# QSFP+ Stacked Connector and Cage Assembly

## 1. INTRODUCTION

### 1.1 Purpose

Testing was performed on the TE Connectivity QSFP+ Stacked Connector and Cage Assembly to determine its conformance to the requirements of Product Specification 108-127010, Rev A.

### 1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the QSFP+ 2x1 Stacked Connector Assembly. Testing was performed at the Harrisburg Electrical Components Test Laboratory between September 11, 2012 and November 21, 2012. This documentation is on file at and available from the Harrisburg Electrical Components Test Laboratory under EA20120437T.

### 1.3 Conclusion

The QSFP+ Stacked Connector and Cage Assembly listed in paragraph 1.4 conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-127010, Rev A. Refer to paragraphs 2.1 to 2.24 for the detailed results.

### 1.4 Product Description

The QSFP+ Stacked Connector and Cage Assembly is a Pluggable I/O product, which has an integrated connector and cage that is connected to a printed circuit board with compliant press-fit pins.

### 1.5 Test Specimens

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

**Table 1 – Specimen Identification Information**

| Test Set | Quantity | Part Number | Description |
|---|---|---|---|
| 1 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 2 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 3 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 4 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 5 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 6 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 7 | 5 | 2085945-1 (Pd) | QSFP+ 2x1 Stacked Connector Assembly, PdNi |
| 8 | 5 | 2085945-1 (Au) | QSFP+ 2x1 Stacked Connector Assembly, Au |
| 9 | 5 | 2085945-1 (Au) | QSFP+ 2x1 Stacked Connector Assembly, Au |
| 1,5,7 | 15 | 2053638-5 | QSFP+ Cable Assembly – for Mechanical/IR/DWV Testing |
| 2,3,4,6,8,9 | 30 | N/A | LLCR Transceiver |
| 1,2,3,4,6,7,8,9 | 40 | 60-1821439-1 Rev A | QSFP+ 2x1 Stacked Connector Assembly PCB (LLCR and Force) |

### 1.6 Qualification Test Sequence

The specimens submitted for testing were subjected to the test sequences outlined in Table 2.

**Table 2 – Test Sequences**

| Test or Examination | Test Group (a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Test Sequence (b) | | | | | | |
| Initial Examination of Product | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| LLCR | | 2,5,8 | 3,5,7 | 2,4,6,8,10,12,14 | | 2,4,6,8 | |
| Insulation Resistance | | | | | 2,6 | | |
| Withstanding Voltage | | | | | 3,7 | | |
| Random Vibration | | 6 | | | | | |
| Mechanical Shock | | 7 | | | | | |
| Durability | | 3 | | | | | |
| Transceiver Insertion Force | | | | | | | 2(f) |
| Transceiver Extraction Force | | | | | | | 3(f) |
| Rotation Cable Pull | 2 | | | | | | |
| Press-fit Insertion Force | | | 2 | | | | |
| Press-fit Extraction Force | | | 8 | | | | |
| Module Retention | | | | | | | 4 |
| Cage Latch Axial Retention | 3 | | | | | | |
| Reseating | | | | 13 | | 7 | |
| Mate/Unmate | | | | 7 | | | |
| Thermal Shock | | | | | 4(d) | | |
| Thermal Disturbance | | | | 11 | | 5 | |
| Humidity/Temperature Cycling | | | 6 | | 5 | | |
| Temperature Life, Preconditioning | | 4(d) | | | | | |
| Temperature Life | | | 4(c)(d) | 3(c)(d) | | | |
| Mixed Flowing Gas, Unmated | | | | 5(e) | | | |
| Mixed Flowing Gas, Mated | | | | 9 | | | |
| Dust | | | | | | 3(c) | |
| Final Examination of Product | 4 | 9 | 9 | 15 | 8 | 9 | 5 |

(a) Test Groups 1, 3, 5, 6, and 7 consist of 5 PdNi plated specimens. Test Groups 2 and 4 consist of 5 PdNi plated specimens and 5 Au plated specimens. Therefore, Test Sets 1 thru 7 are in Test Groups 1 thru 7, respectively. Test Set 8 is in Test Group 2 and Test Set 9 is in Test Group 4.
(b) Numbers indicate sequence in which tests are performed.
(c) Precondition specimens with 20 durability cycles.
(d) Mated to blank transceivers.
(e) Transceivers not exposed.
(f) Modified transceiver that removes the kick-out spring and latch from the test.

### 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 Test Sets

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 – Test Sets 2, 3, 4, 6, 8, & 9

All low level contact change in resistance measurements were less than 10 milliohms.

### 2.3 Insulation Resistance – Test Set 5

All insulation resistance measurements were greater than the $1x10^9$ Ohms minimum requirement.

