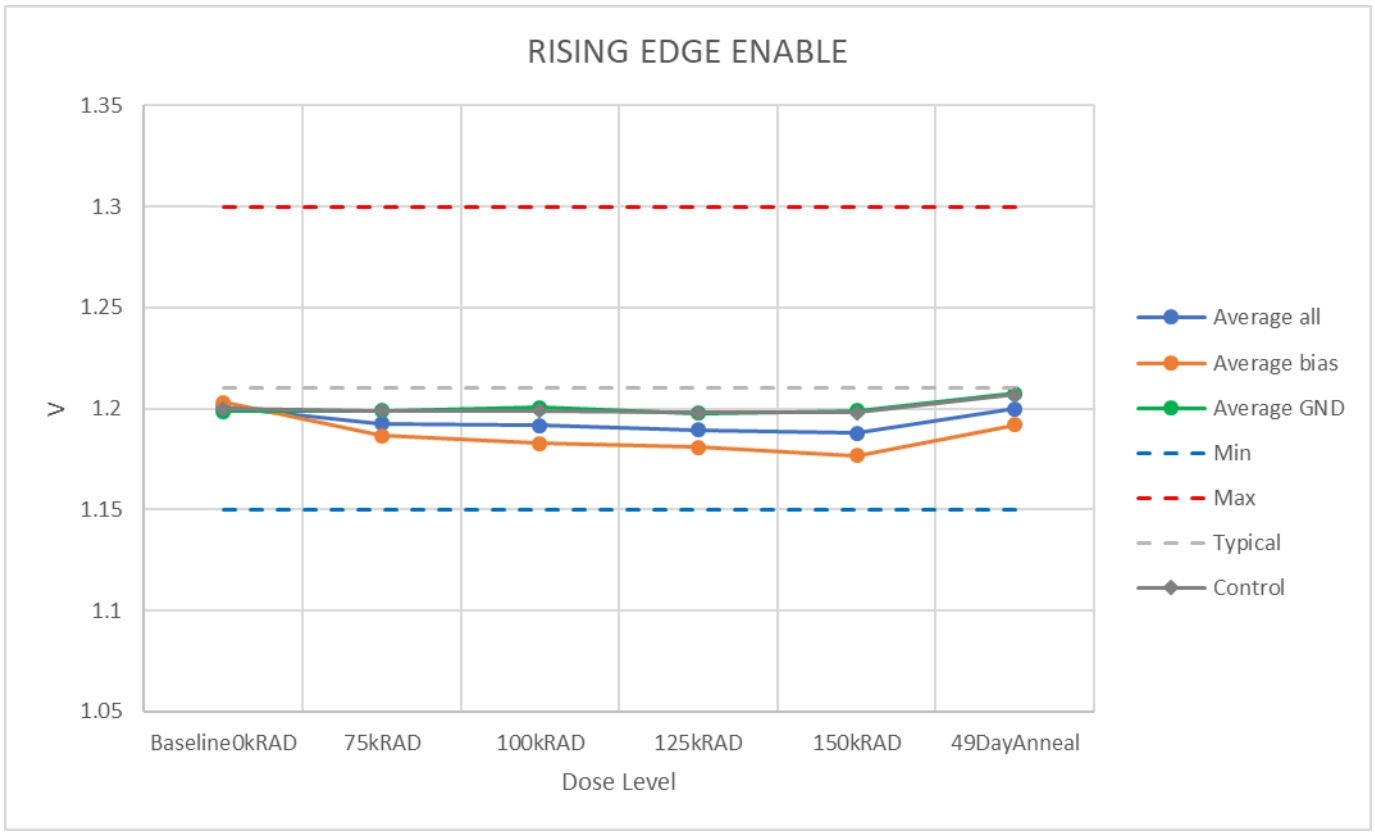

LINE REGULATION
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
%
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control


LOAD REGULATION
1.5
1
0.5
0
-0.5
-1
-1.5
%
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

