

Radiation Report

TPS7H6101-SEP Total Ionizing Dose (TID) Radiation Report



ABSTRACT

This report discusses the results of the total ionizing dose (TID) testing for the Texas Instruments TPS7H6101-SEP, 200V e-mode GaN power-FET half bridge with integrated gate driver. The study was done to determine TID effects under high dose rate (HDR) up to 50krad(Si). The results show that all samples passed within the specified limits up to 50krad(Si).

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1 Device Information

1.1 Product Description

The TPS7H6101-SEP is a radiation-tolerant 200V e-mode GaN power-FET half bridge with integrated gate driver. Integration of the e-mode GaN FETs and gate driver simplifies design, reduces component count, and reduces board space. The LGA package is 12mm by 9mm.

1.2 Device Details

[Table 1-1](#) lists the device information used in the TID characterization.

Table 1-1. Device and Exposure Details

TID HDR Details: up to 50 krad(Si)	
TI Device Family	TPS7H6101-SEP
TI Part Name	TPS7H6101MNPRTSEPM
Package	64-pin LGA (NPR)
Technology	Linear BiCMOS 7 (LBC7) and GaN
Quantity Tested	30 Irradiated units + 4 Control Units
Lot Accept/Reject	All levels tested and passed 20, 30, and 50 krad(Si)
HDR Radiation Facility	DCLAB - Texas Instruments, Dallas, TX
HDR Dose Level	20krad, 30krad, 50Krad (Si)
HDR Dose Rate	171.6rads(Si)/s
HDR Radiation Source	Gammacell 220 Excel (GC-220E) Co-60
Irradiation Temperature	Ambient room temperature



Figure 1-1. TPS7H6101-SEP Device

2 Total Dose Test Setup

2.1 Test Overview

The TPS7H6101-SEP was tested according to MIL-STD-883, Test Method 1019.9. For this testing, Condition A was used. For Condition A, the product was irradiated up to target radiation level and then put through full electrical parametric testing on the production Automated Test Equipment (ATE). All devices were functional and passed all electrical parametric tests with the readings within the data sheet electrical specification limits.

2.2 Test Description and Facilities

HDR exposure was performed on biased and unbiased devices in a Co-60 gamma cell at TI facility in Dallas CLAB (DCLAB), Texas. The un-attenuated dose rate of this cell is 171.6 rads(Si)/s. After exposure, the devices were packed in dry ice (per MIL-STD-883 Method 1019.9 section 3.10) and brought to Junkins lab in TI Dallas for full post-radiation electrical evaluation using Texas Instruments ATE. ATE test limits are set per data sheet electrical limits based on qualification and characterization data. Post-radiation measurements were taken within 30 minutes of removing the devices from the dry ice container. The devices were allowed to reach room temperature prior to electrical post-radiation measurements.

3 TID Characterization Test Results

3.1 TID Characterization Summary Results

The parametric data for the TPS7H6101-SEP passes up to 50krad(Si) HDR TID exposure. The drifts of the electrical parameters through HDR were within the data sheet limits.

Overall, the TPS7H6101-SEP showed a strong degree of hardness to irradiation up to 50krad(Si) for both biased and unbiased exposure conditions. The measurements taken post-irradiation for each sample set showed a marginal shift for most parameters at each dose level for both biased and unbiased. See TPS7H6101-SEP Electrical Parameters Table below parameters and associated tests.

See [Appendix A: HDR TID Report Data](#) for HDR report up to 50 krad(Si).

3.2 Data Sheet Electrical Parameters and Associated Tests

Table 3-1. TPS7H6101-SEP Electrical Parameters Table

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT	TEST NUMBERS
GAN POWER FETs								
$R_{DS(on)(ls)}$	Drain-source on resistance - low side	$V_{PWM_LI} = 5V$ $I_D = 2A$	$T_A = 25^\circ C$		16		m Ω	14.3
$V_{SD(ls)}$	Low side source-drain (GND to SW_LS) third quadrant voltage	$I_D = -0.5A$			1.8		V	14.7
		$I_D = -1A$			2		V	14.9
$I_{DSS(ls)}$	Low side drain (SW_LS to GND) leakage current	$V_{DS(LS)} = 150V$ $V_{PWM_LI} = 0V$	$T_A = 25^\circ C$		15	150	μA	14.20
$R_{DS(on)(hs)}$	Drain-source on resistance - high side	$V_{EN_HI} = 5V$ $I_D = 2A$	$T_A = 25^\circ C$		16		m Ω	14.6
$V_{SD(hs)}$	Low side source-drain (SW_HS to HVIN) third quadrant voltage	$I_D = -0.5A$			1.8		V	14.11
		$I_D = -1A$			2		V	14.13
$I_{DSS(hs)}$	Low side drain (SW_HS to HVIN) leakage current		$T_A = 25^\circ C$		15	150	μA	14.27
SUPPLY CURRENTS								
I_{Q_LS}	Low side shut down current	$EN = 0V, VIN = 12V,$ $BOOT = 10V$	MODE = PWM		5	6.8	mA	12.1 12.9, 12.17
			MODE = IIM		5	8	mA	12.25, 12.33, 12.41, 12.49, 12.57, 12.65
I_{Q_HS}	High side shut down current	$EN = 0V, VIN = 12V,$ $BOOT = 10V$	MODE = PWM		5	6.3	mA	12.2, 12.10, 12.18
			MODE = IIM		5	6.3	mA	12.26, 12.34, 12.42, 12.50, 12.58, 12.66

Table 3-1. TPS7H6101-SEP Electrical Parameters Table (continued)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT	TEST NUMBERS
BP5H _R	BP5H UVLO rising threshold	C _{BP5H} = 1μF		4.1		V	15.25, 15.28, 15.31
BP5H _F	BP5H UVLO falling threshold			3.9		V	15.26, 15.29, 15.32
BP5H _H	BP5H UVLO hysteresis			0.25		V	15.27, 15.30, 15.33
BP5L _R	BP5L UVLO rising threshold	C _{BP5L} = 1μF		4.1		V	15.7, 15.10, 15.13
BP5L _F	BP5L UVLO falling threshold			3.9		V	15.8, 15.11, 15.14
BP5L _H	BP5L UVLO hysteresis			0.25		V	15.9, 15.12, 15.15
BP7L _R	BP7L UVLO rising threshold	C _{BP7L} = 1μF		6.4		V	15.16, 15.19, 15.22
BP7L _F	BP7L UVLO falling threshold			6.1		V	15.17, 15.20, 15.23
BP7L _H	BP7L UVLO hysteresis			0.3		V	15.18, 15.21, 15.24
VIN _R	VIN UVLO rising threshold		8.0	8.6	9.0	V	15.1
VIN _F	VIN UVLO falling threshold		7.5	8.1	8.5	V	15.2
VIN _H	VIN UVLO hysteresis			0.5		V	15.3
BOOT _R	BOOT UVLO rising threshold		6.6	7.1	7.4	V	15.4
BOOT _F	BOOT UVLO falling threshold		6.2	6.65	7.0	V	15.5
BOOT _H	BOOT UVLO hysteresis			0.45		V	15.6
INPUT PINS							
V _{IR}	Input rising edge threshold		1.85		2.85	V	17.1, 17.4, 17.11, 17.14, 17.21, 17.24
V _{IF}	Input falling edge threshold		0.95		1.95	V	17.2, 17.5, 17.12, 17.15, 17.22, 17.25
V _{IHYS}	Input hysteresis			0.7		V	17.3, 17.6, 17.13, 17.16, 17.23, 17.26
R _{PD}	Input pull-down resistance ^{ev}	V = 2.15V applied at input (EN_HI or PWM					

Table 3-1. TPS7H6101-SEP Electrical Parameters Table (continued)

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT	TEST NUMBERS
$t_{p(off)(ls)}$	Low side turn-off propagation delay	From $V_{PWM_LI} = V_{IR}$ to $V_{LSG} = 2.5V$ $I_D = 400mA$	Mode = PWM		41	51	ns	19.25, 19.31, 19.37
		From $V_{PWM_LI} = V_{IF}$ to $V_{LSG} = 2.5V$ $I_D = 400mA$	Mode = IIM		33	42	ns	19.44, 19.54, 19.64, 19.74, 19.84, 19.94
$t_{p(on)(ls)}$	Low side turn-on gate drive propagation delay	From $V_{PWM_LI} = V_{IR}$ to $V_{LSG} = 2.5V$ $I_D = 400mA$	Mode = IIM		33	42	ns	19.43, 19.53, 19.63, 19.73, 19.83, 19.93
$t_{p(off)(hs)}$	High side turn-off propagation delay	From $V_{PWM_LI} = V_{IF}$ to $V_{HSG} = 2.5V$ $I_D = 400mA$	Mode = PWM		35	50	ns	19.26, 19.32, 19.38
		From $V_{EN_LI} = V_{IF}$ to $V_{HSG} = 2.5V$ $I_D = 400mA$	Mode = IIM		35	45	ns	19.46, 19.56, 19.66, 19.76, 19.86, 19.96
$t_{p(on)(hs)}$	High side turn-on propagation delay	From $V_{EN_HI} = V_{IR}$ to $V_{HSG} = 2.5V$ $I_D = 400mA$	Mode = IIM		35	50	ns	19.45, 19.55, 19.65, 19.75, 19.85, 19.95
$t_{d(on)(ls)}$	Low side turn-on delay	From $V_{PWM_LI} = V_{IF}$ to $V_{DS(ls)} = 4V$ $I_D = 400mA$	Mode = PWM		45	60	ns	19.27, 19.33, 19.39
		From $V_{PWM_LI} = V_{IR}$ to $V_{DS(ls)} = 4V$ $I_D = 400mA$	Mode = IIM		45	60	ns	19.47, 19.57, 19.67, 19.77, 19.87, 19.97
$t_{d(off)(ls)}$	Low side turn-off delay	From $V_{PWM_LI} = V_{IR}$ to $V_{DS(ls)} = 1V$ $I_D = 400mA$	Mode = PWM		51	79	ns	19.28, 19.34, 19.40
		From $V_{PWM_LI} = V_{IF}$ to $V_{DS(ls)} = 1V$ $I_D = 400mA$	Mode = IIM		45	60	ns	19.48, 19.58, 19.68, 19.78, 19.88, 19.98
$t_{d(on)(hs)}$	High side turn-on delay	From $V_{PWM_LI} = V_{IR}$ to $V_{DS(hs)} = 1V$ $I_D = 400$						

Table 3-1. TPS7H6101-SEP Electrical Parameters Table (continued)

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT	TEST NUMBERS
$t_{PW(IIM)}$	Minimum input pulse width (turn-on)		MODE = IIM		5	8	ns	19.103, 19.105, 19.107, 19.109, 19.111, 19.113
$t_{PW(IIM)}$ (OFF)	Minimum input pulse width (turn-off)		MODE = IIM		12	16	ns	19.104, 19.106, 19.108, 19.110, 19.112, 19.114

4 Applicable and Reference Documents

4.1 Applicable Documents

- Texas Instruments, [TPS7H6101-SEP 200V, 10A GaN Half Bridge Power Stage](#) datasheet
- Texas Instruments, [TPS7H6101-SEP Evaluation Module](#) EVM user's guide

4.2 Reference Documents

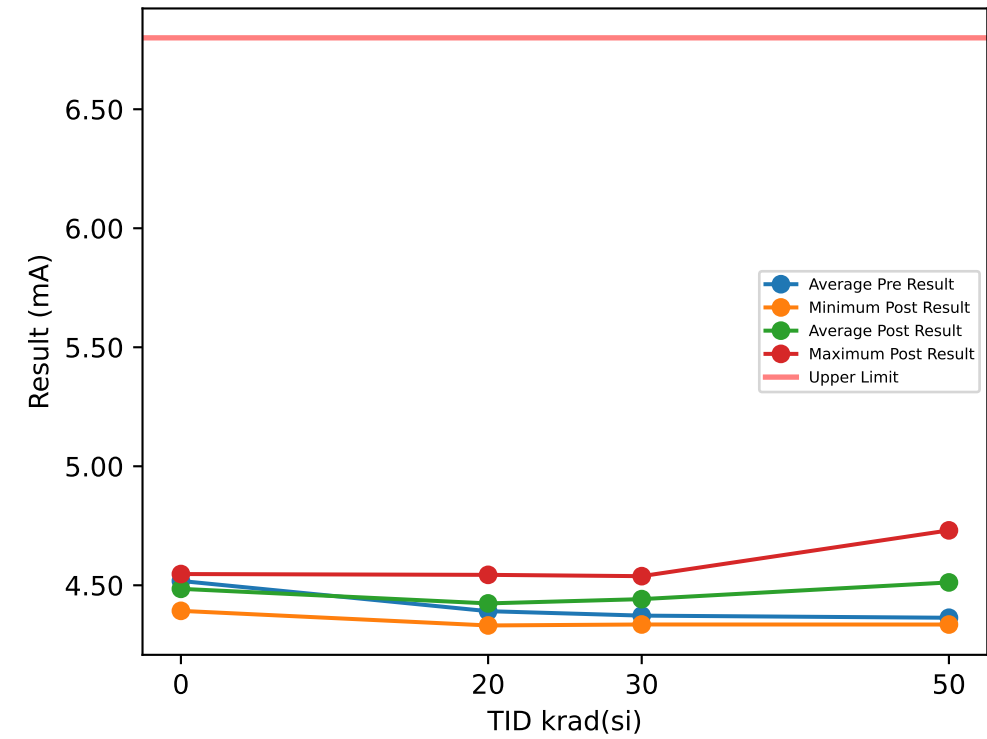
Texas Instruments total ionizing dose radiation (total dose) test procedure follows the standards put forth in MIL-STD-883 TM 1019. The document can be found at the DLA website.

A Appendix A: HDR TID Report Data

This appendix contains the HDR TID report data.