### 2.4 Dielectric Withstanding Voltage – Test Set 5

No dielectric breakdown, flashover or leakage exceeding 5 milliamperes (5000 µamperes) occurred on any specimen.

### 2.5 Random Vibration – Test Sets 2, 8

No discontinuities of one microsecond or greater were detected during vibration. Following vibration, no cracks, breaks, loose parts or apparent physical damage on the specimens were visible.

### 2.6 Mechanical Shock – Test Sets 2, 8

No discontinuities of one microsecond or greater were detected during mechanical shock. Following mechanical shock testing, no cracks, breaks, loose parts or apparent physical damage on the specimens were visible.

### 2.7 Durability – Test Sets 2, 8

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

### 2.8 Transceiver Insertion Force – Test Set 7

The maximum transceiver insertion force was 5.18 lbf, below the maximum requirement of 9.0 lbf (40 N).

### 2.9 Transceiver Extraction Force – Test Set 7

The maximum transceiver extraction force was 3.99 lbf, below the maximum requirement of 6.7 lbf (30 N).

### 2.10 Rotational Cable Pull – Test Set 2

The cage and connector assembly did not displace from the Printed Circuit Board and the transceiver did not dislodge from the cage with the 7.5 lbf (33.4 N) load applied at a 40° angle and a 360° rotation.

### 2.11 Press-Fit Insertion Force – Test Set 3

The maximum press-fit insertion force was 229.6 lbs, below the maximum requirement of 292 lbf (1.3 kN).

### 2.12 Press Fit Extraction Force – Test Set 3

The minimum press-fit extraction force was 38.6 lbf, above the minimum requirement of 34.8 lbf (155 N).

### 2.13 Module Retention – Test Set 7

All specimens were able to support a weight of 20.2 lbf (90 N) for a minimum of 1 minute without dislodging from the cage.

### 2.14 Cage Latch Axial Retention – Test Set 1

The minimum cage latch axial retention force was 30.99 lbf, above the minimum requirement of 29.2 lbf (130 N).

### 2.15 Reseating – Test Sets 4, 6, & 9

No evidence of physical damage was visible as a result of unmating and mating each specimen 3 times.

### 2.16 Mate/Unmate – Test Sets 4 & 9

No evidence of physical damage was visible as a result of unmating and mating each specimen.

### 2.17 Thermal Shock – Test Set 5

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

### 2.18 Thermal Disturbance – Test Sets 4, 6, & 9

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

### 2.19 Humidity-Temperature Cycling – Test Sets 3 & 5

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

### 2.20 Temperature Life, Preconditioning – Test Sets 2 & 8

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

### 2.21 Temperature Life – Test Sets 3, 4 & 9

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

### 2.22 Mixed Flowing Gas – Test Sets 4 & 9

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

### 2.23 Dust – Test Set 6

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

### 2.24 Final Examination of Product - All Test Sets

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

## 3. TEST METHODS

### 3.1 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.

### 3.2 Low Level Contact Resistance

Low level contact resistance measurements at low level current 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. The positive voltage and current were applied to the board access connectors, while the negative voltage and current was applied to the transceiver cable. The PCB in the transceiver had only 2 leads attached and contact pads were bussed together.

### 3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts (signal to signal and signal to ground) of mated specimens (cabled transceiver and QSFP+ 2x1 stacked connector) per EIA-364-21. A test voltage of 300 Volts DC was applied for two minutes before the resistance was measured. The test voltage was applied to the cable. The connector was not assembled to a PCB.

### 3.4 Dielectric Withstanding Voltage

A test voltage of 300 V AC was applied between the adjacent contacts (signal to signal and signal to ground) of mated specimens (cabled transceiver and QSFP+ 2x1 stacked connector) per EIA-364-20 and Product Spec 108-127010, Rev A. The voltage was held for 1 minute and then returned to zero. The ramp rate was set at 500 V/s. The test voltage was applied to the end of the cable. The connector was not assembled to a PCB.

### 3.5 Vibration, Random

The test specimens were subjected to a random vibration test as stated in TE Connectivity Specification 108-127010, Rev A, in accordance with specification EIA-364-28F, test condition “VII”, test condition letter “D”. See Figures 1 and 2 for vibration setup photographs.

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.

**Figure 1- Vibration Setup**

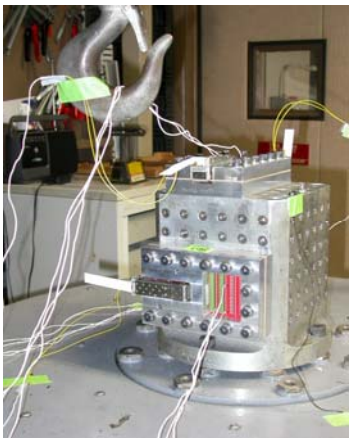


**Figure 2- Vibration Setup**

### 3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test as stated in TE Connectivity Specification 108-127010, Rev A, in accordance with specification EIA-364-27C, test condition “H”. See Figures 3 and 4 for shock setup photographs.

