1. INTRODUCTION

1.1 Purpose

Testing was performed on TE Connectivity (TE) Universal Power Module (UPM) Power Connector to determine its conformance to the requirements of Product Specification.

1.2 Scope

This report covers the electrical, mechanical performance of TE Connectivity (TE) Universal Power Module (UPM) Power Connector. Qualification Test was performed at the Americas Regional Laboratory between 07Apr95 and 06Feb96. The test file number for this testing is CTL 2989-005. Additional testing on palladium nickel plated contacts was performed between 24May06 and 26Jul06. The test file number for this testing is CTL3081-012, and tested at the China Engineering Center Testing Laboratory between 02 Apr. 2019 and 15 Apr. 2019.

1.3 Conclusion

TE Connectivity (TE) Universal Power Module (UPM) Power Connector conformed to the electrical, mechanical performance requirements of Product Specification 108-1651.

1.4 Test Specimens

The specimens were representative of normal production lots, Specimens identified with the following part numbers were used for test. Sample quantity: 10 pcs every connector.

TE Part Number	Description
5223961-1/5223954-* (3P~12P)	TE UPM STD Header Power Connector, gold plating.
5223961-1/5223954-* (3P~12P)	TE UPM STD Receptacle Power Connector, gold plating.
5-5223961-1(3P) 120954-1(4P) 120958-5(8P) 120962-1(12P)	TE UPM HC Header Power Connector, gold plating.
5-5223955-2(3P) 120953-1(4P) 120953-5(8P) 1-120943-0(12P)	TE UPM HC Receptacle Power Connector, gold plating.
120943-*	TE UPM HC Rec Power Connector, gold plating.
1645498-*	TE UPM HC Header Power Connector, 15mm stack height
1645499-*	TE UPM HC Header Power Connector, 18mm stack height.
3-5223955-0	TE UPM STD Header Power Connector, Pd/Ni+Gold plating.
3-5223961-0	TE UPM STD Receptacle Power Connector, Pd/Ni+Gold plating

Figure 1

1.5 Environmental Conditions

Unless otherwise stated. The following environmental conditions prevailed during testing

Temperature: 25±10 °C
Relative Humidity: 50±25% RH

1.6 Product Qualification and Requalification Test Sequence

Test or Examination	Test Group (a)							
	1	2	3	4	5	6	7	8
	Test Sequence (b)							
Examination of product	1,17	1,12	1,11	1,10	1,7	1,8	1,5	
Product contact resistance, Au plating	2,13	2,8	2,7	2,7	2	2,6	2,4	
Product contact resistance, Au+Pd/Ni plating								1,3,5,7,9,11, 13
Insulation resistance	3,12	3,9	3,6	3,8	3			
Dielectric withstanding voltage	4,14	4,10	4,8	4,9	4			
Temperature rise vs current						7		
Sinusoidal vibration, Au plating	7					5		
Sinusoidal vibration, Au+Pd/Ni plating								12
Mechanical shock	8							
Durability, Au plating		5,7		5				
Durability, Au+Pd/Ni plating								4,10
Contact retention					6			
Mating force	5,15		9					
Unmating force	6,16		10					
Termination strength					5			
Static load, transverse		11						
Thermal shock	9							
Humidity, steady state			5					
Humidity/temperature cycling	11(c)							
Electrical load, high temperature				6				
Temperature life, Au plated product	10					4		
Temperature life, Au+Pd/Ni plating								2
Mixed flowing gas (3 gas)						3(d)		
Mixed flowing gas (4 gas), Au plating							3	
Mixed flowing gas, Au+Pd/Ni plating								6(e),8(f)
Industrial atmosphere		6						

NOTE

(a) See paragraph 1.5.
(b) Numbers indicate sequence in which tests are performed.
(c) Perform dielectric withstanding voltage at 30000 feet after first cycle
(d) Precondition specimens with 10 cycles durability.
(e) Mated specimens.
(f) Unmated specimens.

2. SUMMARY OF TESTING

2.1 Initial Examination of Product

All specimens submitted for testing were representative of normal production lots. A Certificate Conformance (C of C) was issued by Product Assurance. Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

2.2 Product Contact Resistance Test

All low level contact resistance measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 0.2 milliohms initially and after testing for power contacts.

