



ABSTRACT

This report covers the radiation characterization results of the ADC3664-SEP which is a space grade, 14-bit, 125-MSPS, low noise, ultra-low power, dual channel ADC. The study was done to determine Total Ionizing Dose (TID) effects under high dose rate (HDR) up to 50 krad(Si) as a one-time characterization. The results show that all samples passed within the specified limits up to 50 krad(Si).

In production, the Radiation Lot Acceptance Testing (RLAT) is performed using 5 units on every fab-lot to the specified rating of 30 krad(Si). Furthermore, the ADC3664-SEP has a Single Event Latch-Up (SEL) immunization up to 43 MeV-cm²/mg which makes it suitable for Radiation Hardness Assured Space Applications in VLEO, LEO and MEO orbits.

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1 Device Information

The ADC3664-SEP is a low noise, ultra-low power, 14-bit, 125-MSPS, dual channel ADC. Designed for lowest noise performance, the device delivers a noise spectral density of -156.9dBFS/Hz combined with excellent linearity and dynamic range. The ADC3664-SEP offers DC precision together with IF sampling support making the device an excellent choice for a wide range of applications. High-speed control loops benefit from the short latency as low as only 1 clock cycle. The ADC consumes only 100 mW/ch at 125-MSPS and the power consumption scales well with lower sampling rates.

The device uses a serial LVDS (SLVDS) interface to output the data which minimizes the number of digital interconnects. The device supports two-lane, one-lane and half-lane options. The device comes in a 40-pin RSB package (5mm x 5mm) with NiPdAu lead-finish and supports a temperature range from -55°C to +105°C. The ADC3683-SEP is pin-to-pin compatible with other ADC36xx family devices in the RSB package.

1.1 Device Details

Table 1-1. Device and Exposure Details

TID HDR Details	
TI device number	ADC3664-SEP
Package	40-RSB
Technology	C021
Die lot number	1188999DM6
Device / package lot number	3415462CL3
Lot trace code (LTC)	36AZCPI
Quantity tested	5 units biased at 10 krad(Si) 5 units biased at 30 krad(Si) 5 units biased at 50 krad(Si)
Lot accept / reject	5 / 0
HDR radiation facility	Texas Instruments CLAB, Dallas, TX
HDR dose level	10-50 krad(Si)
HDR dose rate	200-260 rad(Si) / sec, Gamma (GR420) Co-60
HDR irradiation temperature	Ambient, room temperature
Radiation test date	4/24/2024
Test Method	MIL-STD-883 and MIL-STD-750

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2 Total Dose Test Setup

2.1 Test Overview

The ADC3664-SEP was tested according to MIL-STD-883, Test Method 1019.9, Conditions A. For this test, the product was irradiated up to the target radiation level, and then put through full electrical parametric testing on the production Automated Test Equipment (ATE). All devices remained functional passing all parametric test limits.

2.2 Test Description and Facilities

The ADC3664-SEP HDR exposure was performed on biased devices at TI CLAB facility in Dallas, Texas. The dose rate of the exposure was between 200-260 rad(Si)/s. After the exposure, the devices were electrically tested at TI CLAB facility. The electrical test guard-band limits were set within the data sheet electrical specifications to maintain a minimum Cpk and test error margin based on initial qualification and characterization data.

2.3 Test Setup Details

The devices were tested in biased conditions as described below.

