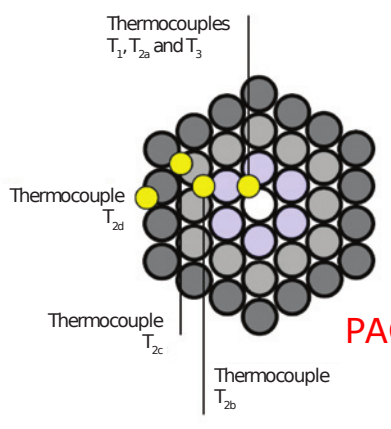
Analysis of "The impact of remote powering (PoE) on Balanced Twisted Pair Cables.

A white paper by Excel Networking

http://www.excel-networking.com/_assets/downloads/Excel_Whitepaper_Impact_of_PoE_on_Balanced_Twisted_Pair_Cables.pdf



The testing method in this paper is Cenelec TR EN50174-99-1 which uses a 37 perfect-cable bundle. Thermocouples are installed at various locations in the bundle.

PAGE 1

In total 3 levels of testing were completed, PoE+ at 34.2 watts, UPoE at 60 watts and 100 watts which is a level being discussed by the IEEE for the development of the new 802.3bt, which has a stated minimum of 49watts and could be in excess of 100 watts when finally ratified, this also relates to some of the higher claims coming from proprietary systems such as HDBase-T which is a hybrid application intended for the AV market. PAGE 2

It is stated that PoE power levels are tested, calling out PoE+, UPoE and IEEE 802.3bt.
While the power levels are mentioned, the test **current** is not. This makes it difficult to duplicate or verify the results. Also unclear is how many conductors were used, since PoE+ (IEEE 802.3at) uses 4 out of 8 conductors for DC power transfer

Results with CAT5e UTP (see page 2)
Open air PAGE 2

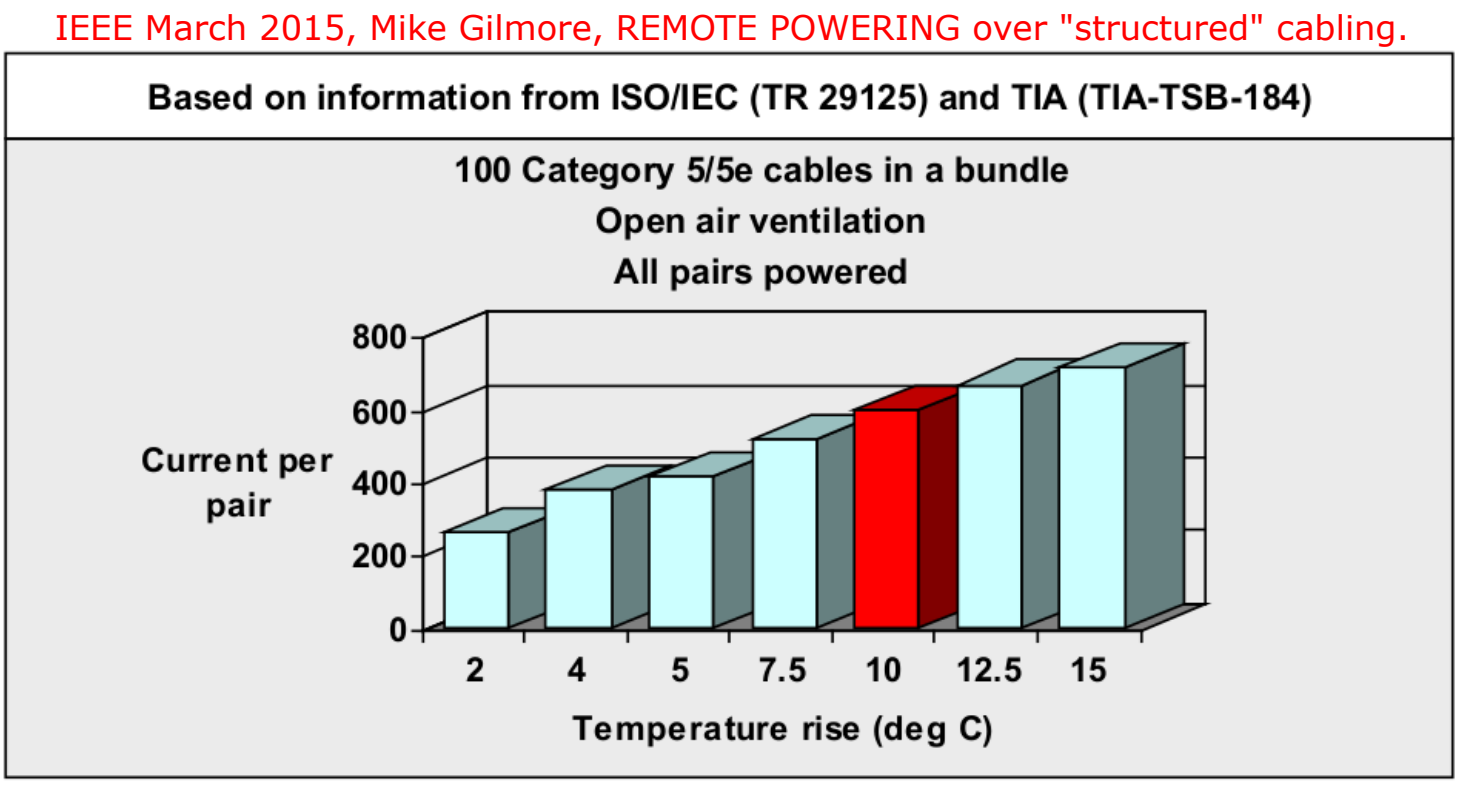
Temperature Rise above Ambient					
Power	T1	T2a	T3	T2b	T2c
Watts	°C	°C	°C	°C	°C
34.2	14.21	14.39	13.79	13.4	11.8
60	25.09	25.52	24.57	24.02	21.33
100	40.38	41.02	39.62	38.63	34.29

