QSFP Double Density Receptacle

1. INTRODUCTION

1.1 Purpose

Qualification testing was performed on TE Connectivity (TE) QSFP Double Density (DD) Receptacles to evaluate its conformance to Product Specification 108-130016 Rev A.

1.2 Scope

This report covers the electrical, mechanical and environmental performance of TE QSFP DD Receptacles. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between 13-November-2018 and 31-January-2019. Detailed test data is stored at HECTL under EA20180406T.

1.3 Conclusion

Specimens met the requirements listed in Product Specification 108-130016 Rev A. Detailed results are located in Section 2.

1.4 Product Description

TE's QSFP DD (quad small form-factor pluggable double density) doubles the density of QSFP interconnects with an eight-lane electrical interface capable of 28 Gbps NRZ or 56 Gbps PAM-4 to achieve 200 or 400 Gbps aggregate per port. The QSFP DD portfolio's backwards compatibility allows existing QSFP modules to be plugged into QSFP DD ports. Our QSFP DD cages feature a proprietary heat sink design, making them the only solution to work in 15-18W applications.

1.5 Test Specimens

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

Table 1 – Test Specimens

Test Set	Qty	Part Number	Description
1,2	5 each	2318579-2	QSFP DD 76 Position SMT Receptacle
	5 each	2327362-1	QSFP DD 1x1 Cage Assembly
	5 each	N/A	QSFP Double Density Plug
	5 each	N/A	QSFP Double Density Bezel
	5 each	60-1937412-1	QSFP Double Density Test Paddlecard
	5 each	60-1937411-1	QSFP Double Density LLCR Test PCB
3	6	2318579-2	QSFP DD 76 Position SMT Receptacle
	6	2323256-1	QSFP DD 1x1 Cage Assembly
	6	N/A	QSFP Double Density Plug
	6	N/A	QSFP Double Density Bezel
	6	60-1937412-1	QSFP Double Density Test Paddlecard
	6	60-1937411-1	QSFP Double Density LLCR Test PCB
4,5,6	5 each	2318579-2	QSFP DD 76 Position SMT Receptacle

1.6 Qualification Test Sequence

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

Table 2 – Test Sequence

Test or Examination	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 (LLCR)	3,5,9	2,4,7	3,6,8			
Insulation Resistance				2,6		
Withstanding Voltage				3,7		
Random Vibration	6					
Mechanical Shock	7					
Durability	4					
Mating Force	2					
Un-mating Force	10					
Connector Solderability					2	
Resistance to Reflow Soldering Heat						2
Thermal Shock				4		
Humidity/Temperature Cycling		5		5(c)		
Temperature Life		3(b)				
Mixed Flowing Gas (MFG)			4			
Thermal Cycling			7			
Minute Disturbance			5			
Re-Seating	8	6	2			
Final Examination of Product	11	8	9	8	3	3

(a) Numbers indicate the sequence in which tests were performed.
(b) Precondition specimens with 20 durability cycles with latches engaged.
(c) Unmated

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

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

2.2 Low Level Contact Resistance

Specimens met the required maximum delta of 20 mohm. Refer to Table 3 to Table 5 for LLCR summary data.

Table 3 – LLCR Summary Data in milliohms, Test Set 1

Reading	Initial Reading (Actual R)	After Durability (ΔR)	After Vibration, Shock and Re-Seating (ΔR)
Minimum	8.25	-2.12	-2.80
Maximum	18.98	2.05	3.22
Average	11.78	0.06	-0.03
Std. Dev.	2.63	0.51	0.55
N =	380 [380]	380 [380]	380 [380]

Table 4 – LLCR Summary Data in milliohms, Test Set 2

Reading	Initial Reading (Actual R)	After Temp Life (ΔR)	After Re-Seating (ΔR)
Minimum	8.08	-1.25	-5.69
Maximum	24.35	16.73	14.69
Average	11.85	0.76	1.39
Std. Dev.	2.75	1.86	1.75
N =	380 [380]	380 [380]	380 [380]

Table 5 – LLCR Summary Data in milliohms, Test Set 3

Reading	Initial Reading (Actual R)	After MFG and Minute Disturbance (ΔR)	After Thermal Cycling (ΔR)
Minimum	8.04	-3.56	-3.84
Maximum	20.24	16.56	3.32
Average	11.81	0.59	-0.09
Std. Dev.	2.65	1.68	0.71
N =	456 [456]	456 [456]	456 [456]

2.3 Insulation Resistance

All specimens had an insulation resistance greater than 1000 Megaohms, meeting the testing requirements.

