zSFP+ Stacked Belly to Belly Receptacle Assembly

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity zSFP+ Stacked Belly to Belly Receptacle Assembly to determine its conformance to the requirements of TE Product Specification 108-60129 Rev A.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the zSFP+ Stacked Belly to Belly Receptacle Assembly. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between January 3, 2019 and March 25, 2019. Detailed test data is stored at HECTL under EA20180534T.

1.3 Conclusion

The zSFP+ Stacked Belly to Belly Receptacle Assembly specimens listed in paragraph 1.5 met the performance requirements of TE Product Specification 108-60129 Rev A. See Section 2 for detailed results.

1.4 Product Description

TE's zSFP+ was inspired by our customers' high density interface requirements. It combines elements of our zSFP+ cages with elements of our zQSFP+ connector and supports stacked belly to belly applications (zQSFP+) and backwards compatibility to all current SFP style interfaces. zSFP+ operates up to 25 Gbps NRZ and 56 Gbps PAM4 data rates. The zSFP+ platform allows for increased airflow, thus improving thermal performance and supports customized LED light pipes.

1.5 Test Specimens

Specimens identified with the following part numbers were used for this test program (Refer to Table 1).

Table 1 – Test Specimens

Test Set ID	Quantity	Part Number	Description
1,2,3,4,6	5 Each	2323270-1 Rev A	zSFP+ Stacked 2x8 Belly to Belly Receptacle Assembly
	10 Each	2074402-1	SFP+ to SFP+ 24 AWG Cable Assembly (Paddlecard P/N: 60-1042244-1)
	5 Each	60-1940286-1 Rev A	zSFP+ Stacked Belly to Belly LLCR Test PCB
5	5	2323270-5 Rev 2	zSFP+ Stacked 2x8 Belly to Belly Receptacle Assembly

NOTE

The cable assemblies were cut in half, so there were 20 total transceivers per test set for Test Sets 1,2,3,4, and 6 (4 ports per cage).
Where specified, "dummy" transceivers were used during temperature life, thermal shock, and temp/humidity testing and to fill empty ports during vibration and shock testing.

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1.6 Qualification Test Sequence

Specimens identified in Table 1 were subjected to the test sequences outlined in Table 2.

Table 2 – Qualification Test Sequence

Test or Examination	Test Groups					
	1	2	3	4	5	6
	Test Sets					
	1	2	3	4	5	6
	Test Sequence (a)					
Initial Examination of Product	1	1	1	1	1	1
Low Level Contact Resistance		3,6,9	3,5,7	2,4,6,8 10,12,14		2,4,6,8
Insulation Resistance					2,6	
Withstanding Voltage					3,7	
Random Vibration		7(e)				
Mechanical Shock		8(e)				
Durability		4				
Transceiver Insertion Force		2				
Transceiver Extraction Force		10				
Rotational Cable Pull	2					
Press-Fit Insertion Force			2			
Press-Fit Extraction Force			8			
Cage Latch Strength	3					
Reseating				13		7
Mate/Unmate				7		
Thermal Shock					4(c)	
Thermal Disturbance				11		5
Humidity/Temperature Cycling			6		5(c)	
Temperature Life, Preconditioning		5(c)				
Temperature Life			4(c)(d)	3(c)(d)		
Mixed Flowing Gas, Unmated				5(b)		
Mixed Flowing Gas				9		
Dust						3(d)
Final Examination of Product	4	11	9	15	8	9

NOTE

(a) The numbers indicate sequence in which tests were performed.
(b) Transceivers not exposed.
(c) Tested ports mated to "Dummy" transceivers.
(d) Precondition with 20 durability cycles.
(e) Empty ports filled with "Dummy" transceivers.

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%

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2. SUMMARY OF TESTING

2.1 Initial Examination of Product

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 Low Level Contact Resistance

Refer to Table 3 through 6 for LLCR summary data in milliohms. All low-level contact resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage had a change in resistance (ΔR) of less than 10.0 milliohms after testing.

