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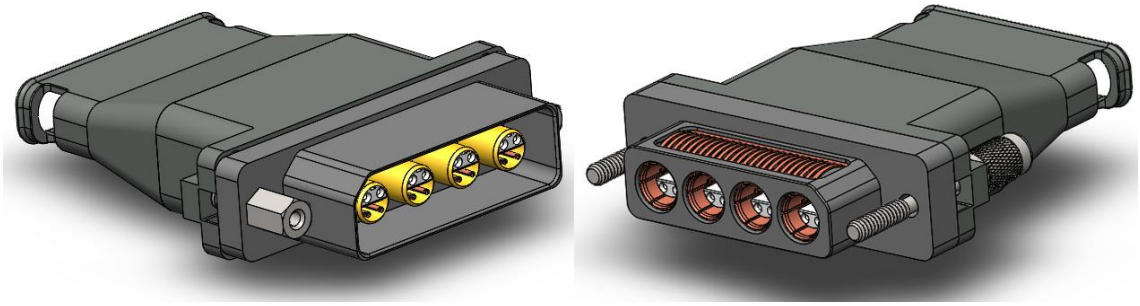
Qualification Test Report

Rugged D-Sub connectors
equipped with 4 split pair quadrax contacts



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List of Tables

1 Scope

The purpose of this document is to define the test samples, test sequence, and test methods, required for qualification testing.

2 Order of Precedence

In case of a conflict between the text of this document and the applicable referenced documents, the text of this document shall take precedence.

3 Description of Test Articles

All test samples utilized in the design validation will be fully assembled mated pair connectors where appropriate.

Table 1: Description of Test Articles

Part Number	Qty.	Description
Groups 1 & 2		
Plug Assembly		
052800-0004	2	Rugged D-Sub Plug for 4x Size 9 Twinax
124-0201-100	1	Backshell, 4 Way Rugged D-Sub Plug (Group 1 only)
121-0025-000	8	Screw, Socket Cap, #2-56 x 0.250
121-0068-001	4	Jack Screw, #4-40
019235-8033	8	Size 9 Pin, Quadrax Splitter, 100 Ohms, Using W.L.Gore #RCN9007 Quadrax Data Cable
Receptacle Assembly		
100-2695-105	2	Rugged D-Sub Receptacle for 4x Size 9 Twinax
124-0201-100	1	Backshell, 4 Way Rugged D-Sub Plug (Group 1 only)
121-0025-000	8	Screw, Socket Cap, #2-56 x 0.250
121-0056-002	4	Jackpost, #4-40
122-0047-000	8	Jam Nut, #4-40
019135-8033	8	Size 9 Socket, Quadrax Splitter, 100 Ohms, Using W.L.Gore #RCN9007 Quadrax Data Cable
Group 3		
Shells		
100-3004-300	2	Body, #9 Socket (with W.L.Gore #RCN9007)
100-3059-300	2	Body, #9 Pin (with W.L.Gore #RCN9007)
111-0352-300	4	Crimp Ferrule, Inner
Inner Contacts		

102-3165-300	8	Contact, Center, Size 9 Pin, Quadrax/Twinax (with W.L.Gore #RCN9007)
102-3703-300	8	Contact, Center, Size 9 Socket, Quadrax/Twinax (with W.L.Gore #RCN9007)

4 Standard Ambient Test Conditions

All tests and examinations specified by this qualification test procedure will be continued under any combination of conditions within the ranges stated in this paragraph, unless specified otherwise.

Temperature: 15°C to 35°C
Relative Humidity: 25% to 75%
Barometric Pressure: 86 kPa to 106 kPa

5 References

Military Specifications

MIL-DTL-24308	Connectors; Electrical Rectangular, Non Environmental, Miniature
MIL-STD-202	Test Method Standard Electronic and Electrical Component Parts
MIL-DTL-83513	Connectors, Electrical, Rectangular, Microminiature, Polarized Shell, General Specifications For

Electronic Industries Alliance (EIA)

EIA-364-08	Crimp Tensile Strength Test Procedure for Electrical Connectors
EIA-364-13	Mating and Unmating Force Test Procedure for Electrical Connectors and Sockets
EIA-364-23	Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets
EIA-364-29	Contact Retention Test Procedure for Electrical Connectors
EIA-364-37	Contact Engagement and Separation Test Procedure for Electrical Connectors
EIA-364-110	Thermal Cycling Test Procedure for Electrical Connectors and Sockets

Smiths Interconnect

ANSI/NCSL Z540-1-1994	Calibration System Requirements
QMM 400A	Smiths Connectors Quality Assurance Manual

6 Test Equipment and Facilities

6.1 Test Equipment

Table 2 lists the equipment to be used during the performance of the testing required herein. Equivalent items may be used if the effectiveness and accuracy of the tests are not adversely affected. Substitutes will be noted in Table 2.

