148 Position Vertical Sliver Card Edge Connector Qualification

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity 148 Position Vertical Sliver Card Edge connector when tested to Product Specification 108-32138 Rev A.

1.2 Scope

The purpose of this program was to verify the mechanical, environmental and electrical performance of the TE Connectivity 148 Position Vertical Sliver Card Edge connector. This testing took place at the TE Connectivity Harrisburg Electrical Components Testing Laboratory (HECTL) between 18-July-2017 and 04-August-2017. Detailed test data is stored at HECTL under EA20170212T.

1.3 Conclusion

The148 Position Vertical Sliver Card Edge specimens listed in paragraph 1.5 conformed to the electrical, mechanical and environmental performance requirements of Product Specification 108-32138.

1.4 Product Description

With a 0.6mm contact pitch, Sliver products are super slim, allowing you to fit more inside the box. In addition to card-edge configurations, we provide a highly robust metal housing design on the connector cage to help withstand cable pull while an active latch provides additional connection security. This new connectivity technology simplifies design and helps lower overall costs by eliminating the need for re-timers and more costly lower-loss PCB materials while reaching speeds up to 25 Gbps with the use of TE high speed cable. Sliver products can be used across many applications, data rates and protocols (PCI Express, SAS, Ethernet).

1.5 Test Specimens

Specimens identified with the following part numbers were used for this test. Refer to Table 1 for test specimen identification information.

Table 1 – Test Specimens

Test Set	Test Group	Qty	Part Number	Description
1	1	5	2297117-2	Sliver Connector, Vertical Receptacle with Paddle Card (60-1824823-1)
2	2	5	2297117-2	Sliver Connector, Vertical Receptacle with Paddle Card (60-1824823-1)
3	3	6	2297117-2	Sliver Connector, Vertical Receptacle with Paddle Card (60-1824823-1)
4	4	5	2297117-2	Sliver Connector, Vertical Receptacle with Paddle Card (60-1824823-1)
5	5	5	2297117-2	Sliver Connector, Vertical Receptacle
6	6	5	2297117-2	Sliver Connector, Vertical Receptacle

Note: Date Code on all test specimens was 17186D.

1.6 Qualification Test Sequence

Table 2 – Test Sequence

Test or Examination	Test Group					
	1	2	3	4	5	6
	Test Sequence (a)					
Initial Visual Examination	1	1	1	1	1	1
Low Level Contact Resistance	3,5,9	3,6	3,6,9			
Insulation Resistance				2,6		
Withstanding Voltage				3,7		
Random Vibration	6					
Mechanical Shock	7					
Durability	4 (b)					
Connector Solderability					2	
Resistance to Reflow Soldering Heat						2
Thermal Shock				4		
Humidity/Temperature Cycling				5		
Temperature Life		4				
Mixed Flowing Gas			4			
Thermal Cycling			7			
Minute Disturbance	2,8	2,5	2,5,8			
Final Visual Examination	10	7	10	8	3	3

(a) The numbers indicate the sequence in which testing took place
(b) 95 cycles

1.6 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 Visual Examination – All Test Groups

No damage or defects was observed in any specimen when visually examined as received prior to the start of any testing.

2.2 Low Level Contact Resistance – Test Group 1, 2 & 3

All specimens met the requirement of 20 milliohms maximum change in low level contact resistance. See Tables 3 through 5 for all summary data.

Table 3 – Test Group 1 LLCR Summary Data in Milliohms

Milliohms	Initial	After Durability(ΔR)	Final(ΔR)
Minimum	8.28	-4.98	-5.04
Maximum	15.14	4.53	5.10
Average	10.98	0.36	0.58
Std. Dev.	1.34	1.37	1.29
N=	460	460	460

Table 4 – Test Group 2 LLCR Summary Data in Milliohms

Milliohms	Initial	Final(ΔR)
Minimum	8.59	-2.26
Maximum	15.03	8.37
Average	11.24	2.11
Std. Dev.	1.33	1.61
N=	460	460

Table 5 – Test Group 3 LLCR Summary Data in Milliohms

Milliohms	Initial	After Mixed Flowing Gas(ΔR)	Final(ΔR)
Minimum	8.09	-2.52	-2.60
Maximum	16.20	13.92	9.66
Average	10.97	1.96	2.08
Std. Dev.	1.32	2.08	1.57
N=	552	552	552

2.3 Insulation Resistance – Test Group 4

All specimens met the requirement of 1000 Megohms minimum insulation resistance when tested between adjacent signal contacts.

