Remote Powering

Impact on Cabling Infrastructure

LEVITON

Remote Power

- The recently ratified IEEE 802.3bt enables many more devices to converge onto the Telecommunications cabling infrastructure, receiving both Power and Data on the same cable.

Desktop Computers

Video Conferencing

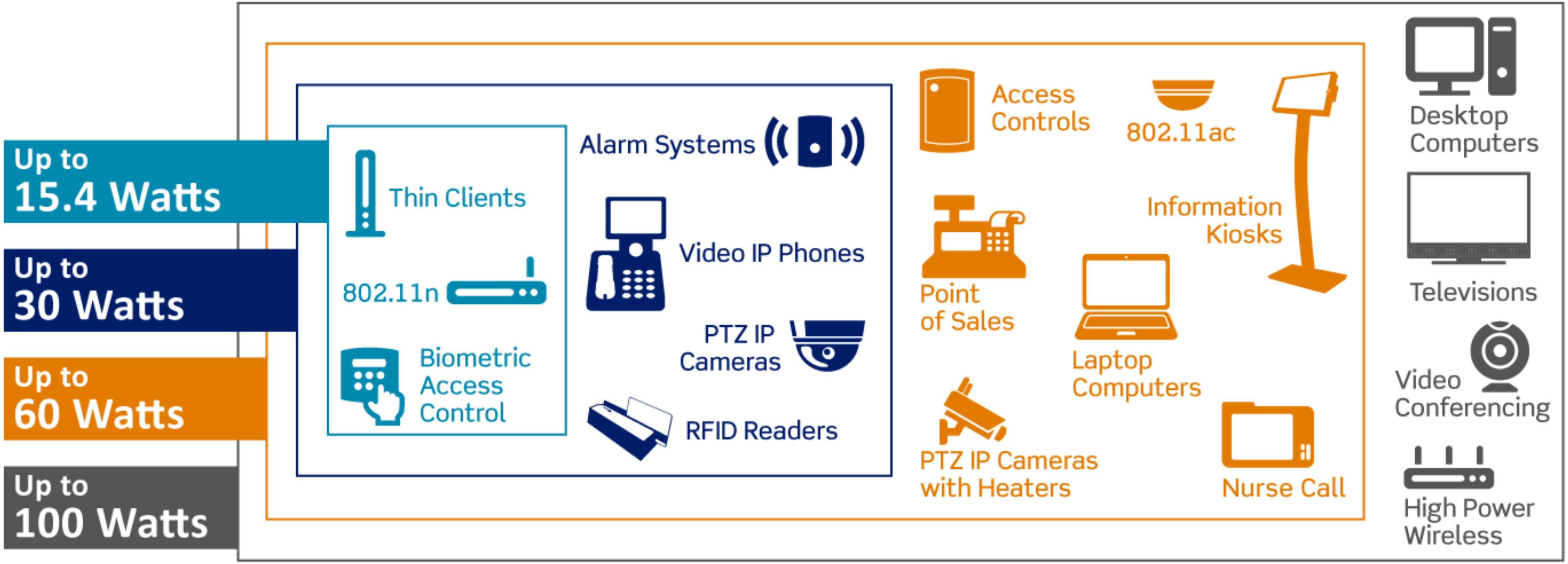
Televisions

High Power Wireless

EST 2018: IEEE 802.3BT (TYPE 4)

Up to 100 Watts: 4-Pair Remote Powering

Applications
Why we need more power



Remote Powering Development

2 pairs:

- 13W (PoE) (802.3at Type 1) 175mA = per Conductor
- 25W (PoE+) (802.3at Type 2) 300mA

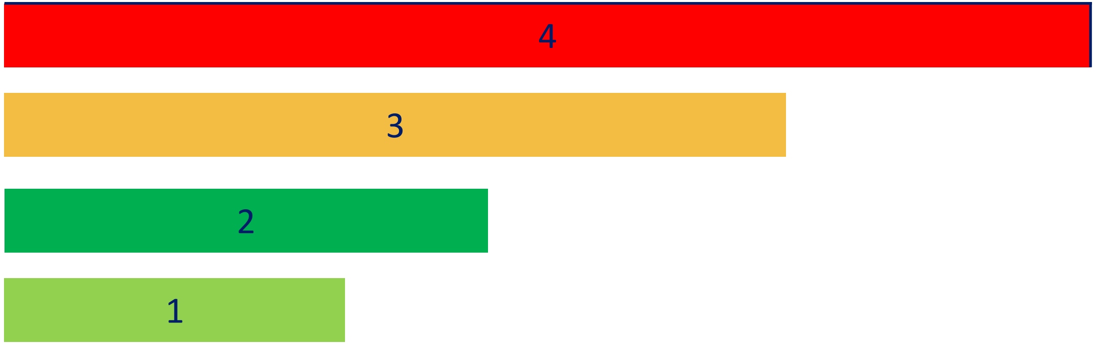
4 pairs:

