

# REMOTE POWERING over “structured” cabling

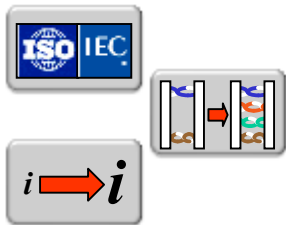
A review of European standardization activities

Mike Gilmore  
e-Ready Building Limited

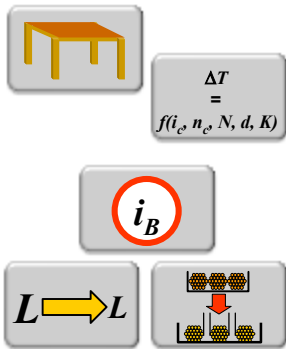
# Mike Gilmore

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



### Next steps



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e-Ready Building Limited

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## Standards Activities



**Member**  
JTC1 SC25 WG3: "Generic Cabling"



**Leader**

WG3 Cabling Implementation Task Group: ISO/IEC 14763-2

**Meeting Secretary**

WG3 Automated Infrastructure Management Ad-hoc: ISO/IEC 18598



**Chairman - Elect**

TC215:



Electrotechnical Aspects of Telecommunication Equipment

**Convenor**

TC215 WG1: Cabling design

**Meeting Secretary**

TC215 WG2: Cabling installation - QA and installation practices

**Member**

TC215 WG3: Facilities and infrastructures (data centres)

**Member**

CEN/CLC/ETSI CG Green Data Centres



**Past-Chairman**

TCT7: Telecommunications - Installation Requirements



**Chairman**

TCT7/1: Cabling: Infrastructure design, planning and commissioning

**Meeting Secretary**

TCT7/2: Cabling; Installation and UK implementation

TCT7/3: Facilities and infrastructures

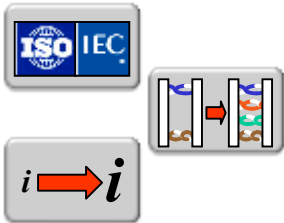
Fibreoptic Industry Association  
[www.fia-online.co.uk](http://www.fia-online.co.uk)

Director  
**standards@fia**

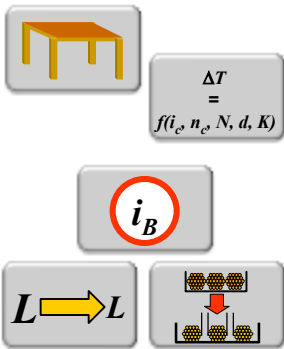
# Common Infrastructure

## Introduction

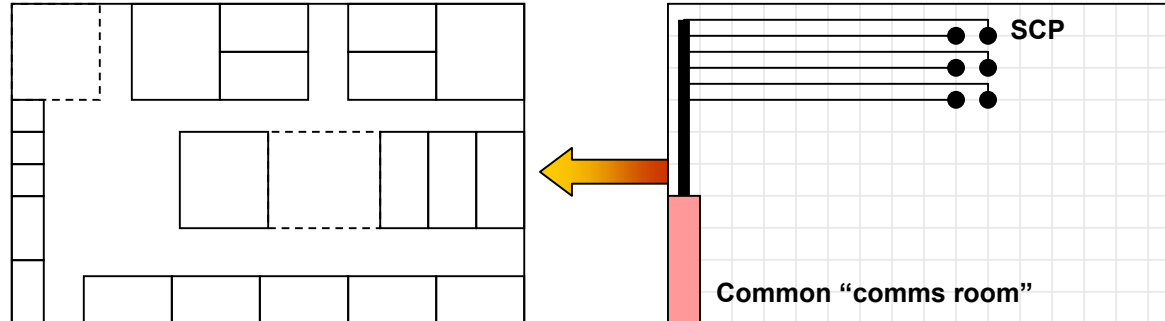
### Remote powering overview



### CLC TR 50174-99-1



### Next steps



SCP = Service Concentration Point

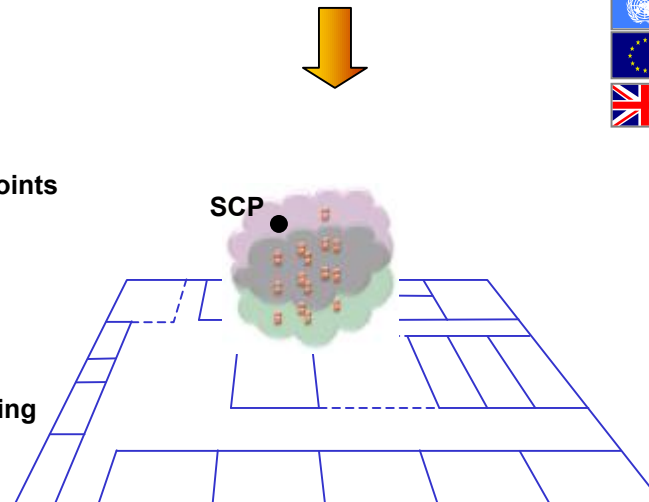


Future ISO/IEC 11801-6

CLC EN 50173-6

BS EN 50173-6

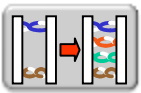
- Fixed IT
- Mobile IT: Wireless access points
- Mobile telephony: DAS/MAP
- Lighting
- HVAC sensors
- Local device powering
- Building sensing
- Door control
- Space and "footfall" monitoring
- Digital signage
- Clocks
- Surveillance
- Alarms



# 802.3at:2009 Type 2

## Introduction

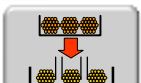
### Remote powering overview



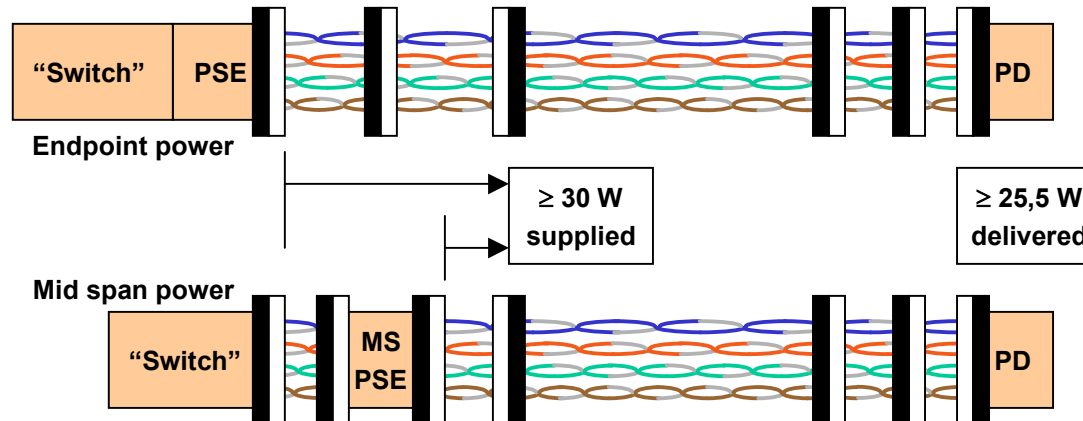
### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps

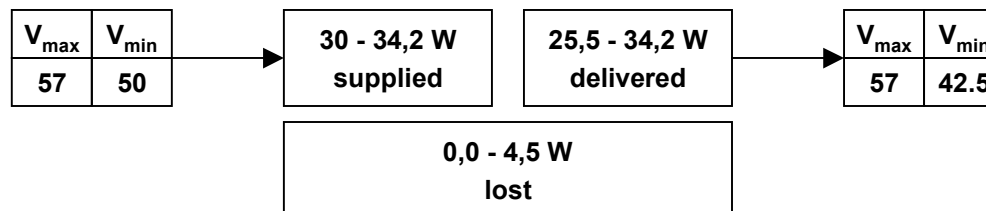


10/100BASE-T  
or  
1000BASE-T  
which supports  
10/100BASE-T

2-pair  
powering

$$i_c = 300 \text{ mA (per conductor)}$$

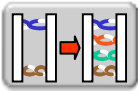
$$R = 12,5 \, \Omega \text{ Category 5/Class D cabling}$$



# ISO/IEC 29125:2010

## Introduction

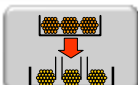
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps



ISO/IEC TR 29125

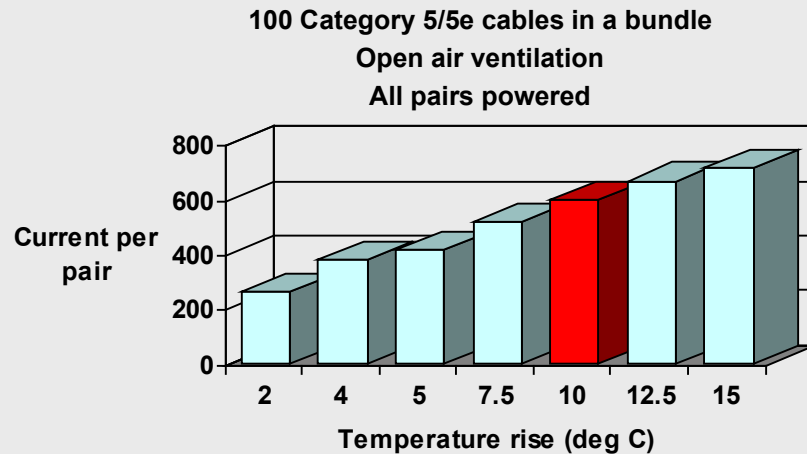
Information technology - Telecommunications cabling guidelines for remote powering of terminal equipment



ANSI/TIA-TSB-184

Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling

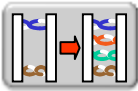
Based on information from ISO/IEC (TR 29125) and TIA (TIA-TSB-184)



# Installation Conditions

## Introduction

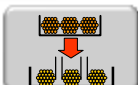
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



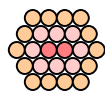
### Next steps



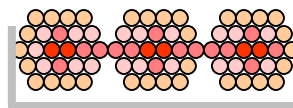
Typical bundle size is 24 cables

... but installation conditions will affect thermal impact

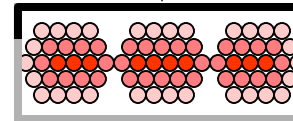
Fully ventilated



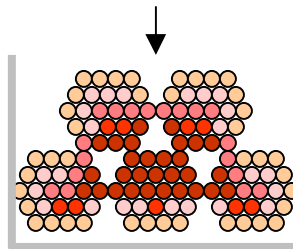
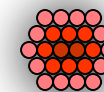
Partially ventilated



Unventilated



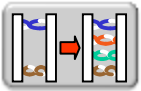
Insulated



# 802.3 Developments

## Introduction

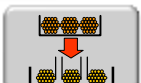
### Remote powering overview



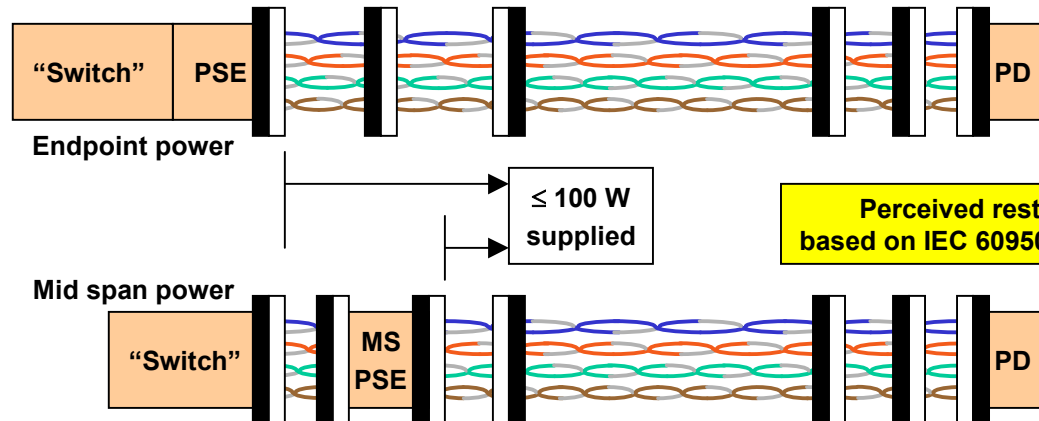
### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps

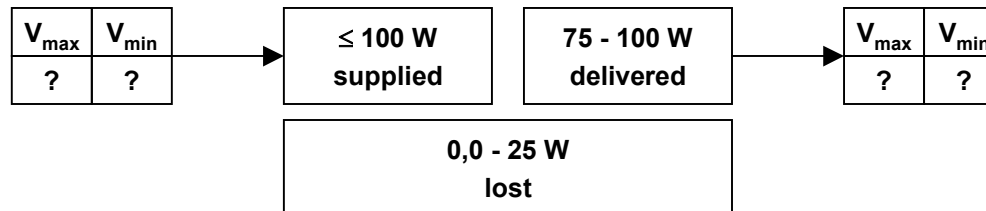


Perceived restriction 100 W input based on IEC 60950 "Access network" text

4-pair powering

$$i_c = 500 \text{ mA (per conductor)}$$

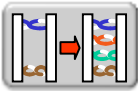
$R = 12,5 \Omega$  Category 5/Class D cabling



# Proprietary “PoE” Products

## Introduction

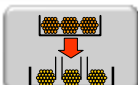
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps



## PRODUCTS OFFERING UP TO 100 W

2-pair  
powering

$$i_c = 848 \text{ mA (per conductor)}$$

$$R = 12,5 \, \Omega \text{ Category 5/Class D cabling}$$

## PRODUCTS OFFERING UP TO 232 W

4-pair  
powering

$$i_c = 1000 \text{ mA (per conductor)}$$

$$R = 12,5 \, \Omega \text{ Category 5/Class D cabling}$$

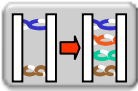
Perceived restriction  
100 W input  
based on US  
National Electrical  
Codes  
-  
but not elsewhere



# Thermal Impact

## Introduction

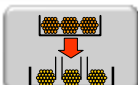
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps



## CHALLENGES FOR CABLING

### LOCALISED HEATING

$T > \text{Operating specification}$

### GLOBAL HEATING

Insertion loss increased

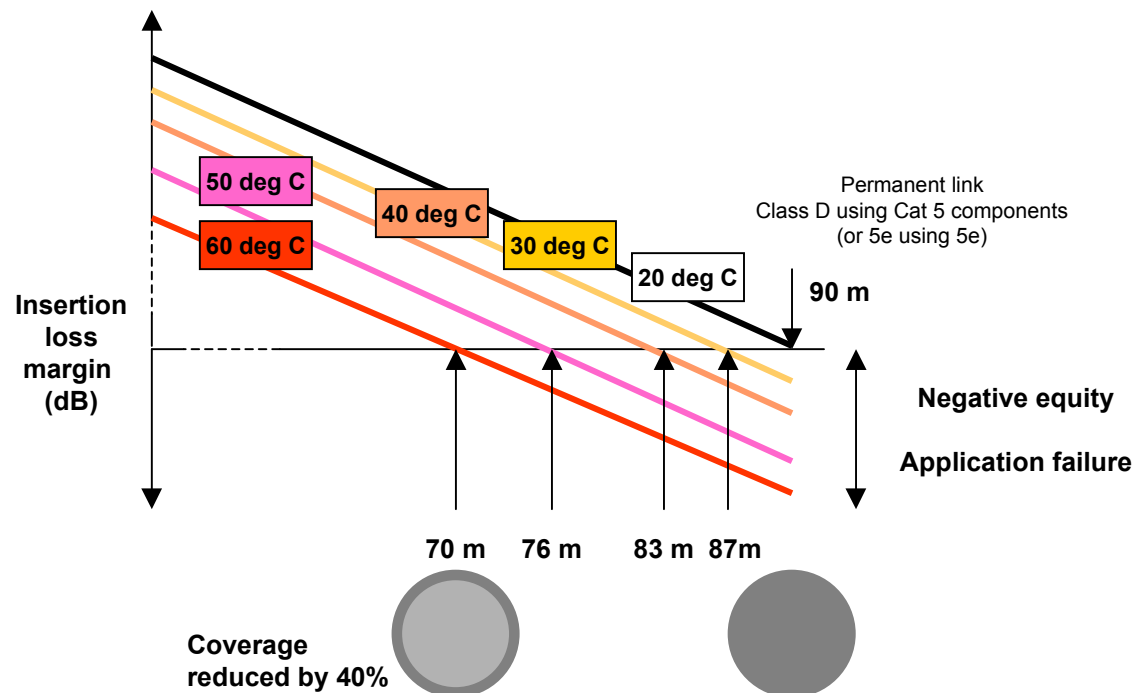
Transmission length reduced

### CONNECTOR PERFORMANCE

$i_c > \text{operating specification}$

All cable and cabling specifications are specified at 20 °C  
Maximum operating temperature is typically 60 °C

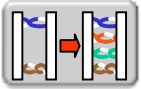
Current carrying capacity  
750 mA @ 60 °C



# CLC TR 50174-99-1:2015

## Introduction

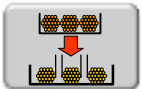
### Remote powering overview



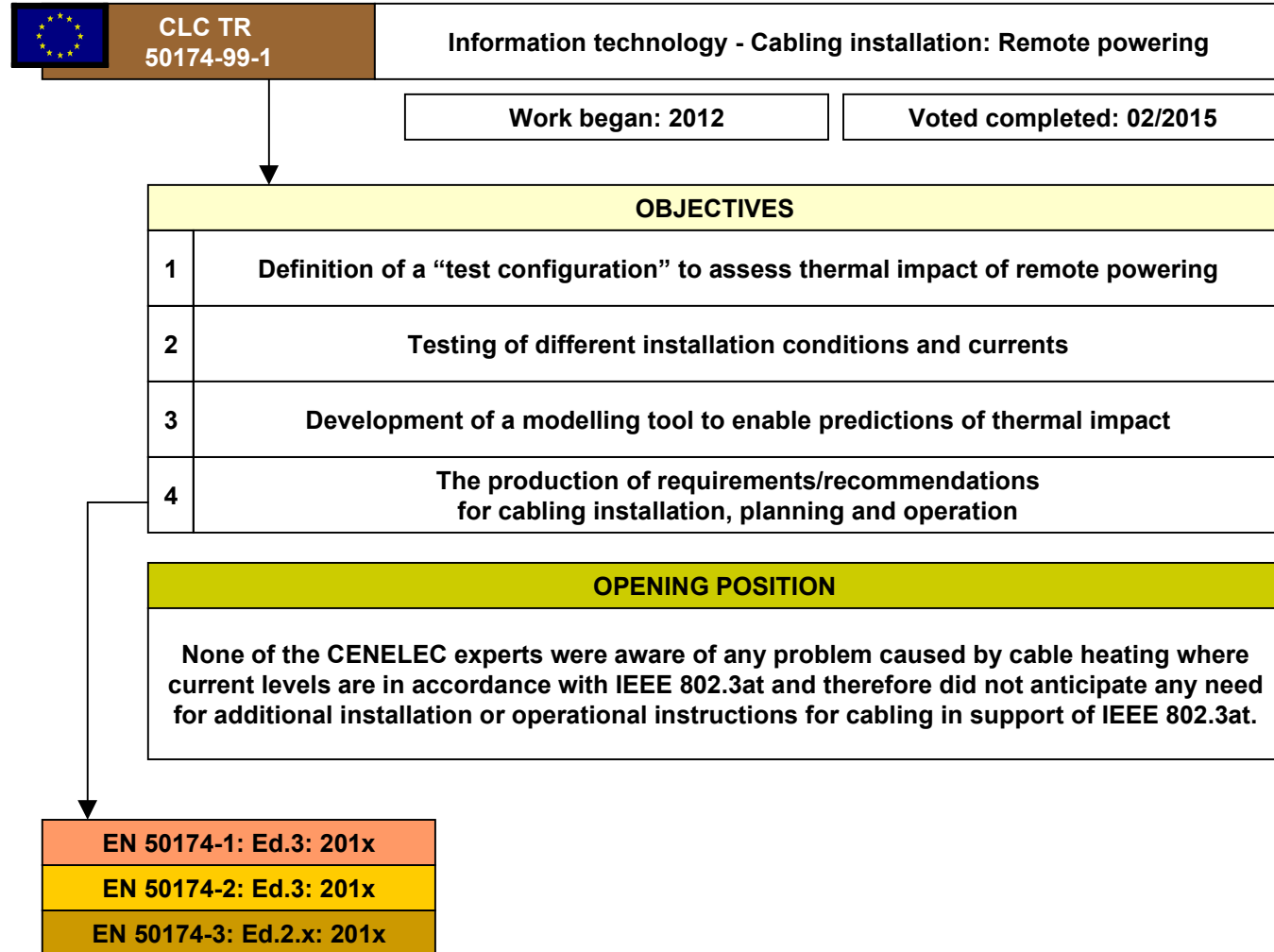
### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



