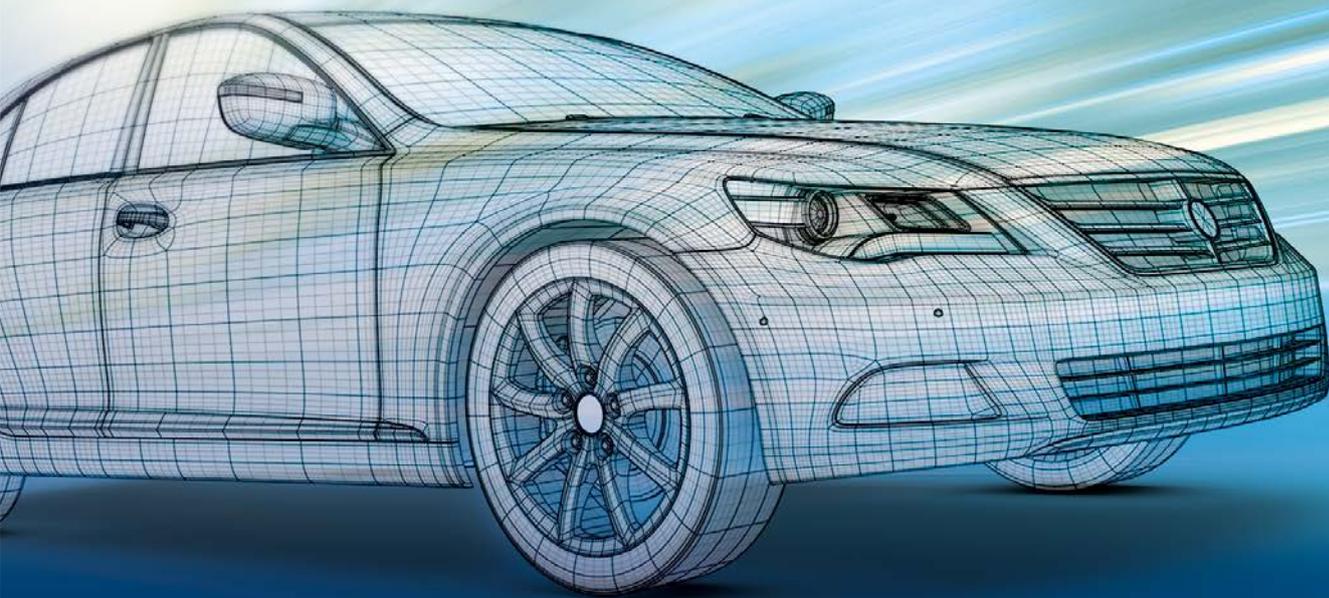
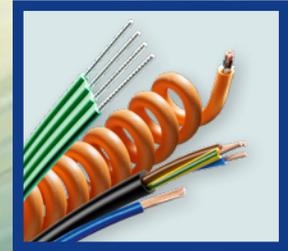


