Qualification
Test Report

microQSFP Receptacle

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity microQSFP Receptacle to determine its conformance to the requirements of Product Specification 108-32108 Rev B.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the microQSFP Receptacle. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between January 31st, 2017 and April 18th, 2017. Detailed test data is stored at HECTL under EA20160647T.

1.3 Conclusion

The microQSFP specimens listed in paragraph 1.5 conformed to the electrical, mechanical and environmental performance requirements of Product Specification 108-32108 Rev B.

1.4 Product Description

microQSFP interconnects provide zQSFP+ (QSFP28) functionality in a smaller, generally SFP-sized form-factor. At 33% higher density than QSFP, microQSFP interconnects fit more ports (up to 72) on a standard line card, saving significant design space. The integrated module thermal solution on these products offers significantly better thermal performance than other pluggable solutions on the market today, requiring less energy to cool equipment and allowing greater ease in system thermal design.

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	Quantity	Part Number	Description
1,3	5 each	2291536-1 Rev 10	38 Pos microQSFP Receptacle (Au over PdNi)
	5 each	2297551-1 Rev 9	Cage
	5 each	N/A	Bezel
	5 each	N/A	Direct Attach Copper Plug Assembly w/ Test Paddlecard 60-1824736-1 Rev C
	5 each	60-1824735-1 Rev B	38 Pos microQSFP LLCR Test PCB
2	5	2291536-2 Rev 12	38 Pos microQSFP Receptacle (Au)
	5	2297551-1 Rev 9	Cage
	5	N/A	Bezel
	5	N/A	Direct Attach Copper Plug Assembly w/ Test Paddlecard 60-1824736-1 Rev C
	5	60-1824735-1 Rev B	38 Pos microQSFP LLCR Test PCB
5	6	2291536-1 Rev 10	38 Pos microQSFP Receptacle (Au over PdNi)
	6	2297551-1 Rev 9	Cage
	6	N/A	Bezel
	6	N/A	Direct Attach Copper Plug Assembly w/ Test Paddlecard 60-1824736-1 Rev C
	6	60-1824735-1 Rev B	38 Pos microQSFP LLCR Test PCB
6	6	2291536-2 Rev 12	38 Pos microQSFP Receptacle (Au)
	6	2297551-1 Rev 9	Cage
	6	N/A	Bezel
	6	N/A	Direct Attach Copper Plug Assembly w/ Test Paddlecard 60-1824736-1 Rev C
	6	60-1824735-1 Rev B	38 Pos microQSFP LLCR Test PCB
7,8,9	5 each	2291536-1 Rev 10	38 Pos microQSFP Receptacle (Au over PdNi)

NOTE *The LLCR test paddlecards were supplied assembled into a plug assembly.*

1.6 Qualification Test Sequence

Table 2 – Qualification Test Sequence

Test or Examination	Test Group					
	1	**2**	**3**	**4**	**5**	**6**
	Test Set					
	1, 2	**3**	**5, 6**	**7**	**8**	**9**
	Test Sequence (a)					
Initial Examination of Product	1	1	1	1	1	1
Low Level Contact Resistance	3,5,9	3,6	3,6,9			
Insulation Resistance				2,6		
Dielectric Withstanding Voltage				3,7		
Random Vibration	6					
Mechanical Shock	7					
Durability	4(b)					
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 Examination of Product	10	7	10	8	3	3

NOTE
(a) The numbers indicate sequence in which tests were performed
(b) Measure LLCR after 100 cycles, replace module and add 100 cycles, re-insert original module, measure LLCR

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 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

All low level contact resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum had a change in resistance (ΔR) of less than 20 milliohms after testing. Refer to Table 3 through Table 7 for LLCR summary data in milliohms.

