A contribution on cabling current de-rating vs temperature for PoE+

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A contribution on the development of current de-rating vs temperature for PoE+

Table 1, Worst Case Temperature rise vs current

Current Level	WC 5e	WC 6	WC 6A
350	0.00	0.00	0.00
500	0.00	4.03	0.00
550	5.40	4.73	4.00
750	10.81	7.40	7.40
800			
850	14.10	11.30	5.60
1000	16.79	14.95	11.73
1300			
1600	51.75	37.95	31.05

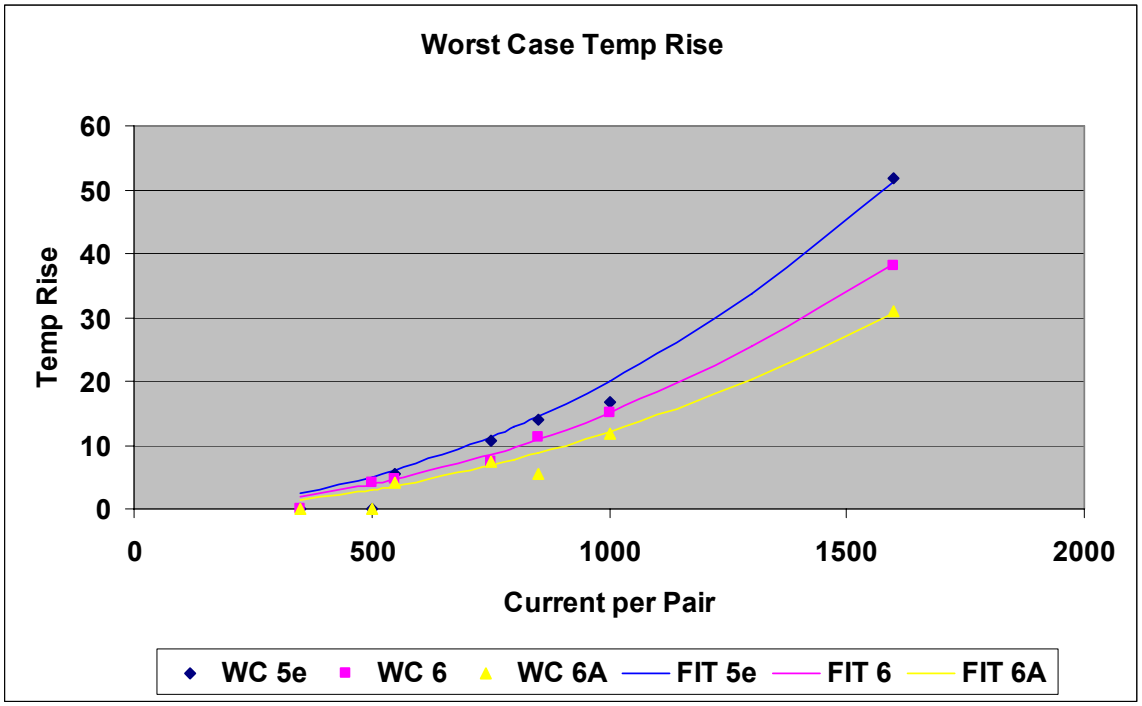

Figure 1. Worst case temperature rise vs current

The data was used to generate curve fits based upon an I^2*R relationship.

$$\Delta T = R \cdot I^2 \quad (1)$$

Where R represents the thermal resistance of the cable bundle and:

Where: R = 20 for Cat5e, R = 15 for Cat6 and R = 12 for Cat6A

The calculated curves are shown on figure 1 along with the data.

