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| NUMBER GS-12-474 | TYPE PRODUCT SPECIFICATION |  | |
| TITLE Pwr Blade ® I/O Cable Assembly Product Specification | | PAGE 1 of 13 | REVISION D |
| | | AUTHORIZED BY Wilson Wang | DATE 11-22-10 |
| CLASSIFICATION UNRESTRICTED | | | |

1.0 OBJECTIVE

This specification defines the performance, test and reliability requirements of PwrBlade ® I/O Cable Assemblies with Signal Dubox Receptacles when mated with 0.63 mm square pins.


2.0 SCOPE

This specification is applicable to PwrBlade ® I/O cable assemblies with signal Dubox Receptacles when mating with PwrBlade ® I/O cable assemblies with 0.63 mm square wire pins or Male Pin Crimp to Wire terminals. Standard operating temperatures for this product is -5°C to 80°C.

3.0 GENERAL

This document is composed of the following sections:

| <u>Paragraph</u> | <u>Title</u> |
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| 2.0 | SCOPE |
| 3.0 | GENERAL |
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4.0 **APPLICABLE DOCUMENTS**

4.1 Standards and Specifications

- 4.1.1 EIA-364-1000.01, Electrical / Socket Test Procedures Including Environmental Classifications
- 4.1.2 SAE/USCAR-21, Performance Specification for Cable to Terminal Electrical Crimps
- 4.1.3 FCI Product Specification: GS-12-377
- 4.1.4 FCI CTW Male Pin Product Specification BUS-12-474
- 4.1.5 FCI Test Specification: BUS-03-601
- 4.1.6 FCI Test Specification: BUS-03-404
- 4.1.7 FCI product drawings
- 4.1.8 PwrBlade Product Specification: GS-12-149
- 4.1.9 Engineering Guide for RoHS information: GS-22-007
- 4.1.10 Dubox Signal Contact Product Specification: BUS-12-055

4.2 Military Standards

- 4.2.1 MIL-STD-1344A: Test Method for Electrical Connectors
- 4.2.2 MIL-STD-202: Test Methods of Electronic and Electrical Component Parts

4.3 Federal Specification

- 4.3.1 PLATINGS

4.4 Other Standards and Specifications

- 4.4.1 UL 94V-0: Flammability
- 4.4.2 EIA 364: Test Procedures for Electrical Connectors, Sockets and Coaxial Contacts
- 4.4.3 ISO 9000
- 4.4.4 SAE/CAR 21
- 4.4.5 UL 1977: UL Standard for Safety for Component Connectors.

4.5 FCI Lab Reports – Supporting Data


- 4.5.1 Cross-section, crimp Lab reports
- 4.5.2 GS-29-149

4.6 Cable Specifications

- 4.6.1 Fire Performance – VW1 $\geq 4\text{mm}^2$ (12 AWG), IEC332-1 $\geq 0,85\text{mm}^2$ (18 AWG)
- 4.6.2 Stranded Copper Wire – IEC60228, Class 5

5.0 **REQUIREMENTS**

- 5.1 Qualification - PwrBlade ® cable assemblies furnished under this specification shall be capable of meeting the qualification test requirements specified herein.
Dubox terminal must meet Crimping Specifications per TA-317 and PwrBlade Specification TA-681.
Cable must be 76.2 mm (3.0 inches) long minimum to test to the following parameters.
- 5.2. Material - The material for each component shall be as specified herein or equivalent.
 - 5.2.1 Power Contacts – ½ Hard Copper base alloy
 - 5.2.2 Signal Contact - C51000 Phosphor Bronze
 - 5.2.3 Signal Male Pin Contact – ¾ Hard UNS-C26000 Brass
 - 5.2.4 Receptacle Housing – Glass Filled HTN (High-Temperature Nylon)