Table 3 – Contact Resistance Data in Milliohms, (Test Group 2)

Milliohms	Initial	After Temperature Life	After Vibration & Mechanical Shock
Test Set 2			
Minimum	10.79	-5.87	-2.27
Maximum	28.57	5.89	9.42
Average	18.25	1.04	1.54
Std. Dev.	4.94	1.49	1.45
N =	400	400	400

Table 4 – Contact Resistance Data in Milliohms, (Test Group 3)

Milliohms	Initial	After Temperature Life	After Temperature/ Humidity Cycling
Test Set 3			
Minimum	10.91	-2.96	-2.58
Maximum	28.67	5.77	5.70
Average	18.62	0.78	0.81
Std. Dev.	4.88	1.32	1.40
N =	400	400	400

Table 5 – Contact Resistance Data in Milliohms, (Test Group 4)

Milliohms	Initial	After Temp. Life	After 10 Days Unmated MFG	After Mate/ Unmate	After 10 Days Mated MFG	After Thermal Disturbance	After Reseating 3X
Test Set 4							
Minimum	11.13	-2.24	-2.65	-2.06	-2.65	-2.70	-2.38
Maximum	29.07	6.26	9.60	6.93	5.20	9.25	6.71
Average	18.67	0.80	0.81	0.66	0.73	0.83	0.69
Std. Dev.	4.91	1.26	1.47	1.19	1.34	1.38	1.36
N =	400	400	400	400	400	400	400

Table 6 – Contact Resistance Data in Milliohms, (Test Group 6)

Milliohms	Initial	After Dust	After Thermal Disturbance	After Reseating 3X
Test Set 6				
Minimum	10.64	-4.49	-3.94	-5.19
Maximum	28.68	2.56	6.00	3.76
Average	18.80	-0.81	0.21	-0.51
Std. Dev.	5.03	1.06	1.34	1.37
N =	400	400	400	400

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2.3 Insulation Resistance

All initial insulation resistance measurements were greater than 1 X 10^9 ohms.

2.4 Withstanding Voltage

No dielectric breakdown or flashover occurred.

2.5 Random Vibration

No discontinuities were detected during vibration. Following vibration, no cracks, breaks, or loose parts on the specimens were visible. A total of 39 discrete signal contacts were monitored for discontinuities.

2.6 Mechanical Shock

No discontinuities were detected during mechanical shock. Following mechanical shock testing, no cracks, breaks, or loose parts on the specimens were visible. A total of 39 discrete signal contacts were monitored for discontinuities.

2.7 Durability

No physical damage occurred to the specimens as a result of mating and unmating the specimens 100 times.

2.8 Transceiver Insertion Force

Refer to Table 7 for transceiver insertion force data in Newtons. All force measurements were less than the requirement of 34.0 Newtons maximum for transceiver insertion force.

Table 7 – Transceiver Insertion Force Data in Newtons

Newtons	Transceiver Insertion Force
Minimum	20.24
Maximum	29.03
Average	24.80
Std. Dev.	2.32
N =	20

2.9 Transceiver Extraction Force

Refer to Table 8 for transceiver extraction force data in Newtons. All force measurements were less than the requirement of 18.0 Newtons maximum for transceiver extraction force.

Table 8 – Transceiver Extraction Force Data in Newtons

Newtons	Transceiver Extraction Force
Minimum	5.68
Maximum	15.14
Average	10.11
Std. Dev.	2.08
N =	20

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2.10 Rotational Cable Pull

All transceiver specimens held 7.5 lbs. for 1 full rotation without displacement of cage assembly or connector from the PCB.

2.11 Press-Fit Insertion Force

Refer to Table 9 for press-fit insertion force data in Newtons. All specimens were below the requirement of 35.0 Newtons maximum per pin for press-fit insertion force. The average press-fit insertion force was obtained by dividing the connector force by 412 *(total number of EONs)*.

Table 9 – Press-Fit Insertion Force Data in Newtons

Specimen ID	Connector Force	Average Per Pin
	Newtons	Newtons
Minimum	5049.31	12.26
Maximum	5973.55	14.50
Average	5560.45	13.50
Std. Dev.	358.27	0.87
N =	5	5

2.12 Press-Fit Extraction Force

Refer to Table 10 for press-fit extraction force data in Newtons. All specimens met the requirement of 852.8 Newtons minimum overall for press-fit extraction force per calculations below.

