Qualification
Test Report

501-134056 Rev A

23-June-2016

3 Position Make First Break Last (MFBL) Power Triple Lock Wire to Wire Connectors

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity, 3 Position Make First Break Last (MFBL) Power Triple Lock Wire to Wire Connector to determine its conformance to the requirements of Product Specification 108-106147, Revision A.

1.2 Scope

This report covers the electrical, mechanical and environmental performance of the TE Connectivity, 3 Position Make First Break Last (MFBL) Power Triple Lock Wire to Wire Connector. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL). Documentation for this testing is on file at HECTL under EA20150651T and EA20160092T.

1.3 Conclusion

All part numbers listed in paragraph 1.5 conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-106147, Revision A.

1.4 Product Description

The PTL MFBL connector system is a variation of PTL Wire to Wire connectors designed for Power applications. It consists of a Plug housing that accepts Receptacle contacts crimped to wires and a Cap housing that accepts Tab contacts and a Ground Tab contact crimped to wires. The Ground Tab in the center position is longer and provides the first electrical connection. The housings have 3 positions with a centerline spacing of 6.0 and latches for panel mounting. An optional CPA and TPA are available to install onto the housing. These devices provide added security to ensure that the mated housings remain together and ensure proper contact insertion and retention in the circuit cavities.

1.5 Test Specimens

The test specimens were representative of normal production lots, and the part numbers are identified in Table 1.

Table 1 – Specimen Identification

Test Group	Test Set	Qty	Part Number & Revision	Description
1	1	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
1	1	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
1	1	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
1	1	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
1	1	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 16 AWG Wire
2	2	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
2	2	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
2	2	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
2	2	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
2	2	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 16 AWG Wire
2	3	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
2	3	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
2	3	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
2	3	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
2	3	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 18 AWG Wire
2	4	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
2	4	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
2	4	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 19 AWG Wire
2	4	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 19 AWG Wire
2	4	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 19 AWG Wire
3	5	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
3	5	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
3	5	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
3	5	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
3	5	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 18 AWG Wire
4	6	10	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
4	7	10	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
4	8	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 16 AWG Wire
4	9	10	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
4	10	10	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
4	11	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 18 AWG Wire
4	12	10	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 19 AWG Wire
4	13	10	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 19 AWG Wire
5	14	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
5	14	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
5	14	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
5	14	10	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
5	14	5	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 18 AWG Wire
6	15	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
6	15	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
7	16	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
7	16	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
7	16	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
7	16	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 18 AWG Wire
7	16	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 18 AWG Wire
8	17	10	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
8	17	10	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
9	18	5	5-2232362-3, Rev A	Plug Housing, 3 Position MFBL Power Triple Lock
9	18	5	5-2232353-3, Rev A	Power Triple Lock, MFBL, PM Cap, 3 Position
9	18	15	2232723-1, Rev A	Receptacle Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
9	18	5	2232724-1, Rev A	Ground Tab Contact, 3P MFBL, Power Triple Lock, Terminated to 16 AWG Wire
9	18	10	1971784-1, Rev C	Tab Contact, Power Triple Lock, Terminated to 16 AWG Wire

1.6 Qualification Test Sequence

The specimens identified in paragraph 1.4, Table 1 were subjected to the sequences listed in Table 2.

Table 2 - Test Sequence

Test or Examination	Test Sets								
	1	2,3,4	5	6 thru 13	14	15	16	17	18
	Test Group								
	1	2	3	4	5	6	7	8	9
	Test Sequence (a)								
Examination of Product	1,7	1,9	1,8	1,3	1,4	1,4	1,7	1,3	1,3
Termination Resistance (Low Level)	2,6	2,7					2,5		
Insulation Resistance			2,6				3,6		
Dielectric Withstanding Voltage			3,7						
Temperature Rising		3,8							
Sinusoidal Vibration (Low Freq.)	4								
Random Vibration		6(b)							
Mechanical Shock	5								
Connector Mating Force									2
Contact Insertion Force					2				
Contact Retention Force					3				
Crimping Tensile Strength				2					
Durability(Repeated Mating/Unmating)	3								
Housing Locking Strength						2			
Housing Panel Retention Force						3			
Thermal Shock			4						
Humidity-Temperature Cycling		4(c)	5						
Salt Spray							4		
Temperature Life		5							
Glow Wire Test								2	