2.4 Withstanding Voltage

No breakdown or flashover occurred between adjacent contacts.

2.5 Random Vibration

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

2.6 Mechanical Shock

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

2.7 Durability

No physical damage detrimental to product performance was visible due to durability.

2.8 Mating Force

Specimens met the 90-Newton maximum mating force requirement. See Table 6 for detailed results.

Table 6 – Mating Force Results, Test Set 1

Specimen ID	Mating Force (N)
1	29.18
2	27.34
3	29.00
4	30.67
5	28.40
Minimum	27.34
Maximum	30.67
Mean	28.92
Std. Dev.	1.21

2.9 Unmating Force

Specimens met the 15 Newton minimum unmating force requirement. See Table 7 for detailed results.

Table 7 – Unmating Force Results, Test Set 1

Specimen ID	Unmating Force (N)
1	27.20
2	22.82
3	27.99
4	28.24
5	30.82
Minimum	22.82
Maximum	30.82
Mean	27.42
Std. Dev.	2.90

2.10 Connector Solderability

The specimens under evaluation exhibited a continuous solder coating, free from defects, over the more than 95% of the critical surface areas. See Figure 1 for a representative image of the typical contacts as tested.

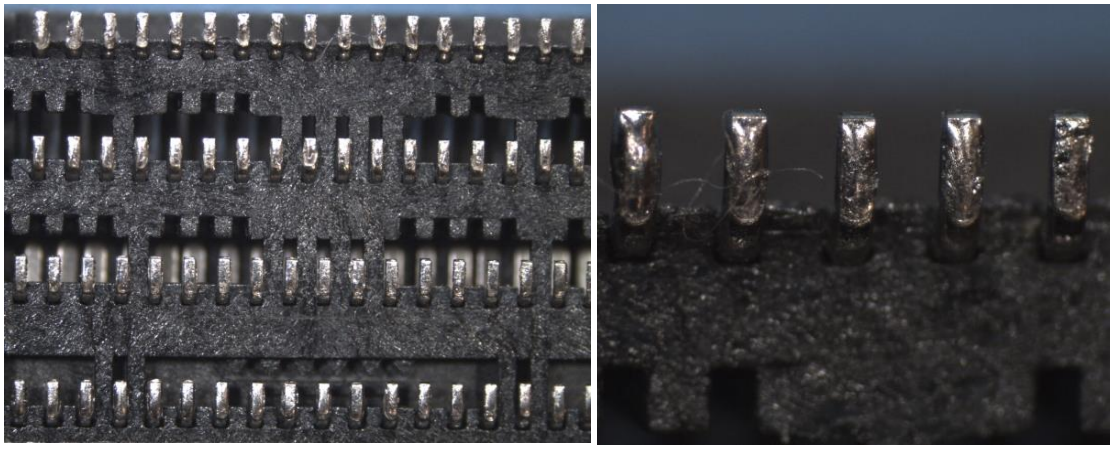

Figure 1 – Connector Solderability Results – Typical Contacts Tested

2.11 Resistance to Reflow Soldering Heat

No defects, damage, or discoloration was observed on any specimen as a result of the moisture soak preconditioning.

No visual evidence of melting, cracking, blistering or other damage was observed on any of the other specimens after the first, second, or third reflow heat exposure.

2.12 Thermal Shock

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

2.13 Humidity / Temperature Cycling

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

2.14 Temperature Life

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

2.15 Mixed Flowing Gas

No physical damage detrimental to product performance was visible due to mixed flowing gas.

2.16 Thermal Cycling

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

2.17 Minute Disturbance

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

2.18 Re-Seating

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

2.19 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. 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.

3.2 Low Level Contact Resistance

Specimens were subjected to low level contact resistance in accordance with test procedure EIA 364-23C. See Figure 2 for a representative image of the test setup.

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 voltage and current were applied to the access headers of the PCB and negative voltage and current were applied to wires of the transceiver module.

