Modular, Nano RF 75 Ohm Connector System

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity* Modular, Nano RF 75 Ohm Connector System to determine its conformance to the requirements of Product Specification 108-163037, Rev. B.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the TE Connectivity Modular, Nano RF 75 Ohm Connector System. Testing was performed at the Harrisburg Electrical Components Test Laboratory and the Harrisburg Signal Integrity EME Laboratory between 05/16/2023 and 08/02/2023. Detailed results are filed under EA20230040T and EMEPRJ-21-905545-002.

1.3 Conclusion

The Modular, Nano RF 75 Ohm Connector System specimens listed in paragraph 1.5 conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-163037, Rev. B.

1.4 Product Description

The TE Connectivity (TE) Modular, Dual Density, Blind Mate, RF Connector System combines a high performance, broad bandwidth multi-position, RF, coaxial interconnect in customer configurable platforms such as specified in the VITA 67.0, 67.1, 67.2 and 67.3 documents.

1.5 Test Specimens

The test specimens were representative of normal production lots, and the following part numbers were used for test:

Table 1 – Test Specimens

Test Group	Quantity	Part Number	Description
1	3	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	3	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	18	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 12"
	18	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 12"
2	3	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	3	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	18	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 12"
	18	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 12"
3	3	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	3	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	18	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 24"
	18	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 24"

* Trademark

1.5 Test Specimens, *continued*

Table 1 – Test Specimens *(continued)*

Test Group	Quantity	Part Number	Description
4	2	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	2	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	10	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 12"
	10	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 12"
5	2	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	2	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	10	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 36"
	10	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 36"
6	2	2402888-1 Rev 3	Nano RF Module Daughtercard, F/O, Cabled Version
	2	2402889-1 Rev 2	Nano RF Module Backplane, F/O, Cabled Version
	10	2430882-1 Rev 3	Cable Assembly, NanoRF-75, Test, Backplane 36"
	10	2430883-1 Rev 3	Cable Assembly, NanoRF-75, Test, Daughtercard 36"

NOTES

- *Specimens in Test Sets 1, 2, 4, 5, and 6 were mounted to fixtures supplied by the requester.*
- *Specimens in Test Set 3 were mounted to test boards 60-1976925 & 60-1976926.*

1.6 Qualification Test Sequence

Table 2 – Qualification Test Sequence

Test or Examination	Test Groups					
	1	2	3	4	5	6
	Test Sequence *(a)*					
Initial Examination of Product	1	1	1	1	1	1
Mating Force	2					
Unmating Force	14					
Low Level Contact Resistance	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			
Vibration Test 2			3			
Vibration Test 3			4*(b)*			
Mechanical Shock, Class OS2			5			
Thermal Shock (Non-Operating)		4				
Humidity / Temperature Cycling		5				
Operating Temperature						2
Voltage Standing Wave Ratio (VSWR)			6	2		
Isolation				5		
Power Handling					2	
Insertion Loss				3		
Frequency Response				4		
Final Examination of Product	15	8	7	6	3	3

NOTES

(a) The numbers indicate sequence in which tests were performed.
(b) The Z-Axis is defined as the axis perpendicular to the contact mating axis in the vertical direction.

1.7 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. Certificates of Conformance were issued by Product Assurance and Electronic Assemblies Mfg.

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 – Group 1

Specimens met the 2.0 milliohm maximum initial requirement for the outer contact measurements and met the 11.0 milliohm maximum initial requirement for the inner contact measurements. Center and outer contacts met the 8 milliohm maximum Delta R requirement after testing. See Table 3 and Table 4 for summary data.