- 60W UPoE (Cisco) 300mA
- 60W (PoE++) (802.3bt Type 3) 300mA
- 100W HDBase-T (PoH) 450mA
- 100W (PoE) (802.3bt Type 4) 450mA = 900mA per Pair

Remote Powering Development

BSEN 50174

Type



Class	1	2	3	4	5	6	7	8
Maximum power input to a cable by power supply equipment	4W	7W	15W POE	30W POE +	45W	60W POE ++	75W	90W (100W)
Number of remote powering pairs	2				4			

Standards Application Classes

Class D (defined up to 100Mhz)			
Class E_A (defined up to 500Mhz)			
Ethernet 2.5GBASE-T	ISO/IEC/IEEE 8802- 3:2017/AMD 7, Clause 126 [a]	2017	2,5 Gigabit Ethernet over twisted Pairs IEEE 802.3bz
Ethernet 5GBASE-T	ISO/IEC/IEEE 8802- 3:2017/AMD 7, Clause 126 [a]	2017	5 Gigabit Ethernet over twisted Pairs IEEE 802.3bz
Ethernet 10GBASE-T	ISO/IEC/IEEE 8802-3, Clause 55 [a]	2017	10 Gigabit Ethernet over twisted pairs
Fibre Channel 2Gb/s	INCITS 435	2007	Twisted pair Fibre Channel 2G-FCBASE-T
Fibre Channel 4Gb/s	INCITS 435	2007	Twisted pair Fibre Channel 4G-FCBASE-T
Multimedia distribution	IEEE 1911.2 (withdrawn)	2015	HDBase-T

Concerns

- The main concerns with the delivery of power over data cables are:
  - Increased temperature of the cables which means reduced channel performance as Insertion Loss is increased
  - Cables exceeding their maximum operating temperature
    - Standards use 60°C
  - Damage to contacts caused where mating and de-mating occurs while the power supply current is flowing
    - Optional IEC test exists

EN 50174-2 Temperature Increase

- From the table below, extracted from EN 50174-2, you can see the temperature increase with all pairs type 4 energised and the increasing volume of cables on Ventilated Basket

	Installation Condition E/F – Ventilated								
	No. of cables *N*	6	12	24	48	72	96	144	216
Cable R & D	ΔT °C								
0.095 Ω/m 0.005m	$\approx \left(0{,}8 \times N + \frac{0{,}0578 \times \sqrt{N}}{D}\right) \times R$	3.0	5.0	7.0	11.0	15.0	18.0	24.0	32.5
0.075 Ω/m 0.007m		2.0	3.0	4.5	7.0	9.5	12.0	16.0	22.0
0.065 Ω/m 0.0077m		1.5	2.5	4.0	6.0	8.0	10.0	13.5	18.5

- It also shows the reduced temperature increase with larger cables

EN 50174-2 Temperature Increase

- From the table below, extracted from EN 50174-2, you can see the temperature increase with all pairs type 4 energised and the increasing volume of cables on open tray

	Installation Condition C – Open perforated tray								
	No. of cables *N*	6	12	24	48	72	96	144	216
Cable R & D	ΔT °C								
0.095 Ω/m 0.005m	$\approx \left(0{,}8 \times N + \frac{0{,}0772 \times \sqrt{N}}{D}\right) \times R$	4.0	6.0	9.0	14.0	18.0	21.5	28.5	38.0
0.075 Ω/m 0.007m		2.5	3.5	5.5	8.5	11.5	14.0	18.5	25.0
0.065 Ω/m 0.0077m		2.0	3.0	4.5	7.0	9.5	11.5	15.5	21.0

- It also shows the reduced temperature increase with larger cables

EN 50174-2 Temperature Increase

- From the table below, extracted from EN 50174-2 you can see the temperature increase with all pairs type 4 energised and the increasing volume of cables in Conduit & Trunking

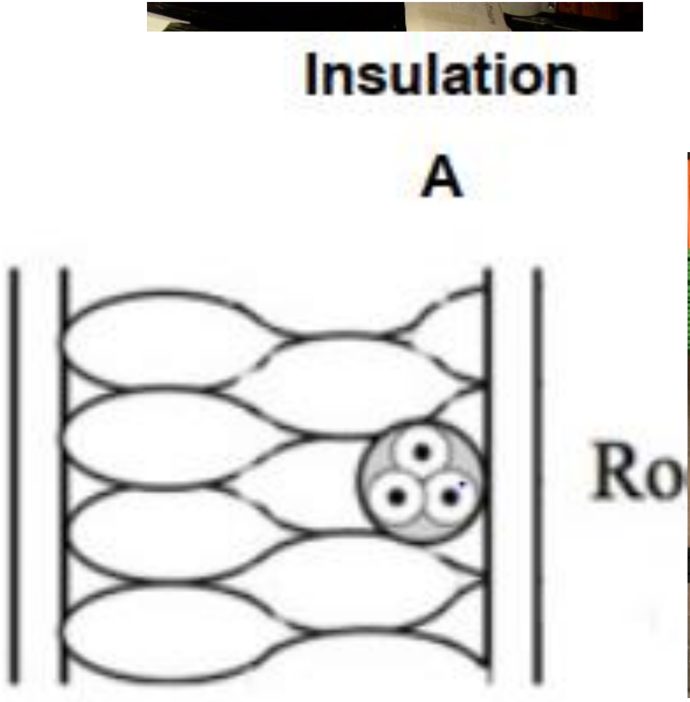
	Installation Condition B – Conduit/Trunking								
	No. of cables *N*	6	12	24	48	72	96	144	216
Cable R & D	ΔT °C								
0.095 Ω/m 0.005m	$\approx \left(0{,}8 \times N + \frac{0{,}12 \times \sqrt{N}}{D}\right) \times R$	6.0	9.0	13.0	19.5	25.0	29.5	38.0	**
0.075 Ω/m 0.007m		3.5	5.0	7.5	12.0	15.0	18.5	24.0	32.0
0.065 Ω/m 0.0077m		2.8	4.0	6.0	9.5	12.5	15.0	19.5	26.0

