Inverted Card Edge Connector Qualification Testing

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity Inverted Card Edge (ICE) Product to determine its conformance to the requirements of Product Specification 108-32041 Rev A.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the Inverted Card Edge Connectors. Testing was performed at the Harrisburg Electrical Components Test Laboratory between 01-October-2014 and 07-November-2014 and is maintained under EA20140548T.

1.3 Conclusion

The Inverted Card Edge Connectors listed in paragraph 1.5 passed all requirements. Testing was performed per the Product Specification 108-32041 Rev A.

1.4 Product Description

The Inverted Card Edge Product, P/N 2213188-X is a 2 position connector that mates to a direct power driver board. The product specification is 108-32041 and the application specification is 114-32054.

1.5 Test Specimens

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

Table 1 – Specimen Description

Test Set	Qty	Part Number & Rev	Description
1a, 3a, 4a, 5a	5 each	2213188-3 Rev 10	ICE Connector with 0.72 mm thick PCB (60-1824255-1 Rev B)
1b, 3b, 4b, 5b	5 each	2213188-3 Rev 10	ICE Connector with 0.9 mm thick PCB (60-1824255-1 Rev B)
1c, 3c, 4c, 5c	5 each	2213188-4 Rev 10	ICE Connector with 1.44 mm thick PCB (60-1824255-1 Rev B)
1d, 3d, 4d, 5d	5 each	2213188-3 Rev 10	ICE Connector with 1.1 mm thick PCB (60-1824255-1 Rev B)
1e, 3e, 4e, 5e	5 each	2213188-4 Rev 10	ICE Connector with 1.76 mm thick PCB (60-1824255-1 Rev B)
1, 3, 4, 5	25 each	60-1824255-2 Rev B	Inverted Thru Board PCB – Connectors Mounted to this PCB
2	5	2213188-1 Rev 10	ICE Connector

1.6 Qualification Test Sequence

Table 2 – Test Sequence

Test or Examination	Test Groups				
	1	2	3	4	5
	Test Sequence (a)				
Initial Examination of Product	1	1	1	1	1
LLCR	2,5		2,5	4,7	3,6
Insulation Resistance				2,8	
Dielectric Withstanding Voltage				3,9	
Temperature Rise vs. Current			3,6		
Solderability		2			
Random Vibration	3				
Mechanical Shock	4				
Durability					4
Mating Force					2
Un-mating Force					5
Thermal Shock				5	
Humidity-Temperature Cycling				6	
Temperature Life			4		
Final Examination of Product	6	3	7	10	7

(a) The numbers indicate 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%

2. SUMMARY OF TESTING

2.1 Initial Examination of Product – All 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 – Groups 1, 3, 4, and 5

All low level contact resistance measurements were taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage. Tables 3 through 6 report LLCR measurements for Test Groups 1, 3, 4, and 5. The LLCR requirements per Product Specification 108-32041 Rev A is 10 milliohms maximum initial and 20 milliohms maximum final. All specimens met these requirements.

Table 3 – Group 1 LLCR Data in mΩ

	Test Set 1A		Test Set 1B		Test Set 1C		Test Set 1D		Test Set 1E	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	2.33	2.36	2.32	2.28	2.36	2.38	2.28	2.26	2.27	2.26
Max	2.48	2.56	2.42	2.47	2.51	2.56	2.35	8.02	2.38	2.43
Avg	2.42	2.45	2.36	2.36	2.43	2.45	2.32	2.94	2.33	2.33
Stdev	0.05	0.07	0.04	0.05	0.05	0.07	0.02	1.79	0.04	0.05

Table 4 – Group 3 LLCR Data in mΩ

	Test Set 3A		Test Set 3B		Test Set 3C		Test Set 3D		Test Set 3E	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	2.39	2.41	2.29	2.33	2.33	2.38	2.25	2.22	2.26	2.27
Max	2.63	2.84	2.43	2.43	2.46	2.55	2.47	2.51	2.34	2.83
Avg	2.52	2.55	2.37	2.38	2.40	2.45	2.30	2.31	2.30	2.41
Stdev	0.07	0.15	0.04	0.04	0.04	0.05	0.06	0.08	0.03	0.18
N	10	10	10	10	10	10	10	10	10	10