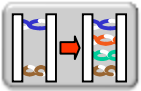
### Next steps



# CLC TR 50174-99-1 Test Bed

## Introduction

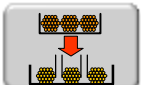
### Remote powering overview



### CLC TR 50174-99-1



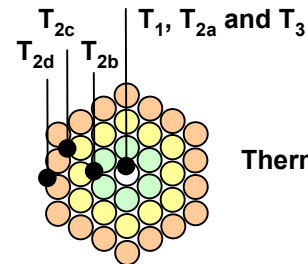
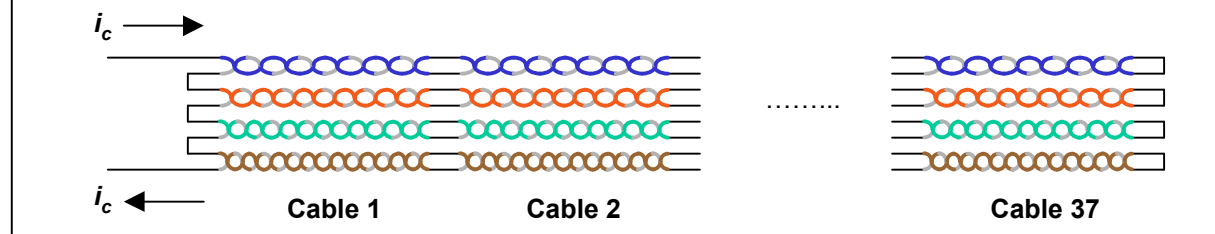
$$\Delta T = f(i_c, n_c, N, d, K)$$



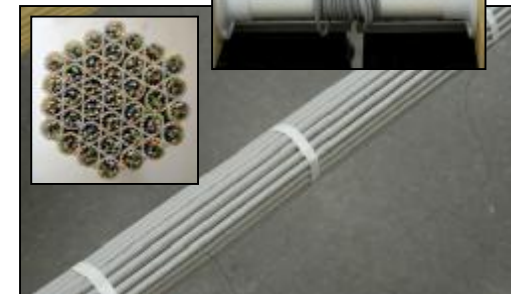
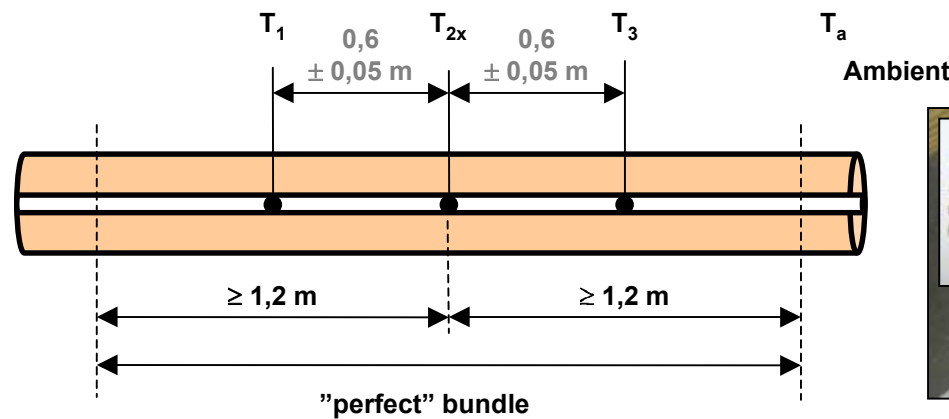
### Next steps



## CURRENT FEED USING 37 CABLE BUNDLE



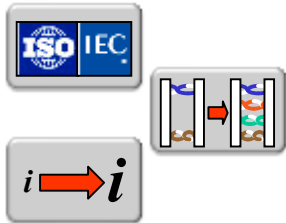
Thermocouples



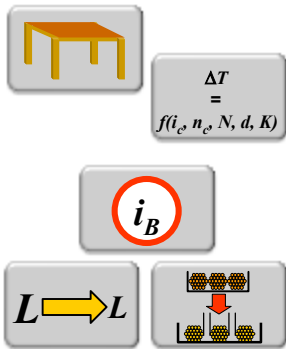
# CLC TR 50174-99-1 Test Bundle

## Introduction

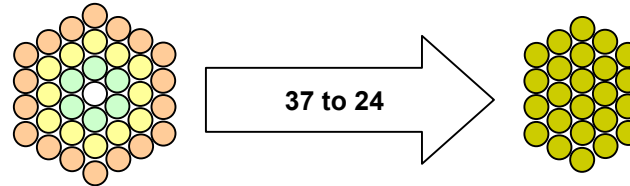
### Remote powering overview



### CLC TR 50174-99-1



### Next steps



37 cable bundle  
represents  
Factor of Safety

### FULLY VENTILATED CONDITIONS

Outer cables @ ~ 80%  $\Delta T_{core}$

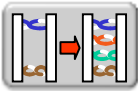
### FULLY INSULATED CONDITIONS

Outer cables @ > 90%  $\Delta T_{core}$

# Localised Conditions

## Introduction

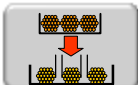
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$

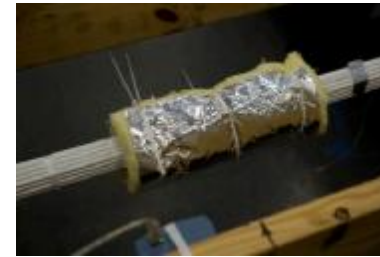
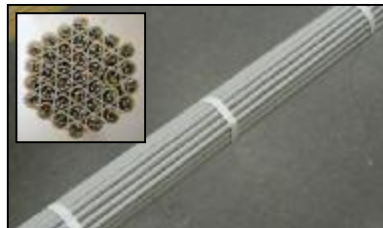


### Next steps



### Fully ventilated pathways

“Base” temperature rise



- fire barriers
- shorter insulated lengths
- limited temperature rises



- trunking/conduit
- lengths in excess of 2,5 m
- temperature rises increase x2

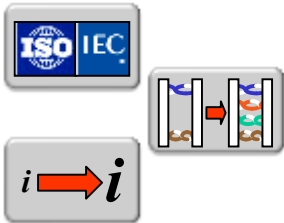


- insulated pathways
- lengths in excess of 2,5 m
- temperature rises increase x5

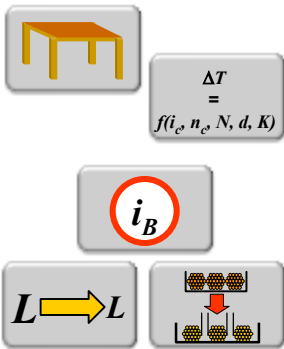
# Localised Conditions

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



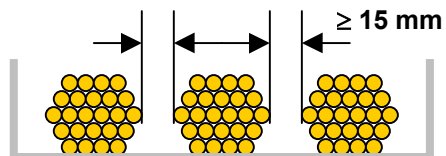
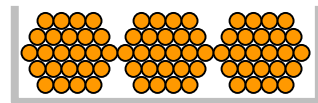
### Next steps



## VENTILATED PATHWAYS

- larger cross-sectional area

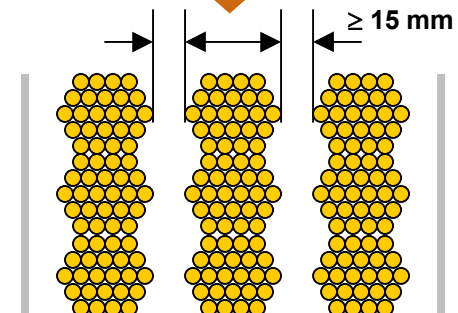
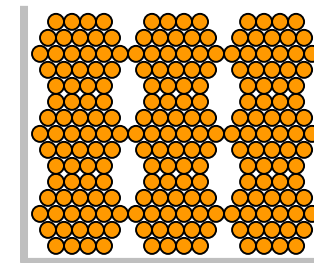
“Dense” single layer  $\approx$  conduit