Test Record of UPM STD Power with Gold Plating.

Test Group	Number of Data Points	Condition	Termination Resistance		
			Min	Max	Mean
1	18	Initial	1.68	2.19	2.000
		After mechanical	1.74	2.28	1.976
2	24	Initial	1.61	2.05	1.819
		After SO_2 exposure	1.54	1.97	1.768
3	12	Initial	1.68	1.99	1.823
		After steady state humidity	1.62	2.10	1.806
4	12	Initial	1.66	2.07	1.894
		After electrical load	1.83	2.07	1.961
5	12	Initial	1.74	2.03	1.871
6	30	Initial	1.52	2.08	1.895
		After environmental	1.62	2.55	1.998
7	20	Initial	1.58	2.10	1.740
		After mixed flowing gas	1.56	2.05	1.690

Test Record of UPM HC Power with Gold Plating.

Test Group	Number of Data Points	Condition	Termination Resistance		
			Min	Max	Mean
1	24	Initial	1.02	1.67	1.29
		After mechanical	0.89	1.86	1.34
2	24	Initial	0.91	1.46	1.19
		After SO_2 exposure	1.02	1.37	1.21
3	24	Initial	1.10	2.31	1.31
		After steady state humidity	0.93	2.10	1.80
4	24	Initial	0.76	1.96	1.35
		After electrical load	0.94	1.92	1.31
5	24	Initial	0.97	1.33	1.19

6	24	Initial	1.06	1.47	1.25
		After environmental	1.02	2.05	1.28
7	24	Initial	0.96	2.24	1.45
		After mixed flowing gas	1.07	2.15	1.70

Test Record of UPM STD Power with Pd/Ni plus Gold Plating.

Measurement	Initial (R)	After Temperature Life (Δ R)	After 1st Durability (Δ R)	After Mated Mixed Flowing Gas (Δ R)	After Unmated Mixed Flowing Gas (Δ R)	After 2nd Durability (Δ R)	After Vibration (Δ R)
30 u" Palladium Nickel + Gold plating							
N	30	30	30	30	30	30	30
Minimum	1.843	-0.282	-0.459	-0.485	-0.326	-0.373	-0.438
Maximum	2.369	0.400	0.338	0.071	0.732	0.157	0.249
Mean	2.129	0.009	-0.127	-0.185	0.044	-0.125	-0.116
Standard Deviation	0.147	0.153	0.141	0.142	0.227	0.127	0.143

NOTE *All values in milliohms.*

2.3. Insulation Resistance

All insulation resistance measurements were greater than 10000 megohms.

2.4. Dielectric Withstanding Voltage

No dielectric breakdown or flashover occurred.

2.5. Temperature Rise vs Current

All specimens had a temperature rise of less than 30°C above ambient when tested using the specific rated current and energizing all power contacts in accordance with product specification 108-1651.

2.6. Sinusoidal Vibration

A. Gold Plated Product

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

B. Palladium Nickel plus Gold Plated Product

No evidence of physical damage occurred as a result of vibration testing.

2.7. Mechanical Shock

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

2.8. Durability

A. Gold Plated Product
No evidence of physical damage occurred as a result of mating and unmating the specimens 250 times.
B. Palladium Nickel plus Gold Plated Product
No evidence of physical damage occurred as a result of mating and unmating the specimens 250 times.

2.9. Contact Retention

All specimens met the maximum axial displacement requirements of 0.2 mm loaded and 0.1 mm unloaded. The maximum displacement recorded for any contact when under load was 0.065 mm, while the maximum unloaded displacement for any contact was 0.03 mm.

2.10. Mating Force

All mating force measurements were less than 1 N per contact.

2.11. Unmating Force

All unmating force measurements were greater than 0.5 N per contact.

2.12. Termination Strength

No evidence of physical damage was visible as a result of a termination strength test.

2.13. Static Load, Transverse

No evidence of physical damage was visible as a result of a static load test.

2.14. Thermal Shock

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

2.15. Humidity, Steady State

No evidence of physical damage was visible as a result of exposure to steady state humidity.

2.16. Humidity/temperature Cycling

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

2.17. Electrical Load, High Temperature

No evidence of physical damage was visible as a result of exposure to a temperature life test with an electrical load applied.