*Overall Requirement: (320 Signal EONs * 1.4 Newtons) + (92 Cage EONs * 4.4 Newtons) = 852.8 Newtons*

Table 10 – Press-Fit Extraction Force Data in Newtons

Specimen ID	Connector Force
	Newtons
Minimum	1029.30
Maximum	1314.72
Average	1217.69
Std. Dev.	120.21
N =	5

2.13 Cage Latch Strength

All specimens held 90.0 Newtons for 60 seconds with no displacement of the transceiver from the cage or the cage from the PCB.

2.14 Reseating

No physical damage detrimental to product performance was visible due to unmating and mating the specimen 3 times.

2.15 Mate/Unmate

No physical damage detrimental to product performance was visible due to unmating and mating the specimen 1 time.

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2.16 Thermal Shock

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

2.17 Thermal Disturbance

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

2.18 Humidity/Temperature Cycling

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

2.19 Temperature Life, Preconditioning

No evidence of physical damage was visible as a result of exposure to temperature life.

2.20 Temperature Life

No evidence of physical damage was visible as a result of exposure to temperature life.

2.21 Mixed Flowing Gas, Unmated

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas. The average copper corrosion rate was 13.3μg/cm^2/day.

2.22 Mixed Flowing Gas

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas.

2.23 Dust

No physical damage detrimental to product performance was visible due to dust exposure. Refer to Figure 1 for typical images following testing.

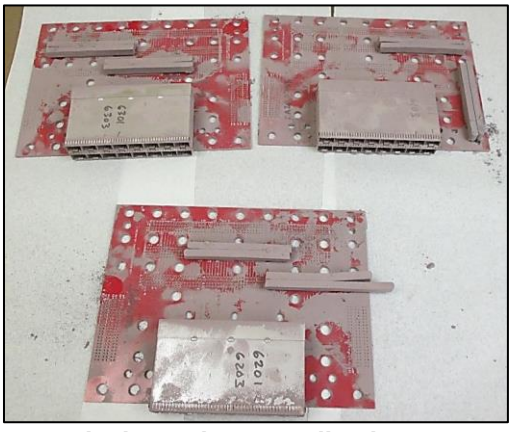


Figure 1 – Typical Specimens Following Dust Exposure

2.24 Final Examination of Product

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

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3. TEST METHODS

3.1 Initial Examination of Product

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. Testing was performed in accordance with EIA-364-18B.

3.2 Low Level Contact Resistance

Low level contact resistance measurements at low level current were made using a four terminal measuring technique (Figure 2). The test current was maintained at 100 milliamperes maximum with a 20-millivolt maximum open circuit voltage. Testing was performed in accordance with EIA-364-23C.

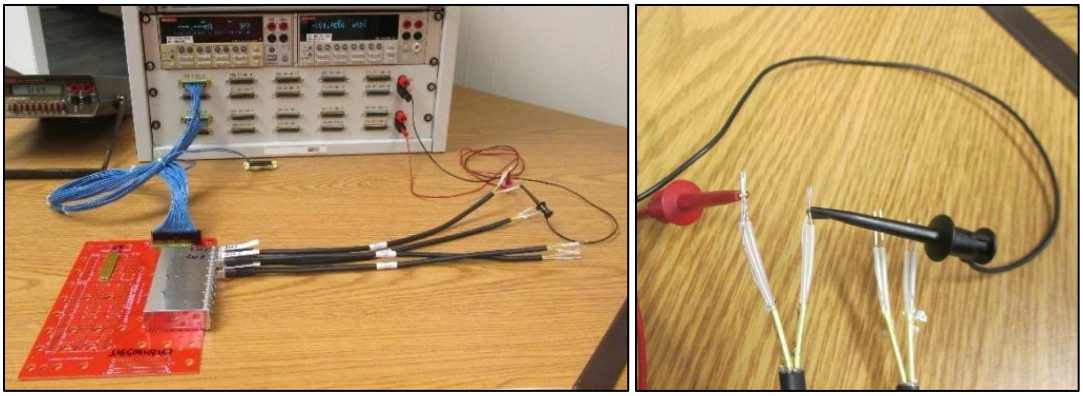


Figure 2 – Typical Low Level Contact Resistance Measurement Points

3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts of unmated specimens. A test voltage of 300 volts DC was applied for two minutes before the resistance was measured. Refer to Figure 3 for an image of the typical test setup. Testing was performed in accordance with EIA-364-21E.

