



Reichle & De-Massari

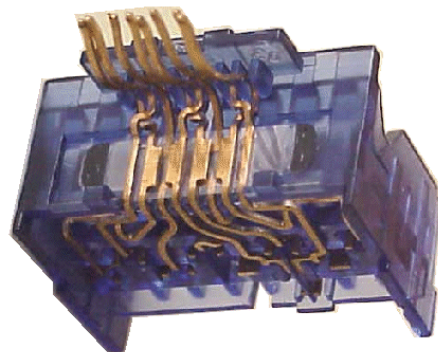
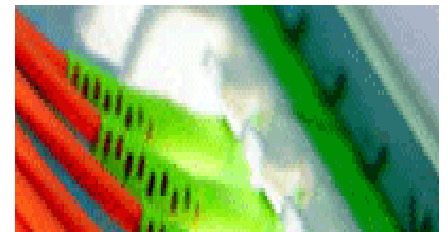
Shielded..? of unshielded Twisted Pair

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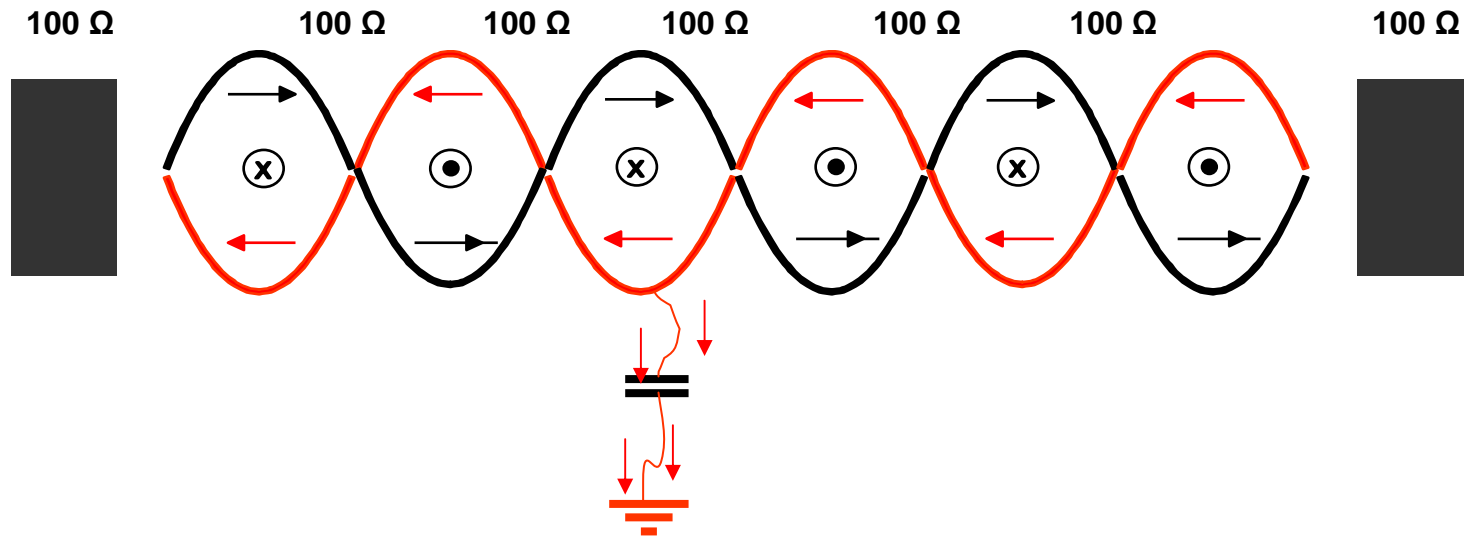
Reichle & De-Massari

- Opgericht in 1964
- Zwitsers bedrijf privé onderneming 
- 90's: Ontwikkeling & productie IBM-ACS Twisted Pair
- Fabrikant van ICT concepten
 - R&M Freenet Enterprise Cabling
 - Carrier Cabling
 - Industrial Cabling

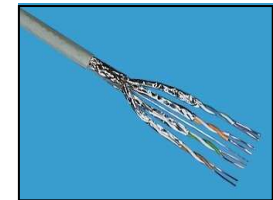


Twisted Pair

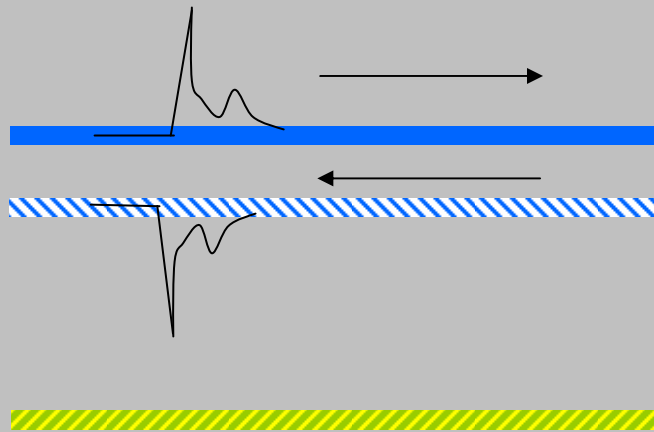
100 Ω , gebalanceerde signalen



- Bij hoge frequenties capacitieve koppeling naar aarde
- Gebalanceerd signaal raakt in onbelans
- Cat 7, 600 MHz kabel kan alleen een PIMF uitvoering zijn

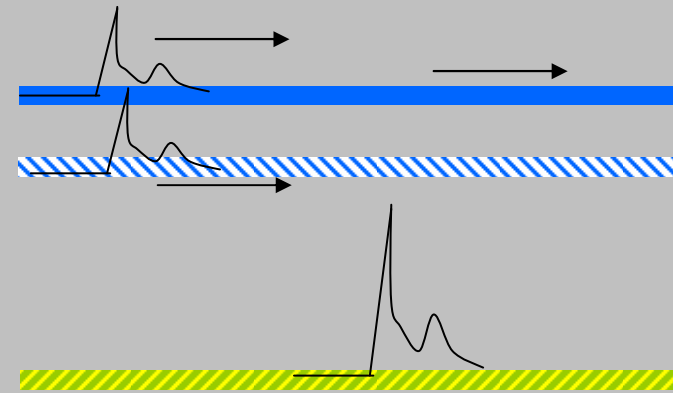


Differential mode



Differential mode noise exist only in theory, since circuit perfect balance is “theory”. DM become soon CM