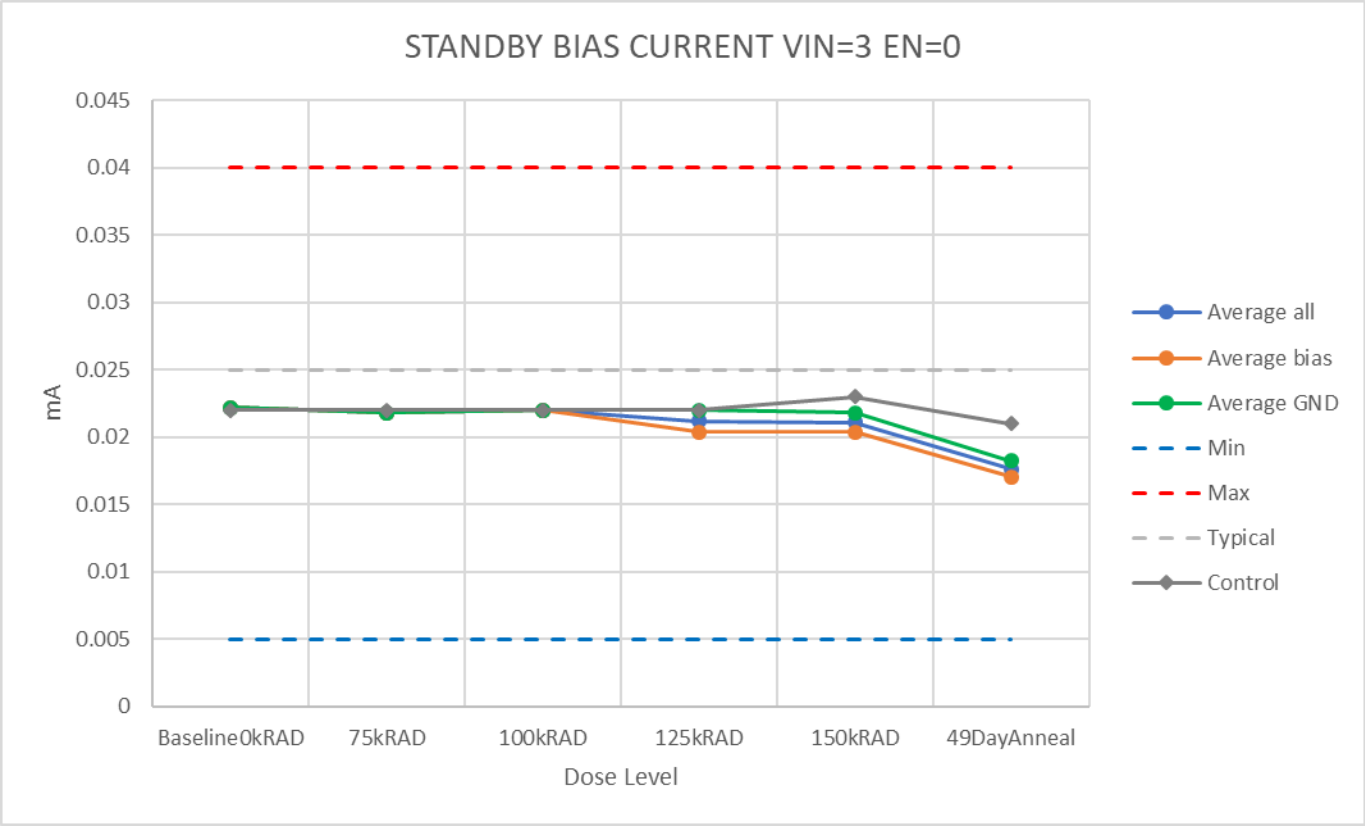

OFF BIAS CURRENT
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
mA
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

