Cable installation guidelines

Business Unit Industrial Projects

The Quality Connection

LEONI

GENERAL

Installation methods

Many different methods are used for cable installation. These include pulling, blowing and pushing into ducts, direct burial and aerial installation.

Cable properties relevant for installation

The most important properties of cables during installation are the tensile force, the bending radius and the installation temperature. The sections below provide some general guidelines for cable installation.

The permissible temperature range, the maximum tensile force and the minimum bending radii are specified in the relevant data sheet for the cable. Additional relevant data may be specified if necessary, for example recommended microduct sizes for microduct cables.
Some cable designs may require special drum handling and installation procedures.

General installation guidelines

Regardless of the cable type and installation method used, a few general recommendations should be complied with.

Details on the various cable types are given in the following sections.

- During transport and installation, drums should always be handled in an upright position. For additional information, please refer to our Guidelines for Cable Drum Handling.
- Cables and drums should be inspected before installation. Special care should be taken in the following cases:
  - If the winding package is loose. A loose package may cause loops during payoff.
  - If the outer surface winding layer of the cable is damaged. Please do not use these cable sections for installation.
  - If the labels on the drum are illegible or missing altogether. Please check to ensure that the right cable is installed.
  - If the drum is lying on its flange or has been dropped. Invisible damages may have occurred or cable windings may have slipped over each other.
  - If a drum is damaged, loose or rotting. It may break down during payoff.
  - If drum screws are loose. Tighten them if necessary.
  - If cable end seals are damaged or missing. Water may have seeped into the cable.
  - If nails or clamps have been driven into or through the flange. In this case, the cable could be damaged or become damaged during installation.
  - A check must be made as to whether any nails on the inside of the flange are loose. They must be removed because they could easily cause damage to the cable sheath.
- Before a cable is unreeled, its inner end on the drum must be released from the flange.
- The permissible temperature range for installation must be complied with at all times. The specified value is related to the cable temperature and not to the environmental temperature. In case of low temperatures, it may be necessary to preheat the cable before installation.
- The maximum tensile force must never be exceeded during installation. The installation equipment must allow online measurement of the tensile force and should have a suitable emergency stop which is activated when the maximum permissible force is exceeded.
- The cable must never be bent around radii smaller than those specified. All rollers, sheaves and sheave assemblies must not have smaller bending radii than those specified as the minimum radii for the cable.
- The radius of a roller is the distance between wheel tread and central axle.
- During installation, all curvatures should be smooth. The cable should be bent as little as possible. Turn-backs and all sharp changes of direction should be avoided.

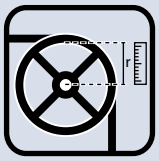
This publication provides information of value for the laying and installation of cables important for us as a cable manufacturer. For this reason, it should not be seen as a "complete" document which treats the subject exhaustively.

INSTALLATION, PROPERTIES AND COMPONENTS

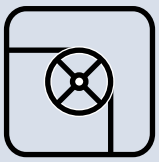
Bending radius

It must be ensured that the permissible minimum bending radius is complied with during the entire installation process. All wheels must have the required minimum radius.

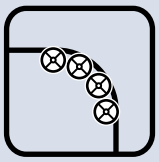
The "real" radius of a wheel is the distance from tread to centre, not from flange to centre.



Avoid excessively small bending radii.



Instead of one big wheel, a set of wheels may be used to ensure a suitable bending radius.



Never use multiple bends.

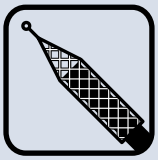
Avoid turn-backs.

Pulling eye and wire mesh grip

A pulling eye or a wire mesh grip is used for pulling cables. These tools transfer the pulling force to the cable. The pulling eye allows higher pulling forces because all strain-bearing elements of the cable are connected to it whereas the wire mesh grip is connected with the outer sheath only.

Cable end equipped with pulling eye

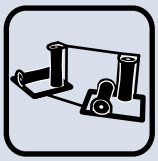
or wire mesh grip.



Cable rollers

During installation, cables should not slide over the floor, causing friction. To avoid damage, cable rollers should be used.

Cable rollers



INSTALLATION METHODS

Depending on their design, cables are installed using various different techniques. Most outdoor cables are installed as underground cables. The following main methods are used for underground installation:

- Installation in ducts (by blowing, pushing or pulling)
- Installation in covered ducts
- Installation via direct burial

The ends of the cables have to be sealed against moisture before, during and after installation. Cable ends should not be damaged during installation.

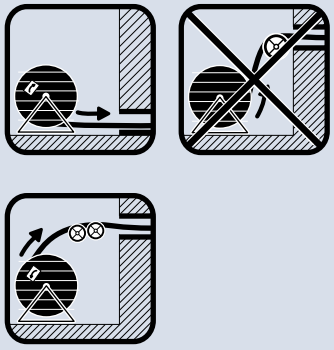
Cables can be pulled using a cable grip (wire mesh grip) on the outer sheath or a pulling eye.

It should be kept in mind that the first few metres (usually approx. 1 to 2 metres) of the cable may be unusable or damaged after installation due to the use of pulling eyes or cable grips and may have to be cut away.