NOTES

(a) The numbers indicate sequence in which tests were performed.
(b) Discontinuities not measured, specimens were energized at 18℃ level for 100% loading per Quality Specification 102-950.
(c) *Precondition specimens with 5 durability cycles.*

1.7 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 15℃ to 35℃
Relative Humidity: 20% to 80%

2. SUMMARY OF TESTING

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

2.2 Termination Resistance (Low Level) – Groups 1, 2 and 7

All initial low level contact resistance measurements were less than the specified 3.5 milliohm maximum requirement. All measurements after testing were less than the specified 10.0 milliohm maximum requirement. Refer to Table 3 for low level termination resistance summary data in milliohms. Wire bulk resistance was subtracted from the measurements.

Table 3 – LLCR Summary Data in Milliohms

Test Set 1: 16 AWG (Test Group 1)		
Milliohms	Initial	Final
Minimum	2.07	2.43
Maximum	2.34	3.46
Average	2.19	2.92
Std. Dev.	0.08	0.35
N =	15	15
Test Set 2: 16 AWG (Test Group 2)		
Milliohms	Initial	Final
Minimum	2.15	2.84
Maximum	2.48	3.62
Average	2.25	3.21
Std. Dev.	0.09	0.20
N =	15	15
Test Set 3: 18 AWG (Test Group 2)		
Milliohms	Initial	Final
Minimum	1.77	2.51
Maximum	2.12	3.52
Average	1.94	2.97
Std. Dev.	0.11	0.34
N =	15	15
Test Set 4: 19 AWG (Test Group 2)		
Milliohms	Initial	Final
Minimum	2.12	2.73
Maximum	2.41	3.66
Average	2.31	3.15
Std. Dev.	0.08	0.28
N =	15	15
Test Set 17: 18 AWG (Test Group 7)		
Milliohms	Initial	Final
Minimum	1.98	2.33
Maximum	2.27	3.87
Average	2.16	2.80
Std. Dev.	0.08	0.44
N =	15	15

2.3 Insulation Resistance – Groups 3 and 7

All insulation resistance measurements were greater than the minimum specified 1000 megaohms initial requirement and the 100 megaohms final requirement.

2.4 Dielectric Withstanding Voltage – Group 3

No dielectric breakdown or flashover occurred and none of the specimens had a leakage current greater than the specified 5 milliamperes maximum requirement.

2.5 Temperature Rise vs. Current – Group 2

When energized at the specified current levels and loadings shown in Table 4, none of the specimens exceeded a temperature rise of 30°C as specified in Appendix II of Product Specification 108-106147, Rev A.

Table 4 – Specified Currents vs. Connector Loading (Amperes)

AWG	100% Energized	Positions 1 & 3 Energized
19	7.2	8.2
18	8	9
16	9.5	10.7

2.6 Sinusoidal Vibration (Low Freq.) – Group 1

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

2.7 Random Vibration – Group 2

During random vibration specimens were energized and maintained the currents that produced an 18°C temperature rise above ambient during initial temperature rise measurements. Following vibration, no cracks, breaks, or loose parts on the specimens were visible.

2.8 Mechanical Shock – Group 1

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

2.9 Connector Mating Force – Group 9

All specimens had mating force measurements less than the specified maximum requirement of 20 N.

2.10 Contact Insertion Force – Group 5

The force required to insert each contact into its housing cavity was less than the specified maximum requirement of 20 N.

