QSFP Stacked Double Density Connector and Cage Assembly

1. Introduction

1.1. Purpose

Testing was performed on the TE connectivity (TE) QSFP Stacked Double Density Connector and Cage Assemblies to determine their conformance to the requirements of Product Specification 108-60130 Revision A.

1.2. Scope

This report covers the electrical, mechanical, and environmental performance of the QSFP Stacked Double Density Connector and Cage Assemblies. Main test was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between March 16, 2020 and September 16, 2020 with L1 qualification test, detailed test data is stored at HECTL under EA20200081T, and partial test were performed at the Shang Hai Electrical Components Test Laboratory between June 16,2020 and June 30, 2020, the test files number for these testing are TP-20-01000. These documentations are on file at and available from the Engineering Assurance Product Testing Laboratory.

1.3. Conclusion

The QSFP Stacked Double Density Connector and Cage Assemblies test items listed in paragraph 1.6, conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-60130, Revision A.

1.4 Test Specimens

Test specimens were representative of normal production lots. Specimens identified with the following part numbers were used for test:

Test Group ID	Quantity	Part Number	Description
1,2,3,4,5,6	5 Each	2329457-1	Cage Assembly, with HS Spring, 2x1 Stacked, QSFP DD
	10 Each	N/A	QSFP DD Transceiver Assembly w/ Test Paddle card (60-1937412-1 Rev A) – (LLCR)
	5 Each	60-1951577-3 Rev A	QSFP DD LLCR Test PCB – Au
6	20	N/A	QSFP DD Transceiver Assembly w/ Production Paddle Card (Durability)
7,8,9	5 Each	2340397-2	Cage Assembly, with HS Spring, 2x1 Stacked, QSFP DD
7,8	5 Each	FP131206-X	QSFP DD Mechanical Test PCB – Au
7,9	10 Each	N/A	QSFP Transceiver Assembly w/ Production Paddle Card
7	10	N/A	QSFP DD Transceiver Assembly w/ Production Paddle Card

Table 1

NOTE: Separate “dummy” transceivers were used for all durability testing. For Test Sets 6, the transceiver was changed after 50 cycles of durability.

1.5 Environmental Conditions

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

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

1.6 Qualification Test Sequence

Test or Examination	Test Group (a)								
	1	2	3	4	5	6	7	8	9
	Test Sequence (b)								
Initial examination of product	1	1	1	1	1	1	1	1	1
Low Level Contact Resistance(e)	2,4,6,8	2,4,6	2,4,6,8	2,5,7	2,4,6	3,5			
Withstanding voltage						2,6			
Random vibration	5								
Mechanical shock	7								
Durability						4	4		
Mating force							2,5(g)		
Un-mating force							3,6(g)		
Rotational cable pull							7		
Compliant pin insertion force								2	
Compliant pin retention force								3	
Cage latch Strength									3
Thermal shock			3(c)						
Humidity/temperature cycling			5						
Temperature life(preconditioning)	3(c)			3(c)					2(c)(d)
Temperature life		3(c)							
Thermal Cycling(disturbance)					5				
Mixed flowing gas				4(f)					
Dust					3(c)				
Reseating		5	7	6	7				
Final examination of product	9	7	9	8	9	7	8	4	4

Table 2

NOTE:

(a) See Paragraph 1.4

(b) Numbers indicate sequence in which tests are performed.

(c) Precondition specimens with 20 durability cycles with latches engaged.

(d) Mated to blank transceivers (no components added to cable connector PCB).

(e) An *extra LLCR measurement was taken after preconditioning durability because of the use of "dummy" transceivers*

(f) Five samples, 2 mated 14 days, 3 un-mated 7 days, mated 7days.

(g) Modified transceiver that removes the kick-out spring and latch from the test.

2. Summary of testing

2.1 Initial Examination of Product - All Test Groups

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

2.2 Low Level Contact Resistance (LLCR) - Test Groups 1, 2, 3, 4, 5 and 6

Refer to table 3 through table 8 for all LLCR measurements summary data, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage had a change in resistance (ΔR) of less than 10 milliohms after testing.