2.4 Withstanding Voltage – Test Group 4

All specimens met the requirement of no breakdowns or flashover when tested between adjacent signal contacts and from signal to ground contacts using a test potential of 300VAC.

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. The Pulse Velocity Change was 132.8 Inches/Second

2.7 Durability – Test Group 1

No apparent damage or defects was observed on any specimen as a result of 95 cycles of manual durability.

2.8 Connector Solderability – Test Group 5

All specimens met the requirement of 95% solder wetting of the critical areas of solderability. See Figures 1 and 2 for photographs representative of all specimens after the solderability test. Figure 3 illustrates the critical area of solderability per IPC/ECA J-STD-002D.

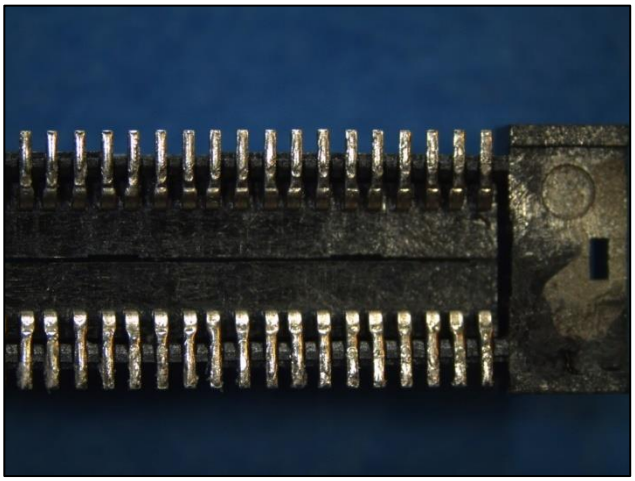

Figure 1 – After Solderability Test

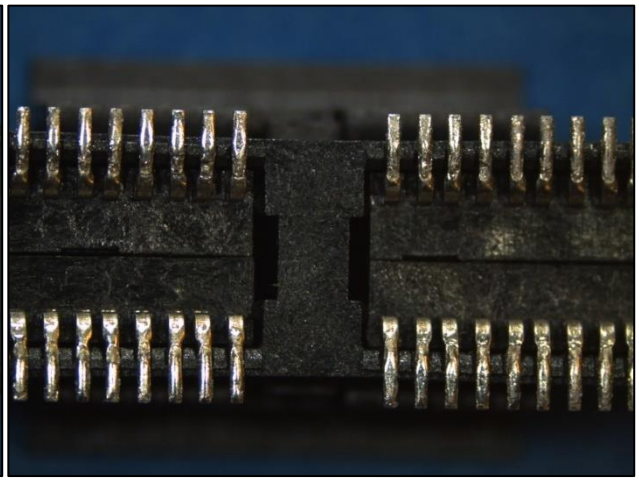

Figure 2 – After Solderability Test

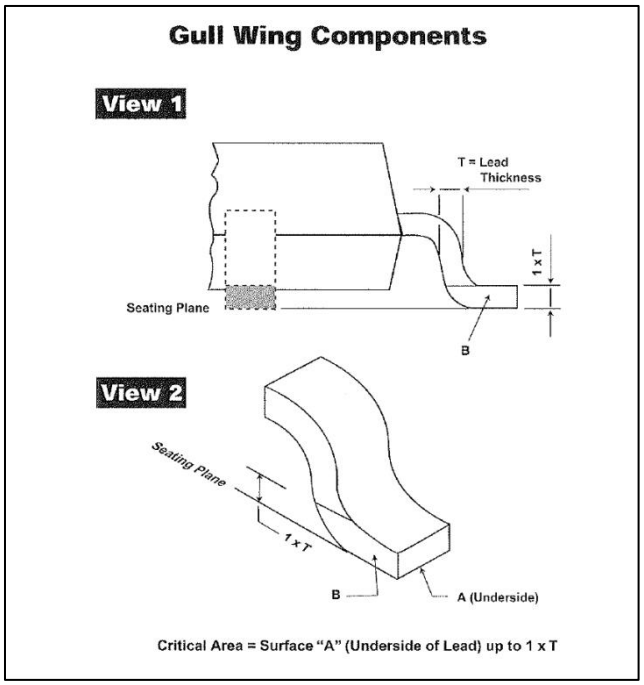

Figure 3 – Critical Area of Solderability

2.9 Resistance to Reflow Soldering Heat – Test Group 6

No blistering, melting, cracking or other damage was observed on any specimen when subjected to a reflow soldering heat with a peak temperature of 255°C - 260°C.

2.10 Thermal Shock – Test Group 4

No damage or defects were observed on any specimen when subjected to a thermal shock environmental exposure.

2.11 Humidity/Temperature Cycling -Test Group 4

No damage or defects were observed on any specimen when subjected to a humidity/temperature cycling environmental exposure.

