# Mono-Shape™ GPL 394

MONO-SHAPE PCB Connector P Code 0319 (PCB Housing-P Code 0321, PCB Contact-P Code 0320)

## 1. SCOPE

### 1.1 Content

This specification covers performance, test and quality requirements for the Mono-Shape™ 5 mm Pitch I.D.C. Connectors for Printed Circuit Board Applications. These connectors are designed and developed for multiple lead connections for household appliances and other commercial equipment.
The proper counterparts are PCB, properly shaped in order to obtain a polarization system between PCB and Connectors to improve reliability of product and application. Forms, shape and dimensions of involved P.C.B. in the connector mating area has been defined by the customer interface requirements. A cross reference between Mono-Shape™ connector and relevant PCB layout is reported on Catalog N°296599 and Customer Dwg. 282042.
Product is applicable on 0.5- 0.75 mm² single stranded wires as describe on par.3.2

## 2. APPLICABLE and REFERENCED DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the latest edition of the document applies. In the event of conflict between requirements of this specification and inspection drawing, inspection drawing shall take precedence. In the event of conflict between requirements of this specification and referenced documents, this specification shall take precedence.

| | |
|---|---|
| - TYCO Product Drawings | Refer to TYCO Customer Drawing N° 282042, as typical design |
| - TYCO Application Spec. | 114-20018 for I.D.C. Connector 5mm Pitch used for PCB Application. |
| - RAST5 | Raster Anschluß Steck Technik 5mm Teilung |
| - DIN 41611Teil 6 | Testing For Insulation Displacement Connection |
| - DIN 46244 -A6,3 - 0,8 -Bz | For Tab Contact shape and dimensioning. |
| - DIN 0281 HD 21.3 S3 | Polyvinyl chloride insulated cables of rated voltages up to 450/750 V General requirements. |
| - VDE 0627 (REV. JUNE 1986) | Connector and plug-and-socket devices for rated voltages up to 1000Va.c./d.c. & rated currents up to 500A for each pole. |
| - IEC 60998-1 (rev.1990-04) | Connecting devices for low voltage circuits for household and similar purposes. Part 1: General requirements |
| - IEC 60998-2-3 (rev.1991-10) (CEI23-20) | Connecting devices for low-voltage circuits for household and similar purposes - Part 2-3: Particular requirements for connecting devices as separate entities with insulation piercing clamping units. |
| - TYCO 109- series | TYCO Test specifications. |
| - TYCO Catalog N°296599 | Connector Systems for Household Appliances |
| - IEC 695-2-1/1 | Fire hazard testing Glow-wire end-product test and guidance |
| - IEC 60112 | Current Tracking Index |
| - EN 60998 - 1 | Ball Pressure Test |

| | | | | |
|---|---|---|---|---|
| C2 | Updated PCB thickness dimensions allowed | F, Virdia | R, Robone | 28.SEP.2016 |
| C1 | Current rating increase after tesing and approval | KD, Cheon | R, Robone | 04.APR.2016 |
| C | REVISED PAGE 10 | C.C. | G.T. | DEC.2009 |
| B1 | Cancelled UL-V1 plastic material version ET00-0046-04<br>ADDED TESTS FOR PLASTIC MATERIAL | C.CORDOLA | G.TURCO | MAR 04 |
| B | REVISED ET00-0335-99 | C.CORDOLA | G.TURCO | 26 OCT 99 |
| A | FIRST ISSUE, I-2822 | G.VIGNOLI | P.CASTELLO | 29 APR.91 |

## 3. REQUIREMENTS

### 3.1. Design and Construction

Product shall be of design, construction and physical dimensions specified on applicable product drawing.

### 3.2. Definition

**3.2.1 Insulation Displacement Connection (I.D.C.)** A terminating technique whereby an insulated wire is forced into a restrictive slot in a terminal, during which time the wire insulation is displaced, and the bare wire engages the sides of the slot.

**3.2.2 Housing-connector** An insulating encapsulation for contacts. When pins or sockets are inserted into a housing, the assembly is usually referred to as a connector. Housing is sometimes referred to as "block."