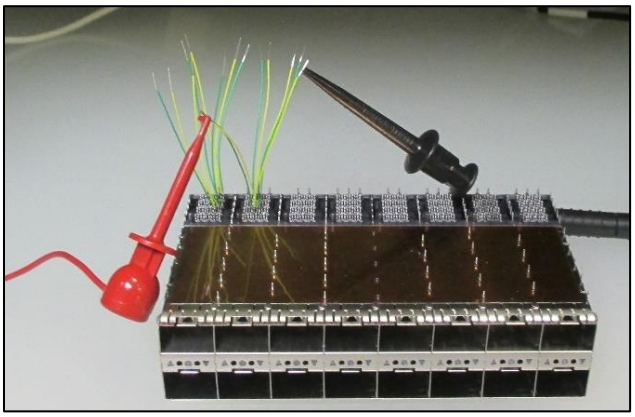


Figure 3 – Typical IR and DWV Test Setup

3.4 Withstanding Voltage

A test potential of 300 volts AC was applied between the adjacent contacts of unmated specimens. This potential was applied for one minute and then returned to zero. Refer to Figure 3 *(above)* for an image of the typical test setup. Testing was performed in accordance with EIA-364-20F.

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3.5 Random Vibration

Mated test specimens were subjected to a random vibration test in accordance with specification EIA-364-28F, test condition “VII”, test condition letter “D”. The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 20 and 500 Hertz (Hz). The spectrum remains flat at 0.02 G^2/Hz from 20 Hz to the upper bound frequency of 500 Hz. The root-mean square amplitude of the excitation was 3.10 GRMS. The test specimens were subjected to this test for 15 minutes in each of the three mutually perpendicular axes, for a total test time of 45 minutes per test specimen. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes. Refer to Figure 4 for an image of the typical test setup.

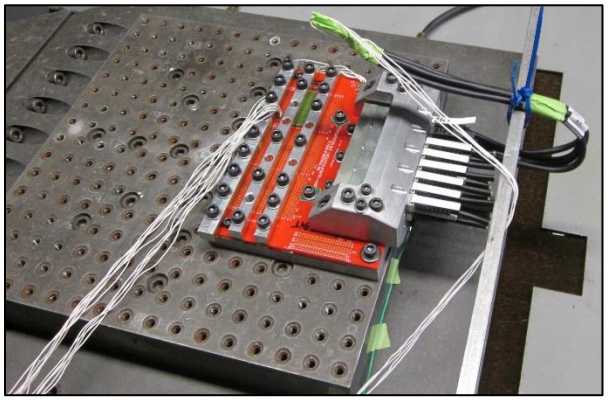


Figure 4 – Typical Vibration Test Setup

3.6 Mechanical Shock

Mated specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, test condition H. The parameters of this test condition are a half-sine waveform with an acceleration amplitude of 30 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. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes. Refer to Figure 5 for an image of the typical test setup.

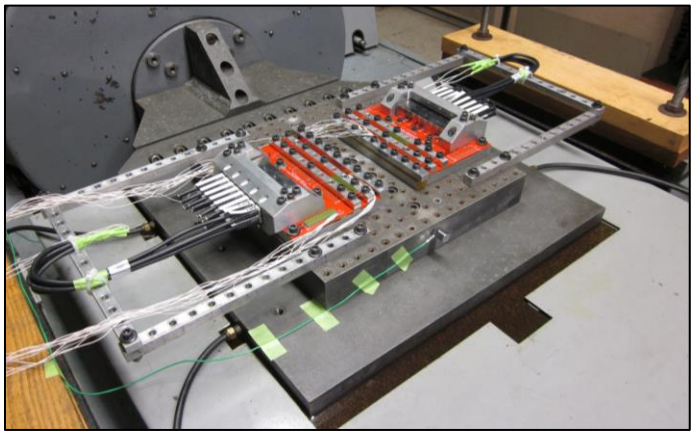


Figure 5 – Typical Mechanical Shock Test Setup

3.7 Durability

Specimens were mated and unmated 100 times at a maximum rate of 300 cycles per hour. Testing was performed in accordance with EIA-364-09D.

