Principles
of
Crimping Technology
The Conductor
Handling – Cutting - Stripping

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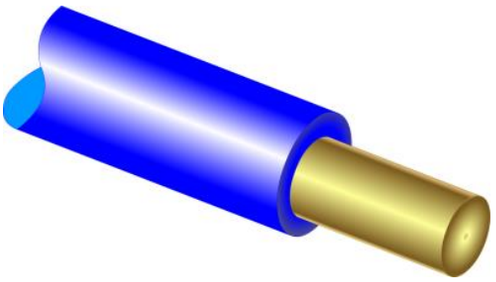
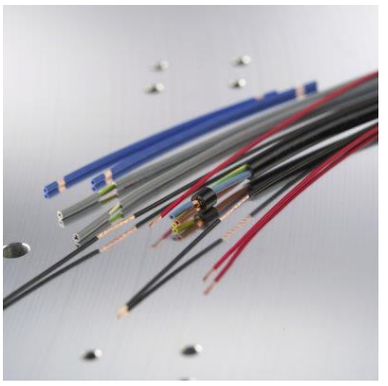
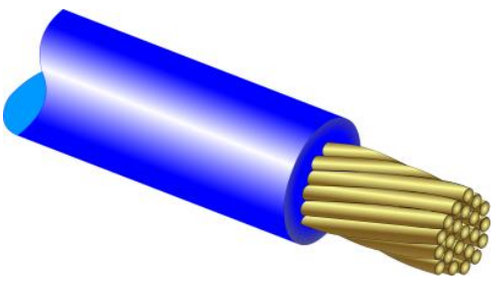
1. *CONTENT*

3. *Basic Conductor Structure*

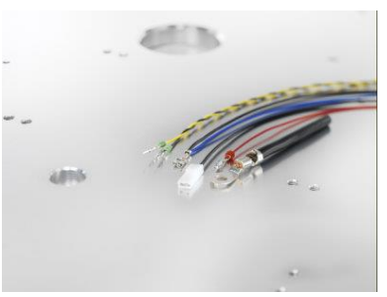


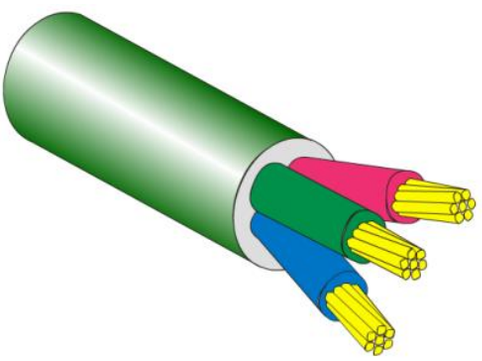
Solid wire
(Main use: electrical installations in buildings)





Stranded wire
The more individual wire strands there are in a cable, the more flexible the cable. The sum of the cross sections of all individual wire strands equals the cross section of the cable.





Sheathed cables (Jacketed cables)
Multiple conductors made of single wires are referred to as multi-conductor or multi-conductor sheathed cables.

Shielded cables
(Coax - Triax)

4.2 DAMAGE TO THE INSULATION

Damage to the insulation must be avoided at all costs when unpacking a delivery and during storage. This also applies to the handling of the cable during the entire manufacturing process, as well as during the final assembly of the finished cable harness.

It's ok, if insulation shows slight pressure marks. But damage to the surface is not permitted!

If the surface of the insulation is damaged, this damage is not necessarily visible at first sight! (Fig. 1)

If the cable is bent, e.g. when producing the cable harness (and/or during installation in the device or vehicle), the insulation can later burst open at the damaged point. (Fig. 2)

The dielectric strength in the damaged area will be reduced or void. (Fig. 3 and 4)

The insulation surrounds the stranded wire and insulates the wires from each other and from all conductive materials (housing wall/body) in the immediate vicinity.

Undamaged insulation is important, especially for cables with high currents.

If the surface of the insulation is damaged, there is a risk of an electrical breakdown ("arcing" or "arc discharge") at high currents.

Info: The dielectric strength is usually specified in kV/mm. It defines the maximum electric field strength that may prevail in the insulation without a voltage breakdown (arc) occurring. Depending on the application of the cable, the required dielectric strength of the insulation is determined.