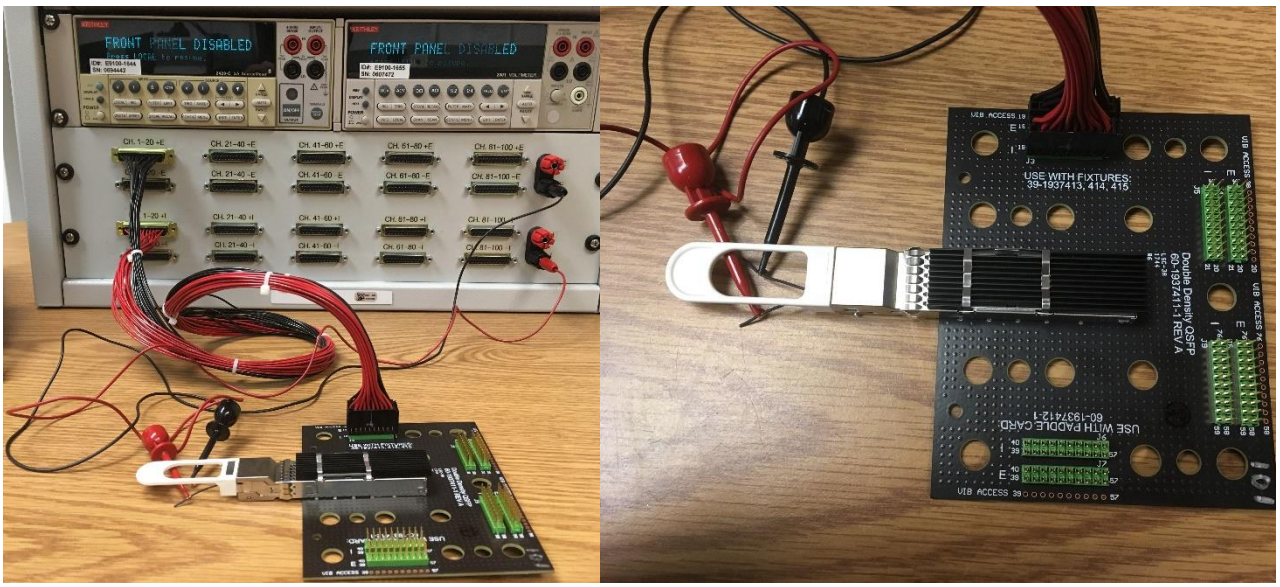

Figure 2 – Low Level Contact Resistance Test Setup

3.3 Insulation Resistance

Specimens were subjected to insulation resistance testing in accordance with test procedure EIA 364-21E. See Figure 3 for a representative image of the test setup. A test potential of 100 VDC was applied to adjacent contacts on mated specimens for one minute with insulation resistance measurements recorded immediately after.

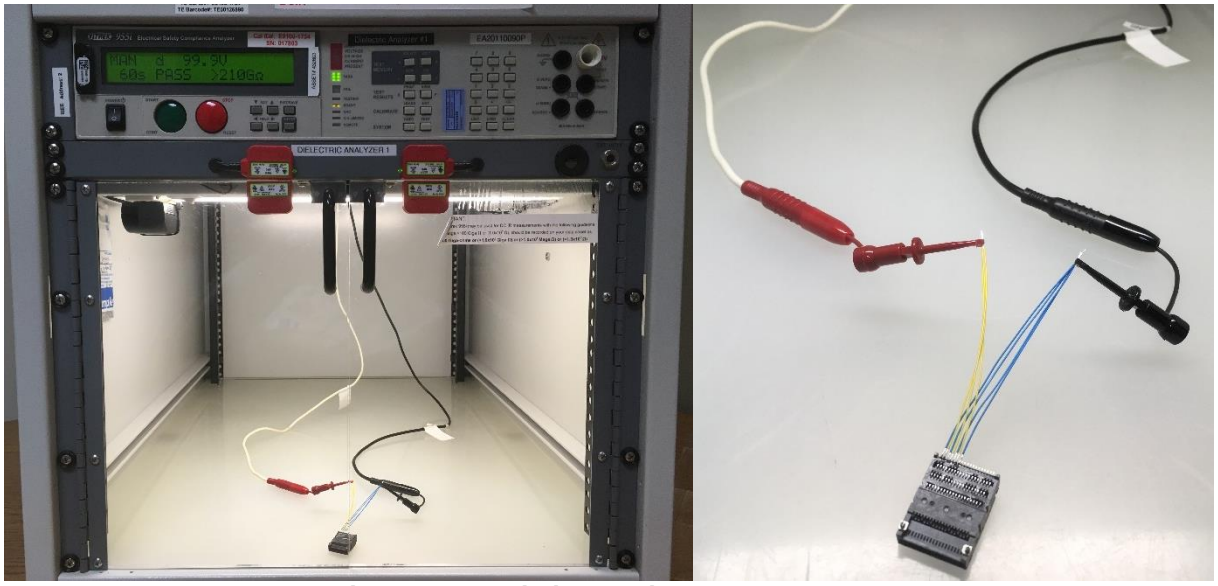

Figure 3 – Insulation Resistance Test Setup

3.4 Withstanding Voltage

Specimens were subjected to withstanding voltage testing in accordance with test procedure EIA 364-20E. See Figure 4 for a representative image of the test setup. Test leads were connected to adjacent contacts on mated specimens with the test voltage increased from zero to 300 VAC at a rate of 300 volts per second. The 300 VAC was held for one minute and the maximum leakage current recorded as well as any occurrence of breakdown or flashover.