2.12 Temperature Life – Test Group 2

No damage or defects were observed on any specimen when subjected to a temperature life environmental exposure of 85°C for 250 hours.

2.13 Mixed Flowing Gas -Test Group 3

The Copper corrosion rate (Average) @ 15.7$\mu g/cm^2$/day, and the EIA Requirement, was 12 - 16.

2.14 Thermal Cycling – Test Group 3

No damage or defects were observed on any specimen when subjected to a thermal cycling environmental exposure.

2.15 Minute Disturbance – Test Group 1, 2, & 3

No damage or defects were observed on any specimen when subjected to a minute disturbance of five cycles of manual durability.

2.16 Final Visual Examination – All Test Groups

No damage or defects were observed on any specimen when visually examined after each sequential test and upon completion of all testing.

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 conducted in accordance with EIA 364-18B.

3.2 Low Level Contact Resistance

Low level contact resistance was measured on 92 positions of each vertical Sliver connector for a total of 460 measurements in Test Sets 1 and 2, and 552 total positions in Test Set 3. A four-terminal resistance measuring method was used to obtain the measurements. Voltage and current probes were connected to wires that were soldered to the paddle card, and to access headers that were pressed into the test PCB. The test potential was 20mV maximum open circuit voltage and 100 mA maximum test current. Testing was conducted in accordance with specification EIA 364-23C. Figure 4 is a photograph taken during the LLCR measurements.