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- 5.2.5 Receptacle Latch – Poly(phenylene ether) - Poly(hexylmethylene adipamide) PPE/PA66 10% Glass fiber Reinforced
- 5.2.6 Receptacle Secondary Lock – Poly(hexylmethylene adipamide) PA66 25% Glass Fiber Reinforced.
- 5.2.7 Receptacle Special Secondary Lock – Poly(phenylene ether)/Poly(hexylmethylene adipamide) PPE/PA66 10% Glass Fiber Reinforced
- 5.2.8 Male Pin Housing – Zytel HTN FR52G45BL
- 5.2.9 Cables – Insulated Stranded Tinned or Bare Copper Conductor

5.3 Finish - The finish for applicable component shall be as specified herein or equivalent.

5.3.1. Power Contacts

5.3.1.1 Mating Area – Au Over 1.27µm (50µ”) Min. Nickel Underplate.

5.3.1.2 Crimp Area - Min. Matte Tin Over 1.27µm (50µ”) Min. Nickel Underplate.

5.3.2 Signal Contacts

5.3.2.1 Mating Area – Au Over 1.27µm (50µ”) Min. Nickel Underplate.

5.3.2.2 Crimp Area – 2.0µm (79µ”) Min. Matte Tin Over 1.27µm (50µ”) Min. Nickel Underplate.

5.3.3 Signal Male Pin Contacts

5.3.3.1 Mating Area – Au 1.27 µm (50µ”) Min. Over 1.27 µm (50µ”) Min. Nickel Underplate.

5.3.3.2 Crimp Area - Au Flash Over 1.27 µm (50µ”) Min. Nickel Underplate.

5.4 Design and Construction –

Terminals, housings and cables shall be of the design, construction and physical dimensions specified on the applicable product drawings.


5.5 Banned/Restricted Substances –

All products where the part number ends in “LF” meets the European Union directives and other country Regulations as described in GS-22-008. Tin plated “LF” products have 100% Tin plating on the interface and have not been tested for whisker growth in all interconnect environments

5.6 Workmanship – This includes freedom from cracks, malformed crimps, discoloration, loose wires, etc.

6.0 ELECTRICAL CHARACTERISTICS

- 6.1 Insulation Resistance – the insulation resistance of mated connectors shall not be less than 10,000 megohms for power contacts and 500 megohms for signal initially and after environmental exposure when measured in accordance with EIA 364 TP21
 - a. Test Voltage 500 volts DC
 - b. Electrification time – 2 minutes
 - c. Points of Measurement – Between adjacent and opposing contacts

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6.2 Current Rating - The temperature rise above ambient shall not exceed 30°C at any point in the system when all power contacts are powered to 30 amperes or one power contact is powered to 48 amperes and signal contacts at 3.0 amperes DC for individual terminals or 2.0 amps DC for the total connector. The following details apply:

- a. Ambient Conditions – Still air at 25°C
- b. Reference – FCI Test Specification BUS-03-601

6.3 Low Level Contact Resistance – Signals only tested at Low Level (LLCR) –The low level contact resistance shall not exceed 15 milliohm initial and 20 milliohms after environmental exposure when measured in accordance with EIA 364 TP06. Crimped terminal samples not to be inserted into housings when tested. The following shall apply: See FIGURE 1 and 1A

- a. Test Voltage Open Circuit – 20 millivolts DC max.
- b. Test Current – 10 milliampere DC