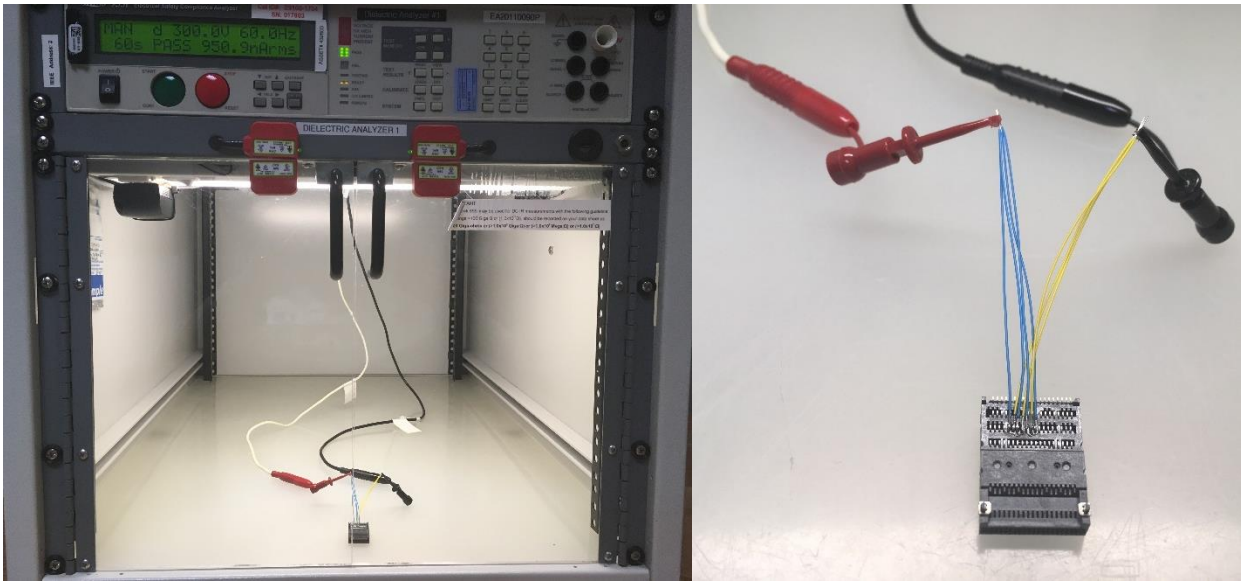

Figure 4 – Withstanding Voltage Test Setup

3.5 Random Vibration

The test specimens were subjected to a random vibration test in accordance with test procedure EIA 364-28F, test condition VII, test condition letter D. See Figure 5 for a representative image of the test setup.

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.