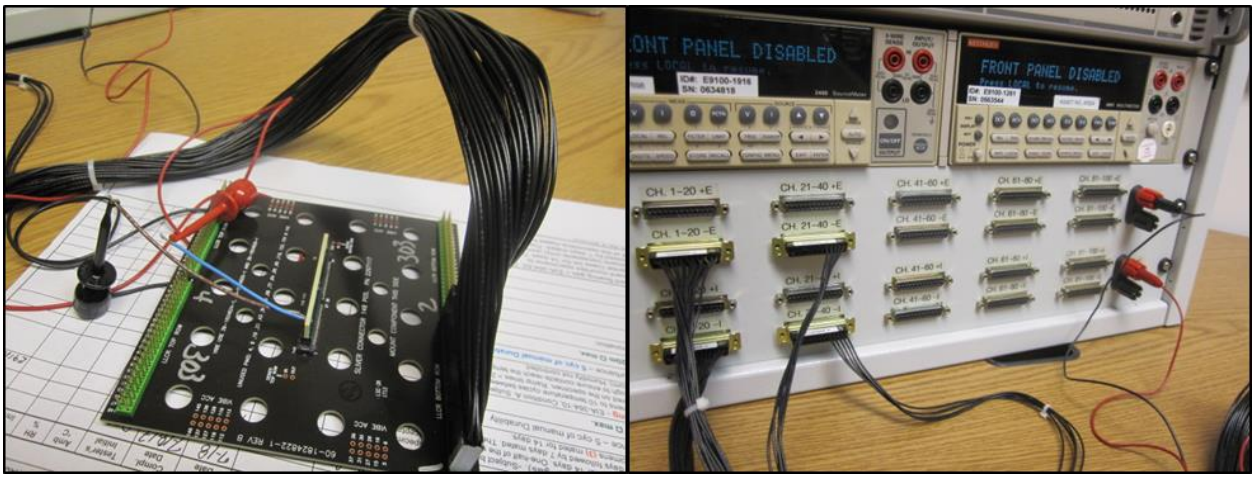

Figure 4 – LLCR Measurements

3.3 Insulation Resistance

The specimens were prepared by soldering 32 AWG wire to the signal and ground contacts with yellow colored wire on the signals and blue colored wire on the ground contacts. Each specimen had a different quadrant prepared to test all contacts across the entire test set as shown in Figure 5. Five unmated specimens were tested using a test potential of 100 DC volts. The test potential was held for a period of one minute or meter stabilization and then measurement was recorded. Adjacent signal contacts were tested at the same time. Figure 6 is a photograph of a specimen being tested. Testing was conducted in accordance with specification EIA 364-21E.

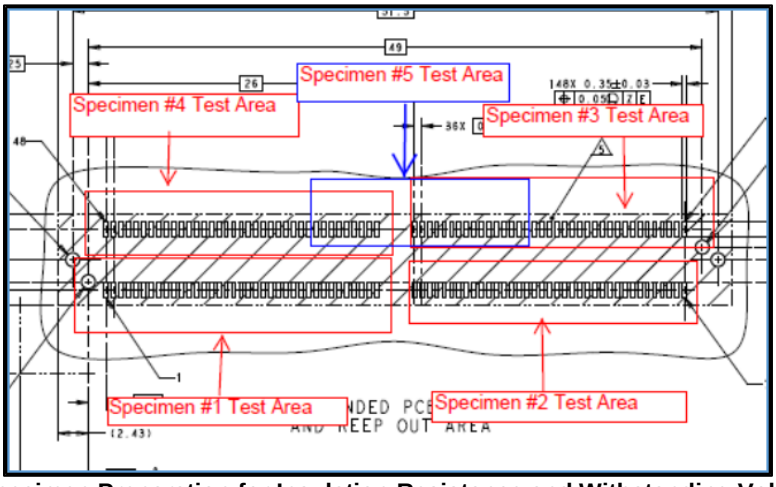

Figure 5 – Specimen Preparation for Insulation Resistance and Withstanding Voltage Testing

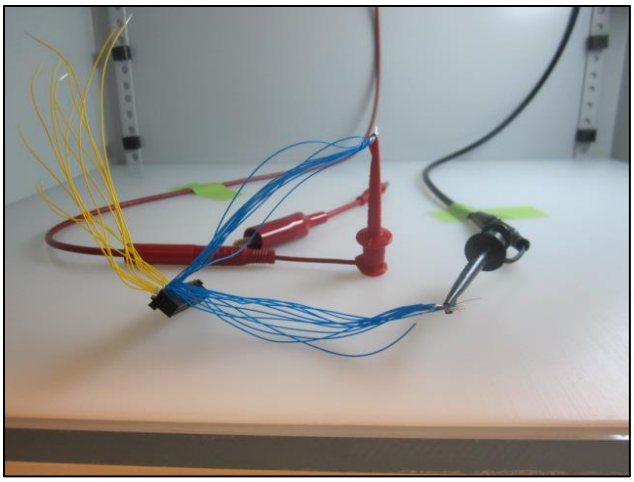

Figure 6 – Signal to Signal Test Connections

3.4 Withstanding Voltage

The specimens were prepared by soldering 32AWG wire to the SMT contacts with each quadrant covered throughout the entire set of specimens. The specimens were tested using a test potential 300 VAC. The test potential was applied at a rate of 500 volts per second and the maximum leakage current was set to 5.0 milliamperes. The test potential was held for a period of one minute while monitoring for any breakdowns or flashovers. First adjacent signal contacts were tested and secondly the adjacent signal and ground contacts were tested. Figure 6 above is a photograph of the signal to signal measurement being performed and Figure 7 below is a photograph of the signal to ground test connections. The signal to ground measurement was performed by applying the test potential between all signals (blue wires) tied together and all grounds (yellow wires). Testing was conducted in accordance with specification EIA 364-20E, Condition 1.