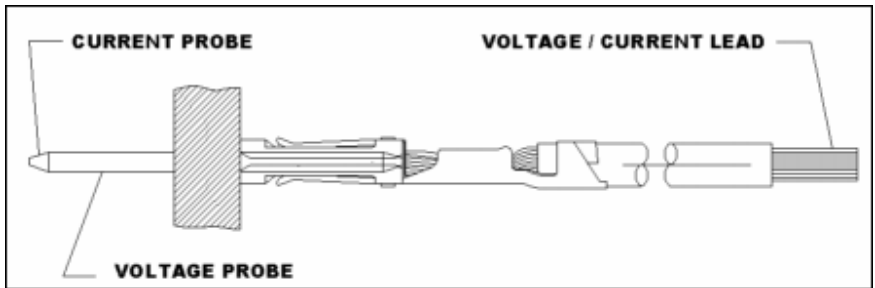


FIGURE 1

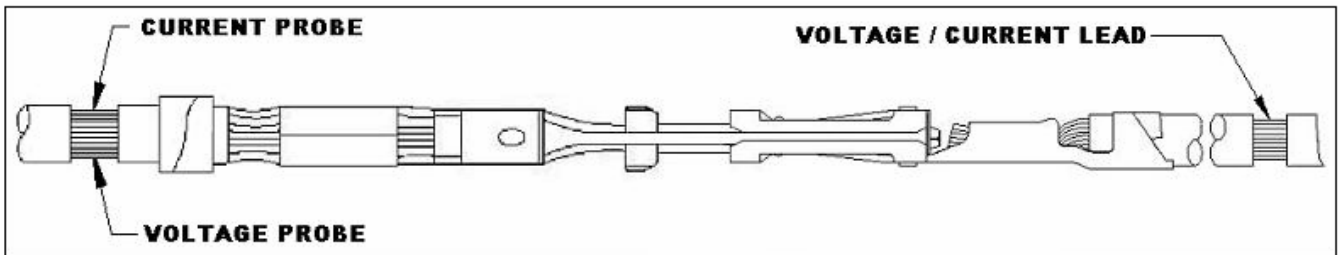



FIGURE 1A

6.4 Power Contact Resistance - Tested at Specified Current, the contact resistance at a specified current shall not exceed 2.0 milliohm initially or after mating cycles and after environmental exposure when measured in accordance with EIA 364 TP06. See Table 1 and Figure 2.

TABLE I

| Contact Resistance at Rated Current For power cable only | Wire Size (AWG) | Test Current (Amps DC) |
|---|-----------------|--------------------------|
| | 8 | 35 |
| | 10 | 20 |
| | 12 | 15 |
| | 14 | 10 |

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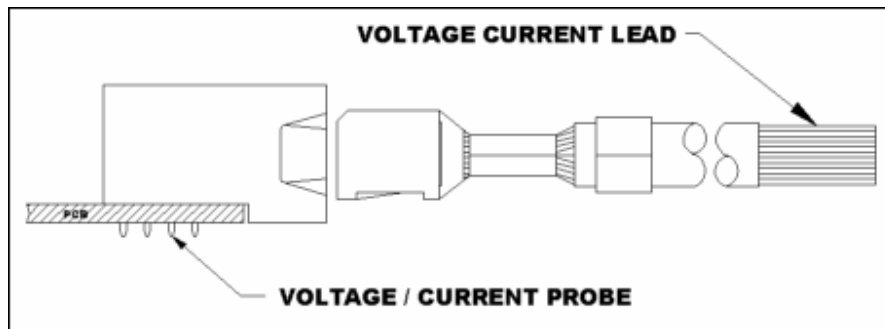



FIGURE 2

- 6.5 Dielectric Withstanding Voltage - There shall be no evidence of arc-over, insulation breakdown or excessive leakage current (> 1 milliampere) when mated connectors are tested in accordance with EIA 364 TP20. The following details apply:
- a Test Voltage – 2500 volts DC (power), 1000 Volts DC (signal)
 - b Test Duration 60 seconds
 - c Test Condition – (760 Torr – sea level)
 - d Points of Measurements – Between adjacent and opposing contacts.
- 6.6 Capacitance - The capacitance between pairs of adjacent or opposing contacts in an unmated connector shall not exceed 1.5 picofarads when measured in accordance with MIL-STD-202, Method 305. The following details apply:
- a Test Frequency – 100 KHz
 - b Special preparation – The connector shall not be terminated.
 - c Sample Size – 20% of connector population
- 6.7 Crimp Resistance Low Level – When properly crimped, the change in crimp resistance shall not exceed 1 milliohms for wire sizes 22-30 AWG for Signal and 8-12 AWG for Power. Crimp resistance shall be measured in accordance with MIL-STD-1344, Method 3002. Terminals not to be inserted into housings for this test. The following conditions shall apply:
- a Method of connection – For Signals attach current and voltage leads as shown in Figure 3 & 3A
For Power attach current and voltage leads as shown in Figure 3B
 - b Test Voltage – 20 millivolts DC max. open circuit
 - c Test Current – Not to exceed 100 milliamperes

