Two, Three and Four Pair HM-Zd Connectors

1. INTRODUCTION

1.1. Purpose

Testing was performed on Tyco Electronics Two and Four Pair HM-Zd Connectors to determine their conformance to the requirements of Product Specification 108-2055 Revision B.

1.2. Scope

This report covers the electrical, mechanical, and environmental performance of Two and Four Pair HM-Zd Connectors with right angle receptacles and vertical headers. Testing was performed at the Engineering Assurance Product Test Laboratory between 19Mar03 and 09Sep03. The test file number for this testing is CTL B026948-030. Additional testing on four pair right angle receptacles and right angle headers was performed between 26Jan05 and 03Mar05. The test file number for this additional testing is CTLF 271-004. This documentation is on file at and available from the Engineering Assurance Product Test Laboratory.

1.3. Conclusion

The Two and Four Pair HM-Zd Connectors listed in paragraph 1.5., conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-2055 Revision B.

1.4. Product Description

The Two and Four Pair HM-Zd Connectors are modular, high speed, board-to-board connecting systems containing 2 or 4 differential signal pairs per column. Both header and receptacle connectors are connected to printed circuit boards using compliant press-fit leads.

1.5. Test Specimens

Test specimens were representative of normal production lots. Specimens identified with the following part numbers were used for test:

A. Two and Four Pair HM-Zd Connectors (right angle receptacle, vertical header)

Test Group	Quantity	Part Number	Description
1,2,3,4,5,6	12 each	1469001-1	4 pair, 80 signal position right angle receptacle
	12 each	1469002-1	4 pair, 80 signal position vertical header
	12 each	1469028-1	2 pair, 40 signal position right angle receptacle
	12 each	1469025-1	2 pair, 40 signal position vertical header

Figure 1A

* Trademark
| Indicates change

B. Four Pair HM-Zd Connectors (right angle receptacle, right angle header)

Test Group	Quantity	Part Number	Description
1	4	1469001-1	4 pair, 80 signal position right angle receptacle
	4	1469048-1	4 pair, 80 signal position right angle header
	2	60-469954-1	PCB with 2 receptacles per board
	2	60-469955-1	PCB with 2 right angle headers per board (see Note)
2	2	1469001-1	4 pair, 80 signal position right angle receptacle
	2	1469048-1	4 pair, 80 signal position right angle header

NOTE *Printed circuit boards were modified to accept right angle headers.*

Figure 1B

1.6. Environmental Conditions

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

- Temperature: 15 to 35˚C
- Relative Humidity: 25 to 75%

1.7. Qualification Test Sequence

A. Two and Four Pair HM-Zd Connectors (right angle receptacle, vertical header)

Test or Examination	Test Group (a)					
	1	2	3	4	5	6
	Test Sequence (b)					
Initial examination of product	1	1	1	1	1	1
Low level contact resistance	4,7,9,11,13	5,8,10,12,14	5(c),8	4,6,8,10,12,14,16,18		
Low level compliant pin resistance	2,15	3,18	3,10	2,20		
Insulation resistance		15				
Withstanding voltage		16				
Temperature rise vs current					2	
Vibration	10					
Mechanical shock	12					
Durability	6	7		5(d),17(d)		
Mating force	3,16	4,19	4,11	3		
Unmating force	5,14	6,17	6,9	19		
Compliant pin insertion force		2	2			
Compliant pin retention force		20	12			
Minute disturbance				15		
Receptacle cover retention						2
Thermal shock		11				
Humidity-temperature cycling		13				
Temperature life			7			
Mixed flowing gas (mated)				11(e),13(e)		
Mixed flowing gas (unmated)				7(e),9(e)		
Dust contamination	8	9				
Final examination of product	17	21	13	21	3	3

NOTE

(a) See paragraph 1.5.
(b) Numbers indicate sequence in which tests are performed.
(c) Perform 10 durability cycles prior to initial measurement.
(d) Perform 125 durability cycles before, and 125 durability cycles after mixed flowing gas testing.
(e) Exposure interval of 5 days.

Figure 2A

B. Four Pair HM-Zd Connectors (right angle receptacle, right angle header)

Test or Examination	Test Group (a)	
	1	2
	Test Sequence (b)	
Low level contact resistance	1,3,5	
Vibration	2	
Mechanical shock	4	
Temperature rise vs current		1

NOTE *(a) See paragraph 1.5.*
(b) Numbers indicate sequence in which tests are performed.

