QSFP-OTB cage and cable mounted receptacle

1. INTRODUCTION

1.1 Purpose

Testing was performed on QSFB-OTB cage and cable mounted receptacle to determine its conformance to the requirements of 108-130044 Rev A.

1.2 Scope

This specification covers performance, test and quality requirements for QSFB-OTB cage and cable mounted receptacle. Testing was performed at TE Connectivity Shanghai Electrical Test Laboratory between Oct.21, 2019 and Nov.15, 2019. The associated test number is TP-19-02977.

1.3 Conclusion

All TE QSFP-OTB cages and cable mounted receptacle assemblies as listed in paragraph 1.5, conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-130044 Rev A.

1.4 Product Description

QSFP-OTB mates to any standard QSFP cable, from QSFP+ to QSFP28, but transmits signals to the processor through internal cables, instead of traces, for cleaner signal integrity performance. These internal cables mate to the QSFP cable through a cable mounted receptacle that latches to the QSFP-OTB cage.

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 Set	Test Group	Qty	Part Number	Description
1	1	5	2352105-1	QSFP-OTB Cage Assembly
		5	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		5	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		5	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
2	2	5	2352105-1	QSFP-OTB Cage Assembly
		5	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		5	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		5	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
3	3	3	2352105-1	QSFP-OTB Cage Assembly
		3	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		3	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		3	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
4		3	2352105-1	QSFP-OTB Cage Assembly
		3	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		3	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		3	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
5	4	5	2352105-1	QSFP-OTB Cage Assembly
		5	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		5	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		5	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
6	5	10	2352105-1	QSFP-OTB Cage Assembly
		10	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		10	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		10	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
7	6	10	2352105-1	QSFP-OTB Cage Assembly
		10	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board
8	7	10	2352105-1	QSFP-OTB Cage Assembly
		10	2362738-1	QSFP-OTB Receptacle Cable Pigtail
		10	60-1824603-1	QSFP28 LLCR Test Paddle Card, mounted in QSFP cable pigtail
		10	60-1950431-1	QSFP-OTB Test PCB, Mechanical Base Board

1.6 Qualification Test Sequence

Table 2 - Test Sequence

Test or Examination	Test Sets						
	1	2	3,4	5	6	7	8
	Test Group (a)						
	1	2	3	4	5	6	7
	Test Sequence (b)						
Initial examination of product	1	1	1	1	1	1	1
Low Level Contact Resistance	3,5,9	3,6	3,6,9				3,8
Insulation resistance				2,6			
Withstanding voltage				3,7			
Random vibration	6						
Mechanical shock	7						
Connector Durability	4(c)						
Cage Durability					5		
Catch latch, axial retention					6		
Mating force, QSFP module to QSFP-OTB cage and connector					3		
Unmating force, QSFP module to QSFP-OTB cage and connector					4		
Cage compliant pin insertion force					2	2	
Cage compliant pin retention force						4	
Receptacle latch durability							4
Receptacle latch, axial retention							5
Receptacle latch, lateral retention							6
Thermal shock				4			
Humidity/temperature cycling				5			
Temperature life		4				3	
Mixed flowing gas			4				
Thermal cycling			7				
Minute disturbance	2,8	2,5	2,5,8				2,7
Final examination of product	10	7	10	8	7	5	9

Note: (a) See paragraph 1.5
(b) Numbers indicate sequence which tests were performed.

1.7 Environmental Conditions

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

Temperature:	15°C to 35°C
Relative Humidity	25% to 75%

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 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 Groups 1, 2, 3, 7

Refer to Tables 3 through 6 for low level contact resistance summary data in milliohms. All recorded readings were below the requirement of a delta R (ΔR) of 20 milliohms maximum for LLCR.