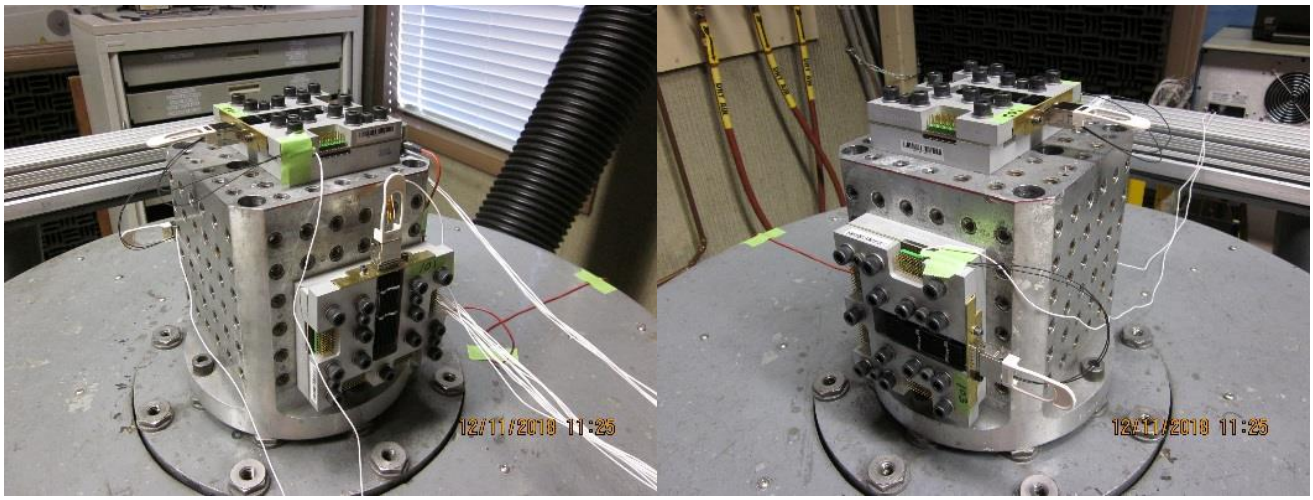

Figure 5 – Random Vibration Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with test procedure EIA 364-27C, test condition H. See Figure 6 for a representative image of the test setup.

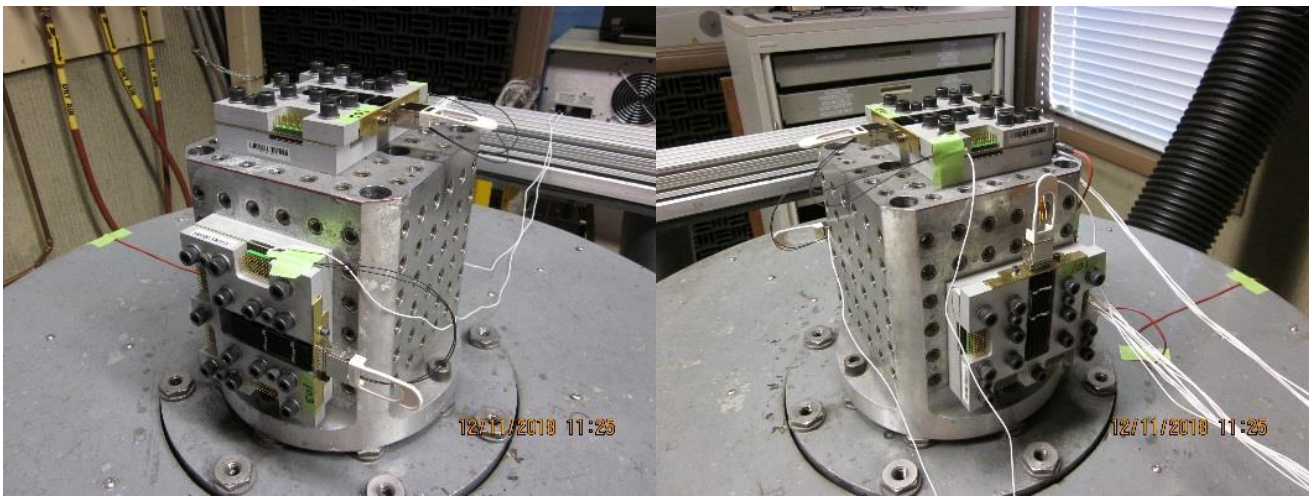

Figure 6 – Mechanical Shock Test Setup

3.7 Durability

Specimens were subjected to durability in accordance with test procedure EIA 364-9D. Specimens were subjected to 50 mate / unmate cycles by hand at a rate of no more than 300 cycles per hour with latches engaged.

Additional durability specific testing was completed outside of qualification. Results can be found in 502-134268.

3.8 Mating Force

Specimens were subjected to mating force in accordance with test procedure EIA 364-13E. See Figure 7 for a representative image of the test setup.

The PCB was attached to a right-angle plate mounted to a mill table. The mill table was attached to the base of the tensile/compression machine. The transceiver module was manually started into the cage. A probe was held in a drill chuck attached to the moveable crosshead of the tensile/compression machine. The probe was manually aligned with the cage and force was applied in a downward direction at a rate of 0.5 inches per minute until the transceiver module was fully inserted and the latches engaged. The peak mating force was recorded.

3.9 Un-mating Force

Specimens were subjected to unmating force in accordance with test procedure EIA 364-13E. See Figure 8 for a representative image of the test setup.

The specimen was secured to an XYR alignment table attached to the base of the tensile/compression machine. The latching release feature was held in a vice attached to the moveable crosshead of the tensile/compression machine. Force was applied in an upward direction at a rate of 0.5 inches per minute until the transceiver module was fully unmated. The peak unmating force was recorded.