Results with CAT5e UTP (see page 2)
Insulated PAGE 3

Temperature Rise above Ambient					
Power	T1	T2a	T3	T2b	T2c
Watts	°C	°C	°C	°C	°C
34.2	52.04	51.06	50.89	49.84	47.94
60	88.26	86.6	86.19	84.8	81.84
100	117.61	114.1	115.51	108.02	104.14

The temperature increase at "60W" is 25.5C for 37 cables in an open air bundle.
How do we reconcile this result with ISO/IEC TR 29125 and TIA-TSB-184 ?

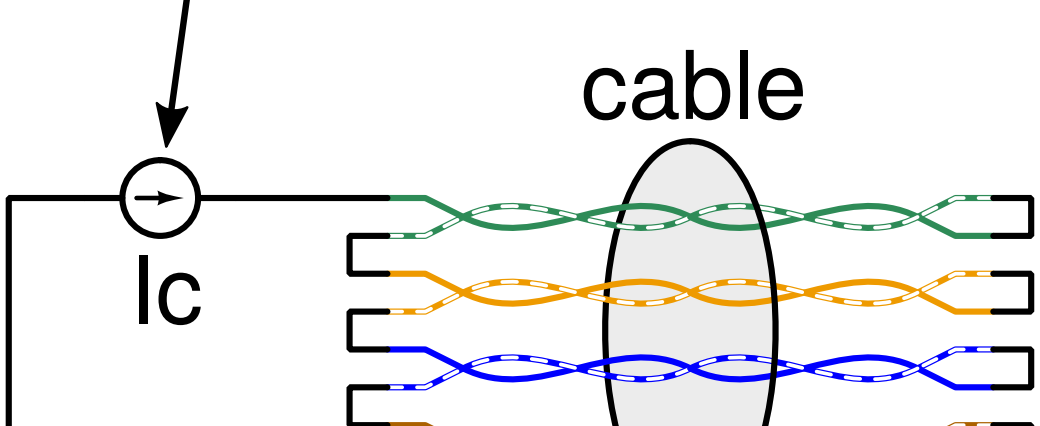
IEEE March 2015, Mike Gilmore, REMOTE POWERING over "structured" cabling.



60W UPoE is a 4-pair proprietary method which has a worst-case conductor current of 300mA with all 8 conductors powered. This matches with the 600mA current per pair in the Figure above. According to TR29125 a 10C rise is expected from a 100 cable bundle. This is a significant difference with 25.5C for 37 cables/bundle - where does the difference come from ?

We contacted on of the authors (prof. Alistair Duffy) to learn more about the test methodology. Specifically the current levels used in the test are critical pieces of missing data.
We learned from the exchange that the power levels stated in the paper, 34.2W, 60W and 100W, do NOT refer to the ouput power of a PSE, but rather the amount of power dissipated in the test cable bundle.

Test Power	Conductor current	Source voltage	Equivalent PoE power
34.2	652 mA	52.5V	130.4W
60	844 mA	73.2V	168.8W
100	1006 mA	94V	209.2W



While the testing done in this paper is very valuable to learn about the effects of DC currents through network cabling, one can easily get the wrong impression.
All three power levels used in this test, when translated to how Power over Ethernet really works, are at a far higher current and power level than the current IEEE 802.3-2012 PoE and also the power levels under consideration by the IEEE P802.3bt task force.