Table 3 – Low Level Contact Resistance Summary Data (Milliohms), Test Set 1 (Au-Pd)

Condition	Initial	After 100 Durability Cycles	After 200 Durability Cycles	After Vibration & Mechanical Shock
	Actual R	Delta R (ΔR)	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms	milliohms
Minimum	10.64	-3.52	-3.82	-3.39
Maximum	16.81	3.49	3.75	3.87
Average	13.85	-0.02	0.45	0.46
Std. Dev.	1.33	1.13	1.31	1.25
N =	190	190	190	190

Table 4 – Low Level Contact Resistance Summary Data (Milliohms), Test Set 2 (Au)

Condition	Initial	After 100 Durability Cycles	After 200 Durability Cycles	After Vibration & Mechanical Shock
	Actual R	Delta R (ΔR)	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms	milliohms
Minimum	10.68	-2.42	-1.26	-1.31
Maximum	18.68	2.73	3.05	3.75
Average	13.55	0.14	0.44	0.64
Std. Dev.	1.36	0.68	0.69	0.84
N =	190	190	190	190

Table 5 – Low Level Contact Resistance Summary Data (Milliohms), Test Set 3 (Au-Pd)

Condition	Initial	After Temperature Life
	Actual R	Delta R (ΔR)
	milliohms	milliohms
Minimum	11.01	-1.50
Maximum	17.97	7.67
Average	13.91	1.07
Std. Dev.	1.28	1.30
N =	190	190

Table 6 – Low Level Contact Resistance Summary Data (Milliohms), Test Set 5 (Au-Pd)

Condition	Initial	After MFG	After Thermal Cycling
	Actual R	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms
Minimum	10.91	-4.44	-3.36
Maximum	19.23	3.35	4.78
Average	13.82	0.48	1.17
Std. Dev.	1.28	0.78	1.08
N =	228	228	228

Table 7 – Low Level Contact Resistance Summary Data (Milliohms), Test Set 6 (Au)

Condition	Initial	After MFG	After Thermal Cycling
	Actual R	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms
Minimum	10.74	-1.39	-2.14
Maximum	17.69	8.16	6.16
Average	13.69	1.22	1.27
Std. Dev.	1.44	1.47	1.26
N =	228	228	228

2.3 Insulation Resistance

All insulation resistance measurements were greater than 1000 megohms.

2.4 Dielectric Withstanding Voltage

No dielectric breakdown or flashover occurred.

2.5 Random Vibration

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

2.6 Mechanical Shock

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

2.7 Durability

No physical damage occurred to the specimens as a result of mating and unmating the specimens 200 times.

2.8 Solderability

The specimens under evaluation exhibited a continuous solder coating, free from defects, over more than 95% of the critical surface areas. The critical area is defined as the underside of the lead, and the sides, up to 1 times the lead thickness, as illustrated in Figure 1 as required by IPC/ECA JEDEC J-STD-002D, Test S1. Figure 2 is a photograph of typical contacts as tested.