Device Test: 12.1 IQ|PWM/VIN/10/8///0MHz/@IQ_LS_PWM

TID vs Result Stats

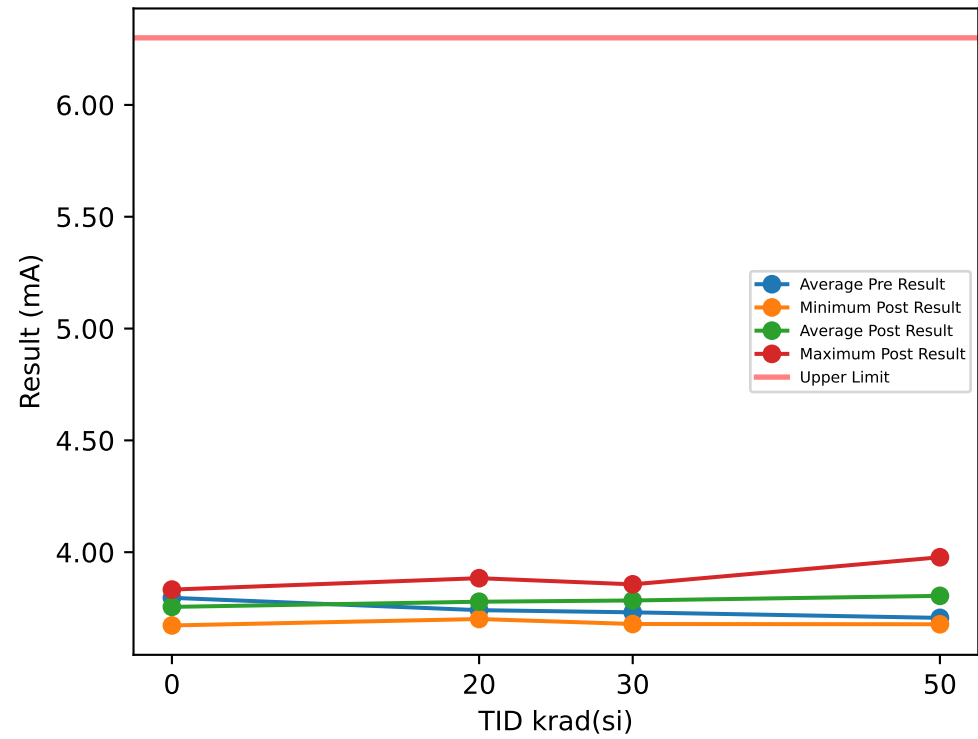


Test Results (Upper Limit = 6.8 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	4.3327	4.3602	0.0275
2	20	HDR BIAS	4.3919	4.4358	0.0439
3	20	HDR BIAS	4.4391	4.4875	0.0484
4	20	HDR BIAS	4.3263	4.3312	0.0049
5	20	HDR BIAS	4.3522	4.3846	0.0324
6	20	HDR UNBIAS	4.3608	4.4084	0.0476
7	20	HDR UNBIAS	4.3813	4.3977	0.0164
8	20	HDR UNBIAS	4.4541	4.4939	0.0398
9	20	HDR UNBIAS	4.3643	4.3953	0.031
10	20	HDR UNBIAS	4.5094	4.5438	0.0344
11	30	HDR BIAS	4.3761	4.4846	0.1085
12	30	HDR BIAS	4.4324	4.4766	0.0442
13	30	HDR BIAS	4.428	4.5383	0.1103
14	30	HDR BIAS	4.3828	4.4769	0.0941
15	30	HDR BIAS	4.2922	4.3353	0.0431
16	30	HDR UNBIAS	4.3448	4.3773	0.0325
17	30	HDR UNBIAS	4.2868	4.376	0.0892
18	30	HDR UNBIAS	4.3974	4.4616	0.0642
19	30	HDR UNBIAS	4.3929	4.459	0.0661
20	30	HDR UNBIAS	4.3919	4.4324	0.0405
2					

Device Test: 12.10 IQ|PWM/BOOT/12/10///0MHz/@IQ_HS_PWM

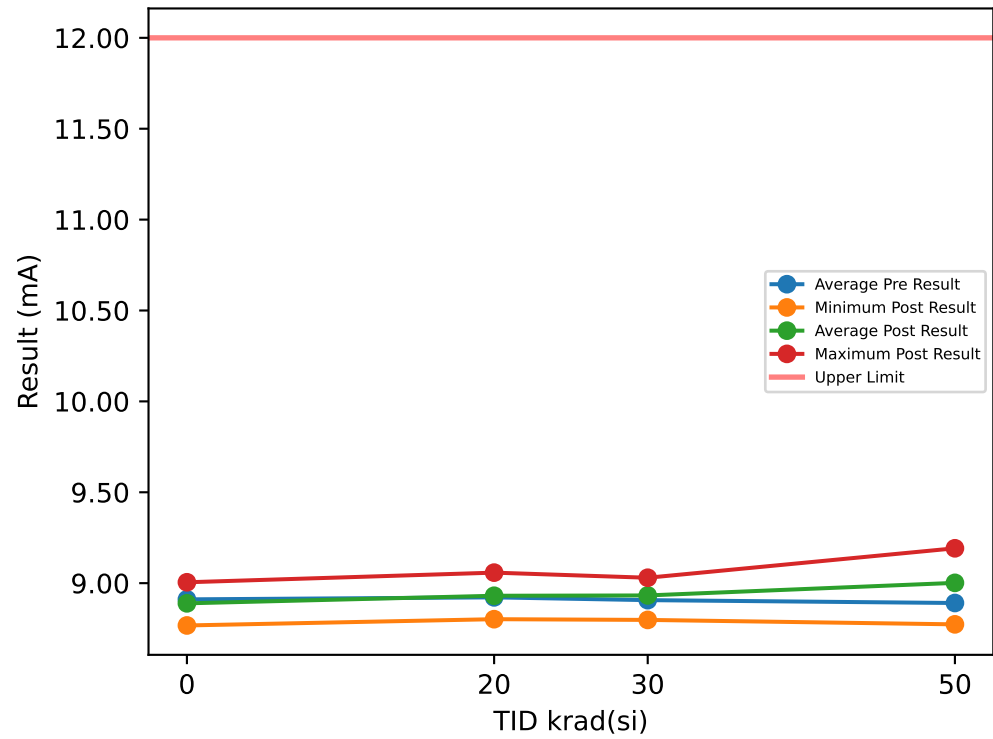
TID vs Result Stats



Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.7148	3.7596	0.0448
2	20	HDR BIAS	3.7725	3.7886	0.0161
3	20	HDR BIAS	3.659	3.7012	0.0422
4	20	HDR BIAS	3.8062	3.8838	0.0776
5	20	HDR BIAS	3.7093	3.7596	0.0503
6	20	HDR UNBIAS	3.7553	3.751	-0.0043
7	20	HDR UNBIAS	3.7915	3.8389	0.0474
8	20	HDR UNBIAS	3.7086	3.7439	0.0353
9	20	HDR UNBIAS	3.6931	3.7253	0.0322
10	20	HDR UNBIAS	3.7978	3.8335	0.0357
11	30	HDR BIAS	3.7532	3.8311	0.0779
12	30	HDR BIAS	3.7348	3.8016	0.0668
13	30	HDR BIAS	3.7466	3.811	0.0644
14	30	HDR BIAS	3.7451	3.7852	0.0401
15	30	HDR BIAS	3.8081	3.8563	0.0482
16	30	HDR UNBIAS	3.6457	3.6789	0.0332
17	30	HDR UNBIAS	3.6817	3.7166	0.0349
18	30	HDR UNBIAS	3.7676	3.8249	0.0573

TID vs Result Stats

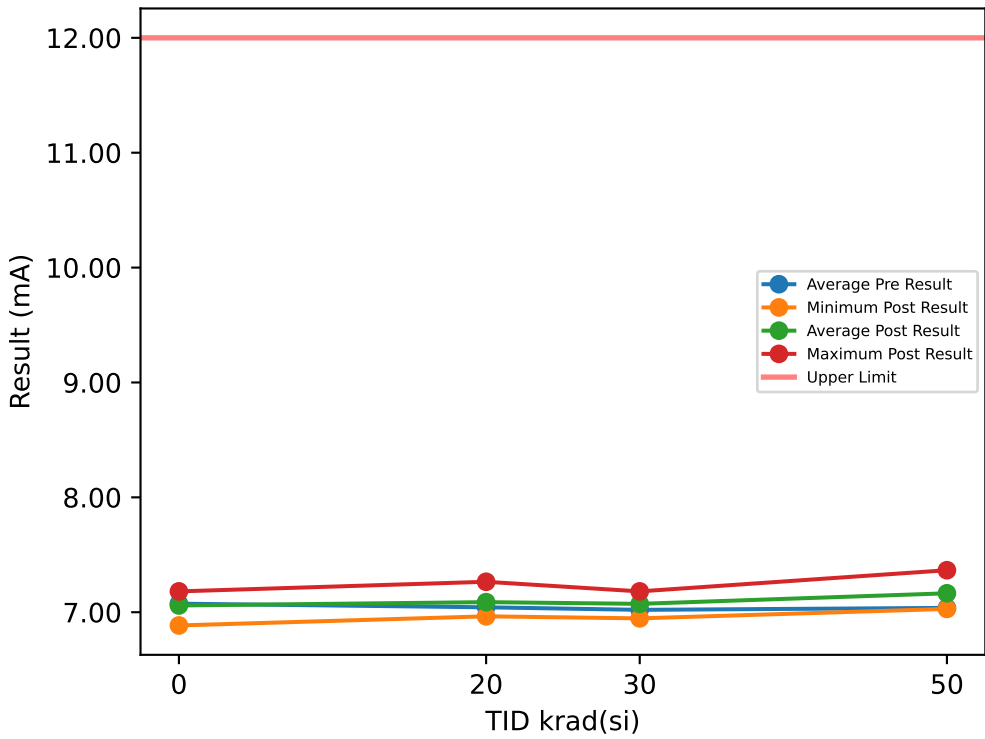


Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	8.8798	8.8277	-0.0521
2	20	HDR BIAS	8.9347	8.9021	-0.0326
3	20	HDR BIAS	8.9553	8.9211	-0.0342
4	20	HDR BIAS	8.9689	8.8666	-0.1023
5	20	HDR BIAS	8.8659	8.8018	-0.0641
6	20	HDR UNBIAS	8.9505	9.0117	0.0612
7	20	HDR UNBIAS	8.9781	9.0216	0.0435
8	20	HDR UNBIAS	8.9286	8.9487	0.0201
9	20	HDR UNBIAS	8.8117	8.9479	0.1362
10	20	HDR UNBIAS	8.9454	9.0579	0.1125
11	30	HDR BIAS	8.9831	9.0138	0.0307
12	30	HDR BIAS	9.0075	8.9783	-0.0292
13	30	HDR BIAS	8.9277	8.9715	0.0438
14	30	HDR BIAS	8.8295	8.8682	0.0387
15	30	HDR BIAS	8.8347	8.7978	-0.0369
16	30	HDR UNBIAS	8.8571	8.8722	0.0151
17	30	HDR UNBIAS	8.8763	8.9691	0.0928
18	30	HDR UNBIAS	8.9873	9.0298	0.0425
19	30	HDR UNBIAS	8.7672	8.816	0.0488
20	30	HDR UNBIAS	8.9954	9.0077	0.0123
21					

Device Test: 12.12 IOP|PWM/BOOT/12/10///0.5MHz/@I_OP_HS_PWM_500KHZ

TID vs Result Stats

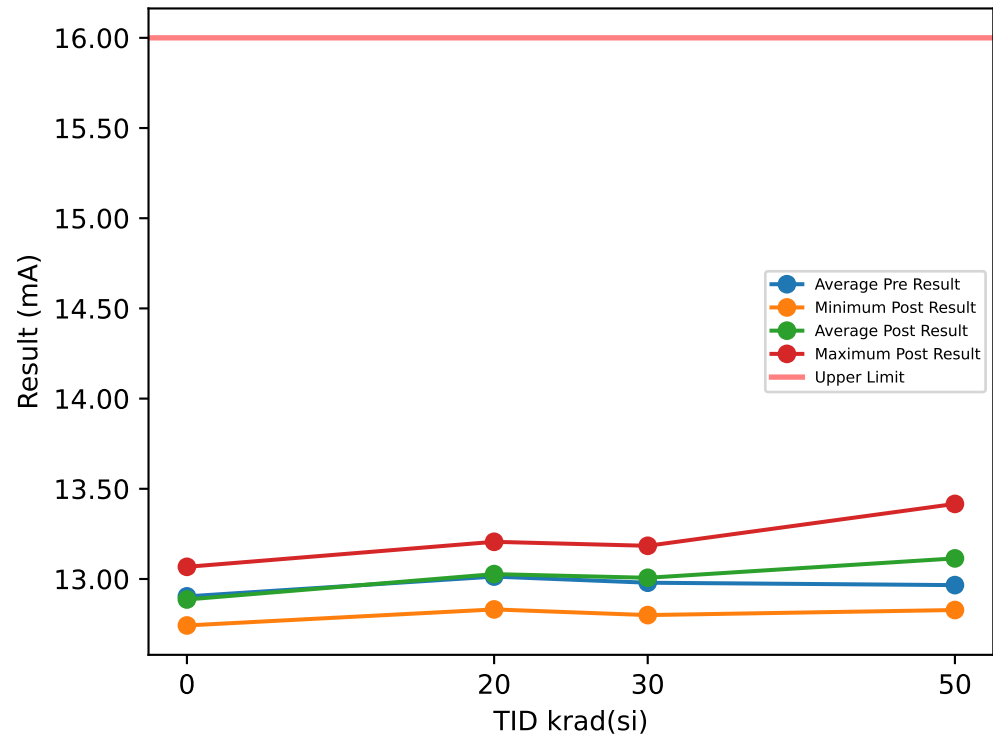


Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	7.0859	7.0622	-0.0237
2	20	HDR BIAS	7.0576	7.034	-0.0236
3	20	HDR BIAS	6.9817	6.9643	-0.0174
4	20	HDR BIAS	7.1208	7.1414	0.0206
5	20	HDR BIAS	6.9667	6.966	-0.0007
6	20	HDR UNBIAS	7.0387	7.0763	0.0376
7	20	HDR UNBIAS	7.176	7.265	0.089
8	20	HDR UNBIAS	7.0046	7.061	0.0564
9	20	HDR UNBIAS	6.9672	7.142	0.1748
10	20	HDR UNBIAS	7.0288	7.1658	0.137
11	30	HDR BIAS	6.9918	7.0381	0.0463
12	30	HDR BIAS	7.0589	7.0757	0.0168
13	30	HDR BIAS	6.9962	7.0173	0.0211
14	30	HDR BIAS	7.107	7.1036	-0.0034
15	30	HDR BIAS	7.0652	7.0834	0.0182
16	30	HDR UNBIAS	7.0051	7.0949	0.0898
17	30	HDR UNBIAS	6.889	6.9465	0.0575
18	30	HDR UNBIAS	7.0281	7.1197	0.0916
19	30	HDR UNBIAS	7.0866	7.1814	0.0948
20	30	HDR UNBIAS	6		

