# LAN - FIRE BEHAVIOUR, FIRE PROPAGATION AND CALORIFIC POTENTIAL

The European standards EN 50167, EN 50168 and EN 50169 require not only screens but also halogen-free outer sheaths for data cables. Consideration and adherence to these standards is particularly recommended for public facilities like hospitals, schools and airports. Moreover, the use of halogen-free cables is recommended for buildings with a high concentration of persons or material goods.

**Cables with PVC sheath**
PVC standard materials can propagate flames under fire conditions, and in combination with moisture (e.g. extinguishing water) they can generate hydrochloric acid (HCl) by splitting off hydrogen chloride gas. In addition, burning PVC (polyvinyl chloride) causes strong smoke development, and corrosive damage to buildings and equipment can often reach a degree far more severe than the actual fire damage.

All **LAN and XLAN-data cables** are manufactured in compliance with fire propagation behaviour according to IEC 60332-1. Manufacturing in accordance with the stricter IEC 60332-3 is possible on demand.

**Cables with halogen-free sheath**
For these cables, materials are used which do not contain halogens (e.g. chlorine) and do not release corrosive gases under fire conditions. The content of toxic gases is also reduced to a minimum, and smoke development and flame propagation are barely present or possible. Designation notes on the cable are e.g. the abbreviations FRNC or LSOH.

In detail these designations have the following meaning:

| | |
|---|---|
| **FR** | flame-retardant (inhibiting flame propagation) |
| **NC** | non-corrosive (no corrosive constitutents) |
| **LS** | low-smoke (low smoke development) |
| **OH** | zero-halogen (halogen-free) |

Using these materials is safety-relevant because free vision in corridors and escape routes is maintained. This, however, requires the use of such materials for other products as well, e.g. for energy cables or cable routing ducts.

All our data cables can be supplied with these halogen-free and flame-retardant sheath materials upon request. These versions are necessary where utmost importance is ascribed to safety. Additional costs for these cables are relatively low.

**Calorific potential (kWh/m), (MJ/m)**
There are many different combustible installations or products in every building. Some of them are cables and wires, which, although perhaps concealed in intermediate ceilings or ducts, can represent a substantial component, especially in adminstration buildings. These cables have different energy (calorific) values and can increase the total calorific potential of a building significantly. This fact should already be considered at the planning stage in order to minimise the fire load amounts.

**T.K. Kabel oHG · Geschwister-Scholl-Straße 11 · 71384 Weinstadt**
Phone +49 (0) 7151/ 60 68 70 · Fax +49 (0) 7151/ 60 91 00 · info@tk-kabel.de · www.tk-kabel.de

# LAN - PLANNING AND INSTALLATION ADVICE

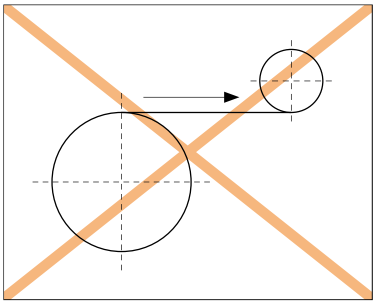
## PLANNING ADVICE

- Fibre-optic cables (FOC) are recommended for establishing the PRIMARY area, whereby the site distributor is usually star-connected to the individual building distributors
- The SECONDARY area can be established using both fibreoptic and copper cables (FOC is recommended), and the structure can be star- or ring-connected.
- The TERTIARY area is designed as star connection consisting of copper cables. 4 pairs covered with a foil screen and a conductor diameter of 0.51 mm are the minimum recommendation.
- In order to cover future applications and requirements, cables with individual pair screening and an overall braid screen are preferable. (higher near-end-crosstalk attenuation and better EMC behaviour)
- Halogen-free cables are recommended for buildings with a high concentration of material goods or persons.
- When selecting the cable type, the system reserves should be designed for an application period of 10-15 years.
- It is also important that all contained components are either screened or unscreened. Existing standards are for facilitation and safety and should be observed.
- In the TERTIARY area sufficiently dimensioned cable runs should be planned due to the high cable density in this section.

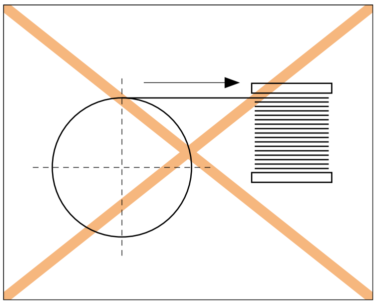
## INSTALLATION ADVICE

- In the tertiary area a maximum cable length of 90 m between the storey distribution boards and the workplace sockets should be observed.
- Attention should also be paid to the grounding balance. The grounding potential difference between any grounding points may not exceed 1 V.
- In combined cable runs energy and telecommunication cables are to be separated by a metallic middle web.
- The cables should be used in closed and dry rooms, and the cable runs should be protected against aggressive chemicals and rodents.
- At storey breakthroughs a subsequent fire barrier is necessary to protect the riser.