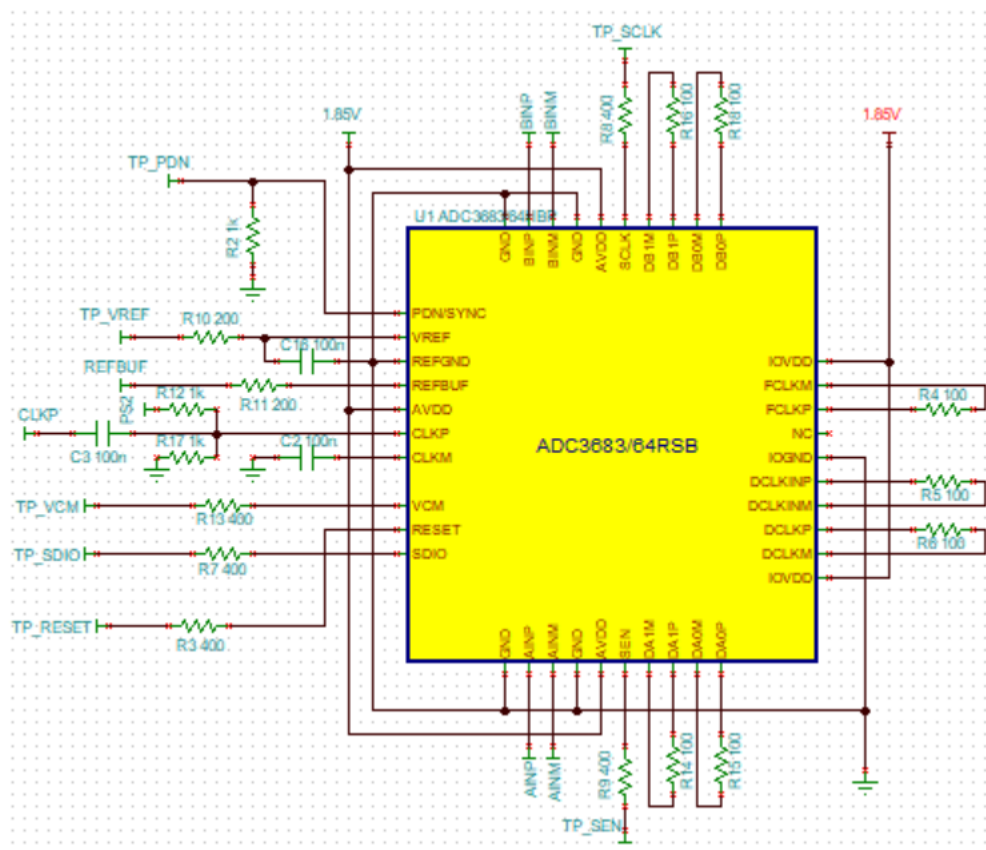


Figure 2-1. Device Biased Conditions During Radiation

2.4 Test Configuration and Condition

Table 2-1. HDR Biased Conditions

Total Samples: 15		
Exposure Levels		
10 krad(Si), 5 ea.	30 krad(Si), 5 ea.	50 krad(Si), 5 ea.
Passed	Passed	Passed

TID Characterization Test Results

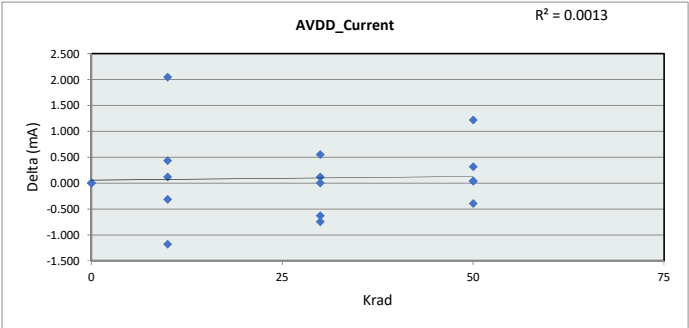
ADC3664-SEP passed HDR up to 50krad at the maximum recommended operating conditions. The drifts of critical parameters were within the specification. All units passed.

A Total Ionizing Dose Report

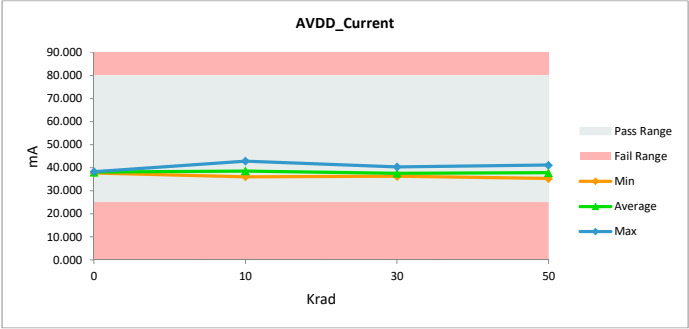
This appendix provides the ADC3664-SEP TID HDR report. The report shows the variation for critical parameters up to 50krad(Si). ADC3664-SEP passed HDR up to 50krad at maximum recommended operating conditions.