Figure 2B

2. SUMMARY OF TESTING

2.1. Initial Examination of Product - All Test 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. Low Level Contact Resistance

A. Two and Four Pair HM-Zd Connectors (right angle receptacle, vertical header) - Test Groups 1, 2, 3 and 4 (Figure 2A)

All low level contact resistance measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 20 milliohms initially, had an individual change in resistance (ΔR) of less than 10 milliohms and an average change in resistance (ΔR) of less than 5 milliohms, at all measurement intervals after initial.

Test Group	Number of Data Points	Condition	Low Level Contact Resistance (ΔR)			
			Min	Max	Mean	StdDev
1	Signal Contacts					
	240	Initial	8.442	18.02	12.304	2.519
	240	After durability	-1.557	0.789	-0.251	0.248
	240	After dust	-1.917	2.307	-0.363	0.311
	240	After vibration	-1.748	0.304	-0.340	0.224
	240	After shock, final	-1.807	0.284	-0.337	0.237
	Ground Contacts					
	40	Initial	5.450	6.492	5.897	0.375
	40	After durability	-0.242	0.047	-0.079	0.059
	40	After dust	-0.296	0.022	-0.146	0.068
	40	After vibration	-1.552	0.018	-0.750	0.687
	40	After shock, final	-0.265	0.011	-0.118	0.064

Figure 3A (cont)

Test Group	Number of Data Points	Condition	Low Level Contact Resistance (ΔR)			
			Min	Max	Mean	StdDev
2	Signal Contacts					
	240	Initial	8.450	17.731	12.354	2.511
	240	After durability	-1.313	0.465	-0.237	0.278
	240	After dust	-1.243	1.813	-0.208	0.341
	240	After thermal shock	-1.304	1.003	-0.281	0.299
	240	After humidity-temperature cycling	-1.324	2.712	-0.331	0.425
	Ground Contacts					
	40	Initial	5.395	6.396	5.859	0.396
	40	After durability	-0.144	1.324	0.132	0.349
	40	After dust	-0.306	0.093	-0.124	0.094
	40	After thermal shock	-0.276	0.089	-0.089	0.084
	40	After humidity-temperature cycling	-0.205	0.682	-0.007	0.143
3	Signal Contacts					
	240	Initial	8.359	17.751	12.247	2.617
	240	After temperature life	-0.985	6.792	0.596	0.992
	Ground Contacts					
	40	Initial	5.429	6.577	5.900	0.381
	40	After temperature life	-0.039	0.697	0.213	0.189
4	Signal Contacts					
	240	Initial	8.557	17.768	12.298	2.530
	240	After durability	-0.958	0.482	-0.182	0.215
	240	After 5 days unmated	-0.862	0.617	-0.182	0.244
	240	After 10 days unmated	-0.944	7.077	-0.037	0.640
	240	After 16 days unmated	-0.936	2.939	-0.019	0.625
	240	After 20 days unmated	-1.029	2.633	0.020	0.628
	240	After minute disturbance	-1.034	2.837	-0.021	0.584
	240	After 125 durability cycles	-0.966	3.184	0.009	0.551
	Ground Contacts					
	40	Initial	5.339	6.598	5.912	0.465
	40	After durability	-0.379	0.034	-0.094	0.098
	40	After 5 days unmated	-0.420	0.038	-0.082	0.136
	40	After 10 days unmated	-0.321	2.853	0.032	0.516
	40	After 16 days unmated	-0.294	2.373	0.058	0.501
	40	After 20 days unmated	-0.422	2.985	0.040	0.571
	40	After minute disturbance	-1.192	1.021	-0.815	0.452
	40	After 125 durability cycles	-0.423	5.247	0.233	1.142

NOTE *All values in milliohms.*

Figure 3A (end)

B. Four Pair HM-Zd Connectors (right angle receptacle, right angle header) - Test Groups 1 and 2 (Figure 2B)

All low level contact resistance measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 50 milliohms initially, had an individual change in resistance (ΔR) of less than 10 milliohms and an average change in resistance (ΔR) of less than 5 milliohms, at all measurement intervals after initial.

Test Group	Number of Data Points	Condition	Low Level Contact Resistance					
			Min	Max	Avg	Min (ΔR)	Max (ΔR)	Avg (ΔR)
1	Signal Contacts							
	320	Initial	13.21	35.85	23.78	---	---	---
		After vibration	13.44	35.36	23.69	-1.48	0.70	-0.09
		After mechanical shock	13.46	35.29	23.67	-1.32	0.56	-0.11
	Ground Contacts							
	40	Initial	5.39	5.55	5.47	---	---	---
		After vibration	5.40	5.51	5.45	-0.06	0.08	-0.02
		After mechanical shock	5.40	5.50	5.46	-0.07	0.06	-0.02

NOTE *All values in milliohms.*

Figure 3B

2.3. Low Level Compliant Pin Resistance - Test Groups 1, 2, 3 and 4

All low level compliant pin resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 1 milliohm initially and had a final change in resistance (ΔR) of less than 1 milliohm.

