Sliver Right Angle and Vertical Receptacles

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity Sliver Right Angle and Vertical Receptacles to determine its conformance to the requirements of Product Specification 108-32107 Rev A.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the Sliver 124 Position Right Angle and Vertical Receptacles. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between January 26, 2017 and April 21, 2017. Detailed test data is stored at HECTL under EA20170010T and EA20170108T.

1.3 Conclusion

The Sliver Receptacle specimens listed in paragraph 1.5 conformed to the electrical, mechanical and environmental performance requirements of Product Specification 108-32107 Rev A.

1.4 Product Description

Sliver Internal Cabled Interconnect system is a leading family of products for internal I/O connections to the board within high-speed data center and networking equipment. 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 and Ethernet).

1.5 Test Specimens

The test specimens were representative of normal production lots. Refer to Table 1 for test specimen identification information.

Table 1 – Specimen Identification

Test Group	Test Set	Quantity	Part Number	Description
1,2,4,5,6	1,2,4,5,6	5 each	2294190-3 Rev 8	Sliver 124 Position R/A Receptacle
3	3	6	2294190-3 Rev 8	Sliver 124 Position R/A Receptacle
1,2	1,2	5 each	60-1824906 Rev A	Sliver 124 Position R/A Receptacle LLCR Test PCB
		5 each	60-1824907 Rev A	Sliver 124 Position LLCR Paddlecard
3	3	6	60-1824906 Rev A	Sliver 124 Position R/A Receptacle LLCR Test PCB
		6	60-1824907 Rev A	Sliver 124 Position LLCR Paddlecard
1,2,4	7,8,9	5 each	2291316-1 Rev 12	Sliver 74 Position Vertical Receptacle
1,2	7,8	5 each	60-1824723-1 Rev B	Sliver 74 Position Vertical Receptacle LLCR Test PCB
		5 each	60-1824973-1 Rev A	Sliver 74 Position LLCR Paddlecard

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

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

1.6 Qualification Test Sequence

The test specimens referred to in paragraph 1.5 were tested according to the test sequences listed in Table 2.

Table 2 – Test Sequence

Test or Examination	Test Group					
	1	**2**	**3**	**4**	**5**	**6**
	Test Set					
	1,7	**2,8**	**3**	**4,9**	**5**	**6**
	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		
Withstanding Voltage				3,7		
Random Vibration	6					
Mechanical Shock	7					
Durability	4					
Connector Solderability					2	
Resistance to Reflow Solder 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

a) Numbers indicate the sequence in 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 20% to 80%

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark
TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

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 (LLCR)

All low level contact resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum had a change in resistance (ΔR) of less than 10 milliohms after testing. Refer to Tables 3 through 7 for LLCR summary data in milliohms.

Table 3 – LLCR Summary Data, Test Group 1 - Test Set 1 (124 Pos R/A)

Condition	Initial	After Durability	After Vibration & Mechanical Shock
	Actual R	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms
Minimum	9.56	-2.07	-1.73
Maximum	16.27	1.52	1.72
Average	12.13	-0.02	-0.05
Std. Dev.	1.35	0.50	0.43
N =	390	390	390

Table 4 – LLCR Summary Data, Test Group 1 - Test Set 7 (74 Pos Vertical)

Condition	Initial	After Durability	After Vibration & Mechanical Shock
	Actual R	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms
Minimum	7.96	-1.61	-1.72
Maximum	11.32	0.92	0.96
Average	9.46	-0.05	-0.01
Std. Dev.	0.67	0.36	0.38
N =	205	205	205

Table 5 – LLCR Summary Data, Test Group 2 - Test Set 2 (124 Pos R/A)

Condition	Initial	After Temp. Life
	Actual R	Delta R (ΔR)
	milliohms	milliohms
Minimum	9.47	-0.98
Maximum	15.61	1.82
Average	11.93	0.26
Std. Dev.	1.38	0.37
N =	390	390

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

Table 6 – LLCR Summary Data, Test Group 2 - Test Set 8 (74 Pos Vertical)