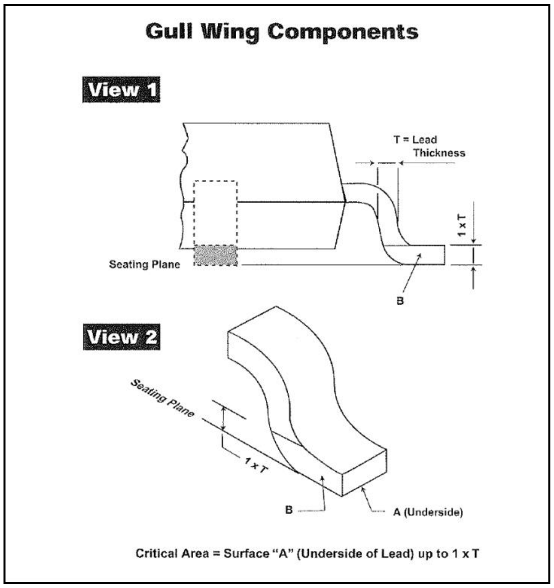


Figure 1 – Critical Area of Solderability per J-STD-002D

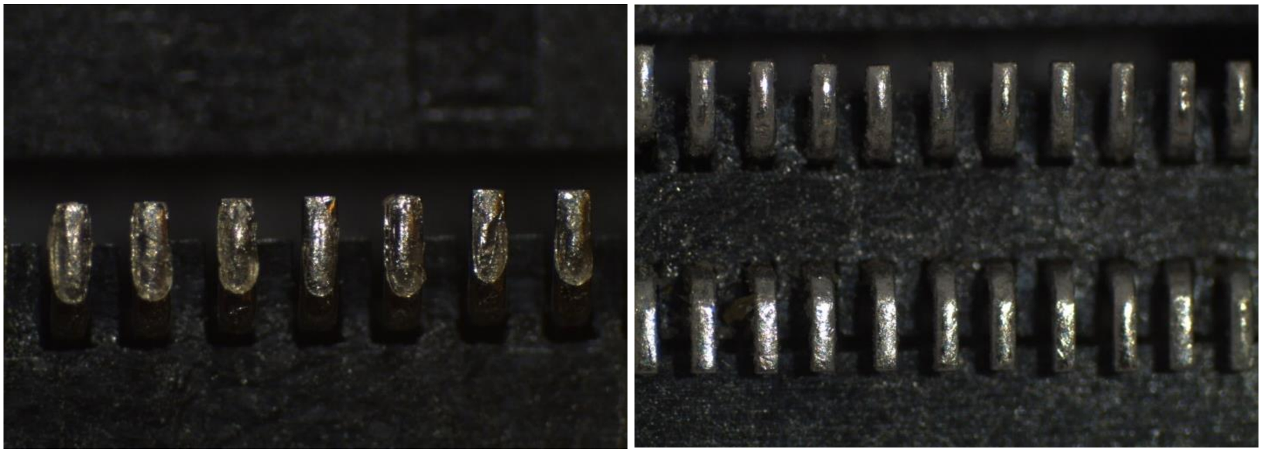


Figure 2 – Tested Specimens

2.9 Resistance to Reflow

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

After the first, second and third reflow heat exposures, no obvious areas of melting, blistering, cracking or other damage was observed on any specimen.

2.10 Thermal Shock

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

2.11 Humidity-Temperature Cycling

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

2.12 Temperature Life

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

2.13 Mixed Flowing Gas

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas. Test Set 5 Copper corrosion rate was 12.8μg/cm^2/day. Test Set 6 Copper corrosion rate was 16μg/cm^2/day.

2.14 Thermal Cycling

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

2.15 Minute Disturbance

No physical damage occurred to the specimens as a result of mating and unmating the specimens 5 times.

2.16 Final Examination of Product - All Groups

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. Testing was performed in accordance with EIA-364-18 Rev B.

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. Refer to Figure 3 for typical low level contact resistance test setup. Testing was performed in accordance with EIA-364-23 Rev C.

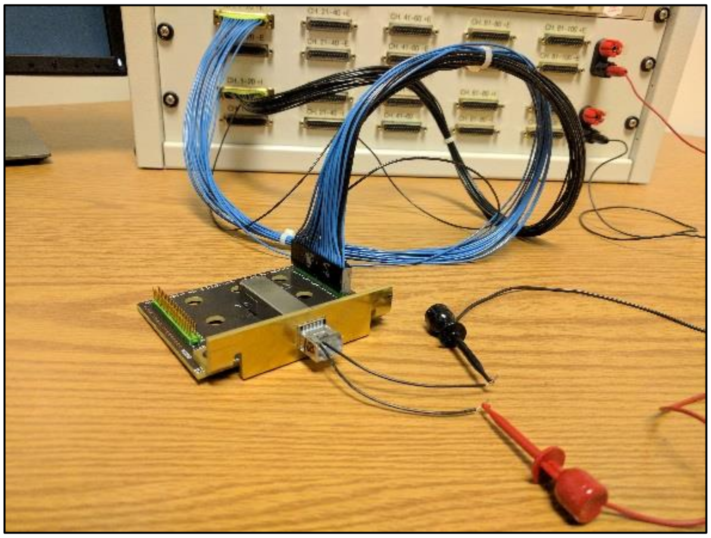


Figure 3 – Low Level Contact Resistance Test Setup

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 minutes before the resistance was measured. Refer to Figure 4 for an image of the typical insulation resistance test setup. Testing was done in accordance with EIA 364-21 Rev E.