TID Report
ADC3664-SEP

AVDD_Current						
Test Site						
Tester						
Test Number						
Unit	mA	mA				
Max Limit	80	80				
Min Limit	25	25				
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	36.091	35.973	0.118	0.33%	0.21%
10	2	37.586	37.901	-0.315	-0.84%	0.57%
10	3	36.996	36.563	0.433	1.17%	0.79%
10	4	44.826	42.780	2.046	4.56%	3.72%
10	5	38.491	39.671	-1.180	-3.07%	2.15%
30	6	36.052	36.681	-0.630	-1.75%	1.14%
30	7	39.553	40.301	-0.748	-1.89%	1.36%
30	8	36.170	36.170	0.000	0.00%	0.00%
30	9	38.688	38.137	0.551	1.42%	1.00%
30	10	36.878	36.760	0.118	0.32%	0.21%
50	11	38.648	38.609	0.039	0.10%	0.07%
50	12	37.389	37.075	0.315	0.84%	0.57%
50	13	36.288	36.681	-0.393	-1.08%	0.72%
50	14	35.304	35.265	0.039	0.11%	0.07%
50	15	42.268	41.049	1.220	2.89%	2.22%
0	16	38.255	38.255	0.000	0.00%	0.00%
0	17	37.704	37.704	0.000	0.00%	0.00%
Max		44.826	42.780	2.046	4.56%	3.72%
Average		38.070	37.975	0.095	0.18%	0.87%
Min		35.304	35.265	-1.180	-3.07%	0.00%
Std Dev		2.401	1.994	0.739	1.78%	1.02%

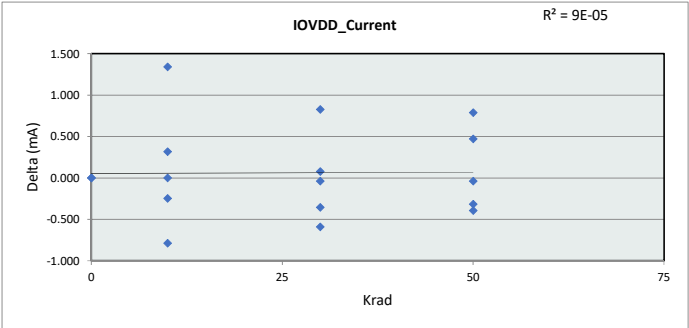


AVDD_Current				
Test Site				
Tester				
Test Number				
Max Limit	80	mA		
Min Limit	25	mA		
Krad	0	10	30	50
LL	25.000	25.000	25.000	25.000
Min	37.704	35.973	36.170	35.265
Average	37.980	38.578	37.610	37.736
Max	38.255	42.780	40.301	41.049
UL	80.000	80.000	80.000	80.000

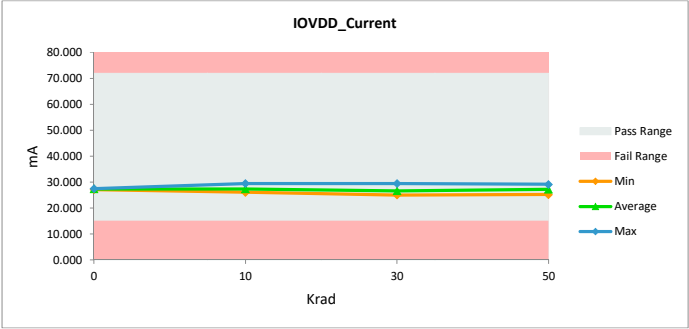


TID Report
ADC3664-SEP

IOVDD_Current						
Test Site						
Tester						
Test Number						
Unit		mA	mA			
Max Limit		72	72			
Min Limit		15	15			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	26.224	26.472	-0.249	-0.95%	0.44%
10	2	26.867	26.867	0.000	0.00%	0.00%
10	3	26.314	25.999	0.316	1.20%	0.55%
10	4	30.812	29.470	1.341	4.35%	2.35%
10	5	27.064	27.853	-0.789	-2.92%	1.38%
30	6	25.486	26.078	-0.592	-2.32%	1.04%
30	7	29.115	29.470	-0.355	-1.22%	0.62%
30	8	25.486	25.526	-0.039	-0.15%	0.07%
30	9	27.735	26.906	0.828	2.99%	1.45%
30	10	25.052	24.973	0.079	0.31%	0.14%
50	11	27.932	27.971	-0.039	-0.14%	0.07%
50	12	27.222	26.748	0.473	1.74%	0.83%
50	13	26.709	27.025	-0.316	-1.18%	0.55%
50	14	24.737	25.131	-0.394	-1.59%	0.69%
50	15	29.904	29.115	0.789	2.64%	1.38%
0	16	27.459	27.459	0.000	0.00%	0.00%
0	17	27.143	27.143	0.000	0.00%	0.00%
Max		30.812	29.470	1.341	4.35%	2.35%
Average		27.133	27.071	0.062	0.16%	0.68%
Min		24.737	24.973	-0.789	-2.92%	0.00%
Std Dev		1.649	1.381	0.547	1.92%	0.66%