Device Test: 12.13 IOP|PWM/VIN/12/10///1MHz/@I_OP_LS_PWM_1MHZ

TID vs Result Stats

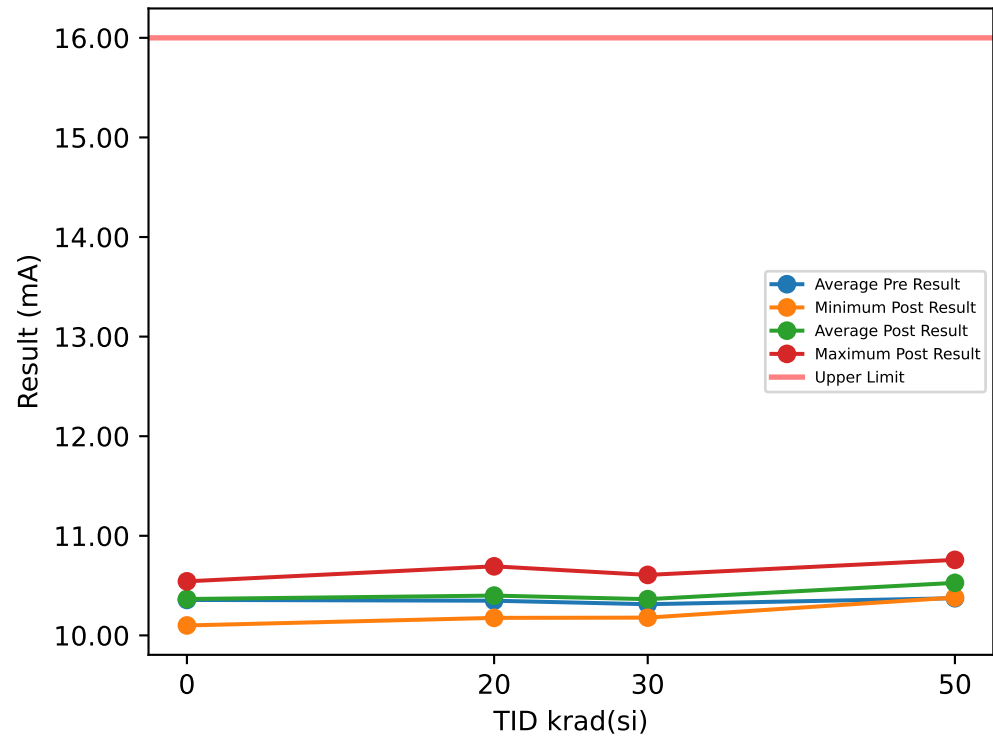


Test Results (Upper Limit = 16.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	12.954	12.856	-0.0984
2	20	HDR BIAS	13.03	12.951	-0.0791
3	20	HDR BIAS	13.059	12.971	-0.0879
4	20	HDR BIAS	13.131	12.956	-0.1753
5	20	HDR BIAS	12.966	12.831	-0.1347
6	20	HDR UNBIAS	13.105	13.206	0.1011
7	20	HDR UNBIAS	13.099	13.198	0.0986
8	20	HDR UNBIAS	12.969	12.998	0.0285
9	20	HDR UNBIAS	12.833	13.101	0.2686
10	20	HDR UNBIAS	12.987	13.203	0.2161
11	30	HDR BIAS	13.083	13.082	-0.001
12	30	HDR BIAS	13.184	13.12	-0.0633
13	30	HDR BIAS	12.947	12.968	0.0211
14	30	HDR BIAS	12.841	12.871	0.0293
15	30	HDR BIAS	12.931	12.856	-0.0748
16	30	HDR UNBIAS	12.906	12.943	0.0373
17	30	HDR UNBIAS	12.948	13.091	0.1428
18	30	HDR UNBIAS	13.118	13.184	0.0662
19	30	HDR UNBIAS	12.728	12.8	0.0722
20	30	HDR UNBIAS	13.107	13.151	0.0434
21	50	HDR BIAS	13.113	13.193</	

Device Test: 12.14 IOP|PWM/BOOT/12/10///1MHz/@I_OP_HS_PWM_1MHZ

TID vs Result Stats

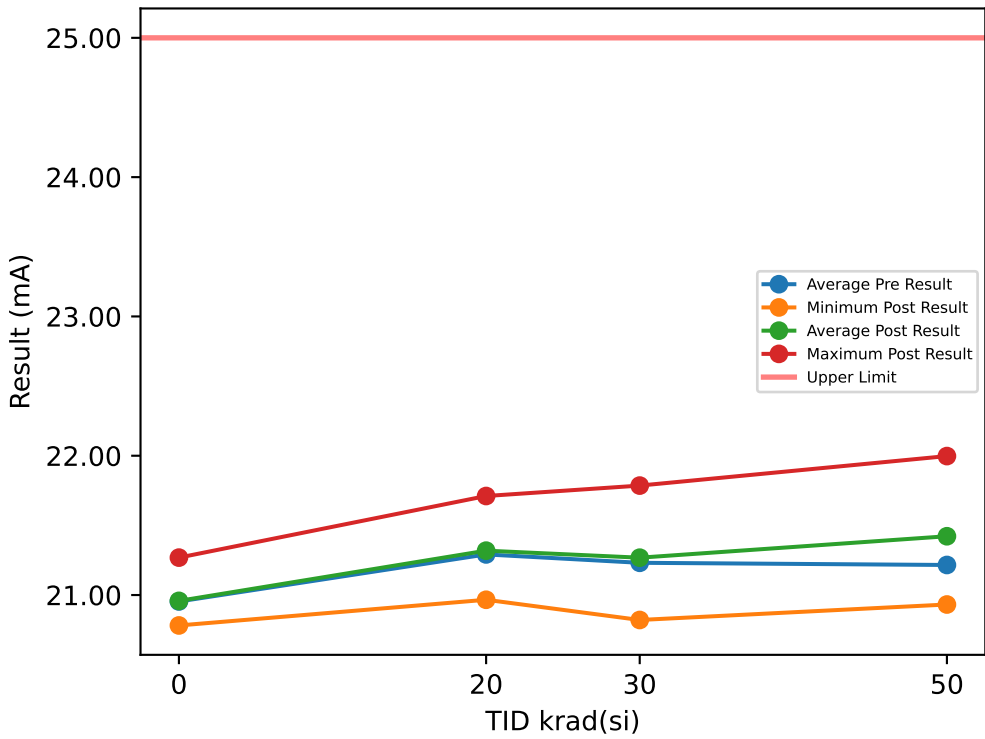


Test Results (Upper Limit = 16.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	10.462	10.371	-0.091
2	20	HDR BIAS	10.345	10.283	-0.0624
3	20	HDR BIAS	10.309	10.232	-0.0777
4	20	HDR BIAS	10.439	10.404	-0.0356
5	20	HDR BIAS	10.227	10.176	-0.051
6	20	HDR UNBIAS	10.324	10.4	0.0756
7	20	HDR UNBIAS	10.566	10.693	0.1275
8	20	HDR UNBIAS	10.303	10.379	0.0759
9	20	HDR UNBIAS	10.246	10.561	0.3153
10	20	HDR UNBIAS	10.261	10.498	0.2373
11	30	HDR BIAS	10.233	10.248	0.0143
12	30	HDR BIAS	10.386	10.354	-0.0315
13	30	HDR BIAS	10.246	10.228	-0.0179
14	30	HDR BIAS	10.472	10.427	-0.045
15	30	HDR BIAS	10.324	10.315	-0.0097
16	30	HDR UNBIAS	10.371	10.512	0.1411
17	30	HDR UNBIAS	10.1	10.178	0.0786
18	30	HDR UNBIAS	10.289	10.414	0.1245
19	30	HDR UNBIAS	10.474	10.607	0.1335
20	30	HDR UNBIAS	10.235	10.355	0.1198
21	50	HDR BIAS			

Device Test: 12.15 IOP|PWM/VIN/12/10///2MHz/@I_OP_LS_PWM_2MHZ

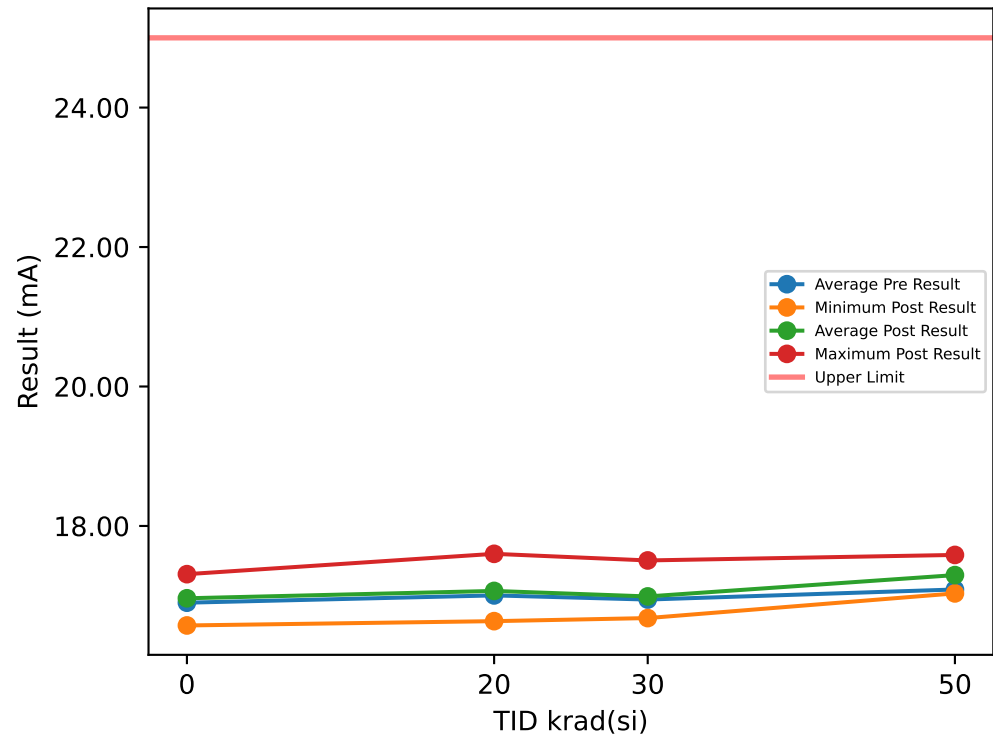
TID vs Result Stats



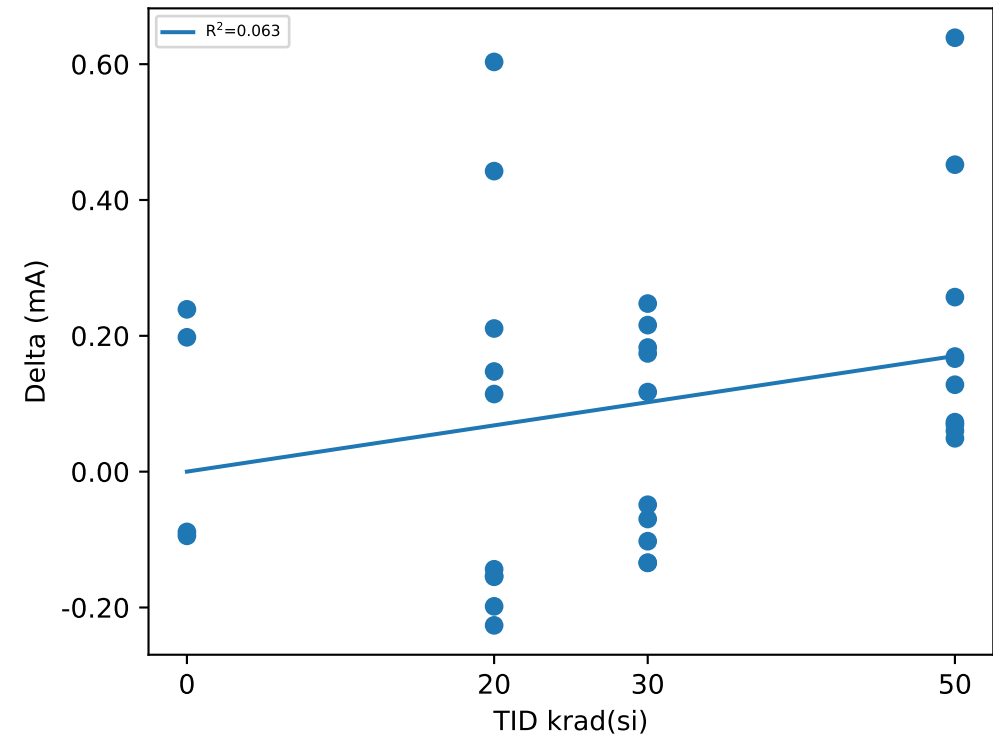
Test Results (Upper Limit = 25.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	21.179	20.976	-0.2028
2	20	HDR BIAS	21.305	21.124	-0.1814
3	20	HDR BIAS	21.348	21.137	-0.2108
4	20	HDR BIAS	21.678	21.36	-0.319
5	20	HDR BIAS	21.265	20.966	-0.2993
6	20	HDR UNBIAS	21.514	21.711	0.1967
7	20	HDR UNBIAS	21.413	21.631	0.2181
8	20	HDR UNBIAS	21.122	21.168	0.0459
9	20	HDR UNBIAS	20.944	21.505	0.5607
10	20	HDR UNBIAS	21.147	21.61	0.4629
11	30	HDR BIAS	21.351	21.274	-0.0771
12	30	HDR BIAS	21.643	21.495	-0.1485
13	30	HDR BIAS	21.042	21.01	-0.0316
14	30	HDR BIAS	20.931	20.93	-0.0005
15	30	HDR BIAS	21.207	21.048	-0.1586
16	30	HDR UNBIAS	21.099	21.223	0.1245
17	30	HDR UNBIAS	21.199	21.445	0.246
18	30	HDR UNBIAS	21.54	21.649	0.1089
19	30	HDR UNBIAS	20.706	20.821	0.1147
20	30	HDR UNBIAS	21.596	21.786	0.1893
21	50	HDR BIAS	21.489	21.57	0.0811
22</					

