Modular, Nano RF Connector System

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity (TE) Modular Nano RF Connector System to determine its conformance to TE Product Specification 108-163006 Rev C.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the TE Modular Nano RF Connector System. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) and the Harrisburg Signal Integrity/EMC Test Laboratory between 10/25/2017 and 3/1/2018. Detailed results are filed under EA20170647T and EMEPRJ-14-0706-008. Additional testing was conducted at HECTL between 8/9/2018 and 9/14/2018, with detailed results filed under EA20180100T. Additional testing was conducted at HECTL between 2/25/2019 and 3/15/2019, with detailed results filed under EA20190052T. Additional testing was conducted at HECTL and Harrisburg Signal Integrity/EMC Test Laboratory between 2/7/2020 and 3/24/2020, with detailed results filed under EA20190463T and EMEPRJ-18-906307-001.

1.3 Conclusion

The TE Modular Nano RF Connector System listed in paragraph 1.4 conformed to the electrical, mechanical, and environmental performance requirements of TE Product Specification 108-163006 Rev C.

1.4 Test Specimens

Test specimens identified in Tables 1 through Table 4 were used for testing. The test specimens were representative of normal production lots.

Table 1 – Test Specimens (EA20170647T[1] and EMEPRJ-14-0706-008[2])

Test Group	Quantity	Part Number	Description (a)
1[1]	5	2828431-1 Rev 2	8 position Nano RF module, PCB mount, daughter card
	5	2828434-1 Rev 2	8 position Nano RF module, PCB mount, backplane
2[1]	5	2828431-1 Rev 2	8 position Nano RF module, PCB mount, daughter card
	5	2828434-1 Rev 2	8 position Nano RF module, PCB mount, backplane
3[1]	5	2828392-1 Rev 2	16 position Nano RF module, PCB mount, daughter card
	5	2828395-1 Rev 2	16 position Nano RF module, PCB mount, backplane
4[2]	8	2828696-2 Rev 7	Cable assembly Nano RF, backplane, semi rigid, 1.85mm, 12in
	8	2828697-2 Rev 7	Cable assembly Nano RF, daughter card, semi rigid, 1.85mm, 12in
	8	2828696-3 Rev 7	Cable assembly Nano RF, backplane, flex cable, 1.85mm, 12in
	8	2828697-3 Rev 7	Cable assembly Nano RF, daughter card, flex cable, 1.85mm, 12in
5[2]	16	2828696-4 Rev 7	Cable assembly Nano RF, backplane, flex cable, 2.92mm, 36 in
	16	2828697-4 Rev 7	Cable assembly Nano RF, daughter card, flex cable, 2.92mm, 36in
6[2]	8	2828696-4 Rev 7	Cable assembly Nano RF, backplane, flex cable, 2.92, 36in
	8	2828697-4 Rev 7	Cable assembly Nano RF, daughter card, flex cable 2.92, 36in
7[1]	3	2828431-1 Rev 2	8 position Nano RF module, PCB mount, daughter card
	3	2828434-1 Rev 2	8 position Nano RF module, PCB mount, backplane
1,2,3,7	184	2828696-5 Rev 6	Cable assembly Nano RF, backplane, flex cable, 24 in
	184	2828697-5 Rev 7	Cable assembly Nano RF, daughter card, flex cable, 24 in

NOTE *(a) Test Groups 1,2,3 and 7 mounted to printed circuit boards 60-1938728-1 Rev. A and 60-1938729-1 Rev A.*

Table 2 – Test Specimens (EA20180100T)

Test Group	Quantity	Part Number	Description (a)
1	3	2313436-2 Rev 4	12 position Nano RF module, PCB mount, daughter card
	3	2313376-2 Rev 2	12 position Nano RF module, PCB mount, backplane
2	3	2313436-2 Rev 4	12 position Nano RF module, PCB mount, daughter card
	3	2313376-2 Rev 2	12 position Nano RF module, PCB mount, backplane
3	3	2313436-2 Rev 4	12 position Nano RF module, PCB mount, daughter card
	3	2313376-2 Rev 2	12 position Nano RF module, PCB mount, backplane
1,2,3	108	2828696-5 Rev 7	Cable assembly Nano RF, backplane, flex cable, 24 in
	108	2828697-5 Rev 7	Cable assembly Nano RF, daughter card, flex cable, 24 in

NOTE *(a) Test Groups 1,2 and 3 mounted to printed circuit boards 60-1938729-1 Rev. A and 60-1940362-1 Rev A.*

Table 3 – Test Specimens (EA20190052T)

Test Group	Quantity	Part Number	Description (a)
2	5	2322335-2 Rev 3	18 position Nano RF module, PCB mount, daughter card
	5	2322337-2 Rev 3	18 position Nano RF module, PCB mount, backplane
3	5	2322335-2 Rev 3	18 position Nano RF module, PCB mount, daughter card
	5	2322337-2 Rev 3	18 position Nano RF module, PCB mount, backplane
2,3	180	2828696-5 Rev 7	Cable assembly Nano RF, backplane, flex cable, 24 in
	180	2828697-5 Rev 7	Cable assembly Nano RF, daughter card, flex cable, 24 in

NOTE *(a) Test Groups 2 and 3 mounted to printed circuit boards 60-1935275-1 Rev. A and 60-1935276-1 Rev A.*

Table 4 – Test Specimens (EA20190463T[1] and EMEPRJ-18-906307-001[2])

Test Group	Quantity	Part Number	Description (a)
1[1]	3	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8) Plus .047 Cable (1)
	3	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (9)
2[1]	3	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8) Plus .047 Cable (1)
	3	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (9)
3[1]	3	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8) Plus .047 Cable (1)
	3	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (9)
4[2]	1	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8)
	1	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (8)
5[2]	1	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8)
	1	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (8)
6[2]	8	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8)
	8	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (8)
7[1]	3	2357971-1 Rev 1	9 Position Nano RF Backplane Module, .086 Cable (8) Plus .047 Cable (1)
	3	2357976-1 Rev 1	9 Position Nano RF Daughtercard Module, .047 Cable (9)
1,2,3,7	96	2352117-5 Rev 1	Nano RF, .086 Cable Assembly
	12	2828696-5 Rev 8	Nano RF Cable Assembly
	108	2828697-5 Rev 9	HDRF Cable Assembly

NOTE *(a) Test Groups 1,2,3 and 7 mounted to printed circuit boards 60-1953009-1 Rev. A and 60-1953010-1 Rev A.*

1.5 Qualification Test Sequence

Table 5 – Test Sequence

Test or Examination	Test Group (a)						
	1	2	3	4	5	6	7
	Sequence (b)						
Initial Examination of Product	1	1	1	1	1	1	1
Mating Force	2						
Unmating Force	14						
Low Level Contact Resistance (LLCR)	3,5,7,9,11,13						
Insulation Resistance		2,6					
Dielectric Withstanding Voltage		3,7					
Durability 500 Cycles (100 cycle intervals)	4,6,8,10,12						
Vibration Test 1			2				2
Vibration Test 2			3				3
Vibration Test 3			4(c)				4(c)
Mechanical Shock, Class OS2			5				5
Humidity / Temperature Cycling		5					
Thermal Shock (non-operating)		4					
Operating Temperature						2	
Voltage Standing Wave Ratio (VSWR)				2			6
Isolation				5			
Power Handling					2		
Insertion Loss				3			
Frequency Response				4			
Final Examination of Product	15	8	6	6	3	3	7

NOTE *(a) See Paragraph 1.4*
(b) The numbers indicate sequence in which tests were performed
(c) The Z Axis is defined as the axis perpendicular to the contact mating axis in the vertical direction

1.6 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 15°C to 35°C
Relative Humidity: 20% to 80%

2. SUMMARY OF TESTING

2.1 Initial Examination of Product – All Groups

All specimens submitted for testing were representative of normal production lots. A Certificate of Conformance was issued by Product Assurance. Where specified, specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

2.2 Mating Force – Group 1

Specimens met the maximum mating force requirement of 11.25 N per contact.

2.3 Unmating Force – Group 1

Specimens met the minimum unmating force requirement of 1.4 N per contact.

2.4 Low Level Contact Resistance (LLCR) – Group 1

Specimens met the requirement of ≤ 8.0 milliohms initial for the center contacts and ≤ 2.0 milliohms initial for the outer contacts. Center and outer contacts had a change of resistance less than 8.0 milliohms following testing. See Tables 6 through 11 for summary data.

2.4.1 Low Level Contact Resistance (LLCR) – Group 1, EA20170647T

Table 6 – LLCR, Center Contact (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	2.32	-1.84	-1.91	-1.85	-2.63	-2.68
Max	7.40	0.89	1.45	1.49	0.33	1.09
Avg	5.43	-0.30	-0.33	-0.15	-1.07	-0.77
Count	40	40	40	40	40	40

Table 7 – LLCR, Outer Contact (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	1.45	-0.09	-0.05	-0.02	-0.04	-0.03
Max	1.61	0.12	0.13	0.15	0.15	0.18
Avg	1.54	0.02	0.03	0.04	0.04	0.05
Count	40	40	40	40	40	40

2.4.2 Low Level Contact Resistance (LLCR) – Group 1, EA20180100T

Table 8 – LLCR, Center Contact (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	4.73	-2.57	-1.95	-2.39	-2.77	-2.27
Max	7.23	3.01	1.96	1.00	2.43	2.39
Avg	6.32	-0.64	-0.08	-0.51	-0.01	-0.05
Count	36	36	36	36	36	36

Table 9 – LLCR, Outer Contact (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	1.17	-0.75	-0.30	-0.43	-0.41	-0.35
Max	1.84	0.32	0.43	0.57	0.57	0.54
Avg	1.60	0.02	0.05	0.08	0.10	0.06
Count	36	36	36	36	36	36

2.4.3 Low Level Contact Resistance (LLCR) Group 1, EA20190463T

Table 10 – LLCR, Center Contact Summary Data (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	3.13	-0.37	-2.61	-1.27	-1.25	-1.64
Max	6.94	2.69	2.98	2.33	2.87	3.54
Avg	5.86	1.00	-0.10	0.14	-0.07	0.33
Count	27	27	27	27	27	27

Table 11 – LLCR, Outer Contact Summary Data (milliohms)

Condition	Initial	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
Reading	Actual R	Delta R	Delta R	Delta R	Delta R	Delta R
Min	0.84	-0.04	-0.05	-0.02	-0.10	-0.18
Max	1.27	0.07	0.14	0.19	0.24	0.21
Avg	0.98	0.01	0.03	0.04	0.04	-0.01
Count	27	27	27	27	27	27

2.5 Insulation Resistance - Group 2

All insulation resistance measurements were greater than 10,000 megohms initially and greater than 5,000 megohms after testing.

2.6 Dielectric Withstanding Voltage - Group 2

No dielectric breakdown or flashover occurred. Leakage current was less than 5 milliamperes.

2.7 Durability - Group 1

No physical damage occurred to the specimens as a result of mating and unmating the specimens 500 times.

2.8 Vibration Test 1 – Groups 3 and 7

No discontinuities were detected during vibration. Following vibration, no cracks, breaks, or loose parts on the specimens were visible.

2.9 Vibration Test 2 – Groups 3 and 7

No discontinuities were detected during vibration. Following vibration, no cracks, breaks, or loose parts on the specimens were visible.

2.10 Vibration Test 3 – Groups 3 and 7

No discontinuities were detected during vibration. Following vibration, no cracks, breaks, or loose parts on the specimens were visible.

2.11 Mechanical Shock, Class OS2 – Groups 3 and 7

No discontinuities were detected during mechanical shock. Following mechanical shock, no cracks, breaks, or loose parts on the specimens were visible.

2.12 Humidity / Temperature Cycling - Group 2

No evidence of physical damage was visible as a result of exposure to humidity / temperature cycling.

2.13 Thermal Shock (non-operating) - Group 2

No evidence of physical damage was visible as a result of exposure to thermal shock.

2.14 Operating Temperature – Group 6

VSWR was less than 1.4 from 1 to 40Ghz.

2.14.1 Operating Temperature – Group 6, EMEPRJ-14-0706-008

See Figure 1 through Figure 5.

