

NUMBER <b>GS-12-380</b>	TYPE <b>PRODUCT SPECIFICATION</b>	<b>Amphenol FCI</b>	
TITLE <b>HCI® Power Connector System</b>		PAGE <b>1 of 12</b>	REVISION <b>F</b>
		AUTHORIZED BY <b>DM LU</b>	DATE <b>04/13/2017</b>
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## 1.0 OBJECTIVE

This specification defines the performance, test, quality and reliability requirements of the HCI Power Connector System.

## 2.0 SCOPE

This specification is applicable to the termination characteristics of the HCI Power Connector System which provides a separable interface for power to daughter card applications.

## 3.0 GENERAL

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#### 4.0 APPLICABLE DOCUMENTS

##### 4.1 FCI Specifications:

Applicable FCI product drawings  
 BUS-12-090: HPC Product specification  
 GS-20-070: Application Specification, HCI Power Connector System.  
 GS-12-220: 2mm High Power Connector System (Compliant Pin)  
 BUS-12-090: High Pin Count (HPCII) Connectors

##### 4.2 Other Standards and Specifications

IEC 664-1: Insulation Coordination for Equipment with Low-Voltage Systems  
 IEC 61984: Connectors - Safety Requirements and Tests  
 UL 60950 (supercedes UL 1950): Safety of Information Technology Equipment  
 IEC 60950-1\*: Information Technology Equipment – Safety, Part 1: General Requirements  
 UL 1977: Standard for Safety for Component Connectors for use in Data, Signal, Control and Power  
 UL94-V0: Tests for Flammability of Plastic Materials in Devices and Appliances  
 GR-1217-CORE: Telcordia Specification “Generic Requirements for Separable Electrical Connectors”  
 EIA 364: Electrical Connector/Socket Test Procedures Including Environmental Classifications  
 TUV Specification: IEC 60664-1 (Up to 50V products)  
                                   IEC 61984 (50V and above up to 1000V products)  
 \* IEC 60950-1 contains the same information as UL 60950

##### 4.3 FCI Lab Reports - Supporting Data

GS-29-380 HCI Qualification Summary.

##### 4.4 UL/CSA/TUV Certification

UL/CSA file # E66906  
 TUV certification # B0707 34414010

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**5.0 REQUIREMENTS**

**5.1 Current Rating**

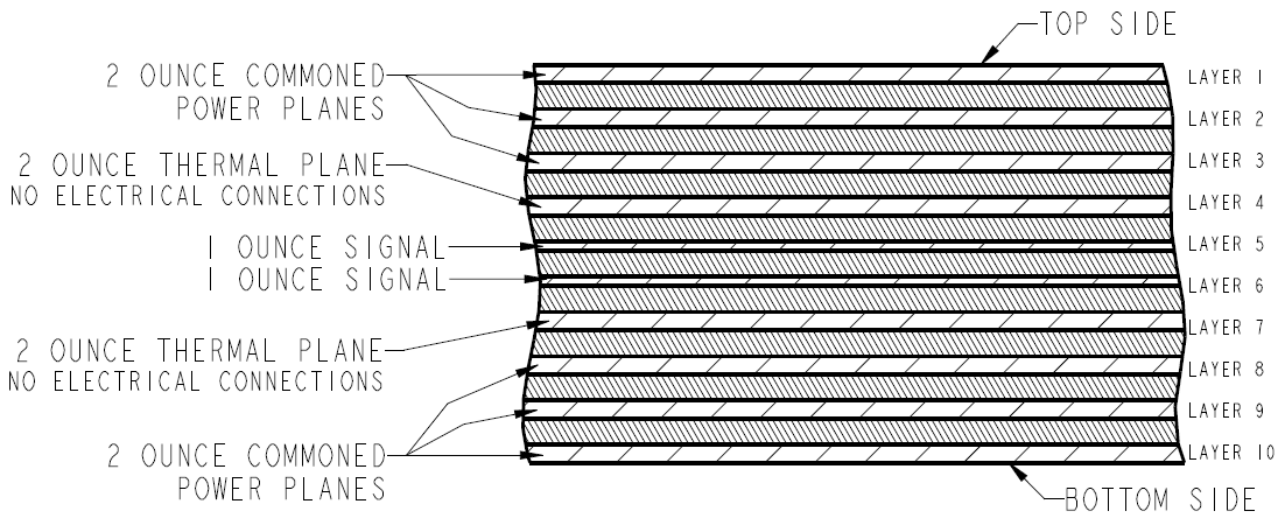
Maximum operating temperature: 105 °C

Maximum operating voltage: (Ref. GS-20-070 Table 4)

