# Power – The Lost Technology

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Recently while sitting in my office, I was pondering the ways of the technological world of connectors. I was struck by the wide variety of new and innovative developments which are currently under way. The ingenious techniques of designing signal circuits interrelating them with signal integrity issues and fiber optics is inspiring. Then there's power. Power – What is power? How is it handled? What are the key issues?

While pondering this, I vaguely remembered the years spent earning my degree in electrical engineering. In that era of the glorious past, we learned all about power interspersed with a few elective courses on that new fledging topic called electronics. Today's engineers know a great deal about electronics but power is in a lost gray area. Now, I'm not referring to power associated with the utility or power station technology but power used to energize electronic subsystems or industrial equipment particularly from 1 to 50 amps.

One of the interesting searches which one can do is to review connector catalogs and find the current rating which is listed and the supporting information validating said rating. The search will reveal the current rating but with a few exceptions (very few) the supporting information is nowhere to be found. For those instances where said rating is listed without supporting data, questions should be asked such as how was the rating established. Odds are that the answer will be evasive or vague at best.

At the outset, a few questions should be asked. Is the rating based on:

a) One contact energized in air? or

b) One contact energized in the connector housing? or

c) A number of contacts energized in air? or

d) A number of contacts energized in the connector housing and if so how many and at what location was the measurement performed at?

Also, does the current rating that is indicated imply that *all* contacts in the housing can carry the current simultaneously?

So how or more importantly, how should current rating be established? What factors impact it? What are the basic concerns involved?

The capability of a contact to carry current is a function of the following variables among others:

a) The contact material

b) Conductivity of the material

c) The crossectional area

d) Area in contact

e) Contact geometry and configuration

f) The connector housing/mating factors

g) Normal force

The key functional element is heat generation or temperature rise. As the current increases or the same current in different designs will generate heat. Contingent on the magnitude of heat generated, damage may occur and possibly a fire may be initiated. Additionally the heat generated will also be exasperated by the number of contacts within a pattern carrying a given current level at the same time. Thus, the temperature rise should be established and controlled to assure that the function of the connector is not constrained.

There are basically two techniques which may be used to establish current ratings.

A) The first is to establish the current which will generate a given temperature rise (i.e. 20°C rise). This is normally accomplished by incrementally increasing the current at specified intervals until the desired rise is achieved and the current rating is established and derated accordingly.

B) A second technique is to generate a series of temperature rise plots at three to five current levels. This data can then be used to generate a current carrying characteristic which in essence states that the temperature rise plus the equipment operating ambient should not exceed the temperature rating of the connector. Thus the hotter the equipment ambient, the less current a current can carry with the reverse being true as well.

Technique ‘A’ is employed by U.L. and automotive generally for safety reasons. Technique ‘B’ was created by the IEC and has been adopted by the Electronic Industries Alliance (EIA). Thus basic procedures are in place to establish the current rating of a given contact system. Whichever technique is chosen, appropriate references should be noted in the literature so that appropriate decisions can be made with the appropriate supporting information.

As previously indicated, the above is the essential data required to prevent damage. It is also the baseline for further analysis to determine if thermal run away is a potential problem. Thermal run away is a time dependent failure mechanism. Temp. rise is a prime function of the contact interface characteristic. It generates an electrical resistance hence a T-rise. If over time the resistance increases, a resultant increase in T-rise will occur. This will continue until the heat generated is of such a magnitude as to create significant damage.

There are also techniques in place to assess if thermal run away is a potential failure mechanism. Once the current rating has been established, a current cycling test can be performed. This is an electrical stress test which can be performed for a specified period of time (usually 500 to 1000 cycles) monitoring T-rise and millivolt drop (optional) at each cycle or at specified increments (i.e. twice a day or other interval). This will determine the *stability* of T-rise over time. Another effective and discriminating test is vibration under load to determine if fretting will be an influencing factor.

While evaluating the contact system other area’s which may be impacted should also be evaluated these areas should include among others:

a) Monitoring heat within a wire bundle

b) Monitoring heat on a pcb adjacent or in proximity to the current input area

c) Monitoring heat on crimp joints particularly saddle styles manufactured from strip material.

The above concise discussion is illustrative of some of the technical issues that have to be resolved or data made available. This is a far cry from simply indicating a current rating in its simplistic form leaving a lot of unanswered questions. The additional technical issues are necessary to understand and comprehend. Yet with a few exceptions this data is not available. It has become increasingly important to understand the interrelationships and interactions. This is particularly true since in many applications signal contacts are being assigned to carry power. It is not unusual, for example, to assign ten contacts to carry 2 amps (in parallel) in order to supply 20 amps to a subsystem. Yet supportive data is rarely available which establishes performance criteria for this type of application. Most qualification specifications specifies a current rating. Yet there is no requirement or test required to show design capability. Even when a document indicates a requirement, the methodology is lacking in most cases – there's no indication of thermocouple placement or indication of the number of contacts to be tested (i.e single contact or multiples) as an example.

There is ample data generation to assure performance characterization and stability of signal contacts. Power on the other hand appears to be in dark void with little or no attempt to establish the stability of power contacts with only one connector manufacturer consistently generating data in this area.

However, not all is lost, the EIA is currently attempting to expand and update its procedure for current rating. It has also been debating establishing a recommended test plan to determine performance criteria for power contacts. But standards tend to move slowly (been discussed for approximately two years without a consensus).

In the meantime, a responsible approach for indicating current rating must occur. Not only should current rating be indicated, but also supporting information should be as well. In other words what's the basis for the rating – One or multiple contacts energized in air or in the housing, etc. The long term goa should be to create techniques to establish stability criteria for power contacts. Until this occurs, power will continue to languish and be a lost technology.

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