Universal MATE-N-LOK* Headers (Separable Interface Testing)

1. INTRODUCTION

1.1 Purpose

Testing was performed on the TE Connectivity (TE) Universal MATE-N-LOK Headers to determine their conformance to the requirements of Product Specification 108-1053, Revision E.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the TE Universal MATE-N-LOK Headers. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between October 24, 2011 and August 23, 2013. Detailed test data is on file and maintained at HECTL under EA20110779T, EA20130183T and EA20140245T.

1.3 Conclusion

All part numbers listed in paragraph 1.5 conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-1053, Revision E.

1.4 Product Description

The Universal MATE-N-LOK printed circuit board headers provide a highly reliable and economical means of interfacing with printed circuit boards in today's home entertainment centers, appliances, vending machines, computers, and other sophisticated commercial equipment.

1.5 Test Specimens

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

Table 1 – Test Specimens

Test Group	Qty	Part number	Description
1	5	350786-1 350786-1 350431-1 641973-1 641973-1	UMNL 2P UMNL 2P w/Tin-Brass (Proposed) Split Pins UMNL 6P w/Tin-Brass (Proposed) Split Pins UMNL 12P UMNL 12P w/Tin-Brass (Proposed) Split Pins
2,4	6	350786-1 350777-1 350851-1	UMNL 2P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 2P Plug (nylon) Sockets on 24 AWG
2,4	6	350786-1 350777-1 350851-1	UMNL 2P Header w/Tin-Brass (Proposed) Split Pins UMNL 2P Plug (nylon) Sockets on 24 AWG
2,4	6	350786-1 350777-1 350537-1	UMNL 2P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 2P Plug (nylon) Sockets on two 18 AWG
2,4	6	350786-1 350777-1 350537-1	UMNL 2P Header w/ Tin-Brass (Proposed) Split Pins UMNL 2P Plug (nylon) Sockets on two 18 AWG

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Table 1, continued

Test Group	Qty	Part Number	Description
2,4	6	350431-1 1-480704-0 350851-1	UMNL 6P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 6P Plug (nylon) Sockets on 24 AWG
2,4	6	350431-1 1-480704-0 350851-1	UMNL 6P Header w/ Tin-Brass (Proposed) Split Pins UMNL 6P Plug (nylon) Sockets on 24 AWG
2,4	6	350431-1 1-480704-0 350537-1	UMNL 6P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 6P Plug (nylon) Sockets on two 18 AWG
2,4	6	350431-1 1-480704-0 350537-1	UMNL 6P Header w/ Tin-Brass (Proposed) Split Pins UMNL 6P Plug (nylon) Sockets on two #18 AWG 6 Position Housing
2,4	6	641973-1 1-480708-0 350851-1	UMNL 12P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 12P Plug (nylon) Sockets on 24 AWG
2,4	6	641973-1 1-480708-0 350851-1	UMNL 12P Header w/ Tin-Brass (Proposed) Split Pins UMNL 12P Plug (nylon) Sockets on 24 AWG
2,4	6	641973-1 1-480708-0 350537-1	UMNL 12P Header w/ Phosphor Bronze (Existing) Split Pins UMNL 12P Plug (nylon) Sockets on two 18 AWG
2,4	6	641973-1 1-480708-0 350537-1	UMNL 12P Header w/ Tin-Brass (Proposed) Split Pins UMNL 12P Plug (nylon) Sockets on two 18 AWG
3	3	641973-1 1-480708-0 350851-1	UMNL 12P Header w/ Phosphor Bronze (Existing) Pins UMNL 12P Plug (nylon) C260 sockets on 14 AWG stranded wire
3	3	641973-1 1-480708-0 350851-1	UMNL 12P Header w/ Tin-Brass (Proposed) Pins UMNL 12P Plug (nylon) C260 sockets on 14 AWG stranded wire

1.6 Qualification Test Sequence

Table 2 - Test Sequence

Test or Examination	Test Group (a)			
	1	2	3	4
	Test Sequence (b)			
Initial Examination of Product	1	1	1	1
Termination Resistance		3,7	2,5(c),7(c),9	
Insulation Resistance				2,6
Dielectric Withstanding Voltage				3,7
Temperature Rise vs. Current			3,10	
Mating Force		2		
Durability		4		
Vibration		5	8 (e)	
Mechanical Shock		6		
Un-Mating Force		8		
Resistance to Soldering Heat	2			
Thermal Shock				4
Humidity-Temperature Cycling			4(d)	5
Temperature Life			6	
Mixed Flowing Gas			4(d)	
Final Examination of Product	3	9	11	8

Note: (a) See paragraph 1.5
(b) Numbers indicate sequence tests were performed.
(c) Optical measurements used for verification.
(d) Each Sample must be mated/un-mated 10 times prior to test,
Non-Noble Plating: Humidity/Temperature Cycling, but not Mixed Flowing Gas.
Noble Plating: Mixed Flowing Gas, but not Humidity/Temperature Cycling.
(e) Discontinuities shall not be measured. Energize at 18°C level for 100% loadings per Quality Specification 102-950.