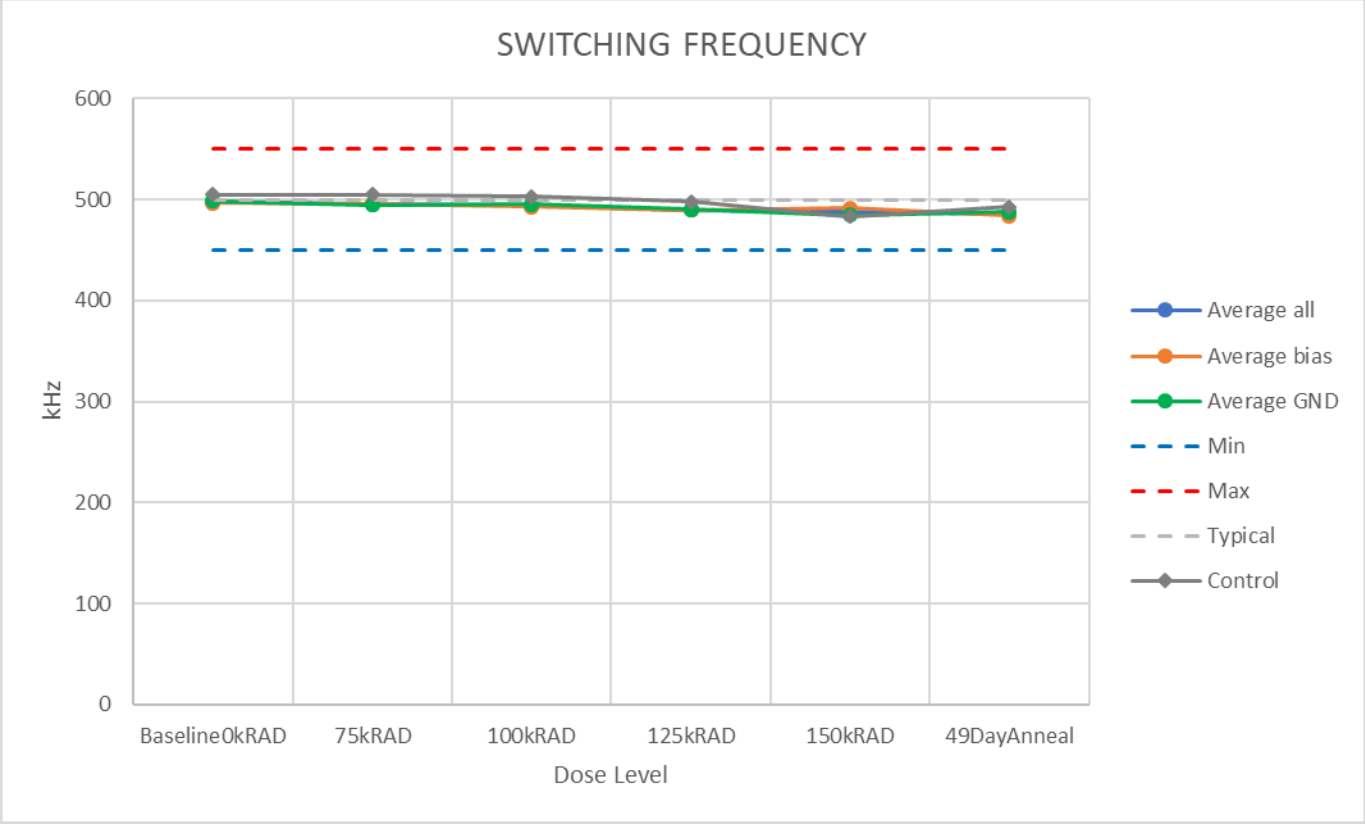

ON BIAS CURRENT
60
50
40
30
20
10
0
mA
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