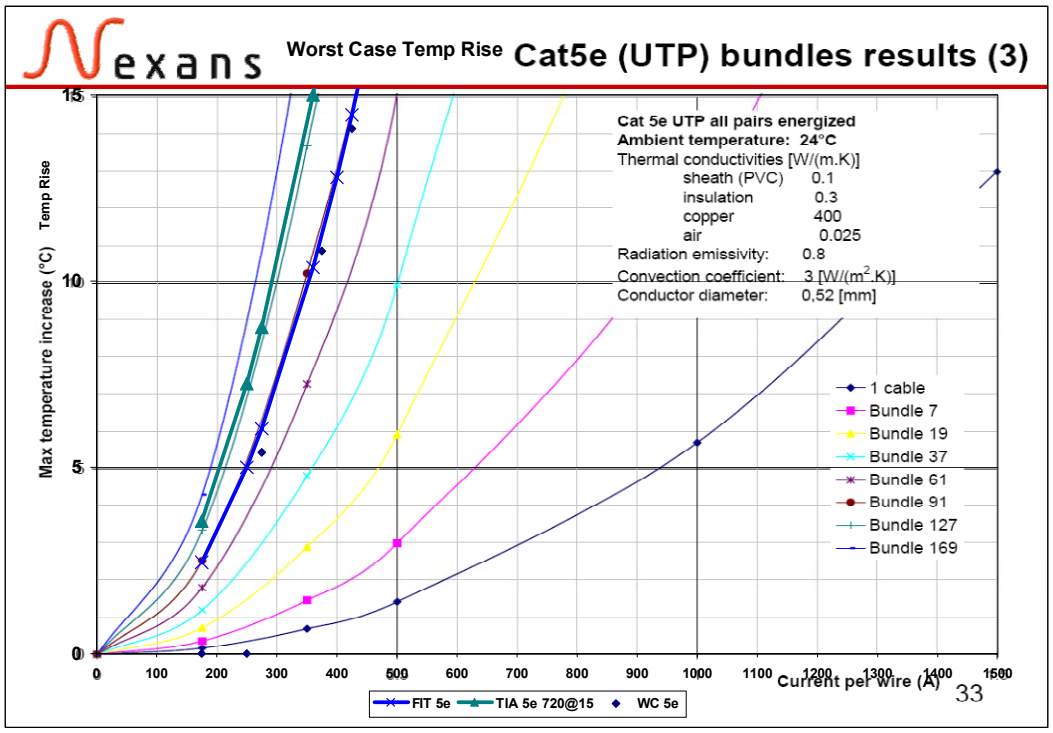

Figure 2. temperature rise vs current on Nexans bundle calculations

The Cat5e curve fit (FIT 5e) in figure 1 coincidentally corresponds to a 91 cable bundle in the Nexans bundle factor curves (from TR42.7-2008-02-014b-BundleFactor.pdf). This presentation has been made in both TIA and ISO WG3. The blue curve in figure 2 (FIT 5e) is plotted upon the bundle simulation results, and is directly correspondent to the Bundle 91 curve. Since the Fit 5e curve is an estimate of the measured temperature rise of an 100 cable bundle this corresponds well to the 91 cable Nexans simulation, which does not factor in the extra convection cooling achieved when bundles are not perfectly constructed.

Previously, TIA TR 42.7 defined a maximum current of 720 mA @ 45° C and this was communicated to IEEE 802.3at. This is a derating of the FIT 5e curve. It corresponds to the TIA 5e 720@15 curve also shown in figure 1 A temperature rise vs current curve can be derived using this point as reference, to achieve a de-rating curve for maximum current vs ambient temperature. . This curve coincidentally aligns well with the 127 cable bundle curve. If we adjust the R factor to achieve 720 mA at 45 degrees, and assume a maximum temperature of 60° C the de-rating curve will be as shown in figure 2 (Cat5e). Similar curves are also calculated for Cat6 and Cat6A based upon scaling the temperature rise vs current R factors by the same ratio. The current vs temperature de-rating curves for Cat6 and Cat6A are also de-rated beginning at 45° C assuming a maximum of 15 degree temperature rise in the cable bundle at any ambient temperature and a maximum cable temperature of 60° C including cable heating by current.

The current carrying capacity at any given ambient temperature can then be found by a simple relationship.