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

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

2.2 Termination Resistance

The termination resistance for Group 2 specimens were less than the final maximum requirement of 15 mΩ maximum for 24 and 18 AWG. Refer to Tables 3 and 4 for the summary data.

Table 3 – Measured Termination Resistance for Test Sets 1 through 6 (Milliohms)

	2 Position 24AWG Termination Resistance (mΩ)				2 Position 18AWG Termination Resistance (mΩ)				6 Position 24AWG Termination Resistance (mΩ)			
	Phosphor Bronze (Existing)		Tin-Brass (Proposed)		Phosphor Bronze (Existing)		Tin-Brass (Proposed)		Phosphor Bronze (Existing)		Tin-Brass (Proposed)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	1.74	1.79	1.40	1.53	1.49	1.56	1.37	1.34	1.24	1.37	1.16	0.65
Max	2.38	2.07	2.31	2.02	2.02	1.98	1.71	1.55	2.05	2.27	2.00	1.98
Avg	1.92	1.92	1.78	1.73	1.65	1.75	1.48	1.41	1.80	1.91	1.72	1.77
Std	0.17	0.08	0.31	0.18	0.16	0.14	0.10	0.06	0.16	0.20	0.16	0.23
N	12	12	12	12	12	12	12	12	36	36	36	36

Table 4 – Measured Termination Resistance for Test Sets 7 through 12 (Milliohms)

	6 Position 18AWG Termination Resistance (mΩ)				12 Position 24AWG Termination Resistance (mΩ)				12 Position 18AWG Termination Resistance (mΩ)			
	Phosphor Bronze (Existing)		Tin-Brass (Proposed)		Phosphor Bronze (Existing)		Tin-Brass (Proposed)		Phosphor Bronze (Existing)		Tin-Brass (Proposed)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Min	1.36	1.37	1.07	1.28	0.74	0.90	1.61	1.79	1.41	1.47	1.25	1.20
Max	1.62	1.73	1.50	1.70	2.00	2.08	1.95	2.13	1.88	1.96	1.58	1.94
Avg	1.47	1.53	1.36	1.42	1.59	1.69	1.80	1.98	1.49	1.62	1.40	1.46
Std	0.06	0.08	0.07	0.08	0.24	0.26	0.07	0.09	0.07	0.09	0.08	0.12
N	36	36	36	36	72	72	72	72	72	72	72	72

The termination resistance for Group 3 specimens was less than the final maximum requirement of 15 mΩ maximum for 14 AWG. Refer to Table 5 for the summary data.

Table 5 – Measured Termination Resistance for Test Sets 5 and 6 (2.00 mΩ)

	12 Position 14AWG Termination Resistance (mΩ)							
	Phosphor Bronze (Existing)				Tin-Brass (Proposed)			
	Initial	HTC	Temp-Life	Final	Initial	HTC	Temp-Life	Final
Min	1.66	1.72	1.77	2.07	1.58	1.82	1.96	2.60
Max	2.72	3.57	3.18	9.53	2.10	3.56	4.50	9.64
Avg	2.09	2.23	2.55	4.15	1.82	2.22	2.69	4.28
Std	0.27	0.40	0.40	1.52	0.14	0.37	0.45	1.36
N	36	36	36	36	36	36	36	36

2.3 Insulation Resistance

All specimens met the insulation resistance minimum requirements listed below:

Initial Minimum Requirement 1.0×10^9 Ω.

Final Minimum Requirement 1.0×10^8 Ω.

2.4 Dielectric Withstanding Voltage

There was no dielectric breakdown or flashover, and the leakage current did not exceed 1 milliampere, when subjected to test potential of 2.9 kVAC for 60 seconds.

2.5 Temperature Rise vs. Current

An F-Factor table was generated for each material with the initial Temperature Rise data. Refer to Table 6 and 7 for the F-Factor Tables. A current rating curve was generated with the final Temperature Rise data for each material. Refer to Figure 1 and 2 for the current rating curves for each material.