“Spaced” single layer  $\approx$  separate bundles

Latest results by Arne Keller, Commscope

“Dense” multi-layers  $\approx$  insulation

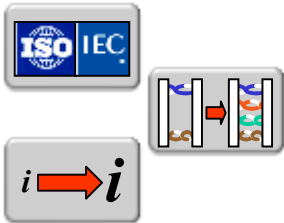


“Spaced” layers  $\approx$  separate bundles

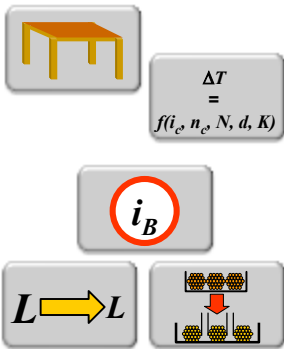
# CLC TR 50174-99-1 Model

## Introduction

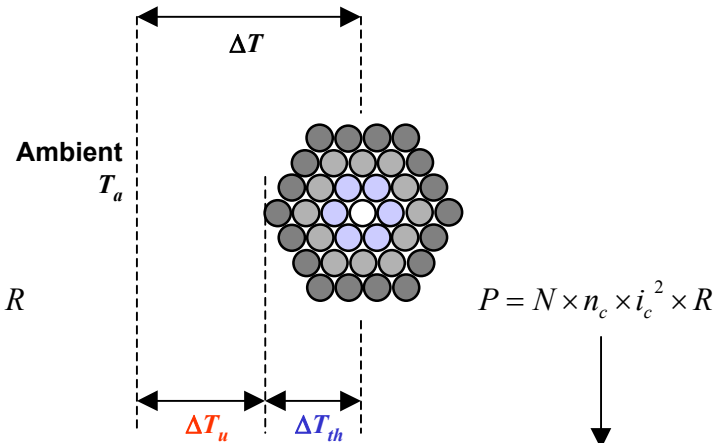
### Remote powering overview



### CLC TR 50174-99-1



### Next steps



$$P = N \times n_c \times i_c^2 \times R$$

$$P = N \times n_c \times i_c^2 \times R$$

$$\Delta T_u = \frac{\rho_u \times P}{\sqrt[4]{0,75 \times \pi^6 \times d \times \sqrt{N}}} \approx \frac{\rho_u \times P}{5,182 \times d \times \sqrt{N}}$$

$$\Delta T_{th} = \frac{\rho_{th} \times P}{4 \times \pi} \approx \frac{\rho_{th} \times P}{12,6 \times \pi}$$

#### Linear impact

- no. of conductors ( $n_c$ )
- d.c. resistance effects ( $\propto R$ )
- current per conductor ( $\propto i_c^2$ )

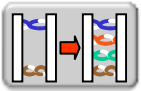
#### Non-linear impact

- no. of cables ( $N$ )
- cable diameter ( $d$ )
- cable type effects ( $\rho_{th}$ )
- installation environment ( $\rho_u$ )

# CLC TR 50174-99-1 Model

## Introduction

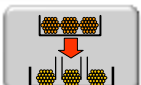
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps



### Cable bundle heating spreadsheet

13th October 2014

ONLY CHANGE THE FIGURES IN THE WHITE CELLS

Number of cables in bundle	37	p bundle	5
Number of loaded conductors	8	p ambient	0.15
Conductor resistance	0.075 ohms		
Cable diameter	0.0075 m		

### CLC TR 50174-99-1 MODEL

		Delta TOTAL	Delta Surface-Ambient	Delta Surface-Core
Load current per conductor	A			
	0.1	0.23	0.14	0.09
	0.15	0.52	0.32	0.20
	0.2	0.92	0.56	0.35
	0.25	1.43	0.88	0.55
	0.3	2.06	1.27	0.79
	0.35	2.81	1.73	1.08
	0.4	3.67	2.25	1.41
	0.45	4.64	2.85	1.79
	0.5	5.73	3.52	2.21
	0.6	8.25	5.07	3.18
	0.7	11.23	6.90	4.33
	0.9	18.56	11.41	7.15
	1	22.92	14.09	8.83
	1.2	33.00	20.28	12.72

Summary as per October 2014	Free-air/ventilated			Insulated			Conduit
	U/UTP	F/UTP, F/FTP	S/FTP	U/UTP	F/UTP, F/FTP	S/FTP	F/UTP
$p_{bundle}$	5	3	2,75	5	3	2,75	3
$p_{ambient}$	0,15	0,15	0,15	0,70	0,70	0,87	0,19

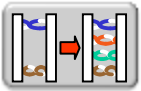
Model is provided with "iterative" resistance calculation: only necessary for high  $\Delta T$



# CLC TR 50174-99-1 Model Updated

## Introduction

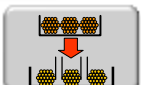
### Remote powering overview



### CLC TR 50174-99-1



$$\Delta T = f(i_c, n_c, N, d, K)$$



### Next steps



### Cable bundle heating spreadsheet

30th November 2014

ONLY CHANGE THE FIGURES IN THE WHITE CELLS

Number of cables in bundle	37	p bundle	5
Number of loaded conductors	8	p ambient	0.7
Conductor resistance	0.095 ohms		
Cable diameter	0.005 m		
Current unbalance	16		
Resistance unbalance	4		

### CLC TR 50174-99-1 MODEL (UPDATED)

			Delta TOTAL	Delta Surface-Ambient	
Load current per conductor	A	0.1	1.38	1.26	0.12
		0.15	3.10	2.85	0.25
		0.2	5.51	5.06	0.45
		0.25	8.61	7.91	0.71
		0.3	12.40	11.38	1.02
		0.35	16.88	15.50	1.39
		0.4	22.05	20.24	1.81
		0.45	27.91	25.61	2.29
		0.5	34.46	31.62	2.83
		0.6	49.62	45.54	4.08
		0.7	67.53	61.98	5.55
		0.9	111.64	102.46	9.18
		1	137.83	126.49	11.33
		1.2	198.47	182.15	16.32

Includes  
d.c. resistance unbalance

- system (current)
- cable (resistance)

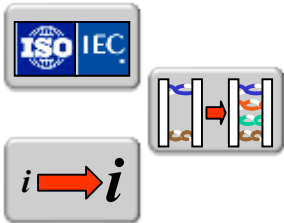
Summary as per October 2014	Free-air/ventilated			Insulated			Conduit
	U/UTP	F/UTP, F/FTP	S/FTP	U/UTP	F/UTP, F/FTP	S/FTP	F/UTP
p <sub>bundle</sub>	5	3	2,75	5	3	2,75	3
p <sub>ambient</sub>	0,15	0,15	0,15	0,70	0,70	0,87	0,19

Model is provided with "iterative" resistance calculation: only necessary for high  $\Delta T$