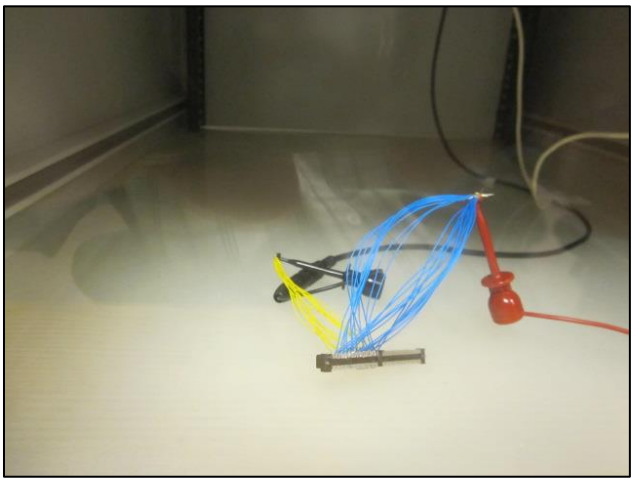

Figure 7 – Signal to Ground Test Connections

3.5 Random Vibration

The test specimens were subjected to a random vibration test as stated in TE Connectivity Specification 108-32138 Rev. A, and in accordance with specification EIA-364-28F, test condition “VII”, test condition letter “D”. See Figure 8 below 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.

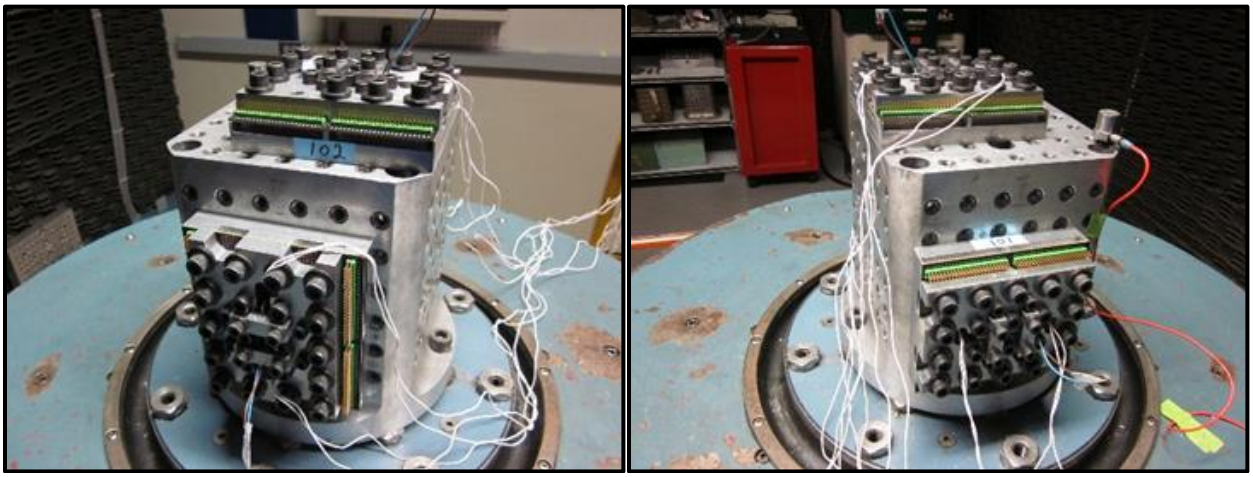

Figure 8 – Vibration/Mechanical Shock Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test as stated in TE Connectivity Specification 108-32138, Rev. A, and in accordance with specification EIA-364-27C, test condition “A”. See Figure 8 above for shock setup photographs.
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.

3.7 Durability

The specimens were manually unmated and mated for a total of 95 times. Testing was conducted in accordance with specification EIA 364-9C.