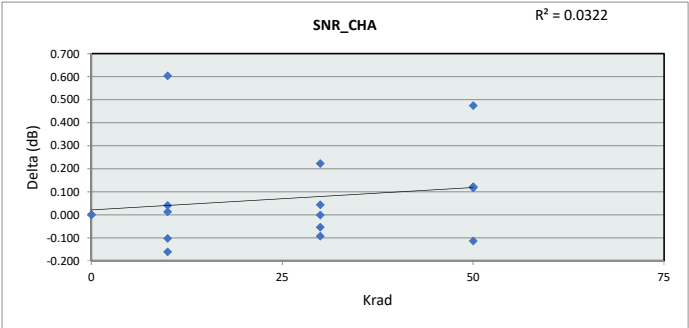


IOVDD_Current				
Test Site				
Tester				
Test Number				
Max Limit		72	mA	
Min Limit		15	mA	
Krad	0	10	30	50
LL	15.000	15.000	15.000	15.000
Min	27.143	25.999	24.973	25.131
Average	27.301	27.332	26.591	27.198
Max	27.459	29.470	29.470	29.115
UL	72.000	72.000	72.000	72.000

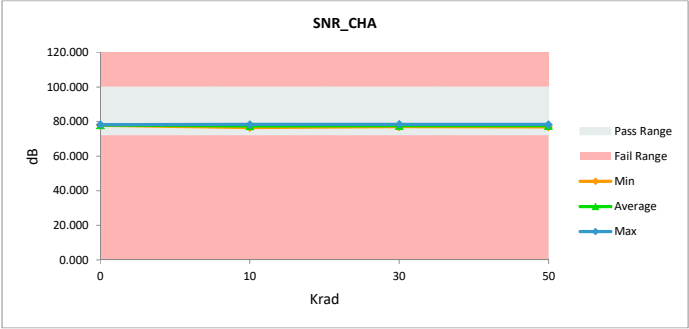


TID Report
ADC3664-SEP

SNR_CHA						
Test Site						
Tester						
Test Number						
Unit		dB	dB			
Max Limit		100	100			
Min Limit		72	72			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	77.854	77.957	-0.103	-0.13%	0.37%
10	2	78.293	78.253	0.040	0.05%	0.14%
10	3	76.559	76.546	0.013	0.02%	0.05%
10	4	77.444	76.840	0.604	0.78%	2.16%
10	5	77.574	77.735	-0.161	-0.21%	0.57%
30	6	77.743	77.797	-0.054	-0.07%	0.19%
30	7	77.686	77.643	0.043	0.06%	0.15%
30	8	78.252	78.345	-0.093	-0.12%	0.33%
30	9	77.699	77.476	0.223	0.29%	0.80%
30	10	76.983	76.984	-0.001	0.00%	0.00%
50	11	78.188	78.302	-0.114	-0.15%	0.41%
50	12	78.348	77.874	0.474	0.60%	1.69%
50	13	77.125	77.003	0.122	0.16%	0.43%
50	14	77.992	77.870	0.122	0.16%	0.44%
50	15	76.946	76.829	0.117	0.15%	0.42%
0	16	77.805	77.805	0.000	0.00%	0.00%
0	17	78.210	78.210	0.000	0.00%	0.00%
Max		78.348	78.345	0.604	0.78%	2.16%
Average		77.688	77.616	0.072	0.09%	0.48%
Min		76.559	76.546	-0.161	-0.21%	0.00%
Std Dev		0.530	0.573	0.203	0.26%	0.59%