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.

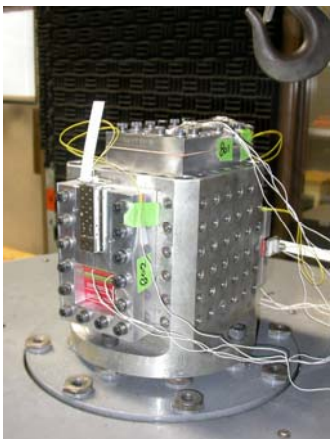


**Figure 3 - Shock Setup**

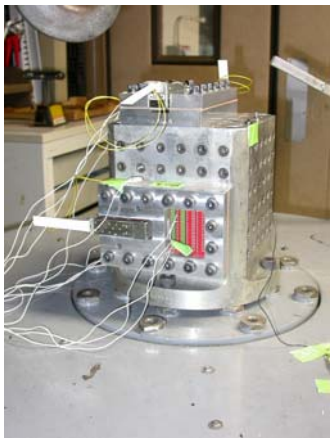


**Figure 4 - Shock Setup**

### 3.7 Durability

Specimens were mated and unmated for 100 cycles at a maximum rate of 500 cycles per hour with the cage latch operable.

### 3.8 Transceiver Insertion Force

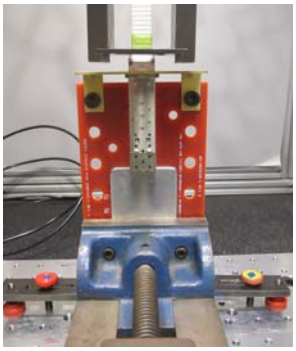


**Figure 5 – Transceiver Insertion Setup**

The PCB, cage/connector and bezel assembly was vertically mounted in a vice. Additional metal plates were used to provide stiffness where the board was vertically clamped. The vice was rigidly secured to the base of the tensile machine. The moving head of the tensile machine was lowered at 0.25 mm/min. An upside down goal post with a slotted plate was used to push on the transceiver. The retention springs were made inoperable by taping the pull tab in an “open” position. The maximum insertion force was recorded. Figure 5 illustrates the test set-up.

### 3.9 Transceiver Extraction Force

The PCB, cage/connector and bezel assembly was vertically mounted in a vice. Additional metal plates were used to provide stiffness where the board was vertically clamped. The vice was rigidly secured to the base of the tensile machine. An air jaw was attached to the moving head of the tensile machine. The pull tab was held in the air jaw which was raised at 0.25 mm/min. The retention springs were made inoperable by taping the pull tab in an “open” position. The maximum extraction force was recorded. Figure 6 illustrates the test set-up.

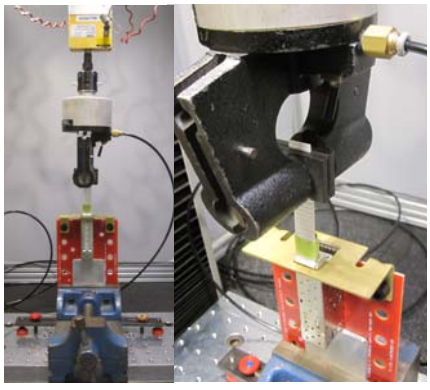


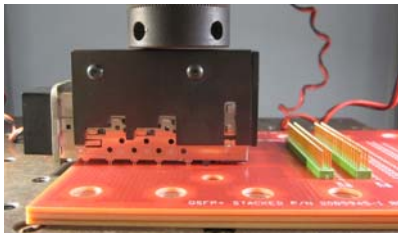
**Figure 6 – Transceiver Extraction Setup**

### 3.10 Rotational Cable Pull

The PCB, cage/connector and bezel assembly was vertically mounted as shown in Figure 7. A 7.5 lb weight was hung from the end of the cable at an angle of 40°. The lower arm was then rotated 360° while the load was applied.

**Figure 7 – Rotational Cable Pull Setup**

### 3.11 Press-Fit Insertion Force



Two additional support PCB's were placed under the PCB for each test. The insertion tool included two pieces – one that fits inside the ports, the second "straddles" the cage. The moving head of the Instron was lowered at a rate of 0.5 in/min. Figure 8 illustrates the test setup.