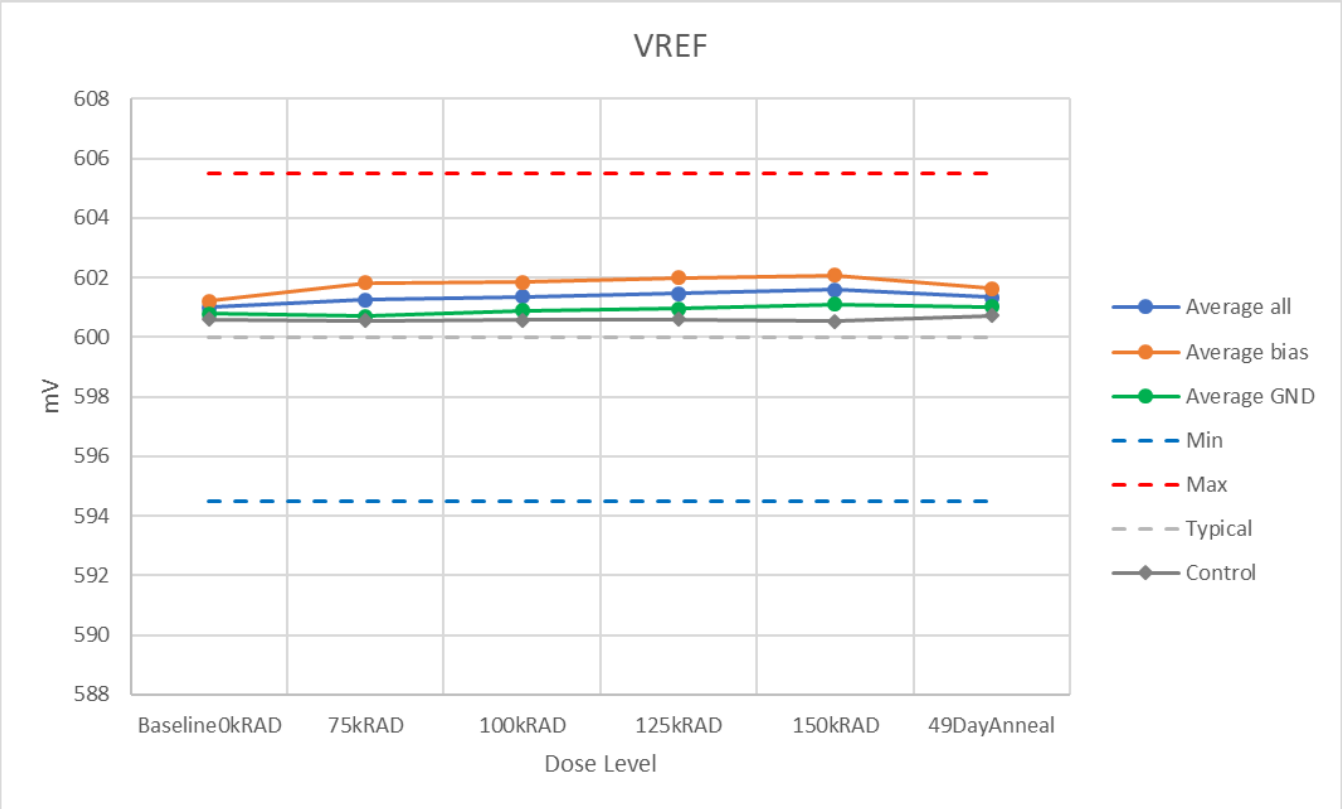

OUTPUT RIPPLE VOLTAGE
40
35
30
25
20
15
10
5
0
mV
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