2.11 Contact Retention Force – Group 5

The force required to remove each contact from its housing cavity was greater than the specified minimum contact retention requirement of 66.7 N.

2.12 Crimping Tensile Strength – Group 4

All 16 AWG and 18 AWG specimens met the minimum specified requirement of 133.4 N. All 19 AWG specimens met the minimum specified requirement of 62.3 N

2.13 Durability (Repeated Mating/Unmating) – Group 1

No physical damage occurred to the specimens as a result of mating and unmating the specimens 50 times.

2.14 Housing Locking Strength – Group 6

All specimens met the specified minimum 98 N requirement without the CPA installed.

2.15 Housing Panel Retention – Group 6

All specimens met the specified minimum 98 N requirement.

2.16 Thermal Shock - Group 3

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

2.17 Humidity-Temperature Cycling – Groups 2 and 3

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

2.18 Salt Spray – Group 7

No evidence of physical damage or corrosion that would be detrimental to product performance was visible as a result of exposure to a salt spray atmosphere.

2.19 Temperature Life – Group 2

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

2.20 Glow Wire Test – Group 8

Specimens were subjected to the Glow Wire test in the vertical rear, horizontal side, and horizontal end orientations. All specimens met the maximum allowable flame duration of 2 seconds at 750℃ and no flame or no dripping on the specified layer. The specimens also met the maximum allowable flame duration of 30 seconds following removal from the glow wire at 850℃.

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. Specimens were visually examined for signs of physical damage with the unaided eye. Testing was conducted in accordance with EIA-364-18B.

3.2 Termination Resistance (Low Level)

Termination resistance measurements at low level current were made using a four terminal measuring technique as shown in Figure 1. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. The wire bulk was subtracted from the measurements. Testing was conducted in accordance with EIA-364-23C.

* Trademark

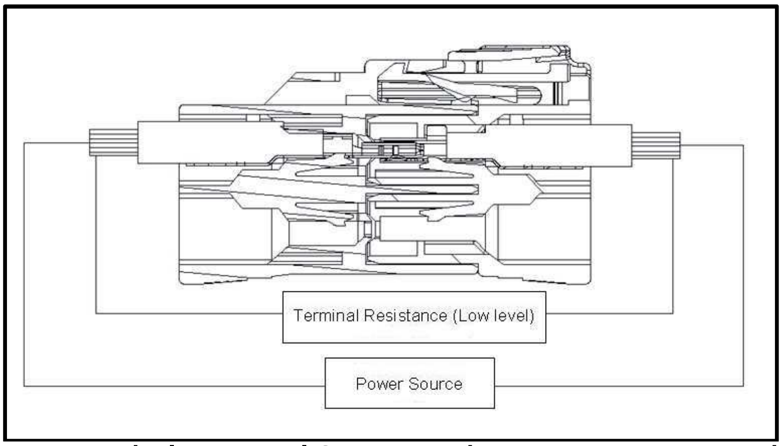

Figure 1 - Typical Low Level Contact Resistance Measurement Points

3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts and between the surface of the housing and contacts of mated specimens. A test voltage of 500 volts DC was applied for two minutes before the resistance was measured. Testing was conducted in accordance with EIA-364-21E.

3.4 Dielectric Withstanding Voltage

A test potential of 5000 volts AC (Initial) and 3000 volts AC (Final) was applied between the adjacent contacts and between the surface of the housing and contacts of mated specimens. This potential was applied for one minute and then returned to zero. The leakage current limit was set to 5 milliamperes maximum. Testing was conducted in accordance with EIA-364-20E, Condition I.

3.5 Temperature Rise vs. Current

Thirty AWG thermocouples were welded and epoxied to the back of the crimp barrel on all Tab and Ground Tab contacts of each Cap specimen in order to measure their temperatures. The ambient temperature was then subtracted from this measured temperature to obtain the temperature rise. When the temperature rise of 3 consecutive readings taken at 5 minute intervals did not differ by more than 1℃, the temperature measurement was recorded. Measurements were taken with the specimens 100% energized and also with only positions 1 and 3 energized. All measurements were taken in a draft free enclosure at the current levels shown in Table 4. Testing was conducted in accordance with EIA-364-70C, Method I. See Figure 2 for an image of the typical test setup.

