

**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

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 ( $\Delta R$ ) of less than 10 milliohms and an average change in resistance ( $\Delta R$ ) of less than 5 milliohms, at all measurement intervals after initial.

| Test Group | Number of Data Points | Condition          | Low Level Contact Resistance ( $\Delta R$ ) |       |        |        |
|------------|-----------------------|--------------------|---------------------------------------------|-------|--------|--------|
|            |                       |                    | 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 ( $\Delta R$ ) |        |        |        |
|------------|-----------------------------|------------------------------------|---------------------------------------------|--------|--------|--------|
|            |                             |                                    | 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 ( $\Delta R$ ) of less than 10 milliohms and an average change in resistance ( $\Delta R$ ) 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 ( $\Delta R$ ) | Max ( $\Delta R$ ) | Avg ( $\Delta R$ ) |
| 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 ( $\Delta R$ ) 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.

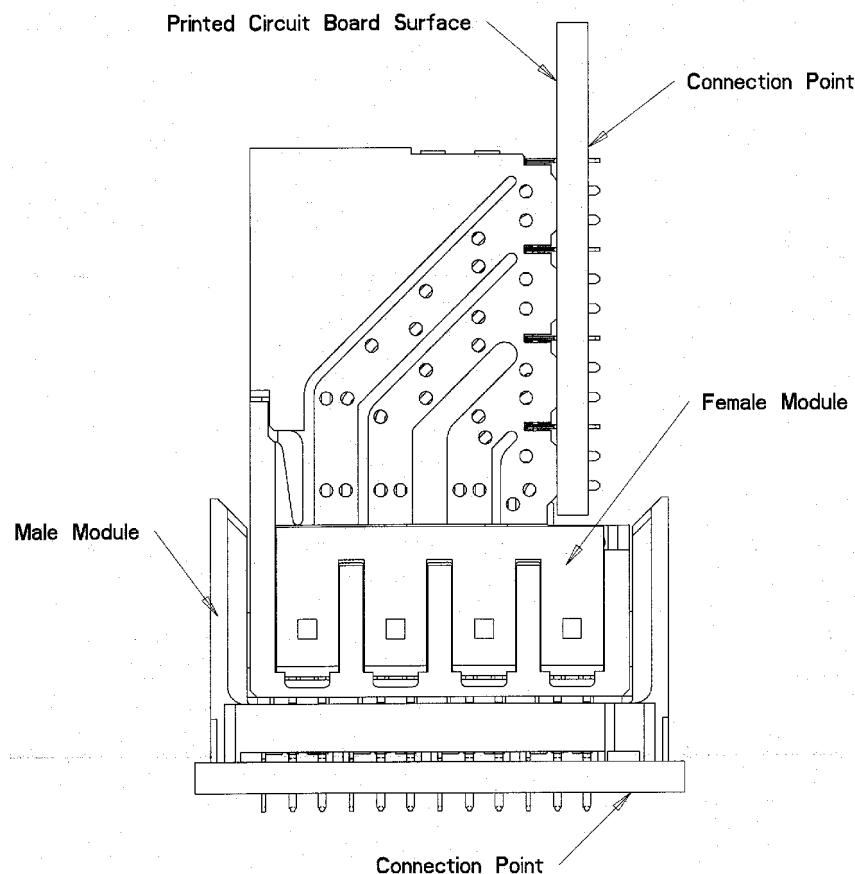


Figure 5

### 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.

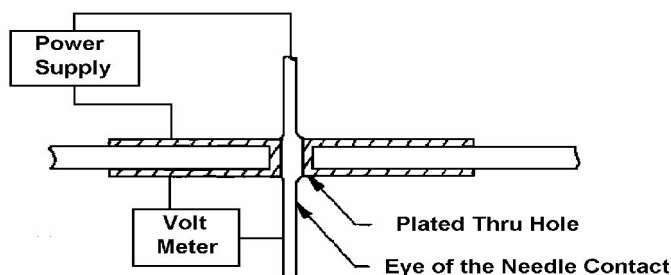


Figure 6

### 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  $0.02 \text{ G}^2/\text{Hz}$  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<sub>2</sub> at 20 ppb, NO<sub>2</sub> at 200 ppb, H<sub>2</sub>S at 100 ppb, and SO<sub>2</sub> 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.