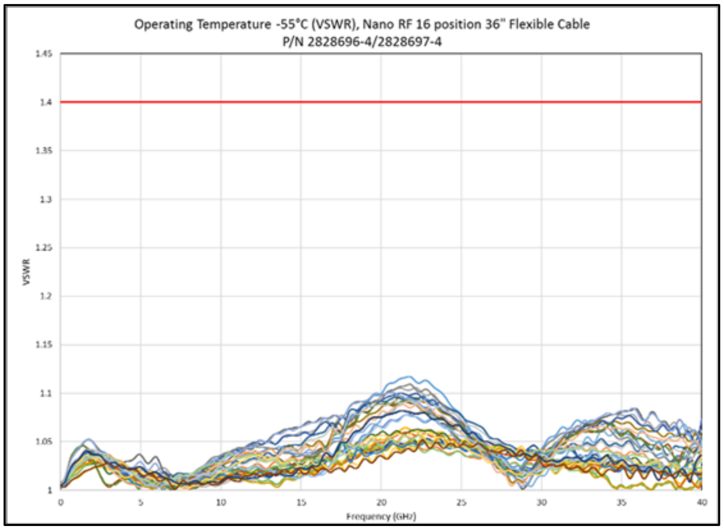

Figure 1 – Operating Temperature, -55°C

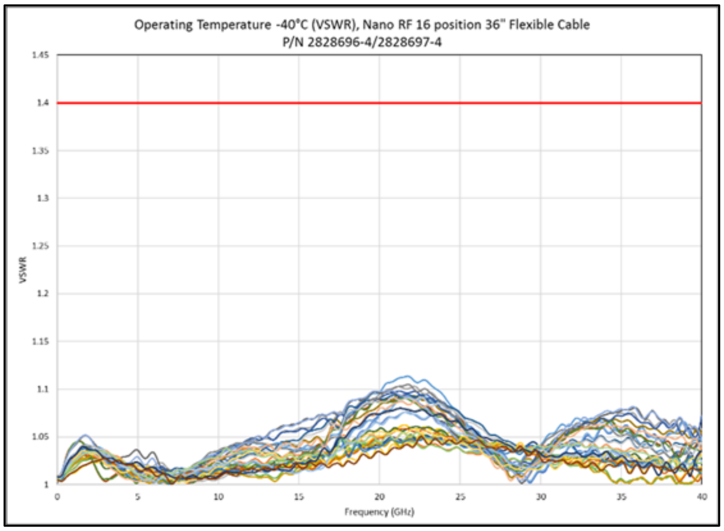

Figure 2 – Operating Temperature, -40°C

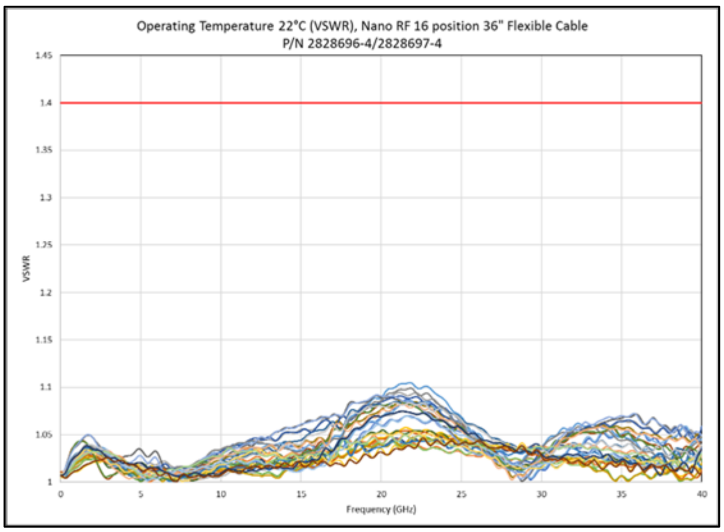

Figure 3 – Operating Temperature, 22°C

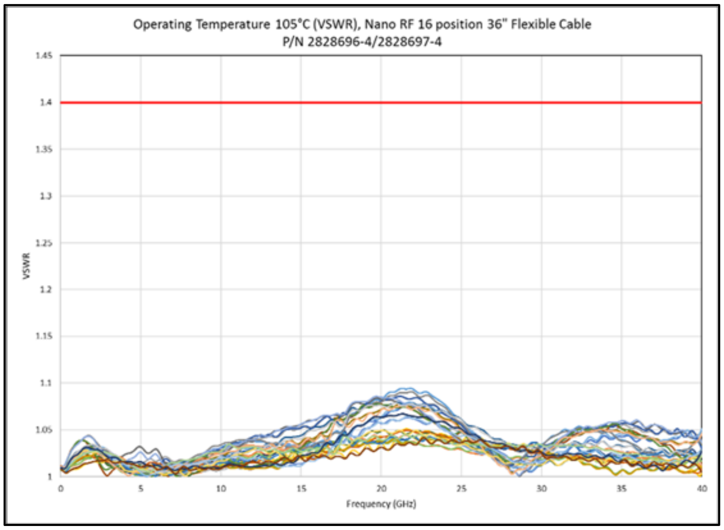

Figure 4 – Operating Temperature, 105°C

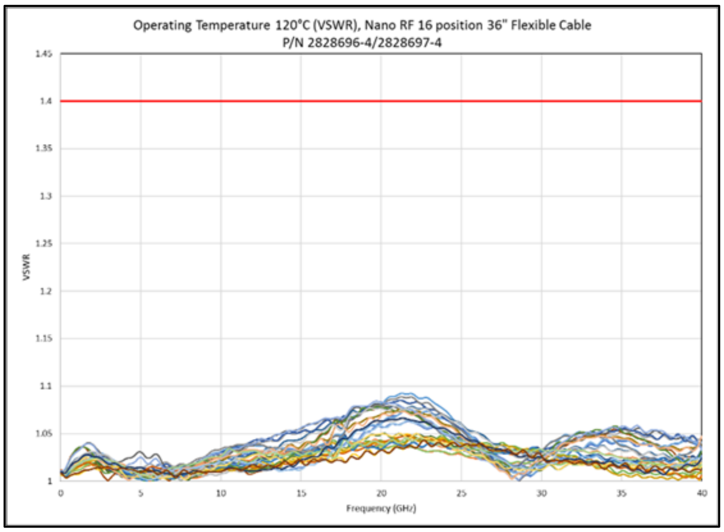

Figure 5 – Operating Temperature, 120°C

2.14.2 Operating Temperature – Group 6, EMEPRJ-18-906307-001

See Figure 6 through Figure 10.

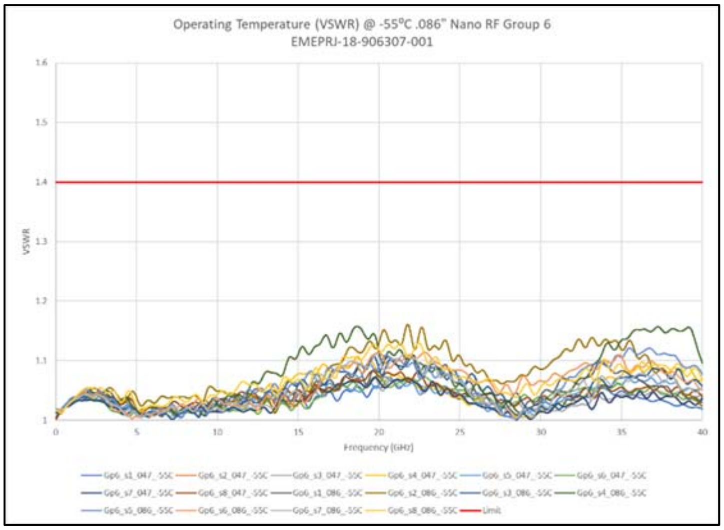

Figure 6 – Operating Temperature, -55°C

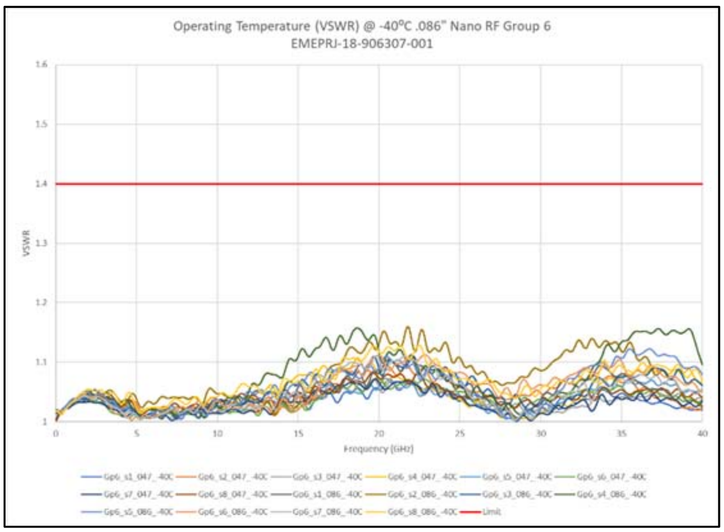

Figure 7 – Operating Temperature, -40°C

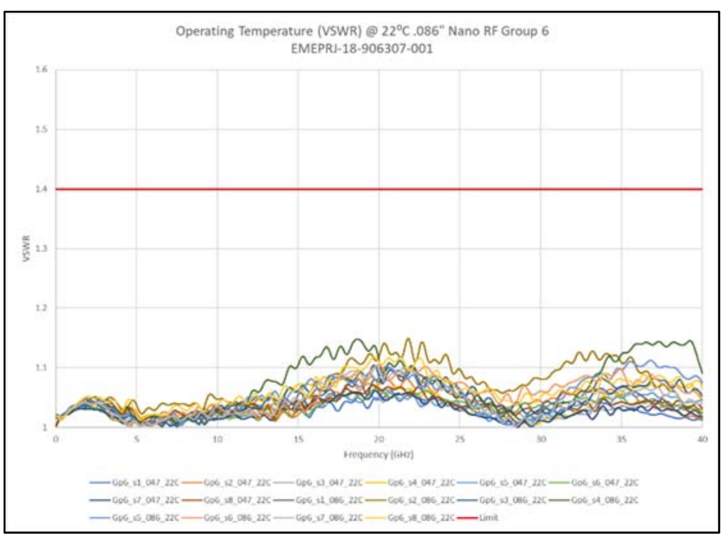

Figure 8 – Operating Temperature, 22°C

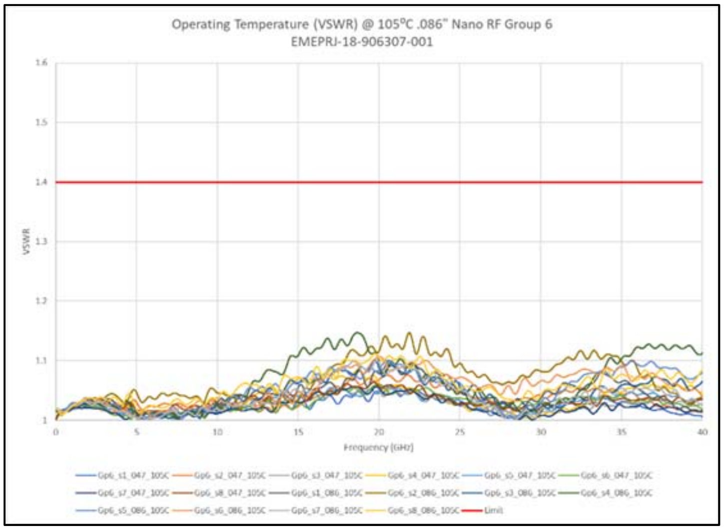

Figure 9 – Operating Temperature, 105°C

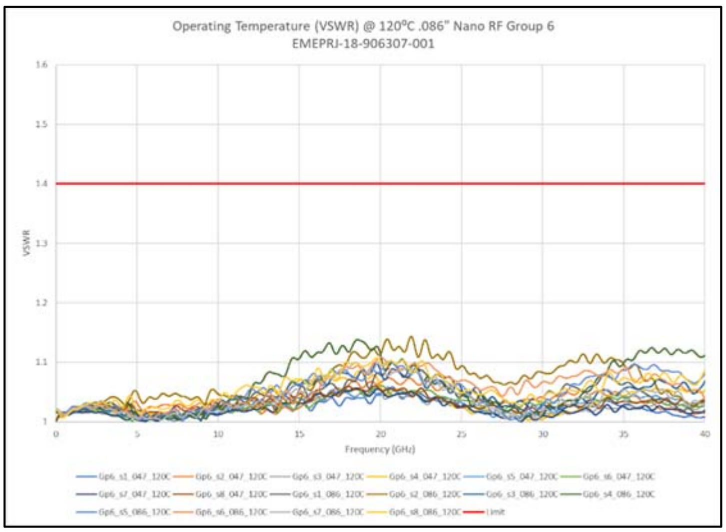

Figure 10 – Operating Temperature, 120°C

2.15 Voltage Standing Wave Ratio – Groups 4 and 7

The voltage standing wave ratio (VSWR) was less than 1.4:1 from 1 to 40Ghz and less than 1.5:1 from 40 to 50 Ghz.

2.15.1 Voltage Standing Wave Ratio – Group 4, EMEPRJ-14-0706-008

See Figure 11 through Figure 12.