TID vs Result Stats



TID vs Post - Pre Exposure Delta

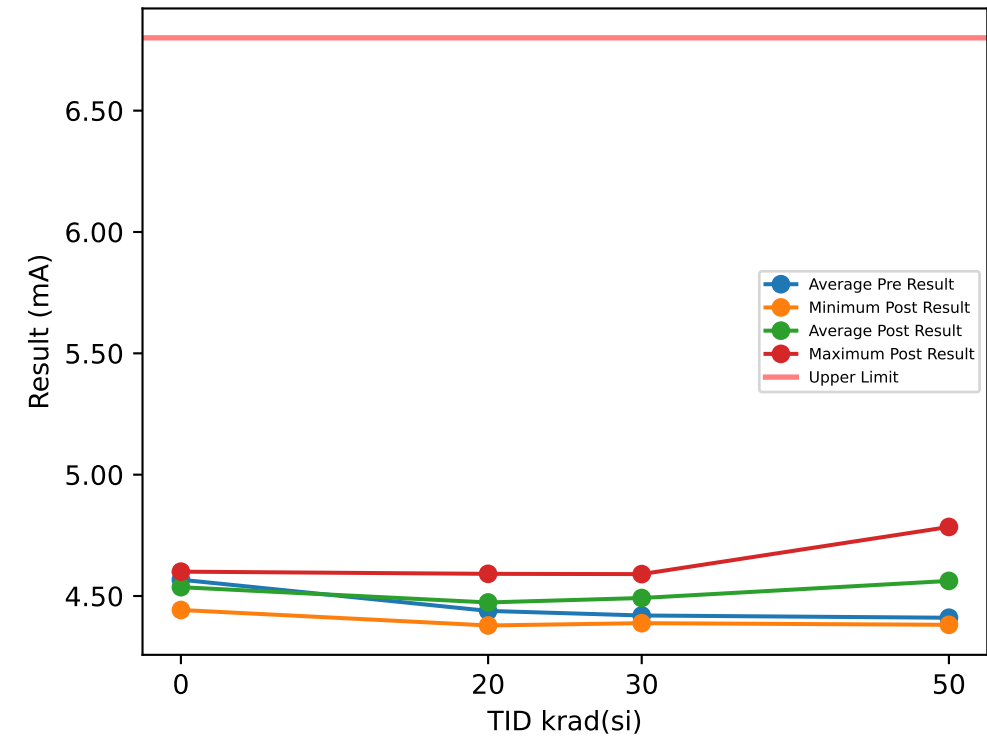


Test Results (Upper Limit = 25.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	17.255	17.029	-0.2263
2	20	HDR BIAS	16.964	16.82	-0.1437
3	20	HDR BIAS	17.001	16.803	-0.1983
4	20	HDR BIAS	17.128	16.974	-0.1535
5	20	HDR BIAS	16.79	16.635	-0.1548

Device Test: 12.17 IQ|PWM/VIN/14/14///0MHz/@IQ_LS_PWM

TID vs Result Stats

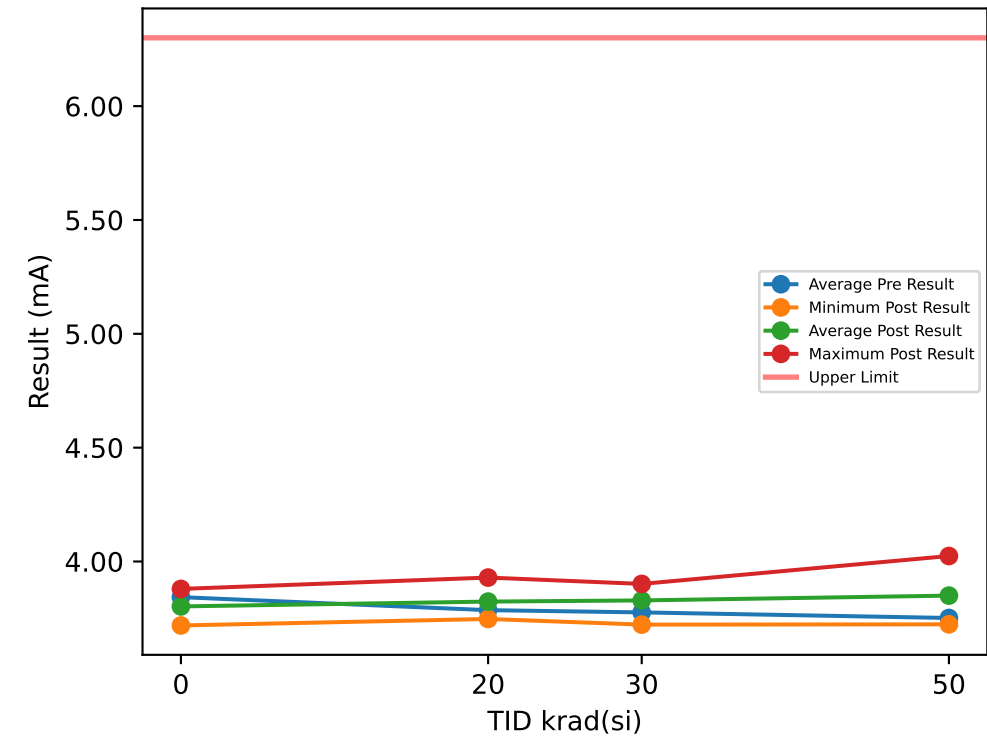


Test Results (Upper Limit = 6.8 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	4.3802	4.4117	0.0315
2	20	HDR BIAS	4.4398	4.4821	0.0423
3	20	HDR BIAS	4.487	4.5401	0.0531
4	20	HDR BIAS	4.3767	4.3787	0.002
5	20	HDR BIAS	4.4007	4.4371	0.0364
6	20	HDR UNBIAS	4.4072	4.4562	0.049
7	20	HDR UNBIAS	4.4272	4.4501	0.0229
8	20	HDR UNBIAS	4.5043	4.5408	0.0365
9	20	HDR UNBIAS	4.4103	4.447	0.0367
10	20	HDR UNBIAS	4.5536	4.5914	0.0378
11	30	HDR BIAS	4.4238	4.5359	0.1121
12	30	HDR BIAS	4.4794	4.5262	0.0468
13	30	HDR BIAS	4.4766	4.5903	0.1137
14	30	HDR BIAS	4.43	4.5234	0.0934
15	30	HDR BIAS	4.3393	4.3881	0.0488
16	30	HDR UNBIAS	4.3926	4.4253	0.0327
17	30	HDR UNBIAS	4.3331	4.4284	0.0953
18	30	HDR UNBIAS	4.4445	4.5088	0.0643
19	30	HDR UNBIAS	4.4387	4.5128	0.0741
20	30	HDR UNBIAS			

Device Test: 12.18 IQ|PWM/BOOT/14/14///0MHz/@IQ_HS_PWM

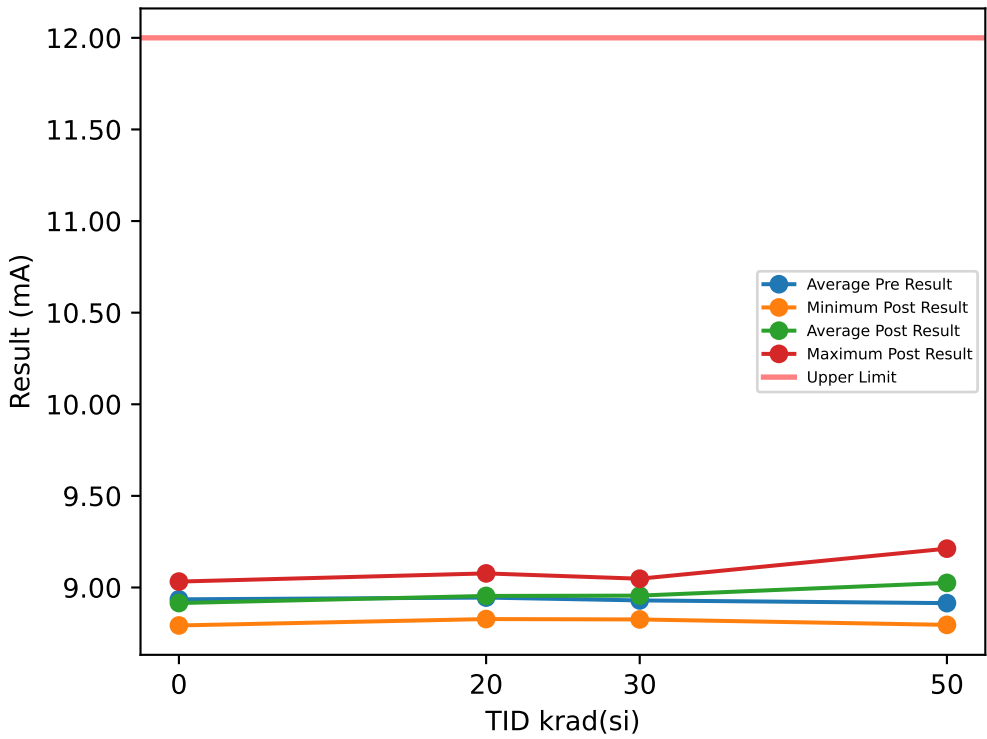
TID vs Result Stats



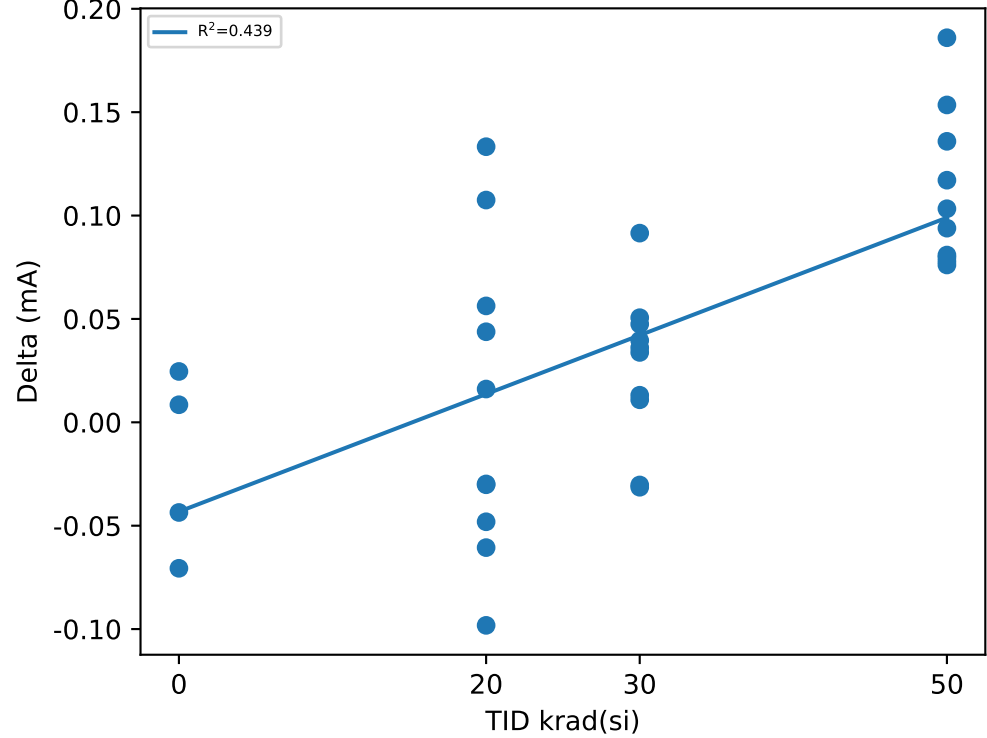
Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.76	3.8045	0.0445
2	20	HDR BIAS	3.8179	3.8333	0.0154
3	20	HDR BIAS	3.705	3.7476	0.0426
4	20	HDR BIAS	3.852	3.9294	0.0774
5	20	HDR BIAS	3.7536	3.8039	0.0503
6	20	HDR UNBIAS	3.8014	3.7979	-0.0035
7	20	HDR UNBIAS	3.8353	3.8829	0.0476
8	20	HDR UNBIAS	3.7548	3.7899	0.0351
9	20	HDR UNBIAS	3.738	3.7705	0.0325
10	20	HDR UNBIAS	3.8448	3.8792	0.0344
11	30	HDR BIAS	3.7977	3.8769	0.0792
12	30	HDR BIAS	3.7806	3.8474	0.0668
13	30	HDR BIAS	3.7934	3.8564	0.063
14	30	HDR BIAS	3.7911	3.8298	0.0387
15	30	HDR BIAS	3.8529	3.9016	0.0487
16	30	HDR UNBIAS	3.6913	3.7228	0.0315
17	30	HDR UNBIAS	3.7262	3.7607	0.0345
18	30	HDR UNBIAS	3.814	3.8698	0.0558
19	30	HDR UNBIAS	3.7471	3.7996	0.0525
20	30	HDR UNBIAS	3		

