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MegaLine® Connect100

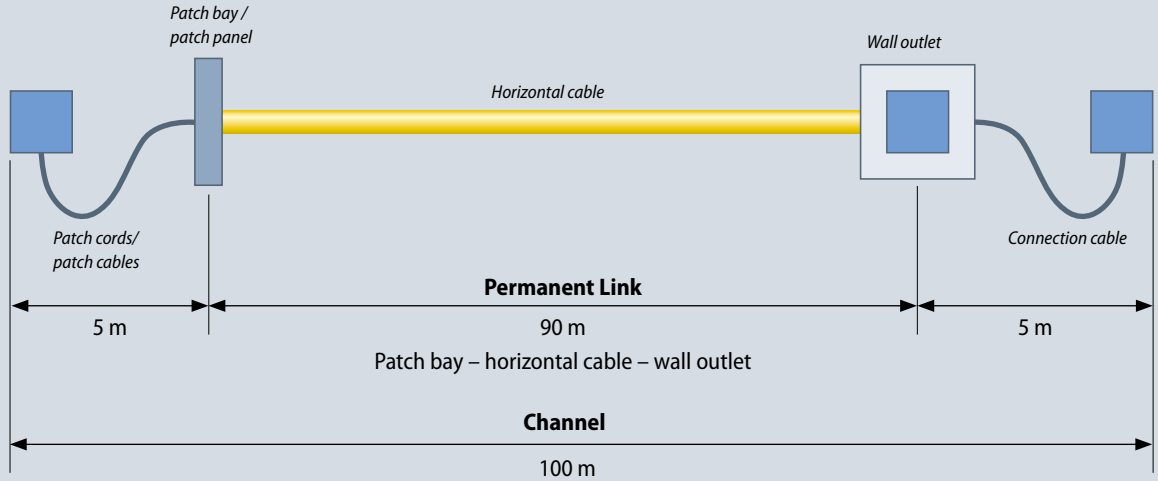
Class E_A links over 100 metres in length

Anyone who has ever been confronted with Class E_A links >100 m in the channel will be familiar with the problem of attenuation, pair cross talk and signal distribution speed.

Since the length of a link is no longer an exclusion criterion for measurements, links > 100 m can now be measured as PASS. In order to achieve optimum success, care should be taken to ensure to use the right components. Otherwise the process can quickly result in frustration and additional costs. In addition, long links should be carefully planned and their usefulness assessed.

The pages that follow describe the feasibility of an extra-long link and look at why the choice of the right components is absolutely critical ›

› Classic structure – 2-connector link



Definition of a channel:
5 m patch cord/patch cable – 90 m horizontal cable – 5 m patch cord/patch cable
Plug and jack components according to IEC 60603-7 or RJ45 (Registered Jack 45)

› Ethernet transmission via twisted pairs

› STANDARDS

- EIA/TIA 568 (USA)
- ISO/IEC 11801 (International)
- EN 50173 (Europe)
- IEEE 802.3

EIA / EUR 568	ISO / IEC 11801-	EN 50173	Bandwidth	Application
Cat. 5	Cat. 5	Class D	< 100 MHz	100Base HS
Cat. 5e	Cat. 5e	Class D	< 100 MHz	1000Base / T
Cat. 6	Cat. 6	Class E	< 250 MHz	1000Base / T
Cat. 6A	Cat. 6_A	> Class EA	< 500 MHz	10GBase / T
–	Cat. 7	Class F	< 600 MHz	10GBase / T
–	Cat. 7_A	> Class FA	< 1,000 MHz	10GBase / T
Cat. 8	–	> Class G	< 2,000 MHz	25/40GBase-T
–	Cat. 8.1	"Class G"	2,000 MHz	25/40GBase-T
–	Cat. 8.2	"Class G"	2,000 MHz	25/40GBase-T