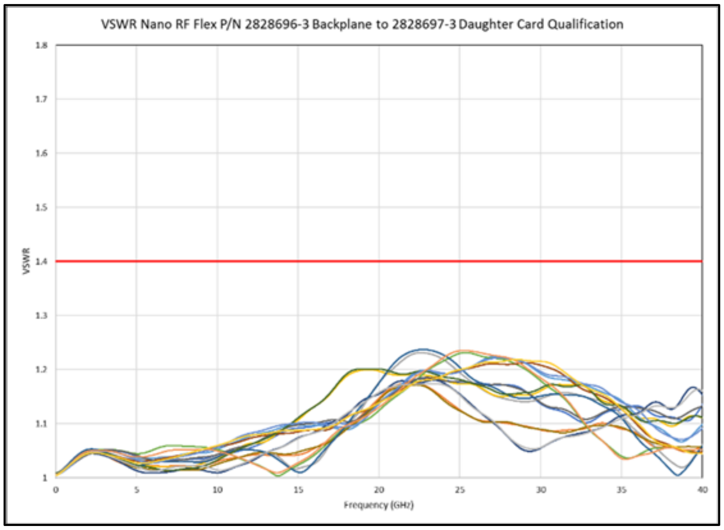

Figure 11 – VSWR, Test Group 4, Flex

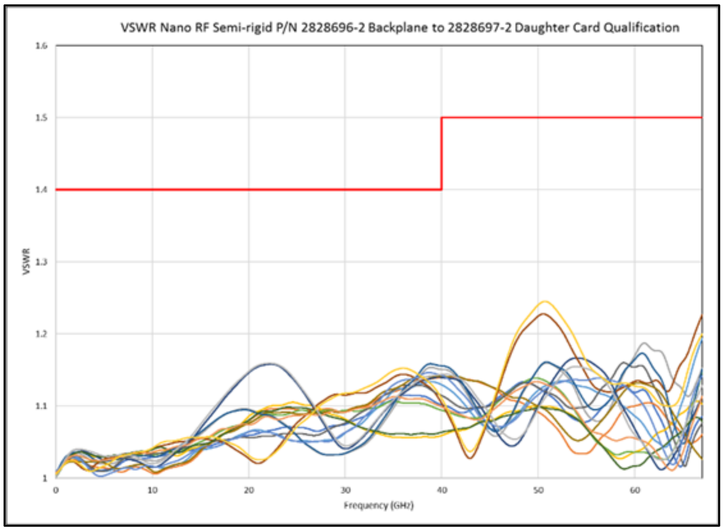

Figure 12 – VSWR Test Group 4, Semi Rigid

2.15.2 Voltage Standing Wave Ratio – Group 7, EA20170647T

See Figure 13 through Figure 15.

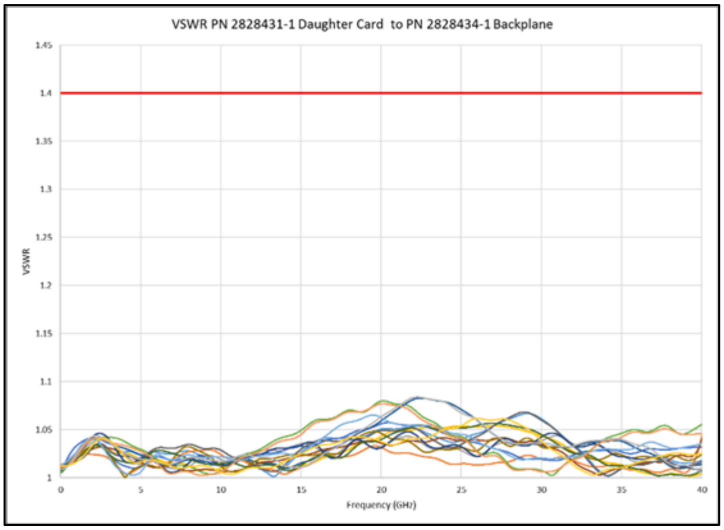

Figure 13 – VSWR, Test Group 7, Flex, Specimen 1

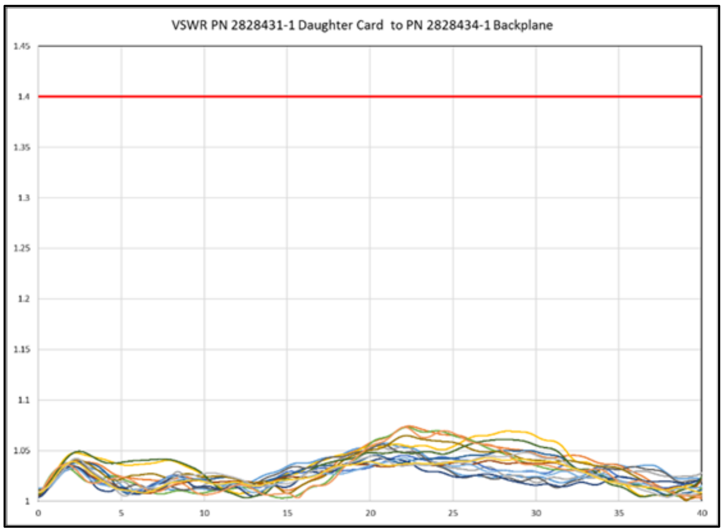

Figure 14 – VSWR, Test Group 7, Flex, Specimen 2

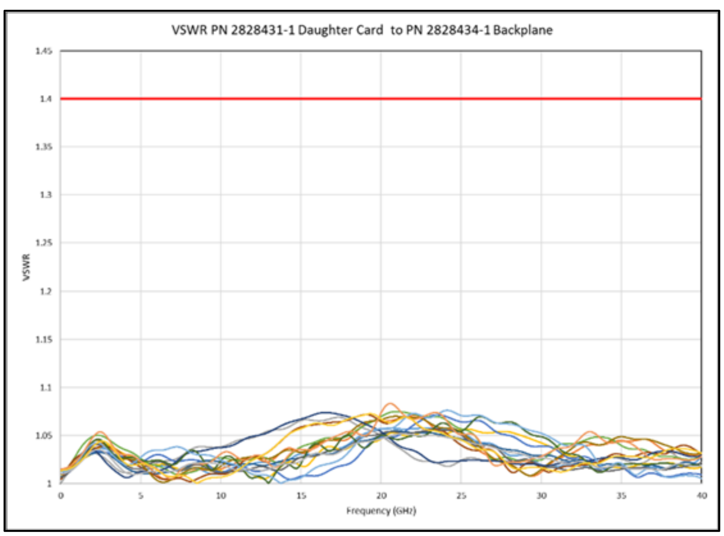

Figure 15 – VSWR, Test Group 7, Flex, Specimen 3

2.15.3 Voltage Standing Wave Ratio – Group 4, EMEPRJ-18-906307-001

See Figure 16 through Figure 17.

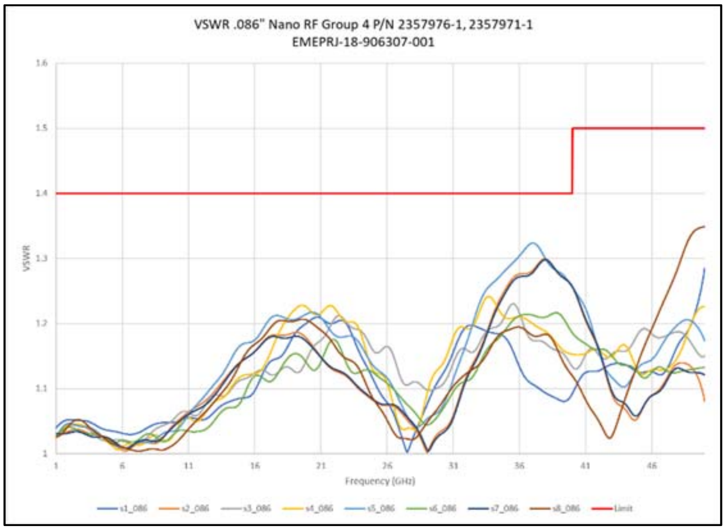

Figure 16 – VSWR, Test Group 4, .086"

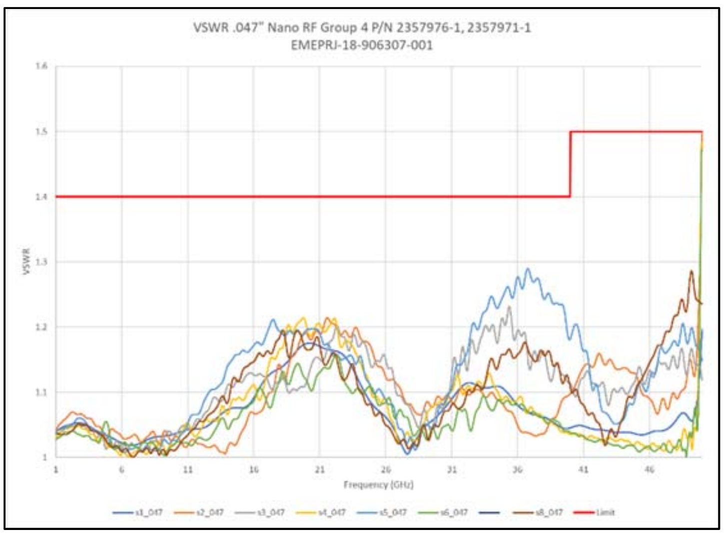

Figure 17 – VSWR, Test Group 4, .047"

2.15.4 Voltage Standing Wave Ration – Group 7, EA21090463T

See Figure 18 through Figure 20.

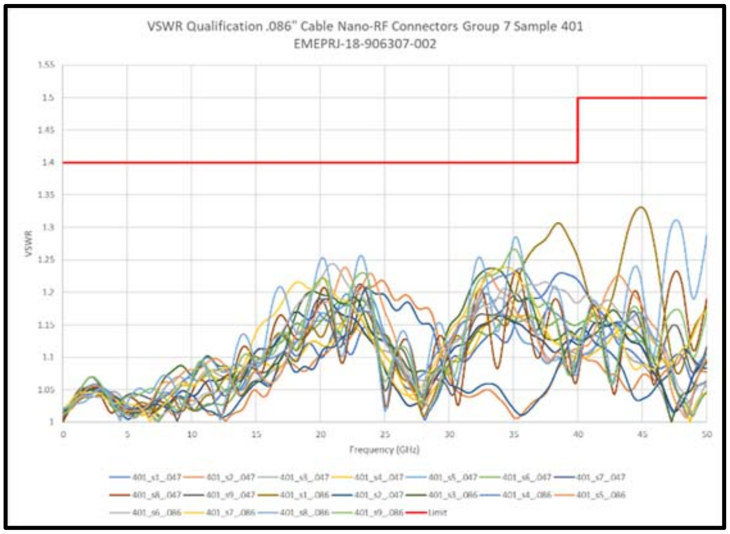

Figure 18 – VSWR, Test Group 7, Specimen 1

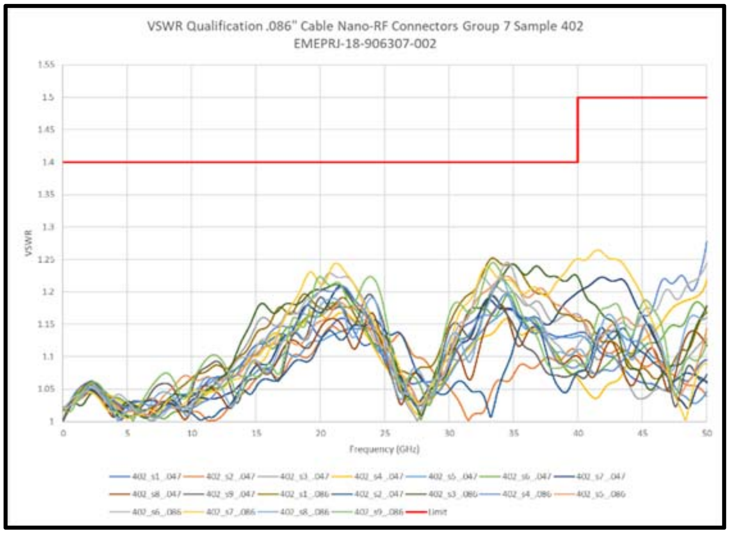

Figure 19 – VSWR, Test Group 7, Specimen 2

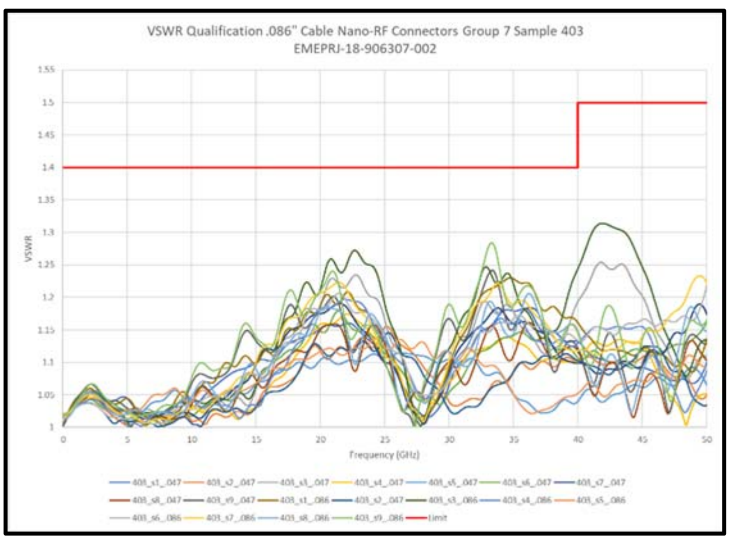

Figure 20 – VSWR, Test Group 7, Specimen 3

2.16 Isolation – Group 4

All isolation results were less than 140 dB from 3MHz to 30MHz, less than 120 dB from 30MHz to 3GHz, less than 100 dB from 3GHz to 27GHz, and less than 90 dB from 27GHz to 40GHz.

2.16.1 Isolation – Group 4, EMEPRJ-14-0706-008

See Figure 21 through Figure 28.