Table 2: Test Equipment

Type	Mfr & Model #	Serial # / I.D. No.	Cal. Due Date
Force Gauge	Mark-10 model BG10	10-0456	7 June 2019
Digital Indicator	Mitutoyo model IDC-112T	01-0210	18 Aug 2018
Power Supply	Kepco model ABC 10-10DM	35-908	31 Jan 2019
Source Meter	Keithley model 2410-C	35-909	31 Jan 2019
DC Hipot Tester	Slaughter model 2503	35-820	30 Sept 2018
Dielectric Analyzer	Hypotultra model 7800	35-901	4 Sept 2019
PNA Network Analyzer	Keysight model N5227A 10MHz-67GHz	25-0838	13 June 2020
Electronic Calibration Module	Agilent N4691-60006	00-0008	30 Oct 2019
Shaker System	Unholtz-Dickie H560B	35-911	5 Jan 2019
Accelerometer	PCB Piezotronics 352A24 S/N LW217535	30-777	15 Jan 2019
Accelerometer	PCB Piezotronics 353B04 S/N LW188714	30-775	28 Nov 2018
Thermal Chamber	Sun Electronic Systems model EC11	35-917	30 Aug 2019
Data Logger Thermometer	Omega HH309A	35-907	29 Nov 2018
Motorized Test Stand	Lloyd Instruments Ltd model LF plus	10-469	28 Feb 2019
Load Cell	Lloyd model 1KN0119	20-613	12 Feb 2019
Load Cell	Lloyd model 20N0130	20-616	28 Feb 2019
Pull Force Tester	Schleuniger PullTester 25	10-468	17 Jan 2019

6.2 Facilities

Smiths Interconnect may use its own facilities or any commercial laboratory that is approved internally, unless otherwise specified.

7 Calibration

All test equipment used in the performance of the tests required herein shall be calibrated in accordance with ANSI/NCSL Z540-1-1994. Records of all equipment shall be maintained in accordance with ANSI/NCSL Z540-1-1994 and made available for review. Unless otherwise specified, Smiths Connectors Quality Assurance will verify that all test data and collection methods are accurate and reliable.

8 Test Sequence

The test procedures shall be composed of three groups. Groups 1 and 2 shall be comprised of one mated connector sample each. Group 3 shall be comprised of 2 pieces each of shell p/n 100-3004-300 and p/n 100-3059-300, each crimped with p/n 111-0352-300 ferrule and W.L.Gore #RCN9007 cable. Group 3 shall also be comprised of 8 pieces each of contacts p/n 102-3165-300 and p/n 102-3703-300, using W.L.Gore #RCN9007 cable.

Table 3: Test Sequence

Test Procedure	Paragraph Reference	Pass/Fail Criteria	PASS/ FAIL
Groups 1 & 2 (2 Samples)		**Pass/Fail Criteria**	
Visual & Mechanical	9.1	Pass Visual & Dimensional Requirements	PASS
Contact Retention	9.10	6 lbf, 0.012 inch max displacement	PASS
Low Level Contact Resistance (LLCR)	9.5	≤ 150mΩ	PASS
Dielectric Withstanding Voltage (DWV)	9.4	No Evidence of Breakdown or Flashover @ 250 VDC	PASS
Insulation Resistance	9.2	> 5000 Megohm @ 200 VDC	PASS
Characteristic Impedance	9.14	90Ω ≤ x ≤ 110Ω	PASS
Insertion Loss	9.12	≤ -2dB	PASS
Near End Cross Talk (NEXT)	9.15	≤ 4%	PASS
Far End Cross Talk (FEXT)	9.16	≤ 4%	PASS
Group 1 (1 Sample)		**Pass/Fail Criteria**	
Vibration	9.7	No Evidence of Discontinuity > 1 microsecond, or Physical Damage @ 15g (peak)	PASS
Mechanical Shock	9.8	No Evidence of Discontinuity > 1 microsecond, or Physical Damage @ 75G	PASS
Low Level Contact Resistance (LLCR)	9.5	≤ 150mΩ	PASS
Temperature Cycling	9.3	-55 to +125°C	PASS
Low Level Contact Resistance (LLCR)	9.5	≤ 150mΩ	PASS
Dielectric Withstanding Voltage (DWV)	9.4	No Evidence of Breakdown or Flashover @ 250 VDC	PASS
Insulation Resistance	9.2	> 5000 Megohm @ 200 VDC	PASS
Insertion Loss	9.12	≤ -2dB	PASS
Group 2 (1 Sample)		**Pass/Fail Criteria**	
Durability	9.6	≤ 50mΩ Δ	PASS
Low Level Contact Resistance (LLCR)	9.5	≤ 150mΩ	PASS
Contact Engagement and Separation Forces	9.11	Inner Socket: Engagement – 10 ozf max Separation – 0.35 ozf min Outer Socket: Engagement – 1.8 lbf max Separation – 2.0 ozf min	PASS