TID vs Result Stats



TID vs Post - Pre Exposure Delta

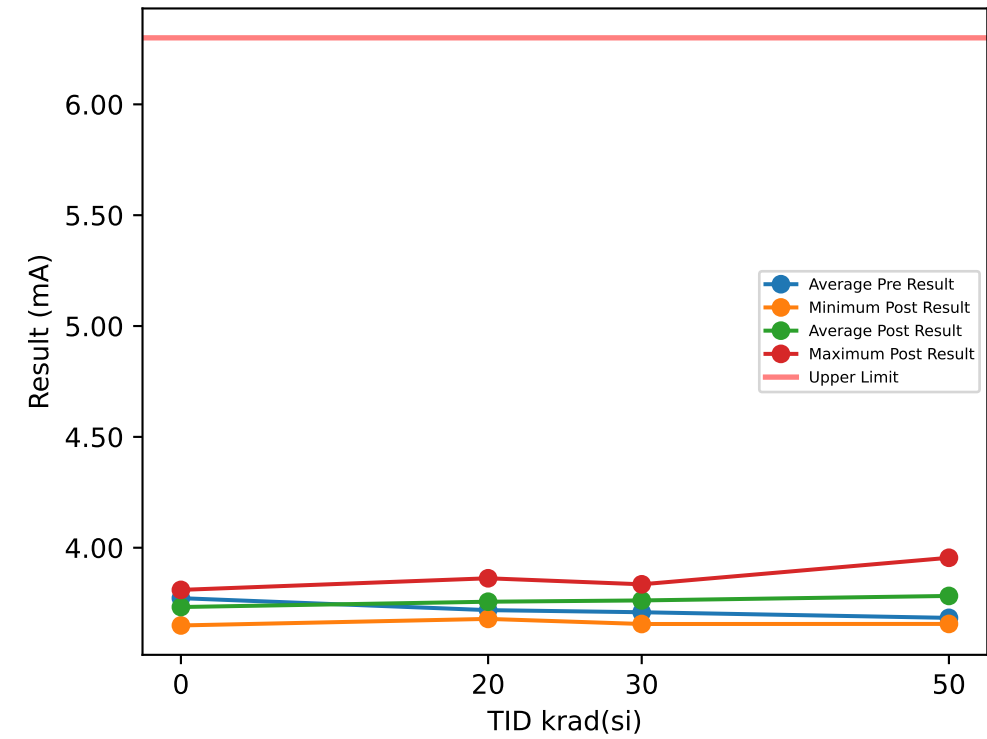


Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	8.9021	8.854	-0.0481
2	20	HDR BIAS	8.9572	8.927	-0.0302
3	20	HDR BIAS	8.9787	8.9489	-0.0298
4	20	HDR BIAS	8.9913	8.8931	-0.0982
5	20	HDR BIAS	8.8883	8.8277	-0.0606
6	20	HDR UNBIAS	8.9753	9.0316	0.0563
7	20	HDR UN			

Device Test: 12.2 IQ|PWM/BOOT/10/8///0MHz/@IQ_HS_PWM

TID vs Result Stats

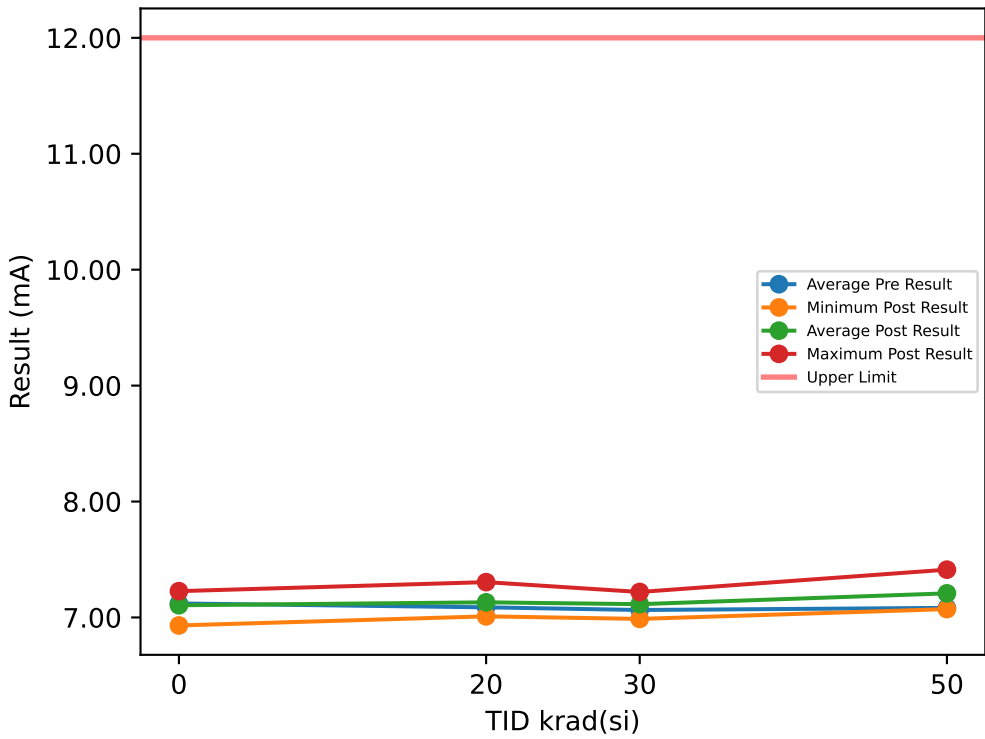


Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.6918	3.737	0.0452
2	20	HDR BIAS	3.7505	3.7667	0.0162
3	20	HDR BIAS	3.6366	3.679	0.0424
4	20	HDR BIAS	3.7838	3.8622	0.0784
5	20	HDR BIAS	3.6872	3.7373	0.0501
6	20	HDR UNBIAS	3.733	3.7293	-0.0037
7	20	HDR UNBIAS	3.7697	3.8169	0.0472
8	20	HDR UNBIAS	3.6863	3.7219	0.0356
9	20	HDR UNBIAS	3.6706	3.7034	0.0328
10	20	HDR UNBIAS	3.7755	3.811	0.0355
11	30	HDR BIAS	3.7312	3.8105	0.0793
12	30	HDR BIAS	3.7127	3.7788	0.0661
13	30	HDR BIAS	3.724	3.7897	0.0657
14	30	HDR BIAS	3.7232	3.7625	0.0393
15	30	HDR BIAS	3.786	3.835	0.049
16	30	HDR UNBIAS	3.6227	3.656	0.0333
17	30	HDR UNBIAS	3.6595	3.694	0.0345
18	30	HDR UNBIAS	3.7459	3.8022	0.0563
19	30	HDR UNBIAS	3.6814	3.7328	0.0514
20	30	HDR UNBIAS	3.7033	3.7612	0.0579
21					

Device Test: 12.20 IOP|PWM/BOOT/14/14///0.5MHz/@I_OP_HS_PWM_500KHZ

TID vs Result Stats

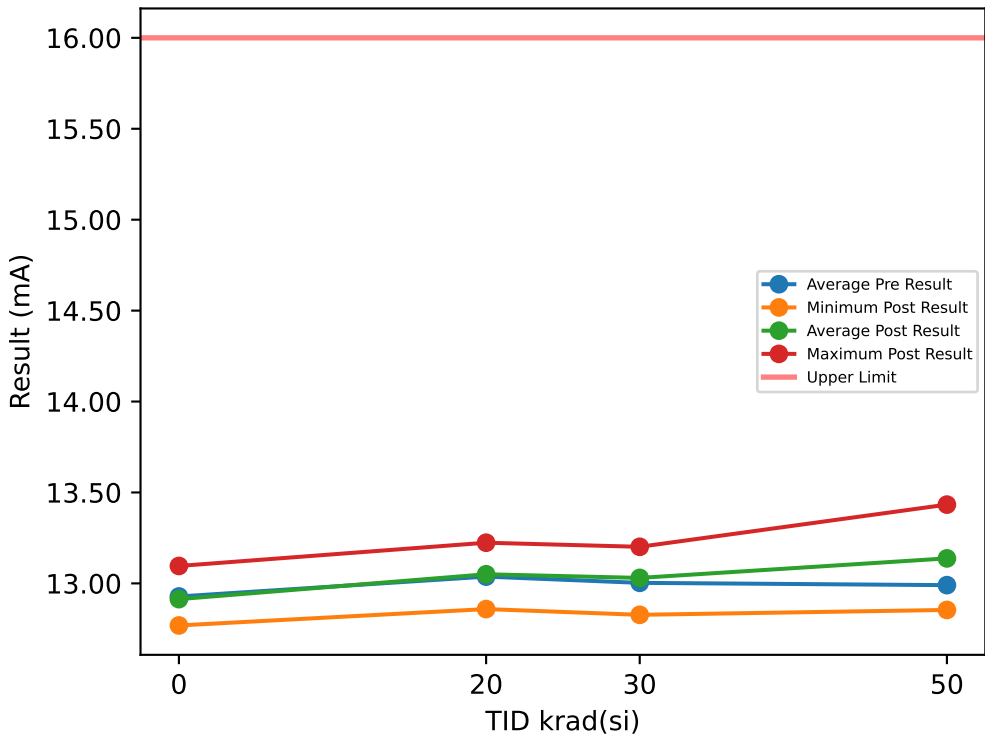


Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	7.13	7.1072	-0.0228
2	20	HDR BIAS	7.1022	7.0783	-0.0239
3	20	HDR BIAS	7.0273	7.0096	-0.0177
4	20	HDR BIAS	7.1659	7.1868	0.0209
5	20	HDR BIAS	7.0106	7.0096	-0.001
6	20	HDR UNBIAS	7.0826	7.1145	0.0319
7	20	HDR UNBIAS	7.2197	7.3048	0.0851
8	20	HDR UNBIAS	7.049	7.1023	0.0533
9	20	HDR UNBIAS	7.0126	7.1837	0.1711
10	20	HDR UNBIAS	7.0741	7.2086	0.1345
11	30	HDR BIAS	7.0352	7.0814	0.0462
12	30	HDR BIAS	7.1037	7.1202	0.0165
13	30	HDR BIAS	7.0395	7.0632	0.0237
14	30	HDR BIAS	7.1508	7.1485	-0.0023
15	30	HDR BIAS	7.1079	7.1255	0.0176
16	30	HDR UNBIAS	7.0499	7.1338	0.0839
17	30	HDR UNBIAS	6.9329	6.9875	0.0546
18	30	HDR UNBIAS	7.0721	7.1594	0.0873
19	30	HDR UNBIAS	7.1298	7.2198	0.09
20	30	HDR UNBIAS	7.0223	7.1062	0.0839
21	50	HDR BIAS	7		

Device Test: 12.21 IOP|PWM/VIN/14/14///1MHz/@I_OP_LS_PWM_1MHZ

TID vs Result Stats

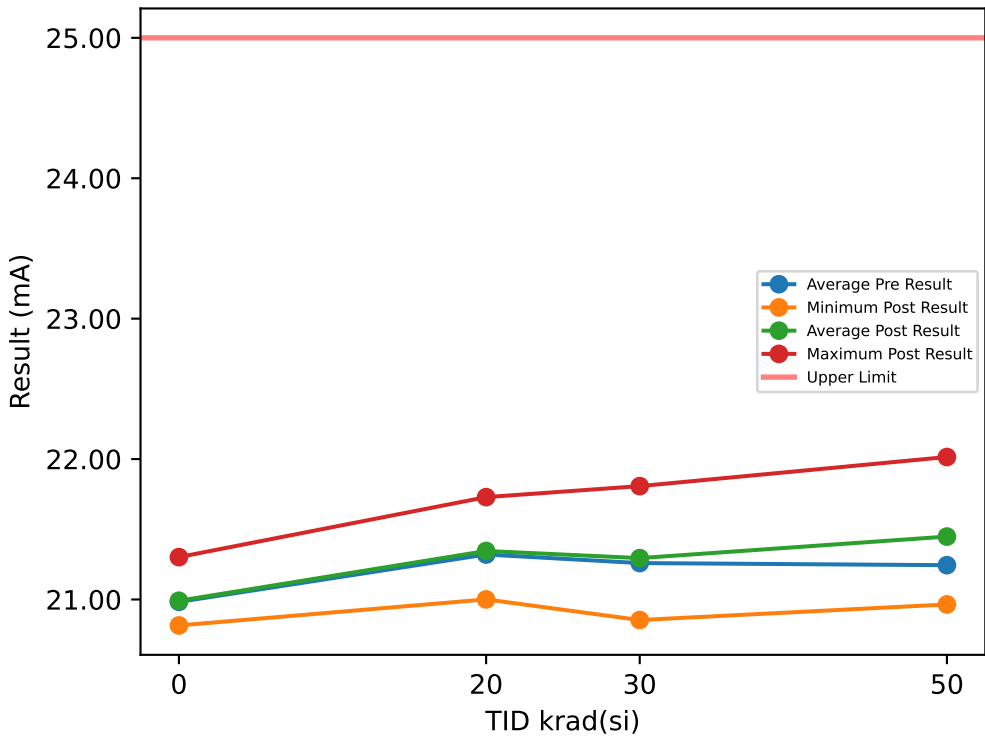


Test Results (Upper Limit = 16.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	12.977	12.884	-0.0927
2	20	HDR BIAS	13.054	12.978	-0.0759
3	20	HDR BIAS	13.084	13	-0.0839
4	20	HDR BIAS	13.153	12.982	-0.1719
5	20	HDR BIAS	12.989	12.859	-0.1298
6	20	HDR UNBIAS	13.128	13.224	0.0961
7	20	HDR UNBIAS	13.121	13.219	0.0971
8	20	HDR UNBIAS	12.993	13.018	0.0242
9	20	HDR UNBIAS	12.859	13.12	0.2616
10	20	HDR UNBIAS	13.014	13.219	0.2049
11	30	HDR BIAS	13.108	13.111	0.0024
12	30	HDR BIAS	13.21	13.146	-0.0641
13	30	HDR BIAS	12.969	12.997	0.0273
14	30	HDR BIAS	12.866	12.896	0.0294
15	30	HDR BIAS	12.953	12.886	-0.067
16	30	HDR UNBIAS	12.929	12.962	0.0328
17	30	HDR UNBIAS	12.972	13.109	0.1362
18	30	HDR UNBIAS	13.14	13.201	0.0614
19	30	HDR UNBIAS	12.752	12.827	0.075
20	30	HDR UNBIAS	13.13</		