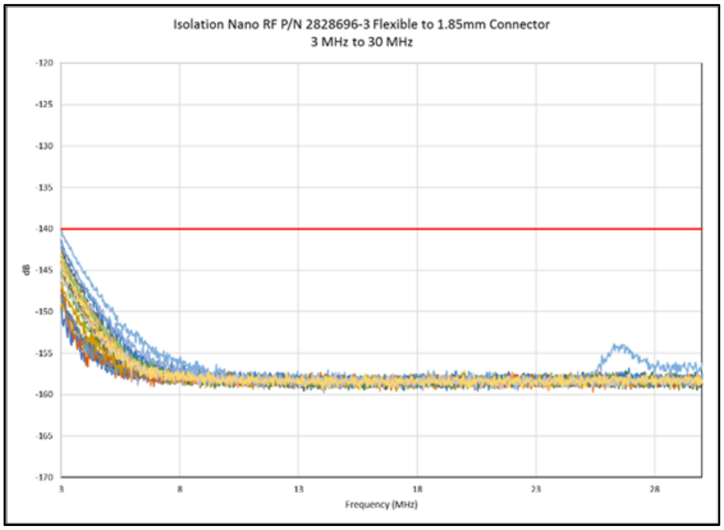

Figure 21 – Isolation, 3MHz to 30Mhz, Flex

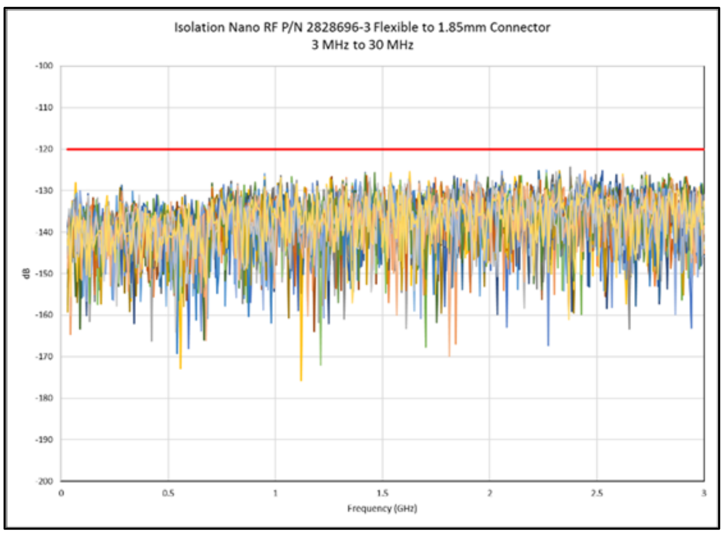

Figure 22 – Isolation, 30MHz to 3Ghz, Flex

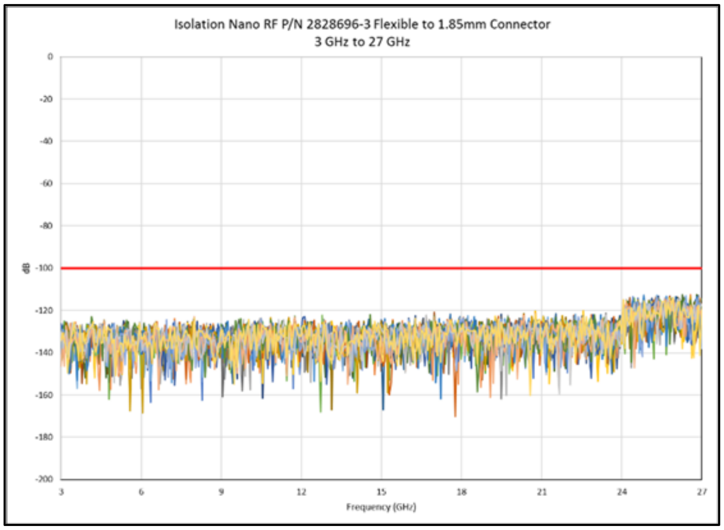

Figure 23 – Isolation, 3GHz to 27GHz, Flex

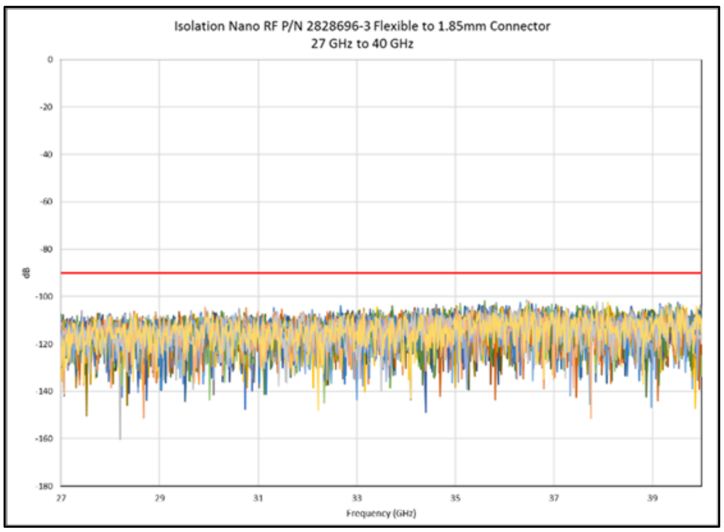

Figure 24 – Isolation, 27GHz to 40Ghz, Flex

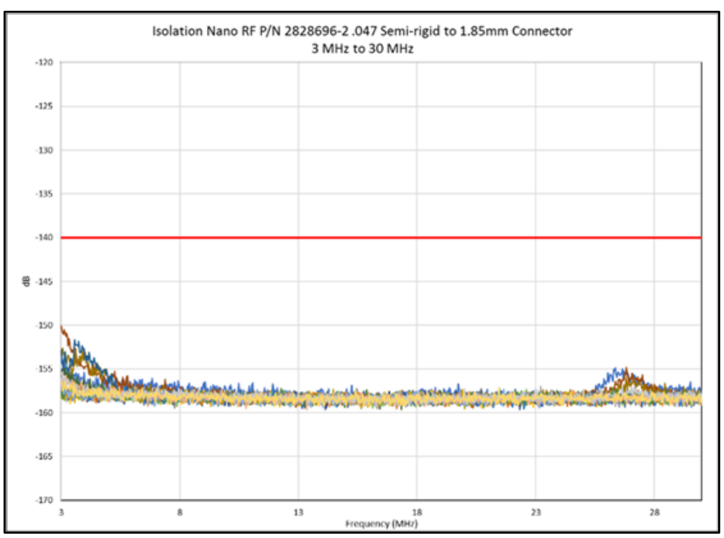

Figure 25 – Isolation, 3MHz to 30Mhz, Semi Rigid

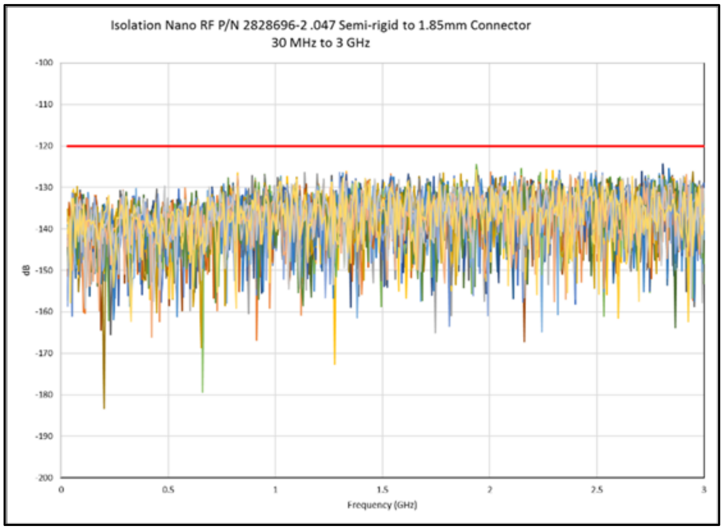

Figure 26 – Isolation, 30MHz to 3GHz, Semi Rigid

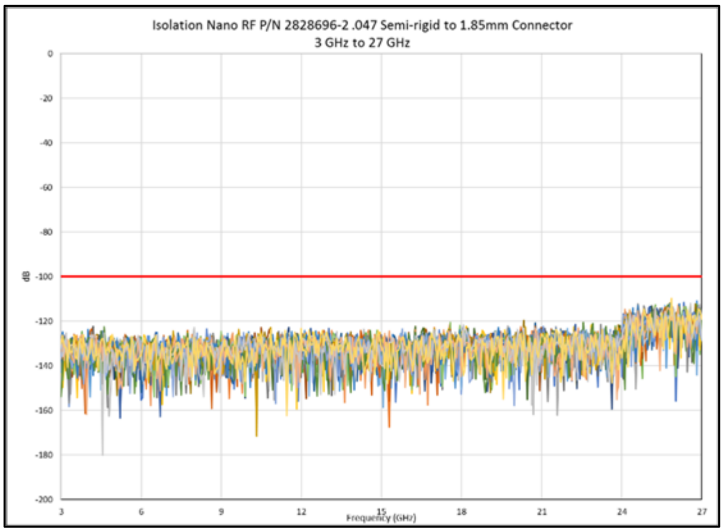

Figure 27 – Isolation, 3GHz to 27Ghz, Semi Rigid

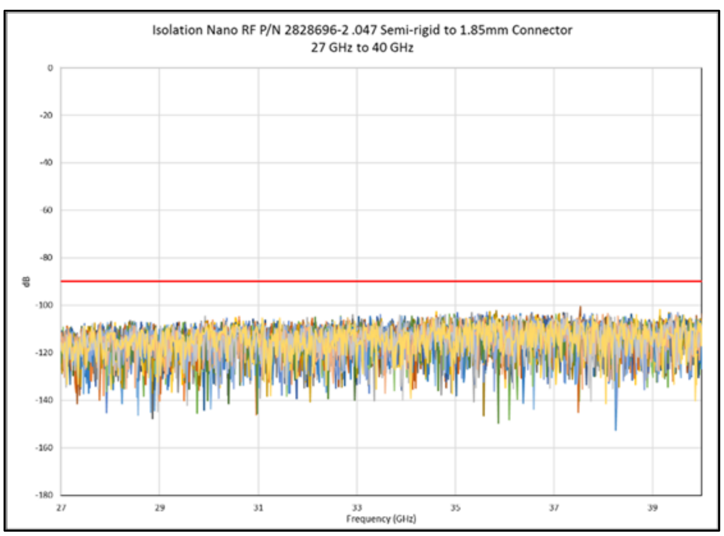

Figure 28 – Isolation, 27GHz to 40Ghz, Semi Rigid

2.16.2 Isolation – Group 4, EMEPRJ-18-906307-001

See Figure 29 through Figure 32.