Mating and Unmating Force	9.9	8 lbf max, 3 lbf min	PASS
Contact Retention	9.10	6 lbf, 0.012 inch max displacement	PASS
Dielectric Withstanding Voltage (DWV)	9.4	No Evidence of Breakdown or Flashover @ 250 VDC	PASS
Insulation Resistance	9.2	> 5000 Megohm @ 200 VDC	PASS
Insertion Loss	9.12	≤ -2dB	PASS
Return Loss	9.13	≤ -10dB	PASS
Group 3		**Pass/Fail Criteria**	
Crimp Tensile Strength	9.17	The axial load required to pull the wire from the crimp barrel or break the wire shall not be less than 3.5 lbf. The minimum tensile strength for the outer shield hex crimp shall be 20 lbf.	PASS

9 Test Procedures

9.1 Visual and Mechanical

Full first article inspection report. Connector assemblies and detail parts or subassemblies shall be examined per Smiths Interconnect's customer use drawing and shall meet the requirements specified herein.

9.2 Insulation Resistance

Scope:
The units were tested to prove that the connectors are capable of meeting the specified insulation resistance requirements. This testing was conducted before and after environmental and durability tests.

Test Specification:
MIL-STD-202, method 302

Test Procedure:
The test voltage shall be raised uniformly from zero to 200VDC then held for 2 minutes at this test voltage. Measurements shall be made between:
a. Inner contact 1 to inner contact 2.
b. Inner contacts and outer body of the twinax contact assembly.

Acceptance Criteria:
The insulation resistance shall be 5000 megohms minimum.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.3 Temperature Cycling

Scope:
The units were tested by cycling to temperature extremes in order to verify that no damage occurs to the connectors.

Test Specification:
EIA-364-110

Test Procedure:
The mated sample shall be placed in a test chamber and cycled as per the following criteria:

a. Temperature Extremes shall be -55 to +125°C
b. Ramp rate shall be an average of 5°C/minute
c. The minimum dwell time shall be 10 minutes after the specimen has reached the chamber temperature specified
d. Samples shall be exposed to 5 cycles

Acceptance Criteria:
There shall be no evidence of visual mechanical damage to the connector.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass

9.4 Dielectric Withstanding Voltage

Scope:
The units were tested to prove that the connectors are capable of meeting the specified dielectric withstanding voltage requirements. This testing was conducted before and after environmental and durability tests.

Test Specification:
MIL-STD-202, method 301

Test Procedure:
The test voltage shall be raised uniformly from zero to 250VDC then held for 60 seconds at this test voltage. Measurements shall be made between:
a. Inner contact 1 to inner contact 2.
b. Inner contacts and outer body of the twinax contact assembly.

Acceptance Criteria:
The insulation resistance shall be 5000 megohms minimum.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass

Group 2	1 Mated Pair	Pass

9.5 Low Level Contact Resistance (LLCR)

Scope:
The units were tested to prove that the connectors are capable of meeting the specified low-level contact resistance requirements. This testing was conducted before and after environmental and durability tests.

Test Specification:
EIA-364-23

Test Procedure:
Units are measured across the contact interface using a test current of 100 milliamperes and 20 millivolts open circuit voltage maximum. Two measurements shall be performed with opposite polarity. The average of the two readings shall be considered as indicative of the low level resistance value. All contacts shall be measured.