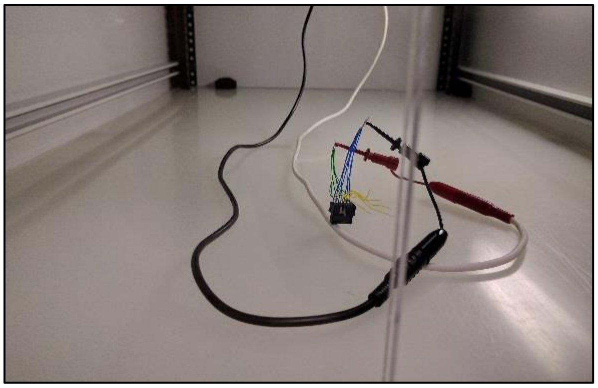


Figure 4 – Typical Insulation Resistance Test Setup

3.4 Dielectric Withstanding Voltage

A test potential of 300 volts AC was applied between adjacent contacts (signal to signal and signal to ground) of unmated specimens. This potential was applied for one minute and then returned to zero. Refer to Figure 5 for an image of the typical dielectric withstanding voltage test setup. Testing was done in accordance with EIA 364-20 Rev E, Condition I.

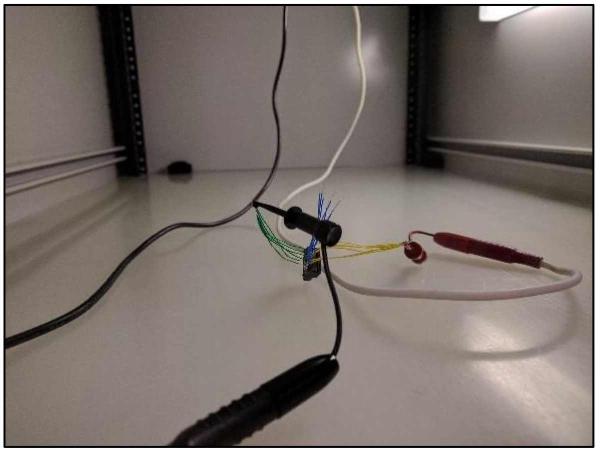


Figure 5 – Typical Dielectric Withstanding Voltage Test Setup

3.5 Vibration, Random

The test specimens were subjected to a random vibration test in accordance with specification EIA-364-28 Rev F, test condition “VII”, test condition letter “D”. 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 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. Refer to Figure 6 for images of the typical test setup.

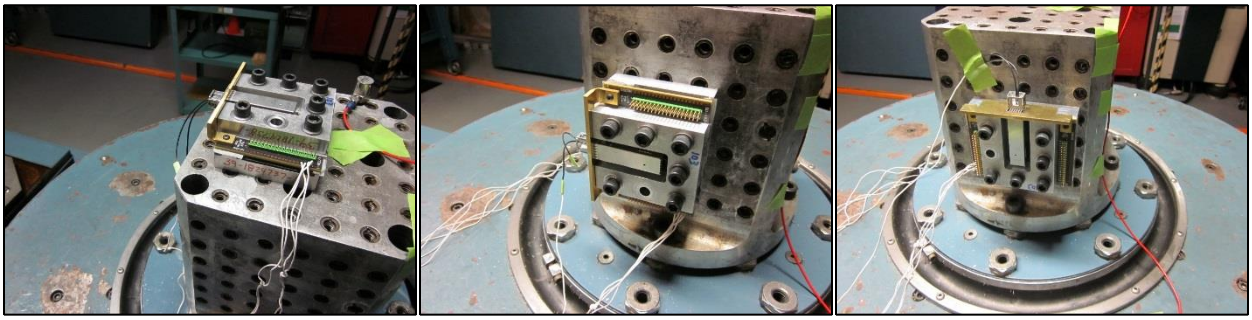


Figure 6 – Vibration Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27 Rev C, test condition “H”. See Figure 7 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. Refer to Figure 7 for images of the typical test setup.

