Hubbell Premise Wiring	White Paper	**Hubbell Premise Wiring** **HUBBELL INCORPORATED (Delaware)** 14 Lord's Hill Rd./P.O. Box 901 Stonington, CT 06378-0901 (860) 535-8326 FAX: (860) 535-8328 http://www.hubbell-premise.com
Title: **Current Carrying Capabilities of Hubbell's Connecting Hardware**		Date: 02/06/03 Contact: Michael O'Connor – Director Technical Marketing

Requirements:

Proliferation of VoIP systems has increased the awareness of and the requirement to insert power onto the cabling plant. Although most VoIP systems operate with about 60 mA of current, the standard being developed to support this application specifies somewhat higher levels of allowable current. The proposed IEEE 802.3af standard for Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI) states that up to 350 mA can be supplied to the DTE over the structured wiring system. This maximum current level was set based on the calculation of the maximum capacity of 26 AWG stranded conductor cables at their maximum environment operating temperature with the maximum allowable temperature rise. This capacity is determined directly by the cross sectional area of the conductor copper, coupled with de-rating that is necessary for bundling considerations of the application.

The current capacity of connecting hardware is determined by the thickness and width of the current carrying traces. Design rules suggest that a 0.0015" thick (1 oz) trace that is 0.015" wide is capable of handling 550 ma of current with less than 10 degrees of temperature rise. Hubbell Premise Wiring's (Hubbell) connecting hardware products have always been designed to exceed this minimum requirement on all current carrying paths. That being said, this testing was undertaken by Hubbell Premise Wiring in order to provide additional assurance to users.

In addition to UL and NEC safety standards that these connectors are already subjected to, the next level of assurance is the ability of the connectors to continuously conduct required current levels without overheating. Excessive heating can reduce electrical performance characteristics of connectors. In addition, heat can increase the likelihood of failure in the form of trace severing or delamination of the printed circuit board's FR4 substrate.

Current ANSI -IEEE /TIA standards in development today call out for power insertion on one of two possible pin/pair combinations, either PINS 1,2(+) and 3,6(-) pairs 2&3 or PINS 4,5(+) and 7,8(-) pairs 1&4. In either case, only one combination of two pairs is to be powered. As a result, the maximum expected current through a connector is 350 mA on two pairs.

With either choice of powering configurations, the total current is divided equally between two conductors of each of the two used pairs, resulting in 175 mA of current per conductor. Furthermore, the power is not applied unless the power sourcing equipment detects a device requiring power and capable of accepting it. Without this feature, ordinary data terminal equipment (DTE) not designed to accept power from the LAN would likely be destroyed if connected. This also guarantees that there is no electrical arcing occurring during the mating cycle of a plug and jack.

Worst Case Determination and Testing Procedure:

Allowing for the worst case of a broken connection on one of the pins of a pair, the resulting maximum current if forced through one conductor would be 350 mA under normal operation. Additional safety margin can be obtained by running 700 mA per conductor. Following the above considerations, this paper presents testing of Hubbell's connectivity by passing approximately 700 mA, (1.4A per pair) through **ALL** connections at the same time while measuring heat rise on the printed circuit board within the connector. This current is double the proposed specification and was applied to **ALL** 8 conductors instead of only 4 as would be done in normal operation.

All testing was performed at room temperature and covered the majority of Hubbell's connectivity products including HPW's "NEXT*SPEED*®" Category 6 jacks/patch panels as well as *SPEED*GAIN™ 5e jacks and patch panels[1].

ITEMS TESTED:

P624U-NEXT*SPEED*® Category 6 Panel

HXJ6OW-Category 6 Xcelerator™ Jack

P5E24U- *SPEED*GAIN™ Category 5E Panel

HXJ5EOW-Category 5E Xcelerator™ r Jack

HXJ3OW-Category 3 Xcelerator™ Jack

Four samples (or ports) were tested for each product. In the case of the patch panels, 4 ports were selected adjacent to each other to capture the worst case heating condition. Thermocouples were attached to each sample on the surface of the PCB, in the area of highest concentration of current carrying traces. All 4 samples were tested at the same time placing each in series with a DC power supply and the load. The load used was comprised of a 105 ohm - 10-watt resistor shunted by a 5µF capacitor in series with a 100µH inductor.