EN 50174-2 Temperature Increase

- From the table below, extracted from EN 50174-2 you can see the massive temperature increase with all pairs type 4 energised and the increasing volume of cables in insulation

	Installation Condition A – Insulation								
	No. of cables *N*	6	12	24	48	72	96	144	216
Cable R & D	ΔT °C								
0.095 Ω/m 0.005m	$\approx \left(0{,}8 \times N + \frac{0{,}27 \times \sqrt{N}}{D}\right) \times R$	13.0	18.5	27.0	39.0	**	**	**	**
0.075 Ω/m 0.007m		7.5	10.5	15.5	23.5	29	34.0	**	**
0.065 Ω/m 0.0077m		6.0	8.5	12.5	18.5	23.0	27.5	35.0	**
Note ** indicated a temperature in excess of 60°C (assuming an ambient of 20°C) which represents unacceptable localized heating									

Insulation



Importance of Ambient Temperature

- It is a general, industry wide, acceptance that the copper channels for Classes D, E, E_A, F & F_A is 100m.
  - There has always been a dependency that the ambient temperature is not greater than 20°C.

- The impact of elevated temperatures leads to a reduced length channel
  - Screened cables cope with elevated temperatures better than unscreened, requiring the link distance to be reduced by the factors below
    - 0.2 % per °C for balanced screened cables up to 60 °C:
    - 0.4 % per °C for unscreened balanced cables up to 40 °C:
    - 0.6 % per °C for unscreened balanced cables between 40 °C and 60 °C

Channel length vs Temperature

	Total length of cords m		
	10	15	20
T_{global} °C	Channel Length m		
20	100	98	95
25	98	96	93
30	97	94	91
35	95	92	89
40	93	90	87
45	90	87	85
50	86	84	82
55	83	81	79
60	80	78	76

Note The channel length values assume the use of cords with an attenuation premium of 50% and an overall temperature coefficient of 0.4% per °C up to 40 °C and 0.6% per °C between 40 & 60 °C

Design criteria

If the reduced channel lengths are acceptable in term of the physical characteristics of the building then no further action is required.

If the reduced channel lengths are incompatible with the physical characteristics of the building then either:

a) a reduction of the specified $i_{c\text{-}average}$ shall be considered;
or

b) a series of possible mitigations shall be considered to lower induced temperature rise in order to support the specified $i_{c\text{-}average}$ including:

1. employ smaller bundles with separation to reduce induced temperature further
2. cables with lower *R* and/or higher *D*
3. changes to the installation environment
4. reduction in ambient Temperature

Controls

- Because of the impact elevated temperatures could have on the functionality of the system there are standards based controls that need to be implemented.

  - EN 50174-1 Requires that the “Remote Powering” objectives be defined as part of the Technical Specification

- It is worth noting that at the typical time of installation, during building construction, the buildings ambient temperature is not normalized and no circuits would be “Live” so advanced planning is required.

EN 50174
Remote Powering Definitions

- Design criteria defined for Remote Powering Objectives
  - Category RP1: attachment of the remote powering equipment at a distributor is controlled such that the average current for all conductors *served by the distributor* ($i_{c\text{-average}}$) is not greater than 212 mA.
  - Category RP2: attachment of the remote powering equipment at a distributor is controlled such that the average current for all conductors *served by the distributor* ($i_{c\text{-average}}$) is restricted to a specified value between 212 mA and 500 mA;
  - Category RP3: attachment of the remote powering equipment at a *distributor* is unrestricted subject to the limit of $i_c \leq 500$ mA.
- RP 3 is a universal approach
  - which requires planning and installation practices of EN 50174-2 which avoid the administration associated with controlling current loads applied to the cables at distributors.