Table 5 – Group 4 LLCR Data in mΩ

	Test Set 4A		Test Set 4B		Test Set 4C		Test Set 4D		Test Set 4E	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	2.44	2.38	2.36	2.32	2.35	2.37	2.28	2.26	2.27	2.28
Max	2.74	2.63	2.41	2.59	2.45	2.46	2.37	2.38	2.35	2.37
Avg	2.51	2.50	2.39	2.41	2.40	2.41	2.32	2.33	2.31	2.32
Stdev	0.09	0.08	0.02	0.08	0.04	0.02	0.03	0.03	0.03	0.03
N	10	10	10	10	10	10	10	10	10	10

Table 6 – Group 5 LLCR Data in mΩ

	Test Set 5A		Test Set 5B		Test Set 5C		Test Set 5D		Test Set 5E	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	2.43	2.55	2.37	2.53	2.44	2.58	2.29	2.30	2.26	2.28
Max	2.86	3.44	2.51	2.84	2.52	3.07	2.36	2.95	2.31	2.48
Avg	2.55	2.79	2.42	2.67	2.47	2.81	2.32	2.46	2.29	2.36
Stdev	0.12	0.29	0.05	0.11	0.02	0.15	0.02	0.24	0.02	0.06
N	10	10	10	10	10	10	10	10	10	10

2.3 Insulation Resistance - Group 4 (Test Sets 4a, 4b, 4c, 4d, and 4e)

All insulation resistance measurements were greater than 1000 megohms initially and 500 megohms finally.

2.4 Dielectric Withstanding Voltage - Group 4 (Test Sets 4a, 4b, 4c, 4d, and 4e)

No dielectric breakdown or flashover occurred on any specimen initially and finally.

2.5 Temperature Rise vs Current - Group 3 (Test Sets 3a, 3b, 3c, 3d, and 3e)

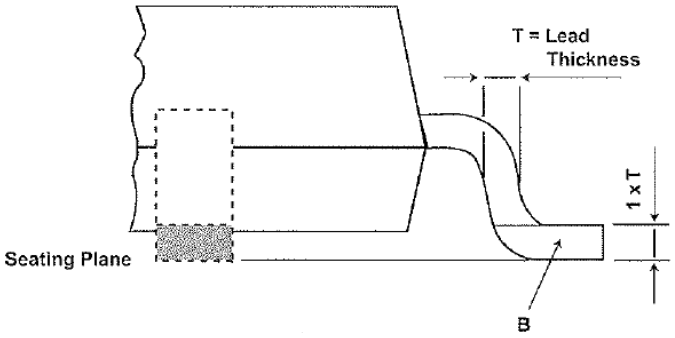
All specimens had a temperature rise of less than 10°C above ambient when tested using a current of 4 amperes, well below the 30 °C requirement. See Table 7 for Initial and Final T-Rise summary data.

Table 7 – Initial and Final T-Rise Data at 4 amperes

GROUP 3 T-Rise Data at 4 amperes (All data in °C)										
	Test Set 3A		Test Set 3B		Test Set 3C		Test Set 3D		Test Set 3E	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	8.04	8.47	7.51	8.37	8.05	8.30	7.35	7.65	7.31	7.77
Max	8.96	9.49	8.65	9.22	8.67	9.24	8.45	8.77	8.67	9.03
Avg	8.35	8.92	8.11	8.76	8.29	8.84	7.94	8.29	7.88	8.48
Stdev	0.34	0.31	0.30	0.27	0.19	0.29	0.37	0.41	0.47	0.43
N	10	10	10	10	10	10	10	10	10	10

2.6 Solderability – Group 2 (Test Set 2)

All specimens met the requirements for solderability when tested to IPC/ECA J-STD-002D, Test S1. All specimens exhibited greater than 95% solder wetting of the critical areas of solderability. 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.



Critical Area = Surface "A" (Underside of Lead) up to 1 x T

Figure 1 – Critical Area for Solderability

2.7 Vibration, Random – Group 1 (Test Sets 1a, 1b, 1c, 1d, & 1e)

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

2.8 Mechanical Shock - Group 1 (Test Sets 1a, 1b, 1c, 1d, & 1e)

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

2.9 Durability - Group 5 (Test Sets 5a, 5b, 5c, 5d, & 5e)

No physical damage occurred to the specimens as a result of mating and un-mating the specimens five times by hand.