3.8 Connector Solderability

Prior to testing, specimens were prepared by removing the locating studs as well as the connector solder lugs. This was done to enable the specimens to sit flush on a ceramic substrate. A solder paste with a composition of Sn96.5, Ag3.0, Cu0.5 RMA, with a mesh of –325 +500 was then placed onto a stencil (Figure 9) with pad geometry, opening, and thickness that was appropriate for the specimens being tested. The stencil was supplied with the specimens. The solder paste was printed onto a 4x6 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 specimen on the ceramic substrate was placed on a conveyor belt through a convection oven (Figure 11). 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-002D, Test S1. 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 10 shows the solder application to the ceramic substrate and a typical connector prepared for testing. Testing was conducted in accordance with specification IPC/ECA J-STD-002D, Test S1.

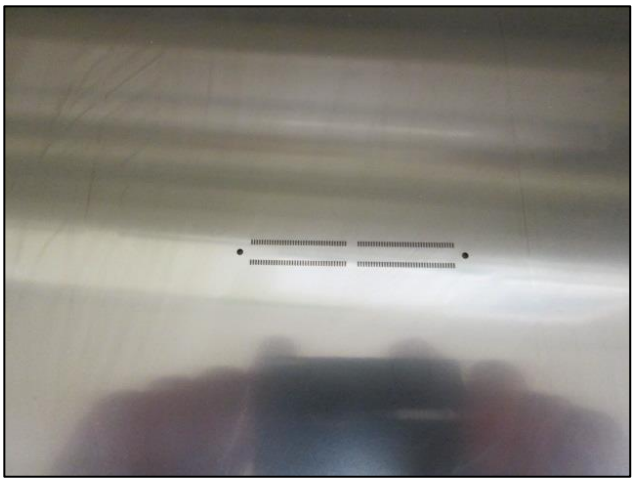

Figure 9 – Solder Stencil

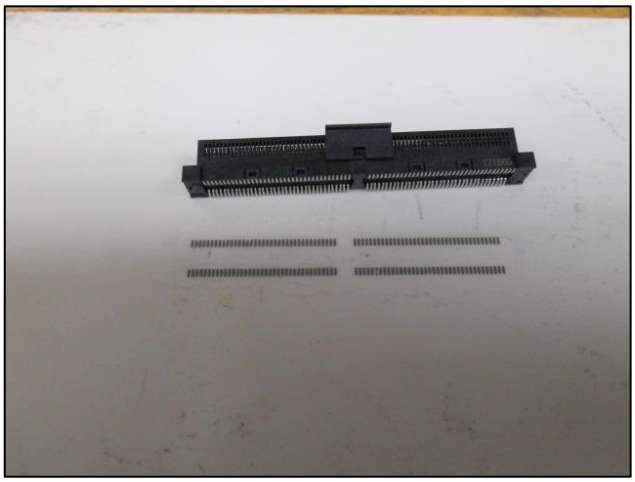

Figure 10 – Solder Paste and Test Specimen

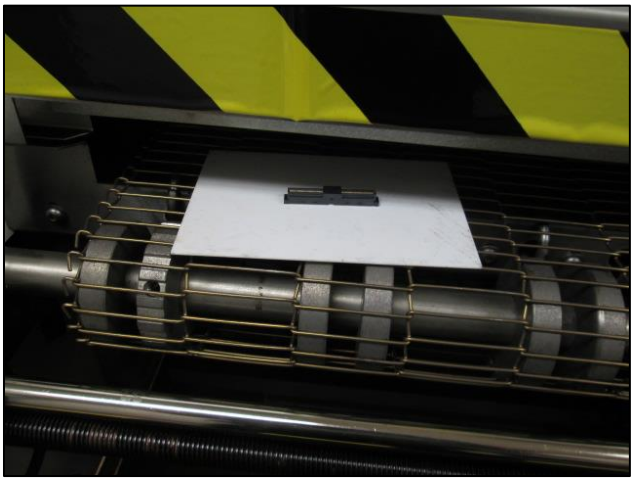

Figure 11 - Test Specimen in Reflow Oven

3.9 Resistance to Reflow Soldering Heat

Moisture Soak

The specimens were placed in a clean, dry, shallow container in such a manner that they did not overlap or touch and were exposed to 85°C at 85% relative humidity for 168 hours. Within 15 minutes to 4 hours after removal from the moisture soak, the specimens were subjected to the heat exposure described below.