**3.2.3 Printed Circuit Board. (P.C.B.).** A conductive pattern, that may or may not include printed components, formed in a predetermined design on the surface of an insulating base in an accurately repeatable manner. The two most common types of printed circuits are etched and plated.

### 3.3 Materials

(1) I.D.C. Terminals: Copper alloy Post-Tinned
(2) PCB connector Housings: Polyammide 6/6 glass fiber filled, UL 94V-1 and/or UL 94V-2
(3) Printed Circuit Board Single Layer, 1.5 ±0.14 mm thickness, tin coated tracks. See Tyco Spec. 92-330805-2 for Test PCB Layout reference,
(4) Wires Types suitable for this product refer to the table shown below

| cross section nominal mm² (AWG) | Stranded Wires diameter mm | numbers of single wire and max. diameter mm | single wire material | *insulation material and type | Insulation Outside diam. MAX Ref. To DIN0281 HD 21.3 S3 |
|---|---|---|---|---|---|
| 0.5 - (AWG20) | 1 | 16x0.21 | tinned or unplated copper | PVC | 2.3 |
| 0.75 - (AWG18) | 1.2 | 24x0.21 | tinned or unplated copper | PVC | 2.5 |

***Cable termination process on product, looking at insulation material type, must be analyzed and examined together with the Application Tooling Manufacturer of the Tooling used to terminate the product.**

### 3.4 Ratings

**3.4.1 Voltage/Current :** Voltages 220 Max, current Rating according to wire size

| Wire Section (mm²) | Current (max.) |
|---|---|
| 0.5 | 6A |
| 0.75 | 6A |

**3.4.2 Operating temperature:** (increase due to current load Included) -25°C to +105°C

## 4. SAMPLE COMPOSITION AND PREPARATION.

Connectors are designed to meet the electrical, mechanical and environmental performances requirements according to test conditions as specified on following paragraphs.
Tests are splitted in four sections
SECTION A: Tests on connection between Wire and I.D.C. contact slot
SECTION B: Tests on connection between Contacts and P.C.B.
SECTION C: Tests on the total connection (wire-I.D.C. contact- P.C.B.)
SECTION D: Tests on the connector (mechanical tests)
For each section of wire applicable the minimum suggested group submitted to the test sequence is listed on paragraph 4.4, at list the minimum wire section (0,5mm²) and the maximum (0.75mm²) must be used for testing.

See attached Fig.1 for detail on mentioned features.

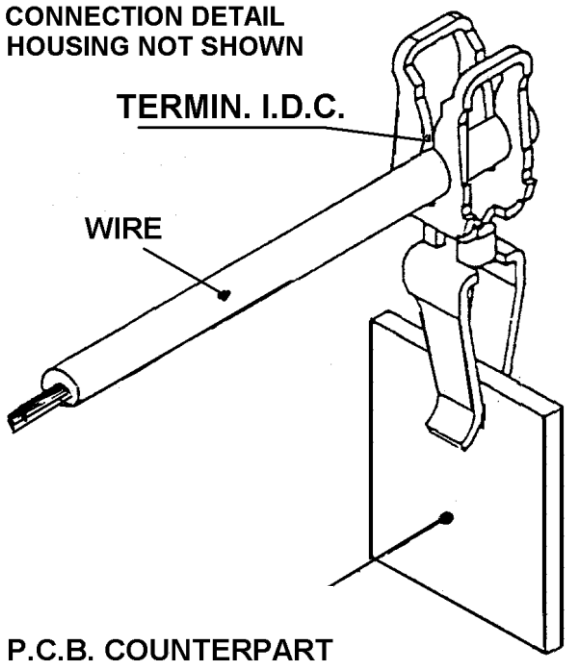


**FIG.1**

### 4.1 Samples selection.
Samples for testing must be selected at random for current production, must be in accordance to relevant Product drawings and functional per applicable inspection plan.

### 4.2 Samples Preparation.
All the operation made in order to prepare Samples for testing must be done in accordance to relevant Specification (Application spec for termination), wires and counterpart must be inspected to verify the conformance to the correspondent specification. Where a temperature measurement probe on the product is requested, this must be applied at the hottest point of the connection. Operations which could be cause of damage or could influence the functionality of the product must be avoided.