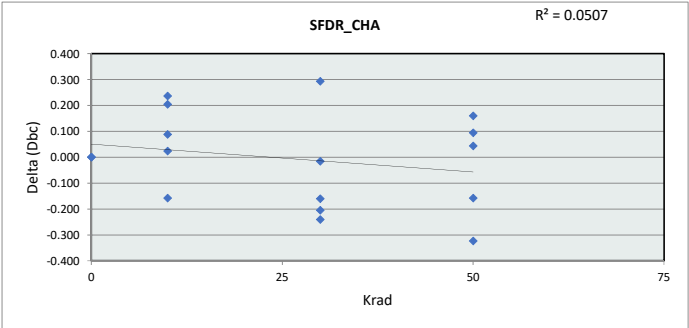


SNR_CHA				
Test Site				
Tester				
Test Number				
Max Limit		100	dB	
Min Limit		72	dB	
Krad	0	10	30	50
LL	72.000	72.000	72.000	72.000
Min	77.805	76.546	76.984	76.829
Average	78.008	77.466	77.649	77.576
Max	78.210	78.253	78.345	78.302
UL	100.000	100.000	100.000	100.000

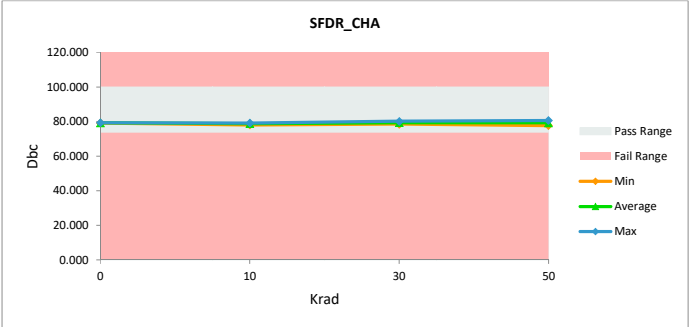


TID Report
ADC3664-SEP

SFDR_CHA						
Test Site						
Tester						
Test Number						
Unit		Dbc	Dbc			
Max Limit		100	100			
Min Limit		73.5	73.5			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	79.213	79.008	0.204	0.26%	0.77%
10	2	79.127	79.102	0.024	0.03%	0.09%
10	3	78.602	78.365	0.237	0.30%	0.89%
10	4	78.900	79.058	-0.158	-0.20%	0.59%
10	5	78.046	77.958	0.088	0.11%	0.33%
30	6	78.755	78.461	0.293	0.37%	1.11%
30	7	79.066	79.082	-0.016	-0.02%	0.06%
30	8	78.979	79.219	-0.241	-0.30%	0.91%
30	9	79.638	79.843	-0.205	-0.26%	0.77%
30	10	79.941	80.101	-0.160	-0.20%	0.60%
50	11	79.576	79.416	0.160	0.20%	0.60%
50	12	80.347	80.671	-0.324	-0.40%	1.22%
50	13	77.699	77.605	0.095	0.12%	0.36%
50	14	77.948	77.904	0.044	0.06%	0.17%
50	15	80.222	80.379	-0.158	-0.20%	0.60%
0	16	79.153	79.153	0.000	0.00%	0.00%
0	17	79.296	79.296	0.000	0.00%	0.00%
Max		80.347	80.671	0.293	0.37%	1.22%
Average		79.089	79.095	-0.007	-0.01%	0.53%
Min		77.699	77.605	-0.324	-0.40%	0.00%
Std Dev		0.746	0.857	0.178	0.22%	0.39%

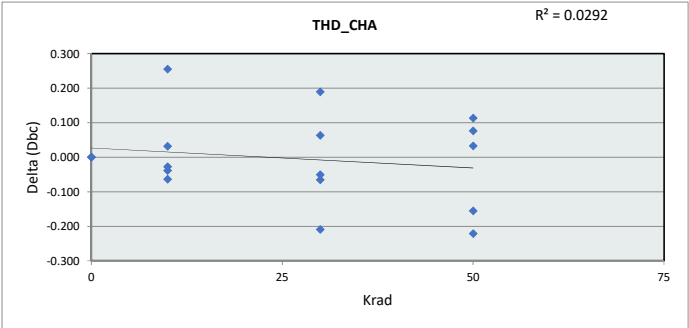


SFDR_CHA				
Test Site				
Tester				
Test Number				
Max Limit		100	Dbc	
Min Limit		73.5	Dbc	
Krad	0	10	30	50
LL	73.500	73.500	73.500	73.500
Min	79.153	77.958	78.461	77.605
Average	79.224	78.698	79.341	79.195
Max	79.296	79.102	80.101	80.671
UL	100.000	100.000	100.000	100.000