Test Group	Number of Data Points	Condition	Termination Resistance			
			Min	Max	Mean	StdDev
1	Signal Contacts					
	13	Initial, header	0.036	0.180	0.080	0.037
	13	Final, header, ΔR	-0.101	0.067	-0.002	0.038
	13	Initial, receptacle	0.007	0.088	0.036	0.030
	13	Final, receptacle, ΔR	-0.005	0.056	0.027	0.023
	Ground Contacts					
	12	Initial, header	0.354	0.447	0.408	0.030
	12	Final, header, ΔR	0.003	0.025	0.011	0.007
	12	Initial, receptacle	0.167	0.209	0.185	0.013
	12	Final, receptacle, ΔR	-0.043	0.038	-0.004	0.025

Figure 4 (cont)

Test Group	Number of Data Points	Condition	Termination Resistance			
			Min	Max	Mean	StdDev
2	Signal Contacts					
	13	Initial, header	0.106	0.200	0.151	0.032
	13	Final, header, ΔR	-0.089	0.010	-0.038	0.033
	13	Initial, receptacle	0.122	0.159	0.144	0.011
	13	Final, receptacle, ΔR	-0.054	0.061	-0.032	0.036
	Ground Contacts					
	12	Initial, header	0.075	0.252	0.167	0.046
	12	Final, header, ΔR	-0.061	0.079	0.004	0.047
	12	Initial, receptacle	0.143	0.269	0.24	0.037
	12	Final, receptacle, ΔR	-0.138	0.116	-0.008	0.071
3	Signal Contacts					
	13	Initial, header	0.071	0.243	0.114	0.058
	13	Final, header, ΔR	-0.093	0.113	0.032	0.067
	13	Initial, receptacle	0.036	0.187	0.067	0.041
	13	Final, receptacle, ΔR	-0.111	0.136	0.081	0.068
	Ground Contacts					
	12	Initial, header	0.039	0.171	0.066	0.037
	12	Final, header, ΔR	0.007	0.242	0.134	0.079
	12	Initial, receptacle	0.054	0.287	0.190	0.077
	12	Final, receptacle, ΔR	-0.109	0.122	-0.012	0.067
4	Signal Contacts					
	13	Initial, header	0.043	0.128	0.085	0.025
	13	Final, header, ΔR	-0.013	0.055	0.026	0.024
	13	Initial, receptacle	0.010	0.035	0.019	0.009
	13	Final, receptacle, ΔR	0.030	0.099	0.055	0.017
	Ground Contacts					
	12	Initial, header	0.359	0.431	0.414	0.020
	12	Final, header, ΔR	-0.002	0.010	0.004	0.003
	12	Initial, receptacle	0.151	0.189	0.174	0.012
	12	Final, receptacle, ΔR	0.003	0.019	0.007	0.004

NOTE *All values in milliohms*

Figure 4 (end)

2.4. Insulation Resistance - Test Group 2

All insulation resistance measurements were greater than 10000 megohms.

2.5. Withstanding Voltage - Test Group 2

No dielectric breakdown, flashover or leakage greater than 0.5 milliampere occurred.

2.6. Temperature Rise vs Current - Test Group 5

All specimens had a temperature rise of less than 30˚C above ambient when tested in a 100% energized wiring configuration using a baseline rated current of 0.7 ampere AC.

2.7. Vibration, Random - Test Group 1

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

2.8. Mechanical Shock - Test Group 1

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

2.9. Durability - Test Groups 1, 2 and 4

No physical damage occurred as a result of mating and unmating the specimens 250 times.

2.10. Mating Force - Test Groups 1, 2, 3 and 4

All mating force measurements were less than 0.38 N [.085 lbf] average per contact.

2.11. Unmating Force - Test Groups 1, 2, 3 and 4

All unmating force measurements were greater than 0.15 N [.03 lbf] average per contact.

2.12. Compliant Pin Insertion Force - Test Groups 2 and 3

All compliant pin insertion force measurements were less than 44.5 N [10 lbf] average per contact.

2.13. Compliant Pin Retention Force - Test Groups 2 and 3

All compliant pin retention force measurements were greater than 4.4 N [1 lbf] average per contact.

2.14. Minute Disturbance - Test Group 4

No physical damage occurred to the specimens as a result of subjecting them to a minute unmate and mate cycle.

2.15. Receptacle Cover Retention - Test Group 6

All receptacle cover retention force measurements were greater than 111.25 N [25 lbf] for a single connector module 25 mm [.984 in] in length.