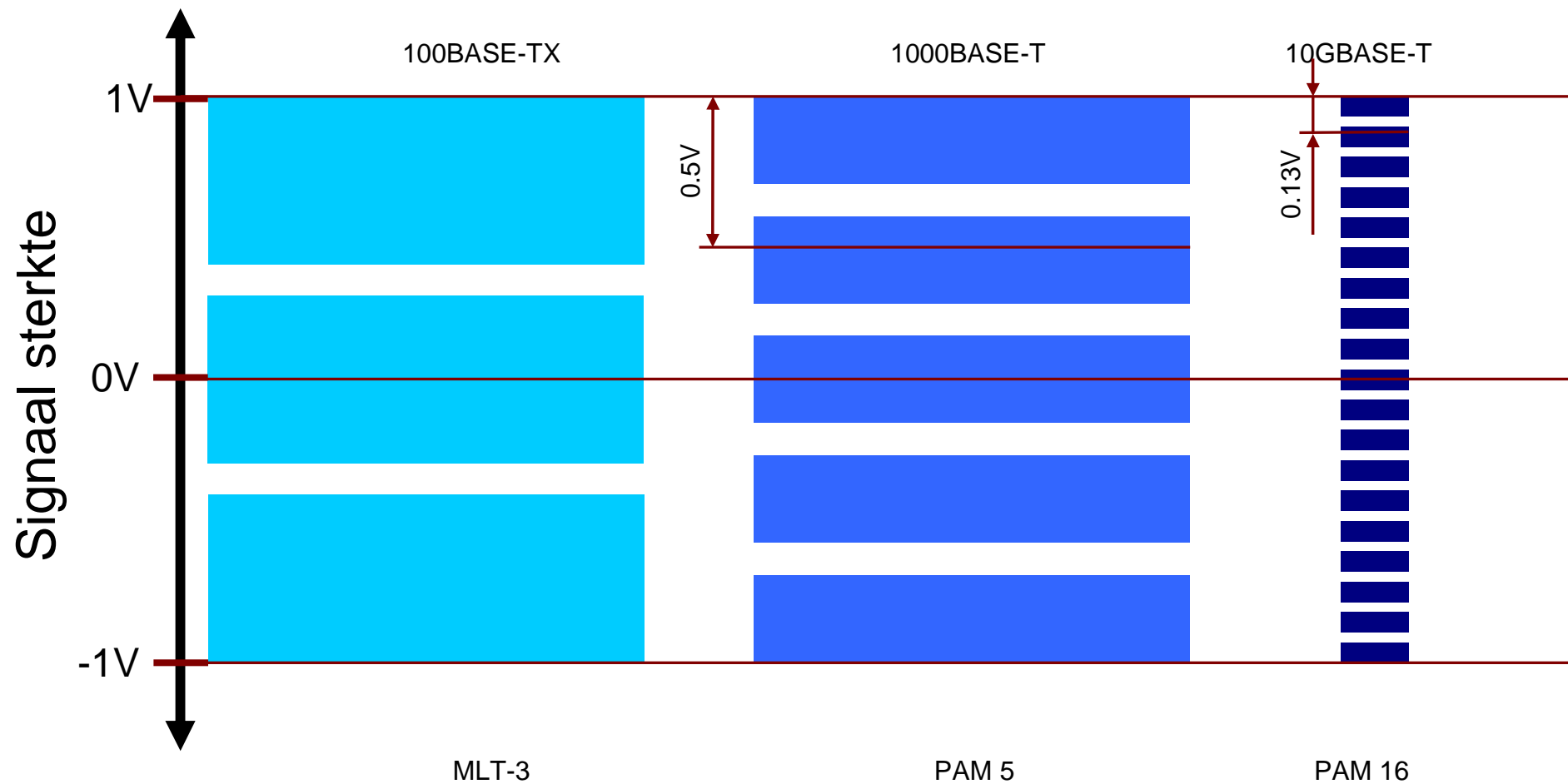
Common mode

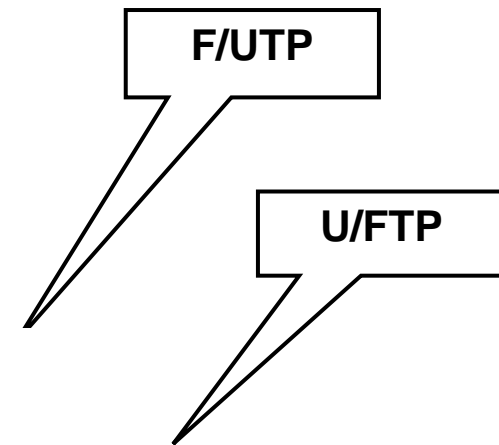
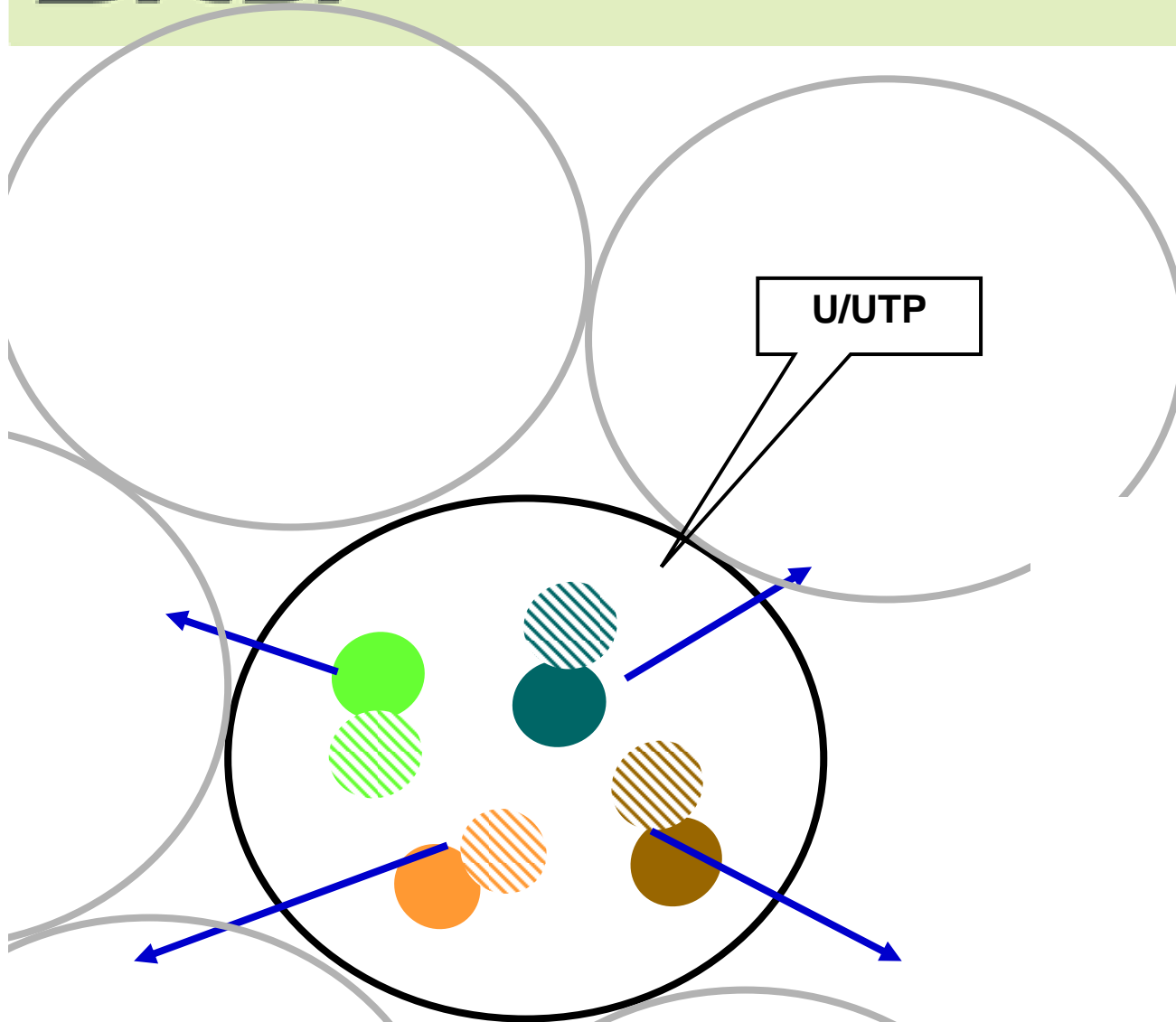