Device Test: 12.23 IOP|PWM/VIN/14/14///2MHz/@I_OP_LS_PWM_2MHZ

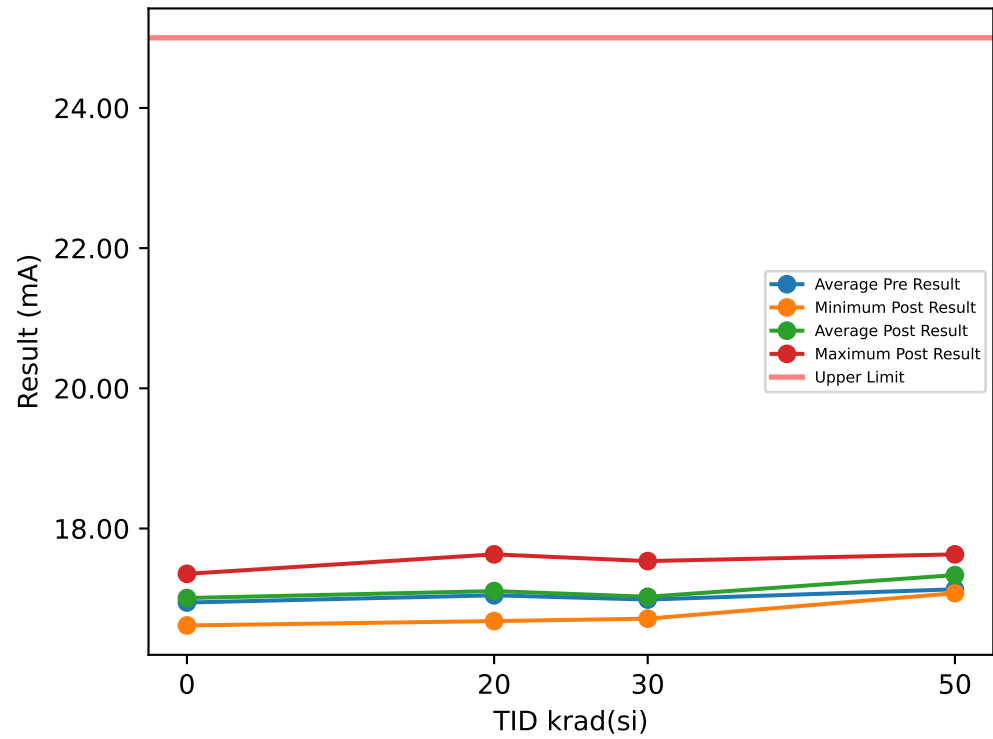
TID vs Result Stats



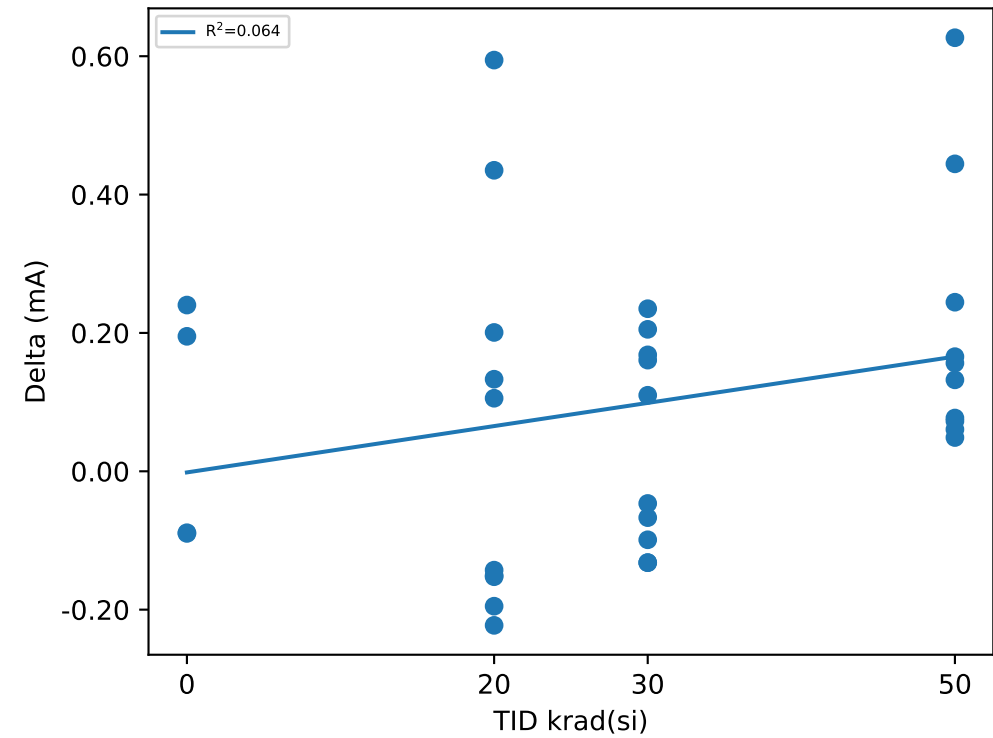
Test Results (Upper Limit = 25.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	21.206	21.01	-0.196
2	20	HDR BIAS	21.334	21.156	-0.1776
3	20	HDR BIAS	21.375	21.171	-0.2041
4	20	HDR BIAS	21.711	21.397	-0.3141
5	20	HDR BIAS	21.29	21	-0.2893
6	20	HDR UNBIAS	21.541	21.729	0.1877
7	20	HDR UNBIAS	21.439	21.652	0.2131
8	20	HDR UNBIAS	21.15	21.191	0.0403
9	20	HDR UNBIAS	20.977	21.523	0.5464
10	20	HDR UNBIAS	21.179	21.626	0.4463
11	30	HDR BIAS	21.378	21.308	-0.0704
12	30	HDR BIAS	21.671	21.525	-0.146
13	30	HDR BIAS	21.069	21.043	-0.0262
14	30	HDR BIAS	20.959	20.961	0.0024
15	30	HDR BIAS	21.232	21.082	-0.1501
16	30	HDR UNBIAS	21.128	21.242	0.114
17	30	HDR UNBIAS	21.228	21.459	0.2316
18	30	HDR UNBIAS	21.569	21.666	0.0969
19	30	HDR UNBIAS	20.735	20.854	0.1185
20	30	HDR UNBIAS	21.624	21.807	0.1834
21	50	HDR BIAS	21.515	21.604	0.0896
22					

TID vs Result Stats



TID vs Post - Pre Exposure Delta

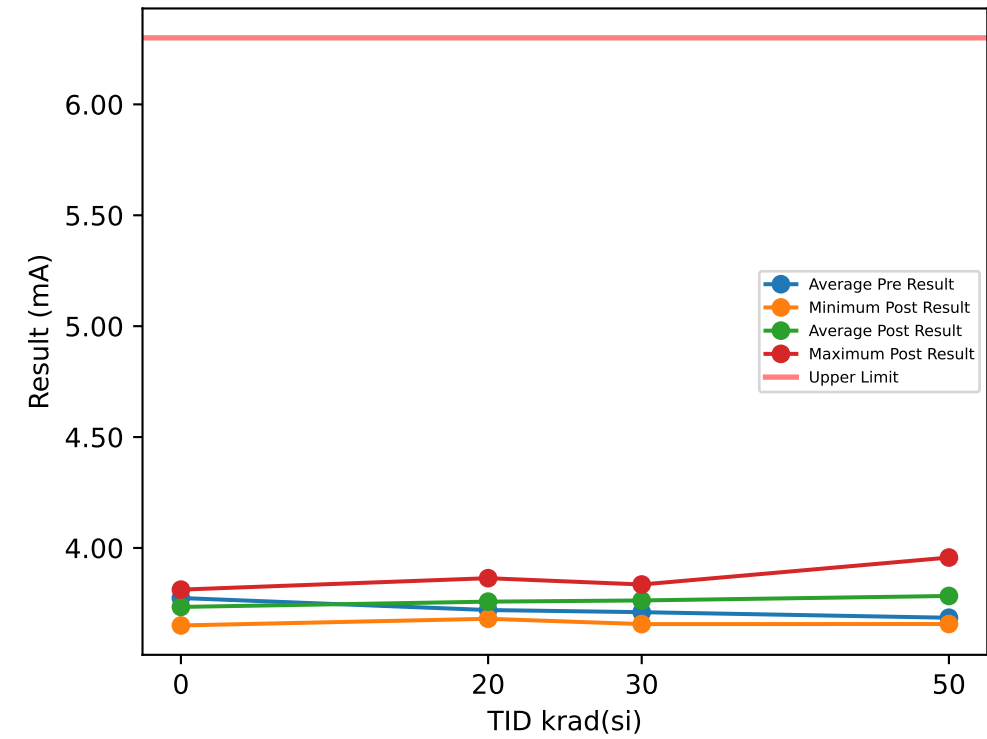


Test Results (Upper Limit = 25.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	17.296	17.073	-0.2227
2	20	HDR BIAS	17.008	16.865	-0.1429
3	20	HDR BIAS	17.043	16.848	-0.195
4	20	HDR BIAS	17.171	17.02	-0.1507
5	20	HDR BIAS	16.832	16.679	-0.1524

Device Test: 12.26 IQ|IIM_EN/BOOT/10/8///0MHz/@IQ_HS_IIM

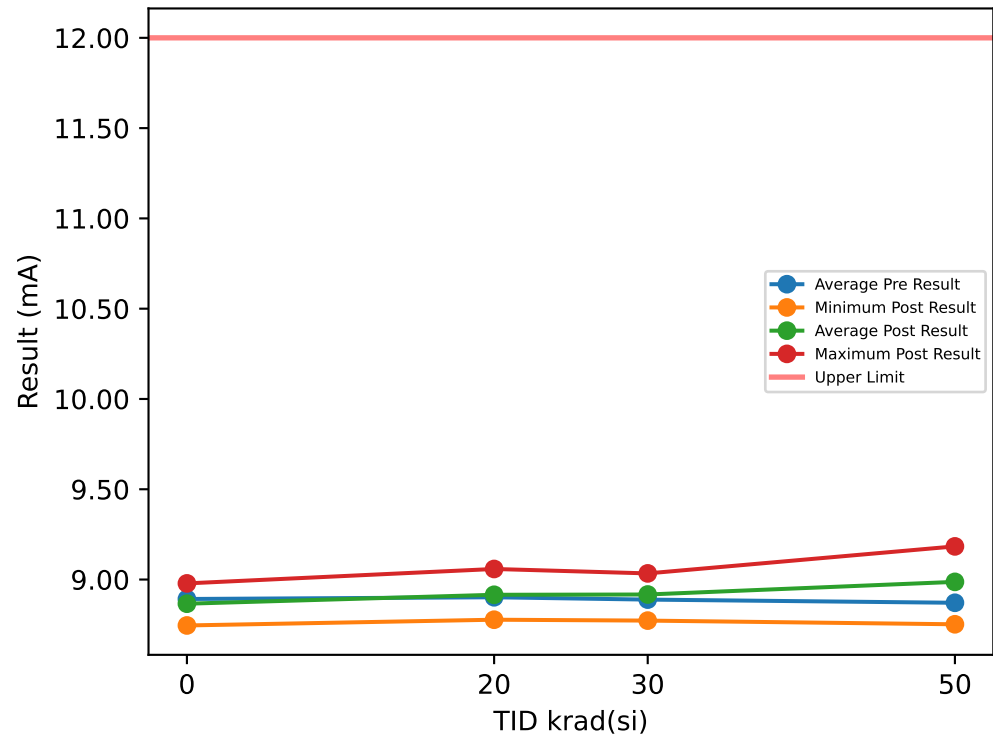
TID vs Result Stats



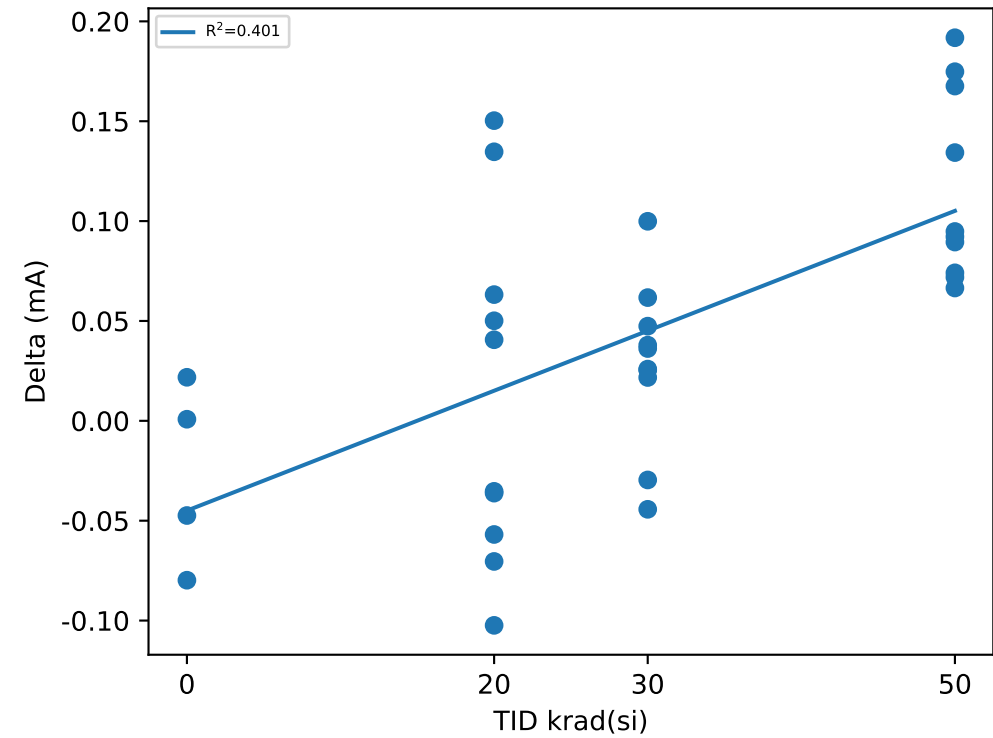
Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.6943	3.7393	0.045
2	20	HDR BIAS	3.7526	3.7685	0.0159
3	20	HDR BIAS	3.6377	3.6807	0.043
4	20	HDR BIAS	3.7853	3.8637	0.0784
5	20	HDR BIAS	3.6881	3.7381	0.05
6	20	HDR UNBIAS	3.7356	3.7311	-0.0045
7	20	HDR UNBIAS	3.7711	3.8184	0.0473
8	20	HDR UNBIAS	3.6882	3.7225	0.0343
9	20	HDR UNBIAS	3.6721	3.7043	0.0322
10	20	HDR UNBIAS	3.7764	3.8128	0.0364
11	30	HDR BIAS	3.7331	3.8111	0.078
12	30	HDR BIAS	3.7147	3.7808	0.0661
13	30	HDR BIAS	3.7249	3.7895	0.0646
14	30	HDR BIAS	3.7248	3.7643	0.0395
15	30	HDR BIAS	3.7874	3.8353	0.0479
16	30	HDR UNBIAS	3.6248	3.6567	0.0319
17	30	HDR UNBIAS	3.6607	3.696	0.0353
18	30	HDR UNBIAS	3.7464	3.8046	0.0582
19	30	HDR UNBIAS	3.6822	3.7341	0.0519
20	30	HDR UNBIAS	3.7057	3.7614	0.0557
21	50	HDR BIAS	3.6226	3.696	0.0734
22	50	HDR BIAS	3.6984	3.813	0.1146
23	50	HDR BIAS	3.7847	3.9233	0.1386
24	50	HDR BIAS	3.828	3.9568	0.1288
25	50	HDR BIAS			