2.10 Mating Force - Group 5 (Test Sets 5a, 5b, 5c, 5d, and 5e)

All mating force measurements were below the maximum requirement of 10.1 lbf (45 N).

2.11 Unmating Force - Group 5 (Test Sets 5a, 5b, 5c, 5d, and 5e)

All unmating force measurements met the minimum requirement of 0.9 lbf (4 N).

2.12 Thermal Shock - Group 4 (Test Sets 4a, 4b, 4c, 4d, and 4e)

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

2.13 Humidity-Temperature Cycling – Group 4 (Test Sets 4a, 4b, 4c, 4d, and 4e)

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

2.14 Temperature Life - Group 3 (Test Sets 3a, 3b, 3c, 3d, and 3e)

No evidence of physical damage was visible as a result of exposure to temperature life. Discoloration of the PCB material was present on all specimens exposed to the temperature life conditioning.

2.15 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.

3.2 Low Level Contact Resistance

Low level contact resistance measurements at low level current were made using a four terminal measuring technique. Figure 2 shows the connection locations for the LLCR measurements. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. There were two measurements taken per test specimen.

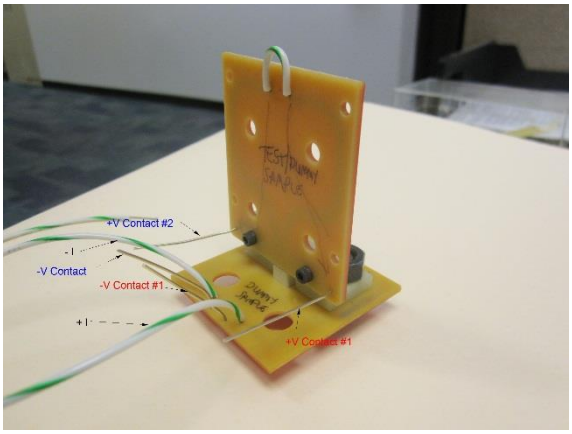


Figure 2 – Typical Low Level Contact Resistance Measurement Points

3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts of unmated specimens. A test voltage of 500 volts DC was applied for two minutes before the resistance was measured. See Figure 3 for a photograph of a specimen under test.

Figure 3 – Specimen Connection Points for IR and DWV

3.4 Dielectric Withstanding Voltage

A test potential of 1800 volts AC was applied between the adjacent contacts of unmated specimens. This potential was applied for one minute and then returned to zero. Figure 3 shows the connections for DWV testing.

3.5 Temperature Rise vs Current

All specimens in Test Sets 3a, 3b, 3c, 3d and 3e were wired in series and connected to a power supply on a T-Rise acquisition system. Each specimen had two thermocouples attached to the PCB traces on the mating card as shown in Figure 4. The coating was first scraped off of the trace to expose the copper and the thermocouples were attached using thermal epoxy. The specimens were energized with 1, 2, 3 and 4 amperes while measuring the temperatures. When stability at each current level was achieved, the system automatically increased the current and it was applied until stability was achieved again. Stability was achieved when three consecutive measurements taken 5 minutes apart did not differ by more than one degree. All t-rise data was recorded. The test setup is shown in Figure 5.