Common mode noise unfortunately exist in theory and practice !

Ethernet over Twisted Pair

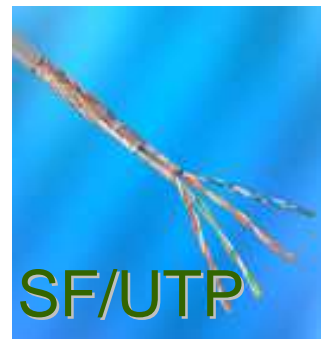
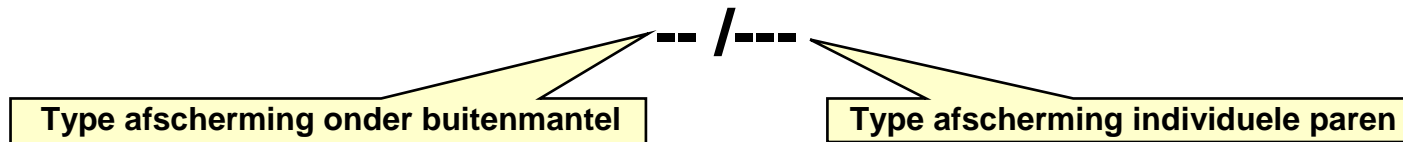
Transmissie signaal





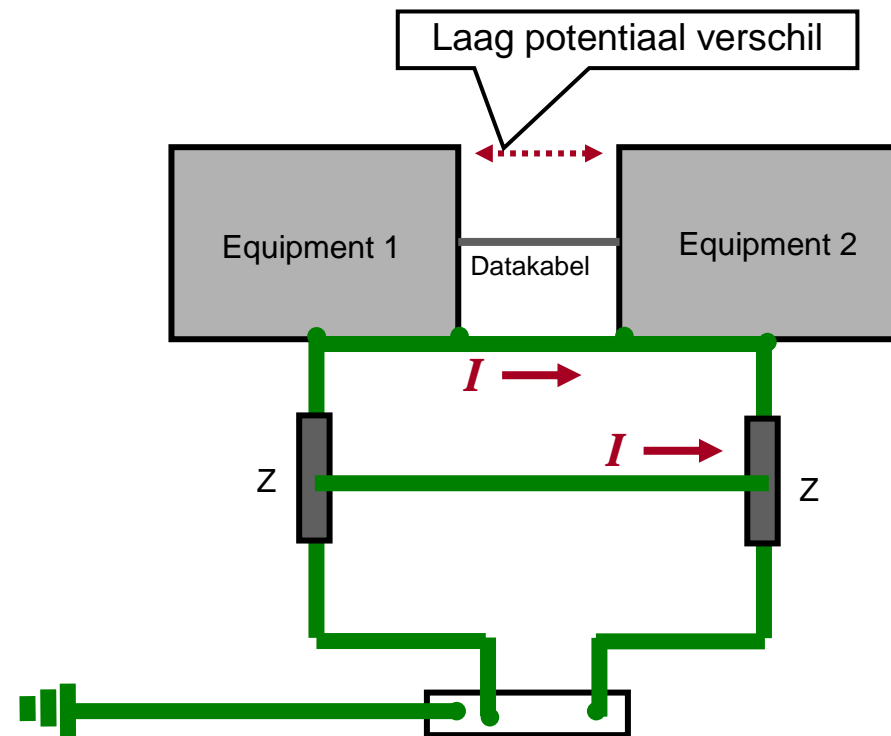
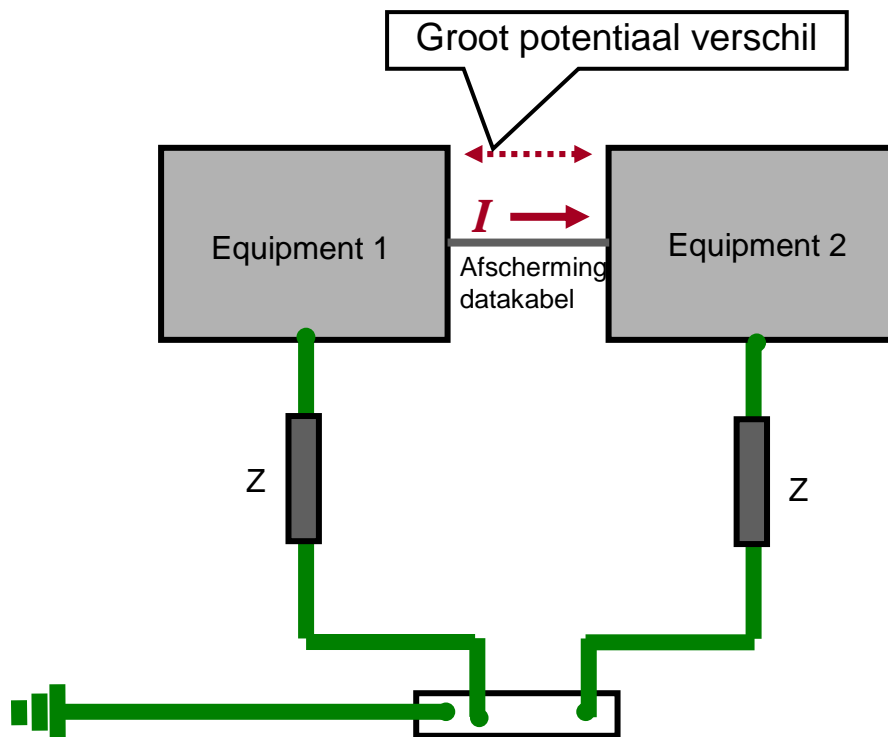
Twisted Pair kabels