Table 3 – Low Level Contact Resistance Summary Data in Milliohms, Test Group 1

Milliohms	Initial	After Durability	After Vibration & Mech. Shock
	Actual R	Delta (ΔR)	Delta (ΔR)
Test Set 1			
Minimum	4.80	-4.93	-6.88
Maximum	17.60	2.60	8.75
Average	8.68	-0.08	0.60

Table 4 – Low Level Contact Resistance Summary Data in Milliohms, Test Group 2

Milliohms	Initial	After Temp. Life
	Actual R	Delta (ΔR)
Test Set 2		
Minimum	6.10	-4.65
Maximum	10.44	3.07
Average	7.53	-0.56

Table 5 – Low Level Contact Resistance Summary Data in Milliohms, Test Group 3

Milliohms	Initial	After Durability	After Vibration & Mech. Shock
	Actual R	Delta (ΔR)	Delta (ΔR)
Test Set 3 - Mated			
Minimum	5.44	-4.14	-3.07
Maximum	9.97	3.14	3.45
Average	8.09	-0.40	-0.04
Test Set 4 – Unmated			
Minimum	5.36	-4.16	-4.07
Maximum	10.96	3.21	3.12
Average	8.52	-0.76	-0.39

Table 6 – Low Level Contact Resistance Summary Data in Milliohms, Test Group 7

Milliohms	Initial	After Latch Durability & Retention
	Actual R	Delta (ΔR)
Test Set 8		
Minimum	5.20	-2.56
Maximum	9.99	2.72
Average	7.63	0.21

2.3 Insulation Resistance – Test Group 4

All insulation resistance measurements were greater than 1000 megohms.

2.4 Withstanding Voltage – Test Group 4

No dielectric breakdown or flashover occurred.

2.5 Random Vibration – Test Group 1

No apparent physical damage or discontinuities of one microsecond or greater occurred during testing.

2.6 Mechanical Shock – Test Group 1

No apparent physical damage or discontinuities of one microsecond or greater occurred during testing.

2.7 Durability – Test Group 1

No physical damage detrimental to product performance was visible due to mating and unmating the specimens 245 times.

2.8 Cage Durability – Test Group 5

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

2.9 Catch latch, axial retention – Test Group 5

Refer to Table 7 for cage latch, axial retention force summary data. All recorded forces were above the requirement of 125.0 Newtons [28.09lbf] minimum for cage latch, axial retention.

Table 7 – Cage Latch, Axial Retention

	Cage Latch Axial Retention
	Newtons
Minimum	219.23
Maximum	299.52
Average	257.82
Requirement	125.0 N Min

2.10 Mating force, QSFP module to QSFP-OTB cage and connector – Test Group 5

Refer to Table 8 for mating force summary data. All recorded forces were below the requirement of 40.0 Newtons [8.99lbf] maximum for mating force.

Table 8 – Mating Force Data in Newtons

	Mating Force
	Newtons
Minimum	8.90
Maximum	19.24
Average	15.75
Requirement	40.0 N Max

2.11 Unmating force, QSFP module from QSFP-OTB cage and connector – Test Group 5

Refer to Table 9 for unmating force summary data. All recorded forces were below the requirement of 30.0 Newtons [6.74lbf] maximum for unmating force.

Table 9 – Unmating Force Data in Newtons

	Mating Force
	Newtons
Minimum	5.38
Maximum	17.47
Average	11.65
Requirement	30.0 N Max

2.12 Cage compliant pin insertion force – Test Groups 5, 6

Refer to Tables 10 and 11 for cage compliant pin insertion force summary data. All recorded forces were below the requirement of 54 Newtons [12.14lbf] maximum average per pin for cage compliant pin insertion force. The connector force was divided by 15 to obtain the average per pin data.

Table 10 – Cage Compliant Pin Insertion Force – Test Group 5

	Connector Force	Average Per Pin
	Newtons	Newtons
Minimum	524.53	34.97
Maximum	709.66	47.31
Average	602.27	40.15
Requirement	810.0 N Max.	54.0 N Max.

Table 11 – Cage Compliant Pin Insertion Force – Test Group 6

	Connector Force	Average Per Pin
	Newtons	Newtons
Minimum	433.03	28.87
Maximum	798.72	53.25
Average	611.92	40.79
Requirement	810.0 N Max.	54.0 N Max.

2.13 Cage compliant pin retention force – Test Group 6

Refer to Table 12 for cage compliant pin retention force summary data. All recorded forces were above the requirement of 8.0 Newtons [1.80 lbf] minimum average per pin for cage compliant pin retention force. The connector force was divided by 15 to obtain the average per pin data.

Table 12 – Cage Compliant Pin Retention Force – Test Group 6

	Connector Force	Average Per Pin
	Newtons	Newtons
Minimum	162.53	10.84
Maximum	291.34	19.42
Average	225.12	15.01
Requirement	120.0 N Min.	8.0 N Min.