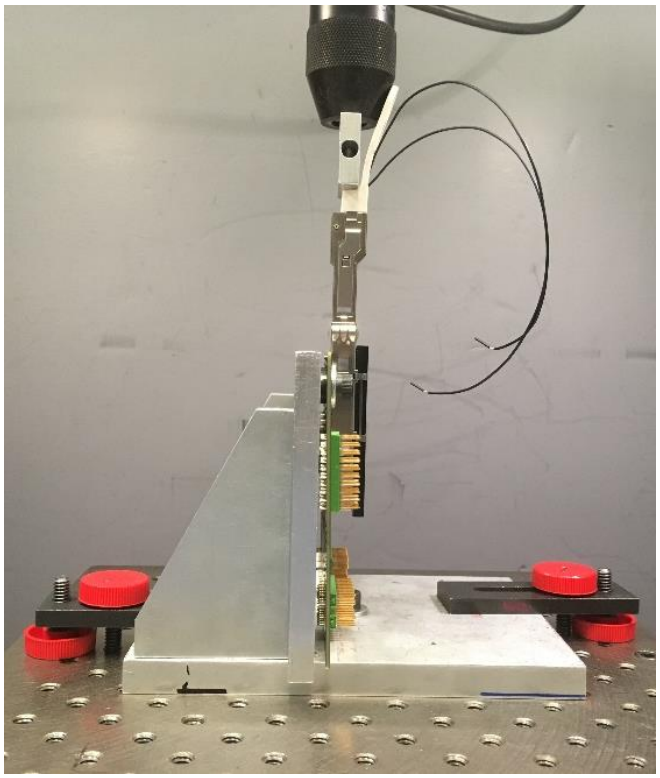

Figure 7 – Mating Force Test Setup

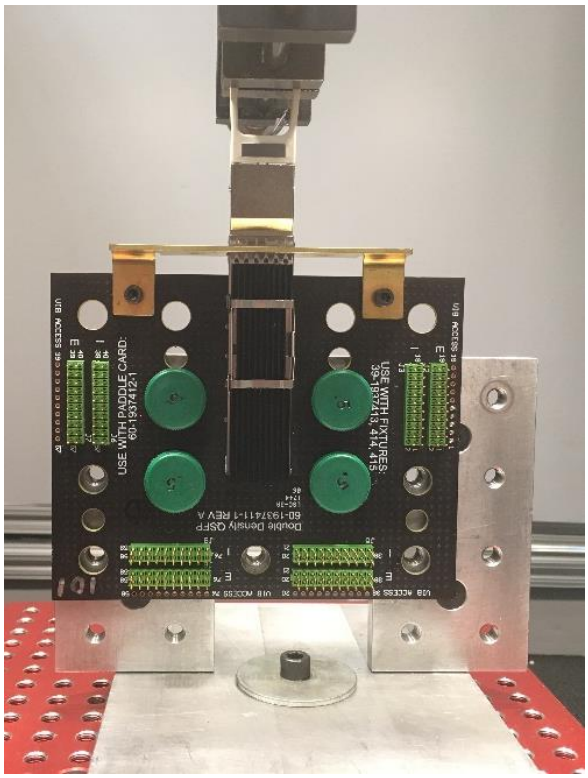

Figure 8 – Unmating Force Test Setup

3.10 Connector Solderability

Specimens were subjected to connector solderability in accordance with test procedure IPC/ECA J-STD-002. See Figure 9 for the reflow profile. See Figures 10 and 11 for representative images of the test setup.

Prior to testing, specimens were prepared by removing the locating studs as well as the connector standoff feature. This was done to enable the specimens to sit flush on the ceramic substrate.

A solder paste with a composition of Sn96.5, Ag3.0, Cu0.5 RMA, with a mesh of –325 +500 was placed onto a stencil with pad geometry, opening, and thickness that was appropriate for the specimens being tested. The solder paste was printed onto a 4 x 6 inch ceramic substrate. The screen was removed and the specimens were placed onto the solder paste print under appropriate magnification. Care was taken to ensure that the specimens were not contaminated in any way and were tested in the “as received” condition.

The specimens and ceramic substrates were placed on a conveyor belt through a convection oven. The specimens were exposed to 60-120 seconds between the temperatures of 150°C and 180°C and to 30-60 seconds between the temperatures of 230°C and 260°C as specified in J-STD-002. The temperature on the ceramic substrate, at a point close to the specimen, was monitored to enable temperature profiling.

All specimens were examined using a microscope for solder wetting.