**4.3 Environmental Test Condition (Laboratory).**

Unless otherwise specified, all tests shall be conducted at:

- Temperature 20°C ±5°
- Relative humidity 30 ÷ 95 %
- Atmospheric pressure 860 ÷ 1060 mBar

**4.4 Suggested Samples for Test Group Composition.**

Unless otherwise specified each group of connectors to be tested, shall be composed at least by:

N°6 PCB Connector 2 ways
N°2 PCB Connector 3 ways
N°1 PCB Connector 5 ways
N°1 PCB Connector 8 ways
N°1 PCB Connector 10 ways

Unless otherwise specified above listed quantity is requested for each section of the wire used to terminate samples under test (see Par. 6 for test group and sequence).

**5. PERFORMANCE: TEST DESCRIPTION.**

**5.1 Section A - Tests on connection between Wire and I.D.C. contact slot**

This section is focused on testing the performance of the I.D.C. connection, in order to facilitate the test procedure and avoid the influence of the P.C.B. portion of the connection, the contact could be soldered in the mating area, for reference see sketch on paragraph 4

**5.1.1 Contact Resistance (dry circuit see also TYCO#109-6-6)**

Conformance of the product shall be measured as shown on following Fig.2. The potential drop shall be measured between points (1) and (2) the applicable test Voltage/Current is 20mV/20mA. After mechanical, electrical or environmental tests sequences, were a contact resistance check is requested, and if not otherwise specified, the difference between Initial and Final values must be ≤ 5mΩ.

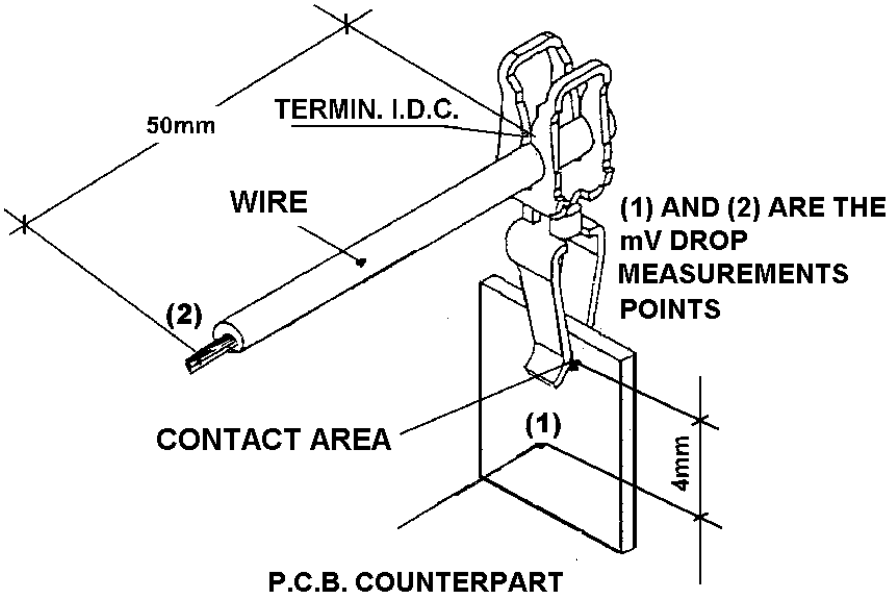


FIG.2

**5.1.2 Current Overload**

The connectors shall be subjected for a period of 45 minutes to an overload of 1.3 times the nominal current in relations with the wire section used, as specified on Par. 3.4. After the test, connectors shall show no evidence of damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.3 Vibration (see also IEC60068-2-6 & Mil STD 1344 A - was Tyco 109-21)**

The connectors shall be mounted assembled with a proper counterpart simulating a typical application (see attached Fig.3 for reference) and fixed on a suitable adapter plate rigidly attached to the vibration table. The wire bundles shall be clamped to the plate in a points at least 200mm from the rear of the connectors.

Test Condition and procedure:

Displacement Amplitude 1.0mm acceleration amplitude 5g (peak values).

Frequency ranges , 10-200-10Hz, speed 1 octave/minute, duration 8 hours in each of 3 mutually perpendicular planes.