EN 50174
Infrastructure Controls

- Remote Powering cabling installation Categories and Controls

Category	$I_{c\ average}$	I_c	Controls required during: Attachment of remote powering equipment	Planning of subsequent cabling installation
RP1	≤ 212mA	≤ 500mA	Yes	Yes
RP2	> 212 mA < 500 mA	≤ 500mA	Yes	Yes
RP3	-	≤ 500mA	No	Yes

Additional Complexity

- $i_{c\text{-}average}$ is not a simple average it is calculated as;

$$i_{c-average} = \sqrt{\frac{\sum_{n=1}^{N} i_{c_n}^2}{N}}$$

- Where
  - *n* is the index of conductors (including those that carry no current)
  - *N* is the total number of conductors (including those that carry no current)
  - i_{c_n} is the current in conductor with index *n* (A)

Installation Practices

- EN 50174 defines the installation requirements;
  - Maximum stacking height (150mm on flat surface)
  - Maximum bundle size (24)

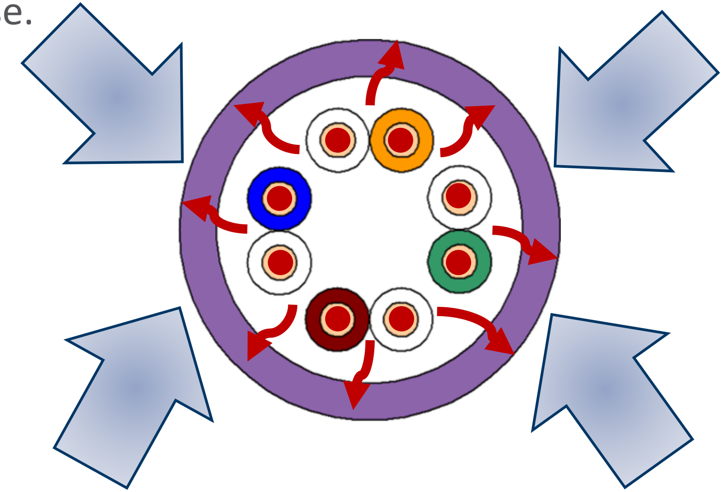
  - Does not define if cables to be Loomed (Bundled) or Loose Laid
    - Loose Lay is common on main cable pathways
      - Large installations often loomed throughout

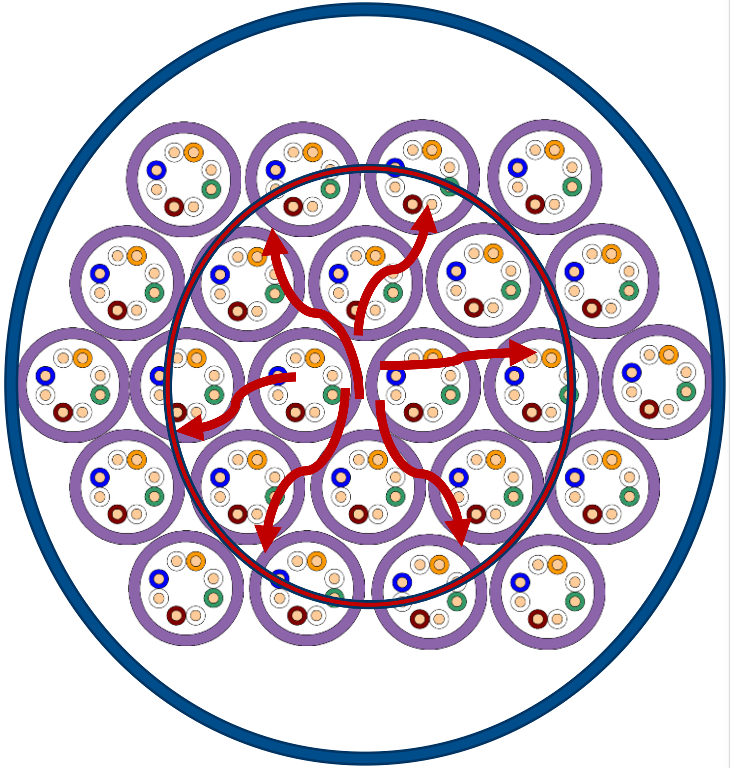
    - Always loomed in cabinets?

    - Typically loomed until cables leave telecommunication room

Mitigation

- cable bundles are generally round which has the lowest possible surface area for a given cross-sectional area and the temperature rises in such bundles are considered to be worst case.