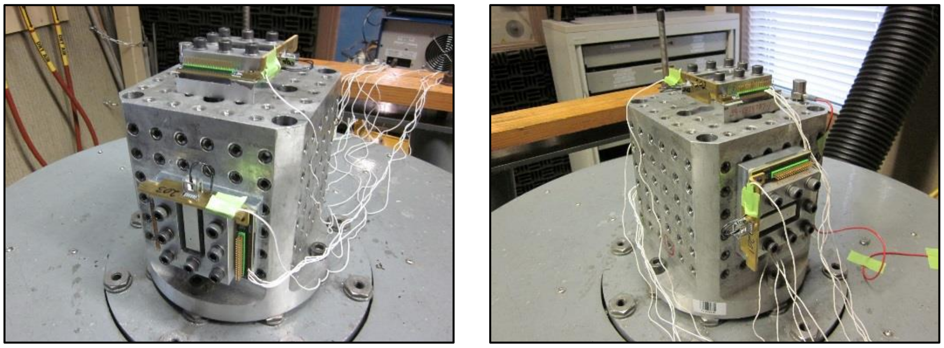


Figure 7 – Mechanical Shock Test

3.7 Durability

Specimens were mated and unmated 200 times. Plugs were subjected to 100 cycles before a dummy plug was used to complete the remaining 100 cycles. Testing was done in accordance with EIA 364-9 Rev C.

3.8 Solderability

Prior to testing, specimens were prepared by removing the locating studs. 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 then placed onto a stencil 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 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 8 illustrates the temperature profile. Figure 9 is a photograph of the solder application on the ceramic substrate.