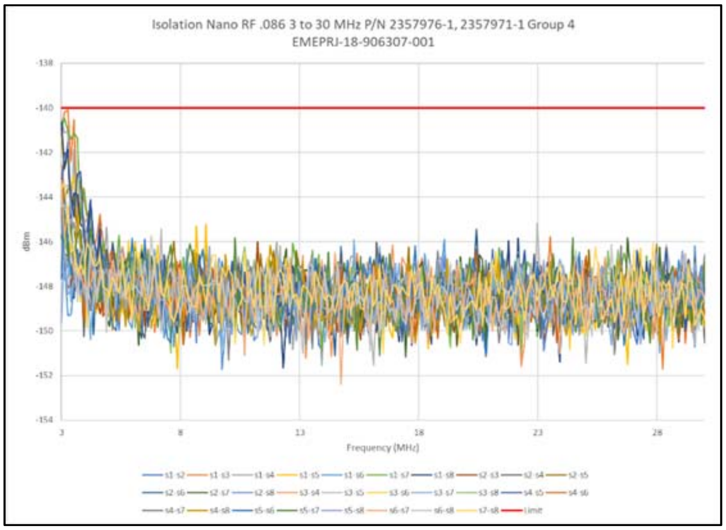

Figure 29 – Isolation, 3MHz to 30Mhz

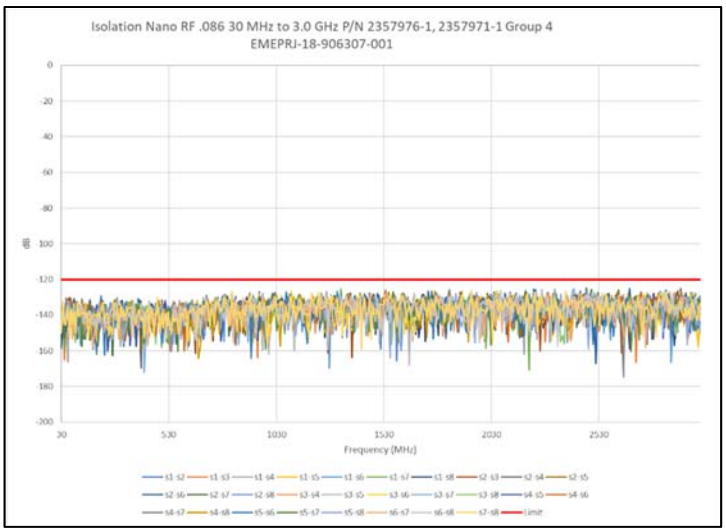

Figure 30 – Isolation, 30MHz to 3Ghz

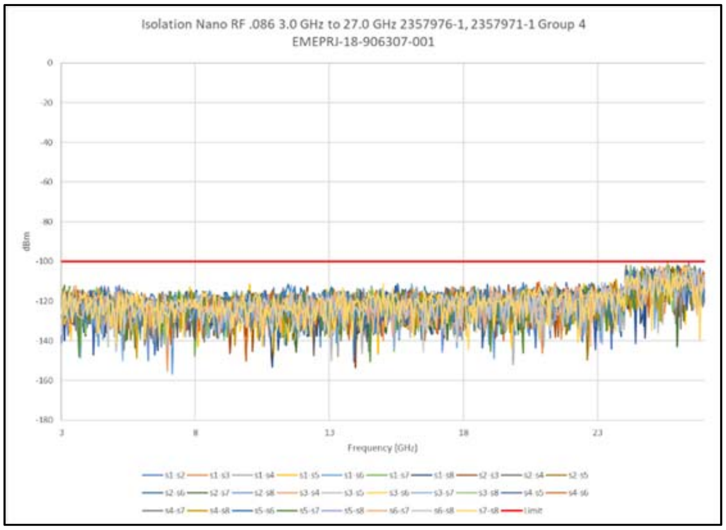

Figure 31 – Isolation, 3GHz to 27GHz

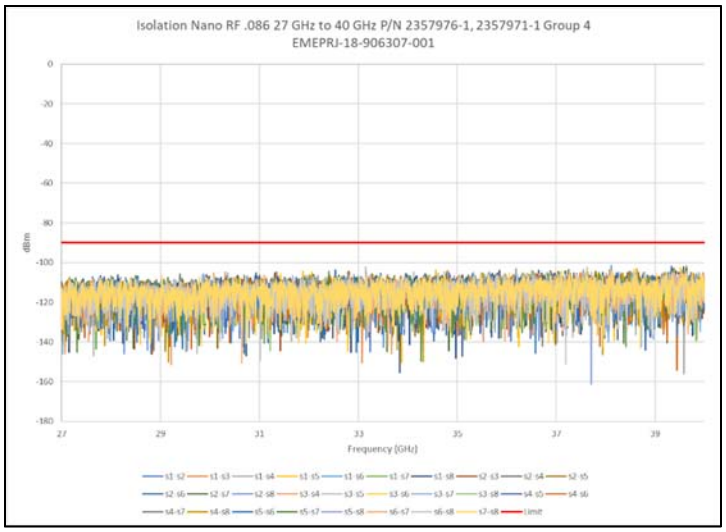

Figure 32 – Isolation, 27GHz to 40Ghz

2.17 Power Handling – Group 5

The VSWR was less than 1.5 from 30MHz to 1Ghz, 30dBm, and less than 1.5 from 1GHz to 40Ghz, 20dBm.

2.17.1 Power Handling – Group 5, EMEPRJ-14-0706-008

See Figure 33 through Figure 34.

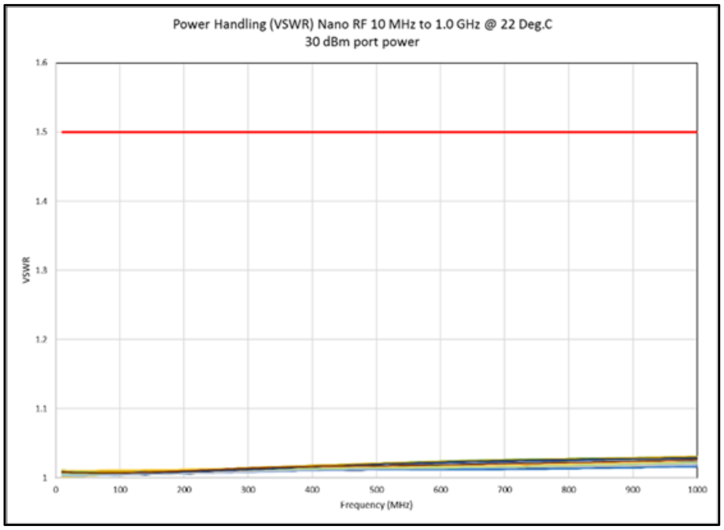

Figure 33 – Power handling, 30MHz to 1Ghz, 30dBm, Flex

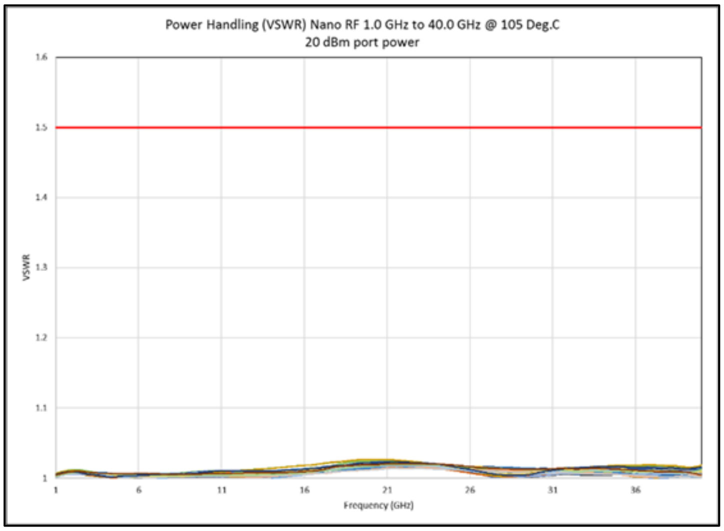

Figure 34 – Power handling, 1GHz to 40Ghz, 20dBm, Flex

2.17.2 Power Handling – Group 5, EMEPRJ-18-906307-001

See Figure 35 through Figure 36.

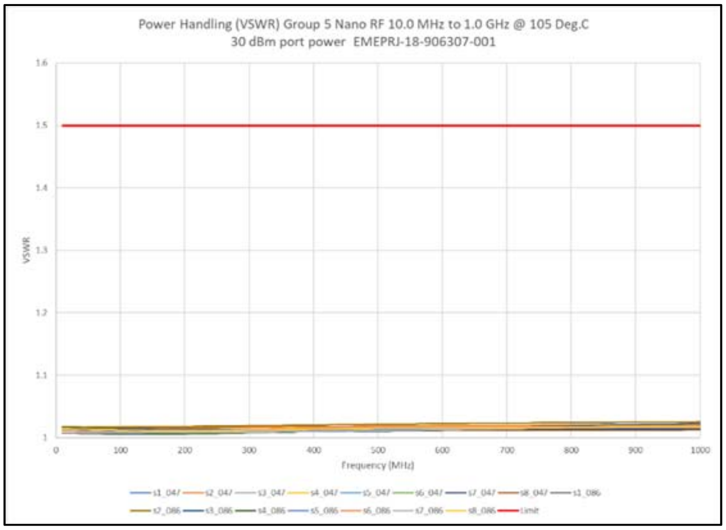

Figure 35 – Power handling, 10MHz to 1Ghz, 30dBm

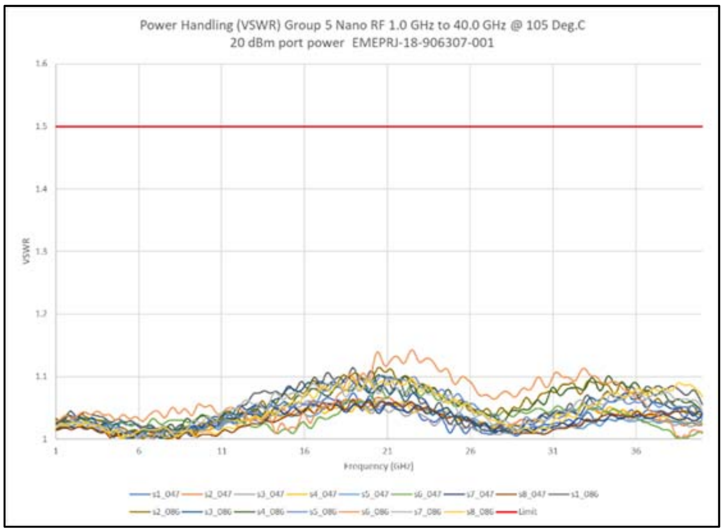

Figure 36 – Power handling, 1GHz to 40Ghz, 20dBm

2.18 Insertion Loss – Group 4

Insertion loss was less than 0.12 √ F.

2.18.1 Insertion Loss – Group 4, EMEPRJ-14-0706-008

See Figure 37 through Figure 38.

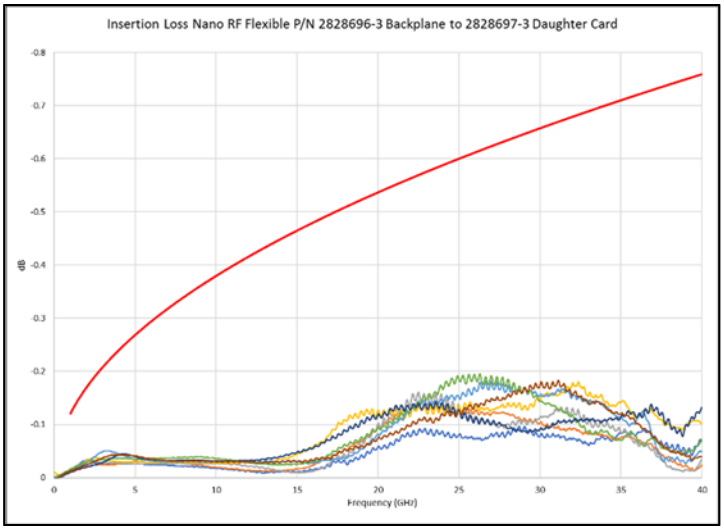

Figure 37 – Insertion Loss, 1GHz to 40Ghz, Flex

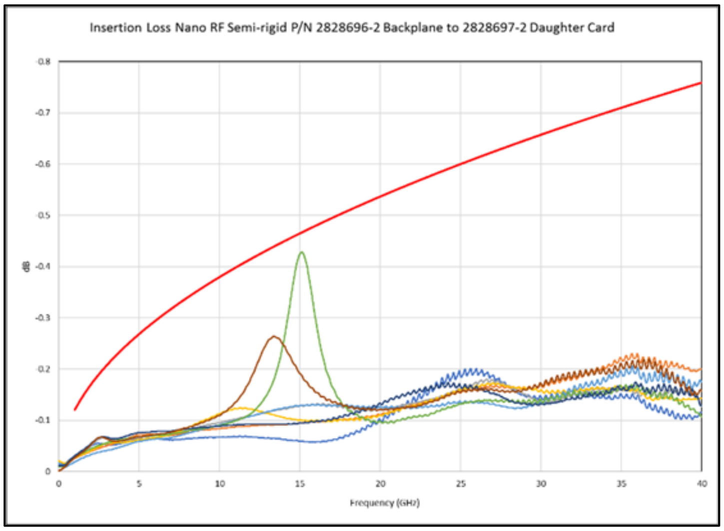

Figure 38 – Insertion Loss, 1GHz to 40Ghz, Semi Rigid

2.18.2 Insertion Loss – Group 4, EMEPRJ-18-906307-001

See Figure 39.

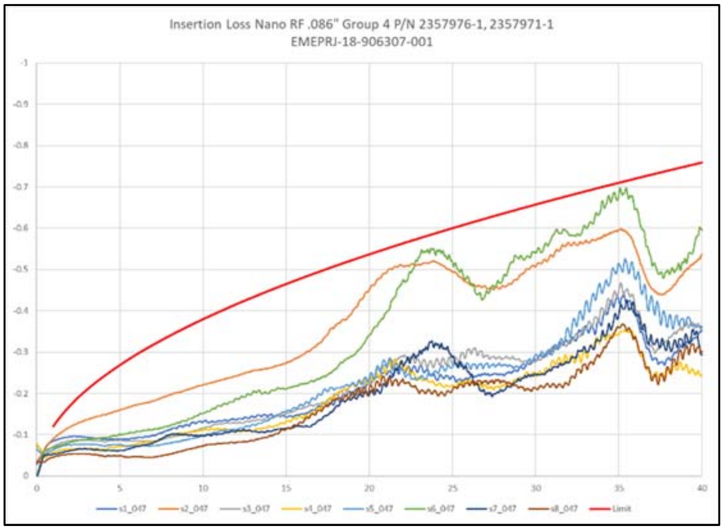

Figure 39 – Insertion Loss, 1GHz to 40Ghz

2.19 Frequency Response – Group 4

Frequency response was less than 1.5 dB from 2.0 GHz to 40GHz.

2.19.1 Frequency Response – Group 4, EMEPRJ-14-0706-008

See Figure 40 through Figure 41.