Contacts shall be wired in series and powered with 100 ±10 mA of current flow, to monitor electrical discontinuance (resistance limit 100 Ohm). During the test electrical discontinuities of 1 microsecond or longer duration shall be monitored and registered. Mated connector are subjected to sinusoidal vibration having an harmonic motion with amplitude of 1,0 mm pk to pk up to crossover frequency, than with an acceleration of 5g. The vibration frequency varies logarithmically between the limits of 10 and 200 Hz and return to 10 at a rate of 1 octave/minute. At the end of the test there shall be no loosening of parts nor indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

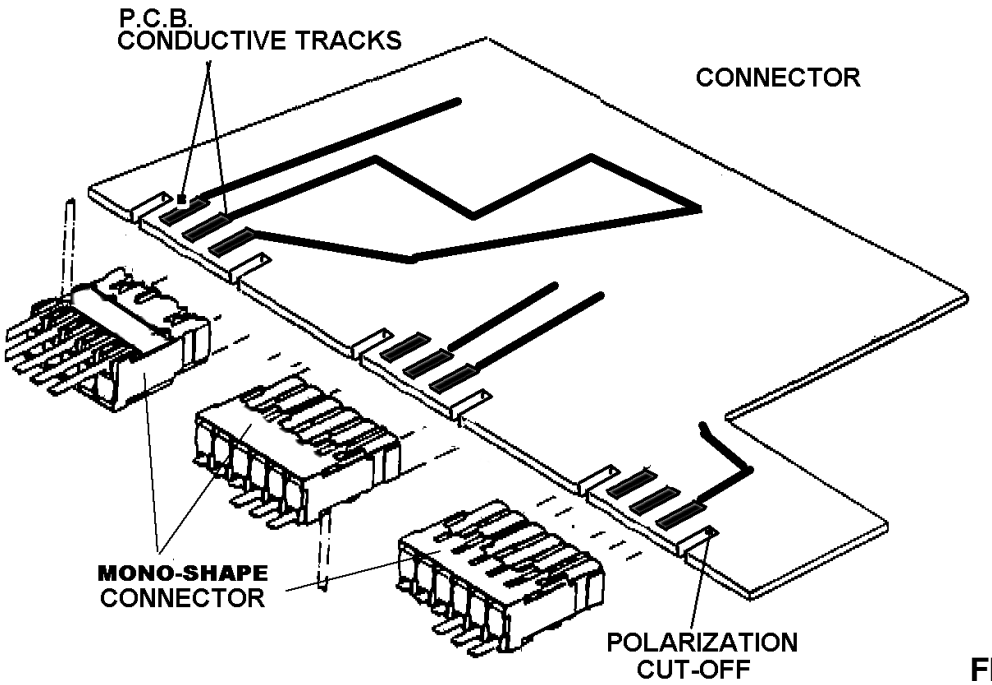


**FIG.3**

**5.1.4 Wires Movement**

Connector under test shall be subjected to 2 cycles of wire movement, according to Par. 7.2 of DIN 41611 Teil 6.
Fig. 3 on mentioned DIN must be followed for testing. At the end of the test there shall be no evidence of wires damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.5 Current Cycling at High temperature (105°C). (see also TYCO#109-51)**

Connectors under test shall be subjected to 500 cycles. Contacts shall be wired in series and powered at a current rate according to wire section as reported on Par. 3.4.1.
Each cycle consist of:
45 minute power on and 15 minute power off. Test must be performed in a climatic chamber, chamber initial temperature shall be arranged if needed in order to have a room temperature of 105°C max when the power is on. This temperature must be reached within 20 minute from the beginning of each cycle and maintained for the remaining portion of 45 minute, than the current must be switched off for 15 minutes; this is a complete cycle. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.6 Temperature Life (see also TYCO#109-43 test level 10)**

Connectors under test shall be withstand for 16 hours at a temperature of 105°C. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.7 Damp Heat (steady state see also TYCO#109-23-2 Condition B)**

Connectors under test shall be withstand for 10 days at a temperature of 40°C and a relative humidity of 93%±2°. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.8 Thermal Shock (see also TYCO#109-22)**