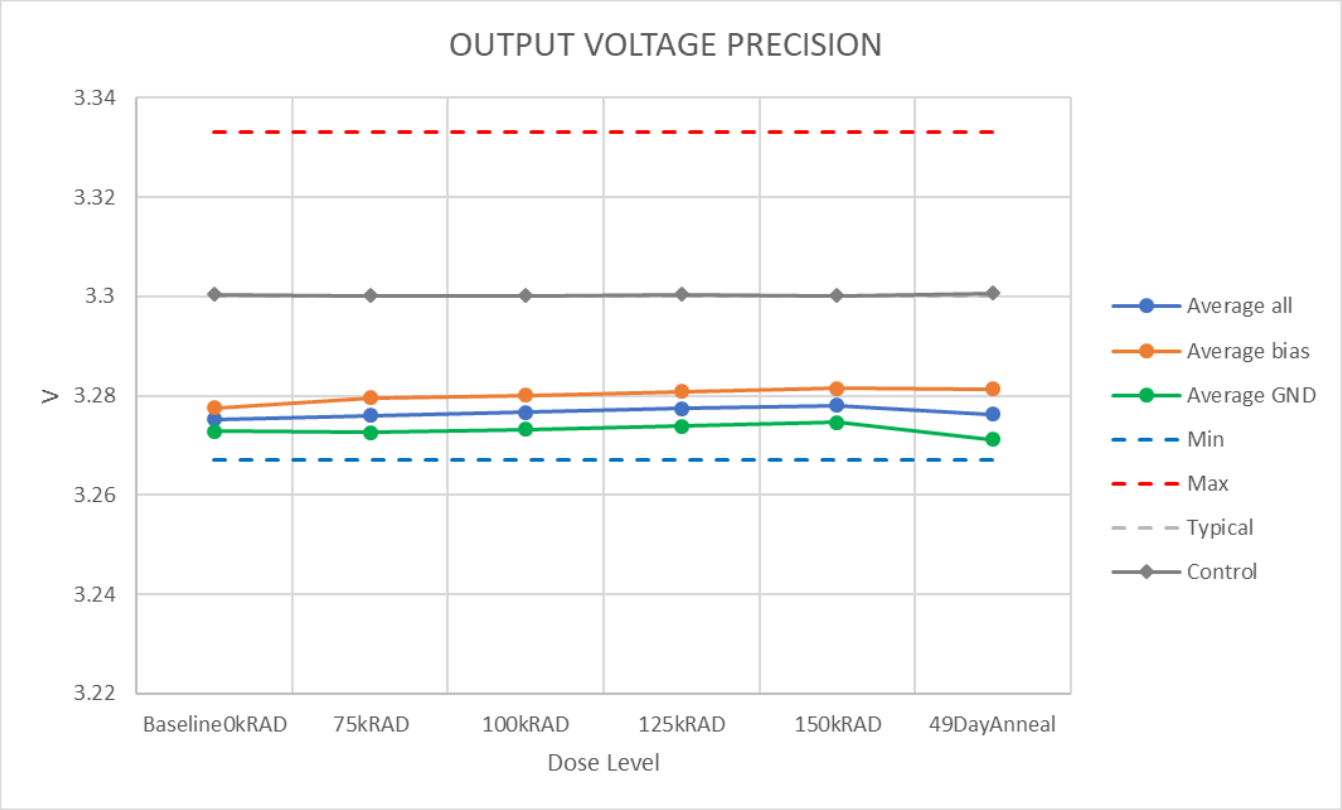

RISING EDGE ENABLE
1.35
1.3
1.25
1.2
1.15
1.1
1.05
V
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control


RISING EDGE UVLO
2.96
2.95
2.94
2.93
2.92
2.91
2.9
2.89
2.88
2.87
V
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control


STANDBY BIAS CURRENT VIN=3 EN=0
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
mA
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control