Table 3 – Center Contact LLCR Summary Data (mΩ)

Statistic	Initial Resistance	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
	Actual R	Delta R				
Minimum	5.961	-1.573	-1.416	-1.992	-1.869	-1.909
Maximum	8.593	1.134	0.908	1.087	1.757	0.972
Average	7.410	-0.299	-0.147	0.237	-0.274	-0.376
Count	18	18	18	18	18	18
Requirement	**≤ 11**	**≤ 8**				

Table 4 – Outer Contact LLCR Summary Data (mΩ)

Statistic	Initial Resistance	100 Durability Cycles	200 Durability Cycles	300 Durability Cycles	400 Durability Cycles	500 Durability Cycles
	Actual R	Delta R				
Minimum	0.842	-0.387	-0.128	-0.016	-0.581	-1.028
Maximum	1.266	0.333	0.329	0.372	0.382	0.352
Average	1.076	0.046	0.090	0.094	0.058	-0.083
Count	18	18	18	18	18	18
Requirement	**≤ 2**	**≤ 8**				

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, and 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 – Group 3

No discontinuities of 1 microsecond or greater were detected during vibration. Following vibration, specimens showed no evidence of physical damage or loosening of parts.

2.9 Vibration Test 2 – Group 3

No discontinuities of 1 microsecond or greater were detected during vibration. Following vibration, specimens showed no evidence of physical damage or loosening of parts.

2.10 Vibration Test 3 – Group 3

No discontinuities of 1 microsecond or greater were detected during vibration. Following vibration, specimens showed no evidence of physical damage or loosening of parts.

2.11 Mechanical Shock – Group 3

No discontinuities of 1 microsecond or greater were detected during mechanical shock testing. Following mechanical shock, specimens showed no evidence of physical damage or loosening of parts. After vibration and shock, outer conductors showed no signs of damage.

2.12 Thermal Shock – Group 2

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

2.13 Humidity / Temperature Cycling – Group 2

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

2.14 Operating Temperature – Group 6

Specimens met the operating temperature requirement of 1.4 maximum VSWR at the specified temperatures from -55°C to 120°C.

2.15 Voltage Standing Wave Ratio (VSWR) – Groups 3 & 4

Specimens met the voltage standing wave ratio test requirement of 1.10:1 max to 18 GHz.

2.16 Isolation – Group 4

Specimens met the isolation test requirements of:

≥ 100 dB from 3 to 18 GHz

≥ 120 dB from 30 MHz to 3 GHz

≥ 140 dB from 3 to 30 MHz

2.17 Power Handling – Group 5

Specimens met the power handling test requirements of 1.5 maximum VSWR at 30 MHz to 18 GHz at 20 dBm.

2.18 Insertion Loss – Group 4

Specimens met the insertion loss test requirement of ≤ 0.16 sqrt f (GHz) dB maximum.

2.19 Frequency Response – Group 4

Specimens met the frequency response test requirement of ≤ 1.5 dB from 1.0 GHz to 16 GHz.

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 – All Groups

Certifications of Conformance were 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 – Group 1

Mating force was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-13E. The daughtercard connector was mounted to a right-angle fixture which was attached to the crosshead of the tensile/compression tester. The backplane connector was attached to a free-floating X-Y-R table at the base of the tensile/compression tester. The specimens were then mated until the distance between the bottom of the daughtercard and top of the backplane was 12.85mm ± .5mm. Specimens were mated at a maximum rate of 12.7 mm/min and the maximum mating force was recorded.

3.3 Unmating Force – Group 1

Unmating force was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-13E. The same setup was used as for mating force, with the exception that the crosshead was moved in the upward direction. The specimens were unmated from the 12.85mm ± .5mm mating distance between the bottom of the daughtercard and top of the backplane. Specimens were unmated at a maximum rate of 12.7 mm/min and the maximum unmating force was recorded.

3.4 Low Level Contact Resistance – Group 1

Specimens were subjected to a low-level contact resistance test in accordance with Product Specification 108-163037, Rev. B and EIA-364-23D. Specimens were mated to the 12.85mm ± .5mm mating distance between the backplane and daughtercard connector boards. A test current was maintained at 100 milliamperes maximum with a 20-millivolt maximum open circuit voltage. Measurements were then made using a four-terminal measuring technique. The wire bulk resistance that was a part of the measurements was calculated and removed.

3.5 Insulation Resistance – Group 2

Mated specimens were subjected to an insulation resistance test in accordance with Product Specification 108-163037, Rev. B and EIA-364-21F. Insulation resistance was measured between the center and outer conductor for each contact position on all connectors. A 500 VDC was applied for two minutes before insulation resistance was measured.