2.14 Receptacle latch durability – Test Group 7

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

2.15 Receptacle latch, axial retention – Test Group 7

No physical damage detrimental to product performance was visible due to applying an axial force of 44 N to the QSFP-OTB cable mounted receptacle.

2.16 Receptacle latch, lateral retention – Test Group 7

No physical damage detrimental to product performance was visible due to applying a lateral force (perpendicular to the mating axis, both perpendicular and parallel to the test board, for a total of 4 directions) of 44 N to the QSFP-OTB cable mounted receptacle.

2.17 Thermal Shock – Test Group 4

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

2.18 Humidity/Temperature Cycling – Test Group 4

No physical damage detrimental to product performance was visible due to humidity/temperature cycling.

2.19 Temperature Life – Test Group 2, 6

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

2.20 Mixed Flowing Gas – Test Group 3

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

2.21 Thermal Cycling – Test Group 3

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

2.22 Minute Disturbance – Test Groups 1, 2, 3, 7

No physical damage detrimental to product performance was visible due to a minute disturbance.

2.23 Final Examination of Product – All Test Groups

Specimens were visually examined and no physical damage detrimental to product performance was visible.

3. TEST METHODS

3.1. Initial Examination of Product

A C of C was issued stating that all specimens in this test package were produced, inspected, and accepted as conforming to product drawing requirements, and were manufactured 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. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Positive current and voltage was applied to the discrete wires of the cable mounted QSFP-OTB receptacle. Negative current and voltage was connected to the paddle card bus. Refer to Figure 1 for an image of the typical test setup. Testing was performed in accordance with EIA-364-23C.

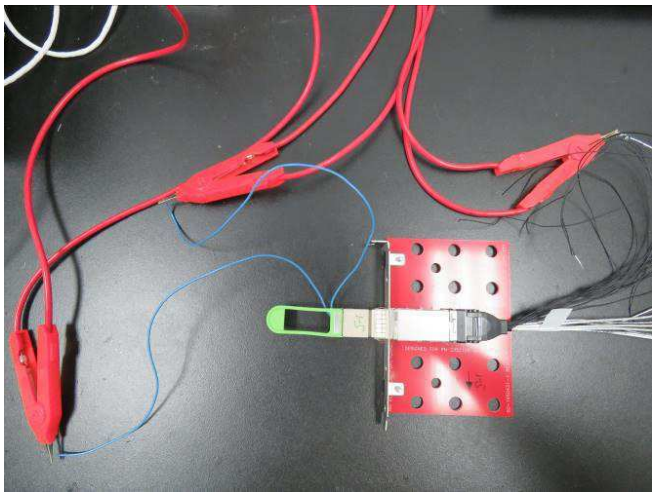

Figure 1 – Typical LLCR Test Setup

3.3 Insulation Resistance

Insulation resistance was measured between adjacent signal contacts of unmated specimens. A test voltage of 100 volts DC was applied for one minute before the resistance was measured. Refer to Figure 2 for an image of the typical test setup. Testing was performed in accordance with EIA-364-21E.

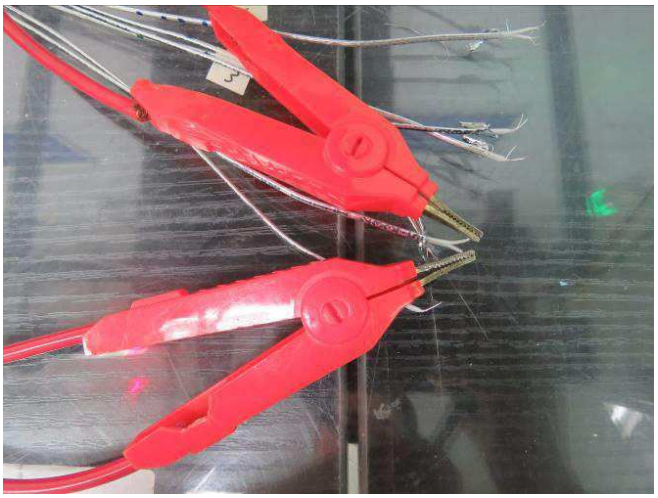

Figure 2 – Typical IR/DWV Test Setup

3.4 Withstanding Voltage

A test potential of 300 volts AC was applied between the adjacent signal to signal and signal to ground contacts of unmated specimens. This potential was applied for one minute and then returned to zero. Refer to Figure 2 (above) for an image of the typical test setup. Testing was performed in accordance with EIA-364-20E.