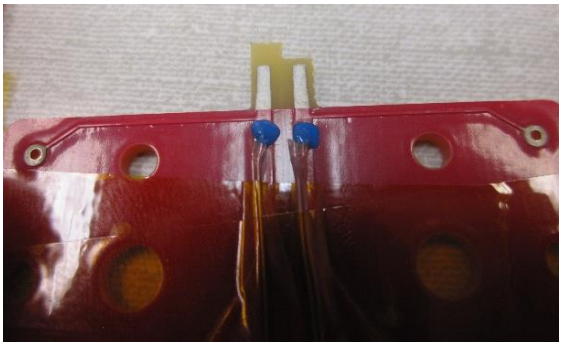


Figure 4 – Thermocouple Placement

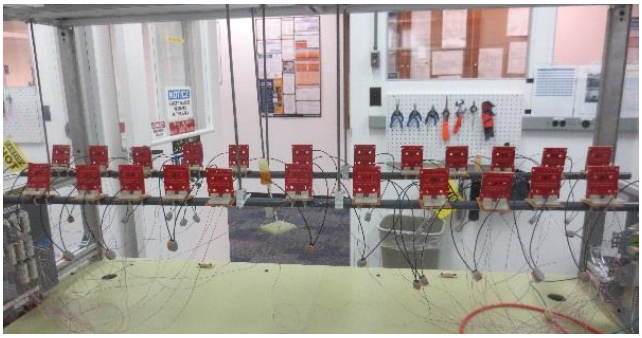


Figure 5 – Temperature Rise Setup

3.6 Solderability

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 stencil was supplied with the specimens. The solder paste was printed onto the back side of PCB # 60-1824255. The PCB was used upon agreement with the test originator as no ceramic plates would accommodate the test specimens was available. 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 PCB 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 250°C as specified in J-STD-002. The temperature on the PCB, at a point close to the specimen, was monitored to enable temperature profiling. All specimens were examined using a microscope for solder wetting. Specimens with a pitch >0.5mm were examined at 10X, and specimens with a pitch of 0.5mm or less were examined at 30X as applicable. Figure 6 illustrates the temperature profile. Figure 7 shows a PCB with the paste applied.

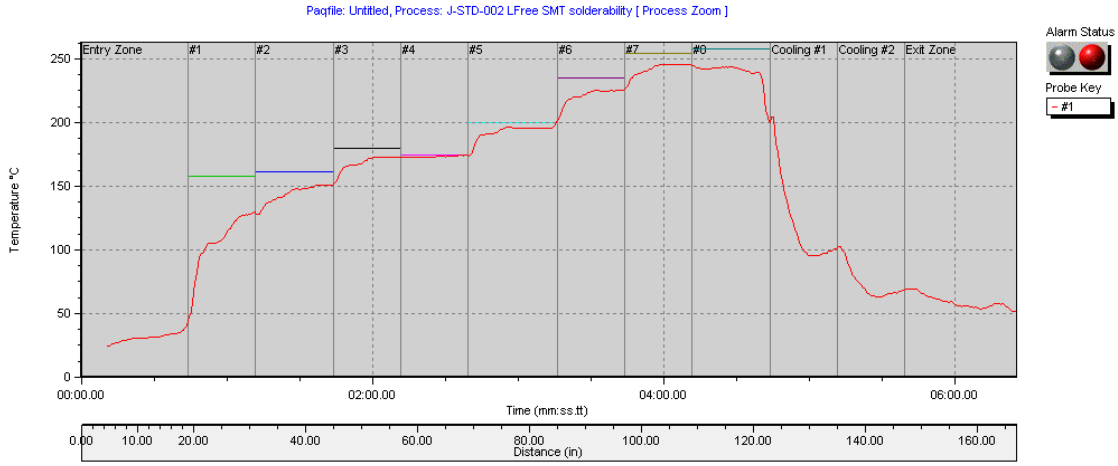


Figure 6 – Temperature Profile

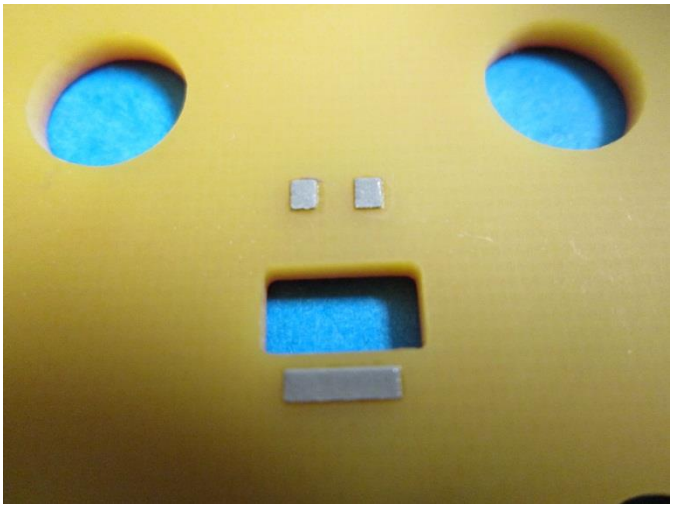


Figure 7 – Solder Paste on Substrate

3.7 Vibration, Random

The test specimens were subjected to a random vibration test in accordance with specification EIA-364-28F, test condition “VII”, test condition letter “D”. See Figure 8 for a vibration setup photograph. 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.