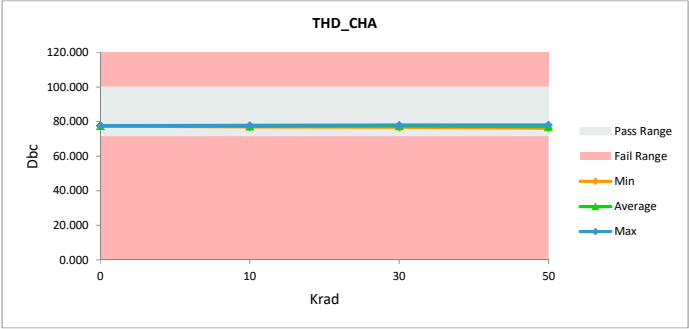


TID Report
ADC3664-SEP

THD_CHA						
Test Site						
Tester						
Test Number						
Unit		Dbc	Dbc			
Max Limit		100	100			
Min Limit		71.5	71.5			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	77.700	77.727	-0.027	-0.04%	0.10%
10	2	77.430	77.494	-0.064	-0.08%	0.22%
10	3	77.124	76.869	0.255	0.33%	0.90%
10	4	77.252	77.290	-0.038	-0.05%	0.14%
10	5	76.817	76.785	0.032	0.04%	0.11%
30	6	76.814	76.624	0.189	0.25%	0.66%
30	7	77.447	77.383	0.064	0.08%	0.22%
30	8	77.425	77.634	-0.209	-0.27%	0.73%
30	9	77.662	77.712	-0.050	-0.06%	0.18%
30	10	77.794	77.859	-0.065	-0.08%	0.23%
50	11	77.675	77.561	0.114	0.15%	0.40%
50	12	77.736	77.958	-0.221	-0.28%	0.78%
50	13	76.006	76.162	-0.156	-0.20%	0.55%
50	14	76.583	76.506	0.077	0.10%	0.27%
50	15	77.630	77.597	0.033	0.04%	0.12%
0	16	77.422	77.422	0.000	0.00%	0.00%
0	17	77.631	77.631	0.000	0.00%	0.00%
Max		77.794	77.958	0.255	0.33%	0.90%
Average		77.303	77.307	-0.004	-0.01%	0.33%
Min		76.006	76.162	-0.221	-0.28%	0.00%
Std Dev		0.490	0.522	0.126	0.16%	0.29%

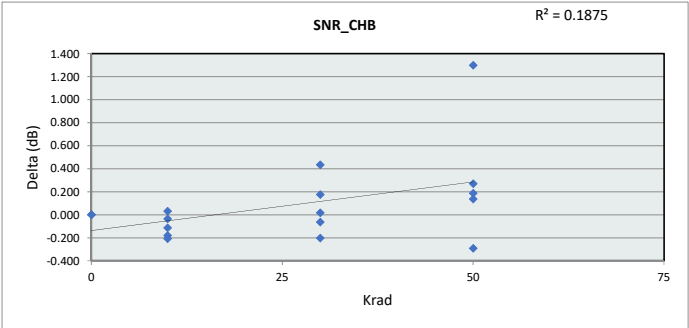


THD_CHA				
Test Site				
Tester				
Test Number				
Max Limit		100	Dbc	
Min Limit		71.5	Dbc	
Krad	0	10	30	50
LL	71.500	71.500	71.500	71.500
Min	77.422	76.785	76.624	76.162
Average	77.527	77.233	77.443	77.157
Max	77.631	77.727	77.859	77.958
UL	100.000	100.000	100.000	100.000