Lower tensile forces occur during blowing because the cable is mainly transported by the air stream. Using an end cap to tighten the cable head towards the duct adds some tensile force. Cables should be unwound without turn-backs.

Unwinding of cables (direction depends on position of duct).

Avoid turn-backs.



Installation in ducts

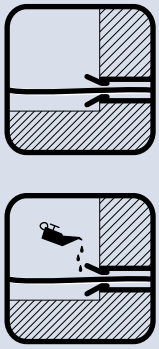
Depending on design, weight and dimensions, cables can be either pulled or blown into the ducts. Lightweight and rigid cables should preferably be installed by blowing whereas heavy cables should be installed by pulling. Pulling methods require higher tensile forces than blowing methods do. It must be ensured that the maximum tensile force permitted for the cable is not exceeded.

Entry into the duct should be in a straight line in order to avoid bends and scratches. This can be ensured by the use of a funnel-shaped bore guide. Lubricating grease may be used to help the cable to slide in the duct. Lubricating materials must be compatible with cable sheath and duct material. A small cavity under the cable front of the duct is suitable to prevent sand, small stones and dust from entering the duct during pulling. After pulling, a cushion layer should be placed under the cable.

Cable should enter the duct in a straight line.

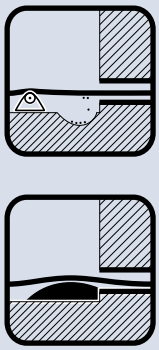
A funnel-shaped duct bore guide.

Lubrication may be used if necessary.



A cavity in front of the duct prevents stones from entering the duct.

Place a cushion layer under the cable after pulling.

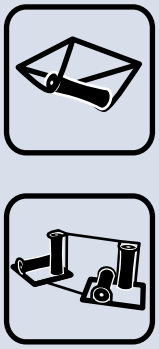


Installation in covered ducts or troughs

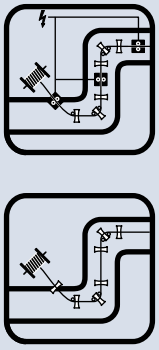
Covered ducts or troughs are cable tunnels which usually contain a larger number of cables. To install cables, the covers are removed. Ducts or troughs should be provided with deflector rollers to avoid friction between cable and duct or trough. The cable may be positioned manually. If feasible, the payoff itself can be moved along the duct or trough.

If the cable is pulled, suitable rollers should be used to guide the cable and to guarantee safe bending radii. It is recommended to use sufficient installation rollers to ensure that the cable does not slide over the floor, causing friction. Motor-driven rollers are recommended for the installation of heavy cables.

Cable rollers



Installation with and without motor-driven rollers.



Installation via direct burial

Underground cables installed via direct burial usually have a stronger sheath design than duct cables in order to allow them to withstand higher mechanical forces such as impact or crushing. Other possible influences on cable design such as rodent protection, chemical resistance, etc. should also be considered.

Cables are either laid in pre-dug trenches or ploughed in when the trench is dug. The trench is filled up with soil again after cable installation. The cable itself is usually protected by a cushion layer of sand or something similar. Suitable measures must be taken to avoid excessively small bending radii.

INSTALLATION OF COPPER CABLES

Tensile load

During the mechanical pulling of cables, particular care must be taken to ensure that the permissible tensile loads are not exceeded. It is vital to make constant checks of the tensile load and provide safety devices which will stop the winch if tensile loads become too high.

The data shown in Table 1 apply for the calculation of the permissible tensile loads. For the exact values, please see the relevant data sheet for the cable.

Table1: Determination of the permissible tensile load

Type of pulling	Cable design	Formula	Factor
With pulling eye on conductors	Cables of all types	P = x S	σ = 50 N/mm²
With pulling grip	Plastic cables without metal sheath and without armouring	P = σ x S	σ = 50 N/mm²
With pulling grip	Plastic cable with wire armouring	P = K x d²	K = 9 N/mm²

P: max. tensile load in N
σ: max. tensile stress in N/mm²
S: sum of conductor cross-sections in mm² (circuit and grounding conductors only, no screens)
K: factor in N/mm²
d: overall diameter of cable

Bending radii

The following values should generally be complied with when cables are installed. For the exact values, please see the relevant data sheet for the cable.

Bending radii can be reduced to half the permitted values in extreme cases provided that they are bent once only and that expert installation is guaranteed (heating up to 30°C, bending over a template). In the case of products manufactured according to specific national or international standards, the relevant bending radii should be complied with.

Table 2: Permissible bending radii

Cable type	Bending radius
Cable without armouring and lead cover	7.5 x overall cable diameter
Cable with armouring	10 x overall cable diameter
Cable with lead cover	15 x overall cable diameter

Installation temperatures

Cables should not be installed below the following minimum temperatures:

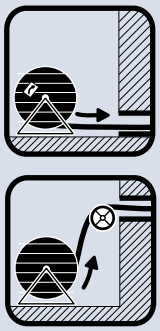
Type of cable	min. temp.
Cable with PVC sheath	– 5 °C
Cable with oil-resistant PVC sheath	+ 5 °C
ICON®Arctic Cable with FRILON PVC sheath (optimised for low temperatures)	– 30 °C
Cable with PE or XLPE insulation and PE sheath	– 20 °C

These figures apply to the cable and not to the ambient temperature. If cables are to be installed at a lower temperature, they must be pre-heated beforehand. Care must be taken to ensure that the temperature of the cable does not drop below the lowest permissible installation temperature during installation.