LEONI-cable handling regulations

Automotive Cable Solutions



The Quality Connection

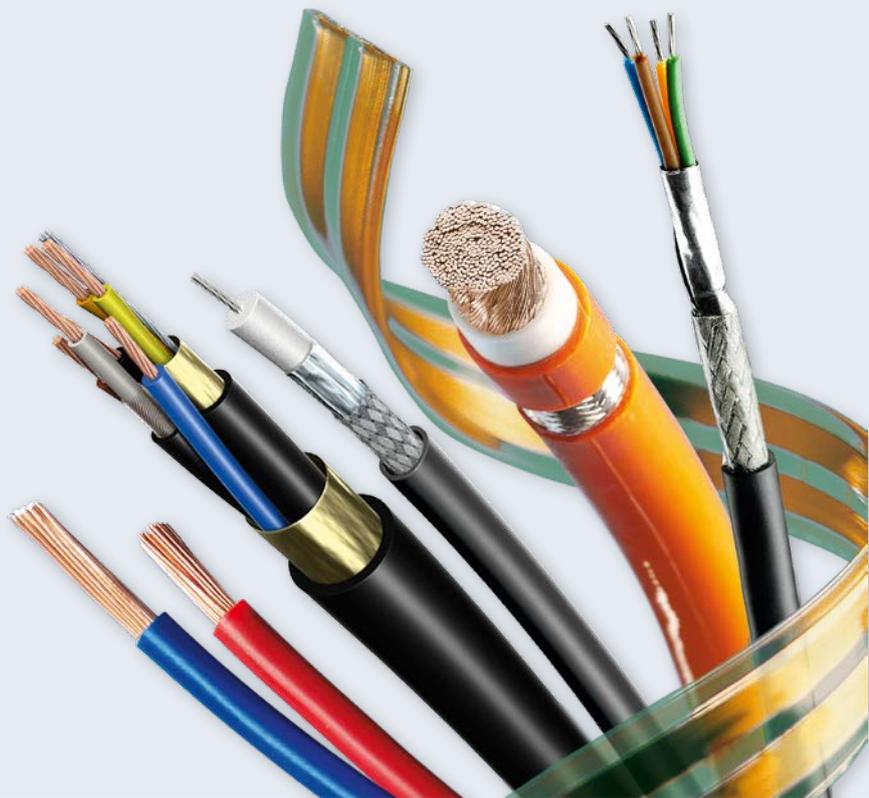
LEONI

The cables and conductors supplied by LEONI Automotive Cable Solutions are, regardless of their respective container, in line with the high standard of an IATF 16949 and ISO 14001 certified company.

The present standard, issued by LEONI, summarizes handling instructions for transport, storage and processing of cables in the form of a directory.

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Remark: The data are based on field experiences with LEONI cables and represent only non-binding advice and recommendations. Compliance does not constitute an extension of the warranty period nor guarantee or compensation claims. The processor must ensure that the contact parts and processes used conform to these handling instructions.



Transportation and storage



Transportation

When transporting the cables, the following guidelines should be adhered to, in order to prevent i.a. crashes, overloading, shocks, overturning or damages of any kind.

Container types and their correct handling:

- Conipacks:
Conipacks must always be transported upright and in single layers. They may not be placed on their side or upside down. The hoisting gear prescribed by the reel manufacturer must be used. Conipacks must be taken apart if returned.

Transportation and storage



- **Barrels/boxes:**
Barrels/boxes are to be transported and stored upright only. It is not permitted to roll barrels. Damage to the covering from tacks/staples must be avoided. If returned, the barrels must always be closed (lid must be on). Adding talcum powder to our pack units is not permitted.
- **Reels/drums:**
All reels/drums must be transported on their sides and are not allowed to lie on the flange.



Transport



wrong



right

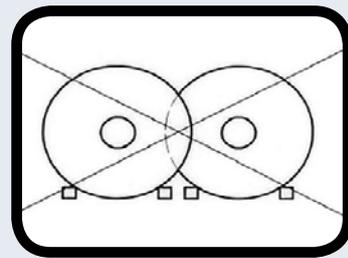
Transportation and storage

Storage

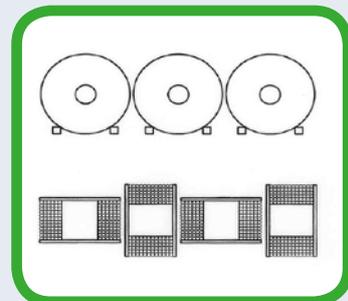
Regardless of the insulation material used in any particular case, a storage period of several years may be assumed by given correct and proper storage conditions.