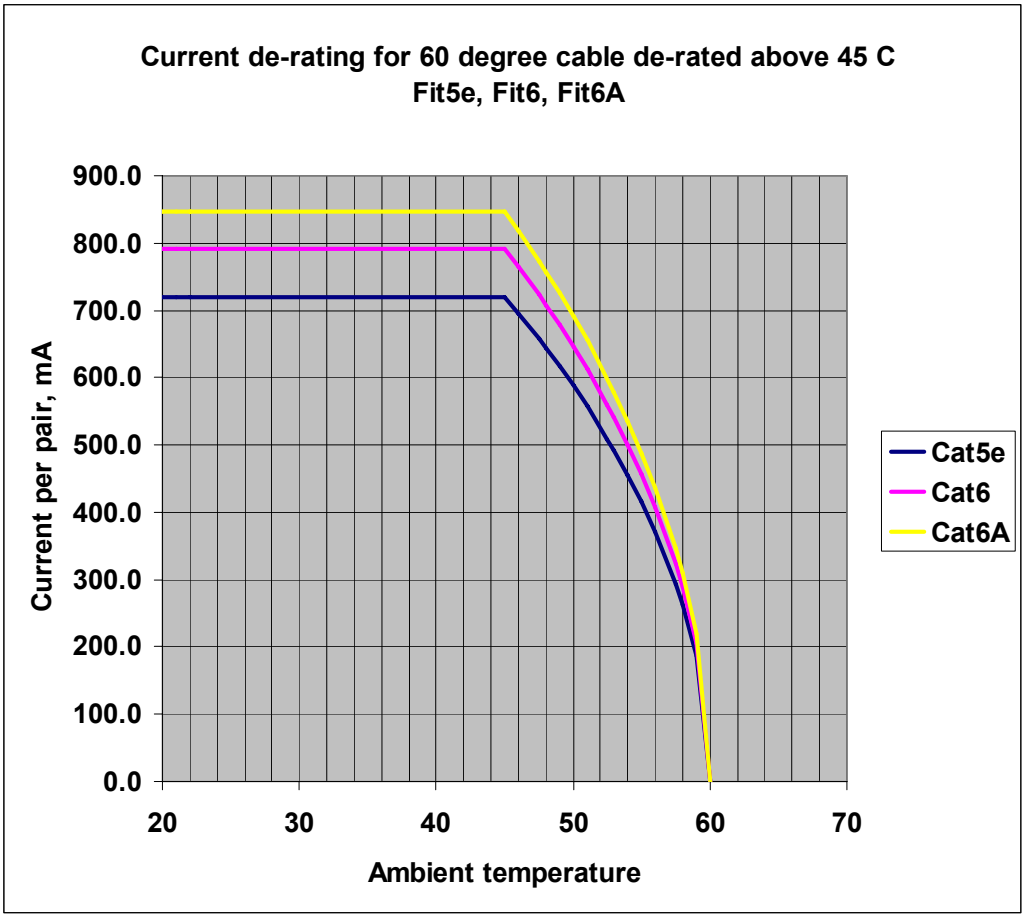

Figure 3. Current de-rating curve based upon TIA curve Fit

Table 1. TIA current de-rated above 45 degrees ambient

Ambient	Current capacity, mA		
	Cat5e	Cat6	Cat6A
60.00	0	0	0
59.00	186	204	218
58.00	263	288	309
57.50	294	323	345
56.00	372	408	436
55.00	416	456	488
54.00	455	500	534
53.00	492	540	577
52.50	509	559	598
51.00	558	612	655
50.00	588	645	690
47.50	657	721	771
45.00	720	790	845
40.00	720	790	845
30.00	720	790	845
20.00	720	790	845

The maximum current per pair for a given ambient temperature (t) can be computed using the following formula:

$$I_t = \sigma \cdot \left(1 - \frac{t}{60}\right)^2 \qquad (2)$$

Table 5. σ Factors for equation 2

Cat5e	Cat6	Cat6A
1.44	1.58	1.69

Other input.

ISO WG3 in Barcelona February 22, 2008, determined current de-rating factors for Cat5 cabling. For a 15 degree temperature rise (and a maximum of 60° C) the maximum current is 720mA. This number corresponds exactly to the TIA current limit of **TR42.7 Update to IEEE 802.3at - Current Carrying Capacity of Cabling** (January 2007) (http://www.ieee802.org/3/at/public/jan07/0107_TR42_1.pdf

These numbers were tabled and enclosed n document 3n864 liaison to IEEE.

The table is shown here.