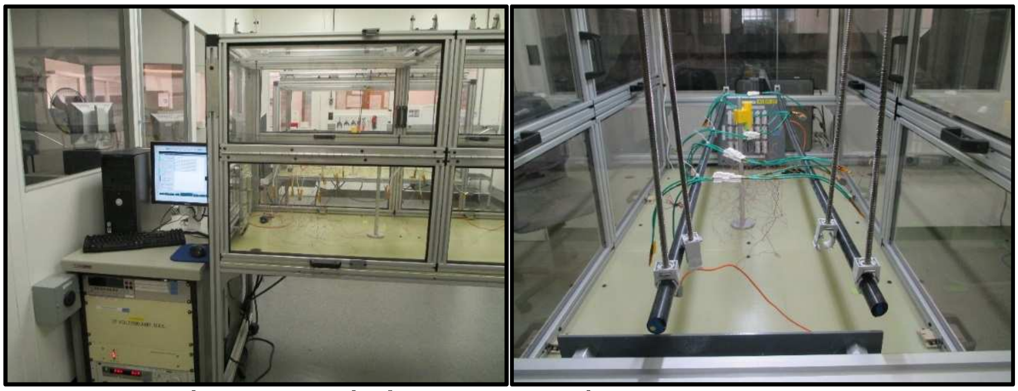

Figure 2 – Typical Temperature Rise vs. Current Setup

3.6 Sinusoidal Vibration (Low Freq.)

The test specimens were subjected to a sinusoidal vibration test in accordance with specification EIA-364-28F, Test Condition I. The test specimens were subjected to a simple harmonic motion having an amplitude of 0.06 inch double amplitude (maximum total excursion). The vibration frequency was varied uniformly between the approximate limits of 10 to 55 Hertz (Hz). The entire frequency range of 10 to 55 Hz and return to 10 Hz was traversed in approximately 1 minute. The motion was applied for a period of 2 hours in each of the three mutually perpendicular axes, so the motion was applied for a total period of approximately 6 hours. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes. See Figure 3 for an image of the typical test setup.

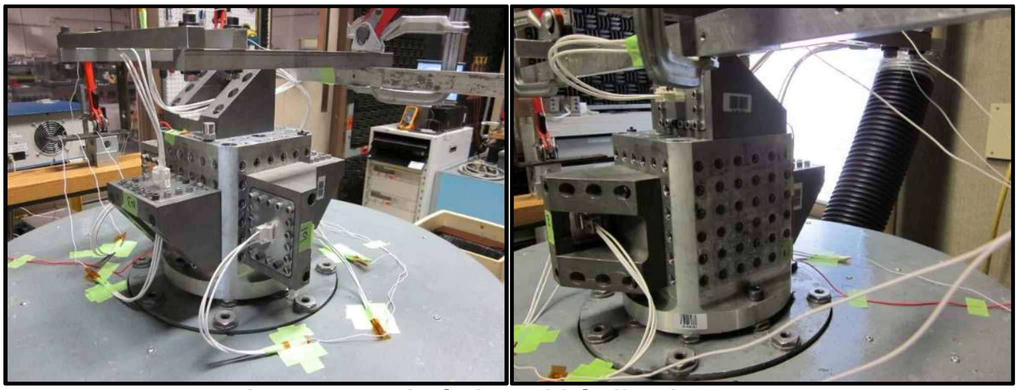

Figure 3 – Typical Sinusoidal Vibration Setup

3.7 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. See Table 5 for energized DC current values for each Test Set. These current values were calculated from initial temperature rise vs. current data. 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. See Figure 4 for an image of the typical test setup.