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3.8 Transceiver Insertion Force

The PCB was bolted to a 90° plate attached to a mill table at the base of the tensile/compression machine. A slotted plate fixture was attached to the moveable crosshead of the tensile/compression machine. The transceiver was started into the cage and aligned with the slotted plate. Force was applied in a downward direction at a rate of 12.7 mm/min until the transceiver was fully mated. Refer to Figure 6 for images of the typical test setup. Testing was performed in accordance with EIA-364-13E.

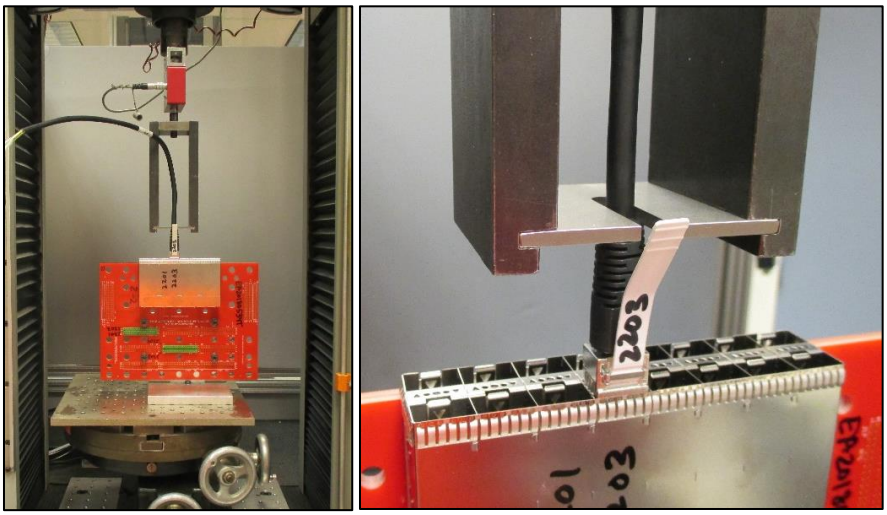


Figure 6 – Typical Transceiver Insertion Force Test Setup

3.9 Transceiver Extraction Force

The PCB was clamped in a vise attached to a free-floating x/y and rotational table at the base of the tensile/compression machine. A vise was attached to the moveable crosshead of the tensile/compression machine. The pull tab of the transceiver was clamped in the vise and force was applied in an upward direction at a rate of 12.7 mm/min until the transceiver was removed from the cage. Refer to Figure 7 for images of the typical test setup. Testing was performed in accordance with EIA-364-13E.

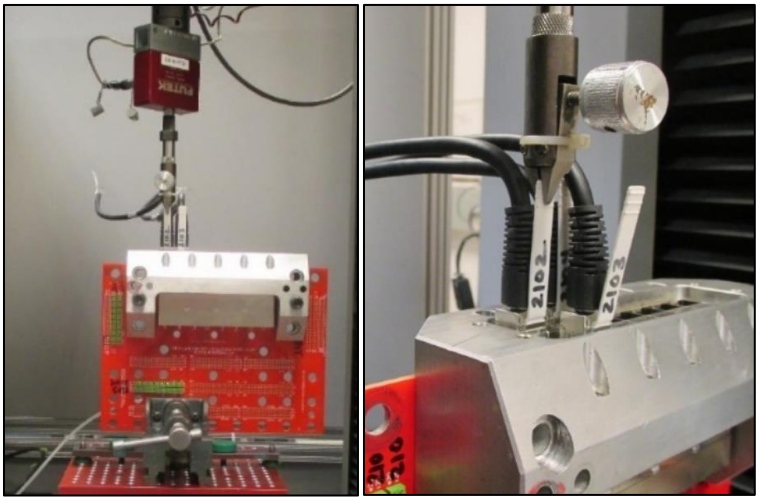


Figure 7 – Typical Transceiver Extraction Force Test Setup

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3.10 Rotational Cable Pull

The vibration fixture bezel was attached to the board mounted cage assembly. The PCB was attached to a plate at the top of the rotational cable pull tester. The transceiver cable was attached to a 7.5 lb. weight. The cable was rotated 40° toward the PCB, then rotated 360° with the load still applied at a rate of 4 RPM. No electrical measurements were made during testing. Refer to Figure 8 for images of the typical test setup.