3.6 Dielectric Withstanding Voltage – Group 2

Dielectric withstanding voltage was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-20F. A test voltage of 325 VAC (rms) was applied between the center conductors and outer conductor for each contact position on all mated specimens. The potential was maintained for 60 seconds.

3.7 Durability – Group 1

Durability was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-09D. The daughtercard was mounted to a right-angle plate that was attached to the upper mounting plate of the durability machine. The backplane board was attached to a free floating X-Y-R table mounted to the base of the durability machine. The specimens were mated until the distance between the bottom of the daughter card and the top of the backplane board was 12.85mm ± .5mm. Specimens were mated a total of 500 times with LLCR measurements taken every 100 cycles. Specimens were mated at a maximum rate of 600 cycles per hour.

3.8 Vibration Test 1 – Group 3

Test specimens were subjected to a random vibration test in accordance with Product Specification 108-163037 Rev. B.

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.

Test specimens were subjected to this test for 1 hour in each of the three mutually perpendicular axes, for a total test time of 3 hours per test specimen.

An electrical load was applied and maintained at a maximum of 100 milliamperes to all center contacts and was monitored for discontinuities of 1 microsecond or longer.

3.9 Vibration Test 2 – Group 3

Test specimens were subjected to a random vibration test in accordance with Product Specification 108-163037 Rev. B.

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 16.5 GRMS.

Test specimens were subjected to this test for 1 hour in each of the three mutually perpendicular axes, for a total test time of 3 hours per test specimen.

3.10 Vibration Test 3 – Group 3

Test specimens were subjected to a random vibration test in accordance with Product Specification 108-163037 Rev. B.

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 16.5 GRMS.

Test specimens were subjected to this test for 12 hours in only the vertical axis, for a total test time of 12 hours per test specimen.

An electrical load was applied and maintained at a maximum of 100 milliamperes to all center contacts and was monitored for discontinuities of 1 microsecond or longer.

3.11 Mechanical Shock – Group 3

Test specimens were subjected to a mechanical shock test in accordance with Product Specification 108-163037 Rev. B and MIL-STD-810H with Change I, Method 516.8, Procedure I.

The parameters of this test condition are a sawtooth 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, for a total of eighteen shocks.

An electrical load was applied and maintained at a maximum of 100 milliamperes to all center contacts and was monitored for discontinuities of 1 microsecond or longer.

3.12 Thermal Shock – Group 2

Thermal shock was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-32H. 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.

3.13 Humidity / Temperature Cycling – Group 2

Mated specimens were subjected to a humidity / temperature cycling in accordance with Product Specification 108-163037, Rev. B and MIL-STD-810H w/Change 1. Specimens were subjected to a 24-hour preconditioning at 23 ± 2°C and 50 ± 5% RH. Then the specimens were then 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. Operational checks were not conducted.

3.14 Operating Temperature – Group 6

Operating temperature was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-108A. VSWR testing was performed using the Keysight N5225B PNA. The HP 2.4mm adapter was connected to port 1 of the network analyzer. The Keysight 75Ω min loss pad was used on port 1. A 1 port calibration was performed using the Maury Microwave 75Ω N calibration kit. The network analyzer was set to collect 2000 data points across a frequency range of 0.01 to 20.0 GHz using a bandwidth of 1 kHz in step mode. 75Ω loads (N adapters, F loads) were 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 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: 7.76ns Stop: 9.52ns.

3.15 Voltage Standing Wave Ratio (VSWR) – Groups 3 & 4

Voltage standing wave ratio was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-108A. VSWR testing was performed using the Agilent E8364C PNA. The 2.4mm to N adapter was connected to port 1 of the network analyzer. The Agilent 11852B Min Loss Pad was connected to the N adapter. A 1 port calibration was performed using the Maury Microwave 8880CK 75Ω N calibration kit. The network analyzer was set to collect 2000 data points across a frequency range of 10.0 MHz to 20.0 GHz using a bandwidth of 1 kHz in step mode. A 75Ω load from the cal kit 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:

Group 3 (After Vibration)	Start: 4.74ns	Stop: 6.54ns
Group 4	Start: 1.92ns	Stop: 3.38ns

3.16 Isolation – Group 4

Isolation was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-90A, Method B.