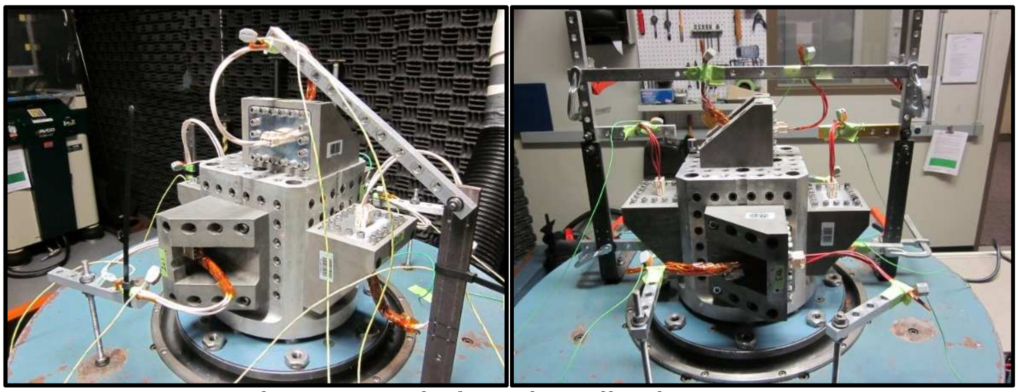

Figure 4 – Typical Random Vibration Setup

Table 5 – Random Vibration Energized DC Currents

Test Set	AWG	DC Current (Amperes)
2	16	8.7
3	18	7.6
4	19	7.2

3.8 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with specification EIA-364-27C, Test Condition A. 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. See Figure 5 for an image of the typical test setup.

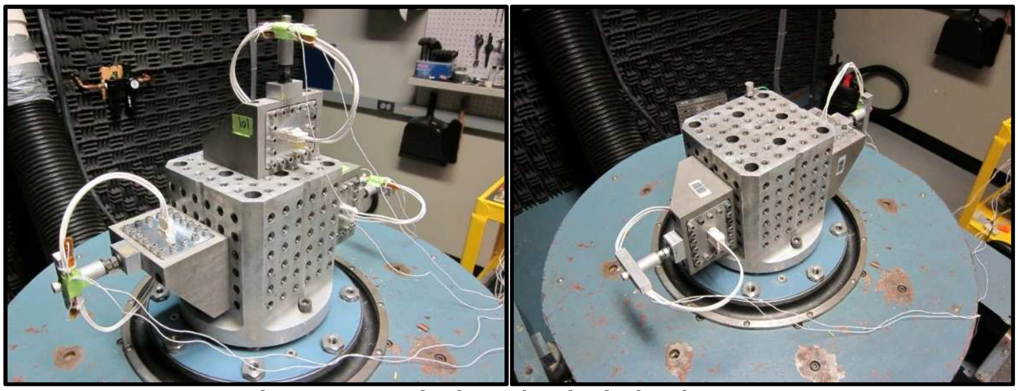

Figure 5 – Typical Mechanical Shock Setup

3.9 Connector Mating Force

The plug specimen was held with a slotted plate fixture and secured to a free floating x/y table in order to provide axial alignment. The x/y table was secured to the base of the tensile/compression machine. The cap specimen was aligned onto the plug with a slotted plate fixture attached to the crosshead and load cell. Force was applied in a downward direction at a rate of 12.70 mm/min until the connectors were fully mated. Testing was conducted in accordance with EIA-364-13E. See Figure 6 for an image of the typical test setup.