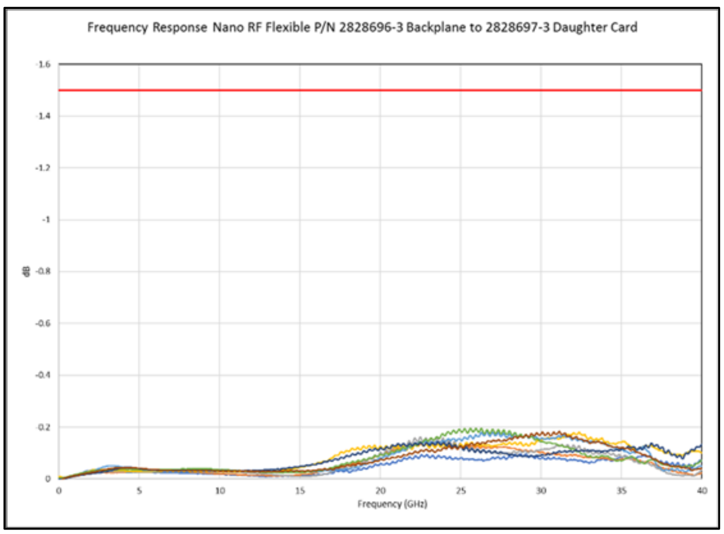

Figure 40 – Frequency Response, 2GHz to 40Ghz, Flex

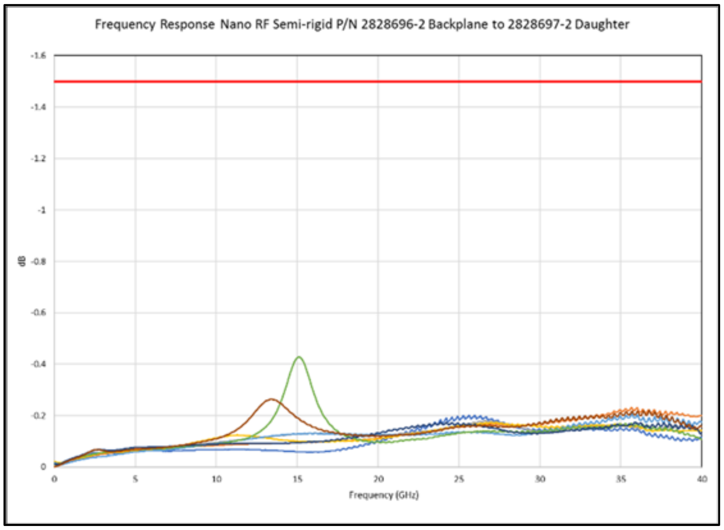

Figure 41 – Frequency Response, 2GHz to 40Ghz, Semi Rigid

2.19.2 Frequency Response – Group 4, EMEPRJ-18-906307-001

See Figure 42.

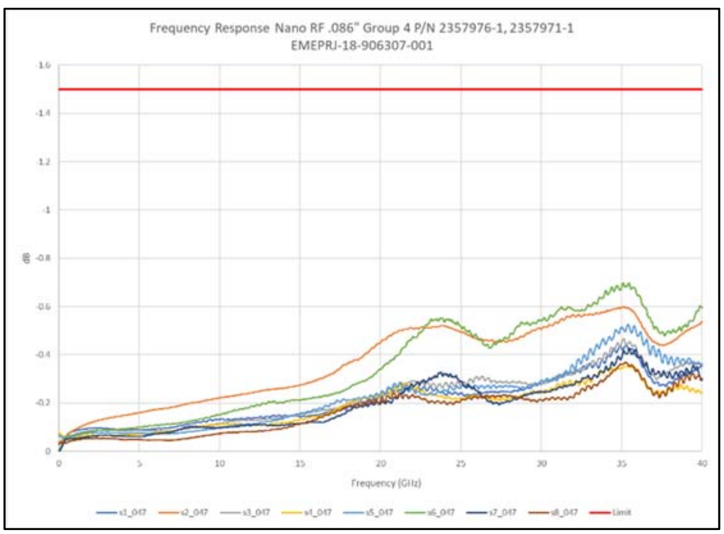

Figure 42 – Frequency Response, 2GHz to 40Ghz

2.20 Final Examination of Product – All Groups

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

3. TEST METHODS

3.1 Initial Examination of Product

Initial examination was conducted in accordance with EIA-364-18B. A Certification of Conformance was issued stating that all specimens in this test package have been produced, inspected, and accepted as conforming to product drawing requirements, and made using the same core manufacturing processes and technologies as production parts.

3.2 Mating Force

Mating force was conducted in accordance with EIA-364-13E. The daughter card was mounted to a right-angle fixture that was attached to the crosshead of the tensile/compression machine. The backplane board was attached to a free floating X-Y-R table at the base of the tensile/compression machine (Figures 43 and 44). The specimens were mated until the distance between the bottom of the daughter card and the top of the backplane board was 0.506 inches (Figure 45). Specimens were mated at a maximum rate of 12.7mm per minute.

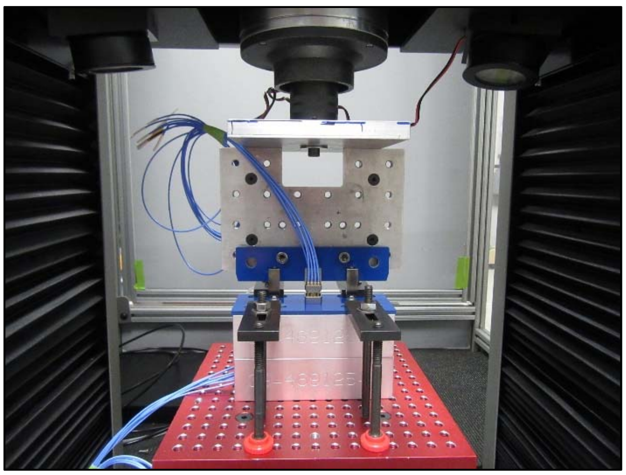

Figure 43 – Mating and Unmating Force

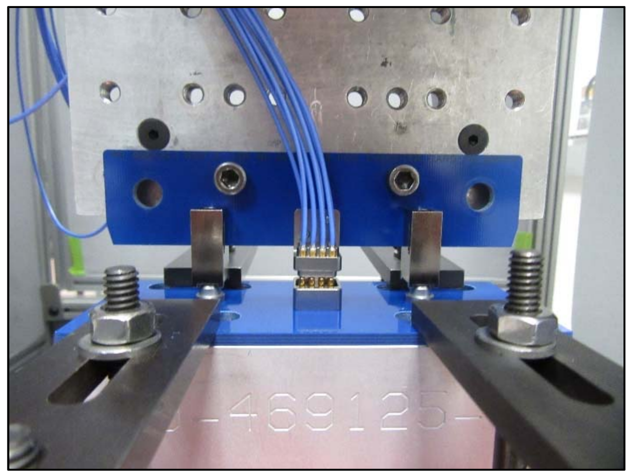

Figure 44 – Mating and Unmating Force

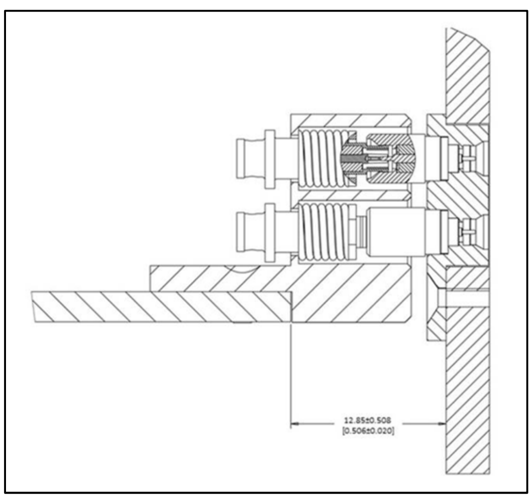

Figure 45 – Mating Distance

3.3 Unmating Force

Unmating force was conducted in accordance with EIA-364-13E. The daughter card was mounted to a right-angle fixture that was attached to the crosshead of the tensile/compression machine. The backplane board was attached to a free floating X-Y-R table at the base of the tensile/compression machine (Figures 43 and 44). The specimens were unmated until the distance between the bottom of the daughter card and the top of the backplane board was 0.506 inches (Figure 45). Specimens were unmated at a maximum rate of 12.7mm per minute.

3.4 Low Level Contact Resistance (LLCR)

3.4.1 Low Level Contact Resistance (LLCR) - EA20170647T, EA20180100T

Low level contact resistance was conducted in accordance with EIA-364-23C. Measurements were made using a four-terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Center contacts were measured by applying current and voltage probes at the wires ends (Figure 46). The wire bulk resistance included in the measurement was calculated and removed. A wire bulk resistance of 324.53 milliohms was removed from each actual measurement. Outer contacts were measured by applying current probes to the wire ends and voltage probes to the wires just behind the contacts (Figure 47).

3.4.2 Low Level Contact Resistance (LLCR) - EA20190463T

Low level contact resistance was conducted in accordance with EIA-364-23C. Measurements were made using a four-terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Center contacts were measured by applying ± current and voltage to the ends of the wires (Figure 46). The wire bulk resistance included in the measurement was calculated and removed. A wire bulk resistance of 210.26 milliohms was removed from measurements on positions A1, A2, B1, B2, C1, C2, D1, D3 and 320.96 milliohms was removed from position D2. Outer contacts were measured by applying ± current to the wire ends and the ± voltage was probed directly behind the contacts (Figure 47). All measurements were taken with the specimens mated to the 0.506” mating depth between the backplane and daughter connector PCB’s. Clamps were used to keep the spring loaded specimens mated while taking measurements.

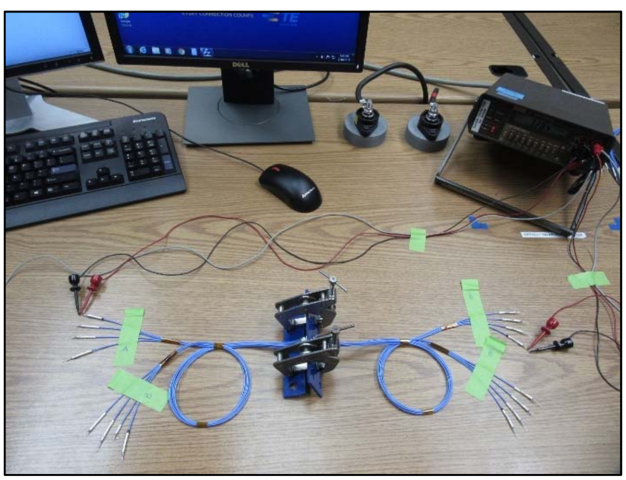

Figure 46 – LLCR, Center Contact

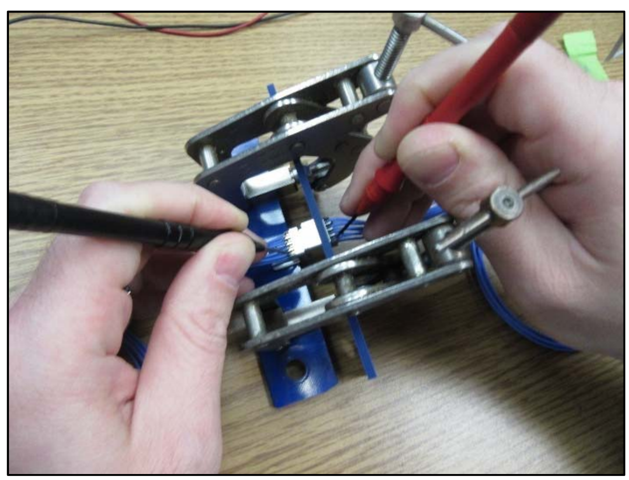

Figure 47 – LLCR Outer Contact

3.5 Insulation Resistance

Insulation resistance was conducted in accordance with EIA-364-21E. A test voltage of 500 VDC was applied between the center conductors and other conductors / shell of mated specimens (Figure 48). The potential was maintained for 120 seconds. All circuits were tested simultaneously.

3.6 Dielectric Withstanding Voltage

Dielectric withstanding voltage was conducted in accordance with EIA-364-20E and EIA-364-20F. A test voltage of 325 VAC (RMS) was applied between the center conductors and other conductors / shell of mated specimens (Figure 48). The potential was maintained for 60 seconds. All circuits were tested simultaneously.

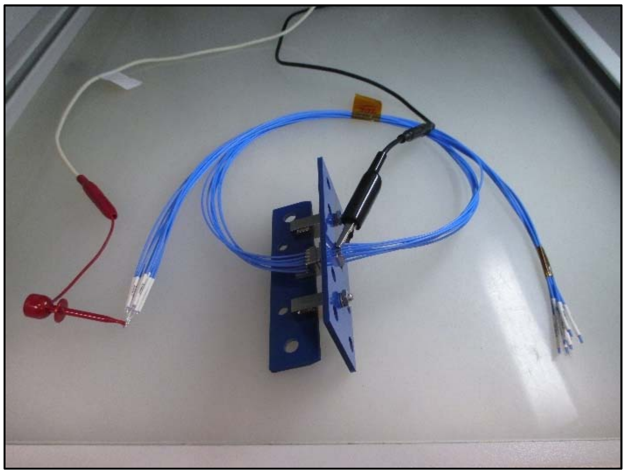

Figure 48 – IR and DWV Test Set Up

3.7 Durability

Durability was conducted in accordance with EIA-364-09D. The daughter card was mounted to a right-angle fixture that was attached to the crosshead of the durability machine. The backplane board was attached to a free floating X-Y-R table at the base of the durability machine (Figures 49 and 50). The specimens were mated until the distance between the bottom of the daughter card and the top of the backplane board was 0.506 inches. Specimens were mated a total of 500 times with LLCR measurements conducted every 100 cycles. Specimens were mated at a maximum rate of 600 cycles per hour.