Table3 – LLCR summary data in Milliohms, test group 1

Milliohms	Initial	After Precond. Durability	After Temperature Life	After Vibration	After Mechanical Shock
	Actual R	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)
Minimum	0.95	-0.83	-1.03	-1.49	-1.14
Maximum	35.74	2.54	1.25	7.00	9.87
Average	14.41	0.05	-0.16	0.01	0.19
Std. Dev.	10.75	0.31	0.34	0.76	0.87
N =	760	760	760	760	760

Table4 – LLCR summary data in Milliohms, test group 2

Milliohms	Initial	After Precond. Durability	After Temperature Life	After Reseating
	Actual R	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)
Minimum	0.87	-2.05	-1.51	-1.32
Maximum	34.49	0.54	1.72	9.61
Average	14.15	-0.13	-0.08	0.52
Std. Dev.	10.64	0.20	0.38	0.84
N =	760	760	760	760

Table5 – LLCR summary data in Milliohms, test group 3

Milliohms	Initial	After Precond. Durability	After Thermal Shock	After Cyclic Temp/Humidity	After Reseating
	Actual R	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)
Minimum	0.96	-2.62	-2.80	-2.70	-1.99
Maximum	34.87	0.42	2.65	5.02	9.32
Average	14.47	-0.16	-0.10	-0.17	0.44
Std. Dev.	10.79	0.34	0.56	0.57	0.91
N =	760	760	760	760	760

Table6 – LLCR summary data in Milliohms, test group 4

Milliohms	Initial	After Precond. Durability	After Temperature Life	After MFG 168 Hours	After MFG 336 Hours	After Reseating
	Actual R	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)
Minimum	0.81	-0.90	-1.04	-0.91	-0.83	-0.62
Maximum	33.91	0.36	0.44	3.49	2.32	6.66
Average	13.99	-0.14	-0.25	0.13	0.06	0.29
Std. Dev.	10.51	0.17	0.28	0.34	0.31	0.46
N =	760	760	760	760	760	760

Table7 – LLCR summary data in Milliohms, test group 5

Milliohms	Initial	After Precond. Durability	After Dust Contamination	After Thermal Disturbance	After Reseating
	Actual R	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)	Delta (ΔR)
Minimum	0.92	-1.01	-0.56	-0.99	-0.82
Maximum	34.87	0.56	6.26	9.41	8.31
Average	14.35	-0.12	0.64	0.50	0.34
Std. Dev.	10.72	0.19	0.87	0.94	0.60
N =	760	760	760	760	760

Table8 – LLCR summary data in Milliohms, test group 6

Milliohms	Initial	After Durability
	Actual R	Delta (ΔR)
Minimum	0.87	-4.68
Maximum	41.92	4.00
Average	15.00	0.11
Std. Dev.	11.14	0.45
N =	760	760

2.3 Durability (preconditioning) – Test Groups 1,2,3,4,5,9

No physical damage detrimental to product performance was visible due to unmating and mating the specimens 20 times.

2.4 Temperature Life – Test Group 2

No physical damage detrimental to product performance was visible due to temperature life exposure.

2.5 Temperature Life (preconditioning) – Test Groups 1,4,9

No physical damage detrimental to product performance was visible due to temperature life exposure.

2.6 Thermal Shock – Test Group 3

No physical damage detrimental to product performance was visible due to thermal shock exposure.

2.7 Cyclic Temperature & Humidity – Test Group 3

No physical damage detrimental to product performance was visible due to cyclic temperature and humidity exposure.

2.8 Vibration – Test Group 1

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

2.9 Mechanical Shock – Test Group 1

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

2.10 Mixed Flowing Gas – Test Group 4

No physical damage detrimental to product performance was visible due to exposure to the pollutants of mixed flowing gas.

2.11 Dust – Test Group 5

No physical damage detrimental to product performance was visible due to dust exposure. Several transceiver paddlecards had an excessive accumulation of dust following exposure. Refer to Figure 1 for typical images following testing.