3.5 Random Vibration

The test specimens were subjected to a random vibration test in accordance with specification EIA-364-28F, test condition “VII”, test condition letter “D”. The test specimens were subjected to 3.10 G RMS between 20 to 500 Hz, for 15 minutes in each of 3 perpendicular planes. They were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes. Refer to Figure 3 for an image of the typical test setup.

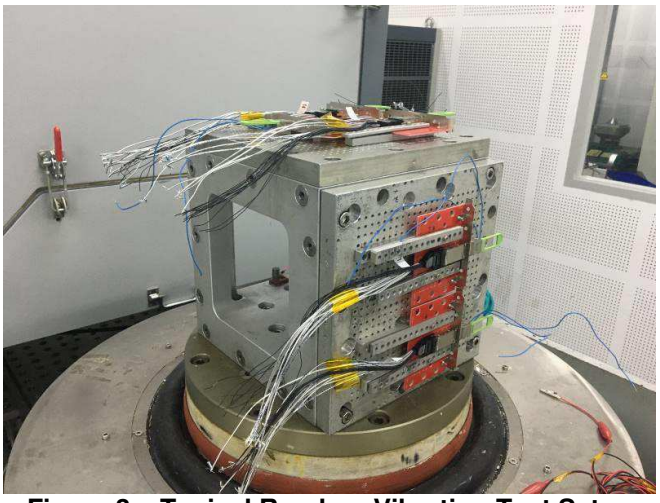

Figure 3 – Typical Random Vibration Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, test condition “H”. Three shocks, 30 Gs half-sine shock pulses of 11 milliseconds duration, 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 3 (Above) for an image of the typical test setup.

3.7 Connector Durability

The specimens were mated and unmated 250 times by hand at a rate less than 6.35mm per minute. Testing was performed in accordance with EIA-364-09D.

3.8 Cage Durability

The specimens were mated and unmated 100 times by hand with latches enabled. Testing was performed in accordance with EIA-364-09D.

3.9 Cage latch, axial retention

The force was measured to remove a QSFP module from the QSFP-OTB cage, with latches enabled, at a rate of 25.4 mm per minute. Refer to Figure 4 for an image of the typical setup. Testing was performed in accordance with EIA-364-09D.

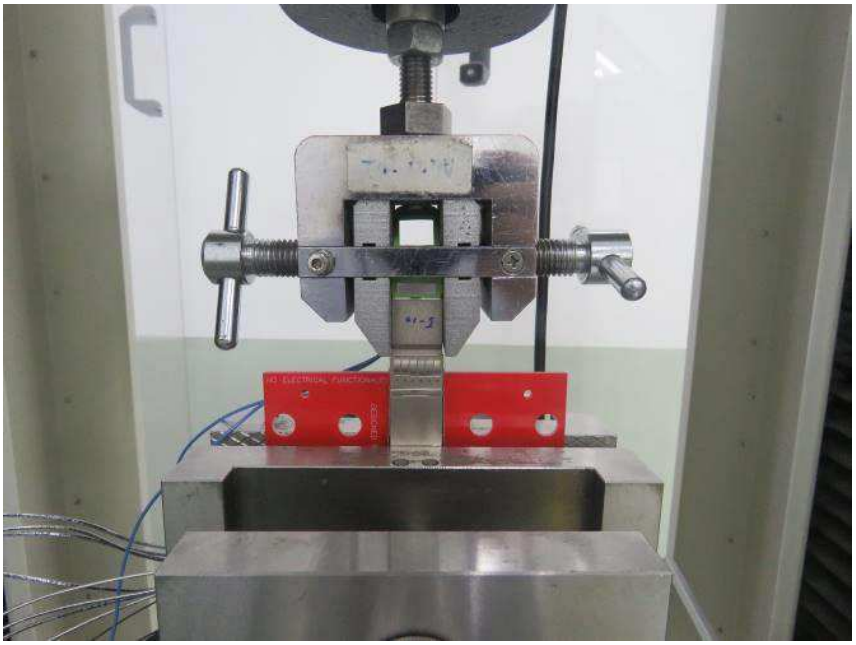

Figure 4 – Typical Cage Latch Axial Retention Test Setup

3.10 Mating force, QSFP module to QSFP-OTB cage and connector

The force was measured to mate a QSFP module to the QSFP-OTB cage and cable mounted receptacle at a rate of 12.7 mm per minute. Refer to Figure 5 for an image of the typical setup. Testing was performed in accordance with EIA-364-13E.

