TB-2296
Advance Plating Process (APP) Telcordia GR-1217-CORE CO Qualification
XCede HD 4 Pair 85 Ohm

Revision "B"

Specification Revision Status

Revision	SCR No.	Description	Initial	Date
A	S2215	APP plating qualification – initial release	M. Osbourne	01/11/13
B	S6454	Added section 9.0 higher level of mechanical vibration and shock testing	R. Gustafson	10/26/17

Amphenol TCS
A Division of Amphenol Corporation

Amphenol TCS
200 Innovative Way, Suite 201
Nashua, NH 03062
603.879.3000

www.amphenol-tcs.com

TABLE OF CONTENTS

1.0 Purpose

2.0 Reference documents

3.0 Equipment

4.0 Qualification test plan

5.0 Test samples

6.0 Qualification results

- 6.1 Group 1 – Mechanical shock and random vibration
- 6.2 Group 2 – Thermal shock, durability, dust, and humidity cycling
- 6.3 Group 3 – Temperature life
- 6.4 Group 4 – Mixed flowing gas
- 6.5 Group 6 – Compliant pin insertion and retention force
- 6.6 Group 7 – Plating evaluation

7.0 Test results summary and discussions

8.0 Conclusions

9.0 Addendum – Increased level of mechanical shock and random vibration

1.0 Purpose

1.1 The purpose of this test is to qualify the XCede HD product with the Advance Plating Process (APP) plating (Nanocrystalline barrier layer). The APP plating system is defined as 10μin minimum gold thickness plated over 20μin to 40μin thick Nanocrystalline nickel. The standard plating system is 30μin minimum gold thickness over 50μin to 150μin thick Nickel Sulfamate. As part of the qualification testing, standard plating process (Nickel Sulfamate barrier layer) plated components will be included in the mixed flowing gas sequence to test intermateability and to use as a control group to compare the results to the APP plated components. The qualification will be performed in accordance with Telcordia GR-1217-CORE Central Office requirements.

2.0 Reference documents

2.1 Telcordia GR-1217-COREi02	Generic Requirements for Separable Electrical Connectors Used in Telecommunication Hardware
2.2 EIA-364-TP	Test Standards and Procedures for Electrical Connectors
2.3 QQ-N-290A	Federal Specification Nickel Plating
2.4 MIL-G-45204C	Military Specification Gold Plating Electrodeposited
2.5 TB-2023	Connector Qualification Plan
2.6 TB-2235	General Product Specification for XCede HD Backplane and Daughtercard Interconnect System

3.0 Equipment

3.1 Instron

3.2 Thermotron temperature chamber

3.3 Cincinnati Sub-Zero thermal shock chamber

3.4 Blue M. Temp-Humidity chamber

3.5 DEC Dust chamber

3.6 MB Elect. Vibration table

3.7 Mixed flowing gas chamber

3.8 Keithley Micro-Ohm meter

3.9 Fischer X-R-F

4.0 Qualification test plan and test conditions - The qualification test plan contains 6 test sequences

4.1 Group 1 – Mechanical shock and random vibration

4.1.1 Mechanical shock test conditions – EIA-364-TP27

4.1.1.1 ‘G’ Level : 30 G’s

4.1.1.2 Duration : 11 Milliseconds

4.1.1.3 Wave form : Half Sine

4.1.1.4 No. of shocks : 3 axis and 3 each direction (18 total)

4.1.2 Random vibration test conditions – EIA-364-TP28

4.1.2.1 Frequency : 50 to 2000 Hz

4.1.2.2 PSD : 0.02 G^2 /Hz

4.1.2.3 ‘G’ Level : 5.35 RMS

4.1.2.4 Duration : 2 hrs/axis, 3 axis (6 hrs total)

4.2 Group 2 – Thermal shock, durability, dust, and humidity cycling (this group also includes dielectric withstanding voltage and insulation resistance)

4.2.1 Thermal shock test conditions – EIA-364-TP32

4.2.1.1 Number of cycles : 5 cycles

4.2.1.2 Hot temp extreme : +105°C (+3°C, -0°C)

4.2.1.3 Cold temp extreme : -65°C (+0°C, -3°C)

4.2.1.4 Exposure at temperature : 30 minutes

4.2.1.5 Transfer time : < 1.0 minute

4.2.2 Durability 250X test conditions – EIA-364-TP09

4.2.2.1 Number of cycles : 250X

4.2.2.2 Rate : 300 cycles/hour

4.2.3 Dust test conditions – EIA-364-TP91

4.2.3.1 Chamber size : 11 cu. ft

4.2.3.2 Amount of dust : 9.0 grams/ cu. ft

4.2.3.3 Exposure time : 1.0 hours

4.2.3.4 Fan speed : 360 cfm

4.2.4 Humidity test conditions – EIA-364-TP31 Procedure II

4.2.4.1 Relative humidity : 90% to 95%

4.2.4.2 Temperature conditions : 25°C to 65°C

4.2.4.3 Duration : 500 hours

4.2.4.4 Cycle time : 8 hours per cycle

4.3 Group 3 – Temperature life

4.3.1 Temperature life test conditions – EIA-364-TP17

4.3.1.1 Temperature : 105°C +/- 2°C

4.3.1.2 Duration : 1000 hours

4.4 Group 4 – Mixed flowing gas

4.4.1 Temperature pre-conditioning test conditions – EIA-364-TP17

4.4.1.1 Temperature : 105°C +/- 2°C

4.4.1.2 Duration : 300 hours

4.4.2 Pre and post durability test conditions – EIA-364-TP09

4.4.2.1 Number of cycles : 100X pre and post durability

4.4.2.2 Rate : 300 cycles/hour

4.4.3 Mixed flowing gas test conditions – EIA-364-TP65

4.4.3.1 Temperature : 30°C +/- 1°C

4.4.3.2 Relative humidity : 70% +/- 2%

4.4.3.3 Exposure time : 20 days (10 days unmated/10 days mated)

4.4.3.4 Gases and concentrations see Table 1.

Gas	Concentration
NO_2	200 ppb ±50 ppb
Cl_2	10 ppb ±3 ppb
H_2S	10 ppb ±5 ppb
SO_2	100 ppb ±20 ppb

Table 1: MFG gas concentrations

4.5 Group 5 – Compliant pin insertion and retention force with temperature life

4.5.1 Compliant pin insertion and retention force test conditions – EIA-364-TS1002

4.5.1.1 Number of insertions : 3

4.5.1.2 Number of retentions : 3

4.5.1.3 Temperature : 105°C

4.5.1.4 Duration : 500 hours

4.6 Group 6 – Plating Evaluation

4.6.1 Plating thicknesses were measured using XRF method (X-Ray Fluorescence).

4.6.2 Porosity evaluated using nitric acid vapor (NAV).

4.7 Test Sequences [1]

GROUP 1

Mate/Unmate force
↓
LLCR
↓
Durability 100X
↓
LLCR
↓
Mechanical shock
↓
LLCR, x-axis
LLCR, y-axis
LLCR, z-axis
↓
Random vibration
↓
LLCR, x-axis
LLCR, y-axis
LLCR, z-axis
↓
Durability 100X
↓
Mate/Unmate force
↓
LLCR

GROUP 2

Mate/Unmate force
↓
LLCR
↓
Insulation resistance (IR)
↓
Dielectric withstanding voltage (DWV)
↓
Durability 250X
↓
LLCR
↓
Dust
↓
LLCR
↓
Thermal Shock
↓
LLCR
↓
Insulation resistance (IR)
↓
Dielectric withstanding voltage (DWV)
↓
Humidity cycling
↓
LLCR
↓
Insulation resistance (IR)
↓
Dielectric withstanding voltage (DWV)
↓
Mate/Unmate force
↓
LLCR

GROUP 3

Mate/Unmate force
↓
LLCR
↓
Temperature life 105°C for 1000 hours
↓
LLCR
↓
Mate/Unmate force
↓
LLCR

GROUP 4

LLCR
↓
Pre-Condition 105°C for 300 hours
↓
LLCR
↓
Durability 100x
↓
Mate/Unmate Force
↓
LLCR
↓
Mixed Flowing Gas (Unmated)
↓
LLCR
5th day
10th day
↓
Mixed Flowing Gas (Mated)
↓
LLCR
15th day
20th day
↓
Mate/Unmate
↓
LLCR
↓
Disturbance
↓
LLCR
↓
Durability 100x
↓
LLCR

GROUP 5

1st insertion force
↓
CPIR
↓
1st retention force
↓
2nd insertion force
↓
CPIR
↓
2nd retention force
↓
3rd insertion force
↓
Temperature life 105°C for 500 hours
↓
CPIR
3rd retention force

GROUP 6

Visual Exam
↓
XRF measurements
↓
Porosity (NAV)

NOTES:

1. Low level contact resistance (LLCR)
2. Compliant pin interface resistance (CPIR)

5.0 Test samples

5.1 The test samples are XCede HD 4 Pair 85 ohm daughtercard and backplane connectors. The test connector configuration is five modules of six positions.

5.2 Group 4 includes the inter-mateability test samples, see Table 2.

Daughtercard Connector	Backplane Connector
Nanocrystalline (APP) P/N: JX410-50029 Date Code: 1235	Nanocrystalline (APP) P/N: 923400C40H Date Code: 1215
Nickel Sulfamate (NiS) P/N: AX410-000158 Date Code: 1218	Nickel Sulfamate (NiS) P/N: 923400C70D Date Code: 1143
Nanocrystalline (APP) P/N: JX410-50029 Date Code: 1235	Nickel Sulfamate (NiS) P/N: 923400C70D Date Code: 1143
Nickel Sulfamate (NiS) P/N: AX410-000158 Date Code: 1218	Nanocrystalline (APP) P/N: 923400C40H Date Code: 1215

Table 2: Inter-matability test matrix

5.3 Test samples were mounted onto ATCS standard qualification printed circuit boards (PCB), see Figure 1. There are 106 signal contacts and 60 ground contacts which were setup to measure low level contact resistance (LLCR) per PCB.