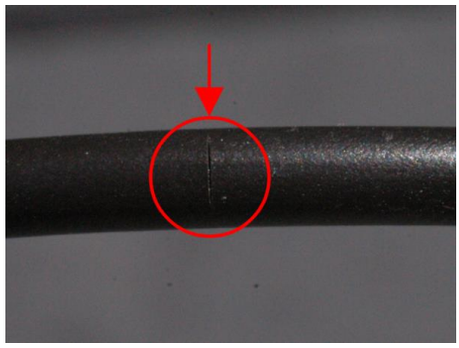


Fig. 1

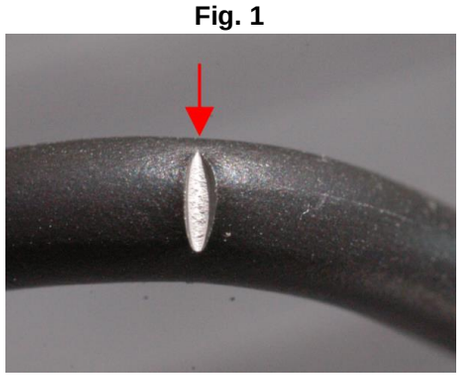


Fig. 2

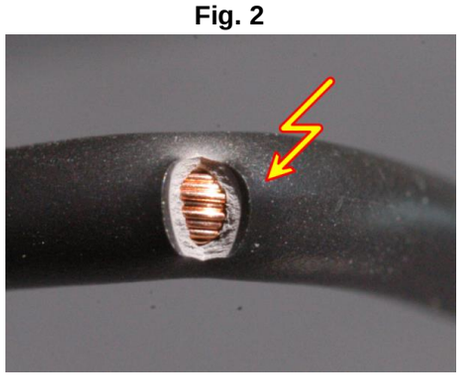


Fig. 3

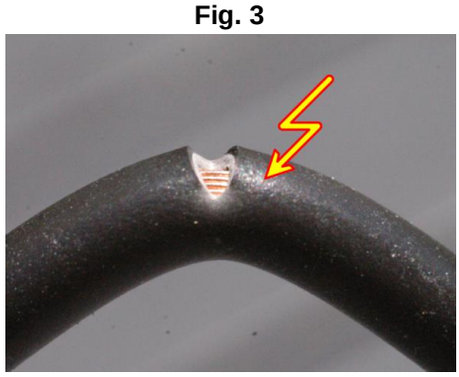
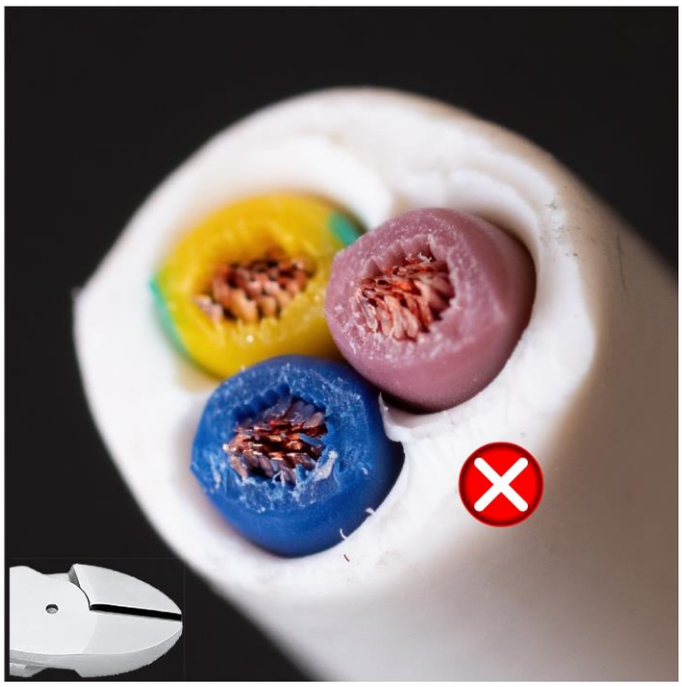


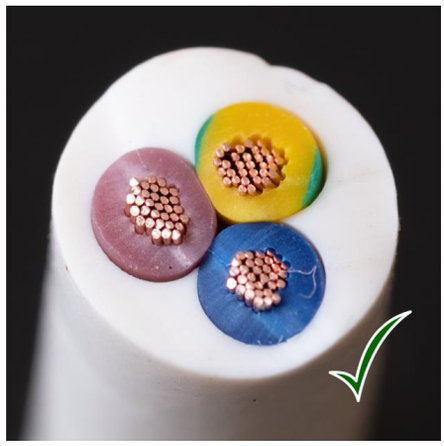
Fig. 4

Test system: Spark Tester (from Komax)

This inspection system can be integrated into fully automatic wire stripping lines and finds the smallest damages to the insulation. Any damaged cable areas are automatically cut out.