Constructie

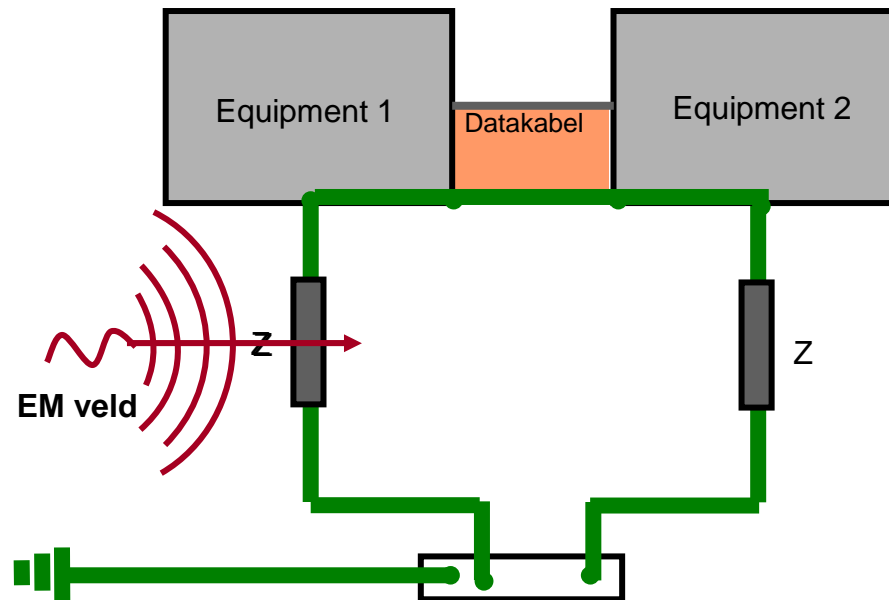
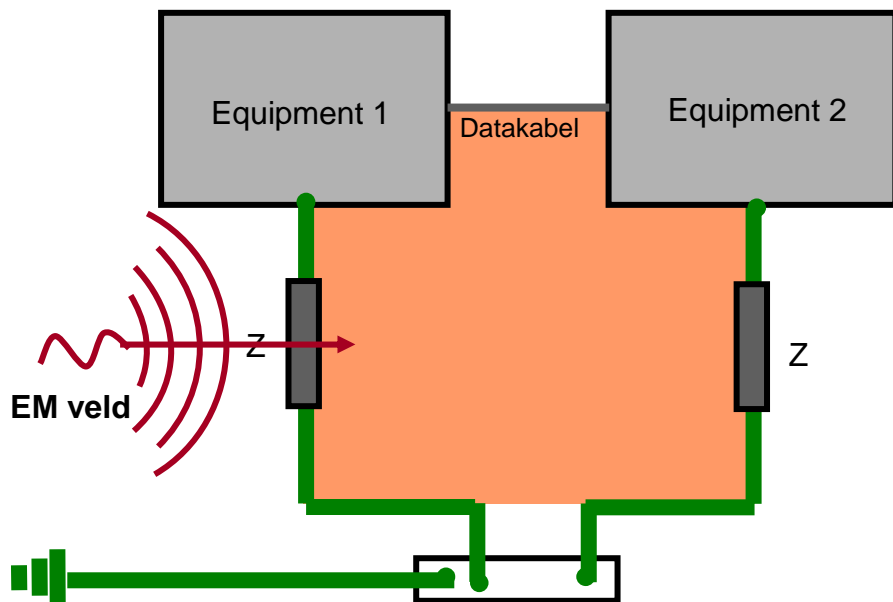


- U/UTP : Geheel onafgeschermd
- F/UTP : Folie rond de hele kabel
- SF/UTP : Breiwerk en folie rond de hele kabel
- U/FTP : Folie om elk paartje
- F/FTP : Folie om elk paartje en folie rond de hele kabel
- S/FTP : Folie om elk paartje en breiwerk rond de hele kabel
- SF/FTP : Folie om elk paartje en breiwerk & folie rond de hele kabel

Eis: Spanningsverschil kleiner dan 1 volt



EM storingen: U/UTP bekabeling vraagt het beste aardsysteem

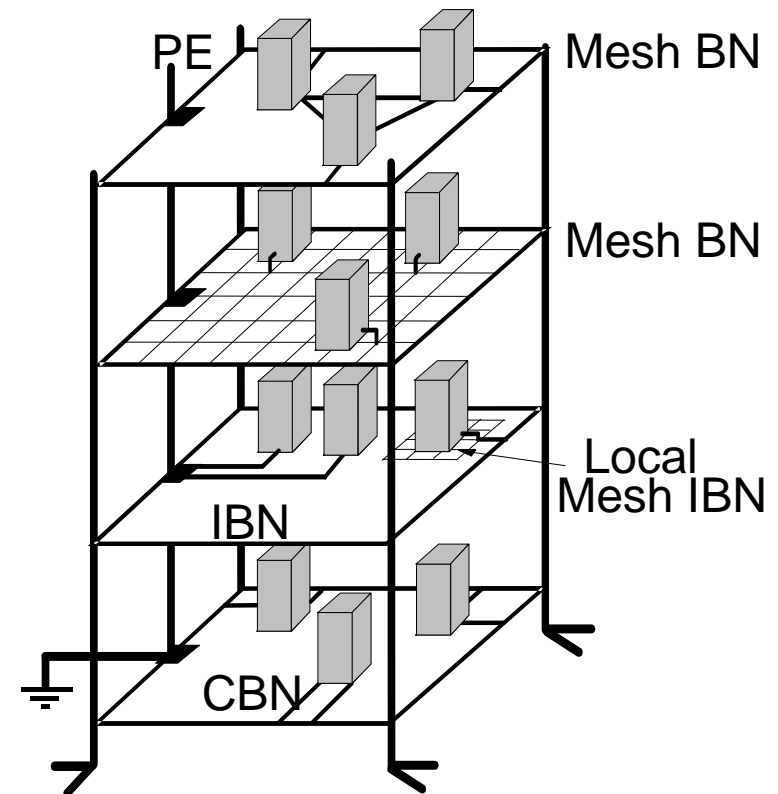
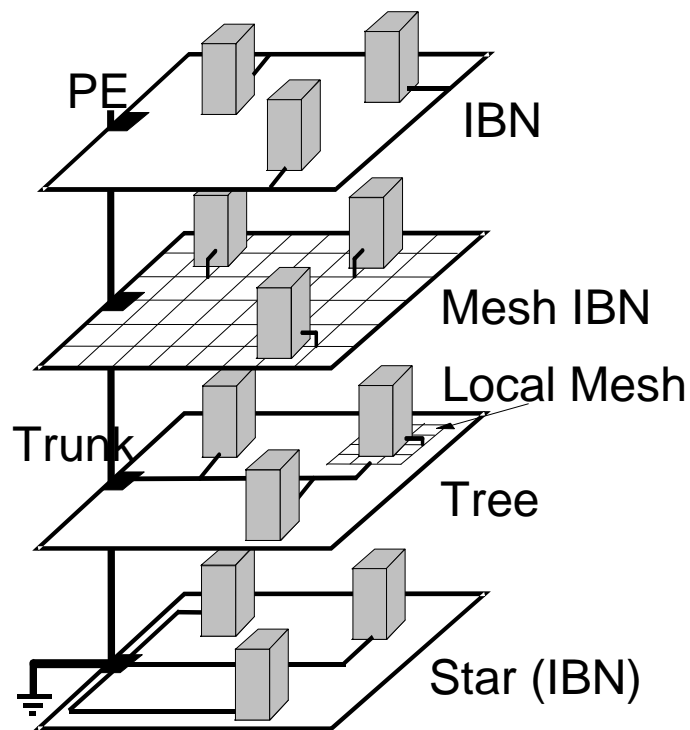