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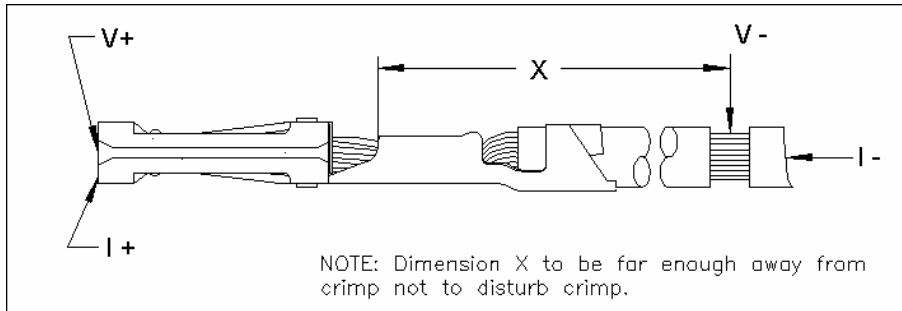


FIGURE 3

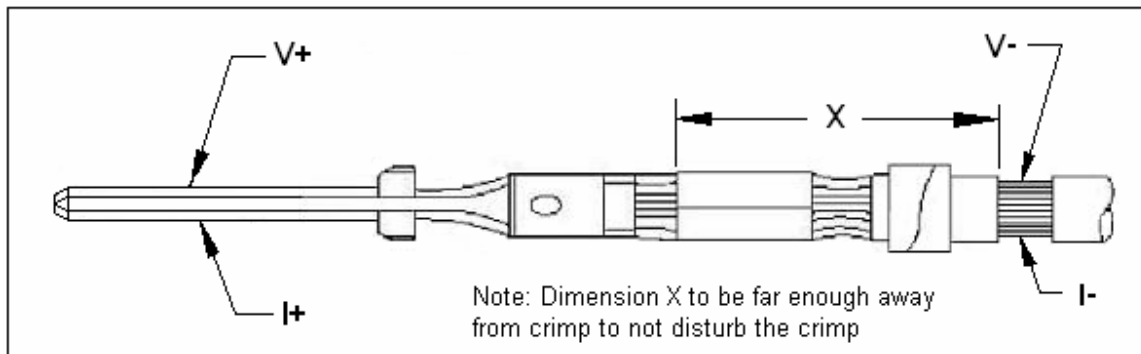


FIGURE 3A

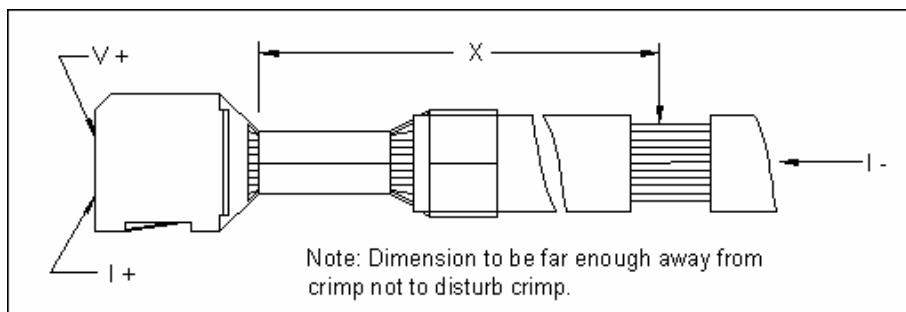



FIGURE 3B

| | | | |
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- 6.8 Hot Insertion / Withdrawal – The connector has to withstand minimal 50 mating powered operations over 20 years. The connectors has to withstand 200A at 0.5ms (capacitive load) powered operations for minimal 50 mating cycles.
The connector may not exceed the maximum connector resistance.
The mating / un-mating speed is maximum 750mm/s and minimum 50mm/s. After each mating and un-mating cycle the load must be discharged.

7.0 MECHANICAL CHARACTERISTICS

- 7.1 Mating/Un-mating Force – The force to mate a receptacle connector and compatible header shall not exceed 6.95 N (25 ounces) per individual power contact and 2.45 N (8.8 ounces) per individual signal contact times the number of contacts per connector. The un-mating force shall not be less than 2.2 N (8 ounces) per individual power contact and .29 N (1.05 ounces) per individual signal contact times the number of contacts per connector. If connector assemblies are equipped with latches, they should be disengaged for this test. The following details apply:
- a. Cross Head Speed – 25.4 mm (1 inch) per minute
 - b. Lubrication – None
 - c. Utilize free floating fixtures
 - d. Reference EIA 364 TP 13
- 7.2 Individual Contact Insertion Force – (Signal Receptacle Contacts Only) When measuring using a maximum gage configured as shown in Figure 4, the individual contact insertion force shall not exceed 250 grams.
- 7.3 Individual Contact Withdrawal Force – (Signal Receptacle Contacts Only) After three insertions of the maximum gage as shown in Figure 4, the force to withdraw a Minimum gage configured in Figure 4 shall be not less than 30 grams.