6.5 A DIRECT COMPARISON: CABLE SHEARS VS. SIDE CUTTER

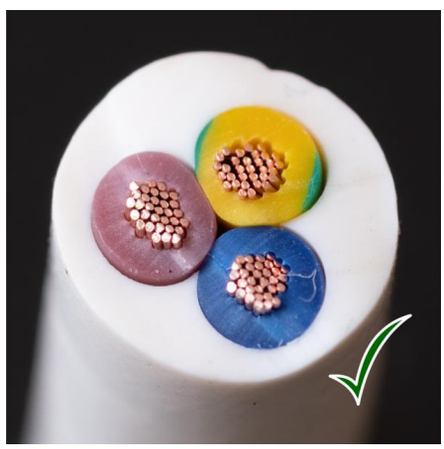




(Sectional view cable shears)

The cut on the left was made with a "brand new" side cutter. Considerably more force had to be used to cut the wire.

The two butting cutting edges deform the sheathed cable and the inner conductors. The individual wire strands are also deformed and look like plucked off.



(Sectional view cable shears)

The cut on the left was made with a "used" side cutter.

Due to the wear of the cutting edges, the force required to cut the sheathed cable increases enormously.

- The geometry of the sheathed cable and the inner conductors are permanently deformed.
- The individual wires are deformed and no longer in the original stranded composite.
- Due to the squeezing, the individual wires have been pressed into undefined lengths.
- The squeezed insulation threads show the poor cutting properties of the side cutter.

7. *WIRE STRIPPING*

7.1 BASIC RULES OF WIRE STRIPPING

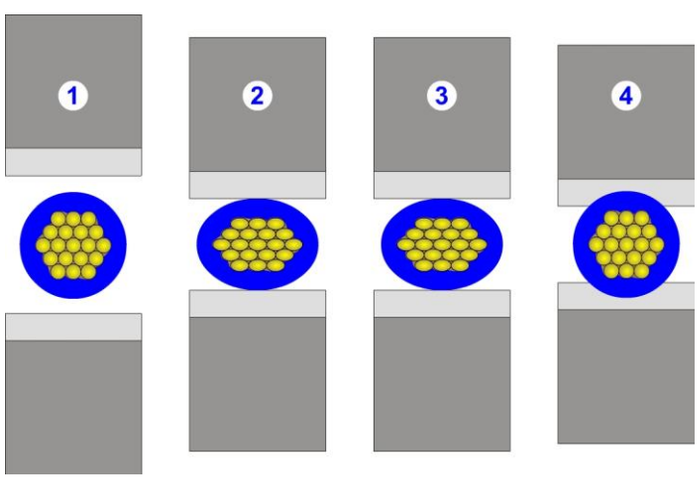
Making a good, working crimp connection starts with properly stripping the wire. During the stripping process, the stripping blades cut the insulation, but must not damage or cut the strands in the process.

Important: According to the official standards, all individual wire strands must be undamaged and complete!

In the field, there are wires that have a large number of individual wires in relation to the nominal cross-section (finest-stranded wires). These conductors can often NOT be stripped without loss. Then, in deviation from the standard, the values defined in the customer's processing instructions or delivery specifications apply.

Example: Specification in % depending on the cross-section whereby the result is rounded down:
Up to 0.5 mm² = 5%; up to 0.75 mm² = 8%; above 0.75 mm² = 8%.

Effective control in manufacturing:
When you find single, cut-off wire strands on the workstation or in the bin!



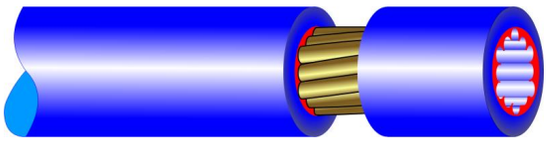
If the cutting edge of the stripping blade hits the insulation (1), the cable is deformed (2). I.e. the insulation is compressed. Then the insulation "flows" around the cutting edge (3) and is cut (4).