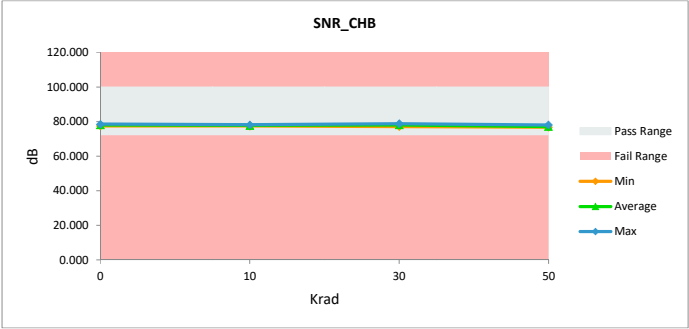


TID Report
ADC3664-SEP

SNR_CHB						
Test Site						
Tester						
Test Number						
Unit		dB	dB			
Max Limit		100	100			
Min Limit		72	72			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	77.706	77.916	-0.209	-0.27%	0.75%
10	2	77.926	78.106	-0.179	-0.23%	0.64%
10	3	77.287	77.322	-0.035	-0.05%	0.13%
10	4	77.602	77.570	0.032	0.04%	0.11%
10	5	77.560	77.674	-0.115	-0.15%	0.41%
30	6	78.472	78.454	0.018	0.02%	0.07%
30	7	77.537	77.103	0.435	0.56%	1.55%
30	8	78.234	78.438	-0.203	-0.26%	0.73%
30	9	78.642	78.705	-0.063	-0.08%	0.22%
30	10	77.650	77.473	0.177	0.23%	0.63%
50	11	77.980	76.681	1.299	1.67%	4.64%
50	12	77.039	76.769	0.270	0.35%	0.96%
50	13	76.437	76.729	-0.292	-0.38%	1.04%
50	14	77.242	77.055	0.187	0.24%	0.67%
50	15	78.188	78.052	0.136	0.17%	0.48%
0	16	77.511	77.511	0.000	0.00%	0.00%
0	17	78.440	78.440	0.000	0.00%	0.00%
Max		78.642	78.705	1.299	1.67%	4.64%
Average		77.733	77.647	0.086	0.11%	0.77%
Min		76.437	76.681	-0.292	-0.38%	0.00%
Std Dev		0.569	0.653	0.365	0.47%	1.08%

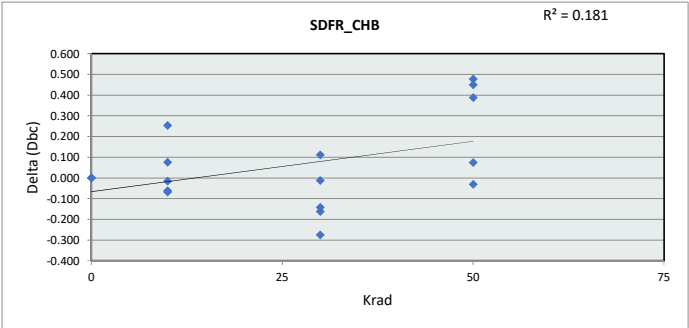


SNR_CHB				
Test Site				
Tester				
Test Number				
Max Limit		100	dB	
Min Limit		72	dB	
Krad	0	10	30	50
LL	72.000	72.000	72.000	72.000
Min	77.511	77.322	77.103	76.681
Average	77.976	77.718	78.034	77.057
Max	78.440	78.106	78.705	78.052
UL	100.000	100.000	100.000	100.000

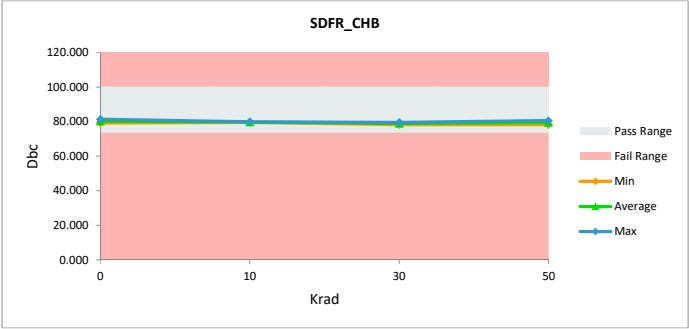


TID Report
ADC3664-SEP

SDFR_CHB						
Test Site						
Tester						
Test Number						
Unit		Dbc	Dbc			
Max Limit		100	100			
Min Limit		73.5	73.5			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	79.415	79.477	-0.061	-0.08%	0.23%
10	2	79.758	79.826	-0.068	-0.09%	0.26%
10	3	79.888	79.635	0.253	0.32%	0.96%
10	4	79.771	79.695	0.076	0.10%	0.29%
10	5	79.712	79.726	-0.015	-0.02%	0.06%
30	6	78.307	78.195	0.112	0.14%	0.42%
30	7	79.531	79.544	-0.013	-0.02%	0.05%
30	8	78.989	79.150	-0.161	-0.20%	0.61%
30	9	78.773	78.914	-0.141	-0.18%	0.53%
30	10	79.015	79.290	-0.275	-0.35%	1.04%
50	11	80.876	80.488	0.388	0.48%	1.46%
50	12	80.175	79.697	0.478	0.60%	1.80%
50	13	78.602	78.153	0.449	0.57%	1.69%
50	14	78.537	78.463	0.074	0.09%	0.28%
50	15	80.407	80.437	-0.030	-0.04%	0.11%
0	16	81.306	81.306	0.000	0.00%	0.00%
0	17	79.082	79.082	0.000	0.00%	0.00%
Max		81.306	81.306	0.478	0.60%	1.80%
Average		79.538	79.475	0.063	0.08%	0.58%
Min		78.307	78.153	-0.275	-0.35%	0.00%
Std Dev		0.833	0.815	0.214	0.27%	0.60%