Table 6- Current Rating Factor (F) for Phosphor Bronze (Existing)

Percent Connector Loading	12 Position	
	Wire Size AWG	
	24	14
Single Contact	.521	1
50	.400	.768
100	.323	.619

Table 7- Current Rating Factor (F) for Tin-Brass (Proposed)

Percent Connector Loading	12 Position	
	Wire Size AWG	
	24	14
Single Contact	.486	1
50	.374	.770
100	.302	.623

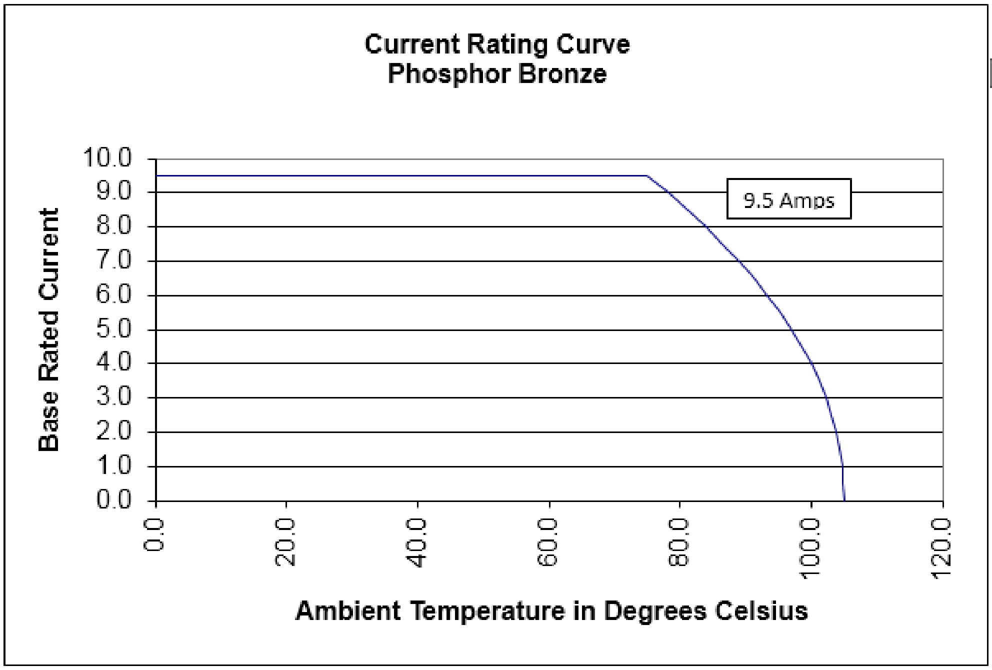

Figure 1 – Current Rating Curve for Phosphor Bronze (Existing)

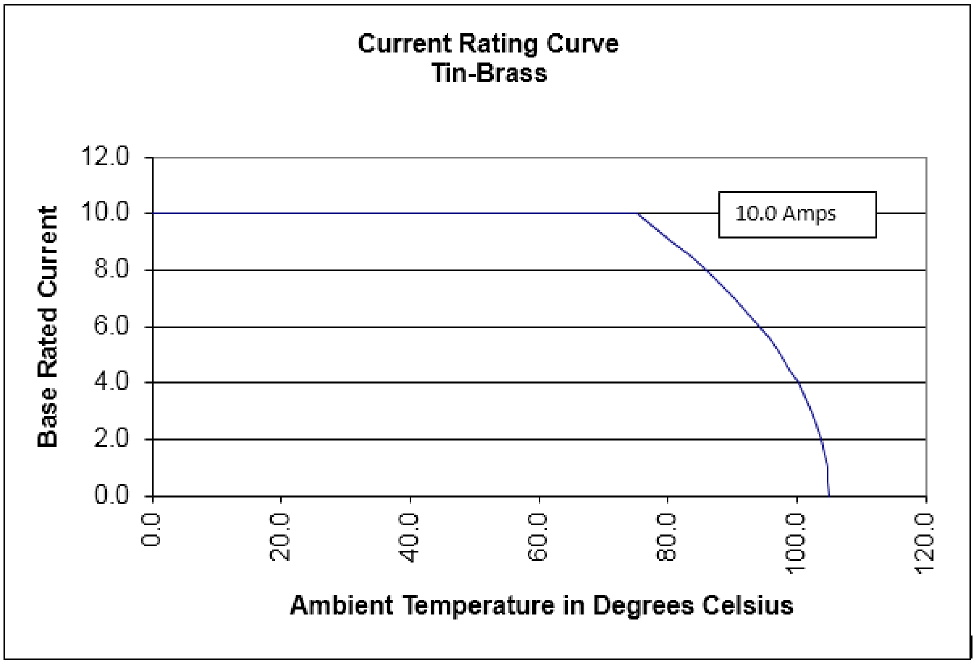

Figure 2 – Current Rating Curve for Tin-Brass (Proposed)

2.6 Mating Force

All specimen mating forces were less than the maximum requirement of 3.0 pounds.