Figure 5 – Typical Mating Force Test Setup

3.11 Unmating force, QSFP module from QSFP-OTB cage and connector

The force was measured to unmate a QSFP module from the QSFP-OTB cage and cable mounted receptacle at a rate of 12.7 mm per minute. Refer to Figure 6 for an image of the typical setup. Testing was performed in accordance with EIA-364-13E.

Figure 6 – Typical Unmating Force Test Setup

3.12 Cage compliant pin insertion force

The force was measured to press the cage into the host board at a rate of 12.7 mm per minute. Refer to Figure 7 for an image of the typical setup. Testing was performed in accordance with EIA-364-05B.

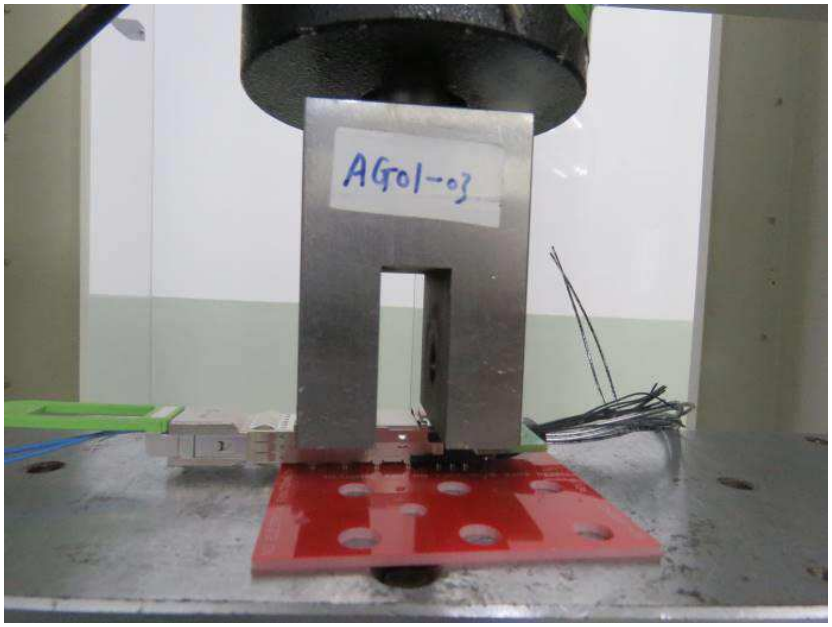

Figure 7 – Typical Cage Compliant Pin Insertion Force Test Setup

3.13 Cage compliant pin retention force

The host board was fixtured to the base of a tensile/compression machine. A separate fixture, attached to the head of the tensile/compression machine, was attached to the cage and applied an upwards force. The force was measured to pull the cage off the host board at a rate of 12.7 mm per minute. Refer to Figure 8 for an image of the typical setup. Testing was performed in accordance with EIA-364-29C.

Figure 8 – Typical Cage Compliant Pin Retention force Test Setup

3.14 Receptacle latch durability

The QSFP-OTB cable mounted receptacle was mated to the cage, latched, unlatched and unmated from the cage with no QSFP module. Testing was performed in accordance with EIA-364-09D.

3.15 Receptacle latch, axial retention

The QSFP-OTB cage, mounted to a host board, with the cable mounted receptacle mated to it but no QSFP module, was fixtured vertically on a tensile/compression machine. The cables from the receptacle were clamped on the head of the tensile/compression machine, which exerted an upwards force on the cable, axially to the mating direction. A 44 Newton force was applied for 5 seconds. Refer to Figure 9 for an image of the typical setup.