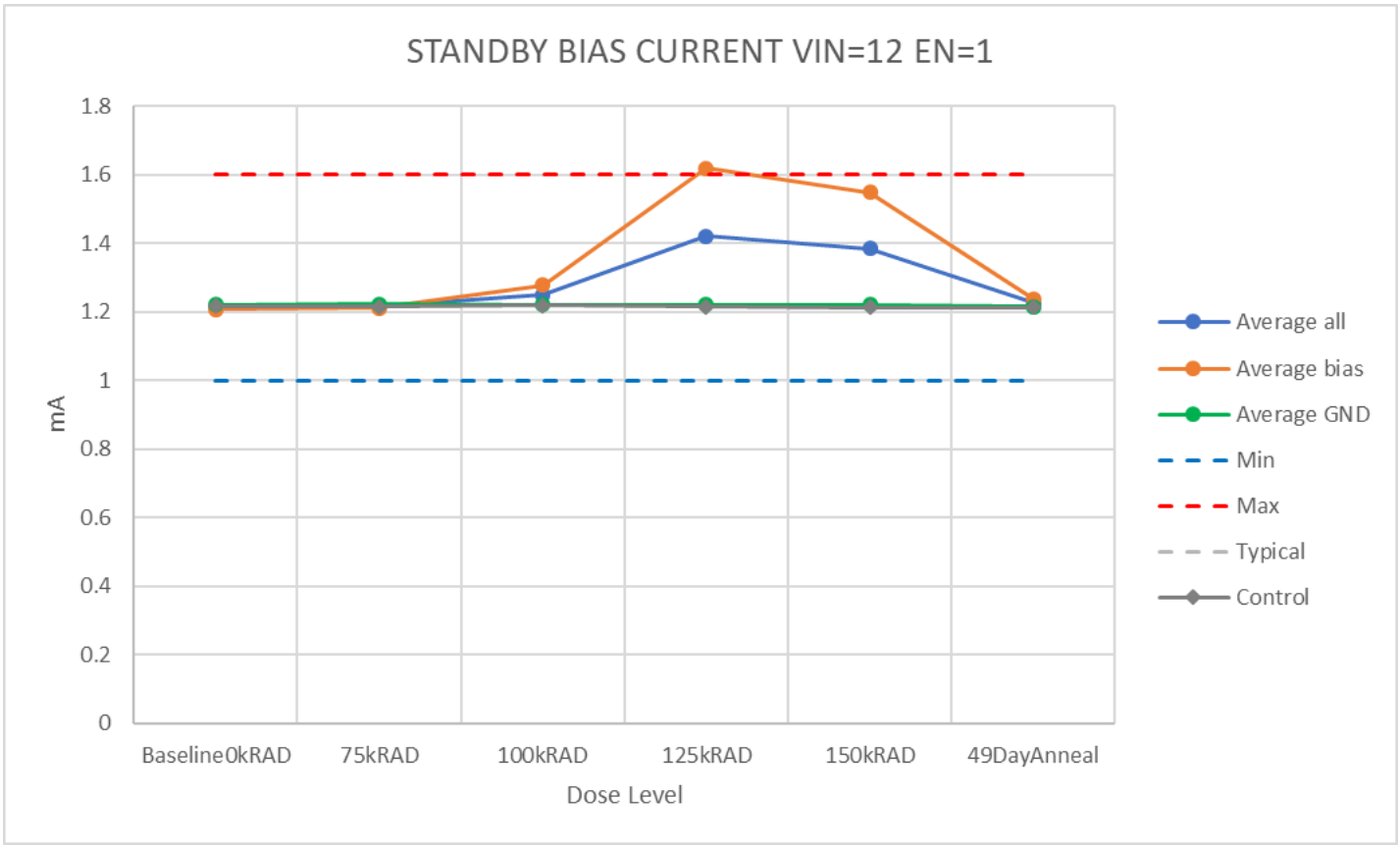

SWITCHING FREQUENCY
600
500
400
300
200
100
0
kHz
Baseline0kRAD
75kRAD
100kRAD
125kRAD
150kRAD
49DayAnneal
Dose Level
Average all
Average bias
Average GND
Min
Max
Typical
Control