Condition	Initial	After Temp. Life
	Actual R	Delta R (ΔR)
	milliohms	milliohms
Minimum	7.85	-0.66
Maximum	11.36	1.99
Average	9.36	0.14
Std. Dev.	0.63	0.39
N =	205	205

Table 7 – LLCR Summary Data, Test Group 3 - Test Set 3 (124 Pos R/A)

Condition	Initial	After Mixed Flowing Gas	After Thermal Cycling
	Actual R	Delta R (ΔR)	Delta R (ΔR)
	milliohms	milliohms	milliohms
Minimum	9.27	-1.09	-0.78
Maximum	15.26	2.17	1.72
Average	11.93	-0.05	0.27
Std. Dev.	1.39	0.33	0.42
N =	468	468	468

2.3 Insulation Resistance

All insulation resistance measurements were greater than 1000 megohms.

2.4 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, 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 95 times.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

2.8 Connector Solderability

Reflow (Connector):

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 Figure1 and required by IPC/ECA JEDEC J-STD-002D, Test S1. Figure 2 is a photograph of typical contacts following testing.

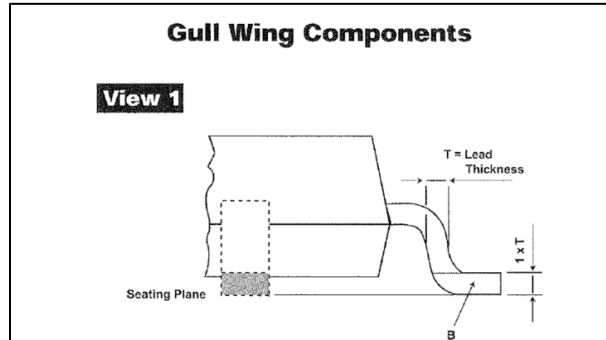

Figure 1 – Critical Area of Solderability per J-STD-002D

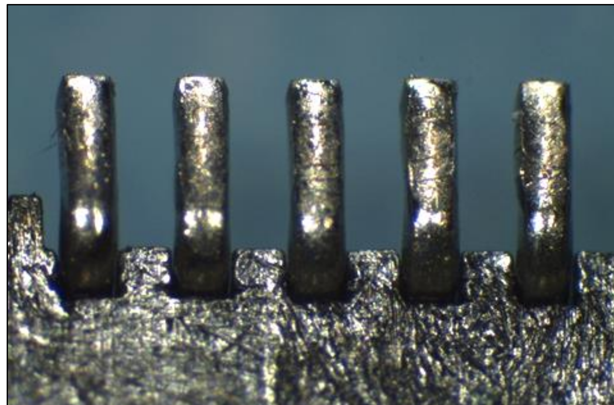

Figure 2 – Typical Solderability Tested Specimens

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

Dip (Cage):

After the steam age pre-conditioning, the specimens exhibited some staining. All solder contacts on all specimens exhibited a continuous solder coating, free from defects, over more than 95% of the critical surface areas. The critical area is defined as shown in Figure 3 as required by IPC/ECA JEDEC J-STD-002D, Test A1. Refer to Figure 4 for typical images in the as received condition, after steam age, and after solder dip.