The subsequent are some of the storage conditions that need to be observed. In case of non-compliance, the quality of the finished cables in their respective containers can be affected:

- Cables should be stored in a dry, frost-free and from direct sunlight secured place, in order to protect the cable sheath from damage and fading. Prior to processing, the cables must be kept in-house storage for at least 24 hours to adopt the room temperature.
- The floor should be clean, with no metal parts, wooden boards or pieces, nails, bricks, etc. to avoid any damage of the cables.
- The cables must not be placed in contact with chemicals and corrosive media.
- Reels and drums must not interlock in storage because the reel flange might otherwise damage the material.
- Cables should be stored at the delivered container to its final processing. Repeated rewinding has to be avoided.



wrong



right

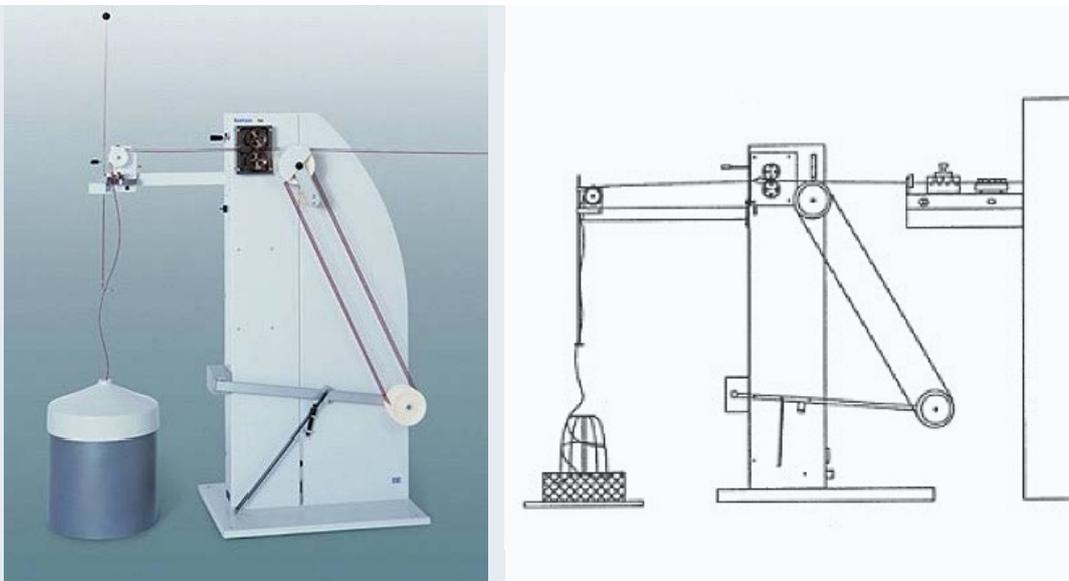
Transportation and storage

Effect of improper storage and transport

Improper storage and transportation of cables affect the material properties and can have a negative effect on further processing.

- Ageing
Extended storage periods beyond normal conditions can result in increased ageing.
- Processing
Processing must be carried out at room temperature, otherwise it could damage the material properties.
- Ultrasonic welding and moulding
In these cases excessive storage periods as well as excessive storage temperatures and bringing the conductor into contact with e.g. grease or oil can compromise the material properties and affect further processing.

Processing



Commissioning

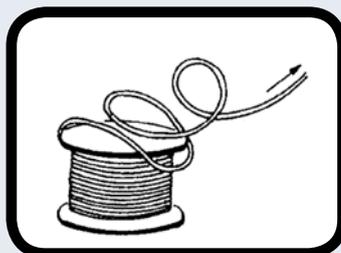
Pay-off device

In the case of single-core cables the pay-off force must be limited to $\frac{1}{4}$ of the conductor material's nominal cross section tensile strength (for Cu the figure is 50 N/mm^2) For conipacks an uncoiling hood must be used, through which the cable is withdrawn tangle-free.

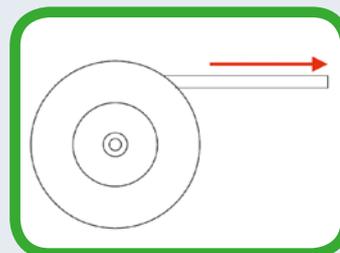
Multi-core and data cables must be uncoiled without twist.

For reels and drums uncoiling must be tension regulated, in order to secure a tension-free and gentle handling. Protective layers, which are fixed as the lowest, single layer to the drum, must not be uncoiled or used.