Horizontale bekabeling

- Horizontal cables FD side are bonded through the patch panel
- Horizontal cables WA side are bonded through patchcord at equipment power ground

Before bonding, different voltage potential between screen and power outlet ground **must** be verified to be equal or less than 1.0 V dc and rms. Deviation must be understood and corrected before bonding.





**Max. aardpotentiaalverschil = 1 Volt DC of RMS
230 Volt voedingsystemen uitsluitend volgens TN-S (Seperate neutral)**



EN 50174-2 existing version

Horizontal cable separation

When EN50081 and EN50082 are exceeded or for backbone cables:

Installation	Distance d		
	Without divider or Metallic divider	Aluminum divider	Steel divider
Both cables unscreened	200 mm	100 mm	50 mm
Unscreened power Screened data	50 mm	20 mm	5 mm
Screened power Unscreened data	30 mm	10 mm	2 mm
Both cables Screened	0 mm	0 mm	0 mm



Final Draft EN 50174-2

Kabelafstand data / power

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

FINAL DRAFT
FprEN 50174-2

September 2008

ICS

Will supersede EN 50174-2:2000

English version

Information technology -
Cabling installation -

Part 2: Installation planning and practices inside buildings

- Segregation Classification van Twisted Pair kabels
 - Shielded & unshielded bekabeling (Class a, b, c, d)
 - Constructie en categorie kabel (Cat 5^e , 6, 7 , U/UTP, U/FTP, SF/FTP)
 - Soort kabelgoot: draadgoot / open goot / goot met deksel / kunststof)
 - Type voedingskabel
- Tabel power cabling factor
 - Hoeveelheid voedingskabels
 - Vermogen voedingskabels (20 Amp / 1-phase)

Minimale kabelafstand wordt berekend : Segregation klasse x Power cabling factor

Final Draft EN 50174-2

Segregation classification

Table 3 – Classification of information technology cables

Information technology cable		
	Unscreened	Coaxial/twinaxial
Coupling attenuation at 30 MHz to 100 MHz dB	TCL at 30 MHz to 100 MHz dB	Screening attenuation at 30 MHz to 100 MHz dB
$\geq 80^a$	$\geq 70 - 10 \times \lg f$	$\geq 85^d$
$\geq 55^b$	$\geq 60 - 10 \times \lg f$	≥ 55
≥ 40	$\geq 50 - 10 \times \lg f^c$	≥ 40
< 40	$< 50 - 10 \times \lg f$	< 40

^a Cables meeting EN 50288-4-1 (EN 50173-1:2007, Category 7) meet Segregation Classification "d".

^b Cables meeting EN 50288-2-1 (EN 50173-1:2007, Category 5) and EN 50288-5-1 (EN 50173-1:2007, Category 5) meet Segregation Classification "c". These cables may deliver performance of Segregation Classification "d" if the relevant coupling attenuation requirements are also met.

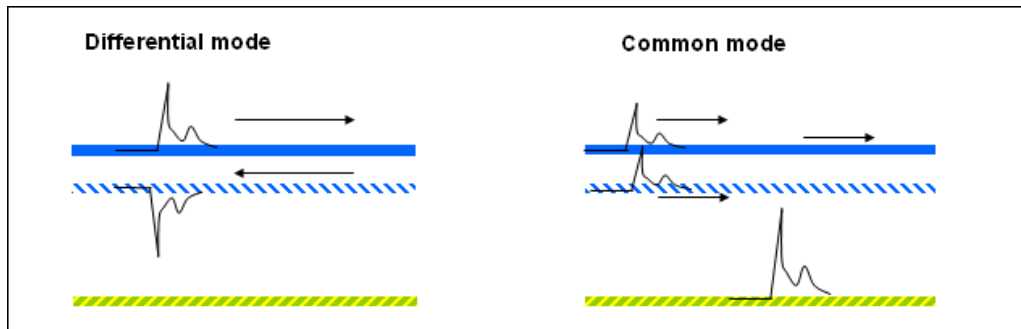
^c Cables meeting EN 50288-3-1 (EN 50173-1:2007, Category 5) and EN 50288-6-1 (EN 50173-1:2007, Category 5) meet Segregation Classification "b". These cables may deliver performance of Segregation Classification "c" if the relevant TCL requirements are also met.

^d Cables meeting EN 50117-4-1 (EN 50173-1:2007, Category BCT-C) meet Classification "d".

SF/UTP & S/FTP = d
F/UTP & U/FTP = c
U/UTP = b

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Segregation classification



	Unscreened
Coupling attenuation at 30 MHz to 100 MHz	TCL at 30 MHz to 100 MHz
dB	dB
≥ 80	$10 \times \lg f$
≥ 55	$10 \times \lg f$
≥ 40	$\geq 50 - 10 \times \lg f^c$
< 40	$< 50 - 10 \times \lg f$

SF/UTP & S/FTP = d
 F/UTP & U/FTP = c
 U/UTP = b

Coupling attenuation: Ratio between wanted signal power and the unwanted radiated power from the cabling

- Useful for screened & unscreened components range 30 – 100MHz
- Combination of balance and screening attenuation
- Not accepted by unscreened lobby

TCL (Transverse Conversion Loss: Ratio between the common mode signal and the injected differential mode signal)

Table 4 – Minimum separation *S*

Segregation Classification (from Table 3)	Separation without electromagnetic barrier	Containment applied to information technology or mains power cabling		
		Open metallic containment ^a	Perforated metallic containment ^{b, c}	Solid metallic containment ^d
d	10 mm	8 mm	5 mm	0 mm
c	50 mm	38 mm	25 mm	0 mm
b	100 mm	75 mm	50 mm	0 mm
a	300 mm	225 mm	150 mm	0 mm

^a Screening performance (0 MHz to 100 MHz) equivalent to welded mesh steel basket of mesh size 50 mm x 100 mm (excluding ladders). This screening performance is also achieved with steel tray (duct without cover) of less than 1,0 mm wall thickness and more than 20 % equally distributed perforated area.