**Figure 8 – Press-Fit Insertion Setup**

### 3.12 Press-Fit Extraction Force

The extraction tool includes a rigid structure that holds the specimen and a second piece that straddles the cage. The moving head of the Instron was lowered at a rate of 0.5 in/min. It pushes on the straddle tool which in turn pushes the PCB off of the cage/connector assembly. Note: Because the majority of the pins are located in the rear of the connector, the Instron was biased towards the rear of the connector. Figure 9 illustrates the test setup.

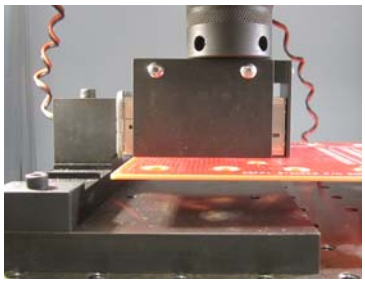
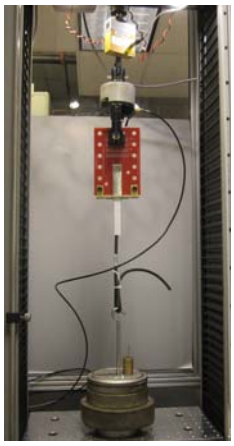


**Figure 9 – Press-Fit Extraction Setup**

### 3.13 Module Retention



The PCB, cage/connector and bezel assembly was vertically held by air jaws that were mounted to the movable head of the tensile machine. A 20.2 lb calibrated weight was attached to the transceiver cable. The movable head was raised at a rate of 0.20 in/min until the weight was completely off of the base. It was held for a minimum of 1 minute before returning to the base. Figure 10 illustrates the test setup.

**Figure 10 – Module Retention Setup**

### 3.14 Cage Latch Axial Retention

The PCB, cage/connector and bezel assembly was vertically clamped in a vice. Additional metal plates were used to provide stiffness where the board was clamped. The vice was rigidly secured to the based of the tensile machine. An air jaw was attached to the moving head of the tensile machine. The cable was held in the air jaw which was raised at the rate of 0.50 in/min. The maximum extraction force was recorded. Figure 11 illustrates the test setup.

**Figure 11 – Cage Latch Axial Retention Setup**

### 3.15 Reseating

Specimens were manually unmated and mated 3 times.

### 3.16 Mate/Unmate

Specimens were manually unmated and mated 1 time.

### 3.17 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.

### 3.18 Thermal Disturbance

Mated specimens were subjected to 10 cycles of thermal disturbance with each cycle consisting of 30 minute dwells at 15°C and 85°C at a maximum transition rate of 2°C/minute.

### 3.19 Humidity/Temperature Cycling

Unmated 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 while maintaining 80 to 100% humidity. See Figure 12.

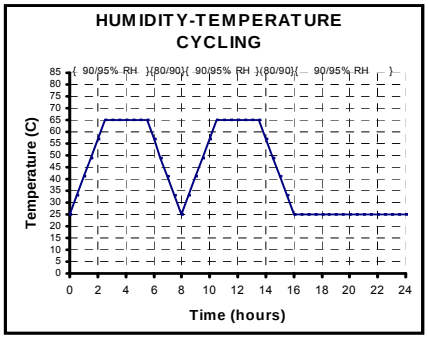



**Figure 12 – Humidity-Temp Cycling Profile**

### 3.20 Temperature Life, Preconditioning

Mated specimens (w/ blank transceivers) were exposed to a temperature of 105°C for 120 hours.

### 3.21 Temperature Life

Mated specimens (w/ blank transceivers) were exposed to a temperature of 105°C for 240 hours. The specimens were preconditioned with 20 cycles of durability.

### 3.22 Mixed Flowing Gas, Class IIA

All specimens were subjected to a Mixed Flowing Gas test in accordance with EIA 364-65B, Class IIA. Test parameters are listed in Table 3.

The test specimens consisted of 10 connector assemblies. They were exposed in the unmated condition for the first 10 days (plugs stored at room ambient) and mated for the final 10 days. All were removed from the test chamber for LLCR measurements after 10 and 20 days of exposure.

**Table 3 – MFG Test Parameters**

| Environment | Class IIA |
|---|---|
| Temperature ($^0$C) | **30 ± 1** |
| Relative Humidity (% ) | **70 ± 2** |
| Chlorine (Cl2) Concentration (ppb) | **10 ± 3** |
| Hydrogen Sulfide (H2S) Concentration (ppb) | **10 ± 5** |
| Nitrogen Dioxide (NO2) Concentration (ppb) | **200 ± 50** |
| Sulfur Dioxide (SO2) Concentration (ppb) | **100 ± 20** |
| Exposure Period | **20 Days** |

### 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 13. 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.

**Figure 12 – 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.