For machine processing, the tangential pay-off device is recommended. This feature prevents wire knotting in the bundle and guarantees smooth feeding.



wrong

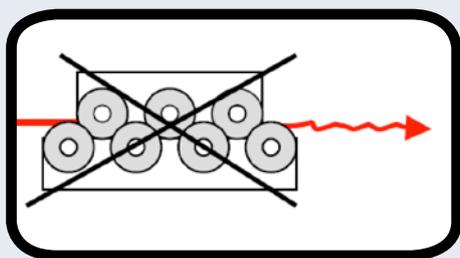


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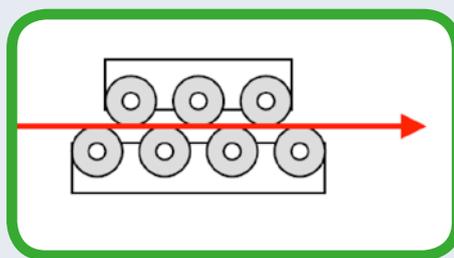
Processing

Straightener

The straightener must be set in such way that the roll straighten the cable but do not damage by applying excessive pressure (which can, for example alter the adherence or the jacket's length relative to that of the conductor).



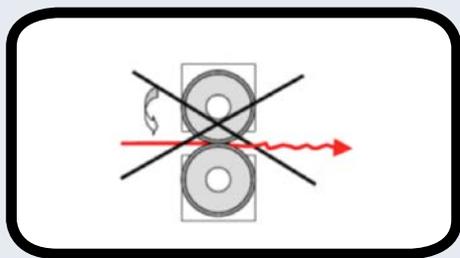
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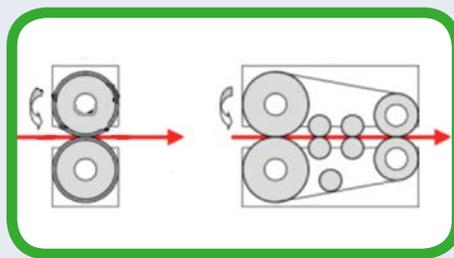
right

Capstan

The downforce selected must be sufficient to prevent the cable from slipping, but not so great that the cable is damaged or changed in shape (oval). It also must be taken care that the arrangement of the single cores or of the conductor is not changed.



wrong



right

Stripping

The stripping depth and the shapes of the stripping blades need to be individually chosen in order to cut the insulation completely, but at the same time keep the substructure undamaged. The processing must be performed without any off pulling or gouging of single-wires or single-cores in case of multi-core cables.

Processing

Characteristics of use

As a matter of principle, the cable must be used in line with the specifications, in accordance with the standards to which the cable has been designed as well as the application for which it was originally intended.

Mechanical forces should only be applicable on the cables if no change or damage is caused to all elements of the cable at any time. This is also to be considered e.g. by using cable ties, metal eyelets and contact with sharp-edged objects.

Bending radius*

To avoid damaging the cable during bending, the inner bending radius must be observed. The given radius is determined by a multiple of the outer diameter. The values are only valid for fix installed cables.

The permissible minimum bending radius for cables and wires in continuous bending applications has to be evaluated individually.

For special cables (e.g. data transmission cables) an individual declaration needs to be done, in order to ensure the special cable properties at any time.

Furthermore, for automotive cables we refer to the winding test according ISO 6722 part 1 and 2 chapter 5.10.

For charging cables see table 3 -minimum bending radius according to IEC 62440.

For cable assembly of automotive cables the subsequent guiding values per cable type need to be considered.

Cable type	Minimum allowed bending radius [mm]	
	Single bending OD = outer diameter	Multiple bending (max. 10 x bending) OD = outer diameter
Single-core cables (FL..., FLR...) nominal cross section $\leq 6.0 \text{ mm}^2$	2 x OD	6 x OD
Single-core cables (FL..., FLR ...) nominal cross-section $> 6.0 \text{ mm}^2$	3 x OD	10 x OD
Twisted, multi-core cables (without sheath)	5 x OD	15 x OD
Multi-core, screened and unscreened cables (with sheath)		
Product portfolio LEONI Adascar® cable types with standard wire A or B	5 x OD	15 x OD
cable types with highly flexible strands (e.g. single wire diameter for 0.5 mm^2 : max. 0.16 mm)	3 x OD	10 x OD
Flat cables with OD = width x thickness	5 x OD	15 x OD

* Information on bending radius are recommendation of working group "AK Technik" of the German Cable Makers' Association ZVEI department Automotive, dated November 2005 and were accepted by all member cable manufacturers. All concerned OEM were informed.