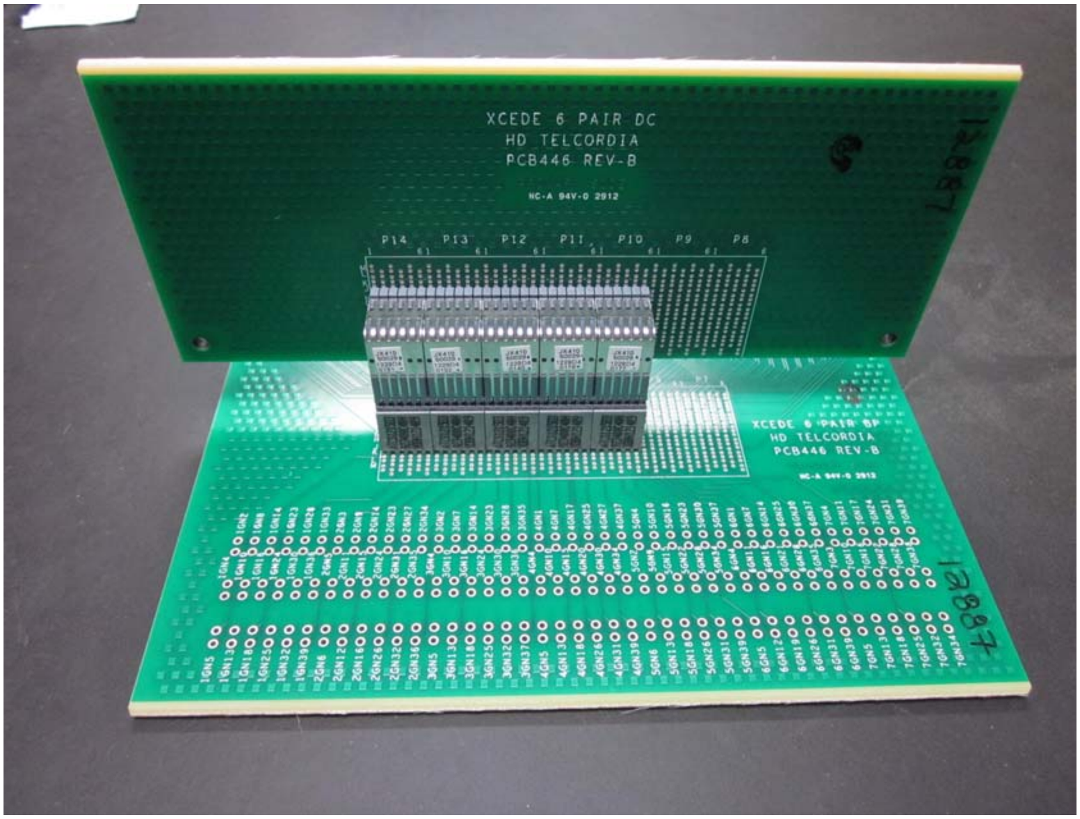

Figure 1: Qualification test samples.

6.0 Qualification results(1)

6.1 Group 1: Mechanical shock and random vibration

6.1.1 Three test boards were exposed to mechanical shock and random vibration (318 signal and 180 ground contacts were monitored for LLCR). The connectors were mechanically shocked to 30g’s in all three axes and exposed to 5.3g’s random vibration in all three axes with pre and post-durability cycles, see Figure 2-4 for the test results.

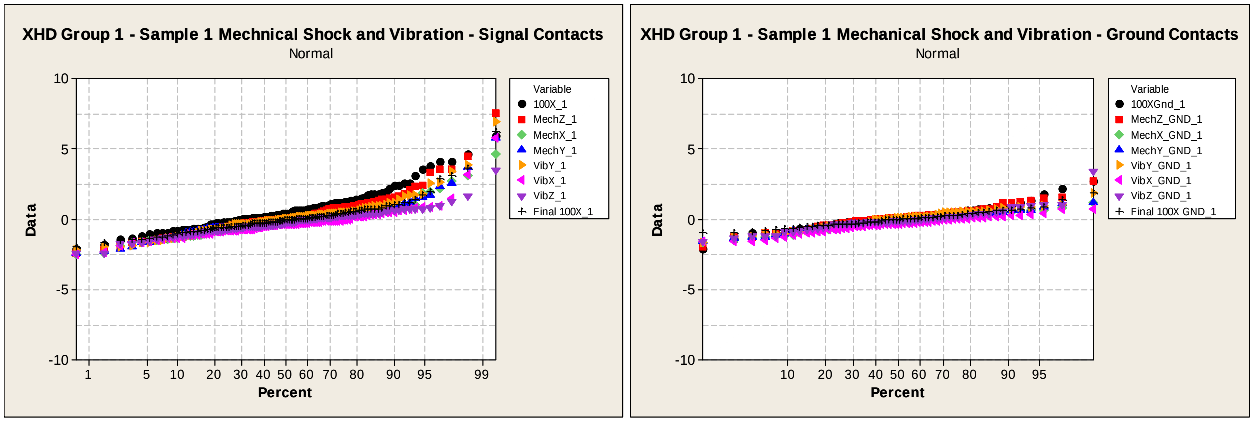

Figure 2: Group 1 sample 1 mechanical shock and random vibration results for signal and ground contacts.

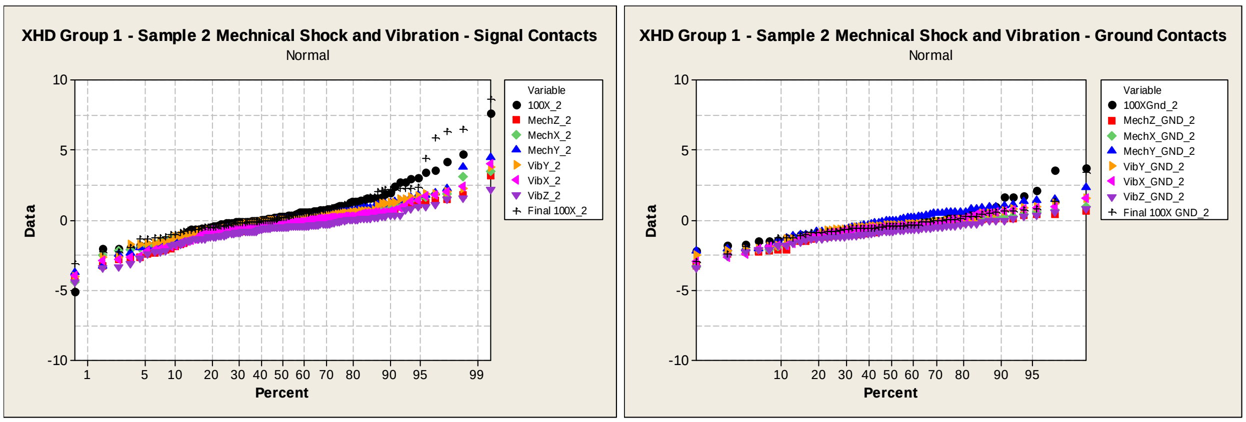

Figure 3: Group 1 sample 2 mechanical shock and random vibration results for signal and ground contacts.

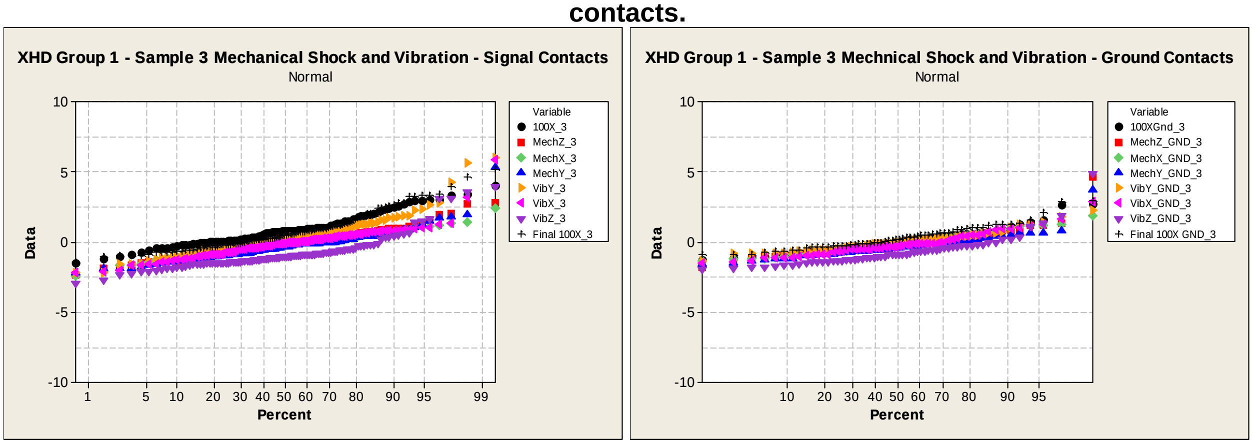

Figure 4: Group 1 sample 3 mechanical shock and random vibration results for signal and ground contacts.

NOTES:

1. The Telcordia GR-1217-CORE delta LLCR requirement is less than 10 milli-ohms increase after exposure to test environments.

6.2 Group 2: Thermal shock, durability, dust, and humidity cycling (this group also includes dielectric withstanding voltage and insulation resistance)

6.2.1 Three test boards were exposed to thermal shock, 250 durability cycles, dust, and humidity cycling (318 signal and 180 ground contacts were monitored for LLCR), see Figure 5-Figure 7 for the test results. Dielectric withstanding voltage and insulation resistance was measured for each mated connector.