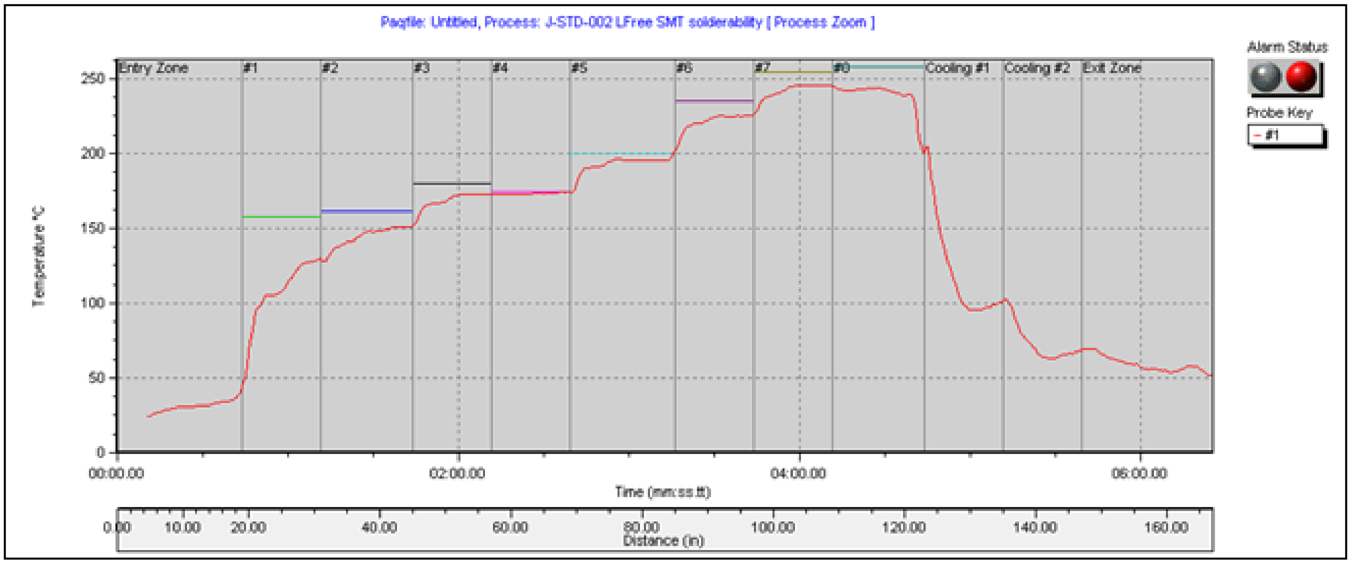


Figure 8 – Reflow Profile

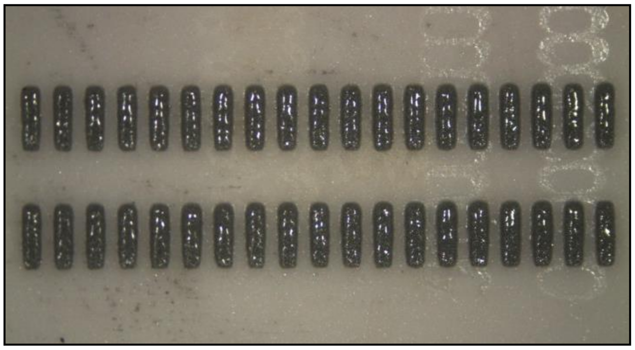


Figure 9 – Solder Paste

3.9 Resistance to Reflow

Dimensional Measurements

Dimensional Measurements were waived for this test.

Moisture Soak

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 Testing

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 as specified in specification TEC-109-201. The temperature on top of the specimen, was monitored to enable temperature profiling. Figure 10 is the temperature profile and Figure 11 shows the reflow results. Thermocouple #1 was placed on the top of the component and thermocouple #2 was in the contact area on the ceramic substrate. The specimens and substrates were allowed to cool to ambient temperatures and then run back through the oven a total of 3 times.

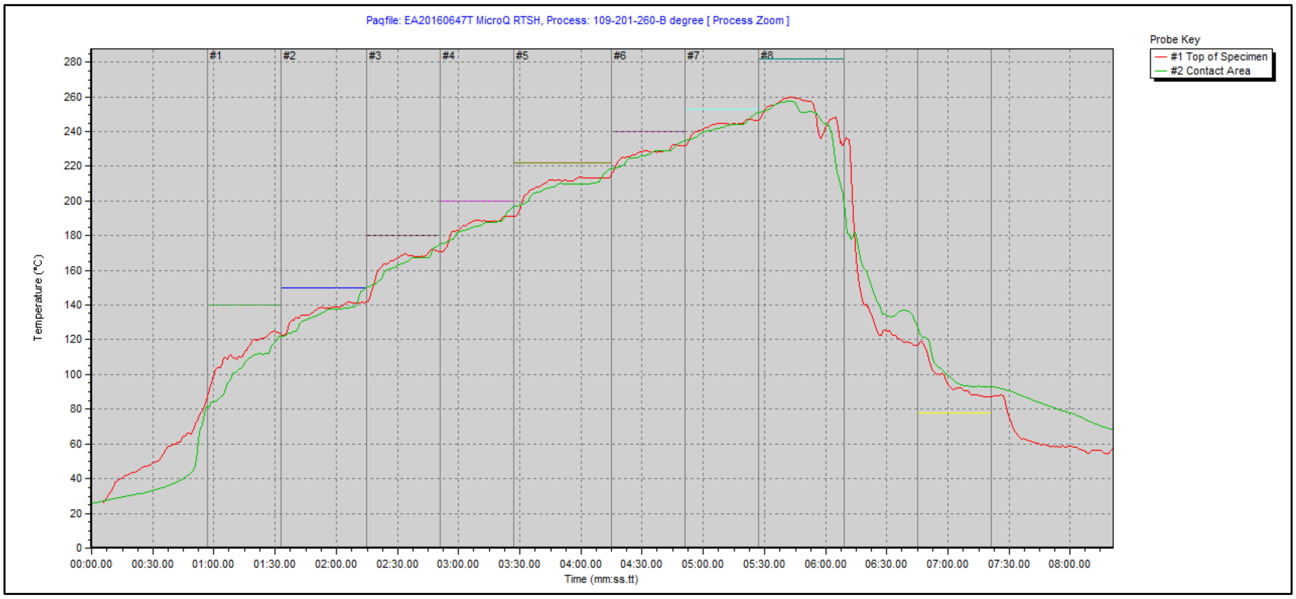
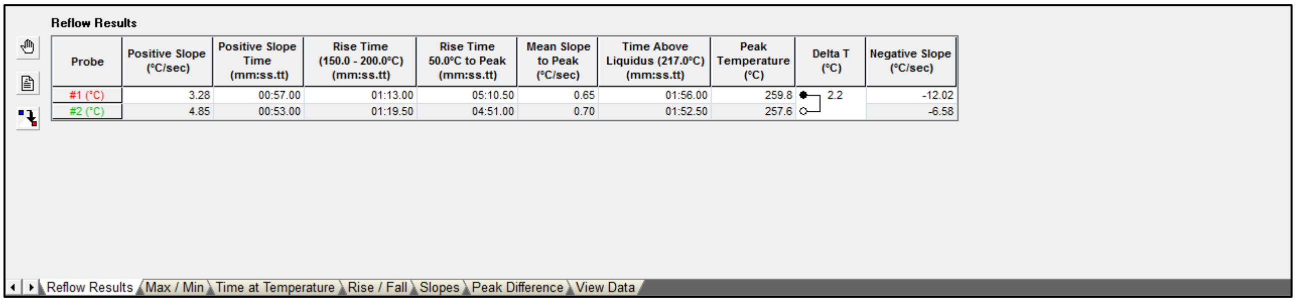