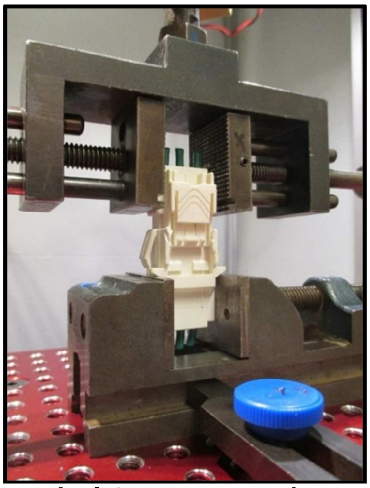

Figure 6 – Typical Connector Mating Force Setup

3.10 Contact Insertion Force

The contact was held by the wire in a drill chuck attached to the moveable crosshead of the tensile/compression machine. The housing was held in a vise attached to the base of the tensile/compression machine. The contact was manually aligned with the housing then force was applied in a downward direction until the contact was fully inserted. Testing was conducted in accordance with EIA-364-05B. See Figure 7 for an image of the typical test setup.

Figure 7 – Typical Contact Insertion Force Setup

3.11 Contact Retention Force

The housing was attached to a free floating x/y table to allow for axial alignment. The x/y table was secured to the base of the tensile compression machine. The wire was clamped in an air jaw and force was applied in an upward direction at a rate of 12.70 mm/min until failure occurred. Testing was conducted in accordance with EIA-364-29C. See Figure 8 for an image of the typical test setup.

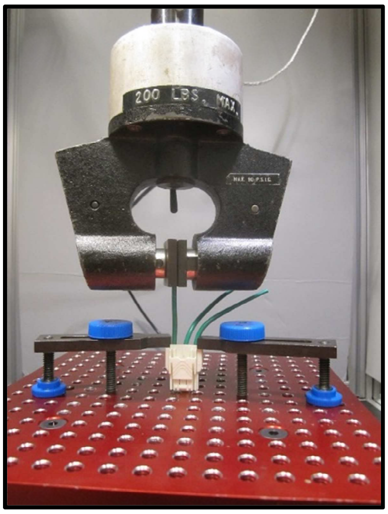

Figure 8 – Typical Contact Retention Force Setup

3.12 Crimping Tensile Strength

The contact was held in a slotted plate fixture attached to a free floating x/y table to allow for axial alignment. The x/y table was secured to the base of the tensile/compression machine. The wire of the specimen was clamped in an air jaw attached to the moveable crosshead of the tensile/compression machine. Force was applied in an upward direction at a rate of 25.40 mm/min until failure occurred. The insulation crimp was disabled prior to testing. Testing was conducted in accordance with EIA-364-08C. See Figure 9 for an image of the typical test setup.

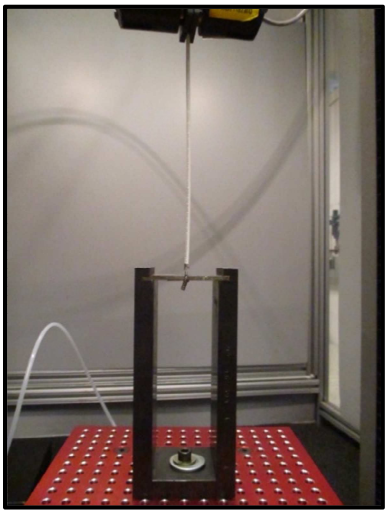

Figure 9 – Typical Wire Crimp Tensile Strength Setup

3.13 Durability (Repeated Mating/Unmating)

The specimens were mated and unmated 50 times by hand at a maximum rate of 500 cycles per hour.

3.14 Housing Locking Strength

The cap was held in a plate clamped to a free floating x/y and rotational table. The table was secured to the base of the tensile/compression machine. The plug was clamped in a vise attached to the moveable crosshead of the tensile/compression machine. Force was applied in an upward direction at a rate of 25.40 mm/min until the housing latch failed. Testing was conducted in accordance with EIA-364-98. See Figure 10 for an image of the typical test setup.

