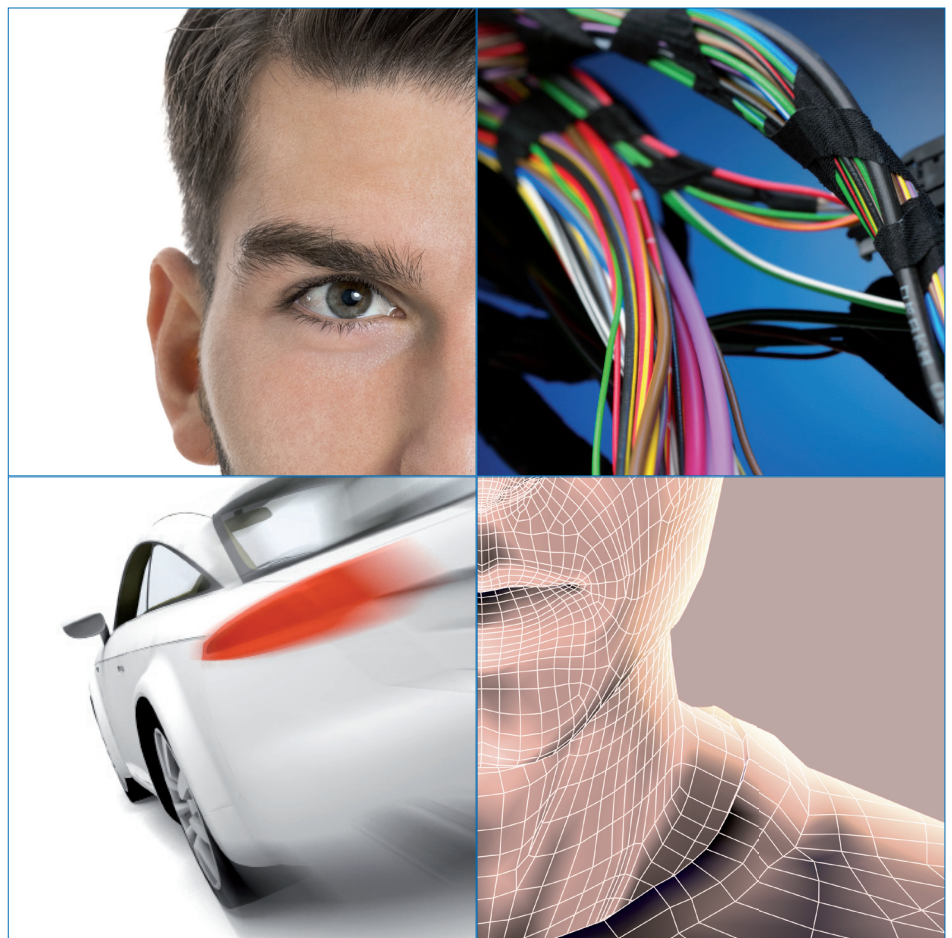


Technical Guideline – TLF 0100:

# Application notes for automotive cables



September 2019

German Cable Makers' Association



Die Elektroindustrie

**Technical Guideline – TLF 0100:  
Application notes for automotive cables**

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# 1 Area of application

The area of application of this TLF (technical guideline) is limited to automotive cables. Automotive cables in this technical guideline are conform/similar to ISO 19642. Equivalent or better products should not be excluded as they may serve the rapid further advancement while taking the increasing requirements during development of motor vehicles into consideration.

# 2 General information

This technical guideline (ZVEI-TLF) in its present version was prepared by representatives of the cable manufacturers represented in the ZVEI (German Electrical and Electronic Manufacturers' Association). The directions in the TLF serve the manufacturer and/or the OEM to prepare individual specifications.

This ZVEI-TLF-0100 is made available, in the various updated versions, to the members of the technical working group on the 'ZVEI-Connects' members' portal and is updated or amended as required by the working group. Once the work is completed, the TLF is released as an association publication without any delay.

The ZVEI-TLF corresponds to the respective working status at the time it was prepared and is intended as a non-binding guide for manufacturers. It does not lay any claim to being complete.