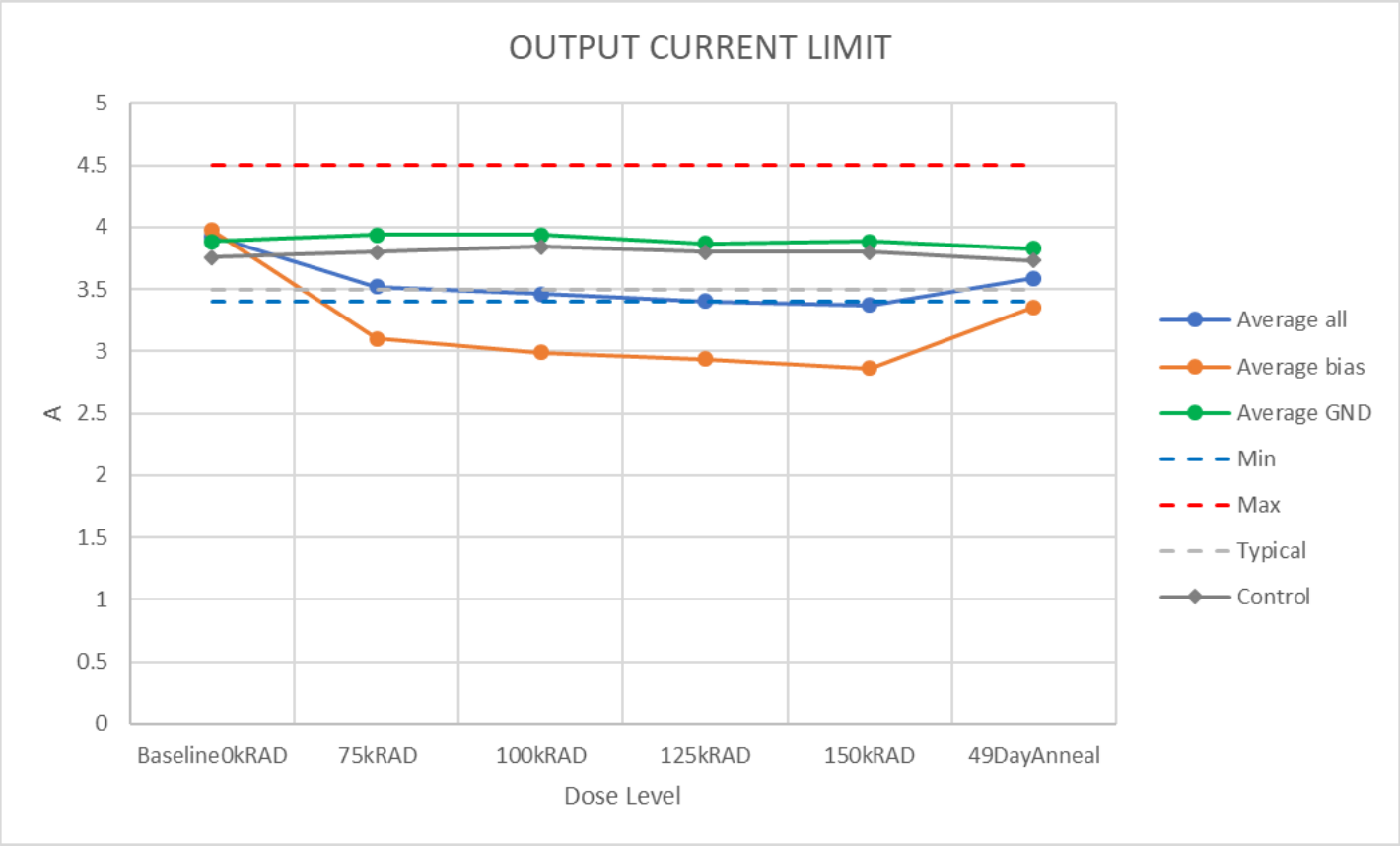


Output Voltage Precision starts on the lower end of the acceptable range due to the internal set resistors drifting during burn-in. This resistor defect was determined to be specific to the lot of resistor used in this assembly and is not indicative of any design or radiation tolerance issue with the MSK5065. Future builds will not utilize this lot of resistor. TID had little to no impact on output voltage precision.

The control device did not experience the 160-hour burn-in process and remains at the typical output.



Standby Bias Current Vin=12 EN=1 fails on one Bias device due to test operator error. During the Rising Edge Enable test the enable pin voltage was mistakenly set higher than the Vin pin voltage, resulting in a partial fuse of the internal protection diode between these pins. Damage was limited due to the power supply connected to the Enable pin entering current limit and latching off. The performance returned to normal after sufficient anneal time, so the device was not struck from the radiation analysis.



Output Current Limit experienced the largest shift of any parameter, specifically on the Bias devices. This is expected given the HDR TID performance of the regulator IC used in the MSK5065RH and is projected to return to specification within the room temperature anneal time permitted by MIL-STD-883 Method 1019.9.

The extended-room-temp-anneal is ongoing and this document shall remain preliminary until the allowed anneal time is met, at which point datasheet specification limits will be re-evaluated and adjusted if needed.