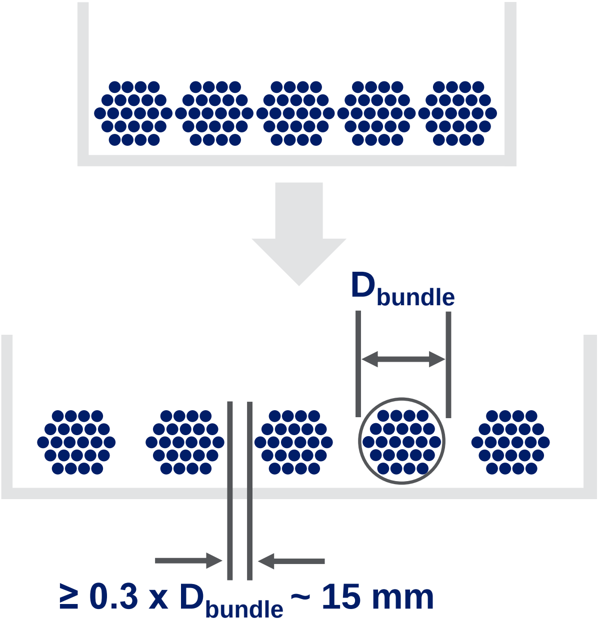




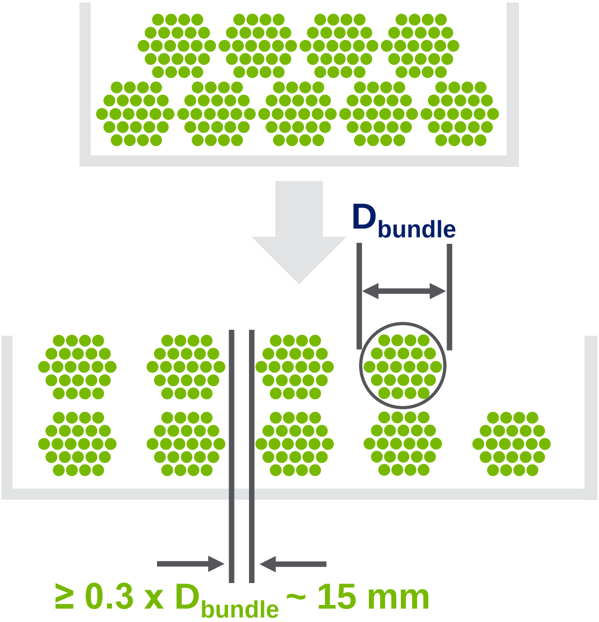
- It is required that cable bundles shall not contain more than 24 cables.

EN 50174-2
Mitigation Techniques Cable separation

Single Row of Bundles



Multiple Rows of Bundles

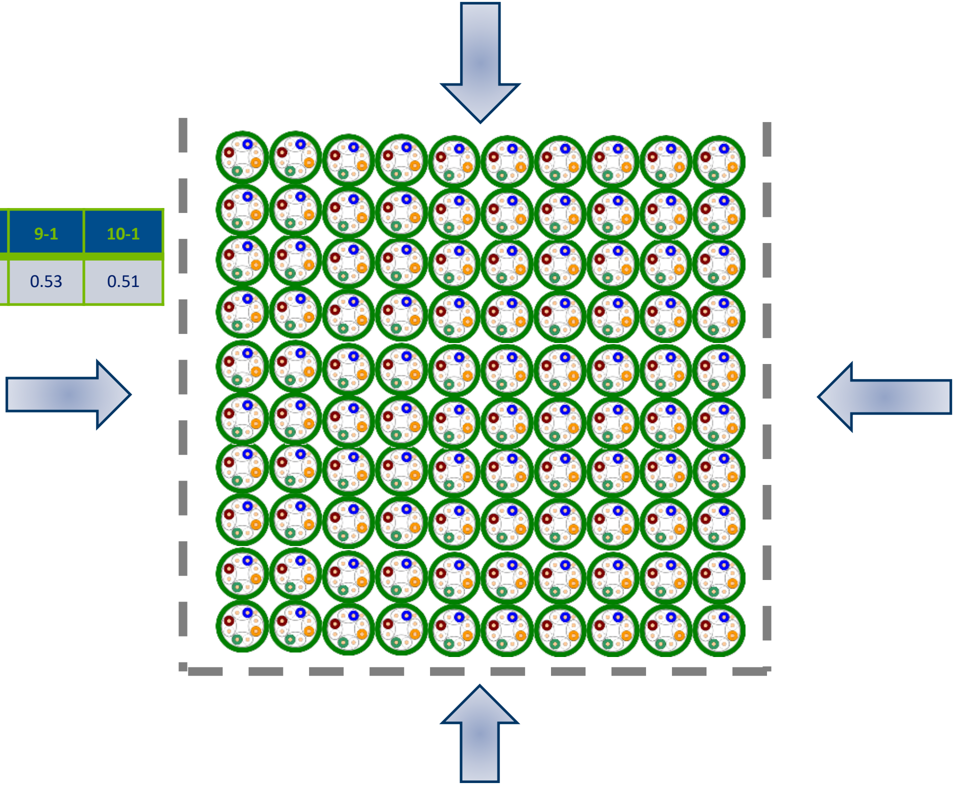


Reduction Factors for rectangular cable groups

- It is recognised that installation conditions C (tray) and E/F (basket) can contain many more than 24 cables in close proximity.