Connectors under test shall be withstand for 10 cycles. First step is 30 minute at a room temperature of 105°C, second step is 30 minute at -25°C. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.1.9 Corrosion - Saturated atmosphere in the presence of sulfur dioxyde-Kesternich (see DIN 50018-0.2S)**

Connectors under test shall be withstand for 1 cycle to $SO_2$ exposure. Test condition as follows:
Room temperature +40°C, $S0_2$ =0.2 $dm^3$ $H_2O$ =2 $dm^3$.
Samples exposure 8 hours plus 16 hours on air. Measure the contact resistance after test, the difference between Initial and Final values must be $\leq$ 5mΩ.
N.B. As alternative to Kesternich , Industrial Atmosphere shall be performed as follows
- $SO_2$ (see also TYCO#109-5107-1)
Connectors under test shall be withstand for 10 days to $SO_2$ exposure.
Gas concentration 10±3 PPM, humidity 90%-95% RH. At the end of the test there shall be no indication of damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.2 Section B - Tests on connection between I.D.C. contact and P.C.B. Counterpart**
This section is focused on testing the performance of the P.C.B. side of the connection, in order to reduce the influence of the IDC portion of the connection, the contact could be soldered to the I.D.C. slot mating area, for reference see sketch on paragraph 4

**5.2.1 Contact Resistance At Specified Current (see also TYCO#109-25)**
Conformance of the product shall be measured as shown on following Fig.4 The potential drop shall be measured between points (1) and (2) the applicable test current is according to wire section as reported on Par. 3.4.1. After mechanical, electrical or environmental tests sequences (if a contact resistance check is requested), the difference between Initial and Final values must be ≤ 5mΩ.

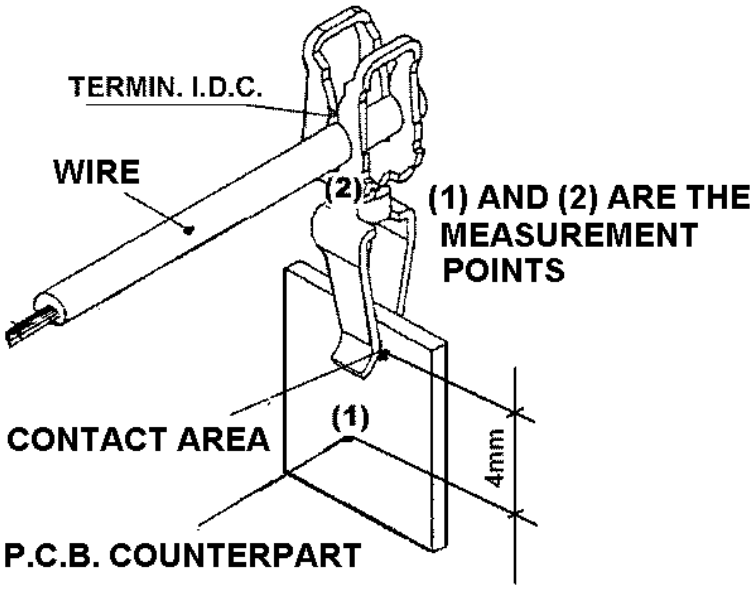


**FIG.4**

**5.2.2 Durability Cycles (see also TYCO#109-27)**
Connector under test shall be withstand for 1 day of a pre-conditioning cycle, at 50% of relative humidity exposure. Than subjected to 6 cycles of Mating / Unmating using a P.C.B. counterpart, as described on Par. 1.1 and 3.3. Cycle rate shall be V= 25.4 mm/minute.
Time interval between cycles 30 seconds. At the end of the test there shall be no indication of damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.2.3 Temperature Rise Versus Current (see also TYCO#109-45-1)**
Connector under test shall be withstand for 1 day of a pre-conditioning cycle, at 50% of relative humidity exposure. Than shall be withstand for 8 hours at the maximum current rate permitted, according to wire section as reported on Par. 3.4.1.
Initial temperature T= 23°C. Test shall be considered passed if, within the 5 hours time line, thermal stability will be achieved and if temperature rise value will be according to following table:

| Wire Section (mm²) | Max. T Rise |
|---|---|
| 0.5 | ≤20°C |
| 0.75 | ≤20°C |

At the end of the test there shall be no indication of damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.2.4 Thermal Shock (see also TYCO#109-22)**