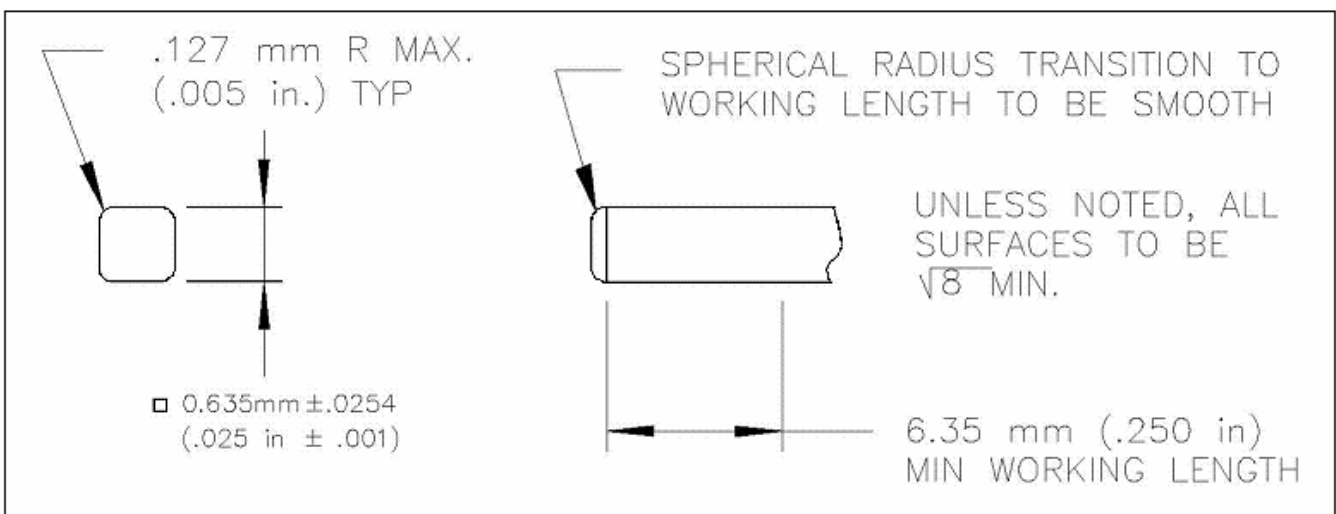



FIGURE 4

| | | | |
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- 7.4 Normal Force – (Power Contacts Only) The contact normal force shall not be less than 350 grams per beam when tested in accordance with BUS-03-404.
- 7.5 Contact retention – Individual contacts shall withstand an axial retention load of 1360.8 g (3 pounds) minimum for Power Contacts and 453.6 g (1.0 pound) minimum for Signal Contacts
The following details apply.
- Rate of 12.7 mm (0.5 inches) per minute without dislodging from the housing cavity
 - Test 30 contacts
 - As per MIL-STD-1344A, Method 2007.1
- 7.6 Crimping Tensile Strength (Power Only) – The force required to pull the properly crimped wire from the terminal shall not be less than the value specified in Table II for Power Cables and Table III for Signal Cables (CTW Male Pin and Receptacles) when tested per SAE/USCAR 21 section 4.4.5. If terminals are equipped with an insulation barrel, they should not be crimped to have an affect on this test.


TABLE II (Power Only)

| | | | | |
|------------------------------|-----|-----|-----|-----|
| Cable size (AWG) | 8 | 10 | 12 | 14 |
| Crimping pull force (N) Min. | 350 | 290 | 240 | 180 |

TABLE III (Signal Only)

| Wire Size AWG | Strength , N (Lbs) |
|---------------|--------------------|
| 22 | 71.2 (16.0) |
| 24 | 48.9 (11.0) |
| 26 | 28.9 (6.5) |

- 7.7 Crimp Acceptance Criteria
General Appearance as defined by SAE/USCAR21section 4.2.5. and **TA-681, TA-317 and TA-211.**
- 7.8 Cross section acceptance as defined by SAE/USCAR21section 4.3.4 and 4.3.5 Exception: Max. allowable burr width is 0.25mm.