# 3 Characteristics of application

## 3.1 General

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 to as well as the application for which it was originally intended. Thermal and mechanical forces shall be applied in a way, that the cable components are at no time altered or damaged. This also applies to the use of cable ties, metal eyelets, or any other contact with sharp-edged objects, for example.

## 3.2 Thermal stress

The upper limits must not be exceeded by heating the cable, through heat current, or ambient thermal effects. The lower limits stipulate the lowest permissible ambient temperature.

## 3.3 Mechanical stress

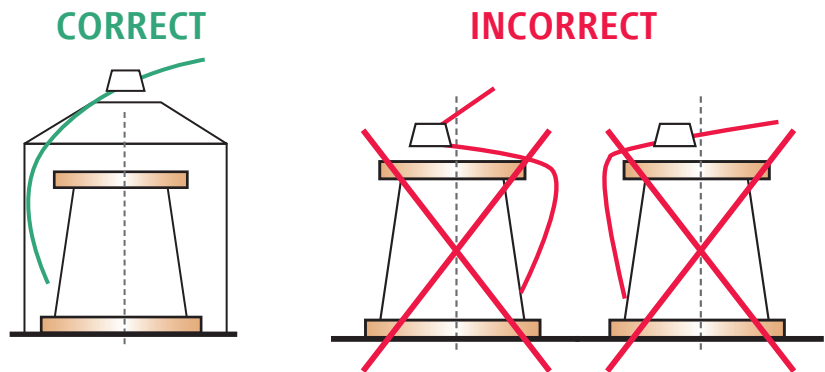
Tension on the cable shall be as low as possible. The following tensile loads on the cables' conductors must not be exceeded. When manufacturing the cable harness (for example with the following work steps: stripping, cutting, wrapping, and laying) and subsequent fitting in the component / vehicle, the individual conductors must not be stressed with more than 50N/mm<sup>2</sup> nominal cross-section for copper conductors or 20N/mm<sup>2</sup> for aluminium conductors. Information on other conductor materials should be obtained from the manufacturer.

# 4 Processing

## 4.1 Decoiling the cables

In the case of single-core cables, the tensile strength must be limited as per 3.3. A decoiling hood shall be used for cable packs, through which the cable is drawn loop-free overhead. In the case of NPS reels, the cable should be decoiled across the middle of the NPS. The use of a decoiling hood is recommended. As a matter of principle, the cables shall, until they are stripped, be fed in such a way that damage and forming of loops is prevented. Consequently, sufficient tension must be selected when cables are pulled off. After processing the required quantities, the loose cable end must be fixed tightly to the upper flange before storage. Powered processes must be used for larger cross sections (e.g. >10 mm<sup>2</sup>).

Fig. 1 and 2: Unwinding the cable



## 4.2 Decoiling of multi-core and data cables without twist

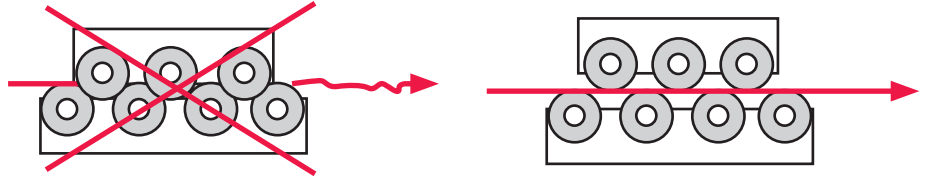
Reels and drums shall be decoiled in a tension-controlled and as gentle as possible manner. Protective layers that are fixed on the inside bottom on the drums as a single layer shall not be decoiled or used. When drums are machine-processed, the recommendation is to use a tangential pay-off as this prevents knotting in the bundle and guarantees seamless further processing.

Fig. 3: Tangential pay-off



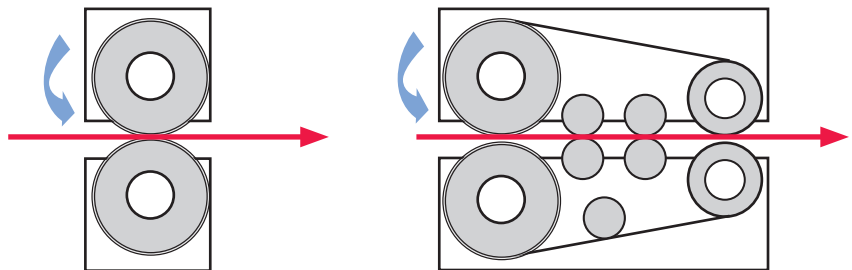
### 4.3 Straighteners

Straightening devices must be set in such a way that the cable's rollers are straight, but do not cause damage due to excessive pressure, which could, for instance, change the adhesion or the length of the insulation on a conductor.