Width to height ratio of cable group	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1	10-1
ΔT multiplier	0.89	0.84	0.77	0.71	0.66	0.62	0.59	0.56	0.53	0.51

- For groups with ratios of width:height > 1, the larger surface area of such groups of cables with a rectangular cross-section will result in a reduced thermal impact. Where such cable groups are planned then the values of ΔT for the relevant *N* of previous tables should be multiplied by the relevant factor shown in Table above



Mitigation for Loose Lay

	Installation Condition E/F – Ventilated								
	No. of cables *N*	6	12	24	48	72	96	144	216
Cable R & D	ΔT °C								
0.095 Ω/m 0.005m		3.0	5.0	7.0	11.0	15.0	18.0	24.0	32.5
0.075 Ω/m 0.007m		2.0	3.0	4.5	7.0	9.5	12.0	16.0	22.0
0.065 Ω/m 0.0077m		1.5	2.5	4.0	6.0	8.0	10.0	13.5	18.5

Width to height ratio of cable group	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1	10-1
ΔT multiplier	0.89	0.84	0.77	0.71	0.66	0.62	0.59	0.56	0.53	0.51

No of cables	*ΔT* °C increase	ΔT multiplier	*Revised ΔT* °C
144	16	0.66	10.6

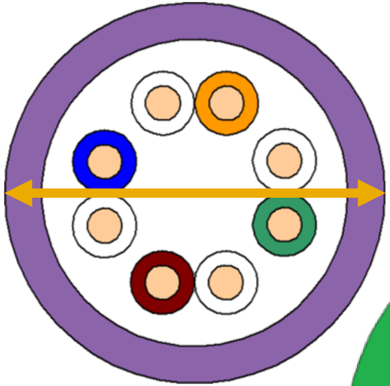
Revised Cable Length Reduction

- Channel was at 36°C = 94m approx
- Now at 31 °C = 96m approx

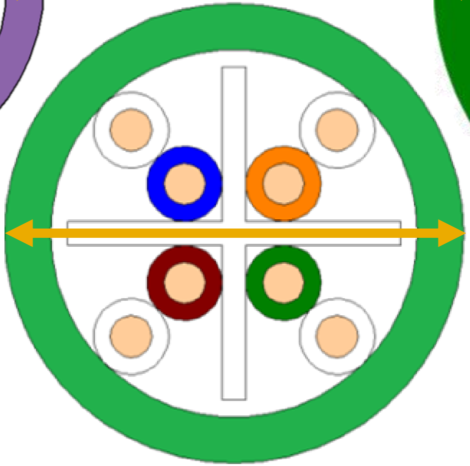
	Total length of cords m		
	10	15	20
T_{global} °C	Channel Length m		
20	100	98	95
25	98	96	93
30	97	94	91
35	95	92	89
40	93	90	87
45	90	87	85
50	86	84	82
55	83	81	79
60	80	78	76

Note The channel length values assume the use of cords with an attenuation premium of 50% and an overall temperature coefficient of 0.4% per °C up to 40 °C and 0.6% per °C between 40 & 60 °C

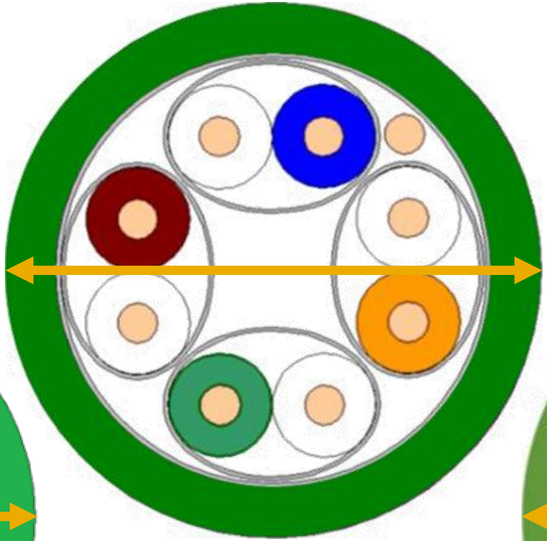
Cable characteristics for mitigation



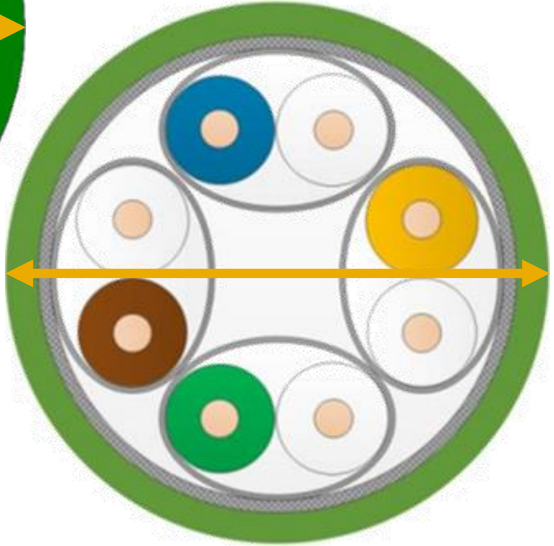
Category 5e
U/UTP
Ø 5.05
Ω/m 0.09



Category 6
U/UTP
Ø 6.1
Ω/m 0.07



Category 6A
F/FTP
Ø 7.0
Ω/m 0.07



Category 7A
S/FTP
Ø 7.2
Ω/m 0.06

The largest influence

Cable Type	AWG	Core Size mm	Standards DC Loop Resistance	Typical DC Loop Resistance	Resistance Ω / m	Improvement over 5e
Category 5e U/UTP	24	0.511	19	18	0.09	0
Category 6 U/UTP	23	0.573	19	14	0.07	22%
Category 6A F/FTP	23	0.573	19	14	0.07	22%
Category 7A S/FTP	22	0.644	19	12	0.06	33%