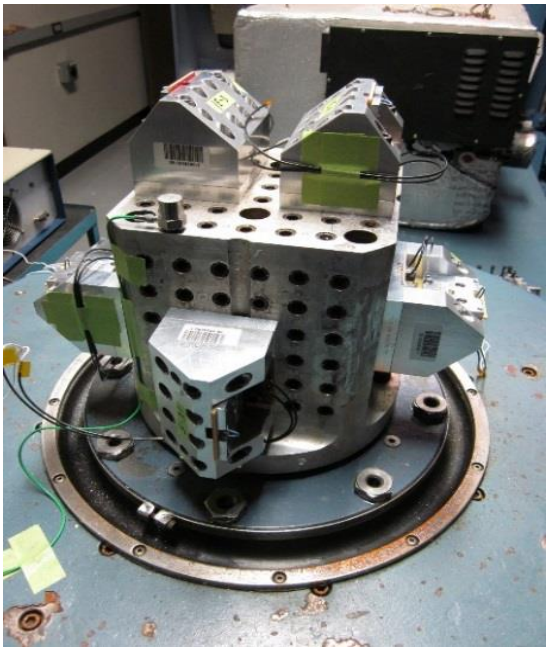


Figure 8 - Vibration/Shock Setup

3.8 Mechanical Shock, Half-sine

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, test condition “H”. See Figure 8 for a shock setup photograph. 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.

3.9 Durability

Specimens were mated and unmated five times by hand at a maximum rate of 500 cycles per hour.

3.10 Mating Force

The card edge PCB that had the card edge contacts on it was mated to the receptacle. The card edge PCB was mounted to a right angle plate that was mounted to the cross head of tensile testing machine. The receptacle PCB was held on two parallel bars that were mounted on an X-Y floating table on the base of the load frame. After aligning the two mating halves to a point where mating would begin, the cross head was started in the compression direction at a rate of 0.5 inches per minute until the components were fully mated and the crosshead was stopped manually. Figure 9 and Figure 10 show the mating force test setup.