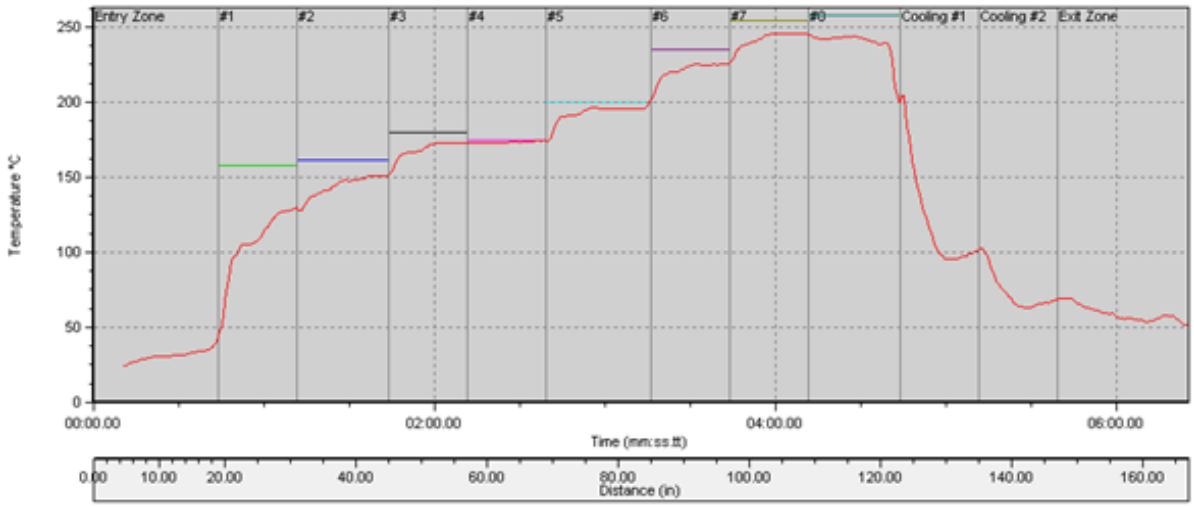

Figure 9 – Solderability Test Setup - Reflow Profile

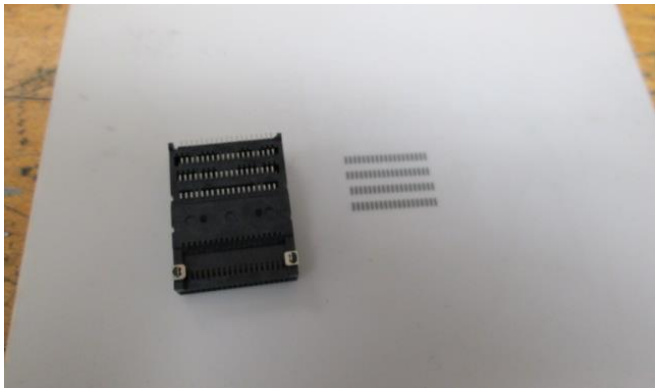

Figure 10 – Solderability Test Setup – Test Specimen and Solder Paste

Figure 11 – Solderability Test Setup – Test Specimen on Oven Conveyor

3.11 Resistance to Reflow Soldering Heat

Specimens were subjected to resistance to reflow soldering heat in accordance with test specification TEC-109-201. See Figure 12 for the reflow profile and Figure 13 for the reflow results.

The specimens were placed on 4 X 6 X 0.0395 inch ceramic substrates and placed on a conveyor belt through a convection air oven. The specimens were exposed to temperatures between 150°C and 200°C for 60 to 180 seconds and between the temperatures of 255°C and 260°C for 20 to 40 seconds, and above liquidus (217°C) for 60 to 150 seconds. The temperature on top of the specimen was monitored to enable temperature profiling. The specimens and substrates were allowed to cool to ambient temperatures, were visually examined, and then run back through the oven a total of 3 times.