Figure 1- Specimens Following Dust Exposure

2.12 Thermal Disturbance – Test Group 5

No physical damage detrimental to product performance was visible due to exposure to thermal disturbance.

2.13 Dielectric Withstanding Voltage – Test Group 6

no dielectric breakdown or flashover and the leakage current was below 5.0 milliamps DC.

2.14 Durability – Test Group 6,7

No physical damage detrimental to product performance was visible due to unmating and mating the specimens 100 times.

2.15 Reseating – Test Groups 2,3,4,5

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

2.16 Transceiver mating/unmating Force – Test Group 7

Refer to Table 9 for transceiver mating/unmating force data in Newtons. All mating force measurements were less than the requirement of 40.0 Newtons maximum for QSFP module and 90.0 Newtons maximum for QSFP-DD module, all unmating force measurements were less than the requirement of 30.0 Newtons maximum for QSFP module and 50.0 Newtons maximum for QSFP-DD module.

Sample	QSFP		QSFP-DD	
	Mating Force	Un-mating Force	Mating Force	Un-mating Force
Max.	37.5	25.9	54.9	28.1
Min.	17.2	12.6	31.1	16.5
Avg.	26.0	16.8	38.2	22.0
After durability test				
Max.	39.2	27.4	61.6	35.0
Min.	23.6	18.4	34.4	22.4
Avg.	31.1	22.9	44.2	29.0

Table 9

2.17. Rotational Cable Pull - Test Group 7

There was no displacement of the cage assembly or connector from the PCB when subjected to a minimum load of 33.4 N.

2.18 Press-Fit Insertion force/Retention force – Test Group 8

Refer to table 10 for total press-fit insertion/retention force data in Newtons, all press-fit insertion force measurements were less than 40N per cage pin and less than 20N per conn pin, and all press-fit retention force measurements were greater than 9.5N per cage front pin and greater than 1.0N per cage rear pin and conn pin(average).

	Insertion force
Max.	1112.5
Min.	986.3
Avg.	1030.2

	Retention force
Max.	289.5
Min.	280.0
Avg.	285.2

Table 10

2.19 Cage Latch Strength – Test Group 9

All specimens held 125 Newtons for 60 seconds with no displacement of the transceiver from the cage or the cage from the PCB.

2.20 Final Examination of Product

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

3. TEST METHODS

3.1 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 20millivolt maximum open circuit voltage. Positive current and voltage were supplied through the access headers on the PCB. Negative current and voltage were supplied through a bussed test paddle card in the transceiver. Testing was performed in accordance with EIA-364-23C.

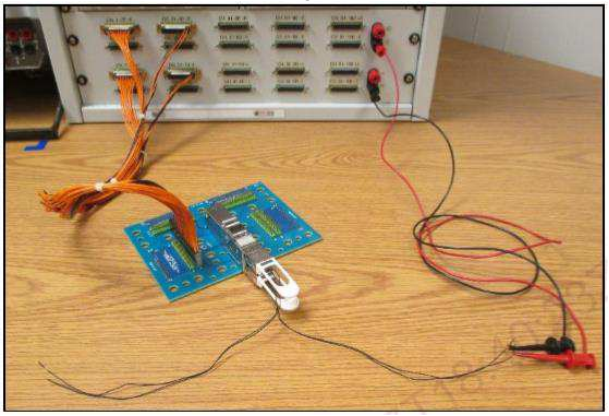

Figure 2 - Typical LLCR Test Setup

3.2 Durability (preconditioning) – 20 cycles

Specimens were mated and unmated 20 times by hand at a maximum rate of 300 cycles per hour. A “dummy” transceiver was used for durability. Testing was performed in accordance with EIA-364-09D.

3.3 Temperature Life

Mated specimens were exposed to a temperature of 105°C for 1000 hours. Testing was performed in accordance with EIA-364-17C.

3.4 Temperature Life (preconditioning)

Mated specimens were exposed to a temperature of 105°C for 66 hours. Testing was performed in accordance with EIA-364-17C.