TID vs Result Stats



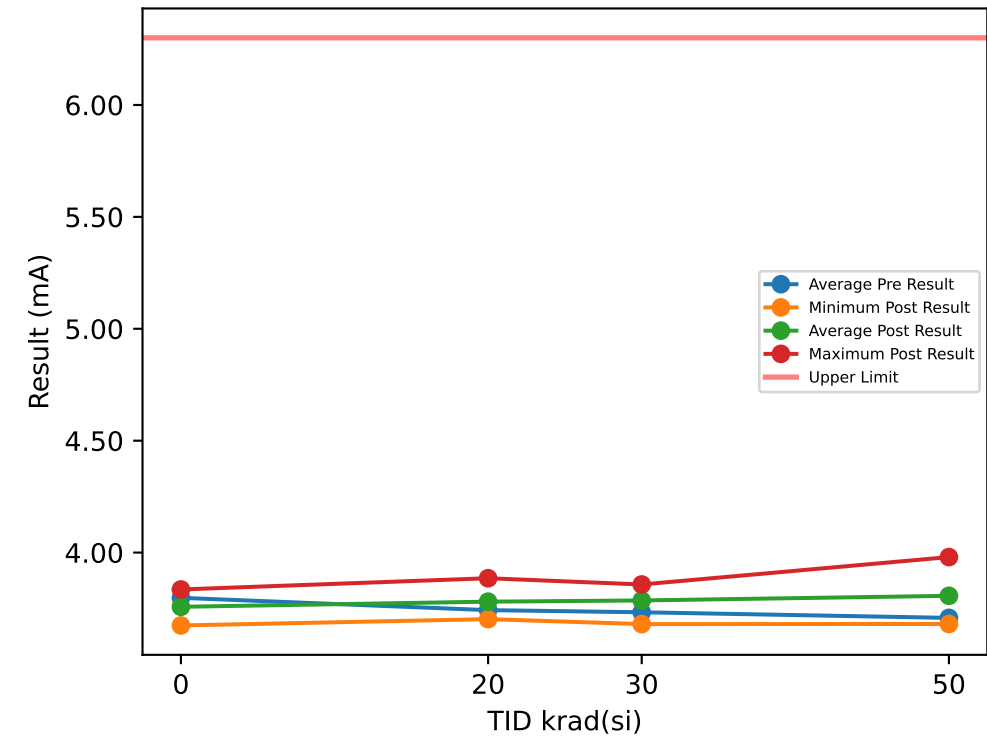
TID vs Post - Pre Exposure Delta



Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	8.8596	8.8027	-0.0569
2	20	HDR BIAS	8.9178	8.8825	-0.0353
3	20	HDR BIAS	8.9343	8.8981	-0.0362
4	20</				

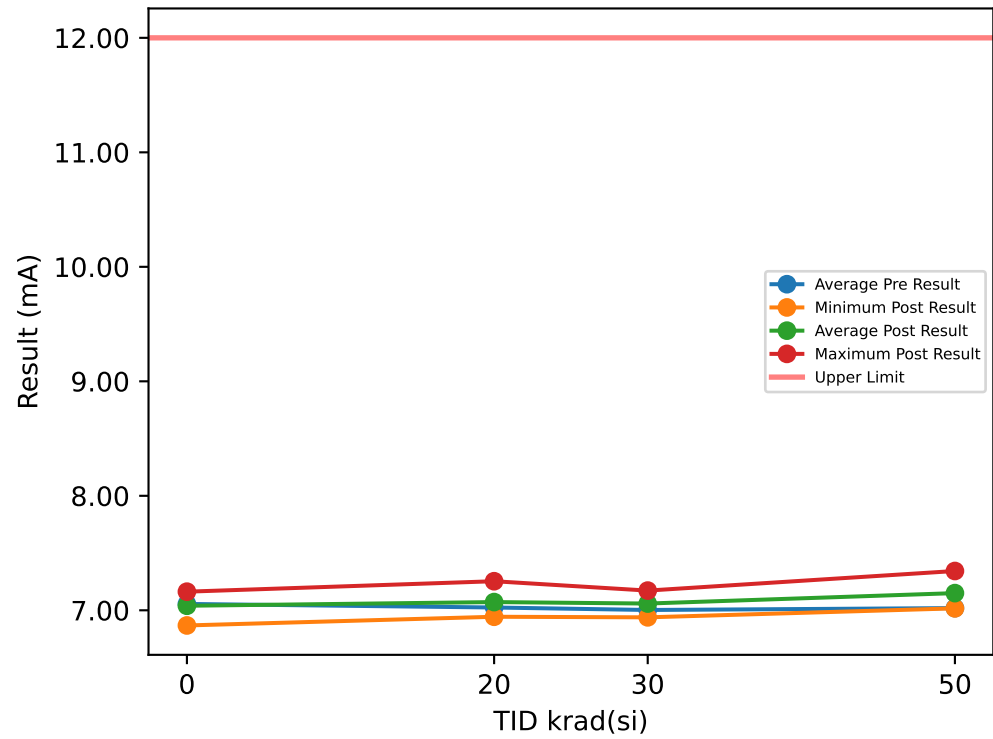
TID vs Result Stats



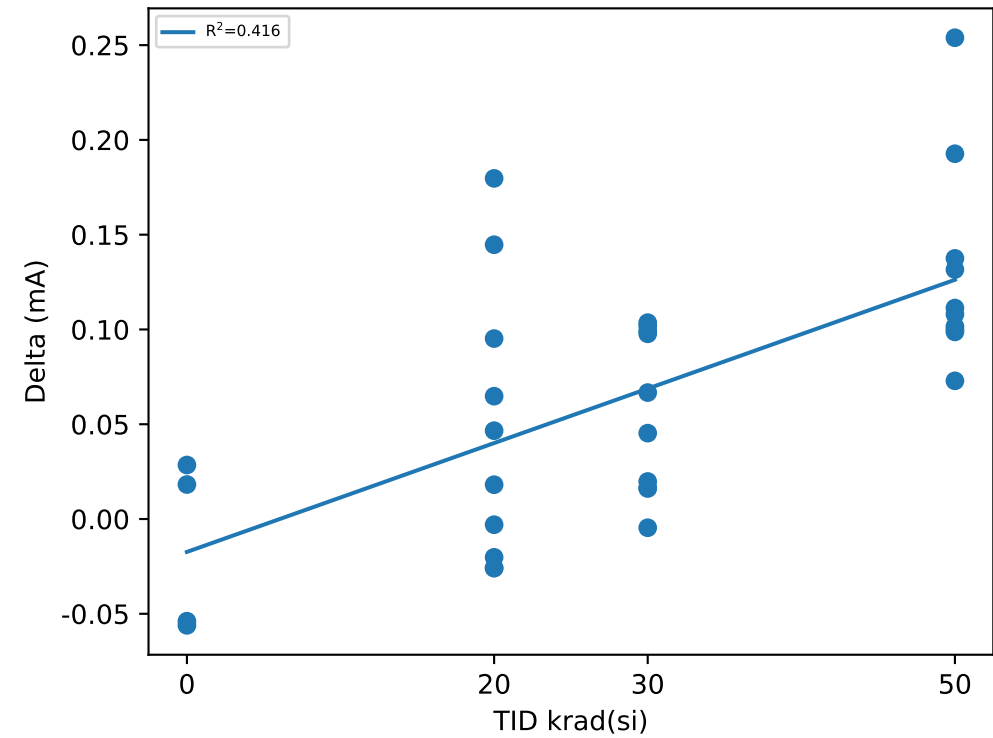
Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.7162	3.7616	0.0454
2	20	HDR BIAS	3.775	3.791	0.016
3	20	HDR BIAS	3.6609	3.7027	0.0418
4	20	HDR BIAS	3.8086	3.8854	0.0768
5	20	HDR BIAS	3.7113	3.7615	0.0502
6	20	HDR UNBIAS	3.7585	3.7554	-0.0031
7	20	HDR UNBIAS	3.7929	3.8407	0.0478
8	20	HDR UNBIAS	3.7105	3.7458	0.0353
9	20	HDR UNBIAS	3.6947	3.7268	0.0321
10	20	HDR UNBIAS	3.8001	3.8363	0.0362
11	30	HDR BIAS	3.7552	3.8335	0.0783
12	30	HDR BIAS	3.7377	3.8033	0.0656
13	30	HDR BIAS	3.7485	3.8128	0.0643
14	30	HDR BIAS	3.748	3.7869	0.0389
15	30	HDR BIAS	3.8103	3.8575	0.0472
16	30	HDR UNBIAS	3.6475	3.6805	0.033
17	30	HDR UNBIAS	3.6832	3.7191	0.0359
18	30	HDR UNBIAS	3.7694	3.826	0.0566
19	30	HDR UNBIAS	3.7044	3.7566	0.0522
20	30	HDR UNBIAS	3.7288	3.7849	0.0

TID vs Result Stats



TID vs Post - Pre Exposure Delta

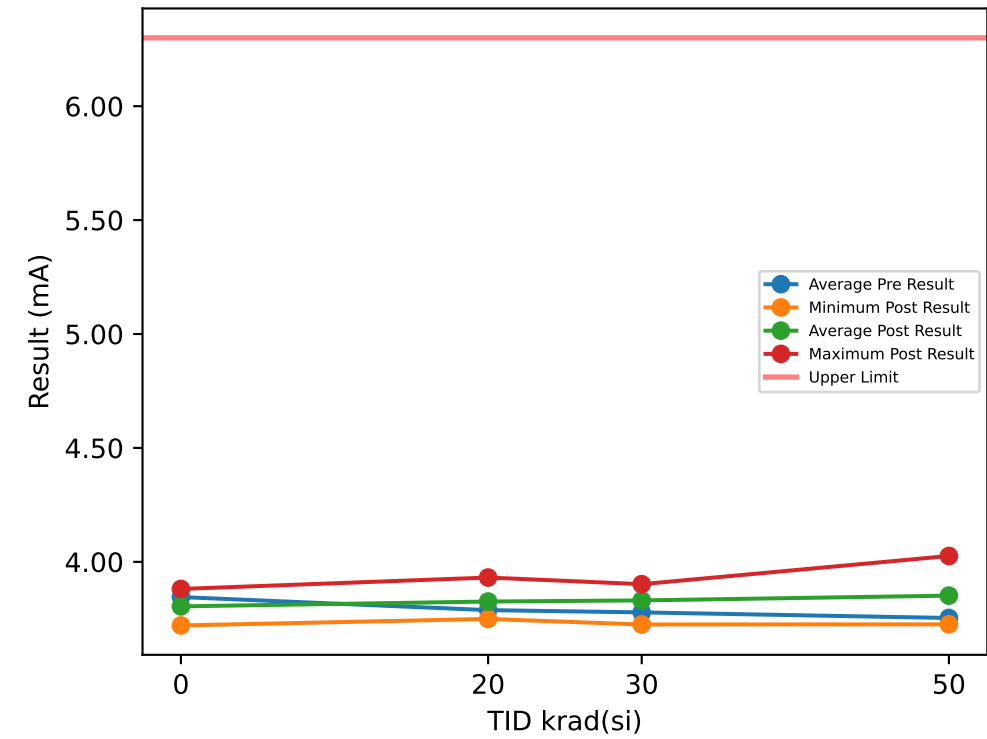


Test Results (Upper Limit = 12.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	7.0674	7.0415	-0.0259
2	20	HDR BIAS	7.0423	7.0165	-0.0258
3	20	HDR BIAS	6.9638	6.9436	-0.0202
4	20	HDR BIAS	7.1012	7.1193	0.0181
5	20	HDR			