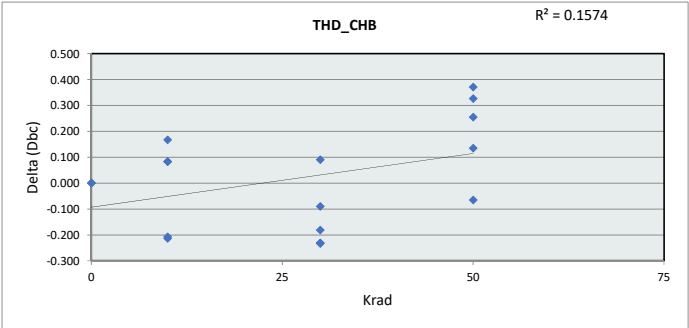


SDFR_CHB				
Test Site				
Tester				
Test Number				
Max Limit		100	Dbc	
Min Limit		73.5	Dbc	
Krad	0	10	30	50
LL	73.500	73.500	73.500	73.500
Min	79.082	79.477	78.195	78.153
Average	80.194	79.672	79.018	79.448
Max	81.306	79.826	79.544	80.488
UL	100.000	100.000	100.000	100.000

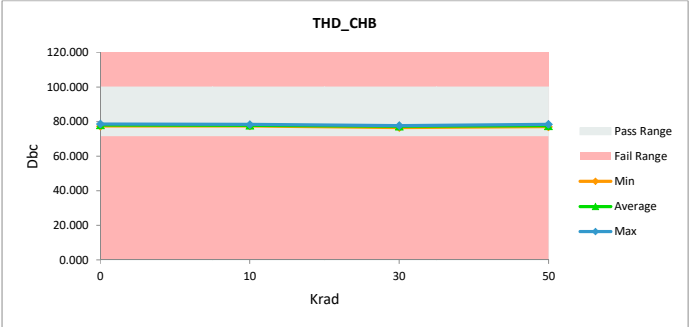


TID Report
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THD_CHB						
Test Site						
Tester						
Test Number						
Unit		Dbc	Dbc			
Max Limit		100	100			
Min Limit		71.5	71.5			
Krad	Serial #	Pre	Post	Delta	Delta %	% of Limit Range
10	1	77.267	77.474	-0.207	-0.27%	0.73%
10	2	78.004	78.217	-0.213	-0.27%	0.75%
10	3	77.738	77.570	0.168	0.22%	0.59%
10	4	77.824	77.741	0.084	0.11%	0.29%
10	5	77.885	77.802	0.083	0.11%	0.29%
30	6	76.684	76.594	0.090	0.12%	0.32%
30	7	77.246	77.479	-0.233	-0.30%	0.82%
30	8	77.514	77.696	-0.182	-0.23%	0.64%
30	9	77.219	77.308	-0.089	-0.12%	0.31%
30	10	77.212	77.442	-0.230	-0.30%	0.81%
50	11	78.043	77.787	0.255	0.33%	0.90%
50	12	78.119	77.748	0.371	0.47%	1.30%
50	13	77.292	76.965	0.326	0.42%	1.14%
50	14	77.081	76.946	0.135	0.18%	0.47%
50	15	78.284	78.349	-0.065	-0.08%	0.23%
0	16	78.580	78.580	0.000	0.00%	0.00%
0	17	77.330	77.330	0.000	0.00%	0.00%
Max		78.580	78.580	0.371	0.47%	1.30%
Average		77.607	77.590	0.017	0.02%	0.56%
Min		76.684	76.594	-0.233	-0.30%	0.00%
Std Dev		0.501	0.505	0.196	0.25%	0.37%



THD_CHB				
Test Site				
Tester				
Test Number				
Max Limit		100	Dbc	
Min Limit		71.5	Dbc	
Krad	0	10	30	50
LL	71.500	71.500	71.500	71.500
Min	77.330	77.474	76.594	76.946
Average	77.955	77.761	77.304	77.559
Max	78.580	78.217	77.696	78.349
UL	100.000	100.000	100.000	100.000



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