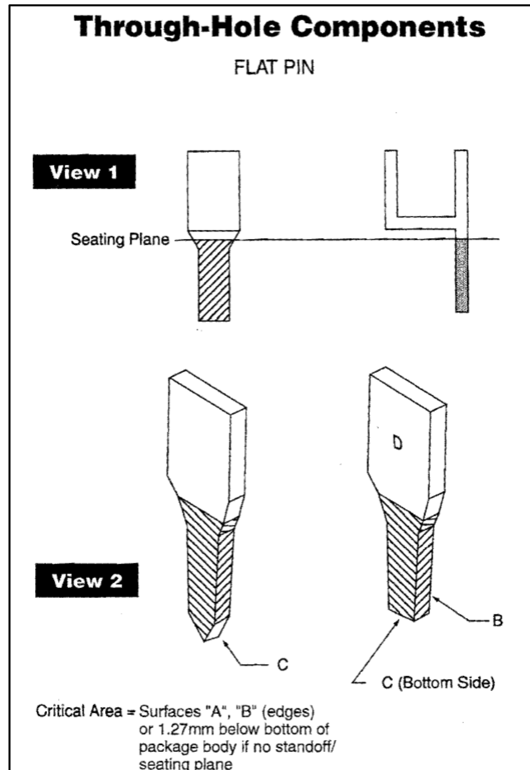

Figure 3 – Critical Area of Solderability per J-STD-002D

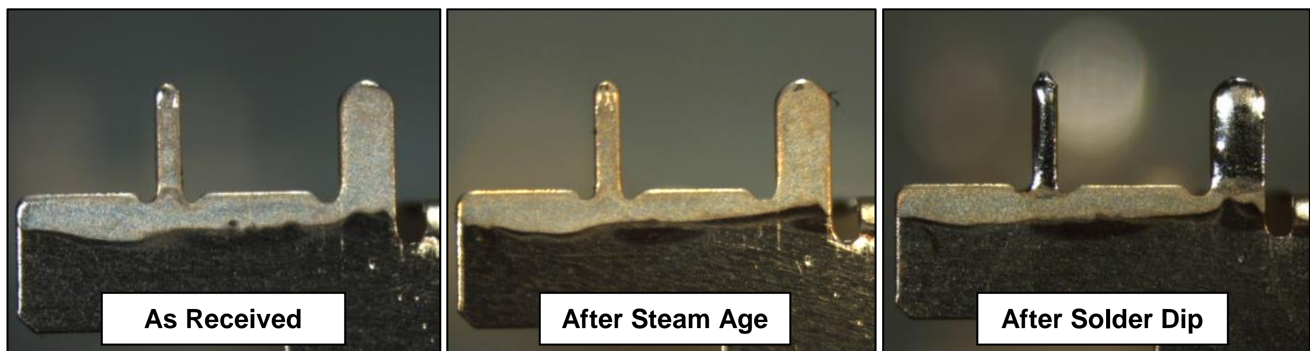

Figure 4 – Typical Solderability Cage Specimens

2.9 Resistance to Reflow Solder Heat

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

No melting, cracking, blistering or other damage that would affect connector performance was observed on any of the specimens due to the 3 reflow heat exposures.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

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. The average copper corrosion rate was 12.8μg/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 evidence of physical damage was visible as a result of mating and unmating the specimens 5 times.

2.16 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 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. Examination 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 (Figure 5). The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Testing was performed in accordance with EIA-364-23C.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

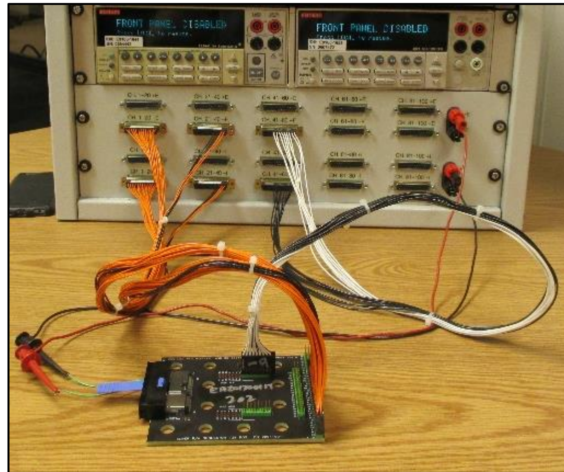

Figure 5 – Typical Low Level Contact Resistance Measurement Points

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 6 for images of the typical test setup. Testing was performed in accordance with EIA-364-21E.