2.7 Durability

No evidence of physical damage detrimental to product performance was observed during and following 50 durability cycles.

2.8 Vibration

Test Group 2 specimens showed no evidence of physical damage detrimental to product performance or discontinuities of one microsecond or greater during testing.

Test Group 3 specimens maintained their required current flow and exhibited no evidence of physical damage detrimental to product performance.

2.9 Mechanical Shock

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

2.10 Un-Mating Force

All specimen un-mating forces were greater than the minimum requirement of 0.5 pounds.

2.11 Resistance to Soldering Heat

All specimens exhibited greater than 95% solder wetting of the critical areas of solderability; thus the specimens met the requirement.

2.12 Thermal Shock

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

2.13 Humidity/Temperature Cycling

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

2.14 Temperature Life

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

2.15 Mixed Flowing Gas

No test data is available for this test.

2.16 Final Examination of Product

Specimens were visually examined with the unaided eye, and no evidence of physical damage detrimental to product performance was visible.

3. TEST METHODS

3.1. Initial Examination of Product

A Certificate of Conformance 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.

3.2 Termination Resistance

Termination resistance measurements at specified current levels were made using a four terminal measuring technique. The test current was maintained at the current listed in Table 8 for the specified wire size. The wire bulk was subtracted from each measurement. Refer to Figure 3 and 4 for the Termination Resistance measurement point figures.