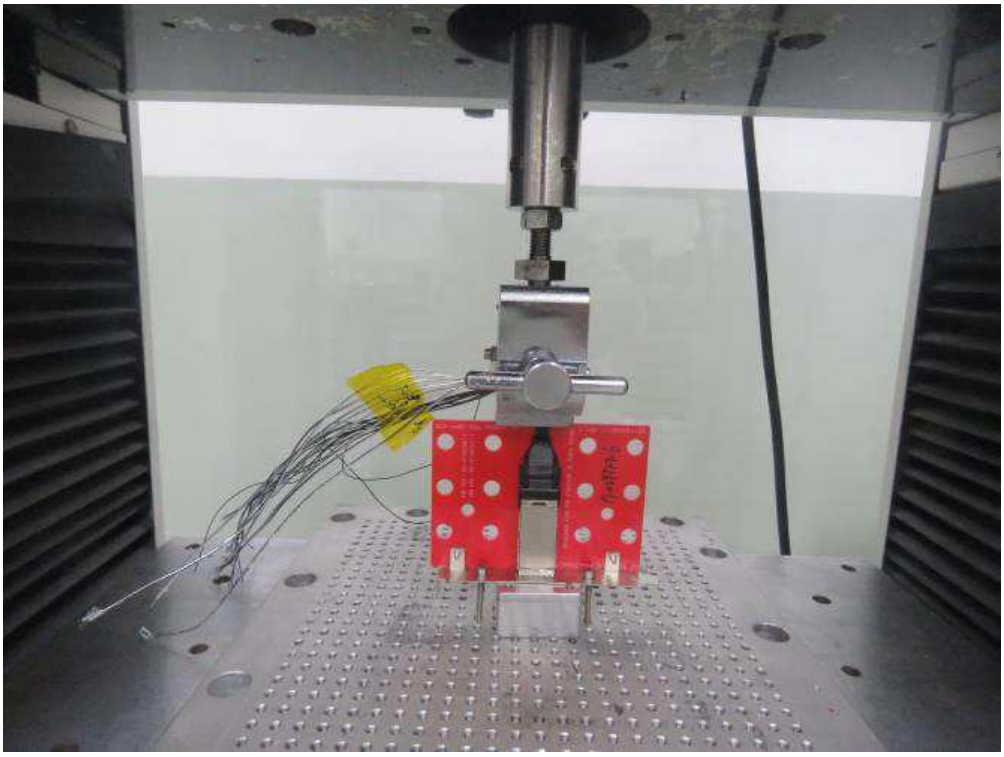

Figure 9 – Typical Receptacle Latch Axial Retention Test setup

3.16 Receptacle latch, lateral retention

The QSFP-OTB cage, pressed on a host board, with cable mounted receptacle but no QSFP module, was fixtured to the base of a tensile compression machine in 4 directions but always perpendicular to the machines head so that the machine would exert a force perpendicular to the mating axis of the cage. The cage was mounted horizontally with the host board between the cage and the head. It was also mounted horizontally with the cage on the same side as the head. The cage was then mounted on it side, with the port always facing forward but with the cage on the left of the host board and then of the right of the host board. The cables from the cable mounted receptacle were clamped to the tensile/compression machine head. A force of 44 Newtons was applied upwards in all 4 directions for 5 seconds each. Refer to Figure 10 for an image of the typical setup.