Processing

For the cable assembly of charging cables, the following standard values according to IEC 62440 per cable type must be observed:

Cable type	Minimum bending radius [mm]			
	Cable diameter ≤ 8	Cable diameter $> 8 \leq 12$	Cable diameter $> 12 \leq 20$	Cable diameter > 20
Cable for fixed installations:				
Normal use	4 D	5 D	6 D	6 D
Careful bending at termination	2 D	3 D	4 D	4 D
Flexible cables (thermoplastic, e.g. PVC)				
Fixed installation	3 D	3 D	4 D	4 D
Free movement	5 D	5 D	6 D	6 D
At inlet of portable appliance or mobile equipment ^a	5 D	5 D	6 D	6 D
Under mechanical load ^b	9 D	9 D	9 D	10 D
Festooned ^c	10 D	10 D	11 D	12 D
Repeated reeling ^b	7 D	7 D	8 D	8 D
Deflected by pulleys ^b	10 D	10 D	10 D	10 D
Flexible cables (thermosetting, e.g. rubber)				
Fixed installation	3 D	3 D	4 D	4 D
Free movement	4 D	4 D	5 D	6 D
At inlet of portable appliance or mobile equipment ^a	4 D	4 D	5 D	6 D
Under mechanical load ^b	6 D	6 D	6 D	8 D
Festooned ^c	6 D	6 D	6 D	8 D
Repeated reeling ^b	6 D	6 D	6 D	8 D
Deflected by pulleys ^b	6 D	8 D	8 D	8 D

D = the overall diameter of round cables or the smaller dimension of flat cables.

^a No mechanical load on the cable.

^b With regard to dynamic stress.

^c As in gantry cranes.

Assembly

The choice of terminals must follow the characteristics of the cable in use. The cable's design must be taken into account in selecting the bonding method in order to not compromise the cable properties. (e.g. when cables remain too long in the solder bath, the insulation shrinks)

The contact area at the terminal must be free of oils, grease, dust and flakes because these could have an adverse effect on the connection between the terminal and the conductor.

Processing

The contact must not have any damage that might harm the cable (conductor and insulation) or adversely influence the connection.

The contact geometry has to be set up in such way that neither the individual wire nor the insulation is damaged (for example by excessive deformation or cutting into the conductor / insulation).

In order to counteract potential contact corrosion, contact materials with the conductor similar standard potential E° must be used and the bonding area has to be kept clear of media that favor corrosion.

The conductor has to be kept clean during handling, storage and assembly (no contamination by other materials, e.g. metal dust, which could have negative influence).

The welding parameters depend on the surface cleanliness and the material properties of the parts to be connected. A correct dimensioning of the welding machine and the optimal maintenance condition of the tools must be ensured. The welding parameters need to be adapted to the contact and machine constitution. Different wire constructions (even with the same conductor cross-section) must also be considered when determining the welding parameters. Standard parameters of equipment manufacturers can only serve as a benchmark, but must conform the parts to be processed.

During soldering, it should be ensured that no solder from the contact zone further penetrates into the cable interior (e.g. by capillary effects), as this leads to impairment of cable properties.

For special cables: to maintain the electrical properties of the cable and in particular to maintaining a good crosstalk attenuation the cable pairs or quads should not be untwisted more than necessary (length <13 mm). For screened cables, the shield must as far as possible be extended into the plug in order to not unnecessarily reduce the EMC characteristics.

Reprinting

In this case excessive storage periods as well as excessive storage temperatures and bringing the jacket into contact with grease or oil can compromise the material. (e.g. ink adheres insufficiently on the insulation)