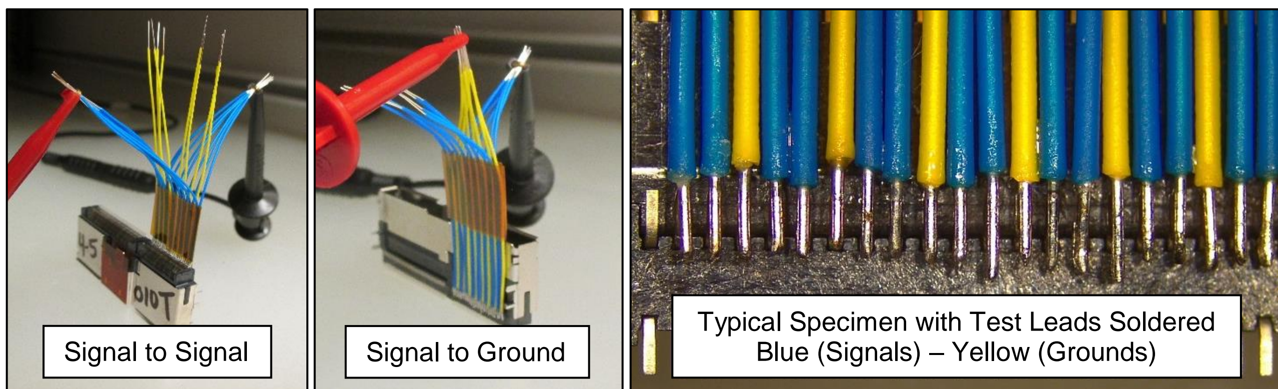

Figure 6 – Typical Insulation Resistance & Withstanding Voltage Test Setup

3.4 Withstanding Voltage

A test potential of 300 volts AC was applied between adjacent signal contacts and adjacent signal to ground contacts of unmated specimens. This potential was applied for one minute and then returned to zero. Refer to Figure 6 (above) for images 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 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. Refer to Figure 7 for images of the typical test setup.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark
TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

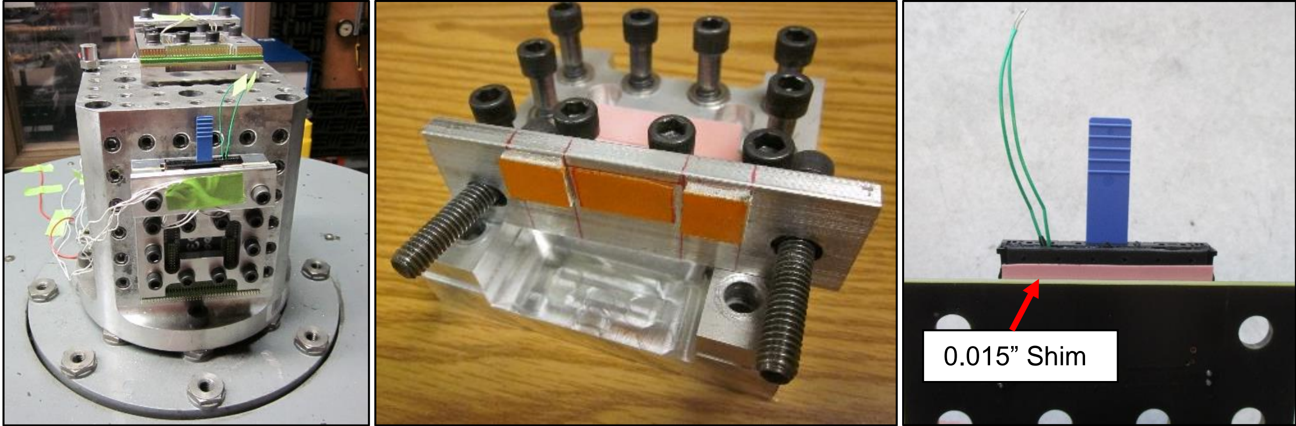

Figure 7 – Typical Vibration & Shock Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, test condition A. A 0.015” shim was placed under the right angle connector housing and a fixture clamp with spacers were used to support the connector during testing as requested by the test requester. 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 7 for images of the typical test setup.

3.7 Durability

Specimens were mated and unmated 95 times by hand. The PCB was clamped to a table to aid in keeping the specimen straight as it was mated and unmated. Refer to Figure 8 for an image of the typical test setup. Testing was performed in accordance with EIA-364-9C.