^b Screening performance (0 MHz to 100 MHz) equivalent to steel tray (duct without cover) of 1,0 mm wall thickness and no more than 20 % equally distributed perforated area. This screening performance is also achieved with screened power cables that do not meet the performance defined in Note d

^c The upper surface of installed cables shall be at least 10 mm below the top of the barrier.

^d Screening performance (0 MHz to 100 MHz) equivalent to a steel conduit of 1,5 mm wall thickness. Separation specified is in addition to that provided by any divider/barrier.

Table 5 – Power cabling factor

Electrical circuit type ^{a, b, c}	Quantity of circuits	Power cabling factor <i>P</i>
20 A 230 V 1-phase	1 to 3	0,2
	4 to 6	0,4
	7 to 9	0,6
	10 to 12	0,8
	13 to 15	1,0
	16 to 30	2
	31 to 45	3
	46 to 60	4
	61 to 75	5
	> 75	6
<p>^a 3-phase cables shall be treated as 3 off 1-phase cables.</p> <p>^b More than 20 A shall be treated as multiples of 20 A.</p> <p>^c Lower voltage AC or DC power supply cables shall be treated based upon the their current ratings, i.e. a 100 A 50 V DC cable = 5 of 20 A cables ($P = 0,4$).</p>		

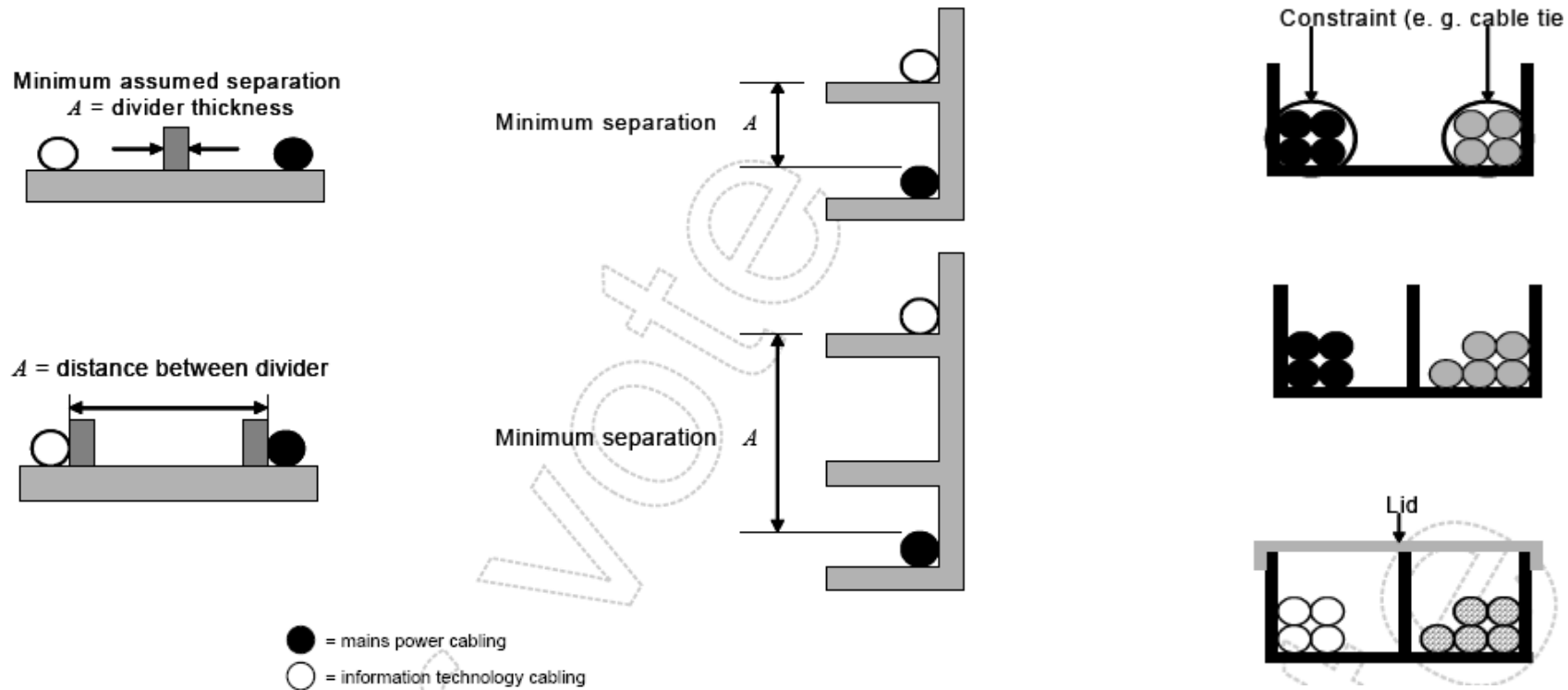



Figure 7 – Separation of mains power and information technology cables with dividers

Table 5 - Separation requirements for specific EMI sources

Source of disturbance	Minimum separation (mm)
Fluorescent lamps	130 ¹
Neon lamps	130 ¹
Mercury vapour lamps	130 ¹
High-intensity discharge lamps	130 ¹
Copiers	400 ¹
Arc welders	800 ¹
Frequency induction heating	1000 ¹
Hospital equipment	See Note 2
Radio transmitter	
Television transmitter	
Wireless telephone	
Radar	
NOTE 1:	The minimum separations may be reduced provided that appropriate cable management systems are used or product suppliers guarantees are provided.
NOTE 2:	Analysis shall be performed about possible disturbances. e.g. frequency range, harmonics, transients, bursts, transmitted power, etc. and the minimum distance shall be calculated according to this.