Special requirements for cables with flat steel wire armour and counter helix

When installing cables with armour made of flat steel wires, special attention must be paid to cable payoff from the drum in order to avoid caging of the armour wires due to multiple bends in the cable.
When a cable is installed in a duct, it must be unwound from the bottom.

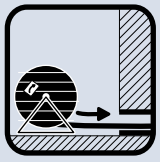
Unwind from the bottom.



Special requirements for heavy cables, e.g. cables with a lead sheath

When installing heavy cables, it must be borne in mind that loose windings will cause loops. Even small loose windings invisible from the outside are critical. In the case of heavy cables, unwinding must be done very carefully, using a slow speed in order to allow the cable to move on the drum. The inner end of the cable must be loose in order to allow free movement. It may be a good idea to always unwind the cable from the bottom.

Unwind from the bottom.



INSTALLATION OF LSZH SHEATHED CABLES

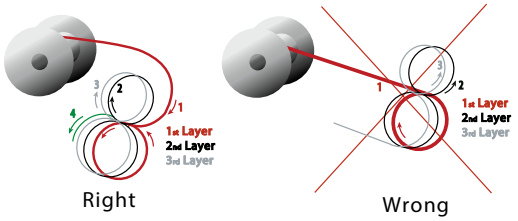
In general, there is no difference between the installation of cables with PVC and LSZH sheaths, except that the strict observance of the installation temperature is of great importance.

Cable with LSZH sheath	min. temp.	max temp.
Minimum temperature	– 5 °C	+ 50 °C

The permissible temperature range for installation must be complied with at all times. The specified value (– 5 °C to + 50 °C) applies to the cable temperature and not to the ambient temperature. During the installation process at temperatures of + 50 °C and above, LSZH sheathed cables are more sensitive to cracks and other damage caused by mechanical stress. The risk of damage occurring during the installation process rises with the temperature.

Mechanical stress can be caused by:

- falling below the permissible bending radius.
- mechanical influences (pressure on the outer sheath) at crossing points: the armour wires of one or two cables crossing each other generate a point of high pressure at this place (figure of eight), so it is important to lay the cable in a figure of eight in the correct way.



- cables damaged beforehand due to the pulling process.
- rough handling of the cables during the pulling process (for example pulling cables over edges).
- torsion of the cable in the "wrong" direction ("opening of armour wires"): it is important that the cables are FIRST turned in such a way that the armouring becomes tighter. If they are first turned in such a way that the armour wires "open" or if this is done too frequently, stress is applied to the outer sheath, causing the outer sheath to open at high temperatures.

In comparison with PVC, LSZH material has a very low tear resistance, so once a cable is damaged, the crack will split further.

INSTALLATION OF FIBER OPTIC CABLES

In addition to installation by pulling or blowing, improved methods for blowing and pushing into microducts are commonly used for Fiber optic cables. These techniques are especially suitable for use with lightweight and rigid cables.

Blowing into microducts

Fiber optic cables should preferably be installed by pulling or blowing. Instead of installing a cable in a duct, several microducts
(= small ducts) can be blown in first. Microduct cables are then blown into the microducts. Common microduct types have inner diameters of between 3.5 mm and 10 mm. Optimised microduct cables and special blowing equipment must be used for these ducts. Regular blowing distances are between 1000 m to 2000 m. Short installation distances of up to 100 m to 200 m can be achieved by pushing in most cases. The installation performance depends to a great extent on cable design, blowing equipment and type and condition of the microduct.

With this installation method, it is vital to use clean cables, i.e. cables may not be stored outside and the drum must always be protected against dirt by a plastic tape. The cable should be lubricated before blowing. Only lightweight drums without defects which allow perfect payoff may be used.

The blowing equipment must have an automatic emergency stop. Otherwise cables may be damaged or destroyed if the blowing process is interrupted.

Bending radii for Fiber optic cables

If not specified otherwise for this type of cable, the bending radius should not fall below the value given below. For exact values please see the relevant data sheet for the cable.

Table 3: Minimum bending radii

Installation	Bending radius
During installation (up to maximum tensile force)	20 x overall cable diameter
After installation (no tensile force)	15 x overall cable diameter

Temperature range

If not specified otherwise, the minimum installation temperatures for the Fiber optic cables are as given in Table 4.

Table 4: Minimum installation temperature

Type of cable sheath	Minimum installation temperature	Minimum storage and transportation temperature
Polyethylene sheath	– 10 °C	– 25 °C
PVC sheath	– 5 °C	– 25 °C
LSZH sheath	– 5 °C	– 25 °C

Find out more:

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