- 7.9 Bending Radius – Cable shall accept a bending radius of 8 times its outer diameter without any cracking to the outer cable jacket or breaking of strands of copper wires.
- 8.0 ENVIRONMENTAL CONDITIONS**
After exposure to the following environmental conditions in accordance with the specified test procedure and/or details, the product shall show no physical damage and shall meet the applicable electrical and mechanical requirements of paragraphs 6.0 and 7.0 as detailed in Table IV test sequences. Unless otherwise specified, assemblies shall be mated during exposure.
- 8.1 Thermal Shock – EIA 364 TP 32
- Test Condition – 25, 1 hour cycles
 - Temperature Range – Between -20°C to +80°C
 - Time at Each Temperature – 30 minutes minimum
 - Transfer Time – 5 minutes maximum

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8.2 Humidity, Steady State – EIA 364 TP 31, Method II

- a. Relative Humidity – 95%
- b. Temperature - +40° C
- c. Test Duration – 96 hours

8.3 High Temperature Life – EIA 364 TP 17

- a. Test Duration – 21 days
- b. Temperature - 105°C
- c. Pre-Condition – Perform number of durability cycles specified for product

8.4 Environmental Sequence:


- a. Phase I –Thermal Shock – EIA 364 TP 32
 - a. Test Duration – 25, 1 hour cycles
 - b. Temperature Range – Between -20°C to +80°C
 - c. Time at Each Temperature – 30 minutes
 - d. Transfer Time – 5 minutes maximum
- b. Phase II –Humidity – EIA 364 TP 31, Method II
 - a. Test Duration – 10 days
 - b. Relative Humidity – 95%
 - c. Temperature - 40°C
- c. Phase III –High Temperature Life – EIA 364 TP 17
 - a. Test Duration – 21 days
 - b. Temperature - 105°C
 - c. Pre-Condition – Perform number of durability cycles specified for product