Cable Type	Cable OD mm	Circumference mm	24 Cables Circumference mm	Improvement over 5e
Category 5e U/UTP	5.05	7.93	89	0
Category 6 U/UTP	6.1	9.58	107.5	21%
Category 6A F/FTP	7.1	11.15	125.13	41%
Category 7A S/FTP	7.2	11.31	126.9	43%

LEVITON

Power Over Ethernet

What Leviton are doing

Leviton Atlas-X1™ System 90 Watt (PoE) Ready

- Tested to deliver 100 watts of power
  - IEEE 4-Pair Remote Powering
- Supports next-generation powered devices
- Complete end-to-end 100W RP-tested system:
  - Cable
  - Patch Cords
  - Patch Panels
  - Connectors

Desktop Computers

Televisions

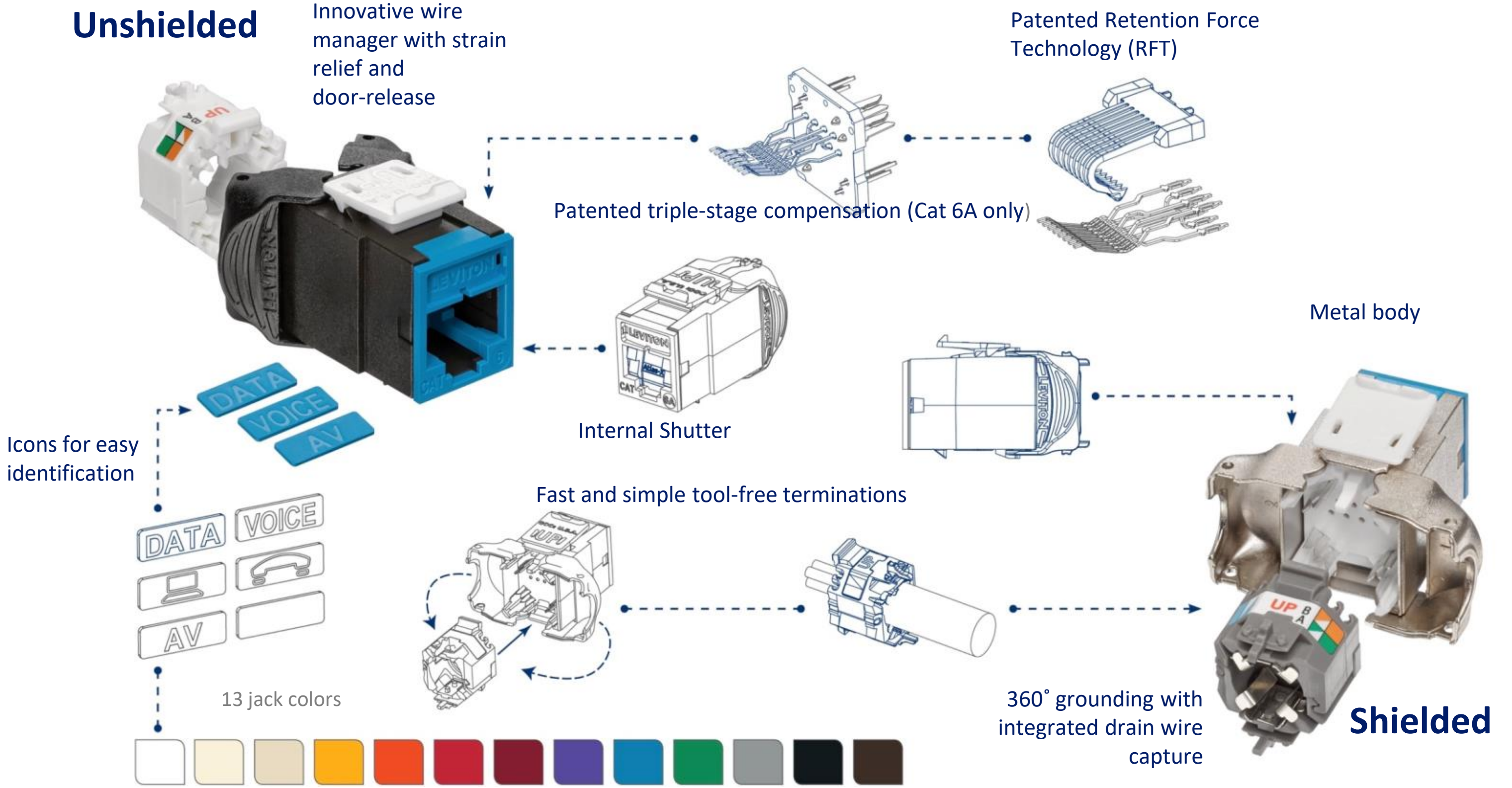
Video Conferencing

High Power Wireless

EST 2018: IEEE 802.3BT (TYPE 4)
Up to 100 Watts: 4-Pair RP

LEVITON

Atlas-X1™ Jack Overview



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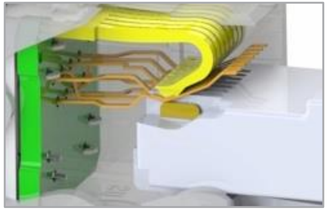
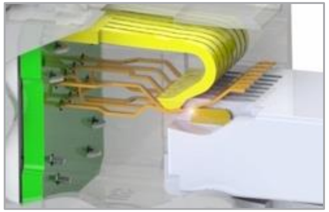
Digital Building Cabling Considerations

Atlas-X1™ Jacks have Patented RFT

- RFT – Unique polymer spring
  - Supports connector tines
  - Increases resistance to strain, damage
  - Helps tines return to their pre-stress position



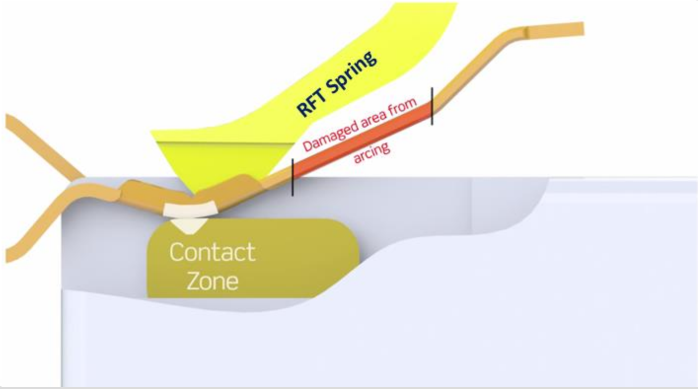
Plug fully engaged in connector



Plug at point of disconnect

- Additional layer of protection against arcing damage
  - Constant contact force
  - Prevents inadvertent intermittent disconnects
  - Extends connector life
  - Prevents tine damage
  - Saves on costly repairs

Industry's Only



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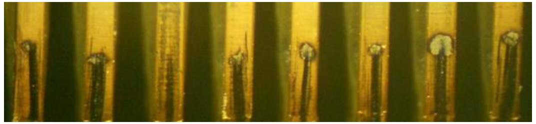