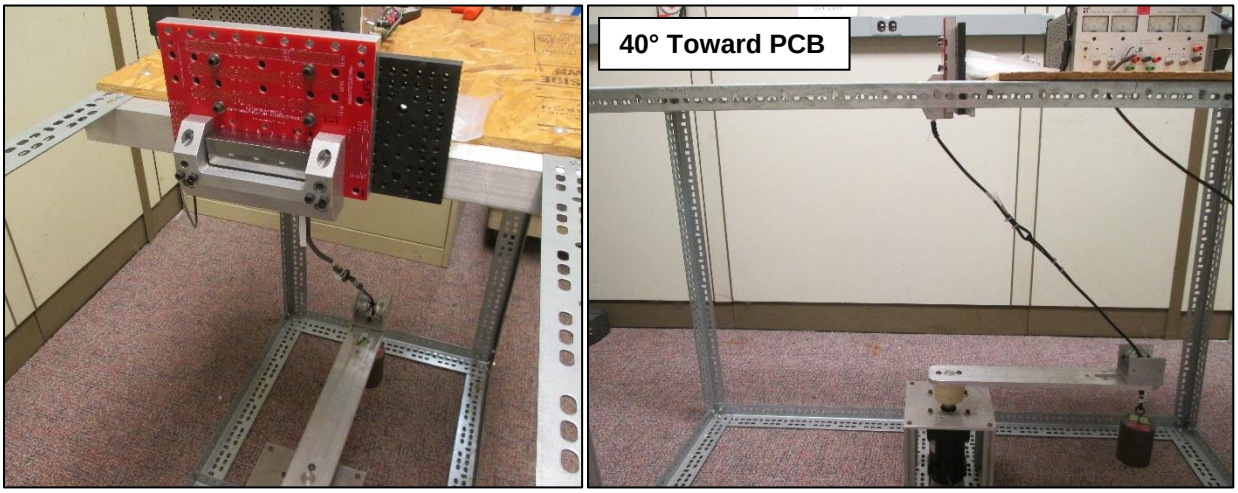


Figure 8 – Typical Rotational Cable Pull Test Setup

3.11 Press-Fit Insertion Force

The connector assembly was started onto the PCB at the base of the tensile compression. The press-fit fixture was inserted into the cage and placed on top to support the cage during insertion. A probe was attached to the moveable crosshead of the tensile/compression machine and aligned with the specimen. Force was applied in a downward direction at a rate of 0.20 in/min until the specimen was fully inserted on the PCB. Refer to Figure 9 for images of the typical test setup.

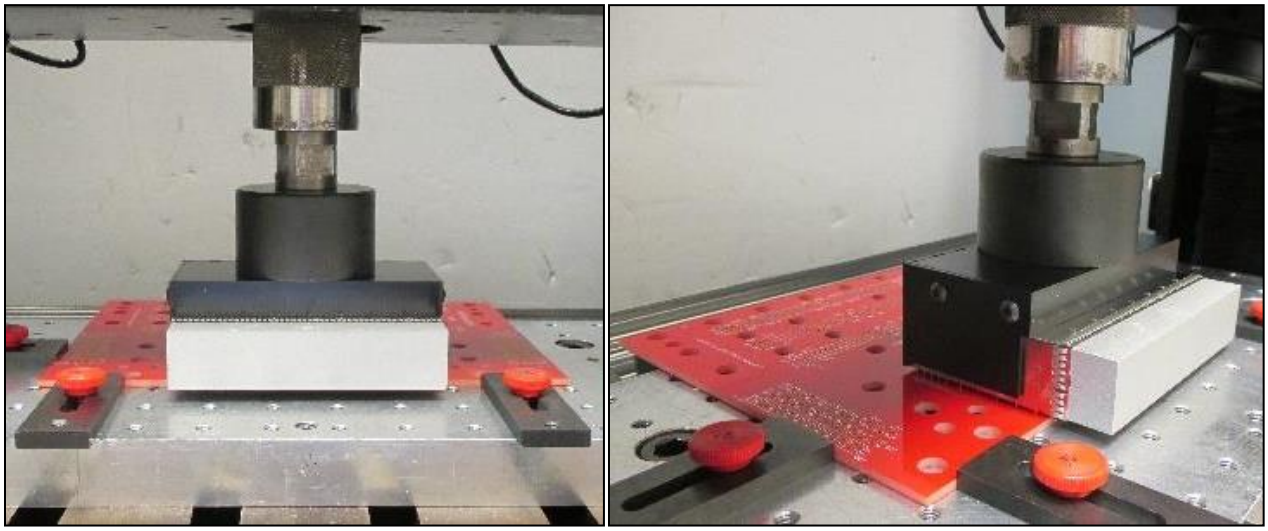


Figure 9 – Typical Press-Fit Insertion Force Test Setup

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3.12 Press-Fit Extraction Force