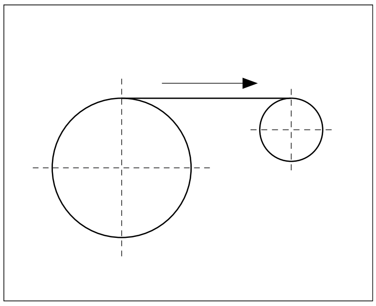
## INSTALLATION GUIDELINES



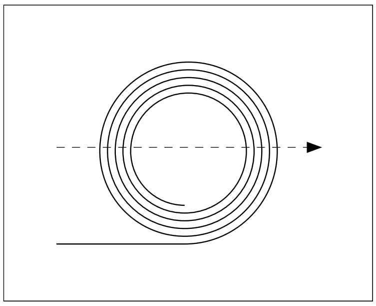
Do not unwind cables from the drum against their original running direction



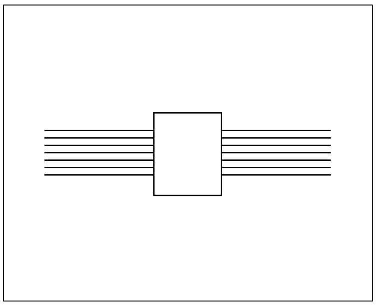
Deflecting the cables is also impermissible.



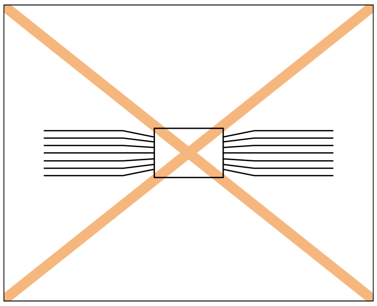
The drum should always be laid horizontally, perhaps on a balancing stand, to avoid mechanical loads.



Cable coils should always be placed in a vertical position and unrolled on the floor to avoid a deflecting effect. If there is not enough space for unwinding the required length, a sufficient bending must be observed when feeding back the cable.



A cable bunch should always lie stretched to avoid potential jammings during installation. If several cables are layed parallel in cable trays, it is recommended to bunch them using a cable tie or insulating tape.



Crushing the individual cables should be avoided when assembling them into bunches.

# LAN - PLANNING AND INSTALLATION ADVICE

## TENSILE LOAD DURING AND AFTER INSTALLATION

Data cables should be subjected to the lowest possible mechanical loads. In relevant standards 5 daN / qmm² Cu conductor are indicated as maximum permissible traction. Depending on the number of pairs and the overall screen construction, the maximum tensile load values are as follows:

| Conductor dimension | Ø NW (mm) | without braid | | with braid | |
|---|---|---|---|---|---|
| | | 2 Pairs | 4 Pairs | 2 Pairs | 4 Pairs |
| AWG 26/7 | 7 x 0.16 | 30 N | 60 N | 70 N | 100 N |
| AWG 24 | 0.51 | 50 N | 90 N | 90 N | 150 N |
| AWG 23 | 0.57 | - | - | 130 N | 190 N |
| Ø 0.6 | 0.6 | 70 N | 120 N | 160 N | 240 N |
| AWG 22 | 0.64 | 80 N | 150 N | 170 N | 250 N |

Attention should be paid to the fact that cables should not be pulled too strongly when bending them around sharp corners or edges. A mechanical load which is too strong can affect the transmission characteristics.

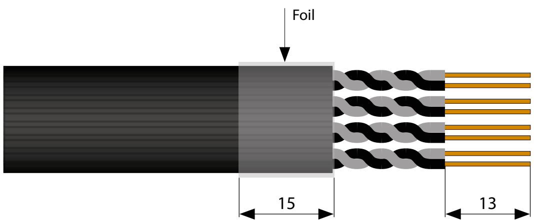
The minimum bending radius may not be less than the octuple cable diameter under installed conditions.

The radius can be reduced to the quadruple cable diameter. In both development and production of **LAN** cables care is taken to achieve the most solid and compact cable construction so that substantial losses of transmission parameters do not occur, even if these installation guidelines cannot be observed due to local conditions.