### 4.4 Cable pull-off

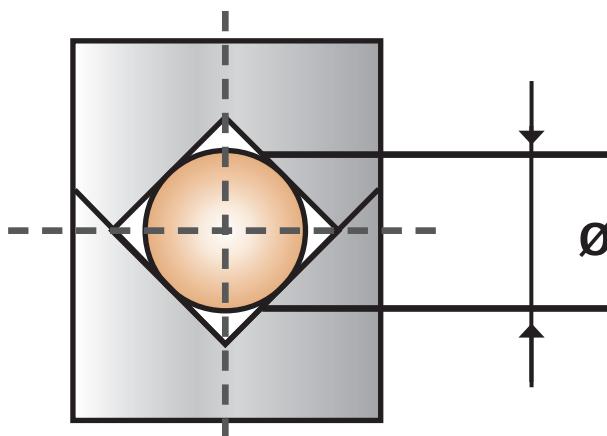
The clamping force must be big enough to ensure the cable does not slip but must not damage it or alter its shape (oval). Care must be taken that the order of the single cores or of the conductor is not altered.



### 4.5 Cable stripping

The stripping depth and the blade shape must be selected in each case in such a way that the insulated coverings are cut without damaging the substructure (stranded conductor or twisted assembly). Processing must avoid distending / cupping of the insulated covering of individual wires or the single cores while stripping a multi-core cable.

Fig. 4: Check of opening distance of the cutting/stripping blade



## 4.6 Bending radius

The inner bending radius must be considered to rule out damage to the cable while bending. The identified radius is determined by a multiple of the outer diameter. The stated values apply only for cables in fixed installations.

The minimum permissible bending radius for cables used in continuously flexed operations must be determined on a case-by-case basis. Particularly in the case of special cables, such as data transmission cables, there will be an individual specification to ensure the special cable properties at all times.

The following parameters must be observed per cable type during cable assembly:

| Cable type   | Minimum permissible bending radius (mm) |  |
|--|---|--|
|  | One-off bend<br>D = diameter            | Repeated bending<br>(max. 10 bends),<br>D = diameter |
| Single-core cables (FL..., FLR...)<br>nominal cross section $\leq 6,0 \text{ mm}^2$                  | 2 x D                                   | 6 x D  |
| Single-core cables (FL..., FLR...)<br>nominal cross section $> 6,0 \text{ mm}^2$                     | 3 x D                                   | 10 x D   |
| Twisted, multi-core cables (without jacket)  | 5 x D                                   | 15 x D   |
| Multi-core, unshielded and shielded sheathed cable   |   |  |
| Version with standard strand A or B  | 5 x D                                   | 15 x D   |
| Version with high-flex strand<br>(e.g. single wire diameter<br>of $0.5 \text{ mm}^2$ : max. 0.16 mm) | 3 x D                                   | 10 x D   |
| Flat cable version with<br>D = width x thickness   | 5 x D                                   | 15 x D   |

# 5 Packaging, storage and handling/transport

## 5.1 Packaging

Cables are supplied, for example, in rings, barrels, on reels, or in (NPS) cable packs. The recommendation is to transport reels and cable packs upright and unstacked. The manufacturer-recommended lifting equipment should be used for cable packs. When returning to the manufacturer, it is recommended to dismantle the cable pack to ensure its recyclability in the manufacturing process.

Fig. 5: Delivery



**Fig. 6: Hoisting gear**



**Fig. 7: Return**



**Fig. 8: Reel placed upright on its flange**



Barrels and boxes shall be transported and stored upright only. They must not be rolled. Damage to the covering from tacks / staples must be avoided. Barrels must always be returned closed. They must be sealed with a lid to avoid contamination.