2.16. Thermal Shock - Test Group 2

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

2.17. Humidity-Temperature Cycling - Test Group 2

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

2.18. Temperature Life - Test Group 3

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

2.19. Mixed Flowing Gas, Mated and Unmated - Test Group 4

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

2.20. Dust Contamination - Test Groups 1 and 2

No evidence of physical damage was visible as a result of exposure to a benign office dust.

2.21. Final Examination of Product - All Test 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

Contact resistance measurements at low level current were made using a 4 terminal measuring technique (Figure 5). The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage.

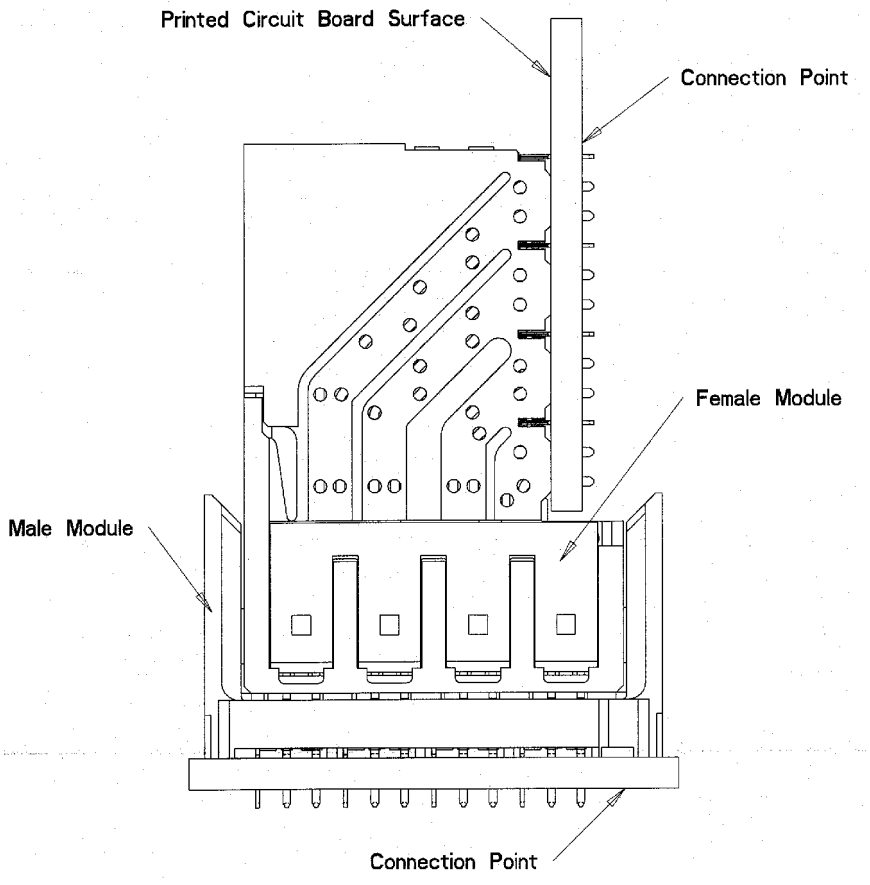

Figure 5

3.3. Low Level Compliant Pin Resistance

Compliant pin resistance measurements at low level current were made using a 4 terminal measuring technique (Figure 6). Current was applied at the interface end of a contact and the pad surrounding the thru-hole. One voltage probe was attached to the end of the contact protruding from the bottom of the thru-hole and the other was attached to the access header connected to the pad surrounding the thru-hole. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage.

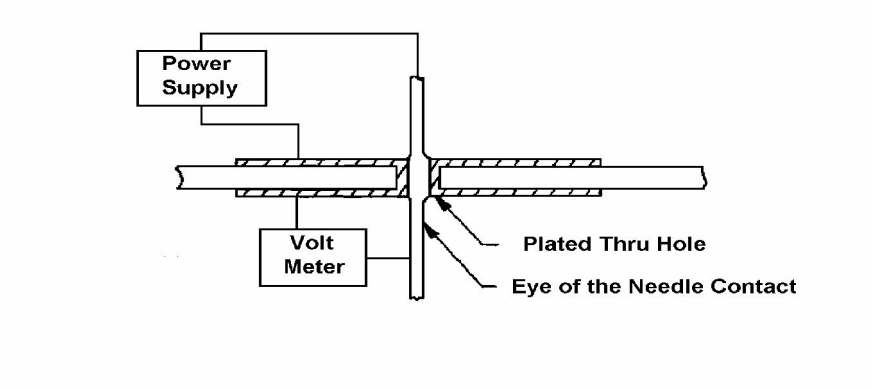

Figure 6

3.4. Insulation Resistance

Insulation resistance was measured between adjacent signal contacts and between adjacent signal and ground contacts of mated specimens. A test voltage of 100 volts DC was applied for 2 minutes or meter stabilization, whichever occurred first, before the resistance was measured.