Figure 8 – Typical Durability Test Setup

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

3.8 Connector Solderability

Reflow (Connector):

Prior to testing, specimens were prepared by removing the locating studs as well as the connector shield, which was dip tested separately. 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 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 specimens and ceramic substrates were placed on a conveyor belt through a convection oven. The specimens were exposed for 60-120 seconds between the temperatures of 150°C and 180°C and for 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 9 shows the solder application to the ceramic substrate and a typical connector prepared for testing.

Figure 9 – Typical Solderability Test Setup, Connector

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

DIP (Cage):

Steam Aging

Prior to the application of flux and the immersion into solder, the specimens were suspended in a closed container, 2 inches above boiling de-ionized water using a stainless steel holder. The specimen surfaces were exposed to this steam environment for 8 hours, per Condition Category C of J-STD-002D. Then within 72 hours the specimens were subjected to solderability testing as described below.

Solderability

The areas of the specimens to be evaluated were immersed in flux type #2, Trade Name SUPERIOR 99-25.39 per J-STD-002D (Test A1) for 5 to 10 seconds (Figure 10). The flux was maintained at room temperature. The specimens were then removed from the flux and the excess was allowed to drain off for 5 to 20 seconds. The dross and any oxidized flux were skimmed away from the surface of the solder pot. The specimens were immersed at a rate of approximately 1 inch per second into a soldering bath filled with melted 96.5% tin, 3% silver and 0.5% copper, controlled at 245±5 °C (473°F) until the entire surface to be evaluated was coated (Figure 11). The specimens were held in the solder bath for 4 to 5 seconds. The specimens were removed from the solder at a rate of approximately 1 inch per second and then subjected to a 5-minute cleaning in isopropyl alcohol. The specimens were then given a visual examination under a microscope at 10X magnification.

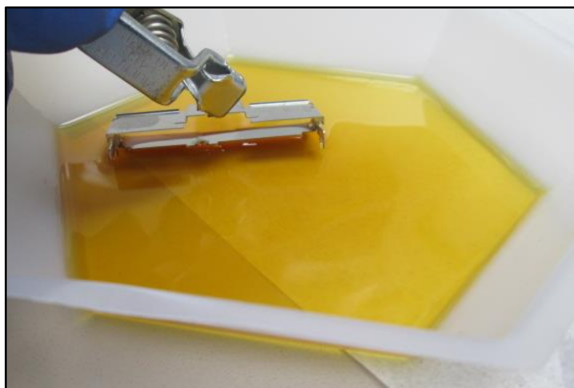

Figure 10 – Typical Flux Application

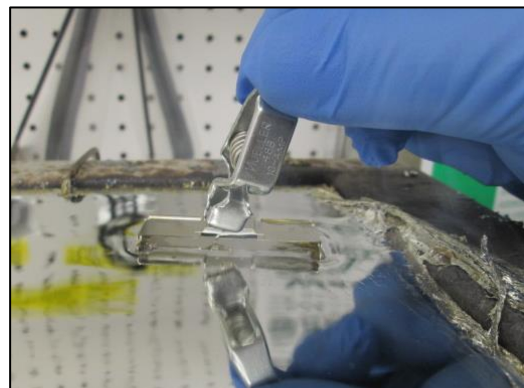

Figure 11 – Typical Solder Exposure

3.9 Resistance to Reflow Solder Heat

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

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 liquidus (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. 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 two more times for a total of 3 exposures.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