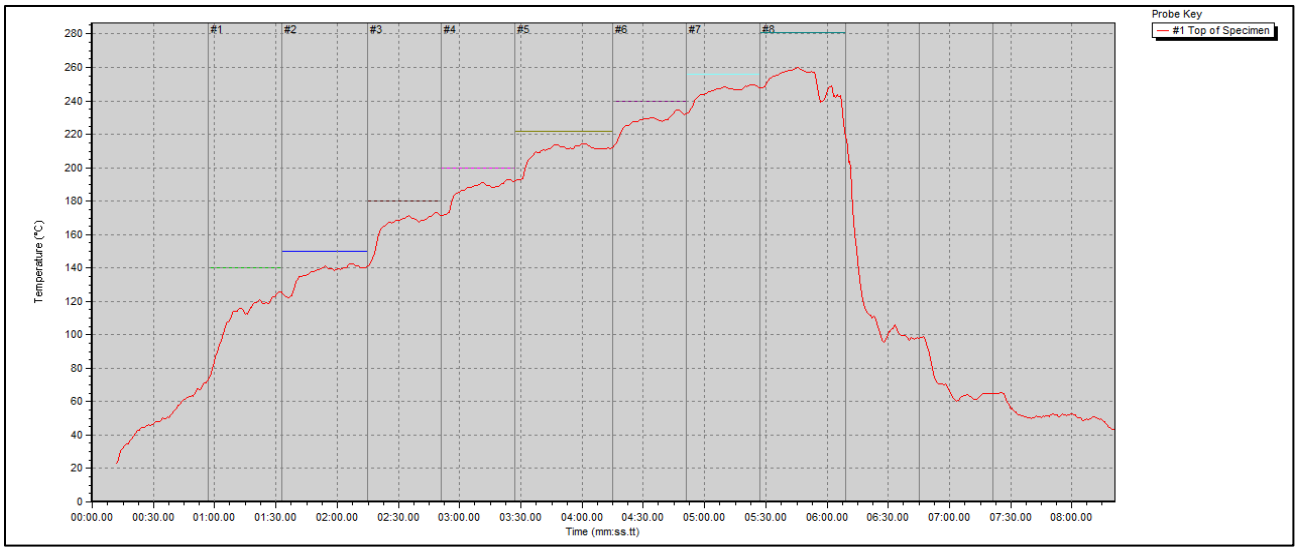

Figure 12 – Resistance to Reflow Soldering Heat – Reflow Profile

Reflow Results

Probe	Positive Slope (°C/sec)	Positive Slope Time (mm:ss.tt)	Rise Time (150.0 - 200.0°C) (mm:ss.tt)	Rise Time 50.0°C to Peak (mm:ss.tt)	Mean Slope to Peak (°C/sec)	Time Above Liquidus (217.0°C) (mm:ss.tt)	Peak Temperature (°C)	Time Above Peak minus 5.0°C (mm:ss.tt)	Delta T (°C)	Negative Slope (°C/sec)
#1 (°C) Top of Specimen	3.96	01:01.50	01:13.50	05:09.50	0.65	01:51.50	259.8	00:20.50		-12.09

Figure 13 – Resistance to Reflow Soldering Heat – Reflow Results

3.12 Thermal Shock

Specimens were subjected to thermal shock testing in accordance with test procedure EIA 364-32G, Test Condition VII.

Unmated specimens were subjected to 5 cycles between -55°C and 105°C with 30-minute dwells at temperature extremes and 1-minute transitions between temperatures.

3.13 Humidity / Temperature Cycling

Specimens were subjected to humidity / temperature cycling in accordance with test procedure EIA 364-31E, Method IV.

Specimens were subjected to 10 cycles (24-hours per cycle) between 25°C and 65°C at 80 to 100%RH. Specimens from Test Set 2 were mated and specimens from Test Set 4 were unmated for the environmental exposure.

3.14 Temperature Life

Specimens were subjected to temperature life in accordance with test procedure EIA 364-17C, Method A.

Mated specimens were exposed to a temperature of 105°C for 1000 hours. Specimens were preconditioned with 20 cycles of durability with the latches engaged.

3.15 Mixed Flowing Gas

Specimens were subjected to mixed flowing gas in accordance with test procedure EIA 364-65B, Class IIA. See Table 8 for the mixed flowing gas test parameters.

The test specimens were subjected to a 4-gas environment for 14 days. Three specimens from each group were exposed in the unmated condition for the first 7 days with the plugs not exposed and in the mated condition for the final 7 days. The other three specimens from each group were exposed mated for the 14-day exposure. LLCR measurements were taken after 7 days on all specimens.

Table 8 – Mixed Flowing Gas 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 [actual]	14 Days
Chamber Volume Exchange Rate [3-10 per Hour]	8.8 per Hour

3.16 Thermal Cycling

Specimens were subjected to thermal cycling in accordance with test procedure EIA 364-110, Test Condition A, Test Duration A.

Mated specimens were subjected to 10 cycles between 15±3° and 85±3° with 30 minute dwell times at each temperature extreme and ramp times greater than 2°C per minute.

3.17 Minute Disturbance

Specimens were manually unmated and mated three times by hand.

3.18 Re-Seating

Specimens were manually unmated and mated one time by hand.

3.19 Final Examination of Product

The specimens were visually examined in accordance with test procedure EIA-364-18B for evidence of physical damage that would be detrimental to the operation of the parts.