Table 8 – Termination Resistance Test Current Levels

Wire Size (AWG)	Test Current (Amps)
24	1.5
22	3.0
20	4.5
18	6.0
16	8.0
14	10.0

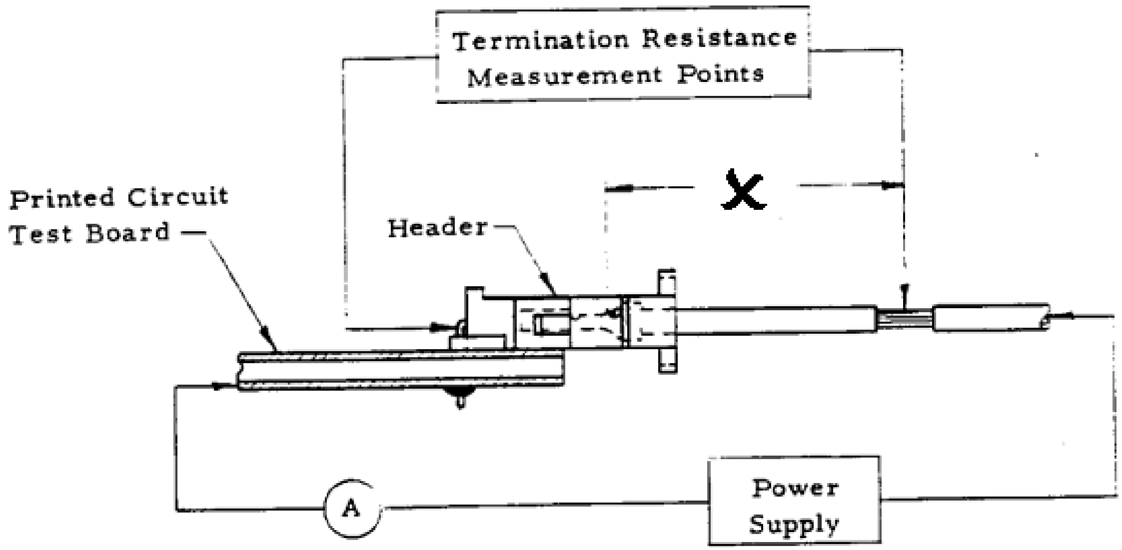

Figure 3 – Right Angle Termination Resistance

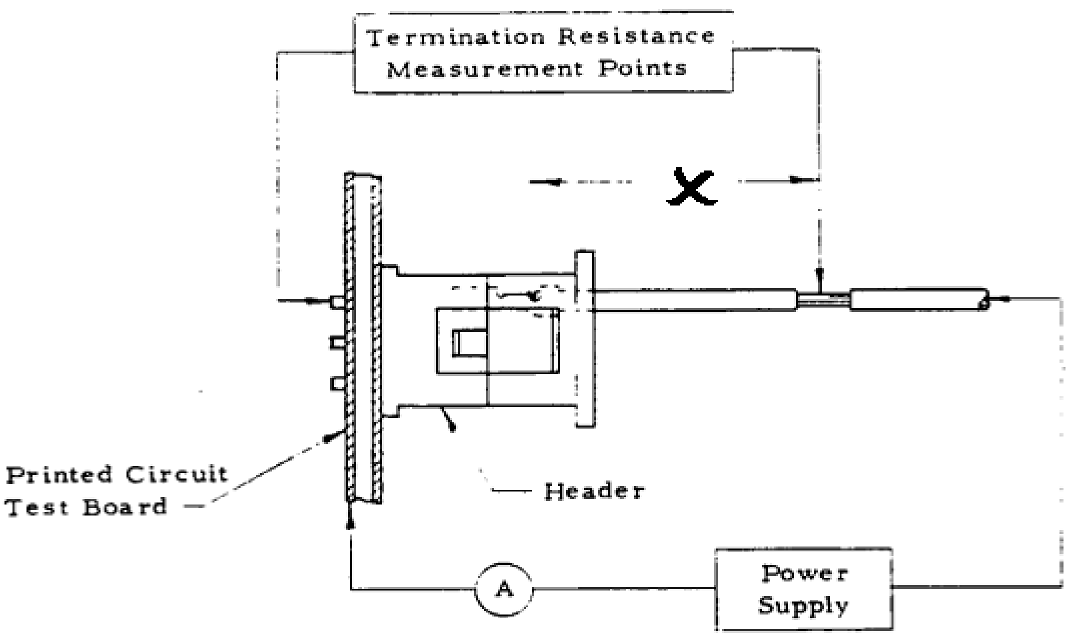

Figure 4 – Vertical Termination Resistance

3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts of mated specimens. A test voltage of 500 volts DC was applied for two minutes, then the resistance value was recorded.

3.4 Dielectric Withstanding Voltage

Dielectric withstanding voltage was measured between adjacent contacts of the mated specimens. A 60 Hz 2.9 kVolts test voltage was applied between the adjacent contacts. The voltage was maintained for a period of 60 seconds while the leakage current was monitored.

3.5 Temperature Rise vs. Current

All test specimens in each test set of each wire size were wired together in a series circuit. The temperature measuring device was a 30 AWG thermocouple that was beaded and welded to the back area of the contact crimp barrel. All specimens were energized at several current levels. When the temperature rise of 3 consecutive readings taken at 5 minute intervals did not change by more than 1°C, the temperature measurements were recorded.

3.6 Mating Force

The receptacle PCB was secured to a floating X-Y table at the base of a tensile testing machine. The plug housing latches were disabled and a slotted plate fixture was used to apply force to the back of the plug housing in the downward direction at a rate of 1.0 inches per minute, until the connector was fully mated.

3.7 Durability

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

3.8 Vibration

The test specimens were subjected to a random vibration test. 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 0.05 G^2/Hz from 20 Hz to the upper bound frequency of 500 Hz. The root-mean square amplitude of the excitation was 4.90 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.

Group 2 specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes, and Group 3 specimens were energized the DC current calculated to provide an 18°C temperature rise. The currents utilized are listed below in Table 9.

Table 9 – Energized Vibration Current Levels

Wire Size	Current, DC
14 AWG	7.5 Amps

3.9 Mechanical Shock

The test specimens were subjected to a mechanical shock test. The parameters of this test condition are a half-sine waveform with acceleration amplitude of 50 gravity units (g's peak) and 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.

3.10 Un-Mating Force

The receptacle PCBs were secured to a floating X-Y table at the base of a tensile testing machine. The plug housing was secured to the crosshead via a clamping fixture and force was applied din the upward direction at a rate of 1.0 inches per minute until the connector was unmated.

3.11 Resistance to Soldering Heat

The areas of the specimens to be evaluated were immersed in flux type "RA", a highly-activated flux, for 5 to 10 seconds. 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 bath, and the specimens were immersed at a rate of approximately 1 inch per second into the bath filled with melted 60% tin and 40% lead, controlled at 245±5°C (473°F) until the entire surface to be evaluated was coated. 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 visually examined under a microscope at 10X magnification.

3.12 Thermal Shock

The test specimens were subjected to 25 cycles of thermal shock testing, with a temperature range of -55 and 85°C.

3.13 Humidity/Temperature Cycling

The mated specimens were subjected to 10 cycles of humidity/temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 25 and 65°C twice while the relative humidity was held at 95%. During five of the first nine cycles, the connectors were exposed to a cold shock at -10°C for 3 hours.

3.14 Temperature Life

The mated specimens were subjected to a temperature of 120°C for a duration of 500 hours.

3.15 Mixed Flowing Gas

No procedure is available for this test, as testing was not required.

3.16 Final Examination of Product

Specimens were visually examined for evidence of physical damage detrimental to product performance.