Figure 10 – Reflow Profile



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)	Delta T (°C)	Negative Slope (°C/sec)
#1 (°C)	3.28	00:57.00	01:13.00	05:10.50	0.65	01:56.00	259.8	2.2	-12.02
#2 (°C)	4.85	00:53.00	01:19.50	04:51.00	0.70	01:52.50	257.6		-6.58

Figure 11 – Reflow Results

3.10 Thermal Shock

Mated 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 done in accordance with EIA 364-32 Rev G, Method A, Test Condition VII.

3.11 Humidity-Temperature Cycling

Mated specimens were exposed to 10 cycles (10 days) of humidity-temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 25°C and 65°C twice while maintaining humidity at 80 to 100% RH. (Figure 12). Testing was done in accordance with EIA 364-31 Rev D, Method IV.

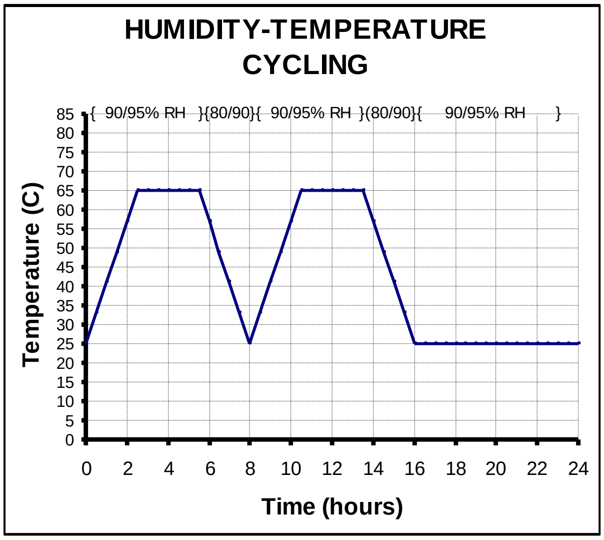


Figure 12 – Typical Humidity-Temperature Cycling Profile

3.12 Temperature Life

Mated specimens were exposed to a temperature of 85°C for 250 hours. Testing was done in accordance with EIA 364-17 Rev C, Method A.

3.13 Mixed Flowing Gas, Class IIA

Specimens were subjected to a 4-gas environment in accordance with EIA-364-65 Rev B, Class IIA for 14 days. Specimens 501, 502, 503, 601, 602 and 603 were exposed in the unmated condition [receptacles only] for the 1st 7 days and mated for the final 7 days. Specimens 504, 505, 506, 604, 605 and 606 were exposed in the mated condition for the test duration of 14 days. No measurements were required during the exposure period. Refer to Table 8 for MFG test parameters.

Table 8 – MFG Test Parameters

Environment	**IIA**
Temperature (^{0}C)	**30±1**
Relative Humidity (%)	**70±2**
Chlorine (Cl2) Concentration (ppb)	**10±5**
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 between 15±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°C per minute. The humidity was not controlled. Testing was performed in accordance with EIA-364-110 Rev F, Condition A.

3.15 Minute Disturbance

Specimens were manually unmated and mated 5 times.

3.16 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-364-18 Rev B.