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Date: October 10, 2016

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Re: TR-42 liaison to IEEE 802.3 regarding elevated temperature operation of cabling

Dear Mr Law:

Thank you for your liaison from the IEEE 802.3 Working Group, approved on July 28, 2016, regarding power delivery over communications cabling.

At our 3-7 October 2016 meeting in Philadelphia, TR-42 discussed existing specifications and the challenges of operating communications cabling at higher operating temperatures. The scope of this response is for Environmental Classification C_1 as specified in ANSI/TIA-568-0-D.

The ambient temperature specified in NFPA table 725.144 is 30 ºC and the current capacities are reflective of that temperature and must be reduced based on higher ambient temperatures. TIA TSB-184-A, currently in draft, is based on an ambient temperature of 45 ºC.

The key points relating to temperature, together with our observations, are listed below as: 1) Transmission, 2) Electrical, 3) Mechanical and 4) Environmental.

1. **Transmission:**

   ANSI/TIA-568-C.2, specifies transmission performance for cabling from -10 ºC to 60 ºC. Performance above 60 ºC would need to be studied to determine its impact on all transmission parameters and if its impact on insertion loss (IL) de-rating at higher temperatures may be different from the de-rating already specified up to 60 ºC. De-rating of IL for balanced cables up to 60 ºC is shown below:

   "The insertion loss for category 5e, 6, and 6A UTP horizontal cables shall be adjusted at elevated temperatures using a factor of 0.4 % increase per °C from 20 °C to 40 °C and 0.6% increase per °C for temperatures from 40 °C to 60 °C. The insertion loss for category 5e, 6, and 6A screened horizontal cables shall be adjusted at elevated temperatures using a factor of 0.2% increase per °C from 20 °C to 60 °C"

   In addition, we would like to note that there would be a need for further study of electrical and mechanical performance for cables at operating temperatures that reflect maximum ambient temperature of 60 °C plus current-induced temperature rise associated with power delivery. This work would need to be carried out in coordination with cable Standards Development Organizations (SDO's) including ICEA.

2. **Electrical:**

   ANSI/TIA-568-C.1 specifies operating temperature for C1 environments

   "Temperature range without mechanical or electrical degradation (°C)

   - *installation: 0 to +50*
   - *operation: –20 to +60"*

   ANSI/TIA-568-C.1 specifies that "*Performance of the connecting hardware shall be maintained over temperatures ranging from 10 °C to +60 °C*"

   For DC resistance (DCR) and DCR unbalance, we make the following observations:

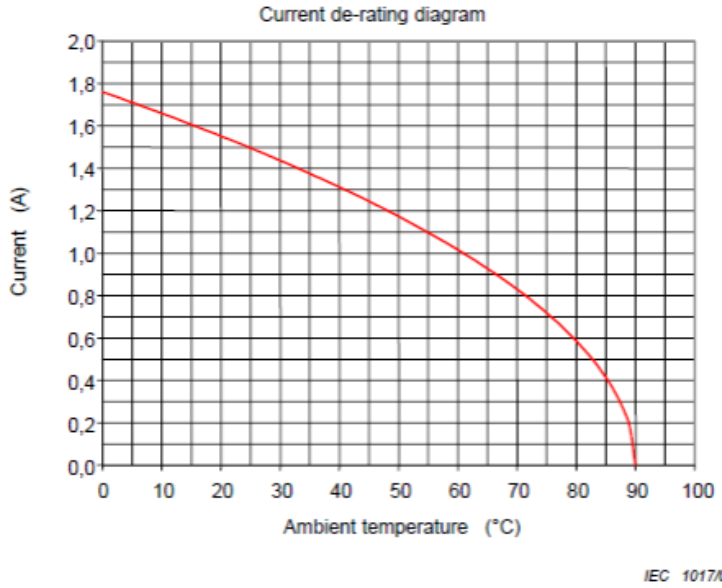
   - DC resistance will increase with temperature by DCR = 0.4 % per °C;
   - DCR unbalance, within a pair and pair-to-pair, has not been studied at temperatures greater than 60°C.

3. **Mechanical:**

   Materials generally age faster at higher temperatures and the impact of aging on key properties should be studied. Mechanical performance of cables is assured based on the temperature rating on the cable jacket, where 60 °C represents the vast majority of the installed base.

   To enable Power over Ethernet support over the installed base as requested by IEEE 802.3, the maximum operating temperature of the cabling was established to be the temperature rating of the cable. In TIA TSB-184-A, the maximum assumed ambient temperature was reduced to 45 °C when these cables are used for remote powering, allowing for a temperature rise of 15°C.

Mechanical performance of connecting hardware is assured by our standards for currents up to 0.75 A at ambient temperatures of 60 °C. The attached graph from IEC 60603-7 indicates rapid reduction of current capacity at higher temperatures to zero at 90 °C.



NOTE 1 The maximum permissible current for a given ambient temperature (t) is: $I_{(t)} = 1{,}76 \cdot \left(1 - \frac{t}{90}\right)^{0{,}5}$

NOTE 2 For ambient temperatures lower than 0 °C, the maximum permissible current per conductor is 1,76 A.

NOTE 3 For further information, see Introduction.

Figure 10 – Connector de-rating curve

4. **Environmental:**

   Operating at higher temperatures increases the DC resistance significantly leading to additional losses within the cabling. This reduces the efficiency of power delivery and increases the amount of energy dissipated.

Operation over a wider temperature range may affect the consistency of other parameters such as delay skew.

Extending the temperature range beyond 60° C will take considerable investment of time, resources, and coordination with ICEA and IEC component committees. We would be happy to address any specific requests or questions you may have regarding operating communications cabling at higher temperatures.

Sincerely,

Ray Emplit
Chair, TIA TR-42 Engineering Committee