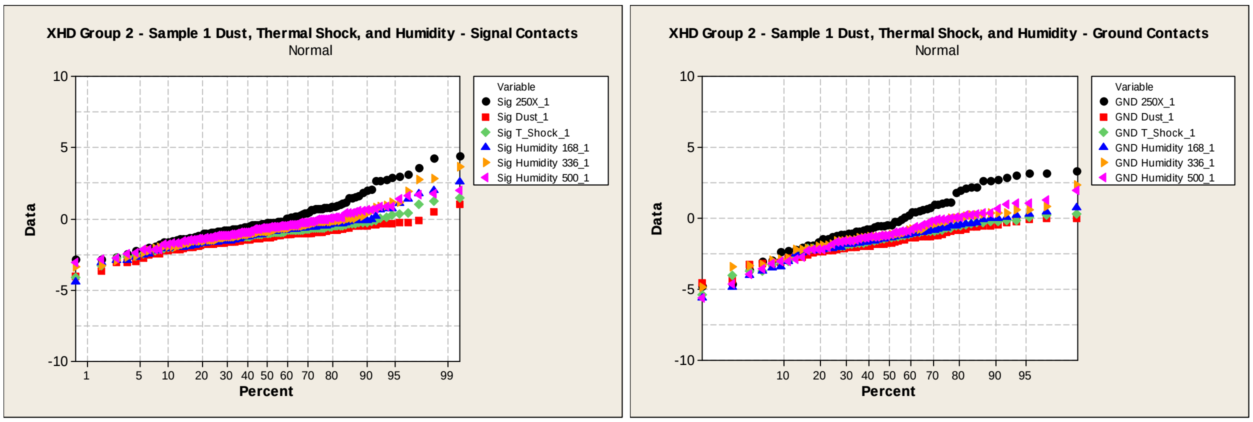

Figure 5: Group 2 sample 1 - Dust, thermal shock, and humidity results for signal and ground contacts.

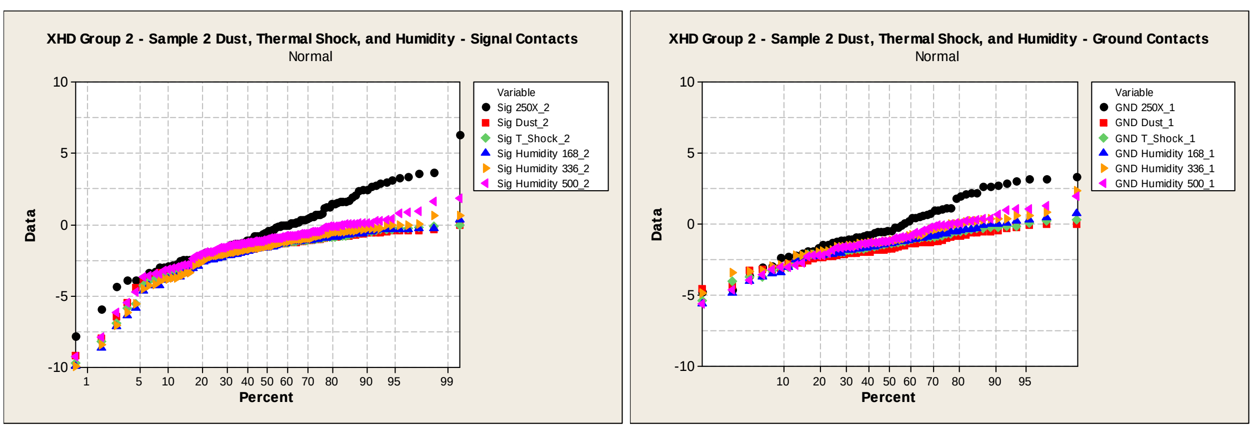

Figure 6: Group 2 sample 2 - Dust, thermal shock, and humidity results for signal and ground contacts.

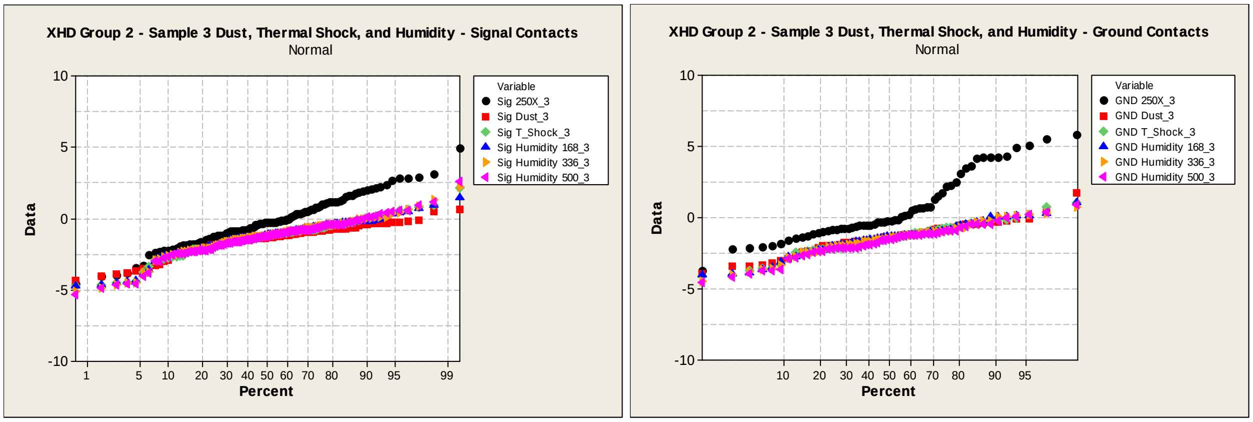

Figure 7: Group 2 sample 3 - Dust, thermal shock, and humidity results for signal and ground contacts.

6.3 Group 3: Temperature life

6.3.1 Two test boards were exposed to 105°C for 1000 hours (212 signals and 120 ground contacts were monitored for LLCR), see Figure 8 and Figure 9 for the test results.

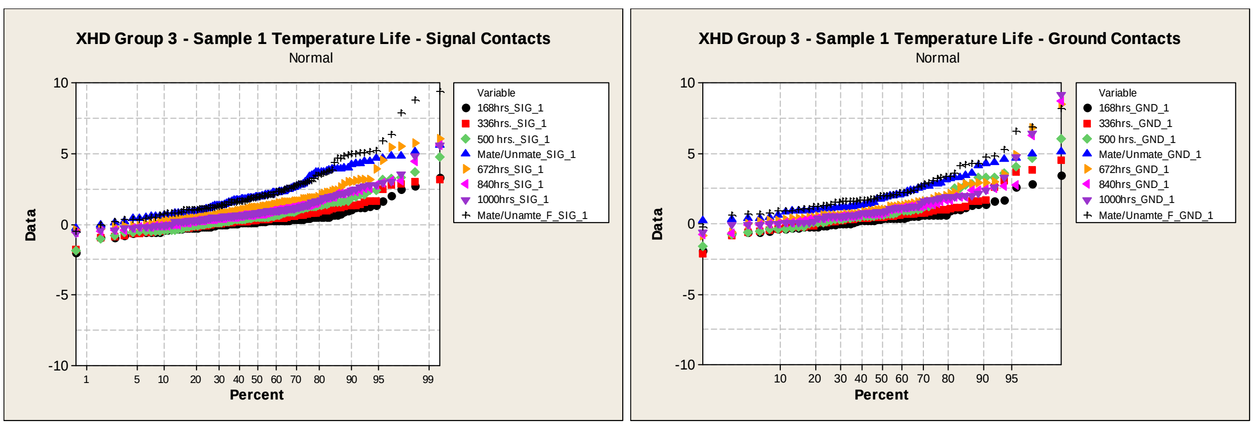

Figure 8: Group 3 sample 1 -Temperature life results for signal and ground contacts.

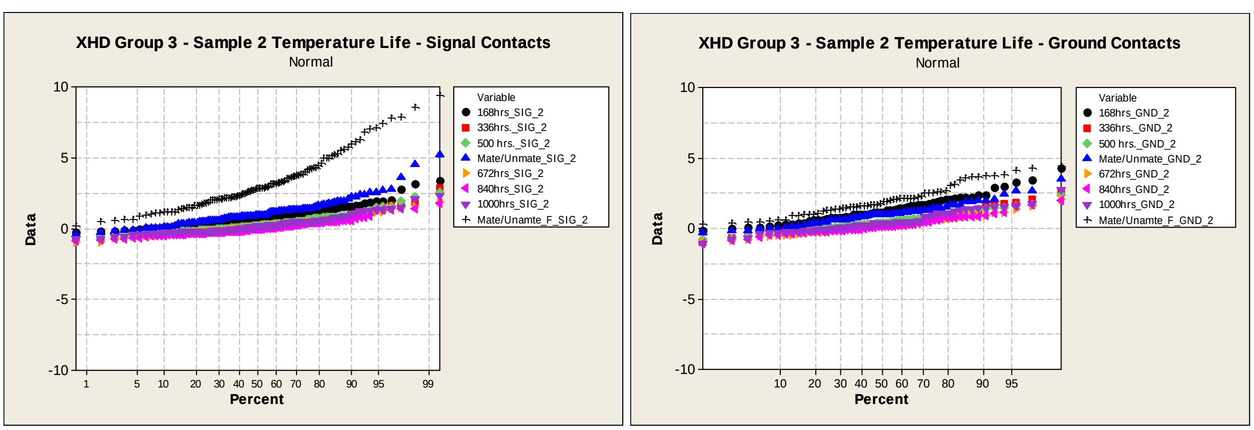

Figure 9: Group 3 sample 2 -Temperature life results for signal and ground contacts.

6.4 Group 4: Mixed flowing gas

6.4.1 Three mated connectors per group were exposed to a four gas mixed flowing gas (MFG) test per Telcordia GR-1217-CORE Central Office requirements (318 signal and 180 ground contacts were monitored for LLCR for each group), see Figure 10-Figure 21 for test results. The MFG groups included test samples with NiS plated contacts (30 µin gold minimum samples) and APP plated contacts (10 µin gold minimum samples). Refer to section 5.2 and Table 2 for the test matrix.