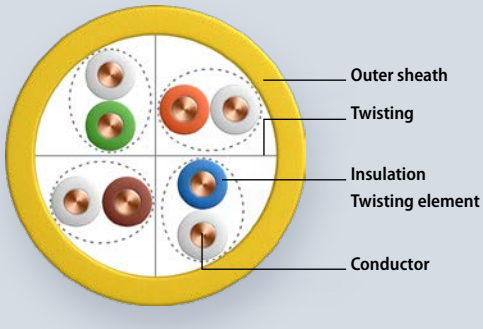
› UNSHIELDED

In Europe, unshielded cables are generally used for structured cabling up to Category 6. When installing cables on cable trays, a larger distance from neighbouring cables has to be observed due to the lack of shielding. Typical signs of unshielded cables: separation of the wire pairs by means of a plastic cross and close twisting of the wire pairs. The main aim here is to suppress pair crosstalk of the signals, which can cause transmission disruption (NEXT / FEXT). The lack of shielding means these cables are easy to strip and assemble. What is more, the cables can be used in buildings with an older electrical installation, even if the earthing is not clearly identifiable.

› SHIELDED

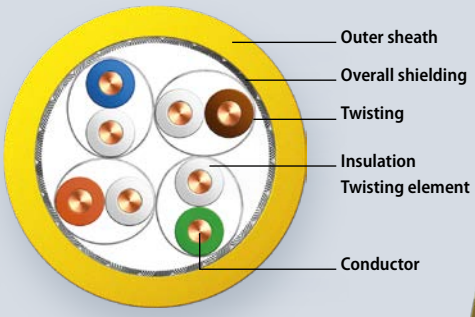
Shielded cables are mainly used in Europe for structured cabling from Category 6+ upwards. The shielding is available in various types. In Europe, both the individual wire pairs are shielded (by means of foil shielding) as well as all four wire pairs together (by

› UNSHIELDED

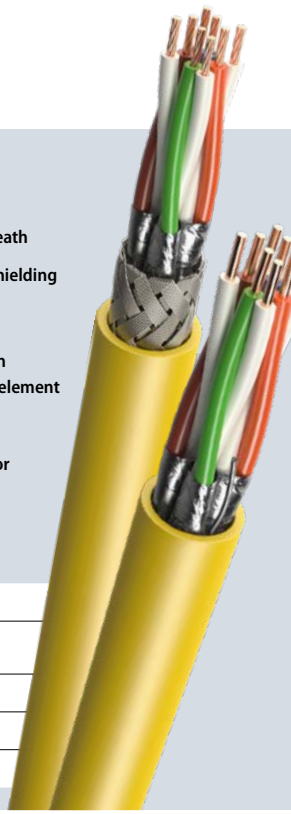


Conductor	Bare copper wire, AWG 23/1
Insulation Twisting element	PE Pair
Twisting	4 pairs separated by a cross element
Outer sheath	PVC / LSZH

› SHIELDED



Conductor	Bare copper wire, AWG 23/1
Insulation Twisting element	PE Pair
Twisting	4 pairs with foil shielding
Overall shielding	Tinned copper braid
Outer sheath	PVC / LSZH



means of foil shielding or braided shielding). As a result of this cable structure, cable designs currently exist which support a frequency of 2,000 MHz. The shielded cables also meet the requirements of the new Categories 8, 8.1 and 8.2. Pair crosstalk (NEXT / FEXT) of the signals is suppressed by means of wire pair shielding. The entire shielding suppresses crosstalk between different cables installed at a short spacing from one another. This allows these cables to be organised on cable trays in greater packing density. Typical features of these cables are the low level of twisting of the wire pairs and the support for frequencies from 300+ MHz, as well as high-quality connectivity. These cables are given preference in new buildings, office areas and data centres.

	Cable types compared			
	Cat. 6A U/UTP	**Cat. 6A U/FTP**	**Cat. 7 S/FTP**	**Cat. 7A S/FTP**
Maximum class	EA	EA	F	FA
Pair shielding	—	✔	✔	✔
Overall shielding	—	—	✔	✔
Type Wire diameter in AWG	23	23	23	22
Type Frequency [MHz]	550	600	1000	1500
Type NEXT at 500 MHz [dB]	29	61	97	105
Type Signal distribution speed [%] of light speed (NVP)	65	80	80	80
Max. DC resistance / 100 m	8	8	7.5	5.7
Standard Coupling attenuation up to 1000 MHz	n/a	65	85	90

› Limiting factors for links > 100 m

- **Twisting of the wire pairs (twisted pair)**
  The twisting of the wire pairs can mean that the propagation delay differs according to the cable design. Because of this, certification by class might involve the permitted propagation delay being exceeded. This will limit the possible link length in the channel. Cables with less twisting enable longer link lengths than heavily twisted cables.