Connectors under test shall be withstand for 1 cycle. First step is 2 hours at a room temperature of -25°C , second step is 168 hours at 105°C. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.2.5 Withstanding Voltage (see also TYCO#109-29-1)**

Connector under test shall be withstand for 1 minute at a Voltage rate of 1750V. Test shall be considered passed if, within 1 minute time line, there will be no discharge. At the end of the test there shall be no indication of damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.3 Section C - Tests on the total connection (Wire + I.D.C. contact + P.C.B).**

This section is focused on testing the performance of the total connection.

**5.3.1 Contact Resistance At Specified Current (see also TYCO#109-25)**

Conformance of the product shall be measured as shown on following Fig.5
The potential drop shall be measured between points (1) - (2) (total connection evaluation) and (2) - (3) (wire - I.D.C. slot) the applicable test Current is according to wire section as reported on Par. 3.4.1. After mechanical, electrical or environmental tests sequences (if a contact resistance check is requested), the difference between Initial and Final values must be ≤ 5mΩ.

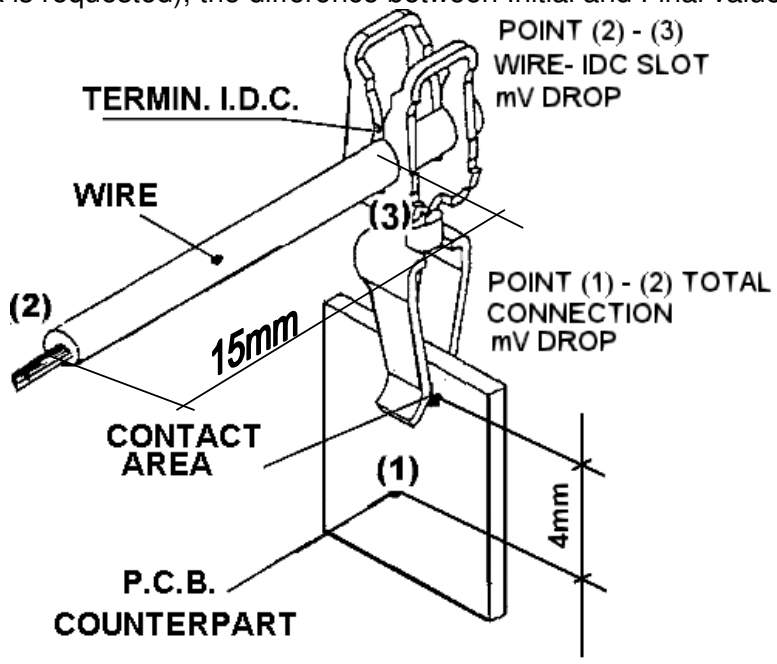


**FIG.5**

**5.3.2 Current Cycling at High temperature (105°C). (see also TYCO#109-51)**

Connectors under test shall be subjected to 500 cycles. Contacts shall be wired in series at a current rate according to wire section as reported on Par. 3.4.1. Each cycle consist of:
45 minute power on and 15 minute power off. Test must be performed in a climatic chamber, chamber initial temperature shall be arranged if needed in order to have a room temperature of 105°C max when the power is on. This temperature must be reached within 20 minute from the beginning of each cycle and maintained for the remaining portion of 45 minute, than the current must be switched off for 15 minutes; this is a complete cycle. At the end of the test

there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.3.3 Salt Spray Corrosion (see also TYCO#109-24)**
Connectors under test shall be subjected for 96 hours to a controlled salt atmosphere, salt solution concentration 5%(NaCl) , Operating condition: Temperature 35°C±2. At the end of the test there shall be no indication of cracking, breaking or other damage which would interfere with mechanical or electrical performance requirements of the subsequent tests.