# LAN - INSTRUCTIONS FOR CONNECTION

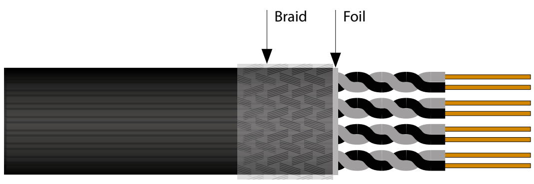
## SCREENED CABLES (FOIL)

The cable ends are to be stripped approx. 10 cm. Then the individual pairs can be straightened corresponding to the pin connection and cut to the required length. The dismantled cable length should be as short as possible to maintain the original twisting. For cable types with aluminium-clad plastic foil care should be taken that the coloured (usually the outer) side is non-conducting. The foil is to be folded back approx. 15 mm over the sheath (so that the conducting side is outside) and fixed with the drain wire. According to EN 50173 maximum untwisting of the pairs may be 13 mm for contacting.



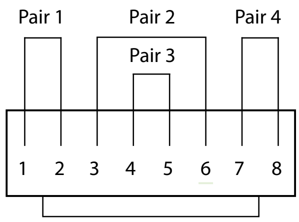

## SCREENED CABLES (FOIL + BRAID)

The screen should always be applied as largely as possible. A possibly present drain wire is only to be used for fixing and not for exclusive contacting. The braid is the only component to be folded back, the foil is not required for screen continuity and can be cut off.




## PIN CONNECTION

The combination of pins and pairs is described in the applicable standards as follows:




| Norm | Pair 1 | Pair 2 | Pair 3 | Pair 4 |
|---|---|---|---|---|
| ISO/IEC 11801<br>EN 50173 | Pair numbers and colours are not defined | | | |
| EIA/TIA-568-B.2 (T568A)<br>EIA/TIA-568-B.2 (T568B) | whbu-bu | whor-or | whgn-gn | whbn-bn |

See installation guidelines of the respective component manufacturer for corresponding pair application to the connection system.

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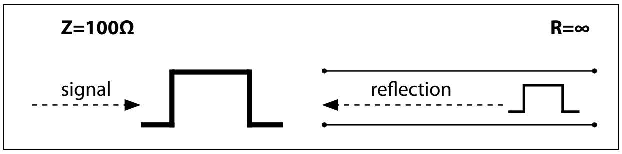
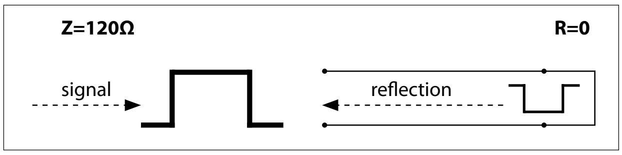
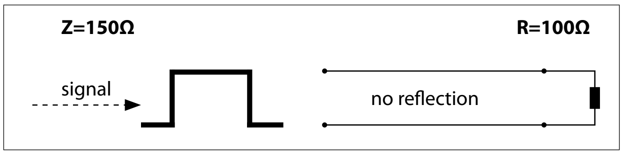
# LAN - KEY CABLE PARAMETERS

**Characteristic impedance – Z (Ω)**
Characteristic impedance describes the terminal resistance of the cable without any line reflections, i.e. the total electrical power fed into a cable by a signal source is transmitted to the output impedance, only reduced by the cable attenuation. The main function of a data cable is to transfer electrical pulse groups. The higher the data bit rate required, the higher the frequency bandwidth of the transmission channel (e.g. cable) to be selected. The output and input impedance values of devices connected to the cable are to be the same as the cable itself (= adapted). Otherwise transmission can be incorrect due to impulse distortions. The characteristic impedance of balanced cables for telecommunications is standardised according to EN 50173-1 bzw. ISO/IEC 11801:




**Attenuation – α (dB)**
The cable attenuation reduces the incoming signal amplitude at the output and thereby, among other things, limits the applicable free cable length. Ohmic loss resistances in longitudianal direction are generated depending on the conductor material and cross-sectional area. Additionally the skin effect (current displacement) reduces the effective conductor cross-section depending on the frequency increase. The frequency-dependence of the selected core insulation material causes additional capacitive loss resistances between conductors. The cable attenuation, which is usually indicated for a reference length of 100 m, defines the transmission ratio between send and receive level.

**Near-End Crosstalk Attenuation – NEXT (dB)**
Crosstalk describes the unintended crossing of signal energy into an adjacent circuit. In this case the electromagnetic field generated by the useful signal of a pair of cores creates a spurious signal in an adjacent pair at the same cable end (NEAR END). The near-end crosstalk attenuation (NEXT) results from the performance ratio„power input at the disturbing pair" to„power output at the disturbed pair" at the same cable end.