Component Heat Resistance to Lead Free Reflow Soldering

The specimens were placed on 4x6 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 liquidous (217°C) for 60 to 150 seconds as specified in specification TEC-109-201 Rev E. The temperature on top of the specimen was monitored to enable temperature profiling. Figure 12 illustrates the temperature profile and Figure 13 shows the reflow results. A thermocouple was placed on the top of a setup component to verify the peak temperature prior to exposing the test specimens, see Figure 14. The specimens and substrates were allowed to cool to ambient temperatures and then run back through the oven two more times for a total of 3 exposures. Testing was performed in accordance with specification TEC-109-201E, Method A, Condition B.

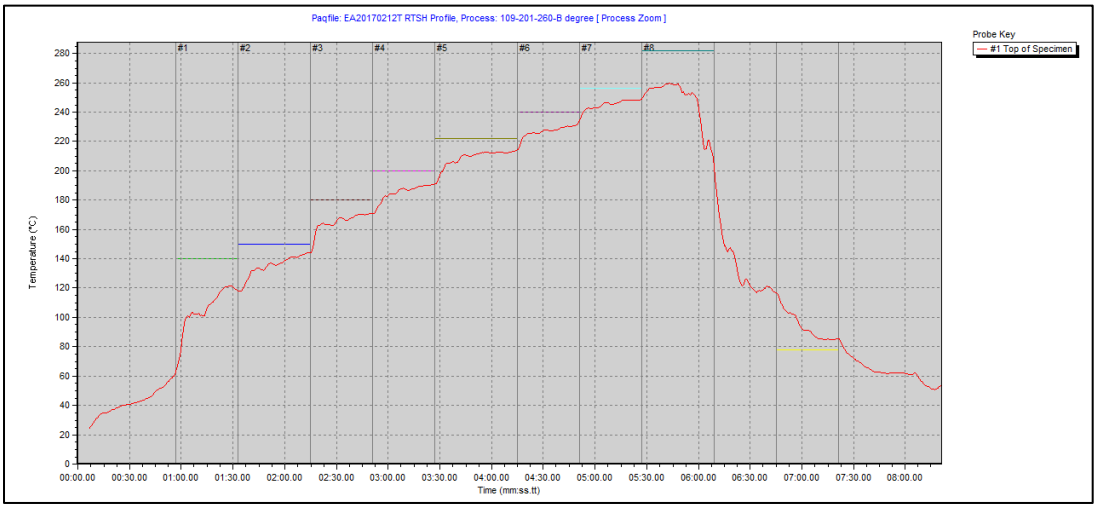

Figure 12 – Reflow Profile

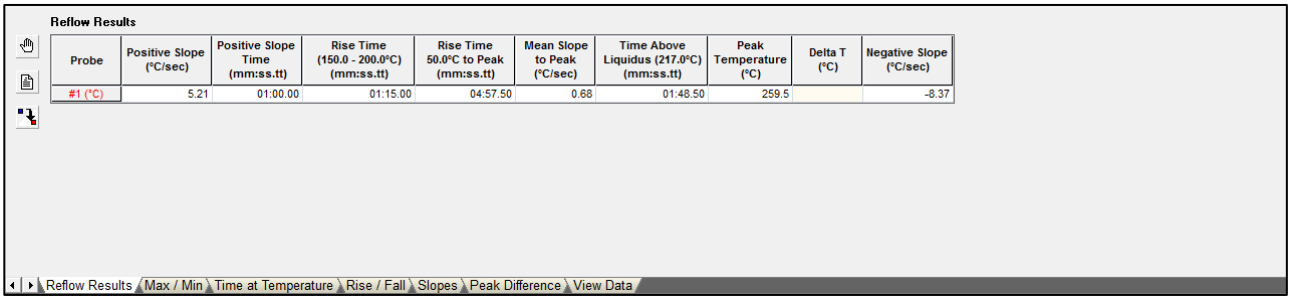

Figure 13 – Reflow Results

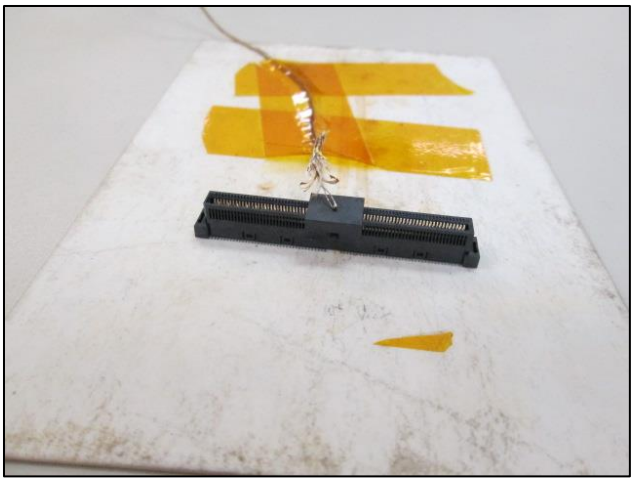

Figure 14 – Thermocouple Placement for Temperature Profiling

3.10 Thermal Shock

Mated specimens were exposed to 5 cycles of thermal shock cycling. Each cycle consisted of 30 minutes at each extreme of -55°C and 85°C with a transition time of one minute between each extreme. Testing was conducted in accordance with specification EIA 364-32G, Method A, Test Condition VII.

3.11 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. (Figure 15) Testing was performed in accordance with EIA-364-31D.

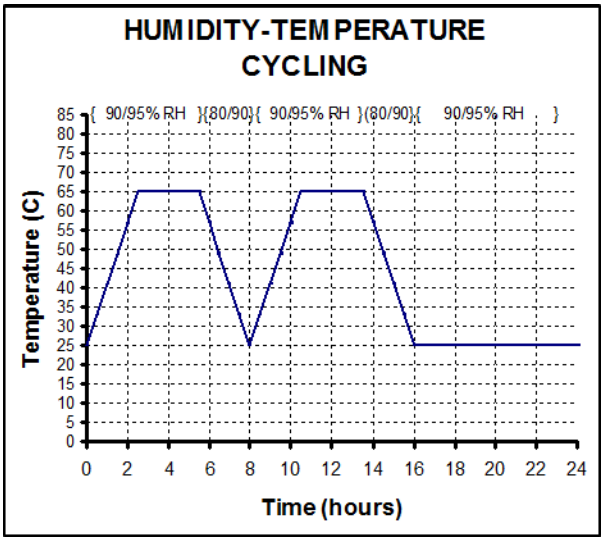

Figure 15 – One Humidity/Temperature Cycle

3.12 Temperature Life