**5.3.4 Insulation Resistance**
The test is carried out measuring with a megaohmeter the resistance after the aplication during one
minute of 500 V DC between live parts, connected together, and earth (earth being the outer metal parts, including a metal foil sheet placed in contact with the outer parts).
The insulation of the components must be 10 MΩ min

**5.4 Section D - Mechanical Tests on the connector.**
This section is focused on testing the mechanical performance of the connector. No electrical check are requested in this section.

**5.4.1 Mating & Unmating Force (see also TYCO#109-42)**
Connectors under test shall be subjected to 6 cycles of Mating-Unmating, using a proper meatable counterparts, P.C.B. used must be shaped according to relevant drawings and applicable documents. Rate for mating V= 25.4 mm / minute, Test shall be considered passed if, the Axial force measured (F) will be in according to the following table:

| Number of ways | F at I°IN | F at I°OUT | F at X°OUT |
|---|---|---|---|
| 2 | ≤28N | ≥10N | ≥8N |
| 3 | ≤42N | ≥15N | ≥15N |
| 4 | ≤56N | ≥20N | ≥15N |
| 5 | ≤70N | ≥25N | ≥20N |
| 6 | ≤78N | ≥30N | ≥24N |
| 7 | ≤84N | ≥35N | ≥28N |
| 8 | ≤100N | ≥40N | ≥32N |
| 9 | ≤108N | ≤45N | ≤36N |
| 10 | ≤120N | ≥50N | ≥40N |
| 11 | ≤132N | ≥55N | ≥44N |
| 12 | ≤144N | ≥60N | ≥48N |

**5.4.2 Wire Termination Tensile Strength - Axial Load (see also TYCO#109-16)**
Wires terminated on the connectors under test shall be subjected to an axial tensile load as shown on attached Fig.6. Load rate V= 25.4mm/minute, the tensile force applied to the wire at a constant rate will cause the separation between wire and I.D.C. contact Slot. Record the tensile value and exanimate the type of failure.
Test is passed for values according to following table

| Wire Section (mm²) | Load |
|---|---|
| 0.5 | ≥50N |
| 0.75 | ≥60N |

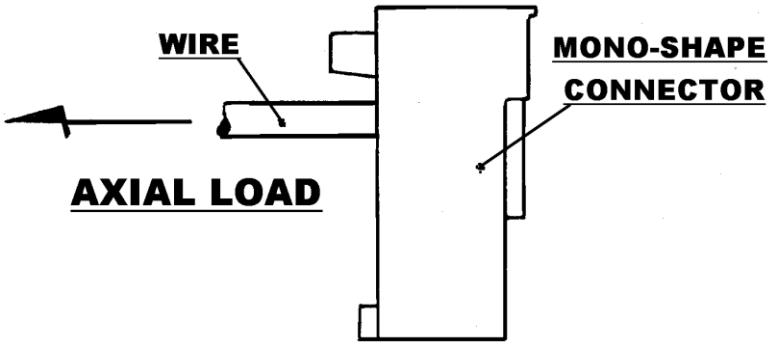


Fig.6

**5.4.3 Wire Termination tensile Strength - Perpendicular Load (see also TYCO#109-16)**

Wires terminated on the connectors under test shall be subjected to an axial tensile load as shown on attached Fig.7. Load rate V= 25.4mm/minute, the tensile force applied to the wire at a constant rate will cause the separation between wire and I.D.C. contact Slot. Record the tensile value and exanimate the type of failure.

Test is passed for values according to following table

| Wire Section (mm²) | Load |
|---|---|
| 0.5 | ≥50N |
| 0.75 | ≥60N |

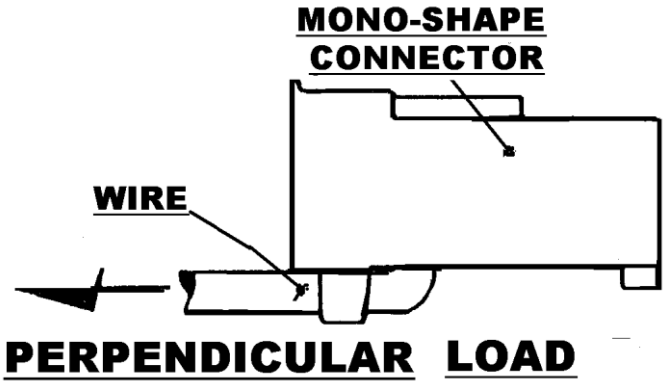


Fig.7

**5.5.1 Glow Wire Test (see IEC 60695-2-1/1)**

**-** Glow-wire flammability test method for end-products

Wires terminated Connectors must be tested to be in according to IEC rules, using relevant test procedure.
The test parameters will be in according to different Housing material versions (different housing means part number), following list reports the test to be passed for each version.