3.5 Thermal Shock

Mated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 1hour dwells at -65°C and 105°C. The transition between temperatures was less than one minute. Testing was performed in accordance with EIA-364-32G.

3.6 Cyclic Temperature & Humidity

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.

3.7 Vibration

The test specimens were subjected to a random vibration test in accordance with specification EIA-364-28F, test condition V, test condition letter C. The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 50 and 2000 Hertz (Hz). The power spectral density (PSD) at 50 Hz is 0.015G²/Hz. The spectrum slopes up at 6 dB per octave to a PSD of 0.06 G²/Hz at 100 Hz. The spectrum is flat at 0.06 G²/Hz from 100 Hz to 1000 Hz. The spectrum slopes down at 6 dB per octave to a PSD of 0.015 G²/Hz at the upper bound frequency of 2000 Hz. The root-mean square amplitude of the excitation was 9.26 GRMS. The test specimens were subjected to this test for 120 minutes in each of the three mutually perpendicular axes, for a total test time of 6 hours 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 3 for images of the typical vibration test setup.

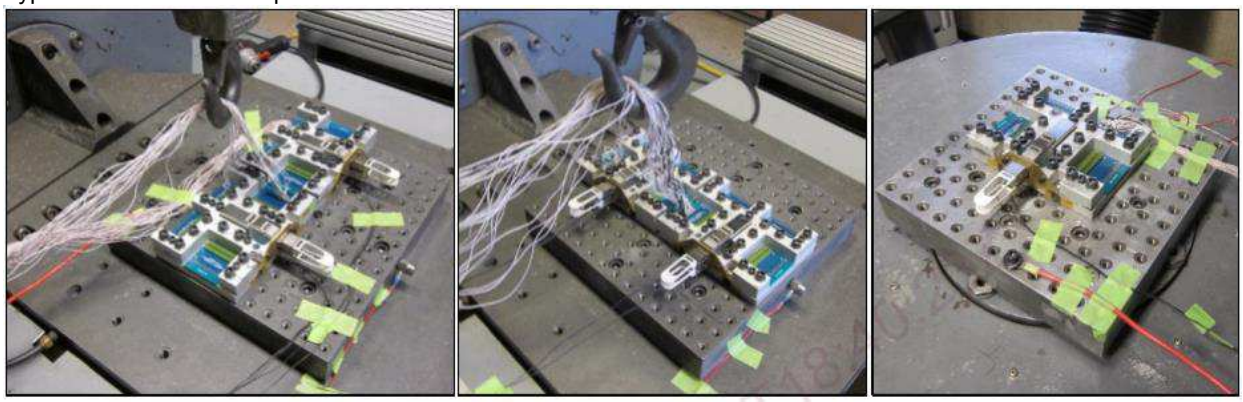

Figure 3 - Typical Vibration Test Setup

3.8 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, test condition A. The parameters of this test condition are a half-sine waveform with an acceleration amplitude of 50 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 4 for images of the typical mechanical shock test setup.