Acceptance Criteria:
The maximum low-level contact resistance shall be 150 mΩ.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.6 Durability

Scope:
The units shall be mated and unmated up to the designated mating cycle life requirements to prove that the contact connections have adequate durability.

Test Specification:
MIL-DTL-24308

Test Procedure:
A cycle is defined as one mating and one unmating. The coupling means shall be operated in a manner to simulate actual service. The plug and receptacle shall be completely separated during each cycle. The test sample shall be adapted to

remove any devices that should interfere with a full engagement. The mating/unmating speed shall be 5 mm/second maximum and the cycling rate shall be 8 cycles/minute maximum.

Acceptance Criteria:
There shall be no mechanical or electrical defects detrimental to the operation of the connector after 500 cycles minimum of mating and unmating. The components shall be visually examined and, except for contact wear, the connectors shall show no evidence of physical damage.

A minimum of 2 hours shall pass before any other testing is to be initiated. For the final LLCR measurement, the resistance shall not have increased greater than 50 mΩ, since the previous LLCR measurement.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 2	1 Mated Pair	Pass

9.7 Vibration

Scope:
The units shall undergo vibration requirements to prove that the connectors are capable of meeting the specified vibration requirements.

Test Specification:
MIL-STD-202, method 204, test condition B

Test procedure:
Mated connectors shall be subjected to vibration with the following requirements:

Test condition B (15g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration as specified.

Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 15g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

Frequency range. The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz.

Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met.

Acceptance Criteria:
The connectors shall not be damaged and there shall be no loosening of parts due to vibration. Counterpart connectors shall be retained in engagement and there shall be no interruption of electrical continuity or current flow longer than 1 microsecond. All contacts shall be wired in series with a minimum of 100 milliamperes of current allowed to flow.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass

9.8 Mechanical Shock

Scope:
The units shall undergo mechanical shock requirements to prove that the connectors are capable of meeting the specified shock requirements.

Test Specification:
MIL-STD-202, method 213, test condition B

Test procedure:
Mated connectors shall be subjected to three shocks in each direction. Shocks shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks). The shock test conditions shall have the following requirements:

Test condition	**Peak value (g's)**	**Normal duration (D) (ms)**	**Waveform**	**Velocity change (Vi) ft/sec**
B	75	6	Half-sine	9.2

Acceptance Criteria:
There shall be no evidence of visual mechanical damage after the test. There shall be no electrical interruptions exceeding 1 microsecond (µs) during exposure to mechanical shock. All contacts shall be wired in series with a minimum of 100 milliamperes of current allowed to flow.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass

9.9 Mating and Unmating Force

Scope:
The units were tested by measuring the force required to fully mate and unmate the connectors to prove adequate force requirements.

Test Specification:
EIA-364-13

Test Procedure:
The connectors are fully mated and unmated to determine if the forces required to connect and separate the connectors are within the specified parameters.

Acceptance Criteria:
Maximum Engagement Force = 6 lbf
Minimum Separation Force = 3 lbf

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 2	1 Mated Pair	Pass

9.10 Contact Retention

Scope:
The units were tested by imposing axial forces on the connector contacts to determine the ability of the connector to withstand forces that tend to displace contacts from their proper location within the connector insert.

Test Specification:
EIA-364-29, method B

Test Procedure:
The unmated connector shall be mounted in a position of axial alignment of the contacts with a plunger of the test gauge. An axial load shall be applied to the contact at a maximum rate of 25.4 millimeters per minute until the specified force has been reached. The specified force shall be maintained for 6 seconds ± 1 second. The axial load shall be 6 lbf.

Acceptance Criteria:
The axial displacement of contacts shall not exceed 0.012 inches while under the 6 lbf load.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.11 Contact Engagement and Separation Forces

Scope:
The units were tested by measuring the engagement and separation forces on contacts to verify that they meet the requirements.

Test Specification:
EIA-364-37, method A

Test Procedure:
The test pin shall be aligned with the contact and axial forces shall be applied gradually, at a rate not to exceed 2 inches per minute. The maximum size gauge pin shall be engaged and the force required to mate the gauge shall be measured. The gauge shall then be removed. The minimum size gauge shall be engaged and then be withdrawn and the force required to withdraw the gauge shall be measured.