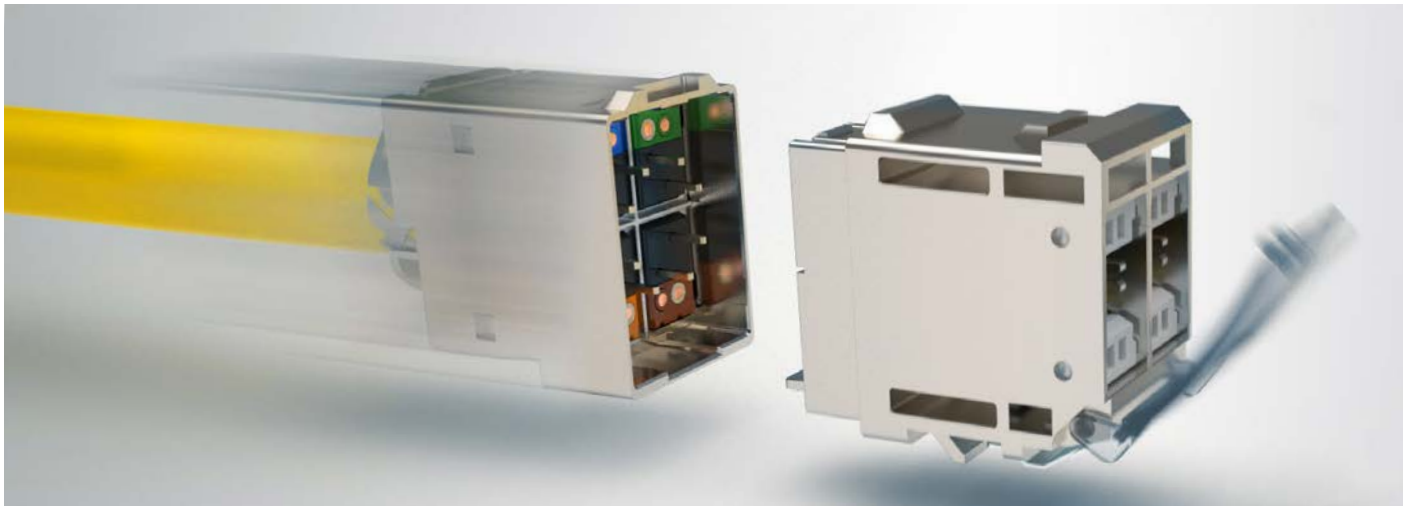
- **Cable attenuation**
  Signal strength decreases along the length of the link. Cables with a small wire cross-section attenuate the signal more than those with a large cross-section. In the same way, cables with close twisting of the wire pair exhibit a higher level of signal attenuation than cables with less intense twisting of the wire pairs.

- **Crosstalk between the wires or wire pairs**
  Cross talks are interference signals between the different wires or wire pairs. If the interference signals are too strong, signal transmission may be disrupted and the connection may be lost. An attempt to suppress this can be made by using unshielded cables with increased twisting of the individual wires and wire pairs, though here it is only possible achieve frequencies of 500 MHz max. For higher frequency ranges, the cable has to exhibit shielding of the wire pairs (PIMF – Pair In Metal Foil) and also overall shielding (foil, braided). One exception here is the Cat. 8 cables according to the EIA/TIA standard, which build on Category 6A-F/UTP cable designs and are specified up to 2,000 MHz. However, this reduces the potential link length for "Class G" applications to 30 m.