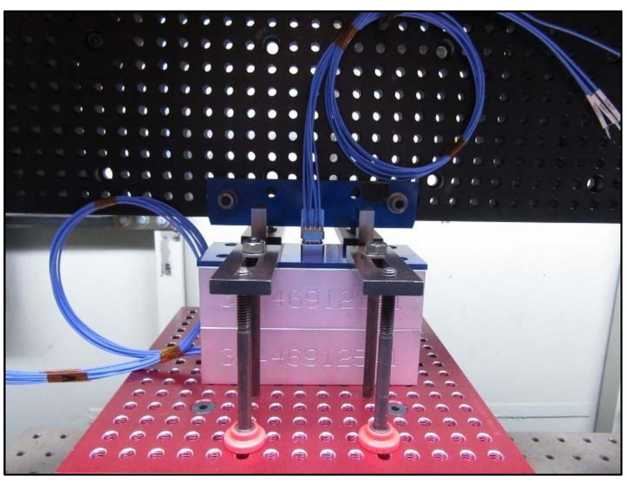

Figure 49 – Durability

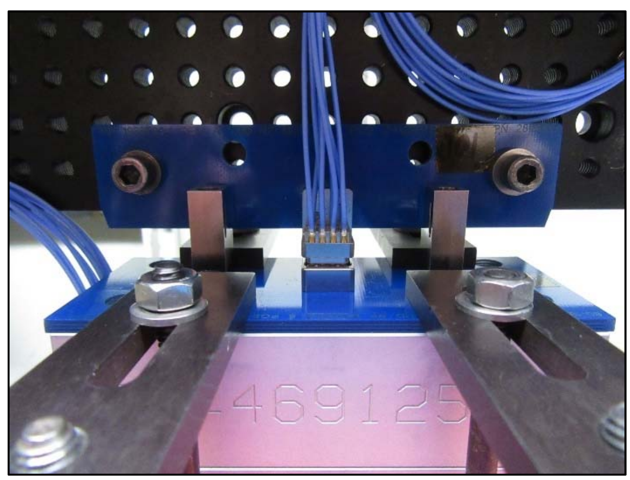

Figure 50 – Durability

3.8 Vibration Test 1

The mated test specimens were subjected to random vibration test as stated TE Product Specification 108-163006, Rev. C. The test specimens were tested at Figure 51 profile levels. The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 5 and 2000 Hertz (Hz). The power spectral density (PSD) at 5 Hz is 0.002 G^2/Hz. The spectrum slopes up to a PSD of 0.04 G^2/Hz at 15 Hz. The spectrum is flat at 0.04 G^2/Hz from 15 Hz to 150 Hz. The spectrum then slopes up to a PSD of 0.1 G^2/Hz at 300 Hz. The spectrum is flat at 0.1 G^2/Hz from 300 Hz to 1000 Hz. The spectrum then slopes down to a PSD of 0.025 G^2/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 11.7 GRMS. The test specimens were subjected to this test for 1 hour in each of the three mutually perpendicular axes (Figure 53 through 55), for a total test time of 3 hours per test specimen. The test specimens in Test Group 3 were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

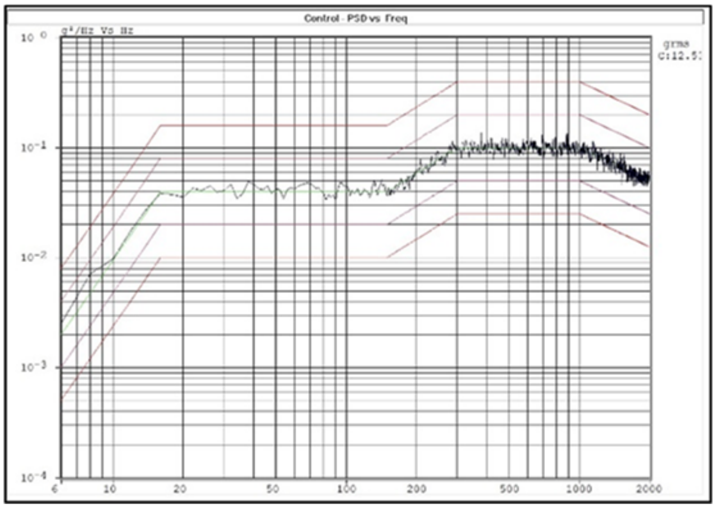

Figure 51 –Vibration Test 1 Profile

3.9 Vibration Test 2

The mated test specimens were subjected to random vibration test as stated TE Product Specification 108-163006, Rev. C. The test specimens were tested at Figure 52 profile levels. The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 5 and 2000 Hertz (Hz). The power spectral density (PSD) at 5 Hz is 0.004 G^2/Hz. The spectrum slopes up to a PSD of 0.08 G^2/Hz at 15 Hz. The spectrum is flat at 0.08 G^2/Hz from 15 Hz to 150 Hz. The spectrum then slopes up to a PSD of 0.2 G^2/Hz at 300 Hz. The spectrum is flat at 0.2 G^2/Hz from 300 Hz to 1000 Hz. The spectrum then slopes down to a PSD of 0.050 G^2/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 16.49 GRMS. The test specimens were subjected to this test for 1 hour in each of the three mutually perpendicular axes (Figure 53 through 55), for a total test time of 3 hours per test specimen.

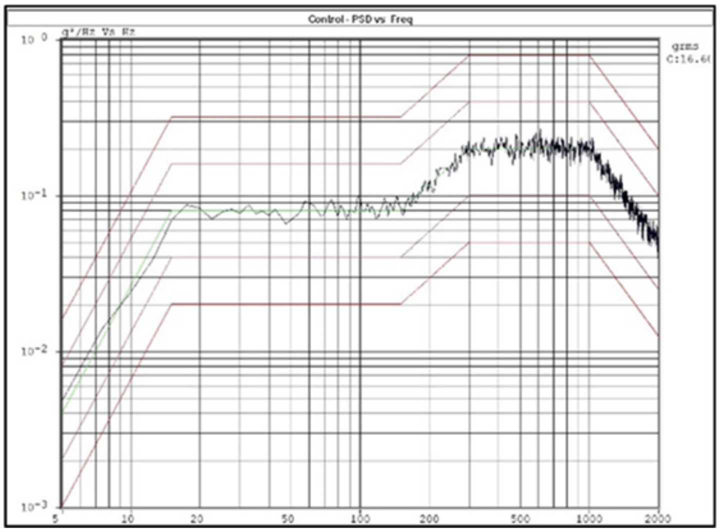

Figure 52 –Vibration Test 2 Profile

3.10 Vibration Test 3

The mated test specimens were subjected to random vibration test as stated TE Product Specification 108-163006, Rev. C. The test specimens were tested at Figure 52 profile levels. The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 5 and 2000 Hertz (Hz). The power spectral density (PSD) at 5 Hz is 0.004 G^2/Hz. The spectrum slopes up to a PSD of 0.08 G^2/Hz at 15 Hz. The spectrum is flat at 0.08 G^2/Hz from 15 Hz to 150 Hz. The spectrum then slopes up to a PSD of 0.2 G^2/Hz at 300 Hz. The spectrum is flat at 0.2 G^2/Hz from 300 Hz to 1000 Hz. The spectrum then slopes down to a PSD of 0.050 G^2/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 16.49 GRMS. The specimen was subjected to this profile for twelve hours in the Z axis only (Figure 55). The test specimens in Test Group 3 were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

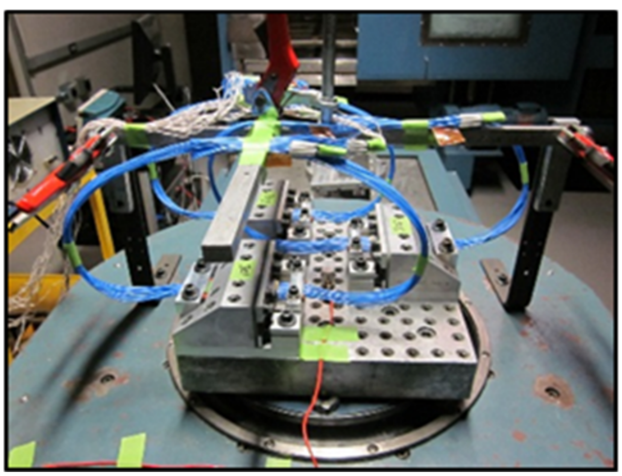

Figure 53 – Vibration Z Axis

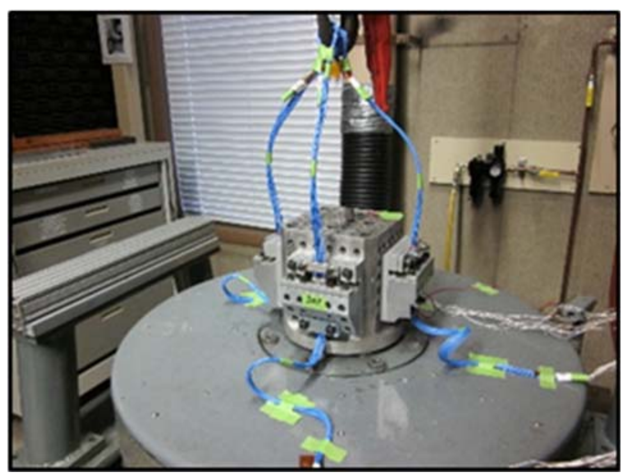

Figure 54 – Vibration Y Axis

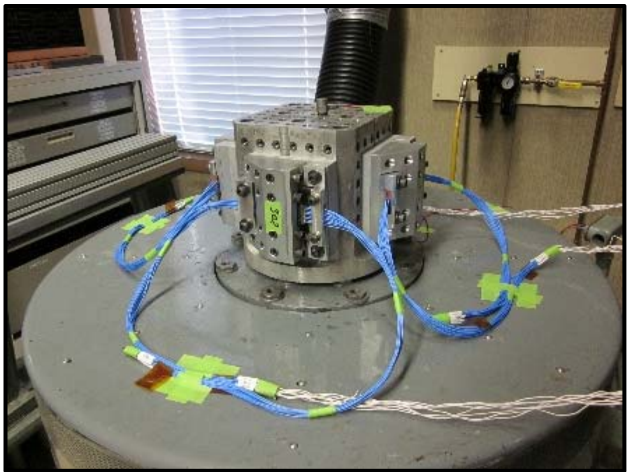

Figure 55 – Vibration X Axis

3.11 Mechanical Shock, Class OS2

Mechanical shock test was conducted in accordance with MIL-STD-810H, 31 January 2019, Method 516.8, Procedure I. See Figure 56 for shock profile. The parameters of this test condition are a saw-tooth waveform with an acceleration amplitude of 40 gravity units (g's peak) and a duration of 11 milliseconds. Three shocks in each direction were applied along the three mutually perpendicular axes of the test specimens (Figure 57 through 59), for a total of eighteen shocks. The test specimens in Test Group 3 were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