The PCB was clamped to a mill table at the base of the tensile/compression machine. The cage of the connector was clamped in a vise attached to a plate on the moveable crosshead of the tensile/compression machine. Force was applied in an upward direction at a rate of 12.7 mm/min until the connector was completely removed from the PCB. Refer to Figure 10 for images of the typical test setup.

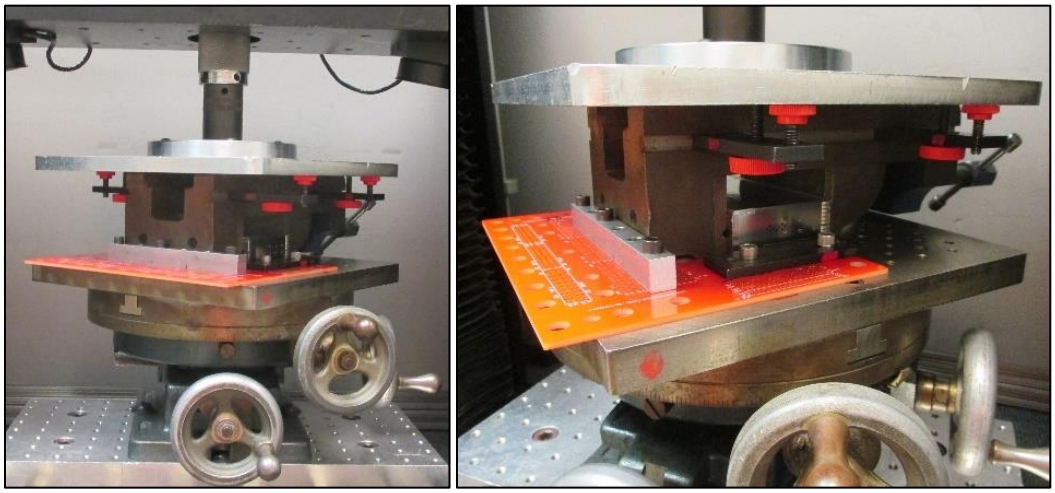


Figure 10 – Typical Press-Fit Extraction Test Setup

3.13 Cage Latch Strength

The vibration fixture bezel was attached to the board mounted cage assembly. The PCB was clamped in a vise attached to a free-floating x/y and rotational table at the base of the tensile/compression machine. The transceiver cable was clamped in an air jaw attached to the moveable crosshead of the tensile/compression machine. Force was applied in an upward direction at a rate of 0.25 in/min until 90.0 Newtons was achieved then held for 60 seconds and returned to zero. Refer to Figure 11 for images of the typical test setup.

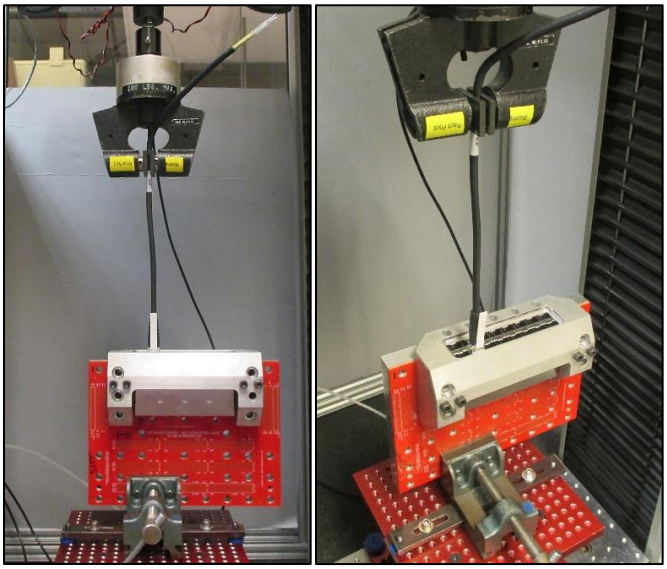


Figure 11 – Typical Cage Latch Strength Test Setup

3.14 Reseating

Specimens were unmated and mated 3 times by hand.