All mated specimens were placed in an air convection oven and subjected to a temperature of 85°C for a period of 250 hours. Testing was conducted in accordance with specification EIA 364-17C, Method A.

3.13 Mixed Flowing Gas

The test specimens consisted of six connector assemblies. They were subjected to a 4-gas environment in accordance with EIA-364-65B, Class IIA for 14 days. One half of the specimens [301 - 303] were exposed in the unmated condition [receptacle half only] for the 1st 7 days [paddle-card stored outside of the test chamber] and mated for the final 7 days. The remaining specimens [304 - 306] were exposed in the mated condition for the test duration. No measurements were required during the exposure period. The test parameters are shown in Table 6 below.

Table 6 – MFG Test Parameters

Environment	**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	**14 days**

3.14 Thermal Cycling

Mated specimens were exposed to 10 cycles of thermal cycling between15±3°C and 85±3°C as measured on the specimen. The dwell times at temperature extremes were 5 minutes minimum and ramp rates were greater than 2° per minute. The humidity was not controlled.

3.15 Minute Disturbance

The specimens were manually unmated and mated five times, per TE Connectivity Specification 108-32138, Rev. A.

3.16 Final Visual Examination

All specimens were visually examined for any damage or defects detrimental to product performance after each sequential test and upon completion of all testing. Testing was conducted in accordance with specification EIA 364-18B.