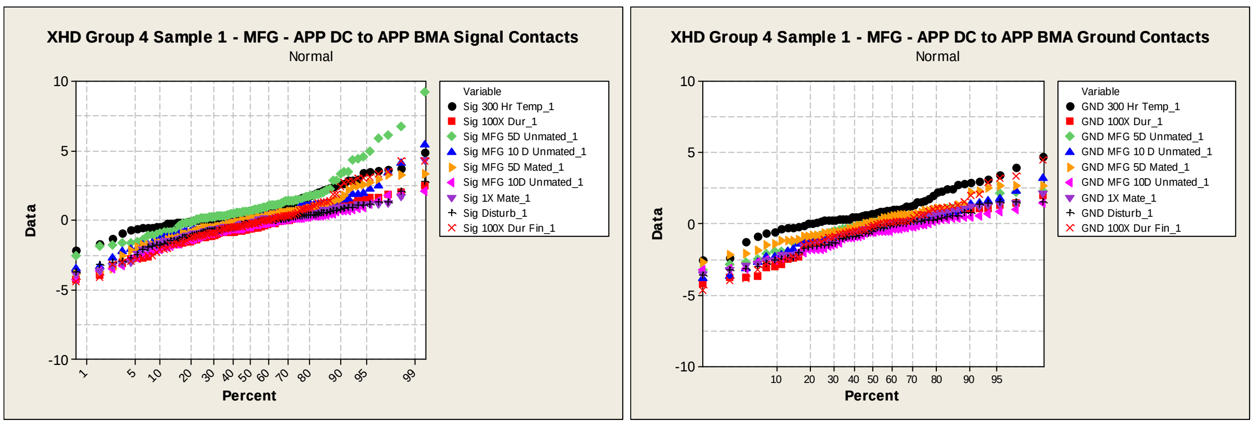

Figure 10: Group 4 APP DC to APP BMA sample 1 - MFG results for signal and ground contacts.

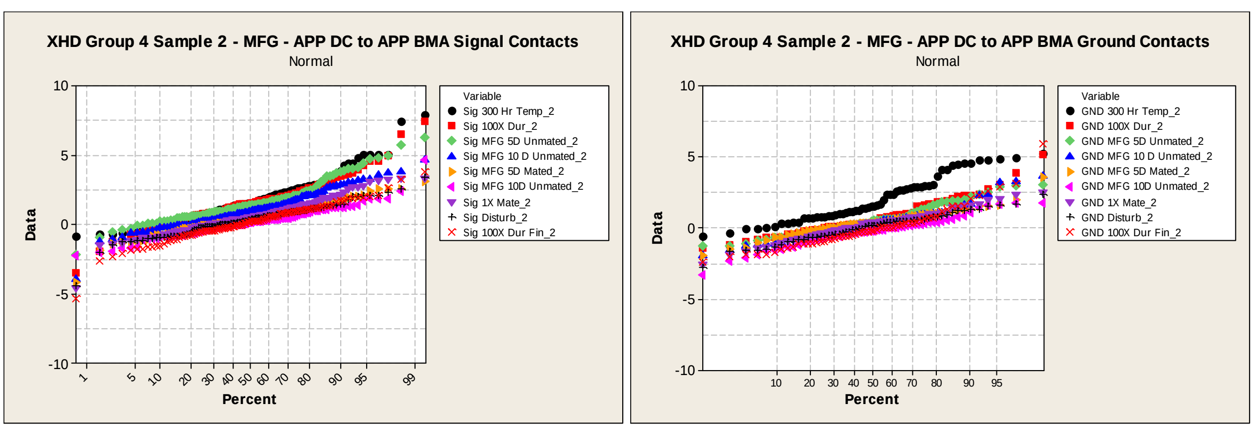

Figure 11: Group 4 APP DC to APP BMA sample 2 - MFG results for signal and ground contacts.

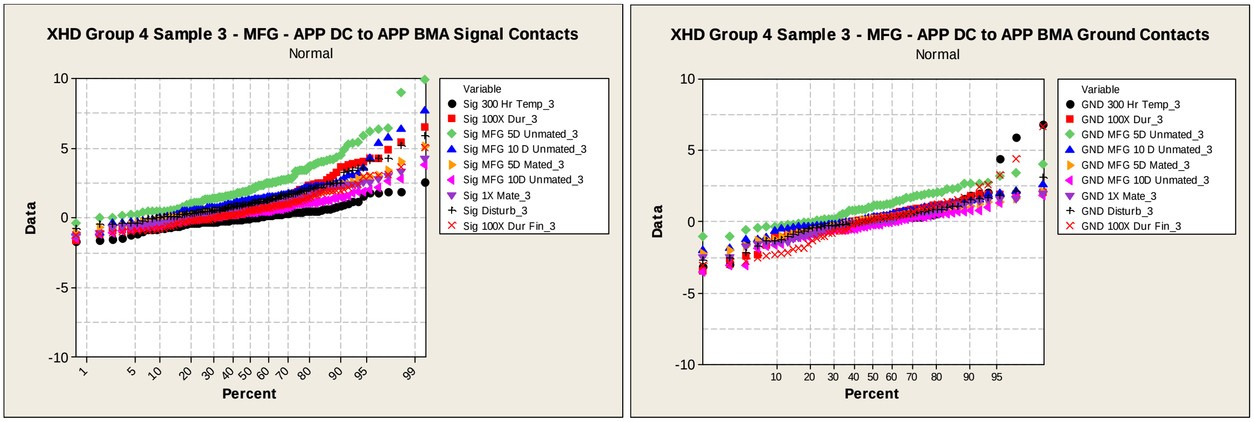

Figure 12: Group 4 APP DC to APP BMA sample 3 - MFG results for signal and ground contacts.

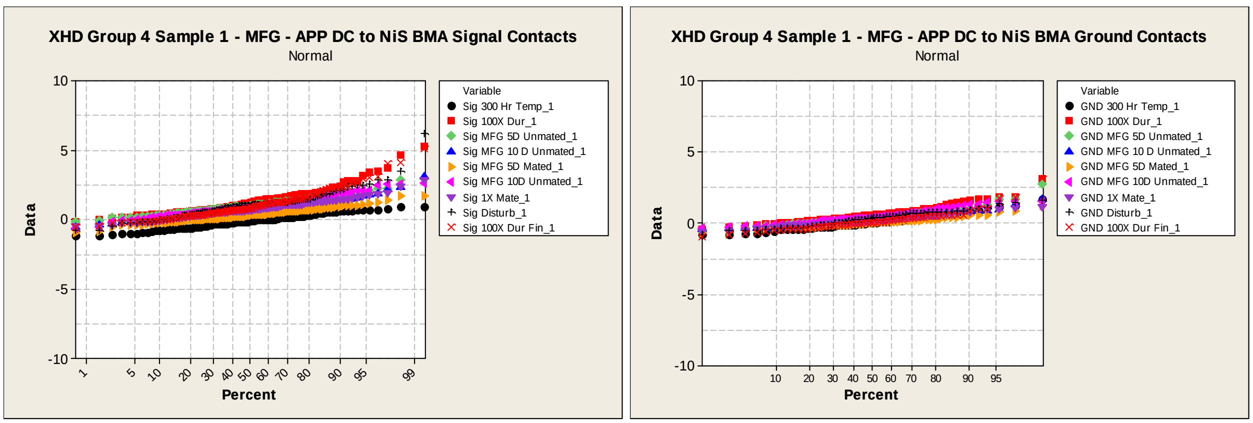

Figure 13: Group 4 APP DC to NiS BMA sample 1 - MFG results for signal and ground contacts.

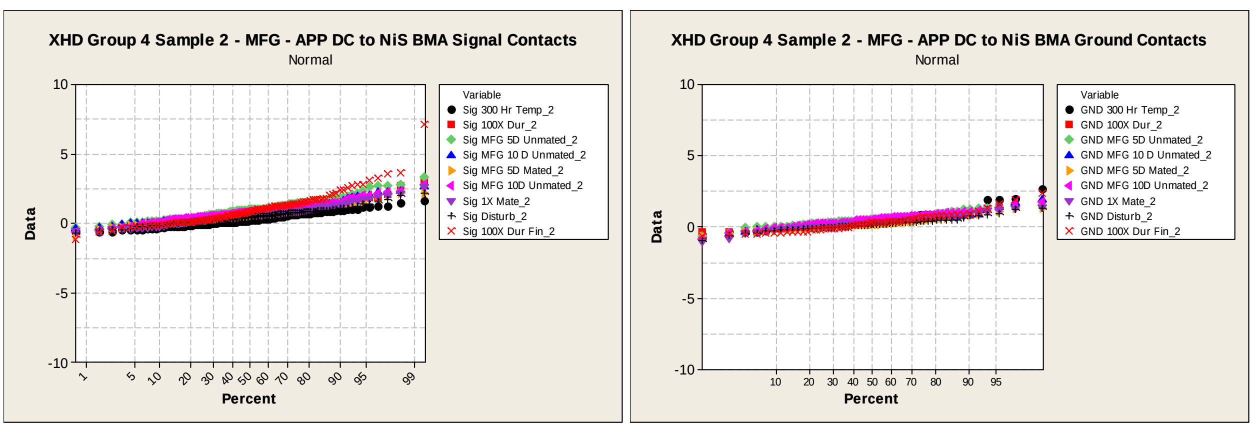

Figure 14: Group 4 APP DC to NiS BMA sample 2 - MFG results for signal and ground contacts.

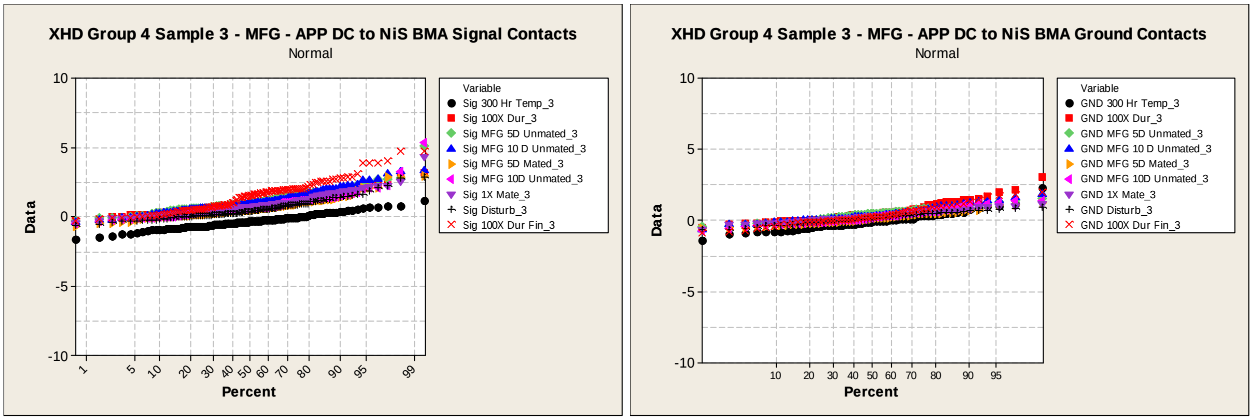

Figure 15: Group 4 APP DC to NiS BMA sample 3 - MFG results for signal and ground contacts.