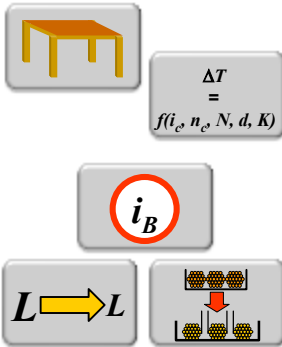
# Model Predictions

## Introduction

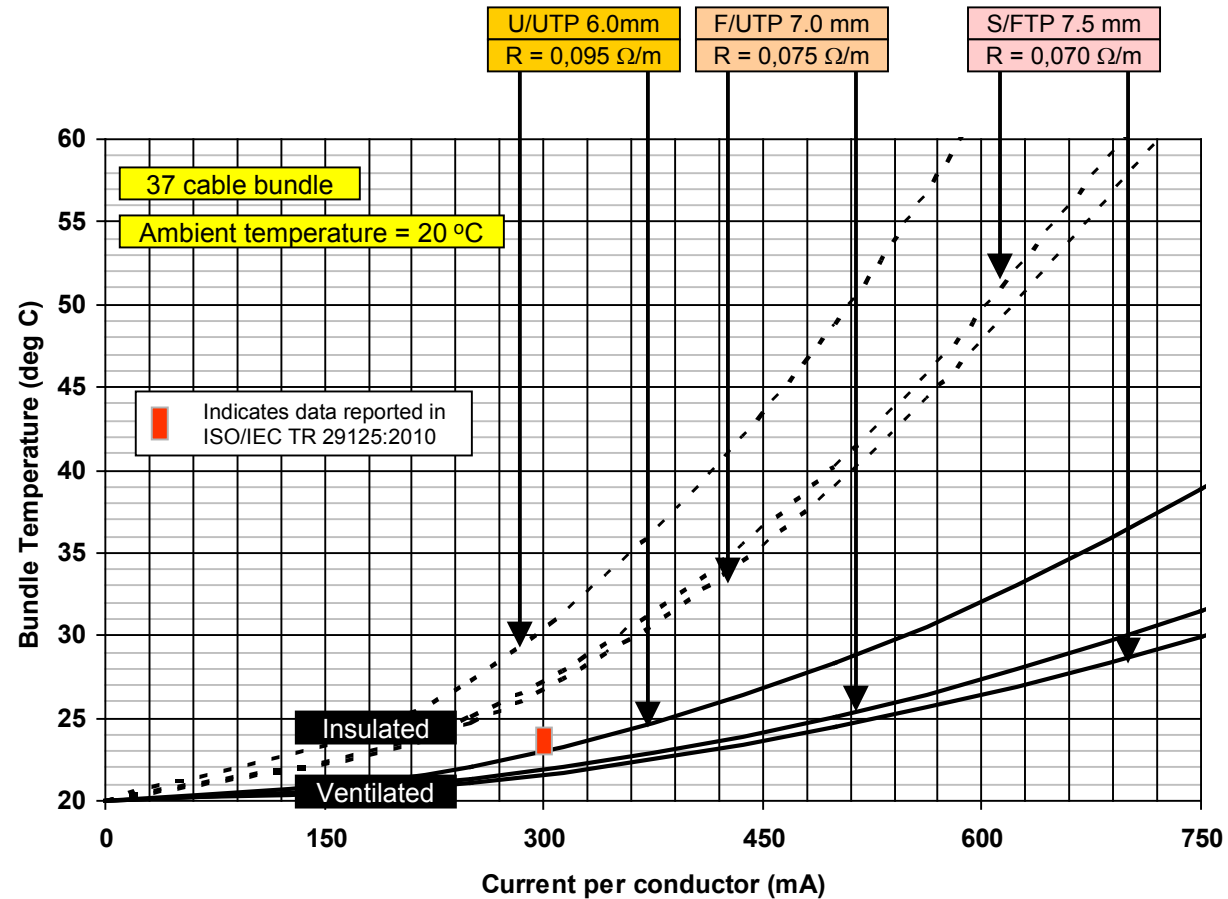
### Remote powering overview



### CLC TR 50174-99-1



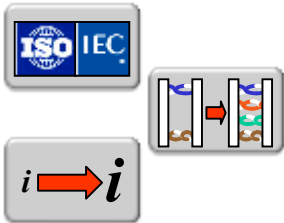
### Next steps



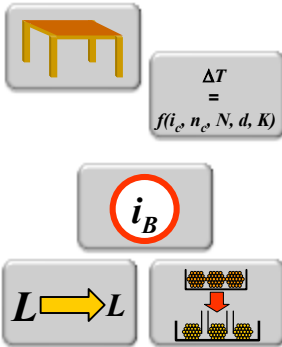
# Model Comparisons

## Introduction

### Remote powering overview



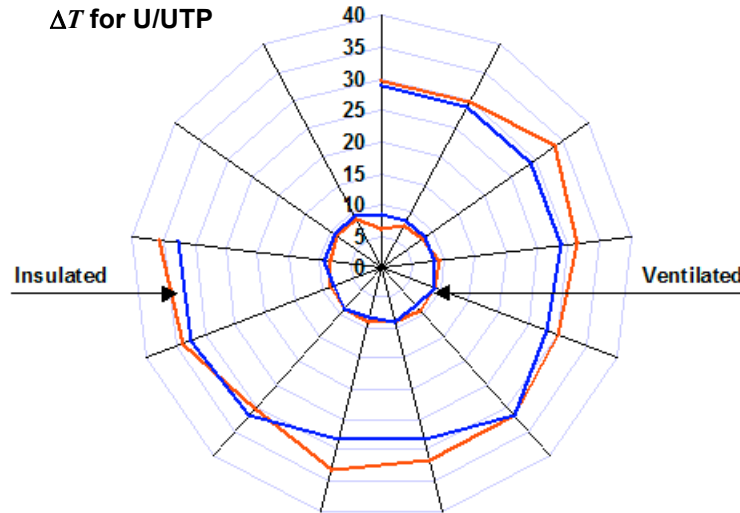
### CLC TR 50174-99-1



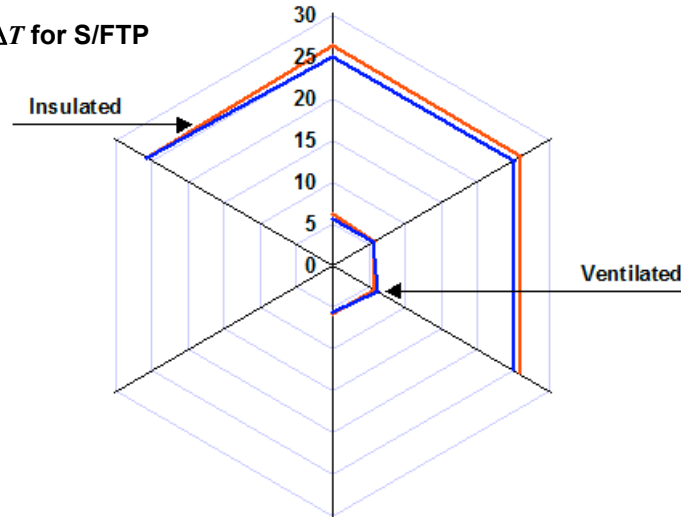
### Next steps



$\Delta T$  for U/UTP



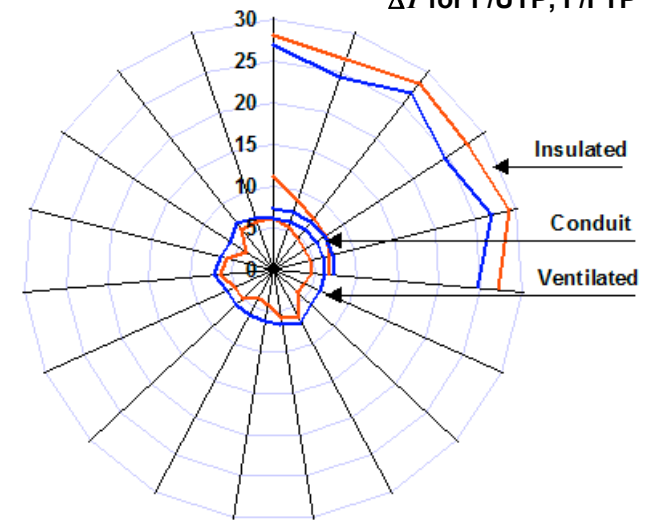
$\Delta T$  for S/FTP



## MODEL vs. MEASUREMENTS

All results normalised to  $R = 0,095 \Omega/m$  and  $i_c = 0,5$

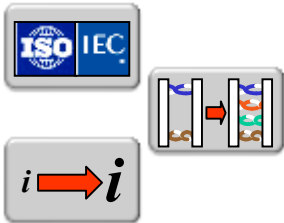
$\Delta T$  for F/UTP, F/FTP



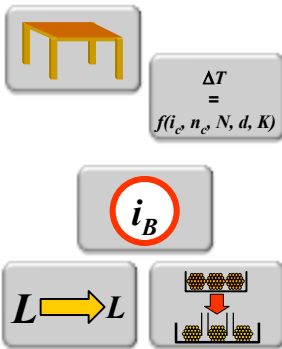
# Outcomes - Channel Design

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



### Next steps



We have to control the temperatures of the channel by:

- controlling the space ambient
- assessing the pathways and pathway systems
- limiting the power supplied

## CABLES

- use larger diameter cables
- use lower resistance cables
- use higher Category cables
- lower temperature increase
- insertion loss buffer

## CONNECTING HARDWARE

- products with higher operating current specification
- products with proven de-mating “under load” performance

## PATHWAYS AND PATHWAY SYSTEMS

- ventilated spaces
- larger cross-section pathway systems

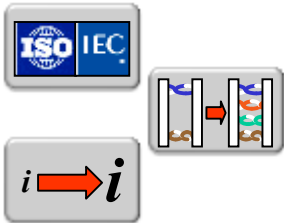