PNA PROCEDURE

Isolation testing was performed using the Keysight N5225B PNA. The Junkosha test port cables were connected to port 1 and 2 of the PNA. The 2.4mm adapters and Min Loss pads were connected to the test port cables. The network analyzer was set to collect 401 data points across a frequency range of 30.0 MHz to 3.0GHz with a bandwidth of 10 Hz linear frequency. Power was turned on and set for 3.0 dBm. For the 3.0 GHz to 20.0 GHz range, 401 data points and a bandwidth of 10 Hz linear frequency were used. Power was turned on and set for 2.0 dBm. A full 2 port calibration was performed using the Maury Microwave 8880CK 75 Ohm Calibration Kit. The cable from the near end was connected to port 1 and the far end was connected to port 2 of the PNA. The noise floor level was below 120 dB for the 30.0 MHz to 3.0 GHz frequency range. The noise floor level was below 100 dB for the 3.0 GHz to 20.0 GHz frequency range.

3.16 Isolation – Group 4, *continued*

SPECTRUM ANALYZER PROCEDURE

Isolation testing was performed using the Agilent N9030A PXA Signal Analyzer and the Agilent E8257D PSG Analog Signal Generator. They were connected with a GPIB cable. 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 10.0 dBm, 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 sweeptime of 192.0 seconds. The driven end of the sample was connected to the 2.4mm bullet adapter on the RF output of the signal generator. The far end (measured end) of the sample was connected to the RF input of the spectrum analyzer. Power was turned on. Measurements were performed on the far end of the sample with the closest and most distant from the aggressor.

3.17 Power Handling – Group 5

Power handling was conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-108A. VSWR testing was performed using the Keysight N5225B PNA 4 port for frequency ranges 30.0 MHz to 18.0 GHz. A 1 port power source calibration was performed using the Maury Microwave 75Ω N calibration kit with the with interpolation on. The 4 port PNA was set to collect 800 data points using a bandwidth of 1 kHz with the port power set at 20dBm. The Keysight 75Ω min loss pad was used on port 1. A broadband gate with the gate shape set at normal was used in the measurement procedure with the following parameters: Start: 7.76ns Stop: 9.52ns.

VSWR measurements were taken driven from both ends of the cable marked according to 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 – Group 4

Insertion loss and frequency response were conducted in accordance with Product Specification 108-163037, Rev. B and EIA-364-101, dated January 2013. Insertion Loss testing was performed using the Agilent E8364C PNA. The 2.4mm adapter was connected to port 1 of the network analyzer. The 2.4mm to N adapter was connected to port 2 of the network analyzer. The 75Ω min loss pads were added to port 1 and port 2. A lab-made 75 Ω N conformable cable (24”) was attached to port 2. A full 2 port calibration was performed using the Maury Microwave 8880CK 75 Ohm Calibration Kit. The network analyzer was set to collect 2000 data points across a frequency range of 0.01 to 20.0 GHz using a bandwidth of 1 kHz in step mode with 1.94% smoothing. After calibration the N 75Ω bullet adapter was added to port 2 at the end of the test port cable on port 2 and is included in the recorded insertion loss measurement.

Insertion Loss measurement was recorded for the EWL/dB per inch sample. The calculation for dB/inch was used because the samples were not the same length as EWL. The cable assemblies were measured individually (cable only) to determine the loss from the cable. This was subtracted from Insertion Loss measurement and recorded as the Insertion Loss measurement.

The cable assemblies were connected to the 75Ω N adapters from port 1 and port 2 of the network analyzer during testing. Forward (S_{21}) insertion loss measures were taken and recorded driven from the marked BP end of the cable. Frequency Response was calculated from Insertion Loss measurements.

3.19 Frequency Response – Group 4

Frequency Response was calculated from Insertion Loss measurements. See section 3.18.

3.20 Final Examination of Product – All Groups

Specimens were visually examined using the unaided eye in accordance with EIA-364-18B.