**FAR-End Crosstalk Attenuation – FEXT (dB)**
The electromagnetic field of the useful signal at the input of a pair of cores creates a spurious signal on the output side (FAR END) of an adjacent pair. The far-end crosstalk attenuation (FEXT) results from the performance ratio„power input at the disturbing pair" to„power output at the disturbed pair" at the.

**ELFEXT (dB)**
ELFEXT (Equal-Level Far-End Crosstalk) describes the difference between FEXT and attenuation and could also be designated as Far-End ACR. ELFEXT is a calculated value defining the ratio between crosstalk interference level and receive level.

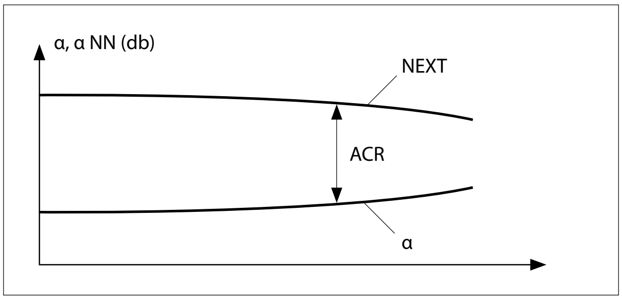
$$\mathbf{ELFEXT_{(f)} = FEXT_{(f)} - \alpha_{(f)}}$$

**Power Sum NEXT – PSNEXT (dB)**
Power sum NEXT is the total near-end crosstalk power sum, i.e. the amount of all spurious signals coupled into a pair of conductors. For twin cables PSNEXT is equal to NEXT. For cables with more than two pairs the difference increases continuously due to the fact that the spurious signals of all adjacent pairs of cores are coupled into one pair of conductors.

**Attenuation to Crosstalk Ratio – ACR (dB)**
ACR is a characteristic variable for basic transmission quality rating of a cable. It describes the ratio between the strength of the incoming useful signal and the disturbing noise signal of an adjacent pair of cores.

$$\mathbf{ACR_{(f)} = NEXT_{(f)} - \alpha_{(f)}}$$

It is important that the useful signal is always stronger than the noise signal, which is indicated by a positive ACR value. At the highest transmission frequency the recommended ACR value of a LINK should be ≥ 4 dB.

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# LAN - KEY CABLE PARAMETERS

**Return Loss – RL (dB)**
If different characteristic impedance values or inhomogeneities occur within a cable system (e.g. between the cable and a component), the fed signal energy at this disturbing point is partially reflected (= backscatter). Return loss is the ratio between fed and backscattered energy and reflects the homogeneity of a cable or a transmission path.These reflections should be minimised in order to ensure faultless transmission.

**Delay Skew (ns)**
Delay Skew describes the difference between signal transit times in the indidviual pairs of a cable (caused by different twisting lengths of the pair). This value - it should be as low as possible - is important for multistage transfer methods because the transit time difference is to be balanced by the receiver.

**Nominal Velocity of Propagation – NVP (%)**
This value indicates the propagation speed of the electrical signal in the cable. Expressed in %, this value is related to light speed in vacuum. The NVP value is also required for length determination of installed cables.

$$\text{NVP} = \frac{\text{expansion speed of the signal}}{\text{speed of light in vacuum}} \times 100\,\%$$

NVP = 77 % expresses a transit time of approx. 0,33 / NVP = 4,2 ns / m

**Transfer impedance – Rκ (Ω/m)**
Electromagnetic compatibility (EMC) gains more and more significance along with increasing transmission frequencies in data cables. In order to protect cables against unwanted noise influence and surrounding electrical equipment against interfering transmissions of cables respectively, for today's data cables more and more attention is paid to a sufficient field screen.

Each current-carrying conductor creates an electromagnetic field. The magnetic field of a pair of cores is to a large extent compensated by twisting the cores, while the electric field is compensated by applying a foil and/or braid screen. The transfer impedance (coupling resistance) is frequency-dependent and increases linearly with the cable length. It is indicated in mΩ/m; the value should be as low as possible. The lower the transfer impedance, the more efficient is the screening effect and thus contributes substantially to the EMC value optimisation of an overall system.

The selection and quality of the earthing point, which should be as low-ohmic as possible for the entire frequency range, is also important for the screening effect.

Using a double screen (foil and overall screen) results in better screening effects especially in the higher frequency range. The transfer impedance can describe the effectiveness of the cable screen: the lower its value the better the screening effect.

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