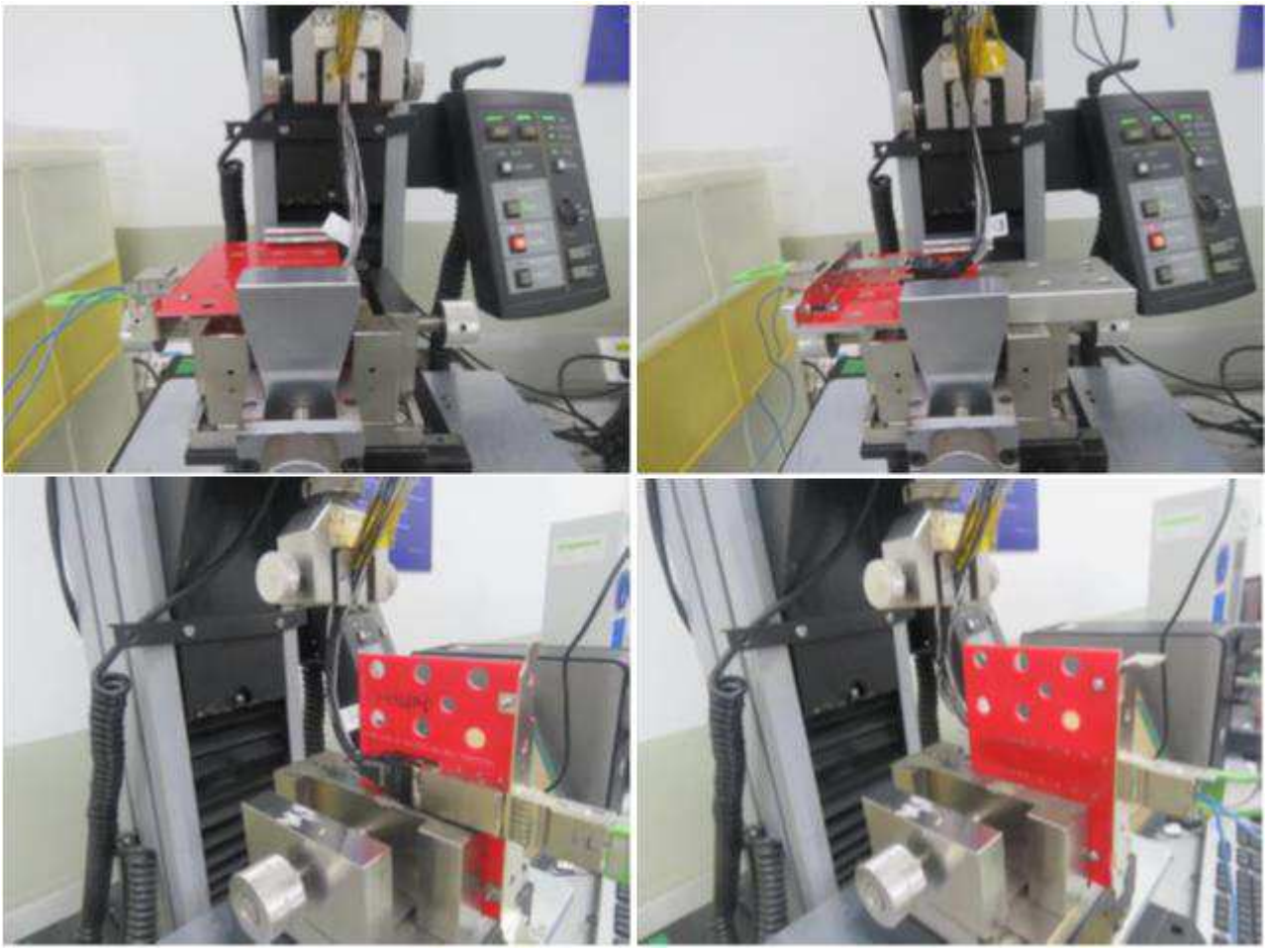

Figure 10 – Typical Receptacle Latch Lateral Retention Test Setup

3.17 Thermal Shock

Unmated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 30 minute dwells at -55 and 85°C. The transition between temperatures was less than one minute. Testing was performed in accordance with EIA-364-32G, Method A, Test Condition I.

3.18 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 at 80 to 100% relative humidity. Testing was performed in accordance with EIA-364-31E, Method IV.

3.19 Temperature Life

Mated specimens were subjected to 105°C for a duration of 250 hours. Testing was performed in accordance with EIA-364-17C, Method A.

3.20 Mixed Flowing Gas

The specimens were subjected to a 4-gas environment in accordance with EIA 364-65B, Class IIA for 14 days. Three specimens from each set were unmated for the first 7 days (receptacle only) and mated for the final 7 days. The remaining three specimens were mated for the entire 14-day exposure period.

3.21 Thermal Cycling

Mated and board mounted specimens were subjected to 10 temperature cycles between 15 ±3°C and 85±3°C as measured on the specimen. The ramp time was > 2°C per minute with dwell times long enough to ensure the contacts reached the temperature extremes (5 minutes minimum), humidity not controlled. Testing was performed in accordance with EIA-364-110, Condition A.

3.22 Minute Disturbance

Specimens were mated and unmated 5 times by hand.

3.23 Final Examination of Product

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