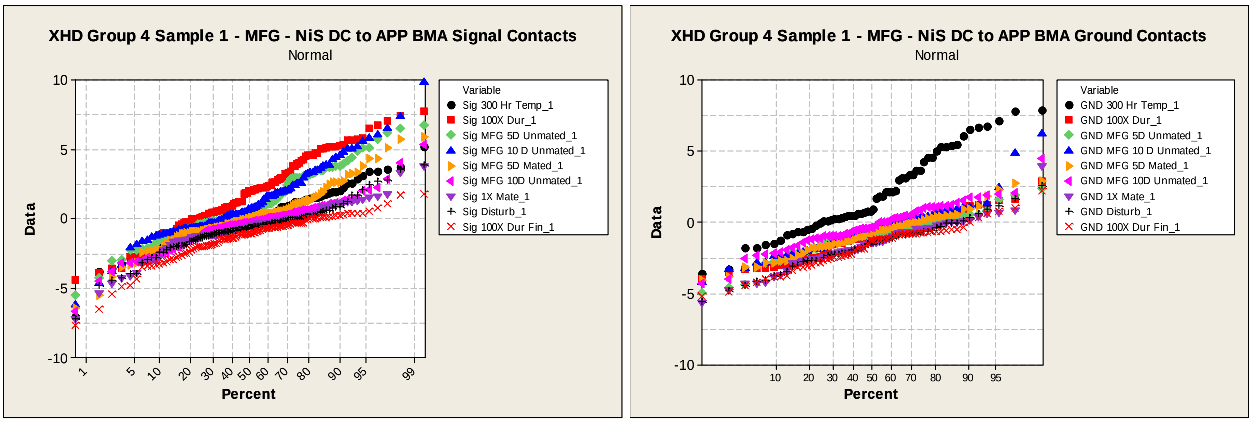

Figure 16: Group 4 NiS DC to APP BMA sample 1 - MFG results for signal and ground contacts.

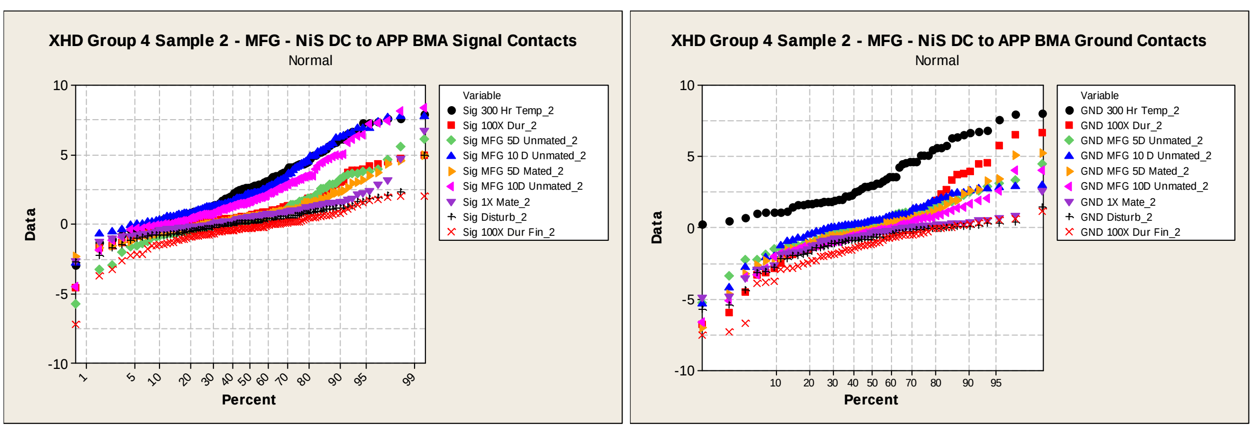

Figure 17: Group 4 NiS DC to APP BMA sample 2 - MFG results for signal and ground contacts.

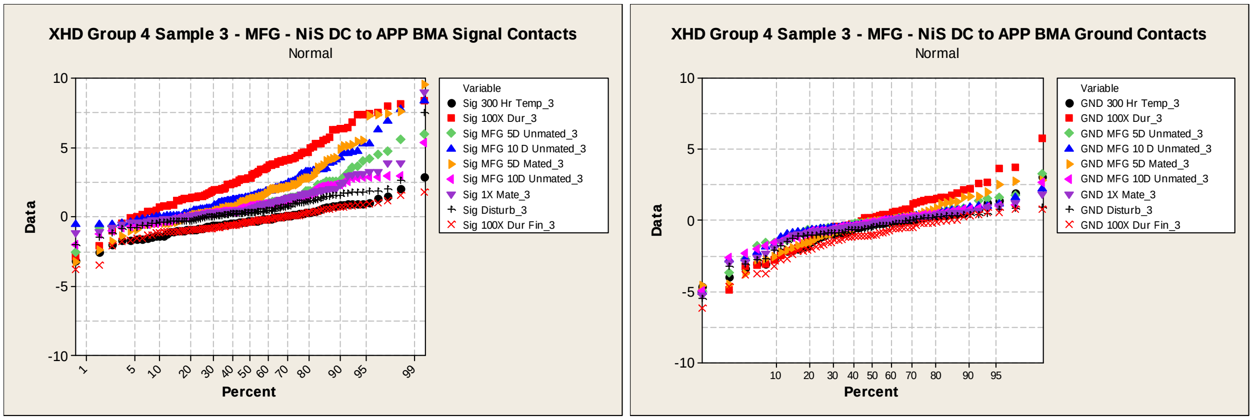

Figure 18: Group 4 NiS DC to APP BMA sample 3 - MFG results for signal and ground contacts.

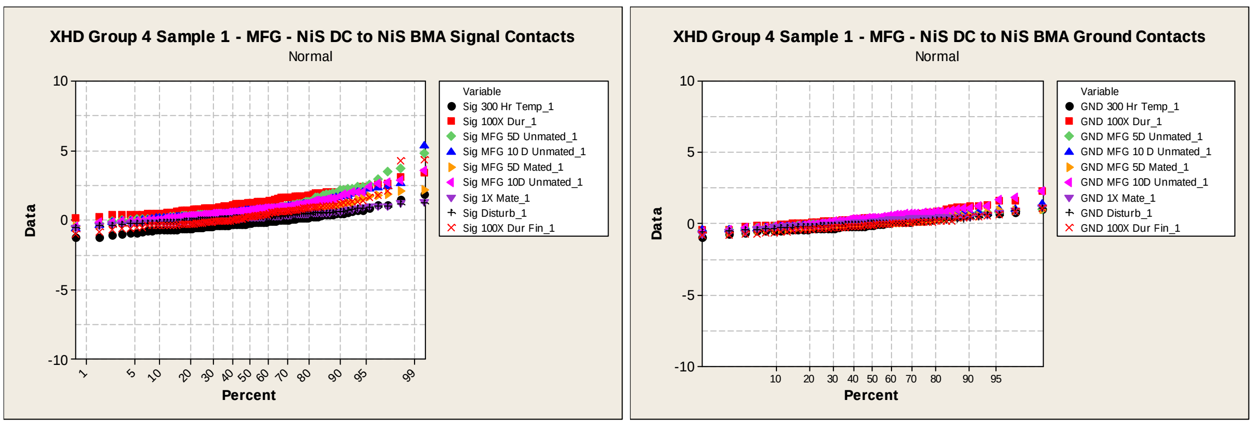

Figure 19: Group 4 NiS DC to NiS BMA sample 1 - MFG results for signal and ground contacts.

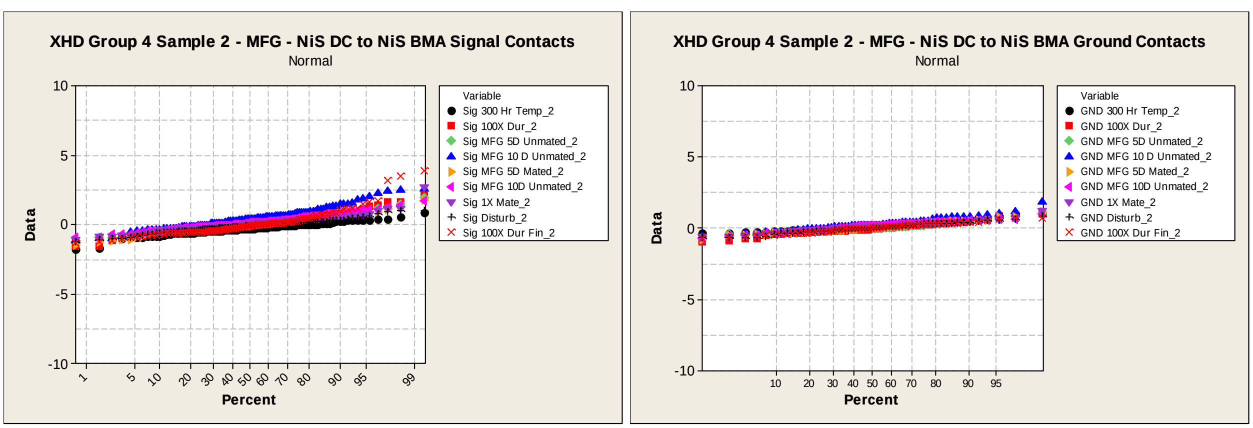

Figure 20: Group 4 NiS DC to NiS BMA sample 2 - MFG results for signal and ground contacts.