Following are the current rating of the HCI Power connector system:

Application	Number of adjacent contacts fully powered	Test Board (Copper Pad)	Air Starting Temp.	Still Air	Forced Air (LFM)	T-Rise (°C)	Current Rating per power contact (Amp)					
HCI General product (Co Planar & Back Plane)	1	5 oz. / 2 external layers	Ambient (xx)	Yes		30	82					
	10						50					
HCI HIGH POWER MODULE (2 & 3 Position)	2						83					
	3						75					
HCI General product (Co Planar & Back Plane)	1						2 oz. / multi layers	Ambient (xx)	Yes		30	144
	2											110
	4	105										
	6	95										
	8	92										
	10	86										

NOTE: Schematic of 10 layer PCB  
Layer 1,2,3 and 8,9,10 aren't commoned.



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## 5.2 Materials

The material for each component shall be as specified herein or equivalent.

Power Contacts: Copper alloy  
Signal Pin Header Contacts: Copper alloy  
Signal Receptacle contacts: Copper alloy  
Housings: High temperature thermoplastic, UL 94V-0 compliant

### Finish:

- Contact Area (Power & Signal):

Performance-base plating, qualified to meet the requirements of this specification

- Tails (Power & Signal)  
Sn Tin plated over Nickel (Standard) or  
SnPb Tin-lead plated over Nickel (special)

## 5.3 Qualification

Connectors furnished under this specification shall be capable of meeting the qualification test requirements specified herein.

## 5.4 Design and Construction

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

## 5.5 Visual

Visual examinations shall be performed using 10X magnification. Parts should be free from blistering, cracks, discoloration, etc.

## 6.1 ELECTRICAL CHARACTERISTICS

6.1 Signal contacts tested at Low level: The Low level contact resistance shall not exceed 20 milliohms initially or after environmental expose when measured in accordance with EIA 364-TP-23. The following details shall apply:

- Test voltage – 20 millivolts DC max open circuit
- Test Current – not to exceed 100 milliamps

6.2 Power contacts tested at specified Current (50A DC):

The contact resistance at a specified current shall not exceed 0.5 mΩ (milliohms) initially or after mating cycles and environmental exposure when measured in accordance with EIA 364-06.

6.3 Insulation Resistance: (20 readings between adjacent contacts) Signal or Power Contact

The insulation resistance of mated connectors shall not be less than 10,000 MΩ (megohms) for the Power contact and 500 MΩ for Signal initially and after environmental exposure when measured in accordance with EIA 364-21. The following details apply:

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- a) Test voltage: 500 volts DC
- b) Electrification time: 2 minutes
- c) Points of measurement: between adjacent contacts

6.4 Dielectric Withstanding: (20 readings between adjacent contacts) Signal or Power Contacts

There shall be no evidence of arc-over, insulation breakdown, or excessive leakage current (>1 mA) when mated connectors are tested in accordance with EIA 364-20. The following details apply:

- a) Test voltage: 2500 volts DC (power), 1000 volts DC (signal)
- b) Test duration: 60 seconds
- c) Test condition: 1 atm
- d) Points of measurement: between adjacent contacts

6.5 Current Rating:

The following details shall apply:

- a) Ambient conditions: still air at Lab ambient
- b) Reference: EIA 364-70 specification
- c) Thermocouple must be attached to the contact near the base of the mating beams header or receptacle.
- d) Copper trace weight: 2 external layers copper trace and 5 oz. test boards
- e) Feed wire size: (Ref. EIA 364-70 specification)

6.5.1. Single Power Contact:

Develop temperature rise versus current curves for six individual contacts. Increase current level until all contacts have exceeded 30°C temperature rise. The current rating is to be determined by the current level at which the first contact exceeds 30°C temperature rise.

Current rating on 2 external layers copper trace and 5 oz test boards: = 82A

6.5.2 10 adjacent Power Contacts (all lines powered):

Develop temperature rise versus current curves for 10 adjacent mated connectors, placing thermocouples on the 2 center most contacts of each connector (10 totals). Increase current level until all contacts have exceeded 30°C temperature rise. The current rating is to be determined by the current level at which the first contact exceeds 30°C temperature rise.