## BUNDLE SIZES

- smallest practical
- enabling air circulation

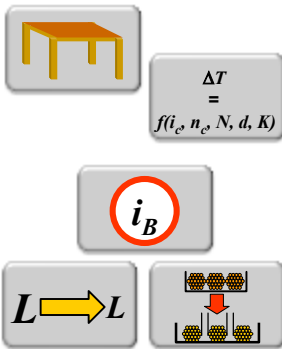
# Outcomes - Bundle Loading

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



### Next steps



$\rho_{th} = 5 \text{ (U/UTP)}, R = 0,095 \Omega/\text{m}, d = 0,006 \text{ m}$						
$\Delta T$ °C	Ventilated conditions $\rho_u = 0,15$			Insulated conditions $\rho_u = 0,7$		
	$i_c$ A	Total bundle current A	Injected bundle power kW	$i_c$ A	Total bundle current A	Injected bundle power kW
5	0,39	74,9	2,1	0,20	38,4	1,1
10	0,55	105,6	3,0	0,29	55,7	1,6
15	NA ( $i_c$ would exceed 0,75 A)			0,36	69,1	2,0
20				0,41	78,7	2,2
25				0,46	88,3	2,5
30				0,51	97,9	2,8
35				0,55	105,6	3,0
40				0,59	113,3	3,2

@ 57 V

$i_B$

$\rho_{th} = 3 \text{ (F/UTP)}, R = 0,075 \Omega/\text{m}, d = 0,007 \text{ m}$						
$\Delta T$ °C	Ventilated conditions $\rho_u = 0,15$			Insulated conditions $\rho_u = 0,7$		
	$i_c$ A	Total bundle current A	Injected bundle power kW	$i_c$ A	Total bundle current A	Injected bundle power kW
5	0,50	96,0	2,7	0,26	49,9	1,4
10	0,70	134,4	3,9	0,36	69,1	2,0
15	NA ( $i_c$ would exceed 0,75 A)			0,44	84,4	2,4
20				0,51	97,9	2,8
25				0,57	109,4	3,1
30				0,63	129,9	3,5
35				0,68	130,5	3,8
40				0,73	140,1	4,1

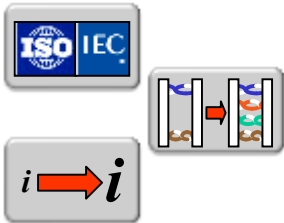
@ 57 V

$i_B$

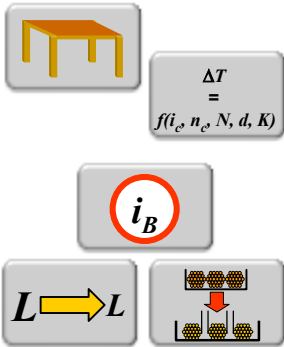
# Outcomes - Channel Design

## Introduction

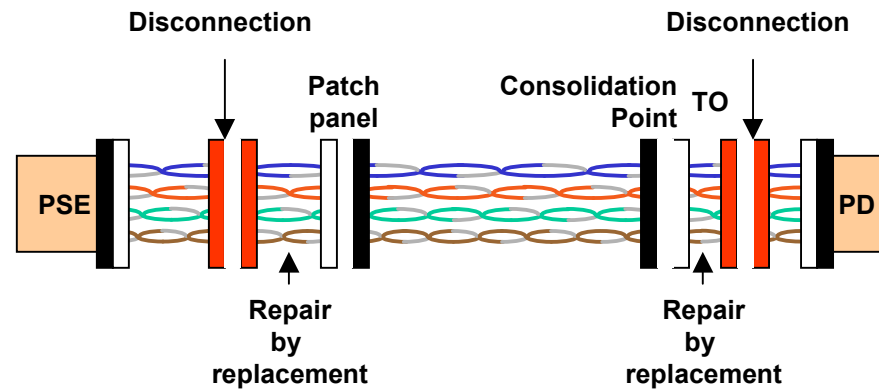
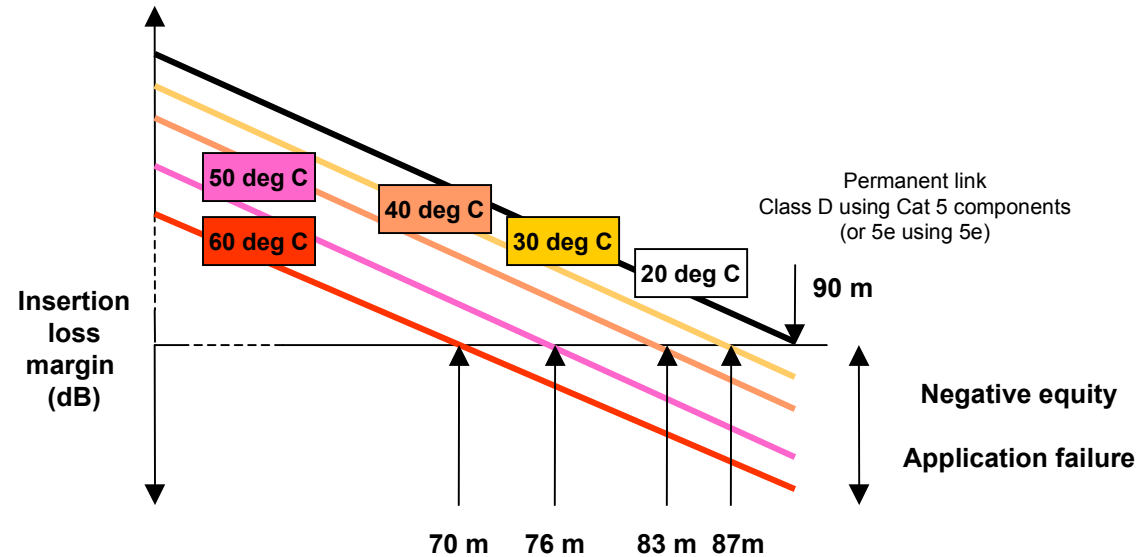
### Remote powering overview