Device Test: 12.42 IQ|IIM_EN/BOOT/14/14///0MHz/@IQ_HS_IIM

TID vs Result Stats

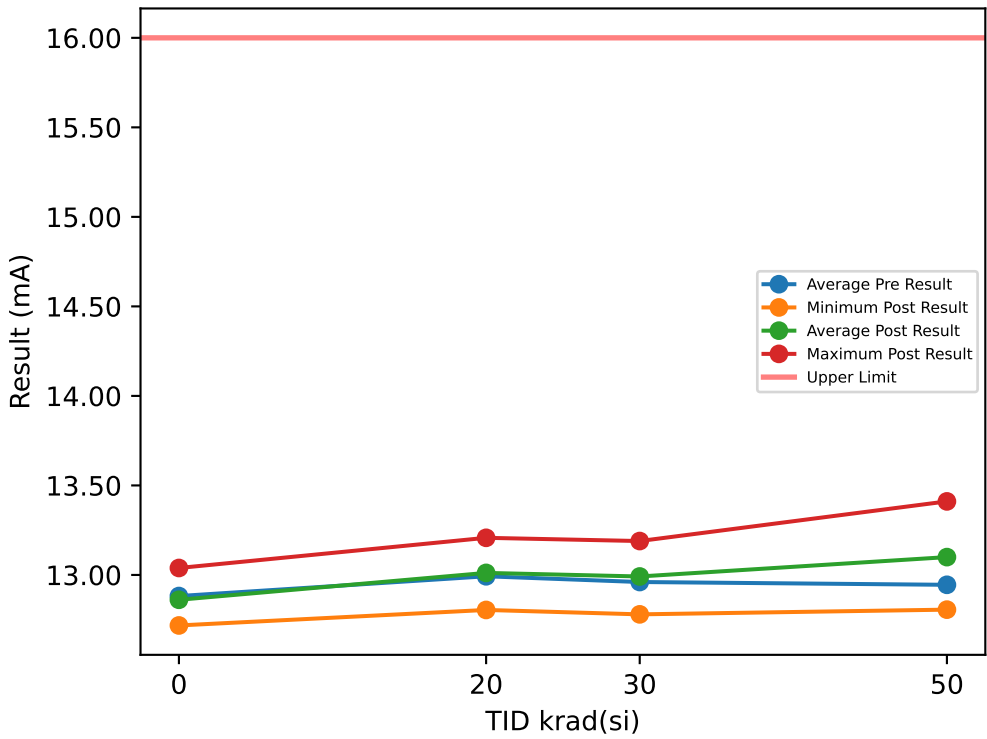


Test Results (Upper Limit = 6.3 (mA))

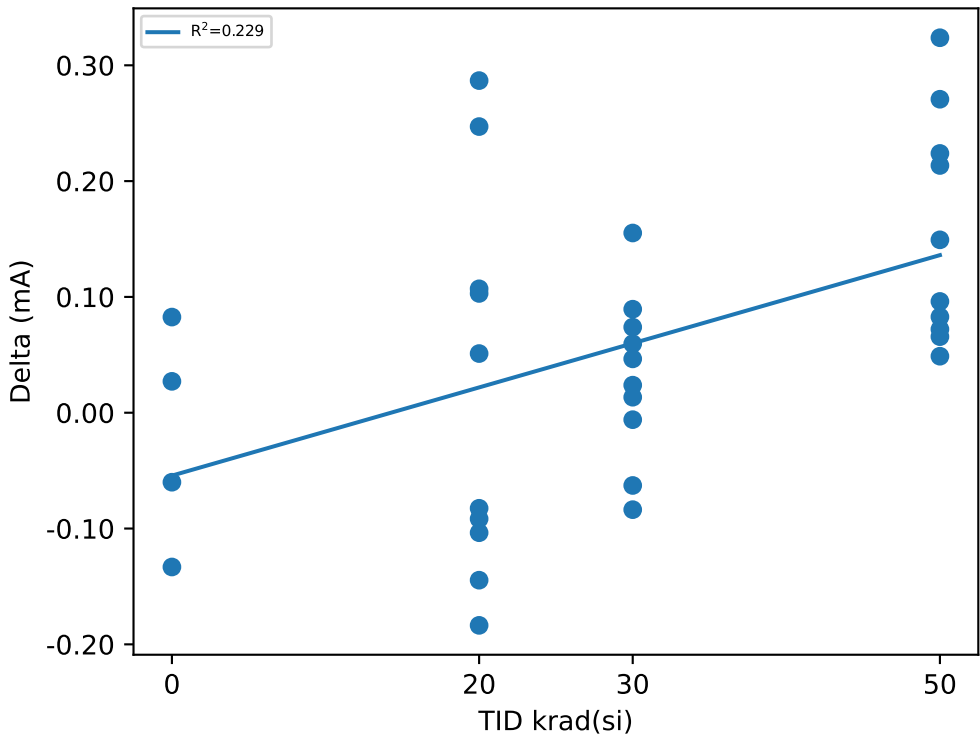
Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.7615	3.8068	0.0453
2	20	HDR BIAS	3.8197	3.8354	0.0157
3	20	HDR BIAS	3.7071	3.7494	0.0423
4	20	HDR BIAS	3.8541	3.9311	0.077
5	20	HDR BIAS	3.7557	3.8051	0.0494
6	20	HDR UNBIAS	3.8031	3.8011	-0.002
7	20	HDR UNBIAS	3.8366	3.8845	0.0479
8	20	HDR UNBIAS	3.7565	3.7905	0.034
9	20	HDR UNBIAS	3.7395	3.7721	0.0326
10	20	HDR UNBIAS	3.8473	3.8819	0.0346
11	30	HDR BIAS	3.7999	3.8775	0.0776
12	30	HDR BIAS	3.7826	3.8484	0.0658
13	30	HDR BIAS	3.7948	3.8584	0.0636
14	30	HDR BIAS	3.7922	3.8323	0.0401
15	30	HDR BIAS	3.8547	3.902	0.0473
16	30	HDR UNBIAS	3.6931	3.725	0.0319
17	30	HDR UNBIAS	3.728	3.7623	0.0343
18	30	HDR UNBIAS	3.8155	3.8721	0.0566
19	30	HDR UNBIAS	3.7482	3.8007	0.0525
20	30	HDR UNBIAS	3.7723	3.8287	0.0564
21	50	HDR BIAS	3.6913	3.7644	0.0731
22	50	HDR BIAS	3.7655	3.8791	0.1136
23	50	HDR BIAS	3.8535	3.9925	0.139
24	50	HDR BIAS	3.8978	4.0257	0.1279
25	50	HDR BIAS	3.7091		

Device Test: 12.5 IOP|PWM/VIN/10/8///1MHz/@I_OP_LS_PWM_1MHZ

TID vs Result Stats



TID vs Post - Pre Exposure Delta

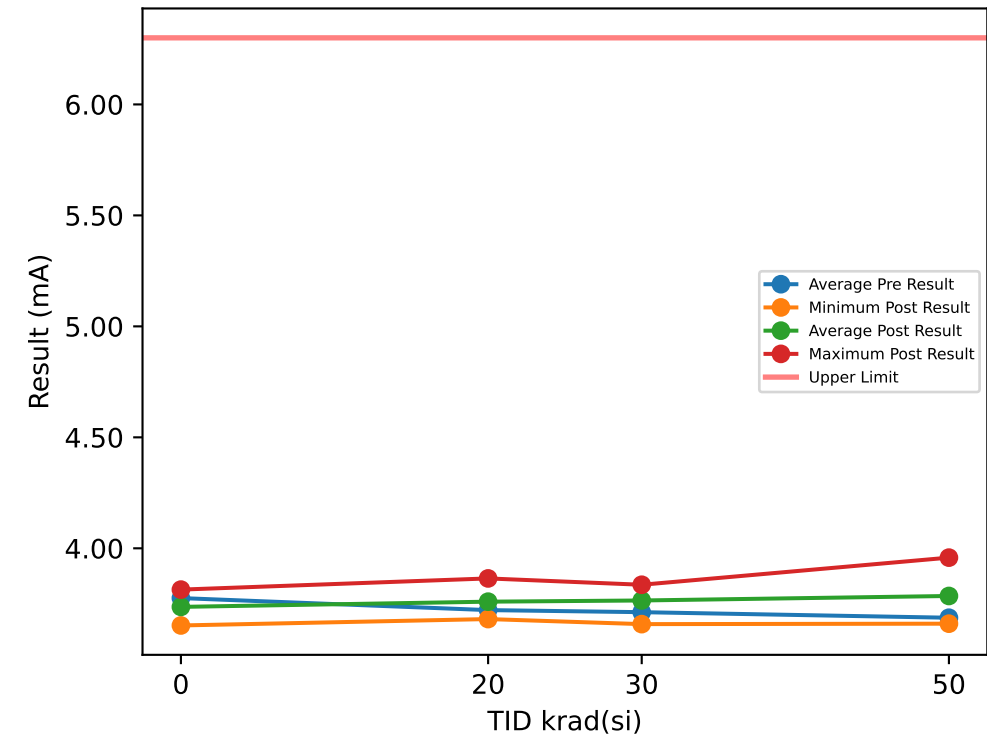


Test Results (Upper Limit = 16.0 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	12.932	12.829	-0.1036
2	20	HDR BIAS	13.011	12.928	-0.0825
3	20	HDR BIAS	13.037	12.946	-0.0916
4	20	HDR BIAS	13.114	12.931	-0.1836
5	20	HDR BIAS	12.949	12.805	-0.1446
6	20	HDR UNBIAS	13.089	13.192	0.103
7	20	HDR UNBIAS	13.077	13.184	

Device Test: 12.50 IQ|IIM_DIS/BOOT/10/8///0MHz/@IQ_HS_IIM

TID vs Result Stats

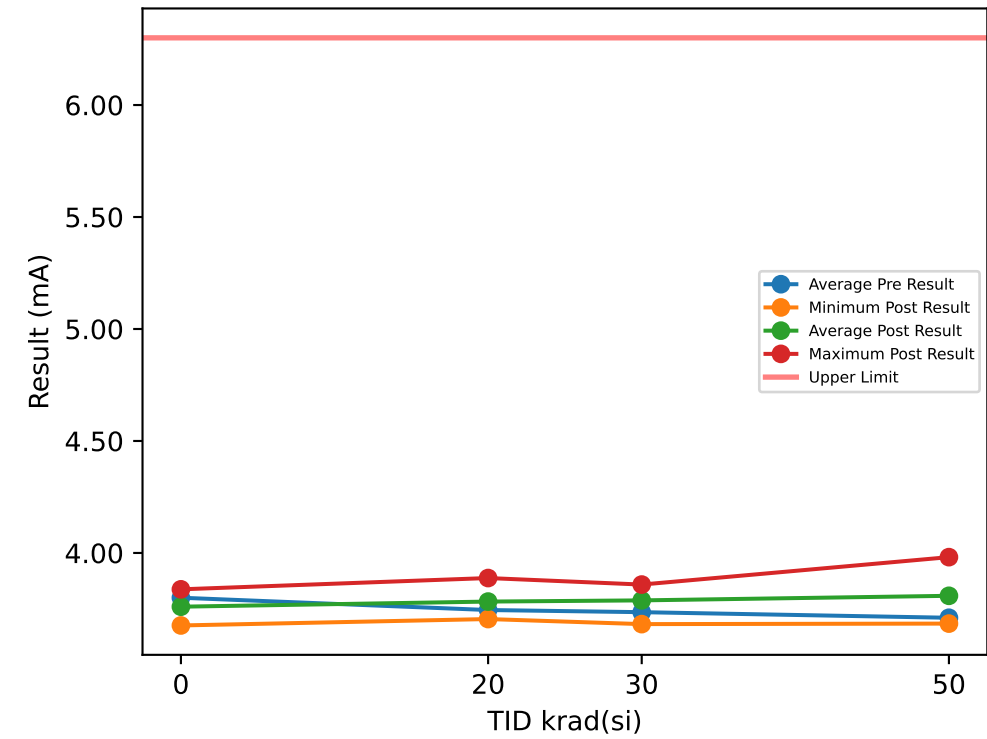


Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.6957	3.7407	0.045
2	20	HDR BIAS	3.7539	3.7705	0.0166
3	20	HDR BIAS	3.639	3.6812	0.0422
4	20	HDR BIAS	3.7864	3.8643	0.0779
5	20	HDR BIAS	3.6898	3.7398	0.05
6	20	HDR UNBIAS	3.7369	3.7334	-0.0035
7	20	HDR UNBIAS	3.7721	3.8215	0.0494
8	20	HDR UNBIAS	3.6893	3.7236	0.0343
9	20	HDR UNBIAS	3.6733	3.7053	0.032
10	20	HDR UNBIAS	3.7794	3.8153	0.0359
11	30	HDR BIAS	3.7351	3.8127	0.0776
12	30	HDR BIAS	3.7166	3.7823	0.0657
13	30	HDR BIAS	3.7262	3.7913	0.0651
14	30	HDR BIAS	3.7274	3.7663	0.0389
15	30	HDR BIAS	3.789	3.8358	0.0468
16	30	HDR UNBIAS	3.6269	3.6584	0.0315
17	30	HDR UNBIAS	3.6619	3.6976	0.0357
18	30	HDR UNBIAS	3.7488	3.8062	0.0574
19	30	HDR UNBIAS	3.6836	3.7351	0.0515
20	30	HDR UNBIAS	3.707	3.7637	0.0567

Device Test: 12.58 IQ|IIM_DIS/BOOT/12/10///0MHz/@IQ_HS_IIM

TID vs Result Stats



Test Results (Upper Limit = 6.3 (mA))

Serial #	krad(si)	Exposure Conditions	Pre Result	Post Result	Delta
1	20	HDR BIAS	3.7188	3.764	0.0452
2	20	HDR BIAS	3.7767	3.7935	0.0168
3	20	HDR BIAS	3.6629	3.7049	0.042
4	20	HDR BIAS	3.8109	3.888	0.0771
5	20	HDR BIAS	3.7134	3.7642	0.0508
6	20	HDR UNBIAS	3.7603	3.7561	-0.0042
7	20	HDR UNBIAS	3.7953	3.8434	0.0481
8	20	HDR UNBIAS	3.7129	3.7478	0.0349
9	20	HDR UNBIAS	3.6973	3.7282	0.0309
10	20	HDR UNBIAS	3.8037	3.8392	0.0355
11	30	HDR BIAS	3.7573	3.8355	0.0782
12	30	HDR BIAS	3.74	3.8069	0.0669
13	30	HDR BIAS	3.7506	3.8152	0.0646
14	30	HDR BIAS	3.75	3.7901	0.0401
15	30	HDR BIAS	3.8128	3.8589	0.0461
16	30	HDR UNBIAS	3.6503	3.6823	0.032
17	30	HDR UNBIAS	3.6853	3.7205	0.0352
18	30	HDR UNBIAS	3.7726	3.8283	0.0557
19	30	HDR UNBIAS	3.707	3.7577	0.0507
20	30	HDR UNBIAS	3.7301	3.7872	0.0571
21	50	HDR BIAS	3.648	3.7212	0.0732
22	50	HDR BIAS	3.7238	3.837	0.1132
23	50	HDR BIAS	3.8097	3.95	0.1403
24	50	HDR BIAS	3.8537	3.	