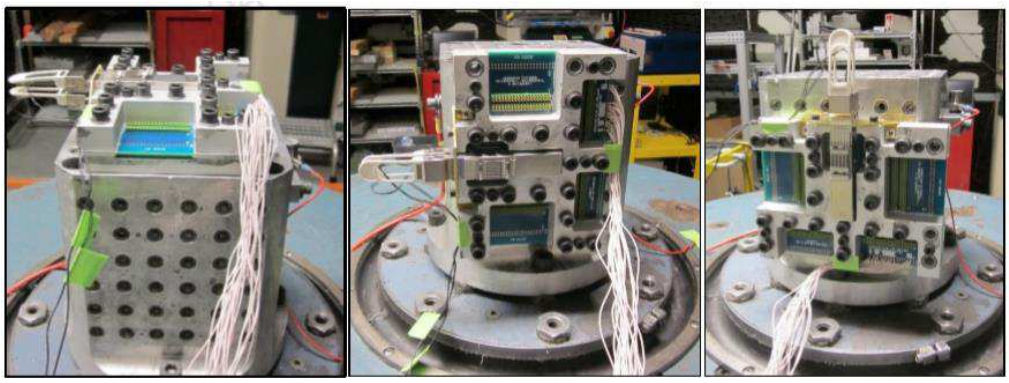

Figure 4 - Typical Mechanical Shock Test Setup

3.9 Mixed Flowing Gas

The test specimens were subjected to a 4-gas environment in accordance with EIA 364-65B Class IIA for 14 days. Three specimens were exposed in the unmated condition for the first 7 days [transceiver not exposed] and mated for the second 7 days. Two specimens were exposed in the mated condition for the entire 14-day test. Refer to Table 11 for the 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
Exposure Period [actual]	14 days
Chamber Volume Exchange Rate [minimum of 6/Hr.]	8.8/hr.*

Table 11 - MFG Test Parameters

3.10 Dust

Prior to exposure, the dust composition #1 (Benign) was placed in a container and evenly spread. The dust was placed in a heated desiccator and dried at 50°C for 1 hour. A dust mass of 9 grams per cubic foot of chamber volume or a total of 125 grams was used. Unmated specimens were placed in the dust chamber at various orientations as shown in Figure 5. 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. Testing was performed in accordance with EIA-364-91B.

Figure 5 - Typical Benign Dust Contamination Test Setup

3.11 Thermal Disturbance

Mated specimens were subjected to 10 cycles between 15°C and 85°C with minimum dwell times of 10 minutes at each extreme after the specimens have reached the specified temperature. This was determined by placing a thermocouple at the midpoint along the longitudinal length on the side of one specimen. Testing was performed in accordance with EIA-364-110.

3.12 Dielectric Withstanding Voltage

A test potential of 300 volts AC was applied between the adjacent signal contacts and signal to ground contacts of unmated specimens. This potential was applied for one minute and then returned to zero. A harness was built to test all adjacent signal contacts in a row at one time, then all signal contacts to ground. When failures occurred, the contacts were tested individually to isolate the failure. Testing was performed in accordance with EIA-364-20F.

3.13 Durability

Specimens were mated and unmated 100 times by hand at a maximum rate of 300 cycles per hour. Two “dummy” transceivers for each port were used to complete the 100 cycles of durability, 50 cycles each. Testing was performed in accordance with EIA-364-09D.

3.14 Transceiver mating/unmating Force

The force required to insert the transceiver into the receptacle with kick-out springs inoperable was measured using a tensile/compression device with a free-floating fixture and a rate of travel of 12.7 mm [.5 in] per minute. Figure 6

The force required to extract the transceiver from the receptacle with kick-out springs inoperable was measured using a tensile/compression device with a free-floating fixture and a maximum rate of travel of 12.7 mm [.5 in] per minute. Figure 6

Test setup (mating force)

Test setup (un-mating force)

Figure 6 – typical transceiver mating/unmating test set up

3.15 Rotational Cable Pull

The cable was held in a test fixture at approximately a 40degree angle. A 33.4 N weight was attached to the end of the cable and then rotated through 360 degrees at an approximate rate of 4 revolutions per minute for 1 revolution.

3.16 Press-fit Insertion Force/Retention Force

The force required to insert the specimen onto the PCB into proper seating location was measured using a tensile/compression device with a free-floating fixture with seating tool at a maximum rate of travel of 12.7 mm [.5 in] per minute. Figure 7.
The force required to extract the specimen from the PCB was measured using a tensile/compression device with a free-floating fixture with extracting tool at a maximum rate of travel of 12.7 mm [.5in] per minute. Figure 7.

Test setup

Test setup

Figure - 7 typical press-fit insertion/retention test setup

3.17 Cage Latch Strength

PCB mounted specimen and bezel with cable module inserted was held in a clamp attached to a movable crosshead while a force of 125 N was applied to the free end of the cable at a maximum rate of 6.35 mm per minute and held for 1 minute.

3.18 Reseating

Specimens were unmated and mated 1 time by hand.

3.19 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.