Current rating on 2 external layers copper trace and 5 oz test boards: = 50A

6.5.3 Signal Contact:

The temperature rise above ambient shall not exceed 30° C at any point in the system when all signal contacts are powered with each contact being powered at 1.0 amperes or only one signal contact is powered at 3.0 amperes. The following details shall apply:

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

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## 7.0 MECHANICAL CHARACTERISTICS

### 7.1 Mating/Un-mating forces per power/Signal contact

Contact Type	Mating Force (N) Max. Allowance	Un-Mating Force (N) Min. Allowance
Power Contact	20	6.5
Signal Contact	0.5	0.2

The following details shall apply:

- a) Cross head speed: 1 inch per minute
- b) Lubrication: None
- c) Utilize free-floating fixtures

### 7.2 Contact Retention

#### Signal Pin

During mating, Individual Header and Receptacle Signal Pin shall withstand an axial retention load of 10 N.

#### Power Contact

During mating, the individual RA Header and Receptacle contacts shall withstand an axial retention load of 50 N, the individual VT Receptacle contacts shall withstand an axial retention load of 35 N.

### 7.3 Compliant Pin Insertion Force:

#### Power Individual compliant Pin

The force required to insert an individual compliant pin into a plated through hole in a printed circuit board at a rate of 0.2 inches/minute shall not exceed 67 N (15 lbs).

Insertion #1: 15 contacts; Record insertion forces based on average of nine tails.

Insertion #2: 15 virgin contacts, same PCB holes; No data.

Insertion #3: 15 virgin contacts; same PCB holes; Record forces based on the average of nine tails.

#### Signal Individual compliant Pin

The force required to insert an individual compliant pin into a plated through hole in a printed circuit board at a rate of 0.2 inches/minute shall not exceed 40 N.

### 7.4 Compliant Pin / Retention Force :

#### Power Individual compliant Pin

The retention force in the axial direction opposite that of insertion shall not be less than 15 N (3.4 lb) per press-fit tail.

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Extraction #1: 15 contacts; Record insertion forces based on average of nine tails.

Extraction #2: 15 virgin contacts, same PCB holes; No data.

Extraction #3: 15 virgin contacts, same PCB holes; Record forces based on the average of nine tails.

Signal Individual compliant Pin (ref. Bus-12-090)

The retention force in an axial direction opposite that of insertion shall not be less than 34 N (7.5 lbs).

#### 7.5 PCB Hole Deformation Radius:

Cross-section is parallel to board surface. Photograph and measure the hole deformation (deformation on board material) radius at a point .010" from the surface, and the center of the compliant pin section. Include 10 holes. The average (of 10 holes) hole deformation radius shall be no greater than 0.0015" when measured from the drilled hole. The absolute maximum deformation radius shall not exceed 0.002". Photograph and measure the copper thickness remaining between the compliant section and the printed wiring board laminate. The minimum average (of 10 holes) copper thickness remaining shall not be less than 0.0003". Reference GR-1217-CORE, November 1995, Section 5.1.7.

#### 7.6 PCB Hole Wall Damage:

Cross-section perpendicular to the board surface, and through the compliant section wear track. There shall be no copper cracks, separations between conductive interfaces, or laminate-to-copper separations. Reference GR-1217-CORE, November 1995, Section 5.1.7.

## 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 sections 6.0 and 7.0 as detailed in Table 1. Unless otherwise specified, assemblies shall be mated during exposure.

8.1 Thermal Shock, (Ref. EIA 364-32, test condition II and Telcordia GR-1217-CORE). The following details shall apply:

- Number of cycles: 5
- Temperature range: -65°C to +105°C
- Time at each temperature: 30 minutes minimum
- Transfer time: 5 minutes maximum

8.2 Cyclical Humidity and Temperature: (ref. EIA 364-31 and Telcordia GR-1217-CORE)

Mated samples are to be exposed to cyclical humidity and temperature in accordance with EIA 364-31, Method IV, with the following exceptions. Samples are to be subjected to 50 cycles of 10-hour durations for a total of 500 hours. A cycle consists of the following steps:

- Ramp from 25±2°C at 80%-98% RH to 65±2°C at 94±4% RH in 2 hours.
- Dwell at 65±2°C at 94±4% RH for 4 hours.
- Ramp down to 25±2°C at 80%-98% RH in 2 hours.
- Dwell at 25±2°C at 80%-98% RH for 2 hours.