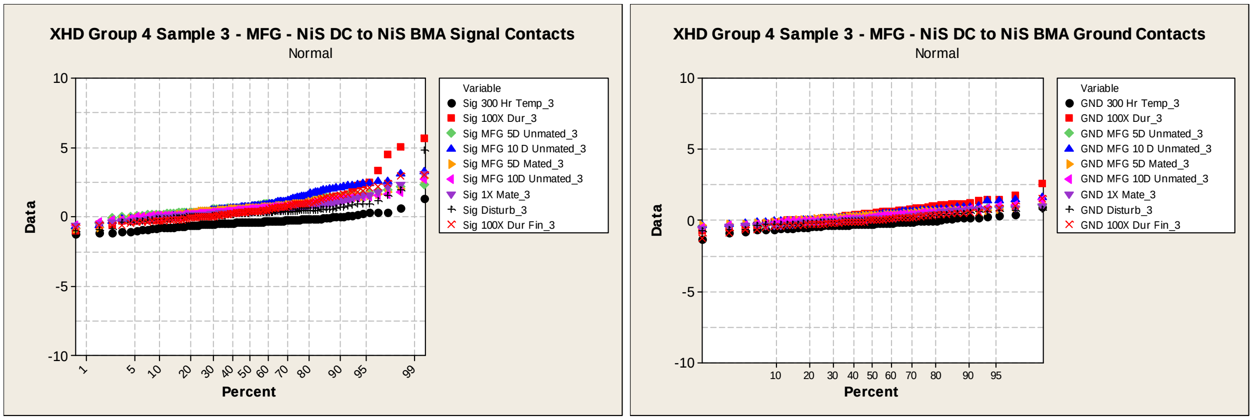

Figure 21: Group 4 NiS DC to NiS BMA sample 3 - MFG results for signal and ground contacts.

6.5 Group 5: Compliant pin insertion and retention force with temperature life

6.5.1 Compliant pins plated with the APP plating system were evaluated for insertion and retention force. The compliant pin area has the same APP barrier layer (nanocrystalline) thickness of 20µin to 40µin, along with 15µin to 60µin thick of matte tin plating. After the third insertion the compliant pins were exposed to 105°C for 500 hours and then pushed out to determine the retention force after temperature exposure, see Figure 22 and Figure 23 for the test results.

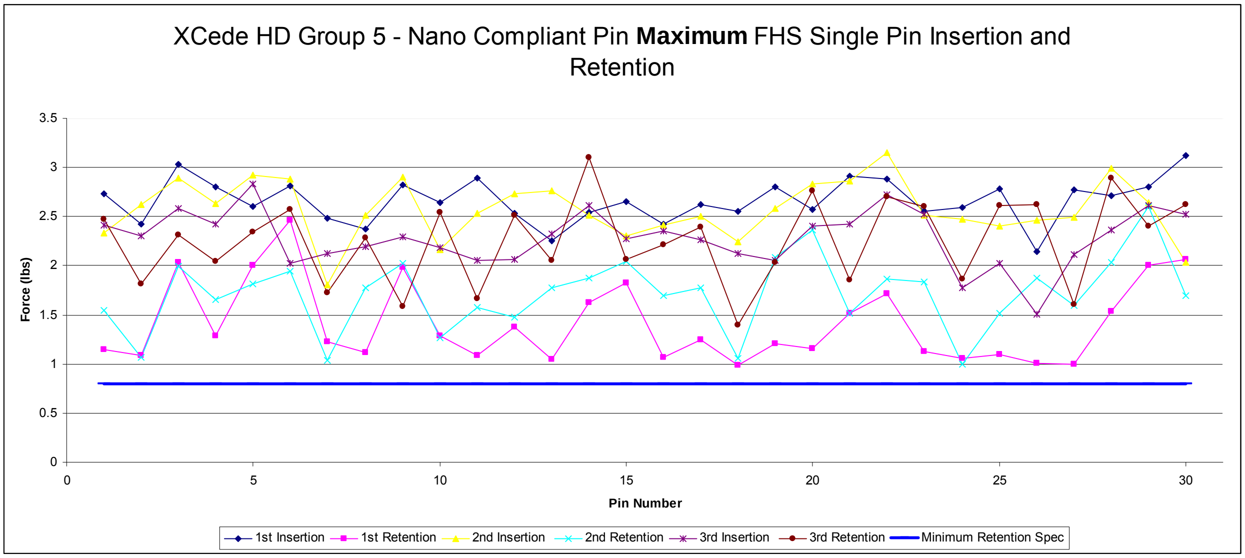

Figure 22: Group 5 - Nano compliant pin insertion and retention force in maximum diameter (0.0158”) plated through holes.

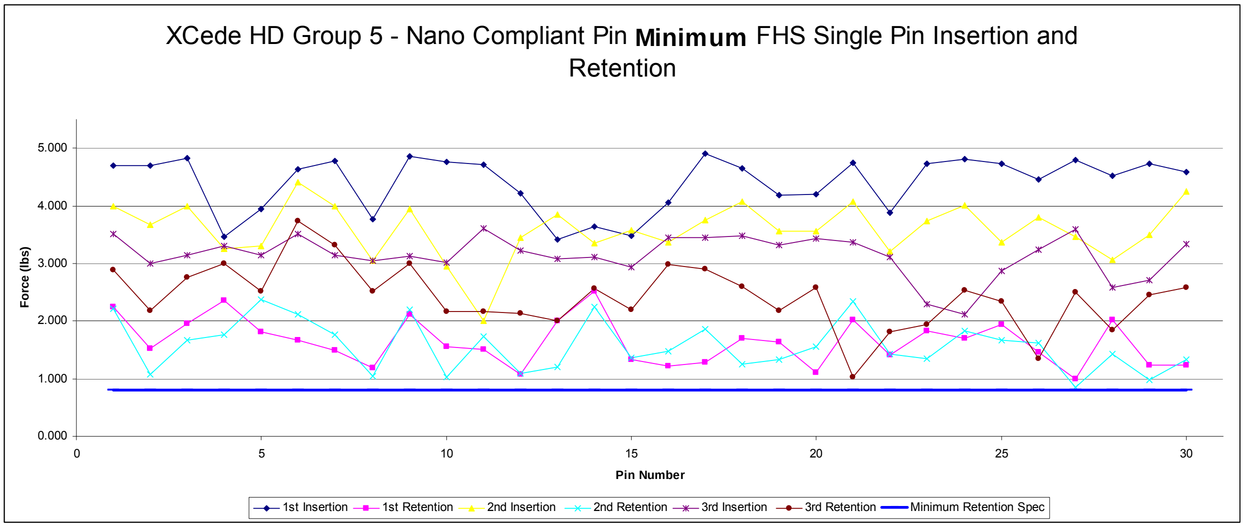

Figure 23: Group 5 - Nano compliant pin insertion and retention force in minimum diameter (0.0124") plated through holes.

6.6 Group 7: Plating evaluation

6.6.1 The qualification test samples' plating thicknesses were measured using an X-R-F analyzer. Refer to Table 3 and Table 4for the thickness measurements.

Daughtercard XRF Measurements		
	Au (µ")	APP Nickel (µ")
1	24.7	25
2	24.2	30.6
3	18.7	21.5
4	18.5	18.8
5	19.8	22.9
6	17.7	18.1
7	18.1	19.1
8	18.1	19.3
9	15.8	18.2
10	16.5	20
11	16.4	20.9
12	17.2	21.8
13	16.7	18.6
14	17.2	19.6
15	17.1	19.3
16	17.3	17.7
17	16.9	19
18	18.3	20.7
19	20.2	19.5
20	19.1	19.6
Max	24.7	30.6
Min	15.8	17.7
Average	18.4	20.5

Table 3: APP Au and APP nickel plating thickness measurements for daughtercard.

Grounds	Au (u")	APP Nickel (u")	**Signals**	Au (u")	APP Nickel (u")
1	12.9	29.5	1	13.0	23.3
2	12.1	30.7	2	13.1	26
3	11.5	32.4	3	12.3	26.6
4	11.1	31.4	4	12.6	25.1
5	12.9	32.2	5	12	24.3
6	11.9	34.2	6	11.9	24.2
7	12.7	33.1	7	11.6	24.1
8	11.8	32.1	8	13.1	23.1
9	10.6	30.6	9	11.9	24.7
10	12.5	31.4	10	12.1	25
11	13.9	31.5	11	12.5	25.7
12	10.4	32.3	12	12.2	23.8
13	11.7	33.2			
Max	13.9	34.2	Max	13.1	26.6
Min	10.4	29.5	Min	11.6	23.1
Average	12.0	31.8	Average	12.4	24.7

Table 4: Au and APP nickel plating thickness measurements for backplane.

6.6.2 Porosity was evaluated using nitric acid vapor per TB 2270. Refer to Table 4 for the NAV results.

Sample #	# of contacts	# of Blooms	# of Pores
1	24	0	0
2	24	0	0
3	24	2	0
4	24	0	0

7.0 Test results summary and discussions

7.1 Group 1: Mechanical shock and random vibration

7.1.1 The XCede HD test samples with the APP plating on the daughtercard and backplane contacts passed the Telcordia GR-1217-CORE C.O. requirements for mechanical shock and random vibration. The maximum signal contact delta low level contact resistance measured 8.6 milli-ohms and occurred after the final 100 durability cycles. The maximum ground contact delta low level contact resistance measured 4.9 milli-ohms and after exposure to the Z-axis random vibration test. The mechanical shock and random vibration test results summary are shown in Table 5 and Table 6.