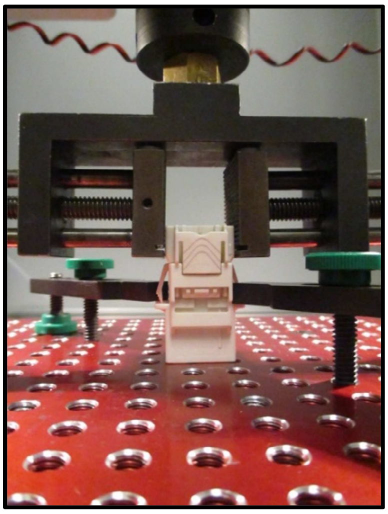

Figure 10 – Typical Housing Locking Strength Setup

3.15 Housing Panel Retention Force

The Cap specimen was held in a panel with nominal dimensions as specified in the customer drawing. The plate was clamped to a mill table attached to the base of the tensile/compression machine. A probe was attached to the moveable crosshead of the tensile/compression machine and manually aligned with the specimen. Force was applied in a downward direction at a rate of 100 mm/min until failure of the retention features occurred. Testing was conducted in accordance with EIA-364-97. See Figure 11 for an image of the typical test setup.

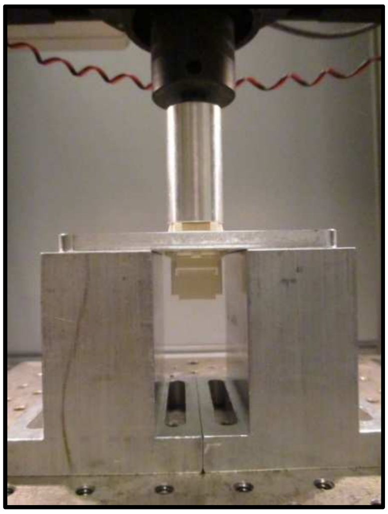

Figure 11 – Typical Housing Panel Retention Setup

3.16 Thermal Shock

Mated specimens were subjected to 25 cycles of thermal shock with each cycle consisting of 30 minute dwells at -55 and 85℃. The transition between temperatur es was less than one minute. Testing was conducted in accordance with EIA-364-32G, Test Condition I.

3.17 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℃ a nd 65℃ at 80-100 % relative humidity. Testing was conducted in accordance with EIA-364-31D, Method IV without the cold shock.

3.18 Salt Spray

Mated specimens were subjected to a 5% salt spray environment for 48 hours. The temperature of the box was maintained at 35 +1/-2℃, and the pH of the sal t solution was between 6.5 and 7.2. After exposure, the specimens were rinsed in warm tap water, shaken lightly and then placed in an air-circulating oven at a temperature of 38℃ for 4 hours minimum to dry. Tes ting was conducted in accordance with EIA-364-26C, Condition B.

3.19 Temperature Life

Mated specimens were exposed to a temperature of 105℃ for 500 hours. Testing was conducted in accordance with EIA-364-17C, Method A.

3.20 Glow Wire Test

Specimens were subjected to a Glow Wire test per IEC60695-2-11, Edition 2.0, 2014-02 for a duration of thirty seconds at 750℃ ± 10℃ and 850℃ ± 10℃ with a glo w wire penetration depth of 7mm. Prior to testing specimens were conditioned at temperatures between 15℃ to 35℃ and a relative humidity of 45 to 75% f or a minimum of 24 hours. The specimens were tested in three orientations as shown in Figures 12 through 14. The test specimens were orientated whereas not to impede the material from igniting the test specimen or dripping down to the specified layer. The tester observed each test for flame height, flame duration, and burning of the specified layer (wrapping tissue paper) beneath the specimen under test as specified in paragraph 5.3 in IEC60695-2-10 First Edition 2000-10, which is referenced in IEC60695-2-11.