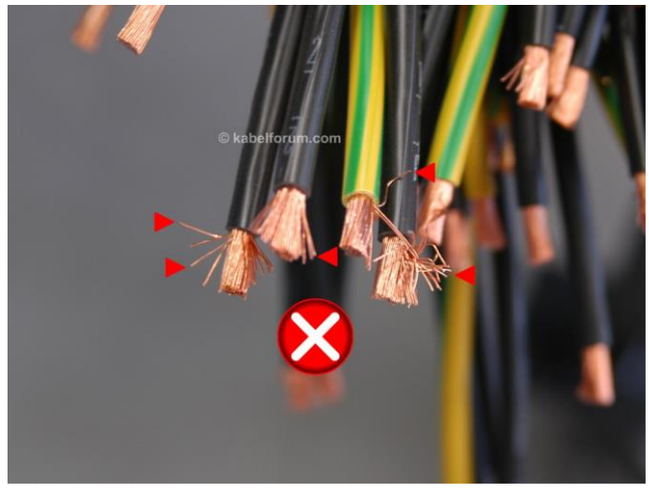
This means that depending on how hard or soft an insulation is, the pressure of the blade must act on the insulation for a certain time until it is cut. The softer the insulation material, the longer this dwell time of the knife. If the dwell time is too short, the insulation is only partially cut.

Of course, the sharpness of the blade also plays an important role. If a knife wears out and becomes increasingly dull, the cutting properties deteriorate and as a result the dwell times become longer.

Important: Optimizing the dwell times increases the production speed. Regular controls of the stripping results give conclusions about the sharpness of the stripping blades.

7.3 Partial Removal of the Insulation Jacket



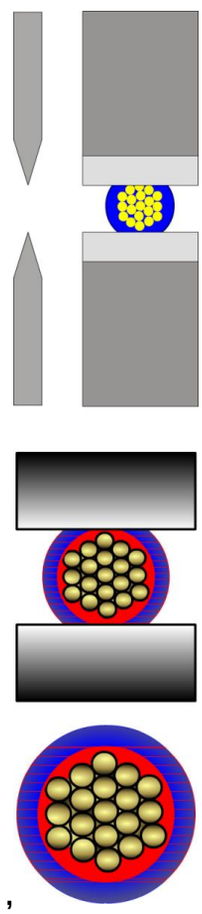
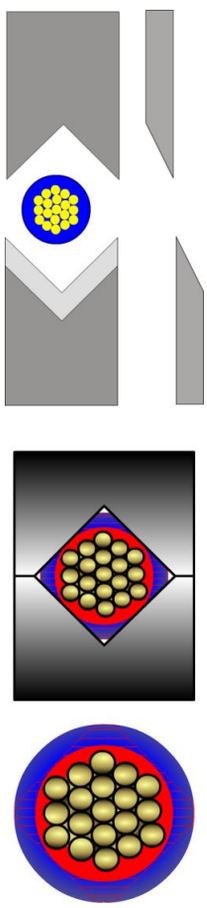
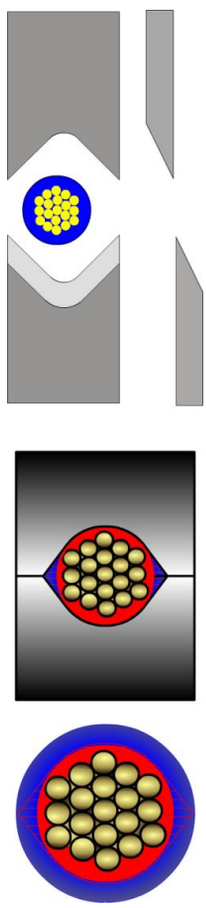
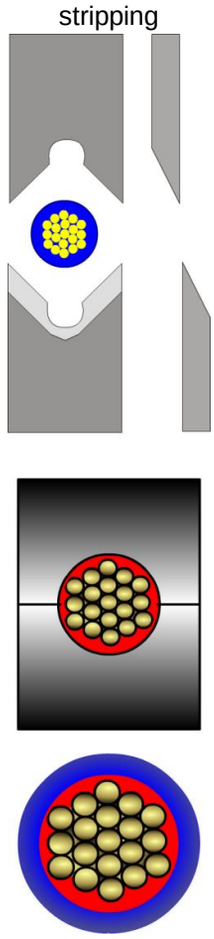
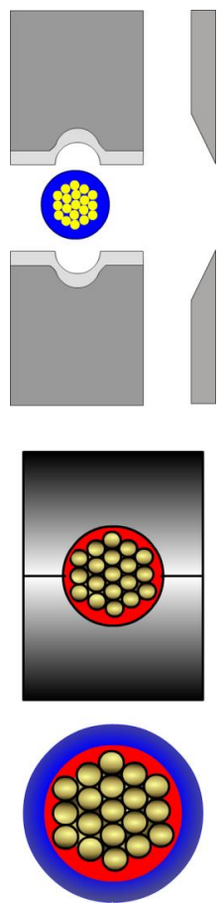


If stripped wires are stored temporarily before further processing, it is absolutely necessary that the stripped jacket part remains on the wire as protection for the cable end.