	100X Durability	M.Shock Z Axis	M.Shock X Axis	M.Shock Y Axis	Vibration Y Axis	Vibration X Axis	Vibration Z Axis	100X Durability
Max	7.6	7.5	4.7	5.8	6.9	5.8	3.9	8.6
Min	-5.1	-4.2	-4.4	-3.7	-4.1	-4.0	-4.4	-3.1
Average	0.6	-0.1	-0.1	-0.1	0.1	-0.2	-0.6	0.4
Std Deviation	1.3	1.2	1.0	1.1	1.2	1.0	1.0	1.4

Table 5: Mechanical shock and vibration test results - Signals

	100X Durability	M.Shock Z Axis	M.Shock X Axis	M.Shock Y Axis	Vibration Y Axis	Vibration X Axis	Vibration Z Axis	100X Durability
Max	3.7	4.6	1.9	3.7	2.3	2.9	4.9	3.4
Min	-2.1	-3.3	-3.4	-2.2	-2.5	-3.0	-3.4	-3.0
Average	0.0	-0.3	-0.3	-0.2	-0.1	-0.4	-0.5	0.0
Std Deviation	0.9	0.9	0.7	0.8	0.8	0.8	0.9	0.8

Table 6: Mechanical shock and vibration test results – Grounds

7.2 Group 2: Thermal shock, durability, dust, and humidity cycling (this group also includes dielectric withstanding voltage and insulation resistance)

7.2.1 The XCede HD test samples with the APP plating on the daughtercard and backplane contacts passed the Telcordia GR-1217-CORE C.O. requirements for thermal shock, durability, dust, and humidity cycling. The maximum signal contact delta low level contact resistance measured 6.3 milli-ohms and occurred after the 250 durability cycles. The maximum ground contact delta low level contact resistance measured 5.8 milli-ohms and occurred after the 250 durability cycles. The Thermal shock, durability, dust, and humidity cycling test results summary are shown in Table 7 and Table 8.

	250X	Dust	T-Shock	Cycling Humidity 168hrs	Cycling Humidity 336hrs	Cycling Humidity 500hrs
Max	6.3	1.0	2.1	2.6	3.6	2.6
Min	-7.8	-9.2	-9.7	-10.0	-9.9	-9.2
Average	-0.2	-1.5	-1.4	-1.4	-1.3	-1.1
Std Deviation	1.8	1.1	1.3	1.4	1.4	1.4

Table 7: Thermal shock, durability, dust, and humidity cycling test results summary - Signals

	250X	Dust	T- Shock	Cycling Humidity 168hrs	Cycling Humidity 336hrs	Cycling Humidity 500hrs
Max	5.8	1.7	1.0	1.2	2.3	2.0
Min	-4.7	-5.1	-5.4	-5.6	-5.6	-5.6
Average	0.2	-1.6	-1.5	-1.5	-1.4	-1.3
Std Deviation	2.1	1.0	1.1	1.2	1.3	1.3

Table 8: Thermal shock, durability, dust, and humidity cycling test results summary – Grounds

7.3 Group 3: Temperature life

7.3.1 The XCede HD test samples with the APP plating on the daughtercard and backplane contacts passed the Telcordia GR-1217-CORE C.O. requirements for temperature life. The samples were exposed to 105°C for 1000 hours which exceeds the Telcordia requirement of 85°C for 500 hours for Central Office environments. The maximum signal contact delta low level contact resistance measured 9.4 milli-ohms after exposure to the temperature life environment. The maximum ground contact delta low level contact resistance measured 9.2 milli-ohms after exposure to the temperature life environment. The temperature life summarized test results is shown in Table 9 and Table 10.

	T-Life 500 hrs.	Mate/Unmate	T-Life 1000 hrs	Mate/Unmate
Max	4.8	5.6	5.6	9.4
Min	-1.9	-0.4	-0.8	-0.5
Average	0.5	1.6	0.6	2.8
Std Deviation	0.8	1.3	0.9	1.9

Table 9: Temperature life test results summary – Signals

	T-Life 500 hrs.	Mate/Unmate	T-Life 1000 hrs	Mate/Unmate
Max	6.0	5.1	9.2	8.2
Min	-1.6	-0.3	-1.1	-0.2
Average	0.7	1.5	0.9	2.2
Std Deviation	1.1	1.2	1.3	1.4

Table 10: Temperature life test results summary – Grounds

7.4 Group 4: Mixed flowing gas

7.4.1 The XCede HD test samples with the APP plating on the daughtercard and backplane contacts passed the Telcordia GR-1217-CORE C.O. requirements for the four gas MFG test.

7.4.2 The results for the test samples plated with APP on the daughtercard and backplane contacts show that the maximum delta resistance change measured was 9.9 milli-ohms for the signal contact after 5 days of unmated MFG. And the maximum delta resistance change for the ground contact measured was 6.9 milli-ohms after the 300 hours of temperature preconditioning. The APP daughtercard to APP backplane MFG results are summarized in Table 11 and Table 12.

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	7.9	7.4	9.9	7.7	5.1	4.7	4.4	5.9	5.1
Min	-2.2	-4.3	-2.5	-4.0	-4.2	-4.2	-4.5	-4.4	-5.3
Average	0.9	0.7	1.7	0.8	0.5	0.0	0.4	0.4	0.2
Std Deviation	1.4	1.7	1.8	1.4	1.2	1.1	1.2	1.3	1.4

Table 11: APP daughtercard and APP backplane MFG results summary - Signals

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	6.9	5.2	4.0	3.7	3.6	1.8	2.5	3.1	6.7
Min	-3.1	-4.2	-3.2	-3.8	-2.7	-3.5	-3.5	-3.6	-4.6
Average	1.1	0.1	0.5	0.1	0.2	-0.4	-0.1	-0.1	-0.1
Std Deviation	1.7	1.4	1.2	1.2	1.0	1.1	1.2	1.2	1.7

Table 12: APP daughtercard and APP backplane MFG results summary - Grounds

7.4.3 The results for the test samples plated with NiS on the daughtercard and backplane contacts show that the maximum delta resistance change measured was 5.6 milli-ohms for the signal contact after the first set of durability cycles. The maximum delta resistance change for the ground contact measured was 2.6 milli-ohms which also was measured after the first set of durability cycles. The NiS daughtercard and backplane MFG results are summarized in Table 13 and Table 14 below.

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	1.9	5.6	4.8	5.3	2.8	3.6	3.1	4.8	4.4
Min	-1.8	-1.6	-1.3	-1.1	-1.5	-1.0	-1.1	-1.2	-1.3
Average	-0.3	0.7	0.6	0.7	0.4	0.5	0.3	0.1	0.3
Std Deviation	0.4	0.9	0.7	0.8	0.6	0.6	0.5	0.5	0.8

Table 13: NiS daughtercard and NiS backplane MFG results summary - Signals

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	1.1	2.6	1.1	1.8	1.2	2.3	1.2	1.1	1.5
Min	-1.3	-0.9	-0.7	-0.6	-0.8	-0.7	-0.7	-0.7	-1.2
Average	0.0	0.3	0.2	0.3	0.2	0.3	0.2	0.0	0.0
Std Deviation	0.4	0.6	0.4	0.4	0.4	0.5	0.4	0.3	0.4

Table 14: NiS daughtercard and NiS backplane MFG results summary - Grounds

7.4.4 The results for the test samples plated with APP on the daughtercard and NiS on the backplane contacts show that the maximum delta resistance change measured was 7.2 milli-ohms for the signal contact after the final 100 durability cycles. The maximum delta resistance change for the ground contact measured was 3.1 milli-ohms after the post MFG durability cycles. The APP daughtercard and NiS backplane results are summarized in Table 15 and Table 16 below.

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	1.6	5.2	5.1	3.3	3.0	5.4	4.3	6.2	7.2
Min	-1.7	-0.5	-0.3	-0.6	-0.9	-0.7	-0.6	-0.8	-1.2
Average	-0.1	1.0	1.1	0.8	0.5	0.9	0.7	0.7	1.2
Std Deviation	0.6	0.8	0.7	0.7	0.6	0.7	0.6	0.8	1.1

Table 15: APP daughtercard and NiS backplane MFG results summary - Signals

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	2.7	3.1	2.7	1.9	1.3	1.8	1.4	1.6	3.1
Min	-1.4	-0.5	-0.6	-0.7	-0.6	-0.8	-1.0	-0.9	-0.9
Average	0.2	0.6	0.5	0.3	0.2	0.4	0.3	0.2	0.3
Std Deviation	0.6	0.6	0.5	0.5	0.4	0.5	0.4	0.4	0.6

Table 16: APP daughtercard and NiS backplane MFG results summary - Grounds

7.4.5 The results for the test samples plated with NiS on the daughtercard and APP on the backplane contacts show that the maximum delta resistance change measured was 9.6 milli-ohms for the signal contact after 10 days unmated MFG exposure. And the maximum delta resistance change for the ground contact measured was 8.0 milli-ohms after 300 hours of temperature preconditioning. The NiS daughtercard and APP backplane results are summarized in Table 17 and Table 18 below.

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	7.9	8.4	6.7	9.8	9.6	8.4	9.0	7.5	2.0
Min	-7.1	-4.6	-5.7	-6.2	-6.4	-6.7	-7.2	-7.2	-7.7
Average	0.9	2.0	0.9	1.9	0.8	0.9	0.3	0.0	-0.7
Std Deviation	2.2	2.3	1.8	2.3	2.0	2.0	1.5	1.3	1.3

Table 17: NiS daughtercard and APP backplane MFG results summary – Signals

	T-Life 300 hrs.	100 X Durability	5 Days Unmated	10 days Unmated	5 days Mated	10 days Mated	Mate/Unmate	Disturbance	100 X Durability
Max	8.0	6.7	4.5	6.3	5.2	4.5	4.0	2.6	2.2
Min	-4.6	-6.8	-5.2	-5.3	-7.0	-6.6	-5.6	-5.7	-7.5
Average	1.6	-0.2	-0.3	-0.1	-0.4	-0.3	-0.8	-1.0	-1.4
Std Deviation	2.7	2.1	1.5	1.6	1.7	1.5	1.4	1.4	1.5

Table 18: NiS daughtercard and APP backplane MFG results summary – Grounds

7.5 Group 5: Compliant pin insertion and retention force with temperature life

7.5.1 The compliant pin test samples with the APP nickel plating passed the Telcordia GR-1217-CORE C.O. and EIA-364-TS1002 requirements. The test results also show that the retention force met the 0.8 lbs minimum requirement after temperature life.