8.3 Temperature Life: (Ref EIA-364-17 and Telcordia GR-1217-CORE)

EIA 364-17, Method A, Test Condition 4. Headers and receptacles shall remain mated w/o any electrical load. The following details shall apply:



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- a) Test duration: 1000 hours
- b) Temperature: 105° +/- 2°C

**8.4 Industrial Mixed Flowing Gas (4-gas MFG):** (ref. EIA 364-65 and Telcordia GR-1217-CORE)

Test Samples are to be exposed to a central office of industrial gas mixture "Class II a" for a total duration of 20 days. The test chamber is to be maintained at a temperature of 30±1°C with a relative humidity of 70 ±2%.

- For Co-Planar configuration samples are exposed in the mated condition throughout (See table 1A)
- For Backplane configuration, vertical receptacle connector are exposed in the unmated condition for 10 days and followed by exposure of mated connectors for the remaining 10 days (See table 1B)
- Measurement at 5 and 10 days are optional.

**8.5 Vibration:**

Perform in accordance with EIA-364-28 and Telcordia GR-1217-CORE, November 1995. The following details shall apply:

- a) Vibration amplitude: 0.06 inch DA or 10G acceleration
- b) Frequency range: 10 to 500 Hz
- c) Duration: 8 hours along each of three orthogonal axes
- d) Mounting: Rigidly mount assemblies
- e) Requirement: No discontinuities greater than 10 nano-seconds

**8.6 Mechanical Shock:**

Perform in accordance with EIA-364-27 and Telcordia GR-1217-CORE, November 1995.

The following details shall apply:

- a) Conditions: half-sine 30G, 11 milli-second duration.
- b) Shocks: 3 shocks along each of three orthogonal axis
- c) Mounting: rigidly mounted assemblies
- d) Measure resistance after shock in each axis

**8.7 Durability:**

Perform in accordance with EIA-364-09

Use standard laboratory procedure as applicable to the specific product.

- a) Number of cycles: see Table 1 (200 mating cycles maximum)
- b) Cycling rate: 127 mm/minute (5 inches/minute)
- c) Mating and unmating force to be measured per Section 7.1 on the first and last cycle

**8.8 Solderability – ANSI-J-002, Test Condition A**

- a) Steam aging – 4 hours
- b) PCB termination are was evaluated and meets the requirements of ANSI-J-002

**8.9 Resistance to Solder Heat – EIA 364-56**

- a) Test Condition – E
- b) There shall be no evidence of physical or mechanical damage.

**8.10 Disturb: (ref. GR-1217-CORE)**

Back the fully seated header from the receptacle approximately 0.10 mm (0.004 in) and reseal fully.

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## 9.0 QUALITY ASSURANCE PROVISIONS

### 9.1 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.

### 9.2 Inspection conditions:

Unless otherwise specified, all inspections shall be performed under the following conditions:

- a) Temperature: 25 +/- 5 °C
- b) Relative humidity: 30 to 60%
- c) Barometric Pressure: Local ambient

### 9.3 Sample Quantity and Description:

The sample size and description is listed for each test in the appropriate section of this document.

### 9.4 Acceptance:

Electrical and mechanical requirements placed on test samples as indicated in the sections of this specification shall be established from test data using appropriate statistical techniques or shall otherwise be customer specified, and all samples tested in accordance with the product specification shall meet the stated requirements.

Failures attributed to equipment, test set-up or operator error shall not disqualify the product. If product failure occurs, corrective action shall be taken and samples resubmitted for qualification.

### 9.5 Qualification Testing:

Qualification testing shall be performed on sample units with equipment and procedures normally used in production. Test sequence is as shown in Table 1.