In each case the samples were energized a minimum of 3 hours which proved to be sufficient for temperature to stabilize after reaching a maximum. Temperature readings were made every hour and ambient temperature recorded. Below are tables showing data for each sample tested. Overall worse case temperature rise and maximum temperature for each product is shown in the far right hand column for each product.

P624U-NEXTSPEED® Cat6 Panel							
NEXT SPEED PANEL (Category 6)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	23	23	23	23	23		
1:00	31.9	32.3	32.1	30.4	23.7		
2:00	31.2	33	32.7	31	23.5	**33**	**9.5**
3:00	31.7	32.7	32.5	30.7	23.2		
HXJ SERIES JACK - XCELERATOR™							
HXJ6 JACK (Category 6)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	22.5	22.5	22.5	22.4	22.4		
1:00	27.6	28.3	27.8	28.2	23.7		
2:00	28.9	29.2	28.5	29.5	24.2	**29.5**	**5.3**
3:00	28.2	27.4	28	28.9	23.6		
HXJ5e JACK (Category 5e)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	23.8	23.6	23.8	23.4	23.4		
1:00	26.5	26.5	26.5	26.2	23.6		
2:00	25.6	26.2	26.5	26.4	24.6	**27**	**3.2**
3:00	26.2	26.8	26.9	27	23.8		

HXJ3 JACK (Category 3)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	23.4	23.4	23.4	23.4	23.4		
1:00	26.8	26.2	26.4	26.3	23.5		
2:00	25.9	26.2	26.8	26.4	24.2	**27.1**	**3.3**
3:00	26.3	26.9	26.9	27.1	23.8		

[1] All HPW products were subjected to and passed this testing. For information on other products, contact moconnor@hubbell-premise.com

4-Port Furniture Adapter							
568A (Category 5e)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	23.5	23.5	23.4	23.5	23.5		
1:00	29.5	32.8	33	33.6	24		
2:00	29.2	32.8	33	33.6	23.8	**33.6**	**9.8**
3:00	29.2	32.6	32.8	33.6	24		
568B (Category 5e)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	22.3	22.2	22.3	22.4	22.4		
1:00	29.2	31.5	31.2	32.2	22.5		
2:00	31.9	34.2	34.2	35.6	22.3	**35.6**	**13.3**
3:00	31.5	34.2	34	35.5	23		
P5E24U SPEEDGAIN™(Category 5e)						**Maximum**	
SAMPLE	1	2	3	4	Ambient	**Temperature**	**Max Rise**
0:00	23.5	23.5	23.4	23.5	23.5		
1:00	39	40.4	39.2	36.2	24		
2:00	39.3	40.3	39.6	36.5	23.8	**40.4**	**16.6**
3:00	39.2	40.2	39.2	36.1	24		

Result:

Temperature rise for all samples was minimal. The worst-case temperature rise was 16.6ºC. The maximum temperature obtained was 40.4ºC. This is far below the de-lamination temperature of the copper clad FR-4 material used wish is 120ºC.

It is also far below **ANY** temperature rise limit given in UL 60950. While UL 60950 does not pertain directly to this application, its most stringent temperature rise limit is 30°C and applies to metal parts that are “continuously held in normal use”.

Conclusion:

Testing performed shows Hubbell’s connectivity is fully capable of handling the current carrying requirements exceeding the proposed specifications without any substantial increase in temperature or failure.

The majority of the industry performs testing that is required for mechanical specifications and some safety requirements such as UL1863 and IEC 60603-7-7. Not surprisingly, Hubbell’s connectors exceed these standards and are UL Listed. However, even though those standards guarantee safety conditions, they may not indicate whether the hardware is designed to operate under continuous current and voltage conditions. As such, we performed the current capacity testing under extreme DTE conditions to provide assurance to our customers that our hardware is designed to operate under those conditions.

Hubbell’s connector design philosophy has been focused not only on exceeding the standards, but also on anticipating the needs and possible applications utilizing connecting hardware. As such, the details of design, such as material choices, trace and contact routing and other proprietary design techniques have been maintained with the goal of supporting power delivery. In particular, the trace dimensions and separation are optimized to provide maximum heat dissipation for reliable, safe, continuous operation. This avoids current related problems with traces and eliminates excessive heating conditions, thus reducing the possibility of failure.