### CLC TR 50174-99-1



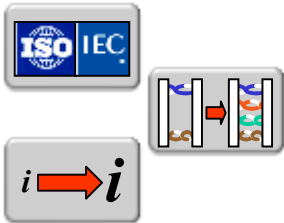
### Next steps



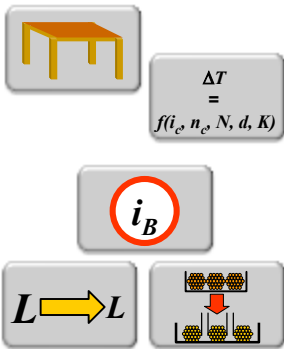
# Next Steps - European/International

## Introduction

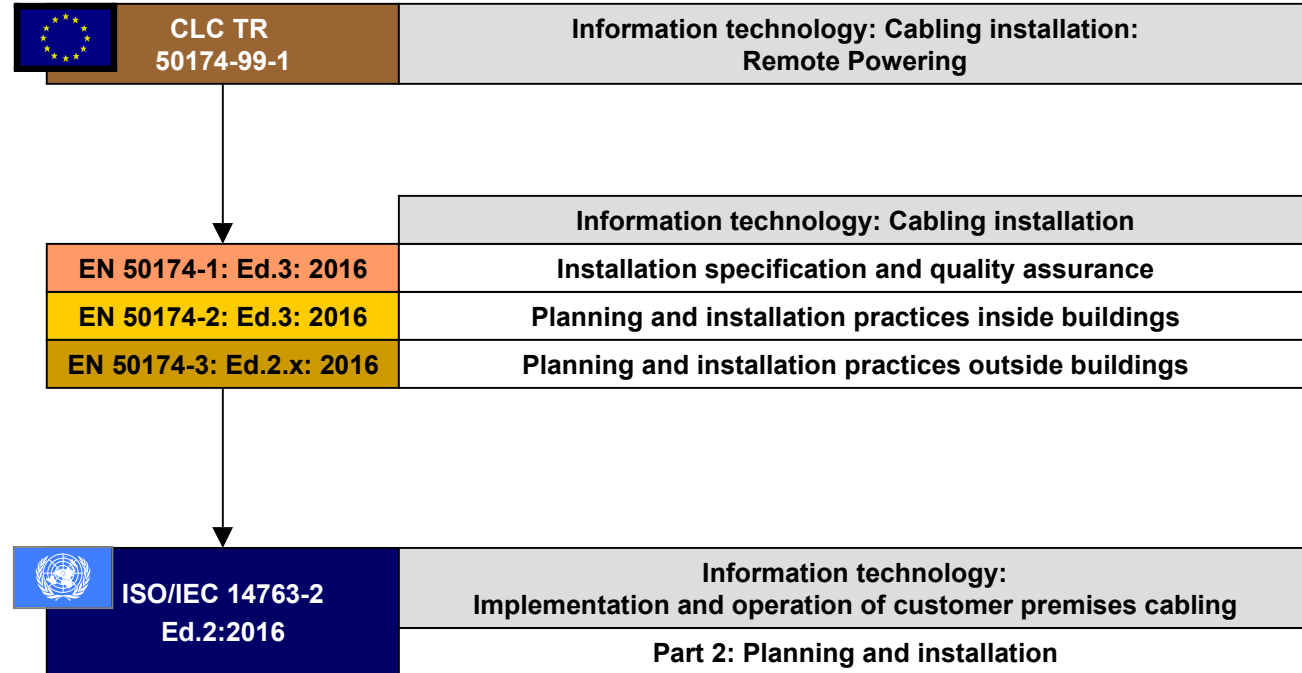
### Remote powering overview



### CLC TR 50174-99-1



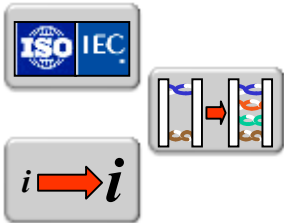
### Next steps



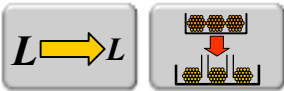
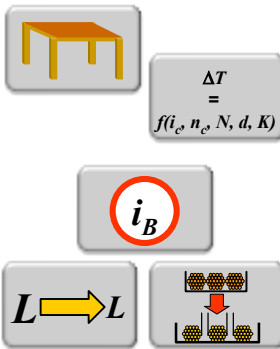
# Next Steps - National Solutions

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



### Next steps



## IET TC2-4 DC POWER SYSTEMS

Code of Practice:  
LOW AND EXTRA LOW VOLTAGE  
DIRECT CURRENT POWER DISTRIBUTION IN BUILDINGS



BS 6701

Telecommunications equipment and telecommunications cabling -  
Specification for installation, operation and maintenance

### INSTALLER SELF-CERTIFICATION

- for a given installation environment
- for a given maximum bundle loading
- what design approaches have been implemented
- what operational controls have to be exercised
- what to connect and where to disconnect

### CREATION OF A GUIDE TO USE

### IMPACT ON POWER SUPPLY CAPACITY

- re-direction from floor distribution to "comms room"

### IMPACT ON ENVIRONMENTAL CONTROL

- power dissipation

ZoneData:		Space:	
Area served:	253 sq.m.	Space:	A22
Outlets served:	334	CombProfile:	Fixed O
Rated DC power at 20:	24495 W	Area:	54 sq.m.
Total power dissipated:	1305 W	Average link length:	45 m
		Resistance:	0.095 Ohm/m

Default settings		Alternative settings	
Fixed IT	Density <input type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 100	Power	0
Wireless Access Points	Density <input checked="" type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 0	Power	0
DAS	Density <input checked="" type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 0	Power	0
Lighting	Density <input checked="" type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 0	Power	0
Environment Control	Density <input checked="" type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 0	Power	0
Windows	Density <input checked="" type="checkbox"/> Power <input checked="" type="checkbox"/> Quantity 12	Power	0

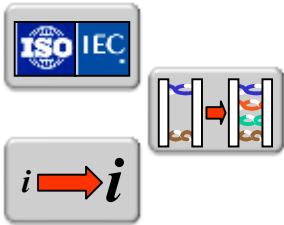
Fixed IT Outlets No	Power	Value
100	Power	13500
3	Power	362
1	Power	16
22	Power	8080
3	Power	27
12	Power	420



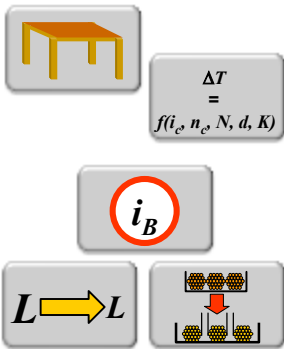
# THANKYOU

## Introduction

### Remote powering overview



### CLC TR 50174-99-1



### Next steps



## REMOTE POWERING over “structured” cabling

A review of European standardization activities

Mike Gilmore  
e-Ready Building Limited