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3.15 Mate/Unmate

Specimens were unmated and mated 1 time by hand.

3.16 Thermal Shock

Mated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 30-minute dwells at -55°C and 105°C. The transition between temperatures was less than one minute. Testing was performed in accordance with EIA-364-32G.

3.17 Thermal Disturbance

Mated specimens were subjected to 10 cycles between 15±3°C and 85±3°C at a ramp rate of 5°C and dwells of 30 minutes at each temperature extreme. Testing was performed in accordance with EIA-364-110.

3.18 Humidity/Temperature Cycling

Mated specimens were exposed to 10 cycles of humidity-temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 25°C and 65°C twice while maintaining high humidity. Testing was performed in accordance with EIA-364-31F.

3.19 Temperature Life, Preconditioning

Mated specimens were exposed to a temperature of 105°C for 120 hours. Testing was performed in accordance with EIA-364-17C.

3.20 Temperature Life

Mated specimens were exposed to a temperature of 105°C for 240 hours. Testing was performed in accordance with EIA-364-17C.

3.21 Mixed Flowing Gas, Unmated

Unmated receptacle specimens were exposed to 10 days of Class IIA mixed flowing gas. The transceivers were not exposed in the unmated condition. Refer to Table 11 for MFG test parameters. Testing was performed in accordance with EIA-364-65B.

Table 11 – MFG Test Parameters

Environment	Class IIA
Temperature (°C)	30±1
Relative Humidity (%)	70±2
Chlorine (Cl_2) Concentration (ppb)	10±3
Hydrogen Sulfide (H_2S) Concentration (ppb)	10±5
Nitrogen Dioxide (NO_2) Concentration (ppb)	200±50
Sulfur Dioxide (SO_2) Concentration (ppb)	100±20
Total Exposure Period [actual]	20 days
Chamber Volume Exchange Rate [minimum of 6/hr.]	8.8/hr.*

**Volume exchange rate for 105-liter test chamber [Total flow rate of 15.4 L/Min]*

3.22 Mixed Flowing Gas, Mated

Mated specimens were subjected to 10 days of Class IIA mixed flowing gas. Refer to Table 11 (above) for the MFG test parameters. Testing was performed in accordance with EIA-364-65B.

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3.23 Dust

Prior to exposure, the dust composition #1 (Benign) was placed in a container and evenly spread. The dust was placed in an oven and dried at 50°C for 1 hour. A dust mass of 9 grams per cubic foot of chamber volume or a total of 120 grams was used. Unmated specimens were placed in the dust chamber at various orientations as shown in Figure 2. The chamber had an air flow rate of 1000 ft/minute. The specimens were exposed for 1 hour. Following the exposure, the specimens remained in the chamber for an additional hour. Each specimen was tapped 5 times for removal of excess dust. Refer to Figure 12 for an image of the typical test setup. Testing was performed in accordance with EIA-364-91B.

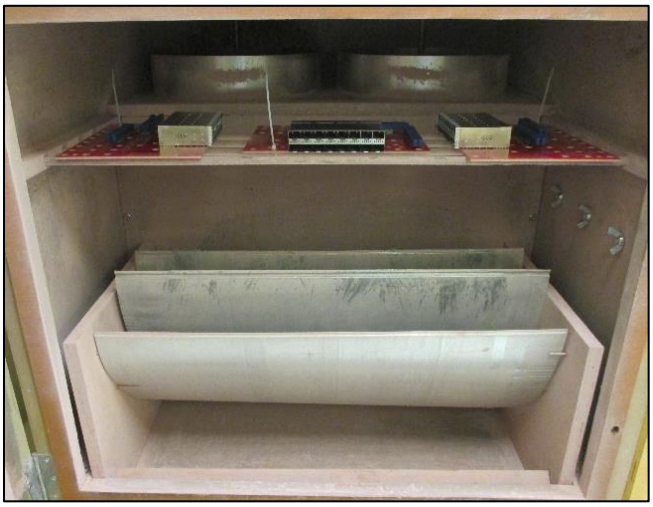


Figure 12 – Typical Dust Test Setup

3.24 Final Examination of Product

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed. Testing was performed in accordance with EIA-364-18B.

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