### 9.6 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, Table 1.

- 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 not be limited to, changes in the plating material composition or thickness, contact force or contact surface geometry, insulator design, contact base material or contact lubrication requirements.
- 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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10. **Table 1: Qualification Test Matrix**

TEST GROUP ID:		1A	1B	2	3	4	5	6	7
TEST DESCRIPTION	SECTION	Mixed Flowing Gas (Mated)	Mixed Flowing Gas (Un-Mated)	Temp Life	Thermal Shock & Humidity (Dielectric)	Thermal shock / Humidity	Vibration / Mech. Shock	Initial Current Rating	Repair ability
VISUAL EXAMINATION	5.5	1, 23,	1,30	1,8	1,10	1,21	1,19	1,5	1, 10,
MATE HEADER & RECEPTACLE		2,	2,10,15,	2	2	2,12	3,10		
UNMATE HEADER & RECEPTACLE			8,13,	9		11	9		
<b>ELECTRICAL:</b>									
CONTACT RESISTANCE AT LOW LEVEL	6.1	3,6,9,12,15, 18,21	3,6,11,16,19,22,25,28	3,6		3,6,9,13,16,19	4,7,11,14,17		
CONTACT RESISTANCE AT SPECIFIED CURRENT	6.2	4,7,10,13,16,19,22	4,7,12,17,20,23,26,29	4,7		4,7,10,14,17,20	5,8,12,15,18		
INSULATION RESISTANCE	6.3				4,7				
DIELECTRIC WITHSTANDING VOLTAGE	6.4				5,8				
CURRENT RATING (HCI Single Power contact)	6.5.1							2	
CURRENT RATING (HCI Multiple Power Contacts)	6.5.2							3	
CURRENT RATING (HCI Single & Multiple Signal Contacts)	6.5.3							4	
<b>MECHANICAL:</b>									
MATING / UNMATING FORCE	7.1						2		
CONTACT RETENTION (Power & Signal)	7.2				9				
COMPLIANT PIN INSERTION FORCE (Power & Signal)	7.3								2,4,6
COMPLIANT PIN RETENTION FORCE (Power & Signal)	7.4								3,5,7
PCB HOLE DEFORMATION RADIUS	7.5								8
PCB HOLE WALL DAMAGE	7.6								9
<b>ENVIRONMENTAL:</b>									
THERMAL SHOCK	8.1				3	5			
CYCLICAL HUMIDITY & TEMP.	8.2				6	15			
TEMPERATURE LIFE	8.3			5					
MFG - RECEPTACLE ONLY, 5 DAYS	8.4		9,14,						
MFG – MATED, 5 DAYS	8.4		18,21						
MFG - MATED, 5 DAYS, 10 days, 15 days, 20 days	8.4	8,11,14,17							
VIBRATION	8.5						16		
MECHANICAL SHOCK	8.6						13		
DURABILITY, 200 CYCLES	8.7	5							
DURABILITY, 100 CYCLES	8.7		5,27			8,18	6		
DISTURB	8.10	20	24						
<b>SAMPLES NEEDED:</b>									
ELEC. TEST BOARDS (R/A HEADER, 2 ext. layers- 5 oz. Cu traces)		5	5	5	5	5	5	5	
ELEC. TEST BOARDS (R/A RECPT, 2 ext. layers- 5 oz. Cu traces)		5		5	5	5	5	5	

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ELEC. TEST BOARDS (VERT.RECEPT, 2 ext. layers- 5 oz. Cu traces)		5				5	5	
R/A HEADER ASSEMBLIES	5	5	5	5	5	5	15	
R/A RECEPTACLE ASSEMBLIES	5		5	5	5	5	15	
VERTICAL RECEPTACLE ASSEMBLIES		5				5	5	
SINGLE POWER CONTACT WITH 9 PRESS-FIT TAILS								15
ELEC. TEST BOARDS (R/A HEADER, Multi layers- 2 oz. Cu traces)							10	
ELEC. TEST BOARDS (R/A RECPT, Multi layers- 2 oz. Cu traces)							10	

## 11. REVISION RECORD

<u>REV</u>	<u>PAGE</u>	<u>DESCRIPTION</u>	<u>EC#</u>	<u>DATE</u>
A	ALL	Release the product specification	V08-0223	05/15/2008
B	ALL	Updated new test data	V08-0260	06/12/2008
C	ALL	Updated HCI Trade Mark to HCI® and Added Back-plane qualification Test Data, added Press-Fit tail test result	V09-0014	01/13/2009
D	ALL	Added Current Rating of the HCI High Power Module to the table	DG10-0108	03/19/2010
E	3-4	Added current rating test requirement of the multi layers test board.	ELX-DG-007547	10/31/2011
F	ALL	Add multilayer PCB schematic and VTR power contact retention, correct the unit error of signal compliant pin insertion force, update format.	ELX-DG-26653-1	04/13/2017