8.5 Vibration Sinusoidal – EIA 364 TP 28

- a. Condition – III
- b. Vibration Amplitude – 0.06" DA or ±15G
- c. Frequency Range – 10 to 2000 to 10Hz
- d. Sweep Time and Duration – 20 minutes per cycle, 4 hours along each of three orthogonal axis (12 hours total)
- e. Mounting – Rigidly mount assemblies
- f. Discontinuities – None greater that 10 nano-seconds

8.6 Mechanical Shock – EIA 364 TP27

- a. Test Condition – I (50G, 11 millisecond half sine wave)
- b. Number of Shocks – 3 shocks in both directions along each of three orthogonal axis (18 total)
- c. Mounting – Rigidly mount assemblies
- d. Discontinuities – None greater than 10 nano-seconds

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8.7 Durability – Standard laboratory procedure as applicable to the specific product. Cable assemblies to be mated side by side with a standard production header and Male Pin connector with same plating. After cycling, the contact resistance shall not exceed 15 milliohms initial and 20 milliohms after test

- a. Number of Cycles – 200
- b. Cycling Rate – 127 mm (5 inches) per minute

9.0 **QUALITY ASSURANCE PROVISIONS**

Equipment Calibration – All test equipment and inspection facilities used in the performance of any test shall be maintained in a calibration system in accordance with ISO 9000.

9.1 Inspection Conditions – Unless otherwise specified, all inspections shall be performed under the following ambient conditions:

- a. Temperature – 25 ± 5°C
- b. Relative humidity – 30 to 60%
- c. Barometric pressure – Local ambient


9.2 Acceptance

- a. Electrical and Mechanical requirements shall be as indicated in paragraphs 6.0 and 7.0 using test data and appropriate statistical techniques.
- b. Failures attributed to equipment, test set-up or operator error shall not disqualify the product.

9.3 Qualification Testing – Qualification testing shall be performed on sample units predicted with equipment and procedures normally used in production. Test sequence is as shown in Table IV.

9.4 Re-Qualification Testing – if any of the following conditions occur, the responsible product engineer shall initiate re-qualification testing consisting of the applicable parts of the test matrix as Shown in Table IV.


- a. A significant design change is made to the existing product that impacts the product form, fit or function. Examples of significant changes shall include, but are not limited to, changes in the plating material composition or thickness, contact force or contact surface geometry, insulator design, contact base material or contact lubrication process.
- b. A significant event occurs during production or end use requiring corrective action to be taken relative to the product design or manufacturing process.
- c. A significant change is made to the manufacturing process that impacts the product form, fit or function.

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9.5 Sample Quantity and Description


- a. Connector Assemblies (CTW Receptacle and CTW Headers) – Sixteen (16) connector assemblies consisting of the largest sizes with wires crimped of largest and smallest AWG wire size and thirteen (13) of the smallest sizes with wires crimped of largest and smallest AWG wire size to be populated and subjected to the qualification inspection. Assemblies to have three 76.2 mm (3) inches long wire leads crimped .
- b. A separate group of 60 crimped to wire sub-assemblies each of signal terminals (CTW Receptacle and CTW Male Pins) and power terminals for each AWG size to be crimped at Minimum and Maximum height and supplied for qualification testing. Wire leads to be three 76.2 mm (3) inches long minimum. No housings required for these samples.