Acceptance Criteria:
The Contact Engagement force shall be:

Inner socket contact mating force: Engagement force 10 ounce-force maximum (dia 0.015" +000/-.0001); Separation force 0.4 ounce-force minimum with gage pin (dia 0.014" +0.0001/-.0000)

Outer socket contact mating force: Engagement force 1.8 pound-force maximum (dia 0.204" +000/-.0001); Separation force 2.0 ounce-force minimum with gage pin (dia 0.202" +0.0001/-.0000)

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 2	1 Mated Pair	Pass

9.12 Insertion Loss

Scope:
The units were tested to prove that the connectors are capable of meeting the specified insertion loss requirements. This testing was conducted before and after environmental and durability tests.

Test Specification:
ESCC 3401, Paragraph 9.1.1.6 and ESCC 3402, Paragraph 9.19

Test Procedure:
Measurements shall be performed with a frequency range up to 5.5 GHz by the swept frequency technique.

Acceptance Criteria:
Insertion Loss (SDD12) shall be measured and be less than -2 dB at 1.5625 GHz.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.13 Return Loss

Scope:
The units were tested to prove that the connectors are capable of meeting the specified return loss requirements. This testing was conducted after durability tests.

Test Specification:
EIA 364-108

Test Procedure:
Measurements shall be performed with the frequency range up to 5.5 GHz.

Acceptance Criteria:
Return loss (-20 log10 |SDD11|) shall be measured and be less than -10 dB.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 2	1 Mated Pair	Pass

9.14 Characteristic Impedance

Scope:
The units were tested to prove that the connectors are capable of meeting the specified characteristic impedance requirements. This testing was conducted before environmental and durability tests.

Test Specification:
EIA 364-108

Test Procedure:
RF measurements the following shall be done:

- Five differential pairs of the mated connector shall be measured.
- A 4-port network analyzer (VNA) shall be used to make differential measurements. All four ports will be used.
- The VNA shall be calibrated with a 4-port E-Cal device.
- De-embedding, fixture removal, and gating techniques may be used to isolate the mated connector with its cable to make accurate measurements.

The rise time shall be 60ps for these measurements. A picture of the TDR trace (TDD11) of the signal entering the connector, going through the cable, and exiting from a different part of the connector shall be taken. Minimum, maximum, and average values shall be displayed on this picture.

Acceptance Criteria:
There shall be an impedance within the range of $90\Omega \leq X \leq 110\Omega$.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**

Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.15 Near End Cross Talk (NEXT)

Scope:
The units were tested to prove that the connectors are capable of meeting the specified near end cross talk requirements. This testing was conducted before environmental and durability tests.

Test Specification:
EIA 364-90

Requirements:
This test shall reference the EIA-364-90 specification.

The connectors shall be measured by sequentially exciting differential pairs within the connector and measuring the coupled signal onto the near end line under test using a 4 x port (minimum) Vector Network Analyzer.

Acceptance Criteria:
There shall be a maximum of 4% crosstalk.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.16 Far End Cross Talk (FEXT)

Scope:
The units were tested to prove that the connectors are capable of meeting the specified far end cross talk requirements. This testing was conducted before environmental and durability tests.

Test Specification:
EIA 364-90

Requirements:
This test shall reference the EIA-364-90 specification.

The connectors shall be measured by sequentially exciting differential pairs within the connector and measuring the coupled signal onto the far end line under test using a 4 x port (minimum) Vector Network Analyzer.

Acceptance Criteria:
There shall be a maximum of 4% crosstalk.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 1	1 Mated Pair	Pass
Group 2	1 Mated Pair	Pass

9.17 Crimp Tensile Strength

Scope:
Inner contacts and outer quadrax contacts were tested to determine the tensile strength of the crimped contacts to conductor joints.

Test Specification:
EIA-364-08

Test Procedure:
The crimped sample is placed into the tensile pull force tester. Activate the pull force tester so that an axial force is exerted at a speed of 1 ± ¼ inch per minute until separation occurs between contact and conductor. Record tensile data and examine sample.

Acceptance Criteria:
Inner Contacts – The axial load required to pull the wire from the crimp barrel or break the wire shall not be less than 3.5 lbf.

Outer Contacts – The minimum tensile strength for the outer hex crimp shall not be less than 20 lbf.

Test Results		
Groups Tested	**Number of specimens to be tested**	**Pass/Fail**
Group 3	16 pieces of inner contacts and 4 pieces of outer quadrax contacts	Pass