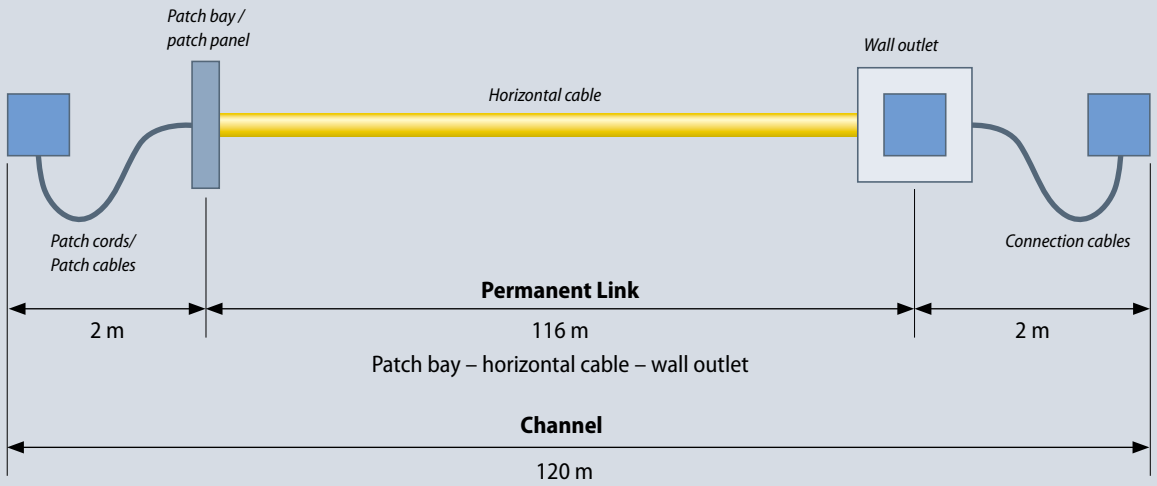
- **Cable crosstalk (AXT – Alien X-Talk or Alien Crosstalk)**
  Just as individual wire pairs can influence each other inside the cable, individual cables can also impact on each other. Here again, as with wire crosstalk, shielded cables have higher performance reserves and frequency ranges. S/FTP cables offer the best performance figures. As a result, these are given preference as a construction product for a diverse range of installations.

- **Connectivity**
  A link is only as good as its weakest component. Connectivity of a low category or quality may prevent a potentially better result. They normally compensate the signals too strongly so as to allow longer links > 100 m. The best performance figures here are to be found in Category 7_A components.

- **Assembly**
  Imprecise or incorrect assembly of cable components impairs signal quality. The better the components are assembled on the cable, the better the signal quality. Manufacturer specifications and installation instructions must be observed at all times. When measurements are carried out to detect various transmission classes, e.g. Class E_A, it is important to ensure good levels for crosstalk, insertion loss and wiring resistance. High levels (dB) for crosstalk and insertion loss, low and even figures (Ω) for wiring resistance.



› Example structure of a 2-connector link > 100 m



Definition of a channel:

2 m patch cord/patch cable – 116 m horizontal cable – 2 m patch cord/patch cable

Components used:

- 116 m horizontal cable – LEONI MegaLine® G12-150 S/F – Category 7_A, Class F_A
  Wire diameter AWG22, 1500 MHz
- Horizontal cable with assembled modules:
  fitted at both ends with ARJ45™ jack modules from the LEONI MegaLine® Connect100 system
  Category 7_A, Class F_A, electrical performance figures as for IEC 60603-7-71
- 2 m patch cable as hybrid cable ARJ45™–RJ45
  LEONI MegaLine® Patch 6_AE_A ARJ45™-RJ45 Category 6_A, Class E_A

› Summary

- **AWG 22**
- **Category 7_A / 8 components**
- **PoE / 4PPoE (PoE++)**
- **Link length > 100 m**
  thereby saving intermediate distributors

In order to ensure longer links >100, it is important to use high-quality products wherever possible. Shielded Category 7_A cables with a high frequency range and shielding allow links of a total length of up to 120 m (channel link) with high-quality 7_A components. No satisfactory result was achieved with standard Category 6_A components, since compensation of the components was too high and the performance reserves were lacking. Collapsed backbone applications for incorporating additional connectivity and wireless LAN access points can best be realised using components of Category 7_A, Class FA.

Both cables and components are standardised and available on the market, giving users maximum flexibility. This simplifies the use of connection points with PoE, PoE+, 4PPoE (PoE++). Planners and users can save costs by doing without intermediate distributors, while also doing away with additional weak points and manipulation points.