Twisted Pair

Horizontale bekabeling

Twisted Pair				
<i>Categorie</i>	<i>Jaar</i>	<i>Snelheid</i>	<i>Bandbreedte</i>	<i>Aantal actieve paren</i>
Cat 3	1992	10 Mbps	16 MHz	2 paren (1-2 & 3-6)
Cat 5	1995	100 Mbps	100 MHz	2 paren (1-2 & 3-6)
Cat 5E	1999	1000 Mbps	100 MHz	4 paren (bi-directioneel)
Cat 6	2002	1000 Mbps	250 MHz	4 paren (TIA/EIA-854)
Cat 7	2002	1000 Mbps	600 MHz	
<hr style="border-top: 1px dashed black;"/>				
Cat 6 /"Cat 6A"	2006	10.000 Mbps	500 MHz	4 paren (bi-directioneel)



10 Gigabit Ethernet over Twisted Pair

Apparatuur standaard: IEEE 802.3an

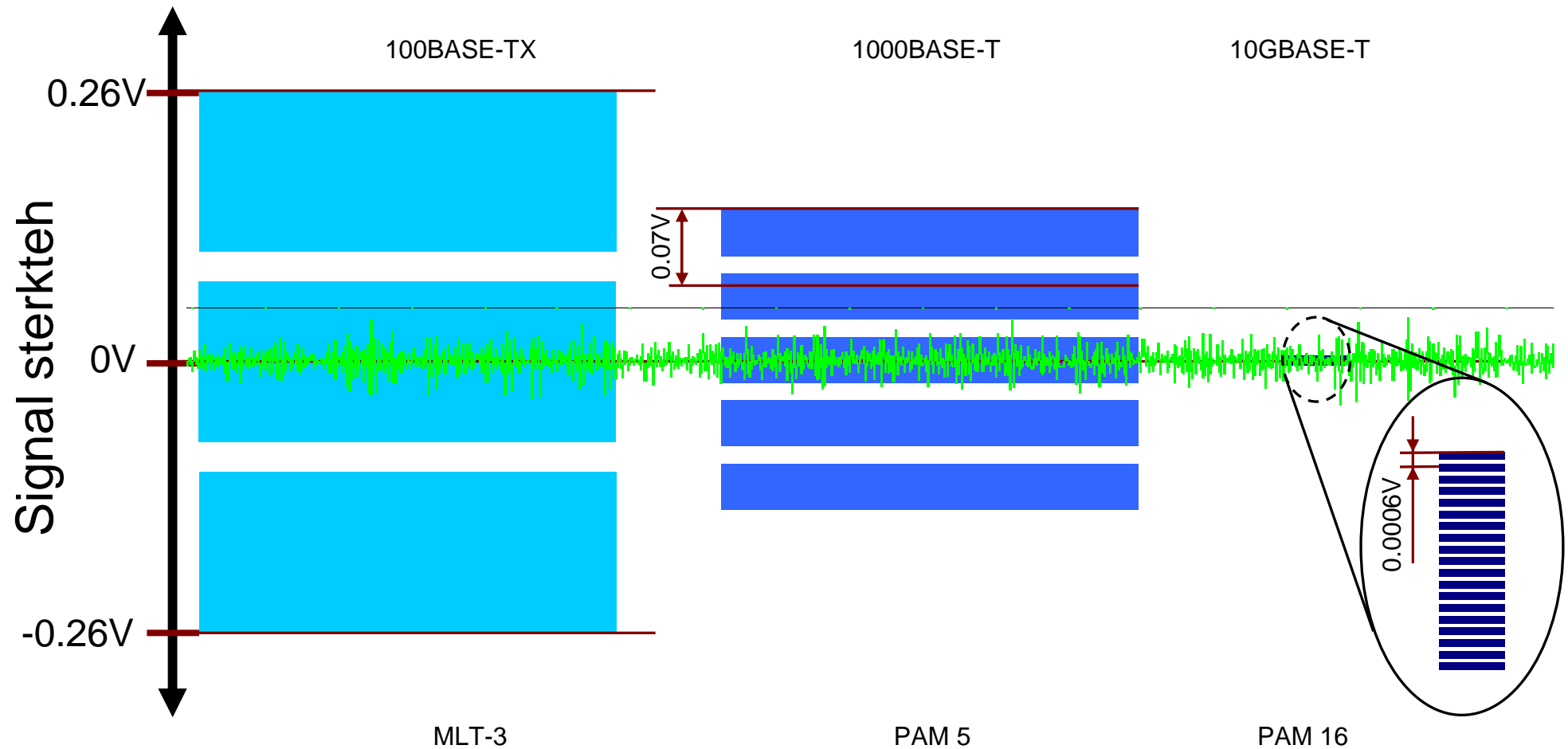
Table 55–11— Cabling types and distances

Cabling	Supported link segment distances	Cabling references
Class E / Category 6	55 to 100 m ^a	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class E / Category 6: unshielded	55 m	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class E / Category 6: shielded	100 m	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class F	100 m	ISO/IEC TR-24750
new Class E / Augmented Category 6	100 m	ISO/IEC 11801 Ed 2.1 / TIA/EIA-568-B.2-10

^aSupported link segments up to 100 m shall meet the alien crosstalk to insertion loss requirements specified in 55.7.3.1.2 and 55.7.3.2.2.

Ethernet over Twisted Pair

Ontvangen signaalsterkte



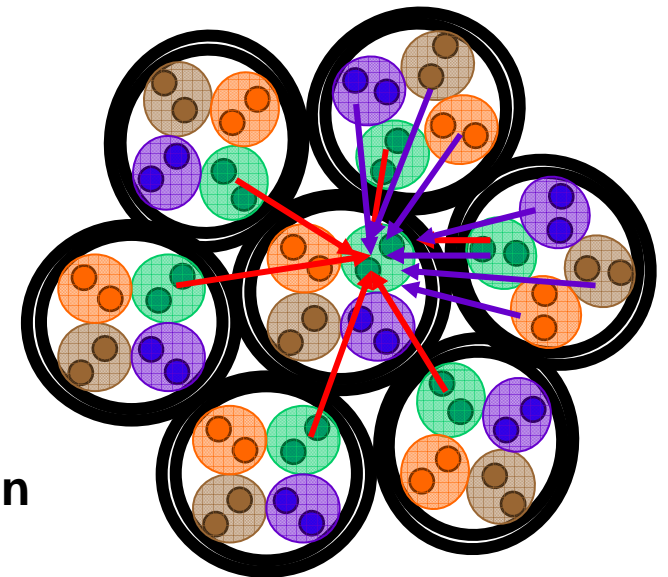
10 Gigabit Ethernet over Twisted Pair 'The Aliens'