Table 1 - Current capacity for a category 5 100-cable bundle

Temperature rise ° C	Current carrying capacity mA
5	420
7,5	550
10	600
12,5	680
15	720

The current numbers were derived from the following graph (bundle 127)

A comparison to the calculated numbers from TIA document TR42.7-2008-02-011a-CurrentvsTemp.pdf (Table 4) yields the following:

Ambient	Current capacity, mA	
	WG3 Cat5	Cat5e
57.50		294
55.00	420	416
52.50	550	509
50.00	600	588
47.50	680	657
45.00	720	720

The following chart plots the Cat5e current de-rating and the ISO current de-rating.

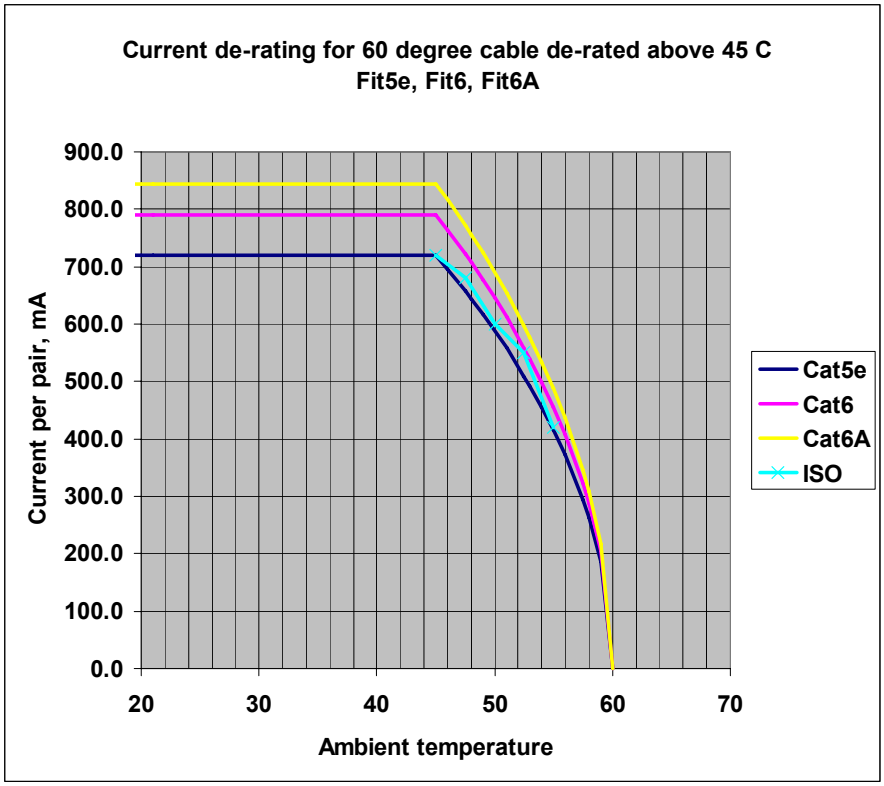

Figure 4. ISO de-rating plotted upon TIA current de-rating

Note that the 720 corresponds exactly to the TIA current, the 420 corresponds closely to the de-rating calculated from equation 2. The other values do not correlate well, and have varying degrees of deviation. It is difficult to determine if there was a consistent method used to develop the numbers.

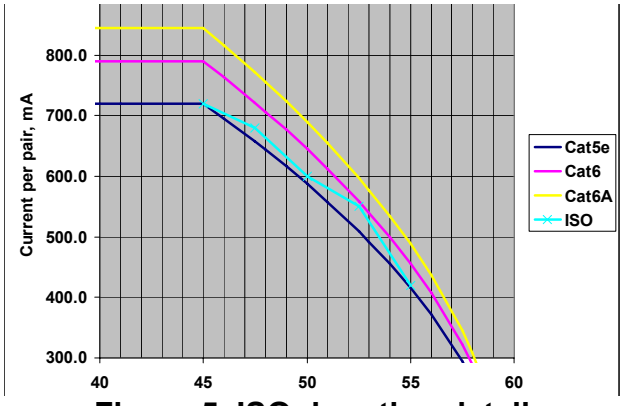

Figure 5. ISO de-rating detail