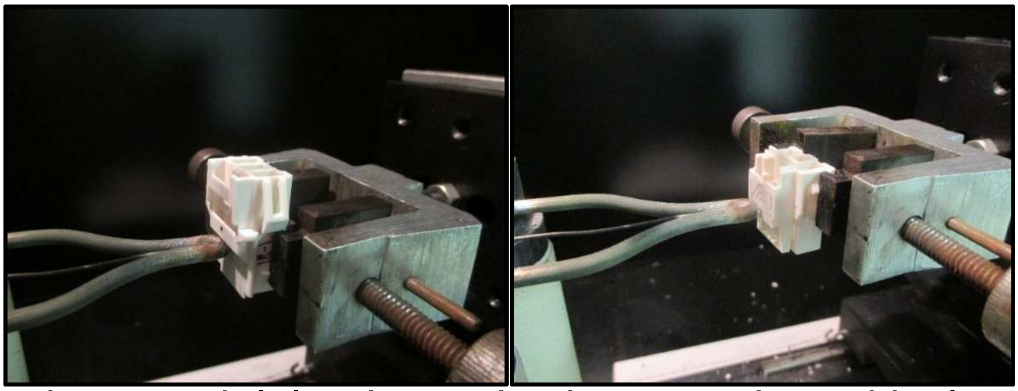

Figure 12 – Typical Glow Wire Test Orientation 1 Setup; Left: Cap, Right: Plug

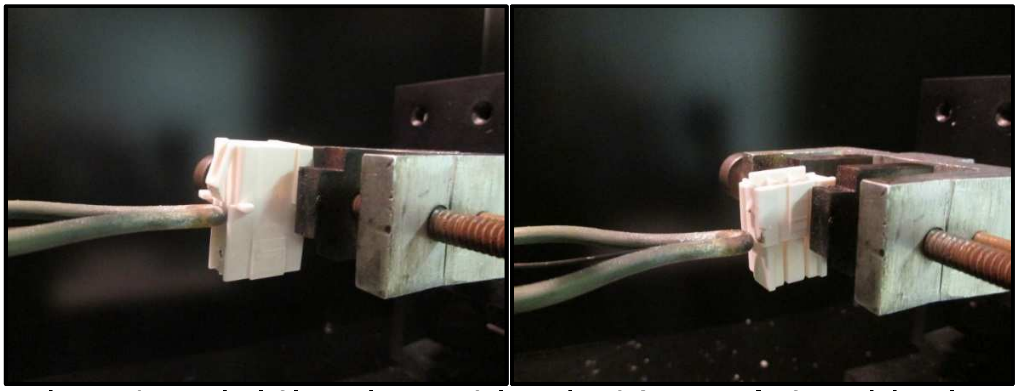

Figure 13 – Typical Glow Wire Test Orientation 2 Setup; Left: Cap, Right: Plug

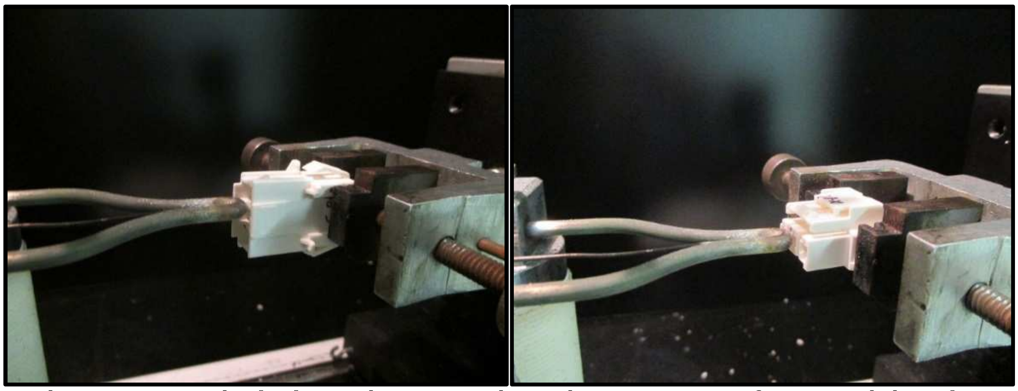

Figure 14 – Typical Glow Wire Test Orientation 3 Setup; Left: Cap, Right: Plug