2.18. Temperature Life

A. Gold Plated Product

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

B. Palladium Nickel plus Gold Plated Product

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

2.19. Mixed Flowing Gas

A. Gold Plated Product

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas.

B. Palladium Nickel plus Gold Plated Product

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas.

2.20. Industrial Atmosphere

No evidence of physical damage was visible as a result of exposure to the pollutants of an industrial atmosphere test

2.21 Final Examination of Product

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

3 TEST METHODS

3.1 Initial Examination of Product

A Certificate of Conformance was issued stating that all specimens in the test package were produced, inspected, and accepted as conforming to product drawing requirements, and manufactured using the same core manufacturing processes and technologies as production parts.

3.2 Product Contact Resistance Test

Low level contact resistance measurements were made with four terminal measuring technique. The test current was maintained at 100 milliamperes maximum with the 20 millivolt maximum open circuit voltage, in accordance with EIA-364-27.

3.3. Insulation Resistance

Insulation resistance was measured between adjacent contacts. A test voltage of 100 volts DC was applied for 1 minute before the resistance was measured.

3.4. Dielectric Withstanding Voltage

A test potential of 1000 volts AC was applied between the adjacent contacts. This potential was applied for 1 minute and then returned to zero.

3.5. Temperature Rise vs Current

Thermocouples were attached to individual contacts to measure their temperatures. The ambient temperature was then subtracted from this measured temperature to find the temperature rise. When the temperature rise of 3 consecutive readings taken at 5 minute intervals did not differ by more than 1°C, the temperature measurement was recorded.

3.6. Sinusoidal Vibration

A. Gold Plated Product

Mated specimens were subjected to sinusoidal vibration, having a simple harmonic motion with an amplitude of 0.71 mm, double amplitude or 5 g's peak, whichever is less. The vibration frequency was varied logarithmically between the limits of 10 and 500 Hz and returned to 10 Hz in 11.25 minutes. This cycle was performed 10.6 times in each of 3 mutually perpendicular planes, for a total vibration time of 6 hours. Specimens were monitored for discontinuities greater than 1.0 microsecond, using 100 milliamperes of current in the monitoring circuit.

B. Palladium Nickel plus Gold Plated Product

Parameters of this test condition are a simple harmonic motion having an amplitude of either 1.5 mm double amplitude (maximum total excursion) or 5 gravity unit (g's peak) whichever is less. The vibration frequency was varied logarithmically between the approximate limits of 10 to 500 Hz. The entire frequency range of 10 to 500 Hz and return to 10 Hz was traversed in approximately 15 minutes. This cycle was performed 12 times in all 3 mutually perpendicular axes (total of 36 times), so that the motion was applied for a total period of approximately 9 hours. Test specimens were not monitored for discontinuities during testing.

3.7. Mechanical Shock

Mated specimens were subjected to a physical shock test, having a half-sine waveform of 50 gravity units (g peak) and a duration of 11 milliseconds. Five shocks in each direction were applied along the 3 mutually perpendicular planes, for a total of 30 shocks. Specimens were monitored for discontinuities greater than 1.0 microsecond, using 100 milliamperes of current in the monitoring circuit.

3.8. Durability Test

Specimens were mated and unmated 250 cycles at a maximum rate of 500 cycles per hour. In accordance with EIA–364-09.

3.9. Contact Retention

A pin-like probe was used to apply a specified force to each end of both the pin and receptacle contacts. The forces were applied at a rate of 2.54 mm per minute and held for 5 seconds. A force of 10 N was applied to the pin contacts in the unmating direction. A force of 5 N was applied to the pin contacts in the mating direction and to the receptacle contacts in both the mating and unmating directions. During application and holding of the forces, axial displacement of the contacts was measured and was not to exceed 0.2 mm while applying the forces or 0.1 mm after removing the forces.

3.10. Mating Force

Test specimens consisted of plugs and receptacles with all contacts installed. Specimens were mounted in test fixtures in a manner similar to normal service. The specimens were aligned and brought to a position where mechanical mating just began, then mated and unmated at a rate of 25.4 mm per minute while the peak mate/unmate forces of the connectors were recorded. The force/contact values were determined by dividing the total measured force by the number of contacts in the connectors.