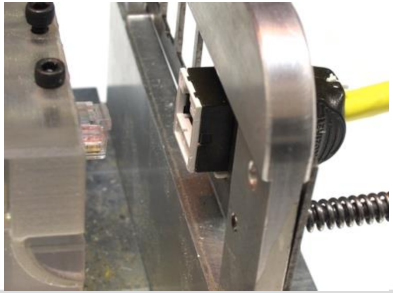
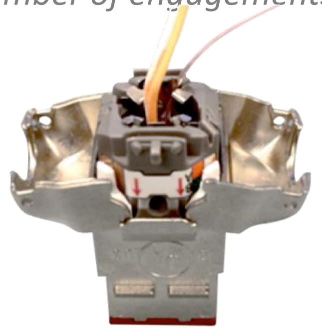
IEC 60512 Compliant

- Atlas-X1™ Connectors are Leviton lab tested and compliant to the IEC 60512-5-2 connectors for electronic equipment standard
  - *Details a standard test method to assess the current-carrying capacity of electromechanical components (essentially connectors) at elevated ambient temperature*

- Atlas-X1™ Connectors are Leviton lab tested and compliant to the IEC 60512-99-001 connectors for electronic equipment standard
  - *test schedule to determine the ability of connectors to withstand a minimal number of engagements and separations when an electrical current is being passed through the connector*





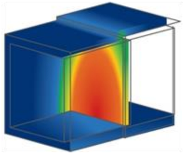


Digital Building Cabling Considerations

Remote Powering – Jack Temperature

- Temperature rise can also impact jack
- Shielded jacks have a metal body, helps dissipate the heat
- UTP jacks typically have a plastic body
- Leviton’s Atlas-X1™ UTP jack features a solid metal body
    - Dissipates heat **53% more efficiently**

Heat Dissipation

Atlas-X1 UTP Connector with Metal Body	Typical Plastic Connector
	
53% improved over plastic connectors	Plastic Runs Much Warmer

Wide Range of CPR cables in 6A higher temp

U/UTP
75°C

U/FTP
75°C

F/FTP
75°C

S/FTP
75°C

Questions

The Industry's Best Service & Support

Committed To Our Customers & the Environment

Outstanding Return On Infrastructure Investment

A Culture of Ingenuity & Innovation

Quality & Performance in every Solution

LEVITON®