**Alien crosstalk
in connectoren**

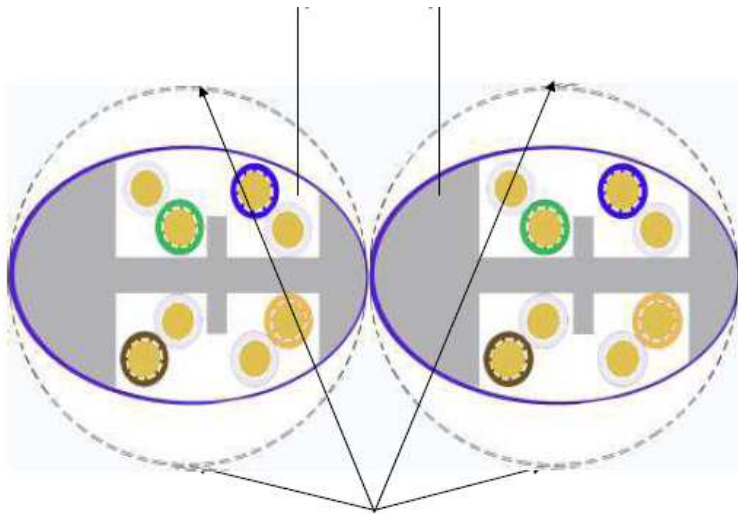
**Alien crosstalk
in kabel**

**Alien common
mode noise**

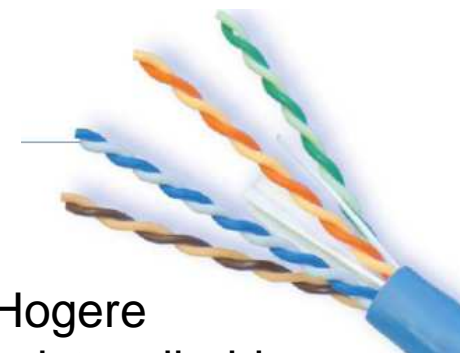


10 Gigabit Ethernet over Twisted Pair

U/UTP cat 6 kabela



Hogere
twistsnelheid





10 Gigabit Ethernet over Twisted Pair

Gootruimte $\frac{1}{4} \pi d^2$

10 x 24 fibres

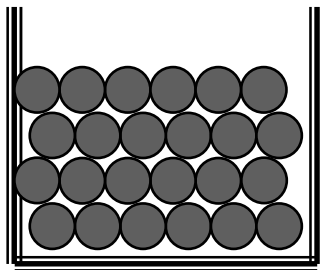
30 x Cat 6A U/UTP

60 x Cat 5 U/UTP

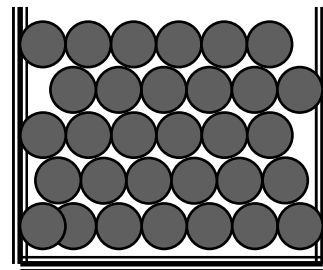
60 x Cat 6A U/FTP



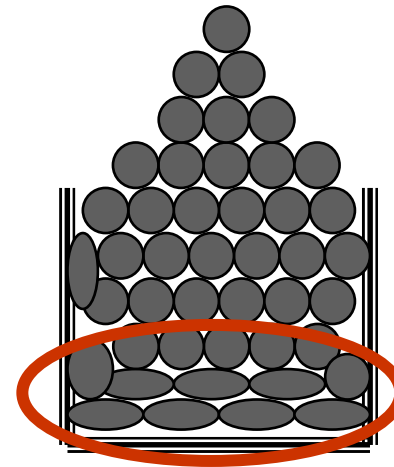
Berekening gootcapaciteit: 1,5 x aantal kabels



66 %



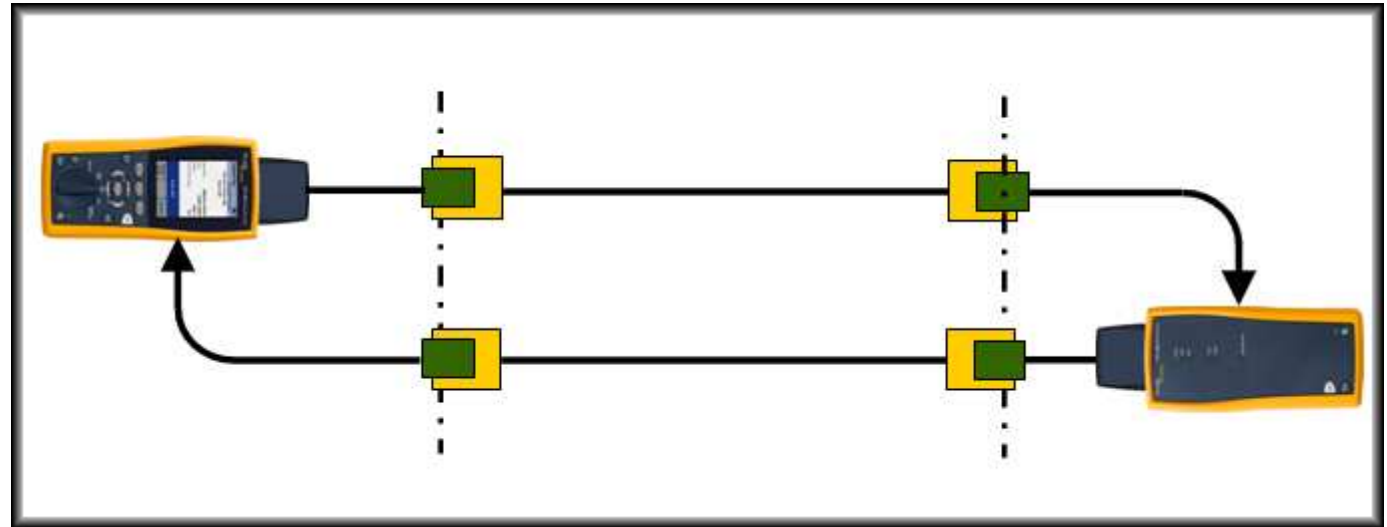
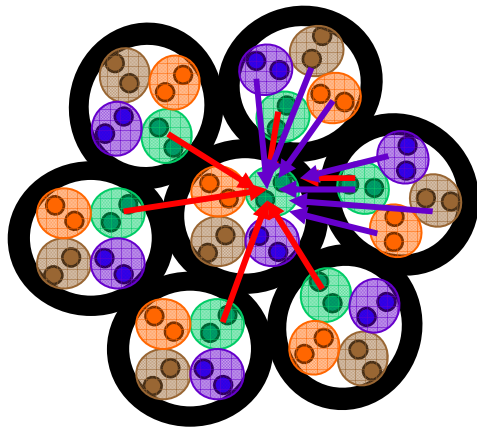
100 %



150 %

10 Gigabit Ethernet over Twisted Pair

Alien Crosstalk meting



- Alien cross-talk meting alleen bij U/UTP bekabeling
- Niet realistisch scenario op de werkvloer
- 10 GBE wordt vastgelegd in het design van de fabrikant
- Mix & match installaties voor 10 GBE zijn niet meer mogelijk



10 GBE shielded versus unshielded

Conclusie:

Nieuwste Ethernet protocollen zijn gevoeliger voor EM storingen

Shielded kabel is dunner dan 10 GBE U/UTP kabels

- Nemen minder goot ruimte in beslag en is een kostenbesparing
- Zijn makelijker te installeren/ kleinere buigradius (vooral bij WCD)

Shielded Tw. Pair 100 meter is strikt volgens de 10 GBE standaard IEEE802.3an

Alien Crosstalk metingen zijn bij shielded bekabeling niet van toepassing

Shielded kabel is (veelal) goedkoper dan “dikkere” 10 GBE U/UTP kabels

Kostenbesparingen op databekabeling kan ten goede komen aan een volwaardige aarding