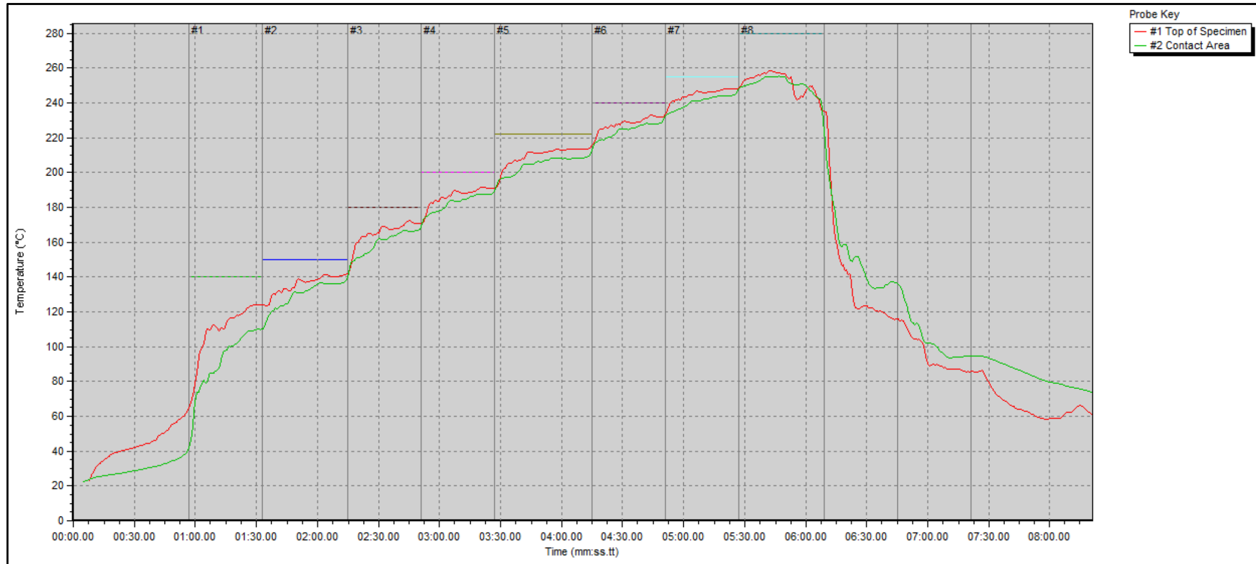

Figure 12 – Reflow Profile

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)	5.45	01:01.00	01:13.50	04:58.00	0.67	01:55.50	258.3	2.9	-11.04
#2 (°C)	5.30	00:59.50	01:19.50	04:48.00	0.71	01:53.50	255.4		-8.74

Figure 13 – 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 performed in accordance with EIA-364-32G.

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 14). Testing was performed in accordance with EIA-364-31D.

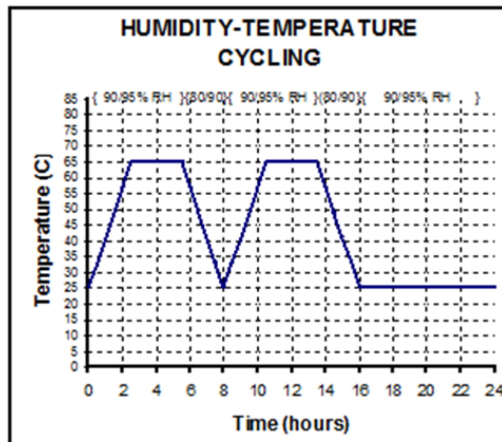

Figure 14 – Typical Humidity-Temperature Cycling Profile

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.

3.12 Temperature Life

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

3.13 Mixed Flowing Gas

Specimens were subjected to a 4-gas environment in accordance with EIA-364-65B, Class IIA for 14 days. Specimens 301, 302 and 303 were exposed in the unmated condition [receptacles only] for the 1st 7 days and mated for the final 7 days. Specimens 304, 305 and 306 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	Class IIA
Temperature (°C)	30±1
Relative Humidity (%)	70±2
Chlorine (Cl_2) Concentration (ppb)	10±5
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	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°C per minute. The humidity was not controlled. Testing was performed in accordance with EIA-364-110.

3.15 Minute Disturbance

Specimens were mated and unmated 5 times by hand.

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-364-18B.

© 2017 TE Connectivity Ltd. family of companies. All Rights Reserved.

* Trademark

TE Connectivity, TE Connectivity (logo) and TE (logo) are trademarks. Other products, logos, and company names used are the property of their respective owners.