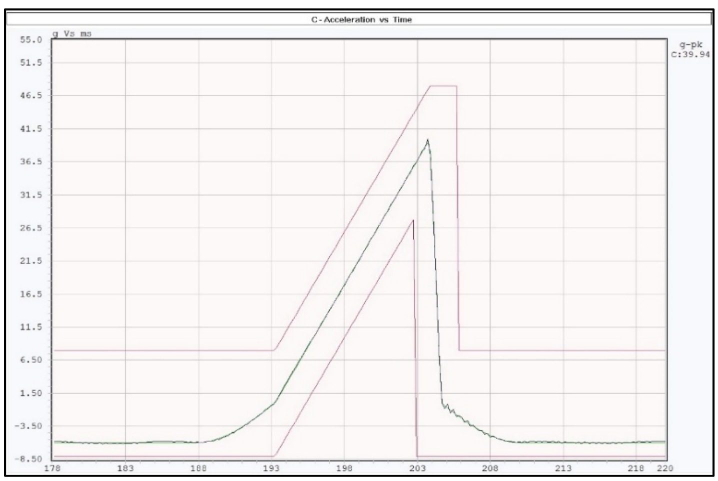

Figure 56 – Shock Profile

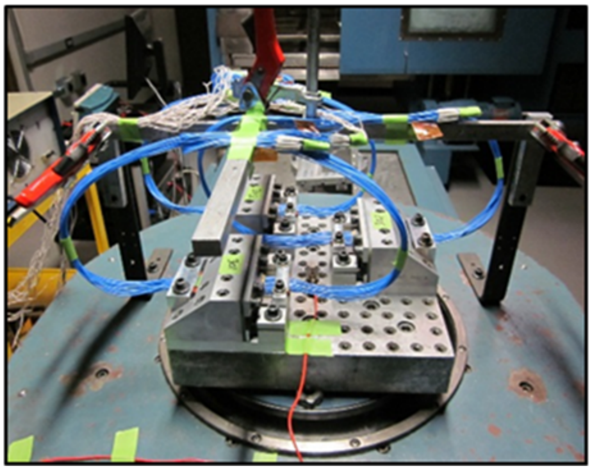

Figure 57 – Shock Z Axis

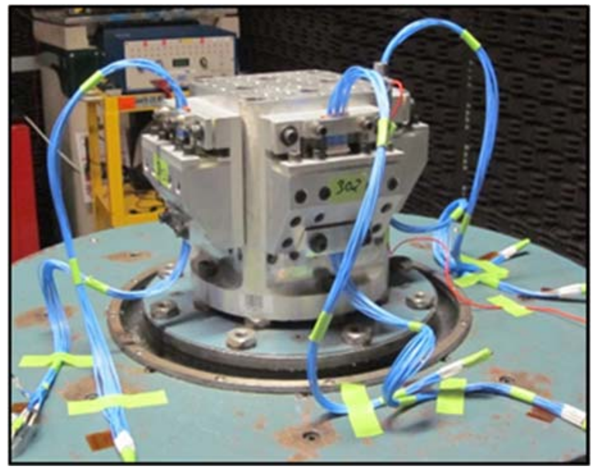

Figure 58 – Shock Y Axis

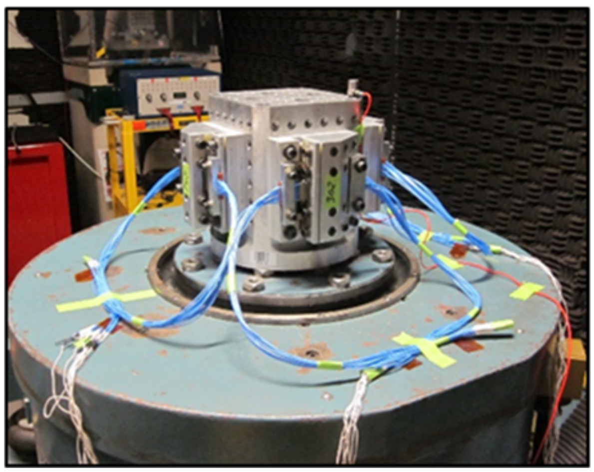

Figure 59 – Shock X Axis

3.12 Humidity / Temperature Cycling

Humidity / temperature cycling was conducted in accordance with MIL-STD-810H, 31 January 2019. Mated specimens were exposed to Method 507.6, Procedure II, 10 cycles of humidity-temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 30°C and 60°C while maintaining high humidity (Figure 60). Operational checks were not conducted.

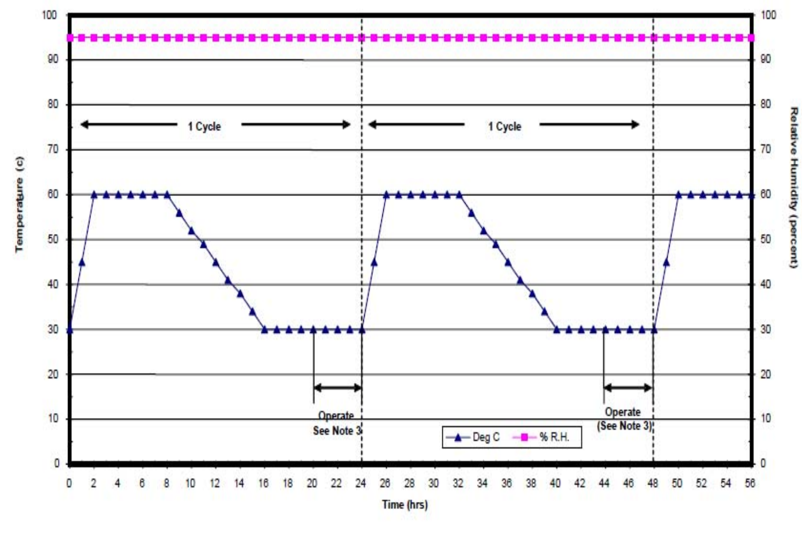

Figure 507.6-7. Aggravated temperature-humidity cycle.

Figure 60 – Typical Humidity-Temperature Cycling Profile

3.13 Thermal Shock (non-operating)

Thermal shock was conducted in accordance with EIA-364-32G. Mated specimens were subjected to 5 cycles between -55°C and 125°C with 30 minute dwells at each extreme. The transition time between each temperature extreme was less than 1 minute.

3.14 Operating Temperature

Operating Temperature was conducted in accordance with EIA-364-108, dated January 15, 2013. VSWR testing was performed using the Agilent E8361A PNA. The HP 2.4mm adapter was connected to port I of the network analyzer. A1 port calibration was performed using the HP 85056A 2.4mm calibration kit. The network analyzer was set to collect 4000 data points across a frequency range of 0.01 to 40.01 GHz using a bandwidth of 1kHz in step mode. After calibration, the 2.4mm to 2.9mm adapter was added to port I of the network analyzer. The other 2.4mm to 2.9mm adapter and 50Ω load was used at the far end of the cable. The driven end of the cable was connected to port I of the network analyzer during testing. VSWR measurements were taken driven from both ends of the cable marked by the part numbers. VSWR measurements were taken at -55°C, -40'C, 22°C, 105'C and 120°C. Gating was used in the measurement procedure using the following parameters: Start: 7.44ns Stop: 10.00ns

3.15 Voltage Standing Wave Ratio (VSWR)

3.15.1 Voltage Standing Wave Ratio (VSWR) – EMEPRJ-14-0706-008

VSWR was conducted in accordance with EIA-364-108, dated January 15, 2013.

Test Group 4
VSWR testing was performed using the Agilent E8361A PNA. The Agilent 1.85mm Test Port Cable was connected to port 1 of the network analyzer. A 1 port calibration was performed using the Agilent 1.85mm ECAL Module calibration kit. The network analyzer was set to collect 6001 data points across a frequency range of 10.0 MHz to 67.01 GHz using a bandwidth of 1 kHz in step mode. A 50Ω load was used at the far end of the cable. The driven end of the cable was connected to port 1 of the network analyzer during testing. VSWR measurements were taken driven from both ends of the cable marked BP or DC. Gating was used in the measurement procedure using the following parameters: Start: 2.40ns Stop: 3 .36ns

Test Group 7
VSWR testing was performed using the Agilent E8361A PNA. The Agilent 2.4mm adapter was connected to port I of the network analyzer. A1 port calibration was performed using the Agilent 2.4mm calibration kit. The network analyzer was set to collect 4001 data points across a frequency range of 10.0 MHz to 40.01 GHz using a bandwidth of I kHz in step mode. A 50Ω load was used at the far end of the cable. The driven end of the cable was connected to port I of the network analyzer during testing. VSWR measurements were taken driven from both ends of the cable marked BP or DC. Gating was used in the measurement procedure using the following parameters: Start: 8.06ns Stop: 9 .20ns

3.15.2 Voltage Standing Wave Ratio (VSWR) – EMEPRJ-18-906307-001

VSWR was conducted in accordance with EIA-364-108A, dated August 2019.

Test Group 7
VSWR testing was performed using the Agilent E8364A PNA. The 2.4mm to 2.4mm adapter was connected to port 1 of the network analyzer. A 1 port calibration was performed using the Agilent 85056D, 2.4mm calibration kit. The network analyzer was set to collect 5001 data points across a frequency range of 10.0 MHz to 50.01 GHz using a bandwidth of 1 kHz in step mode. A 500Ω load was used at the far end of the cable. The driven end of the cable was connected to port 1 of the network analyzer during testing. VSWR measurements were taken driven from both ends of the cable marked 086 or 047. Gating was used in the measurement procedure using the following parameters: Start - 2.40ns, Stop - 3.60ns.

3.16 Isolation

Isolation was conducted in accordance with EIA-364-90, dated January 28, 2013.

PNA PROCEDURE
Isolation testing was performed using the Agilent E8361A PNA. The Agilent 1.85mm test port cables were connected to port I and port 2 of the PNA. The network analyzer was set to collect 160 I data points across a frequency range of27.0 GHz to 40.0GHz. For the 3.0 GHz to 27.0 GHz range and for 30.0 MHz to 3.0 GHZ we used 401 data points and a bandwidth of300 Hz linear frequency. A dwell time of I 0 microseconds was used with a standard sweep sequence. A full 2 port calibration was performed using the 1.85 ECAL module. After calibration, the 1.85mm bullet adapter was connected to port 2 test port cable of the PNA. The cable from the far end was connected to port 2 of the PNA. The noise floor level was below 100dB for the 3.0 to 27.0 GHz frequency range. The noise floor level was below 120 dB for the 30 MHz to 3.0 GHz frequency range. The noise floor level was below 90dB for the 27 GHz to 40.0 GHz frequency range.

SPECTRUM ANALYZER PROCEDURE
Isolation testing was performed using the Agilent N9030A PXA Signal Analyzer and the Agilent E8257D PSG Analog Signal Generator. The 2.4mm bullet adapters were connected to the RF input of the signal analyzer and the RF input of the signal generator. The Signal analyzer was set to collect 801 points across a frequency range of 3.0 MHz to 30.0 MHz using a bandwidth of 100Hz. The attenuator was set at 0dB with the signal generator power at 10.0dBm, using a single sweep with an averaging of 3. The internal pre-AMP was on low range with the source mode and RF output on using a sweep time of 192.0 seconds. The driven end of the cable from the sample was connected to the test port cable on the RF output of the signal generator. The far end (measured end) of the cable from the sample was connected to the RF input of the spectrum analyzer. Power was turned on.

3.17 Power Handling

Power handling was conducted in accordance with EIA-364-108, dated January 15, 2013.

0.01 to 1.0 GHz FREQUENCY PROCEDURE - 30dBm
VSWR testing was performed using the Agilent E8361 C PNA 2 port for frequency range 0.01 to 1.0 GHz. The Agilent. A I port source and receiver power calibration was performed using the Agilent 850330 3.5mm calibration kit with the power set as low as possible without being unleveled. The 2 port PNA was set to collect 101 data points using a bandwidth of 1 kHz with step sweep. A dwell time of 7.276mS was used with a standard sweep sequence. The port power was set at 30dBm in the auto state (on) with a start power of 25dBm and a stop power of 35dBm. The source attenuation was set at 0dB with the leveling mode set on internal. The offset state was off with a limit of 100dBm. The source power start was set at -0.74dBm with the power off set at 29.26dBm. The port power was set at 30dBm with the source cal on. The receiver leveling was set for port I and receiver R1 with a 0.1dB tolerance. The HP 437B power meter was set for address 13 with a tolerance of 0.05dBm with the max number of 3 readings. The power loss compensation was set at 100 KHz at 10dB and 18.0 GHz at 10dB. The power was turned on. A broadband gate with the gate shape set at normal was used in the measurement procedure with the following parameters: Start: 7.44ns Stop:10ns

1.0 to 40.0 GHz FREQUENCY PROCEDURE - 20dBm
VSWR testing was performed using the Agilent E8361 C PNA 2 port for frequency ranges 1.0 to 40.0 GHz. A I port source power calibration was performed using the Agilent 85056K 2.9mm calibration kit with the broadband load with interpolation on (85056A calibration standards were used). The 8487 A power sensor without "N" series adapter, was used during calibration. I 0 dB was entered in the power meter as an offset to account for the I 0 dB attenuator protecting the power sensor. The 2 port PNA was set to collect 1601 data points using a bandwidth of I kHz with the port power set at 20dBm. The power attenuation at port I were set to start at 25dBm and stop at 33 .38dBm with the auto range not checked. The source attenuator was set at 0 with the leveling mode on R1 on. The off-set limits of port 1 were off with a limit of 100dBm. The power source was set at -6.62dBm with the power offset at 13.38dBm. The port power was set at 20dBm with the source cal on. The receiver leveling was set up for R1 with a 0.5dB tolerance A broadband gate with the gate shape set at normal was used in the measurement procedure with the following parameters: Start: 7.44ns Stop:10ns.

VSWR measurements were taken driven: from both ends of the cable marked per the corresponding part number at ambient and the maximum operating temperature of 105° C for each frequency band and power. The fixtures, with samples, were placed in the oven with the cable ends thru the side oven outlet. The samples were held at 105" C for 1 hour to soak before performing VSWR.

3.18 Insertion Loss

Insertion loss was conducted in accordance with EIA-364-101, dated January 15, 2013. Insertion Loss testing was performed using the Agilent E8361A PNA. The HP 2.4mm adapter was connected to port 1 of the network analyzer. The 2.4mm test port cables were connected in series to port 2 of the network analyzer. A full 2 port calibration was performed using the Agilent 1.85mm ECAL module. The network analyzer was set to collect 4001 data points across a frequency range of 0.01 to 40.0 GHz using a bandwidth of 1 kHz in step mode with 1.94% smoothing. After calibration, the 1.85mm adapter was added to the set up from port 1 of the network analyzer and are included in the recorded insertion loss measurement. Insertion Loss measurements were recorded for 3 EWL samples. The average of the 3 EWL samples was measured and the dB/in. was calculated (EWL avg measured/EWL length (inches)) * (sample length minus device under test) minus the measured insertion loss of test sample. This is the recorded Insertion Loss measurement. The cable assemblies were connected to the 1.85mm adapter from port 1 and the test port cable on port 2 of the network analyzer during testing. Forward (S_{21}) insertion loss measurements were taken and recorded driven from the Backplane end of the test sample.

3.19 Frequency Response

Frequency Response was plotted from Insertion Loss calculation. See 3.18.

3.20 Final Examination of Product

Specimens were visually examined cracks, breaks, loose parts, or any damage that may detrimental to the product performance.