3.11. Unmating Force

Test specimens consisted of plugs and receptacles with all contacts installed. Specimens were mounted in test fixtures in a manner similar to normal service. The specimens were aligned and brought to a position where mechanical mating just began, then mated and unmated at a rate of 25.4

mm per minute while the peak mate/unmate forces of the connectors were recorded. The force/contact values were determined by dividing the total measured force by the number of contacts in the connectors.

3.12. Termination Strength

A tensile (pulling) force and a thrust (pushing) force of 10 N was applied axially to the plug contacts for a period of 10 seconds. A force of 10 N was also applied axially to the receptacle contacts in both directions.

3.13. Static Load, Transverse

A 25 N side-to-side load and a 50 N front-to-back load was applied to the unmated plug and receptacle connectors using a 3 mm diameter rod with a rounded end. The forces were applied in the middle of the plug and receptacle modules, approximately 11 and 6 mm above the respective printed circuit boards.

3.14. Thermal Shock

Mated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 30 minute dwells at -55 and 125°C. The transition between temperatures was less than 1 minute.

3.15. Humidity, Steady State

Specimens were exposed for 56 days to a steady state temperature/humidity environment consisting of 40°C and 93% RH. During exposure, a potential of 60 volts DC was applied between adjacent contacts of all specimens.

3.16. Humidity/temperature Cycling

Specimens were exposed to a total of 6 humidity/temperature cycles. Each cycle lasted 24 hours and consisted of the following parameters:

Transition from 25°C and 95% RH to 55°C and 90% RH in 3 hours
Dwell at 55°C and 90% RH for 9 hours
Transition from 55°C and 90% RH to 25°C and 80% RH in 3 hours
Then dwell at 25°C and 95% RH for 9 hours

At the end of the first temperature/humidity cycle, the specimens were removed from the temperature/humidity chamber and exposed to a temperature of -55°C for 2 hours. Specimens were then placed in an altitude chamber with the adjacent contact pairs on each specimen wired to test dielectric withstanding voltage. A test voltage of 200 volts AC was applied for 1 minute to all adjacent pairs at the same time, while the chamber was maintained at a simulated altitude of 30000 feet.

3.17. Electrical Load, High Temperature

Specimens were placed in a 70°C oven and energized at a current of 7.8 amperes DC. Thermocouples, which were attached to the center contact of each specimen, were monitored during the exposure. With the rated current flowing through each contact, the oven temperature was increased until the internal temperature of the specimens stabilized at their rated operating temperature of 125°C. The oven temperature at the time of specimen stabilization was 102°C. The specimens remained in the oven at 102°C for a total of 1000 hours.

3.18. Temperature Life

A. Gold Plated Product

Mated specimens were exposed to a temperature of 125°C for 16 hours.

B. Palladium Nickel plus Gold Plated Product

Mated specimens were exposed to a temperature of 125°C for 16 hours

3.19. Mixed Flowing Gas

A. Gold Plated Product

Mated specimens were exposed for 14 days to a mixed flowing gas Class II exposure. Class II exposure is defined as a temperature of 30°C and 70% RH with the pollutants of Cl_2 at 10 ppb, NO_2 at 200 ppb, and H_2S at 10 ppb. Specimens were preconditioned with 10 cycles of durability.

Unmated specimens were exposed for 10 days to a mixed flowing gas Class IIA followed by 10 days of mated exposure. Class IIA exposure is defined as a temperature of 30°C and 70% RH with the pollutants of Cl_2 at 10 ppb, SO_2 at 100 ppb, NO_2 at 200 ppb, and H_2S at 10 ppb.

B. Palladium Nickel Plated Product

Unmated specimens were exposed for 10 days to a mixed flowing gas Class IIA followed by 10 days of mated exposure. Class IIA exposure is defined as a temperature of 30°C and 70% RH with the pollutants of Cl_2 at 10 ppb, SO_2 at 100 ppb, NO_2 at 200 ppb, and H_2S at 10 ppb.

3.20. Industrial Atmosphere

Four mated and 4 unmated specimens were exposed for 10 days to a 500 part per million concentration of sulfur dioxide and a 100 part per million concentration of hydrogen sulfide at 25°C and 75% RH.

3.21. Final Examination of Product

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