7.6 Group 6: Plating evaluation

7.6.1 The gold plating thickness for all of the test samples met the 10µin minimum thickness. The gold plating thickness averaged 18.4 µin for the daughtercard contacts. The gold plating thickness averaged 12.4 µin for the backplane signal contacts and 12.0 µin for the backplane ground contacts.

7.6.2 The APP nickel plating thickness for the test samples did not all meet the 20 µin to 40 µin thickness requirement. The daughtercard contacts averaged 20.5 µin of the nickel plating for the APP plated contacts. Some of the contacts had less than 20 µin, and still passed all the other test groups. The backplane signal contacts averaged 24.7 µin of APP plating and the backplane ground contacts averaged 31.8 µin of APP plating thickness.

7.6.3 The porosity evaluation of both daughtercard and backplane contacts showed less than the 5% of contact surfaces contained pores, which is the maximum allowable specification. The daughtercard showed 2.1% of the contacts had corrosion blooms, although no pores were observed. For the backplane contacts, no pores were observed.

8.0 Conclusions

8.1 The Telcordia qualification test results for the XCede HD 4 Pair connector plated with the APP plating system show that it passed all of the Telcordia GR-1217-CORE C.O. qualification requirements. As part of the qualification testing, Nickel Sulfamate plated components were also included in the mixed flowing gas sequence as a control group to compare the results to the APP nickel plated components. The results of the testing show that the APP nickel test samples performed well and pass the qualification requirements.

8.2 The inter-mateability tests show that APP nickel and Nickel Sulfamate plating systems performed well and passed all of the Telcordia GR-1217-CORE C.O. requirements. Based on the test results, current connectors in the field plated with Nickel Sulfamate can be inter-mated with connectors plated with the APP nickel.

8.3 Based on these test results, 20 µin to 40 µin of APP nickel plating with 10 µin minimum gold is considered an equivalent qualified inter-mateable alternative for the 50 µin to 150 µin Nickel Sulfamate plating with 30 µin minimum gold.

9.0 Addendum – Increased level of mechanical shock and random vibration

A supplemental test sequence at increased levels of mechanical shock and random vibration was performed to the following parameters outlined in section 9.1. The test sequence is shown in figure 15.

9.1 Test plan and conditions, Group A – Mechanical shock and random vibration:

9.1.1 Random vibration test conditions – EIA-364-TP28

- 9.1.1.1 Frequency : 50 to 2,000 Hz
- 9.1.1.2 PSD : 0.06 g^2/Hz
- 9.1.1.3 ‘G’ Level : 9.26 g RMS
- 9.1.1.4 Duration : 2 hrs/axis, 3 axis (6 hrs total)
- 9.1.1.5 Interrupt monitoring: 15 channels on each mated sample, 1 μsec

9.1.2 Mechanical shock test conditions – EIA-364-TP27

- 9.1.2.1 ‘G’ Level : 50 G’s
- 9.1.2.2 Duration : 11 Milliseconds
- 9.1.2.3 Wave form : Half Sine
- 9.1.2.4 No. of shocks : 3 axis and 3 each direction (18 total)

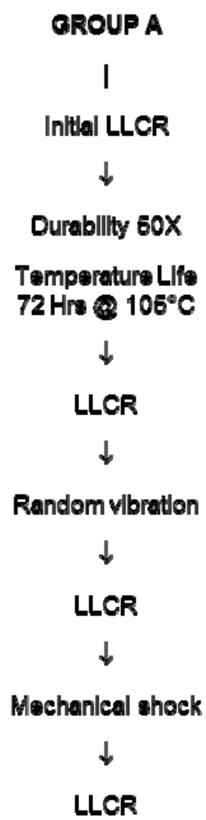

Figure 15 – Group A Test sequence

9.2 Test samples

9.2.1 The test samples are XCede HD 4 Pair backplane and daughtercard connectors. The test connector configuration is an 24 position connector.

9.2.2 Test samples were mounted onto ATCS standard qualification printed circuit board (PCB), see figure 16. There are 65 signal contact and 35 ground contact low level contact resistance (LLCR) test points per PCB. Three samples were subjected to the test sequence.

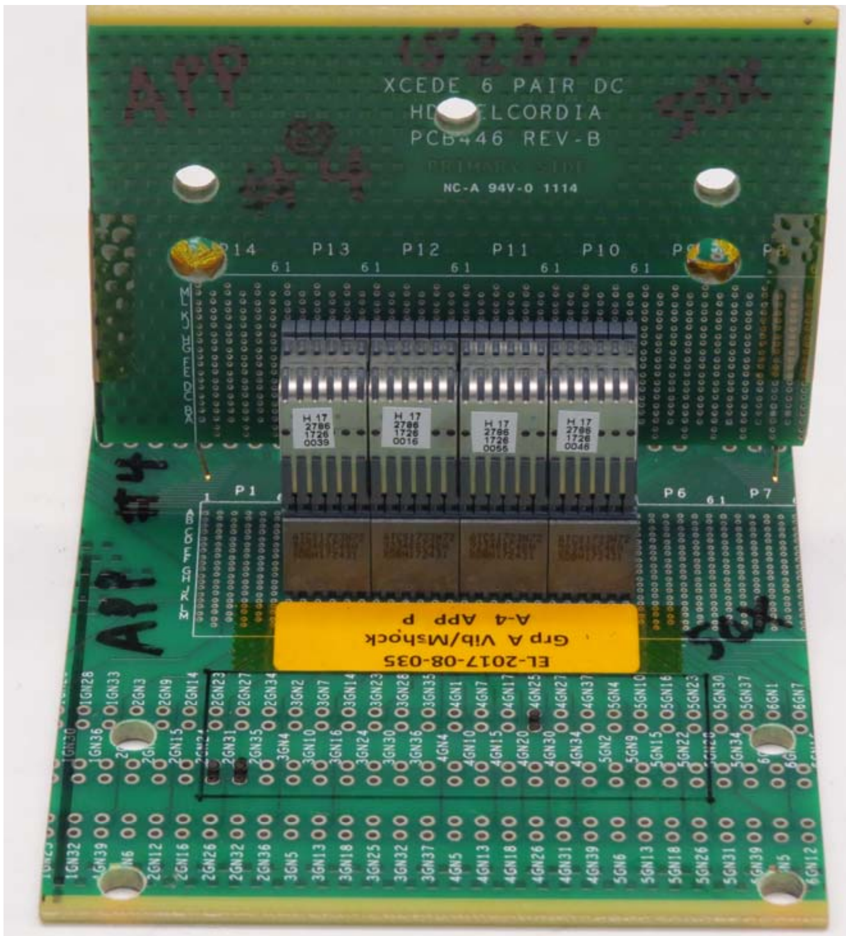

Figure 16 – Test sample

9.3 Results

9.3.1 Three mated connectors were exposed to mechanical shock and random vibration (195 signal and 105 ground contacts were monitored for LLCR). The connectors were mechanically shocked to 50g in all three axes and exposed to 9.26g random vibration in all three axes with pre-durability cycles, see Figure 17 for the test results.

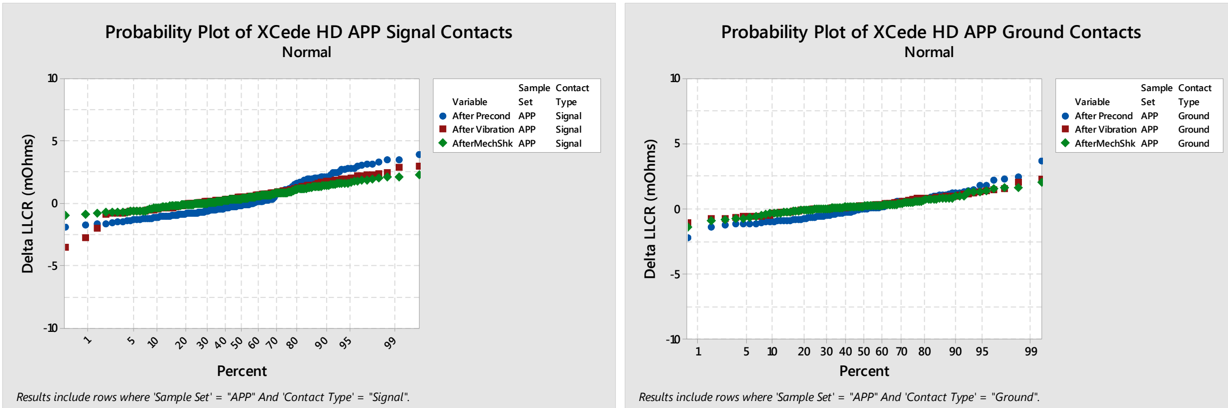

Figure 17 – Low Level Contact Resistance results

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All three samples passed with no delta low level contact resistance exceeding 10 milliohms. The summary results are shown in table 19. Fifteen (15) signal contacts in each specimen were monitored for continuity during vibration and mechanical shock treatments. No discontinuity greater than 1 µsec was detected.

SIGNALS	Pre-conditioning	Vibration	Shock	GROUNDS	Pre-conditioning	Vibration	Shock
Min	-1.93	-3.55	-1.02	Min	-2.21	-1.10	-1.45
Average	0.17	0.47	0.40	Average	0.05	0.28	0.22
Max	3.83	2.91	2.18	Max	3.66	2.24	2.04
Std Dev	1.297	0.882	0.690	Std Dev	0.938	0.583	0.558

Table 19 – Low Level Contact Resistance results summary

9.4 Conclusion

9.4.1 The XCede HD connectors with APP plating passed the higher level of mechanical shock and random vibration.

10.0 Appendix – Reference documents

10.1 Increased level of mechanical vibration and shock testing - EL-2017-08-035