3.5. Withstanding Voltage

A test potential of 650 volts AC was applied between the adjacent signal contacts of mated specimens. A test potential of 550 volts AC was applied between the closest signal and ground contacts of mated specimens. These potentials were applied for 1 minute and then returned to zero.

3.6. Temperature Rise vs Current

Temperature rise was measured on unstressed connectors using infrared imaging. Specimens were 100% energized by wiring all signal contacts in a series circuit. A temperature rise curve was produced by measuring the hottest spot on the bottom of the headers, at 3 different current levels. The ambient temperature at the time of measurement was subtracting from the temperature measured at each level. The resulting values were then plotted to produce a temperature rise versus current curve.

3.7. Vibration, Random

Mated specimens were subjected to a random vibration test, specified by a random vibration spectrum, with excitation frequency bounds of 20 and 500 Hz. The spectrum was flat at 0.02 G^2/Hz from 20 to 500 Hz. The root-mean square amplitude of the excitation was 3.10 GRMS. This was performed for 15 minutes in each of 3 mutually perpendicular planes for a total vibration time of 45 minutes. Specimens were monitored for discontinuities of 1 microsecond or greater using a current of 100 milliamperes DC.

3.8. Mechanical Shock, Half-sine

Mated specimens were subjected to a mechanical shock test having a half-sine waveform of 50 gravity units (g's peak) and a duration of 11 milliseconds. Three shocks in each direction were applied along the 3 mutually perpendicular planes for a total of 18 shocks. Specimens were monitored for discontinuities of 1 microsecond or greater using a current of 100 milliamperes DC.

3.9. Durability

Specimens were clamped in an automated durability machine and then mated and unmated 250 times at a maximum rate of 600 cycles per hour.

3.10. Mating Force

The force required to mate individual specimens was measured using a tensile/compression device with the rate of travel set at a maximum of 12.7 mm [.5 in] per minute and a free floating fixture. The average force per contact was calculated.

3.11. Unmating Force

The force required to unmate individual specimens was measured using a tensile/compression device with the rate of travel set at a maximum of 12.7 mm [.5 in] per minute and a free floating fixture. The average force per contact was calculated.

3.12. Compliant Pin Insertion Force

The force required to fully insert an individual connector into its respective printed circuit board was measured using a tensile/compression device. The connectors were inserted at a maximum rate of 12.7 mm [.5 in] per minute. The average force per contact was calculated.

3.13. Compliant Pin Retention Force

The force required to fully remove an individual header and receptacle connector from its respective printed circuit board was measured using a tensile/compression device. The connectors were removed at a maximum rate of 12.7 mm [.5 in] per minute. The average force per contact was calculated.

3.14. Minute Disturbance

Test specimens were manually unmated and mated a distance of approximately 0.1 millimeter.

3.15. Receptacle Cover Retention

The force required to remove the front cover from a receptacle connector using a fork like fixture was measured on a tensile/compression device. The covers were removed at a maximum rate of 5.08 mm [.2 in] per minute.

3.16. Thermal Shock

Mated specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 60 minute dwells at -65 and 105˚C. The transition between temperatures was less than 1 minute.

3.17. Humidity-Temperature Cycling

Mated specimens were exposed to 50 cycles of humidity-temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 5 and 85˚C twice while maintaining high humidity.

3.18. Temperature Life

Mated specimens were exposed to a dry heat environment of 105˚C for 1000 hours.

3.19. Mixed Flowing Gas, Class IIIA

Test specimens were exposed to a mixed flowing gas Class IIIA exposure for a total of 20 days. Class IIIA exposure is defined as a temperature of 30˚C and a relative humidity of 70% with the pollutants of Cl_2 at 20 ppb, NO_2 at 200 ppb, H_2S at 100 ppb, and SO_2 at 200 ppb. All specimens were unmated during the first 10 days of exposure and mated for the second 10 days of exposure. Specimens were preconditioned with 125 cycles of durability.

3.20. Dust Contamination

Both halves of unmated specimens were exposed to 40 grams of Composition #1 benign dust described in EIA -364-91. This dust was circulated within the chamber, at a flow rate of 360 cfm, for a period of 1 hour. The specimens then remained in the chamber for a minimum of 1 additional hour after turning off the circulating fans.

3.21. Final Examination of Product

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