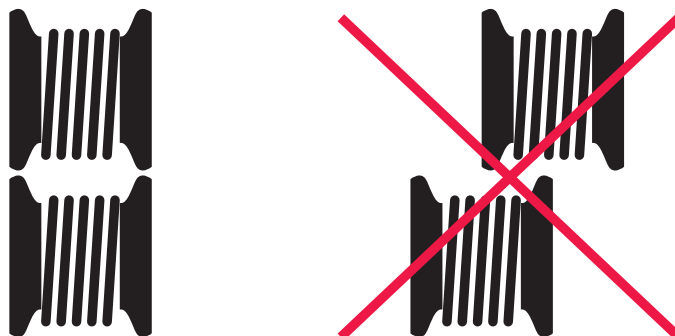
## **5.2 Storage**

Regardless of the insulation material used, a storage period of several years may be assumed given correct and proper storage conditions. The following are some of the storage conditions to be observed, with failure to do so potentially impairing the quality of finished cables in their respective make-up. They must be stored at temperatures between +15 and +35 °C in a dry location protected against influences from weathering.

The recommendation is to not exceed a maximum relative humidity of 75 percent. The location should be protected against direct sunlight and UV exposure to prevent the cable jacket from damage and colour fading. Prior to processing, the cables must be stored in closed spaces for at least 24 hours so they can reach room temperature. The floor should be clean (clear of metal parts, wooden boards or pieces, nails, stones, etc.) to ensure the products are not damaged.



The cables must not be brought into contact with chemicals or corrosive agents. Reels (NPS) and drums must not interlock in storage because the reel flange might otherwise damage the material.



The cables should remain on the packaging units used for shipping until their final processing. Rewinding should be avoided.

The cables must be protected against water penetration (rain / condensation). The storage period may be limited by certain requirements associated with subsequent processing steps. For cables dedicated to ultrasonic welding, it is recommended to limit the storage time to six months after delivery under outlined storage conditions. The process owner must define any restrictions.

### 5.3 Transport

The cables must be protected against all risk of damage during transport.

### 5.4 Impact of incorrect storage and transport

#### 5.4.1 General

Incorrect storage and transport of cables will affect the material properties and may have an adverse effect on the subsequent processing. Extended storage periods beyond normal conditions can result in accelerated ageing.

#### 5.4.2 Impact on ultrasonic welding and overmoulding / bonding

In such cases, excessive storage periods, excessive storage temperatures or contamination of the cable or conductor (e.g. with grease or oils) can result in curtailing of material properties or impairing of processability.

## 6 Assembly

The cable's design must be considered when selecting the bonding method so that the cable properties are not compromised. For example, staying too long time in a solder bath can result in insulation shrinkage. The contact areas at the terminal lug 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. The terminal must not have any damage that could harm the cable (either the conductor or the insulation) and adversely affect the connection.

The contact geometry must be set in such a way that neither the individual wires nor the insulation are damaged.

To counteract possible contact corrosion, the contact materials used must have a Standard Potential E that is similar to the conductor. Furthermore, the connecting surface must be kept free of agents that facilitate corrosion.

The conductor must be kept clean during handling, storage and processing; in other words, contamination by such foreign materials as metal dust must be avoided. The welding parameters depend on the surface cleanliness and the material characteristics of the parts to be connected. Correct dimensioning of the welding machine and optimum service condition of the tools must be ensured. The welding parameters must be adjusted to the nature of the contact terminal and equipment. Different strand constructions (even with the same conductor cross section) must also be considered when setting the welding parameters. The standard parameter settings of equipment manufacturers can only serve as a guide and must be adjusted to the parts to be processed. Care must be taken when soldering so that no solder penetrates from the soldering area further into the inside of cable (e.g. by capillary action) as this would impair the cable properties. The rule for special cables is that, to preserve the cables' electrical properties and particularly to maintain good crosstalk attenuation, the cable pairs or quads must not be unnecessarily torsioned. In the case of shielded cables, the shield must reach into the connector as far as possible for the EMC properties not to be unnecessarily lowered.

## 7 Re-marking

For some insulation materials an additional marking after cable production is not possible. The cable manufacturer should be consulted when in doubt. Excessive storage periods or temperatures and the contact of the jacket with grease or oil could limit the ability to (re)mark the cable.





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