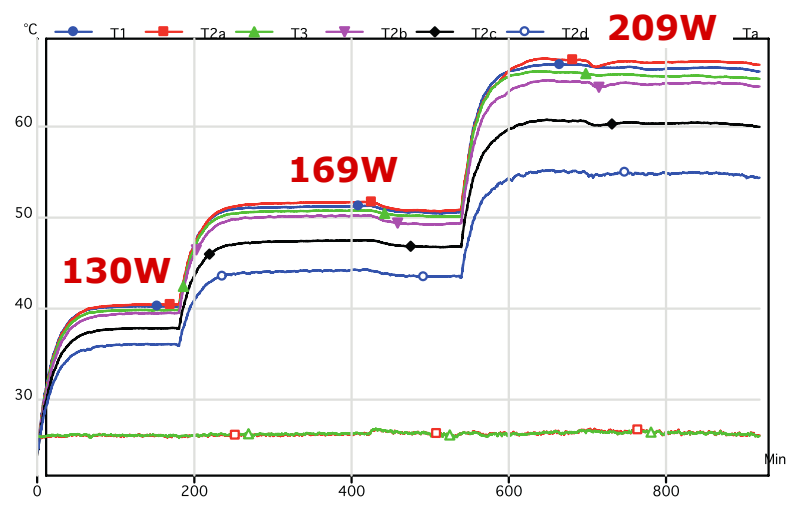
With this new understanding in the actual current levels used during testing, the results of the "34.2W" test are of relevance to the work in P802.3bt.

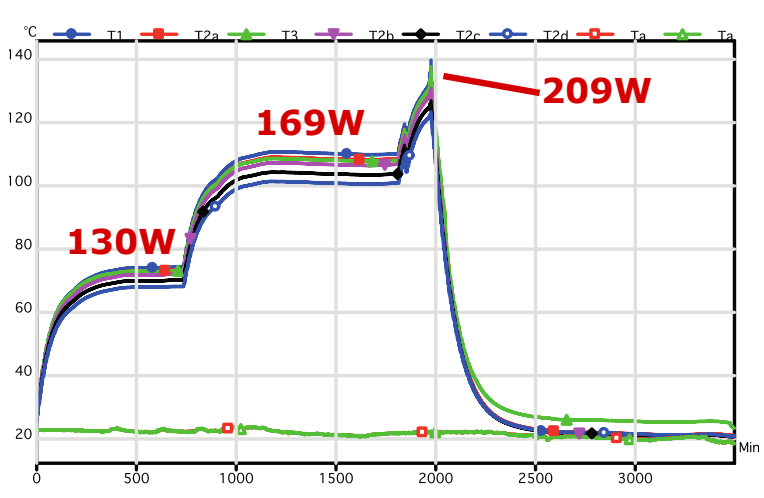
For Type 3 (up to 60W at 50V), the maximum conductor current is 300mA, compared with 652mA in the "34.2W" test, We can expect to dissipate a factor $0.652^2/0.300^2$=4.7x less power in the cable.

For Type 4 (up to 99.9W at 52V), the maximum conductor current is 480mA, compared with 652mA in the "34.2W" test. We can expect to dissipate a factor $0.652^2/0.480^2$=1.84x less power in the cable.

Results with CAT5e UTP (see page 2)
Open air PAGE 2

Results with CAT5e UTP (see page 3)
Insulated PAGE 3





Above are the temperature graphs for CAT5e cable (see details on page 2 and 3), annotated with the "PoE Equivalent" source powers.
What we learn from this is that at current levels significantly higher than what the IEEE P802.3bt task force is considering, this 37 cable bundle, with all conductors powered, reaches 40 degree C in open air and reaches 74 degree C when isolated with 28mm x 25mm foam isolation.

Conclusion

This white paper contains a number of interesting experiments on the effect of cable heating at high currents. It explores both 'free air' and isolated cable bundles of 37 cables and tests a number of different cables.

The paper reaches the conclusion that Power over Ethernet leads to excessive temperatures in cable bundles. The paper refers to PoE, but clearly intents to point to the IEEE 802.3 DTE Power via MDI.
Unfortunately the conclusion is based on a misconception on how Power over Ethernet works and a such incorrect test currents have been used. Even the lowest test current is significantly higher than highest current onder consideration by the P802.3bt task force.

What we can learn from the testing is that actually, even under extreme circumstances, Type 4 power levels (=99.9W over 8 conductors) will not lead to unsafe conditions, nor cable failure.
More work is needed to come to guidelines on what the appropriate number of cables in a bundle is for Type 4 power levels to ensure data integrity.

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