Product shall be tested and pass requirements for 850° Glow Wire and/or requirements for 750° Glow Wire – No Flame depending by the Customer Application.

**5.5.2 Current Tracking Index (see IEC 60112 test A )**

- Method for the determination of the proof and the comparative tracking indices of solid insulating materials

Plastic Material used to mould Connectors must be tested to be in according to IEC rules, using relevant test procedure.
Test passed if Samples shall withstand at a CTI value of 250V min.

**5.5.3 Ball Pressure Test (EN 60998 - 1 test n° 16.3)**

- Fire hazard testing - Abnormal heat - Ball pressure test

Wires terminated Connectors must be tested to be in according to IEC rules, using relevant test procedure.

Test at 125°C temperature for 1 hour, passed if ball imprint diameter < 2 mm

## 6. QUALIFICATION AND/OR PERIODIC TESTS, TABLE FOR GROUPS AND SEQUENCE.

| TEST DESCRIPTION | TEST PAR. | TEST GROUP AND SEQUENCE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | XIII |
| **Contact Resistance** | **5.1.1** | **1,3,5,7,9,11** | **1,3,5** | **1,3** | **1,3** | | | | | | | | | |
| **Current Overload** | **5.1.2** | **2** | | | | | | | | | | | | |
| **Vibration** | **5.1.3** | **4** | | | | | | | | | | | | |
| **Wires Movement** | **5.1.4** | **6,10** | | | | | | | | | | | | |
| **Current Cycling** | **5.1.5** | **8** | | | | | | | | | | | | |
| **Temperature Life** | **5.1.6** | | **2** | | | | | | | | | | | |
| **Damp Heat** | **5.1.7** | | **4** | | | | | | | | | | | |
| **Thermal Shock** | **5.1.8** | | | **2** | | | | | | | | | | |
| **Corrosion Kesternich Test** | **5.1.9** | | | | **2** | | | | | | | | | |
| **Contact Resistance** | **5.2.1** | | | | | **1,3** | **1,3** | **1,3** | | | | | | |
| **Durability Cycles** | **5.2.2** | | | | | **2** | | | **2** | | | | | |
| **Temp. Rise Vs Current** | **5.2.3** | | | | | | **2** | | | | | | | |
| **Thermal Shock** | **5.2.4** | | | | | | | **2** | | | | | | |
| **Withstanding Voltage** | **5.2.5** | | | | | | | **4** | | | | | | |
| **Contact Resistance** | **5.3.1** | | | | | | | | **1,3,5,7** | | | | | |
| **Current Cycling** | **5.3.2** | | | | | | | | **4** | | | | | |
| **Salt Spray Corrosion** | **5.3.3** | | | | | | | | **6** | | | | | |
| **Insulation Resistance** | **5.3.4** | | | | | | | | **8** | | | | | |
| **Mating/ Unmating Force** | **5.4.1** | | | | | | | | | **1** | | | | |
| **Tensile Strength (Axial)** | **5.4.2** | | | | | | | | | | **1** | | | |
| **Tensile Strength (Perp.)** | **5.4.3** | | | | | | | | | | | **1** | | |
| **Glow Wire** | **5.5.1** | | | | | | | | | | | **1** | | |
| **Tracking Index** | **5.5.2** | | | | | | | | | | | | **1** | |
| **Ball Pressure** | **5.5.3** | | | | | | | | | | | | | **1** |

Notes: Groups from I to IV are relevant to samples to be tested according Section A of this specification
Groups from V to VII are relevant to samples to be tested according Section B of this specification
Groups VIII is relevant to samples to be tested according Section C of this specification
Groups from IX to XI are relevant to samples to be tested according Section D of this specification.