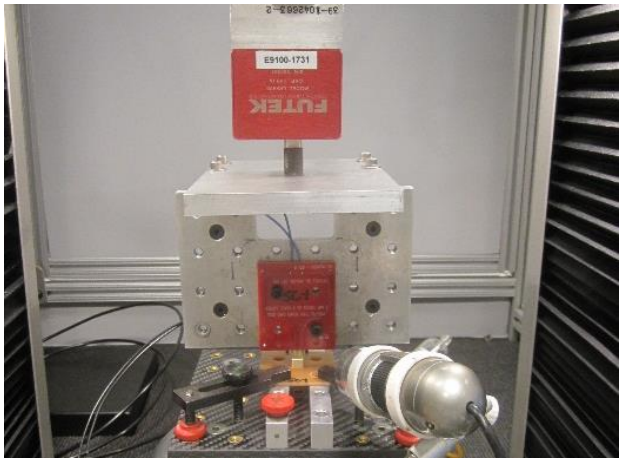


Figure 9 – Mating Force Setup

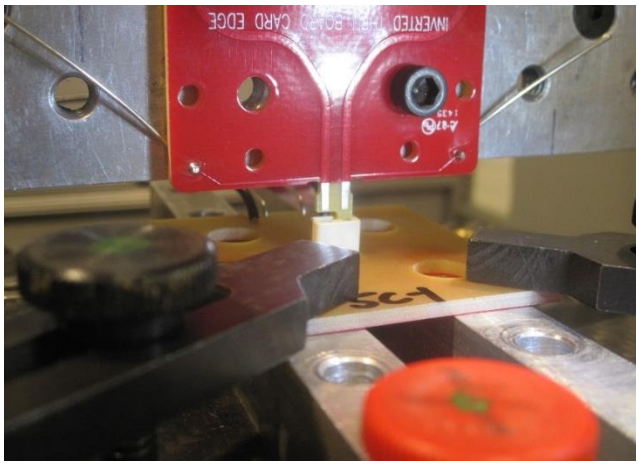


Figure 10 – Mating Force Close-up

3.11 Unmating Force

The receptacle half was mounted to an air bearing table on the base of the tensile machine. A right angle plate was mounted to the load cell on the cross head. A bar was placed across the PCB and bolted to the plate. The receptacle half was held in place, the bolts in the right angle plate were lined up and brought through the holes and the crosshead was started in the tensile direction at a rate of 0.50 inches per minute. The cross head continued until the two halves were unmated and the crosshead was stopped and the maximum force was recorded. See Figure 11 and Figure 12 for photographs of the unmating test setup.

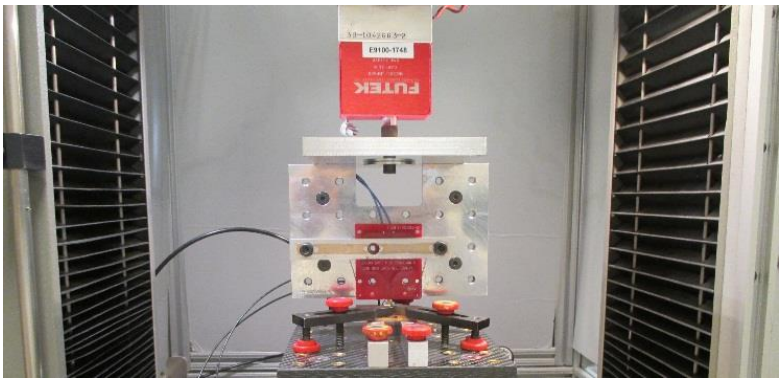


Figure 11 - Unmating Test Setup

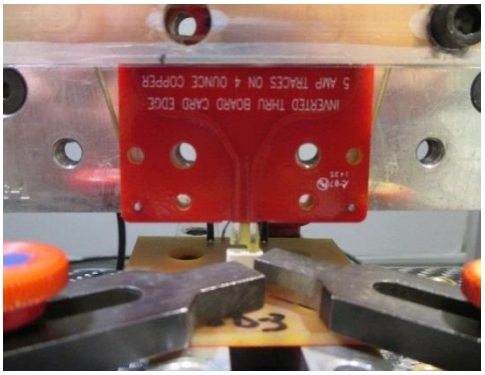


Figure 12 - Unmating Test Setup

3.12 Thermal Shock

Mated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 30 minute dwells at -40 and 130°C. The transition between temperatures was less than one minute.

3.13 Humidity-Temperature Cycling with Cold Shocks

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. During five of the first nine cycles, the specimens were exposed to a cold shock at –10°C for 3 hours (Figure 13).

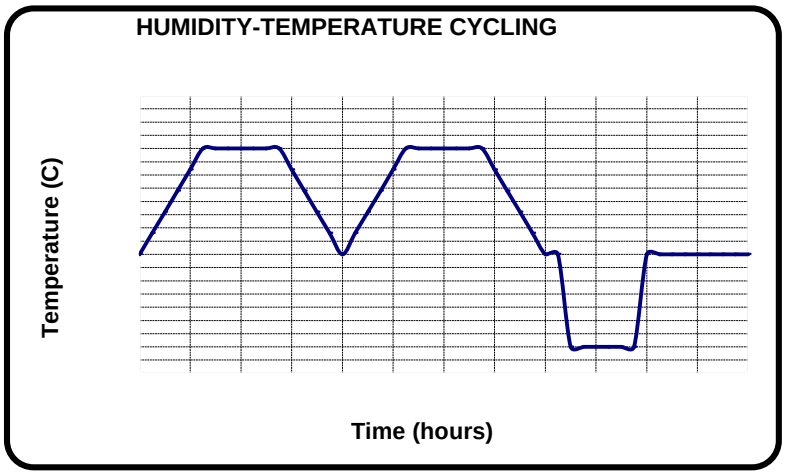


Figure 13– Typical Humidity-Temperature Cycling Profile

3.14 Temperature Life

Mated specimens were placed in a convection oven and exposed to a temperature of 130°C for 500 hours.

3.15 Final Examination of Product

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