| Test Group Table IV | Description | Qty. Conn. Assemblies | Number of Term. Tested |
|---------------------|---|-----------------------|------------------------|
| 1 | 2 largest & 2 smallest populated connectors with wires crimped of largest and smallest AWG wire size. | 4 | All |
| 2 | 3 largest & 3 smallest populated connectors with wires crimped of largest and smallest AWG wire size. | 6 | All |
| 3 | 1 largest & 1 smallest populated connector with wires crimped of largest and smallest AWG wire size. | 2 | All |
| 4 | 3 largest & 3 smallest populated connectors with wires crimped of largest and smallest AWG wire size. | 6 | All |
| 5 | 1 largest & 1 smallest populated connectors with wires crimped of largest and smallest AWG wire size. | 2 | All |
| 6 | 1 largest & 1 smallest populated connectors with wires crimped of largest and smallest AWG wire size. | 2 | All |
| 7 | 3 large populated connectors with terminals with wires crimped of largest and smallest AWG wire size. | 3 | All |
| 8 | Individual Contacts Crimped to each wire size (Power Only) | 0 | 15 each |
| 9 | Individual Contacts Crimped to each wire size (Power & Signal Receptacle and Male Pin) | 0 | 30 each |
| 10 | Individual Contacts Crimped to each wire size (Power & Signal Receptacle and Male Pin) | 0 | 15 each |
| 11 | 2 largest & 2 smallest populated connector with wires crimped of largest and smallest AWG wire size. | 4 | All |

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Qualification Test Table IV

| Test | PAR | Test Group | | | | | | | | | |
|--|-------|--------------------------|--------------|--------|--------------|--------|--------|-------------|---|------------------|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | Test Sequence | | | | | | | | | |
| Examination of Product | 5.6 | 1 19 | 1 12 | 1 5 | 1 5 10 | 1 8 | 1 3 | 1 10 | 1 | 1 9 | 1 |
| Low Level Contact Resistance | 6.3 | 3 6 9 14 17 | 3 6 9 | 2 8 | | 2 6 | | 3 6 9 | | | |
| Contact Resistance at Specified Current | 6.4 | 4 7 10 15 18 | 4 7 10 | 3 7 | | 3 7 | | | | | |
| Insulation Resistance | 6.1 | | | | 2 8 | | | | | | |
| Dielectric Withstanding Voltage | 6.5 | | | | 3 9 | | | | | | |
| Capacitance | 6.6 | | | | 4 | | | | | | |
| Current Rating | 6.2 | | | | | | 2 | | | | |
| Hot Insertion / Withdrawal | 6.8 | 9 | 4 | | | 6 | | | | | |
| Mating/Un-mating Force | 7.1 | 2 11 13 18 | 2 8 | | | | | | | | |
| Normal Force | 7.4 | | | | | | | 2 | | | |
| Individual Pin Insertion | 7.2 | | | | | | | 2 5 7 | | | |
| Individual Pin Withdrawal | 7.3 | | | | | | | 4 8 | | | |
| Contact Retention | 7.5 | | 11 | | | | | | | | |
| Crimp Tensile Strength | 7.6 | | | | | | | | | | 2 |
| Crimp Resistance | 6.4 | | | | | | | | | 2 4 6 8 | |
| Crimp & Cross Section Accept | 7.7&8 | | | | | | | 11 | 3 | | |
| Thermal Shock | 8.1 | | | | 6 | | | | | 3 | |
| Humidity, Steady State | 8.2 | | | | 7 | | | | | 5 | |
| High Temperature Life | 8.3 | | | | | 5 | | | | 7 | |
| Environmental Sequence Phase I Phase II Phase III | 8.4 | 5 8 16 | | | | | | | | | |
| Vibration | 8.5 | | | 4 | | | | | | | |
| Mechanical Shock | 8.6 | | | 5 | | | | | | | |
| Durability | 8.7 | 12 | 5 | | | 4 | | | | | |

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REVISION RECORD

| REV | Page | Description | EC | Date |
|-----|------|--|----------|----------|
| A | All | Release from Preliminary | V07-0701 | 12-04-07 |
| B | 4 | Changed 15 & 20mΩ to 2.0mΩ, Removed 0.7mΩ Max cable only | V08-0467 | 11-24-08 |
| C | All | Added test criteria for PwrBlade Header Assembly | V10-0045 | 1-27-10 |
| D | ALL | Add burr exception to section 7.8 | V10-0431 | 11-22-10 |
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