This "partial stripping" prevents individual wire strands from being kinked and sticking out of the strand composite.

7.4 Types of Stripping Blades

Stripping blade types at a glance

Straight shape	**V-shape Cutting & Stripping Blade**		**Radius Blades**	
	with straight edges	with curved edges	for cutting & stripping	for stripping only
				

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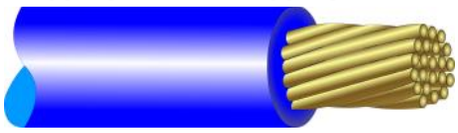
The area of the insulation coloured in red cannot be cut into and is always torn off! The blue and red shaded area is not being cut by that type of stripping blade and is therefore also torn off.

Special blades:
Depending on the requirements of the stripping task, special stripping blades are developed. The picture on the left shows an example of a special blade for stripping multi-core wires in one operation. (This blade was developed by the company Schleuniger).

7.14 Error Descriptions during Stripping

7.14.1 Overview

Good stripping vs. Bad stripping



Stripping OK
All single wires are present and undamaged
Insulation is cleanly cut

Indicated in % depending on the cross-section and the result is rounded down.
Up to 0.5 mm² = 5%* | up to 0.75 mm² = 8%* | over 0.75 mm² = 8%*

From a conductor cross-section of 25 mm², no more than 30 individual strands* may be cut off (finest stranded conductors).

***Attention: The specifications may change, depending on customer specs & requirements!**

Individual wires damaged and / or cut off

Single wire pulled

Surface of single conductor strands scratched on one side

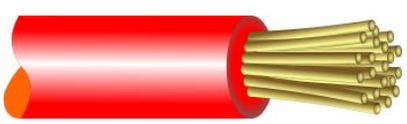
Insulation improperly cut

Insulation threads

Insulation damaged

Insulation residues on the single strands

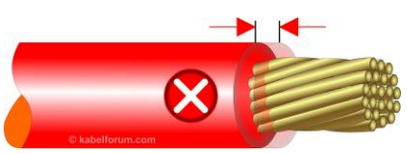
Twisting of the individual strands lifted



Broom shaped conductor

Kinked wire strand

Conductor overtwisted



Variations in stripping length

Wire strands strongly oxidized

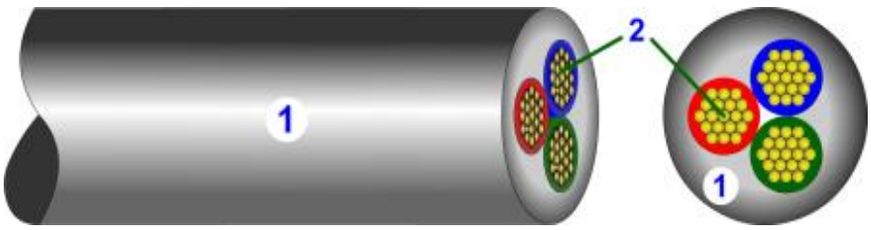
Protruding Insulation („hollow“ cable)

8. *MULTI-CORE SHEATHED CABLES*

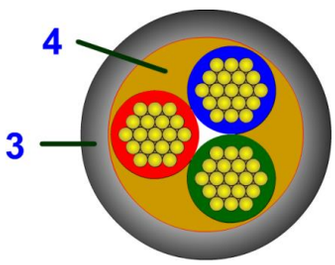
8.1 GENERAL

As a rule, as much as possible of the insulation of the outer sheath must be cut with the stripping blades without damaging the insulation of the inner conductors. The uncut part is torn off during stripping. The insulation of the outer sheath must also not be damaged in the process. Pressure marks are permissible.

8.2 THE STRUCTURE OF MULTI-CORE SHEATHED CABLES

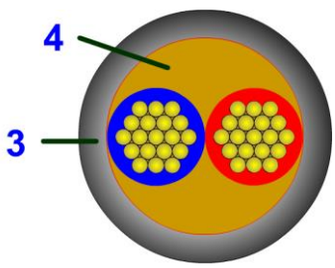


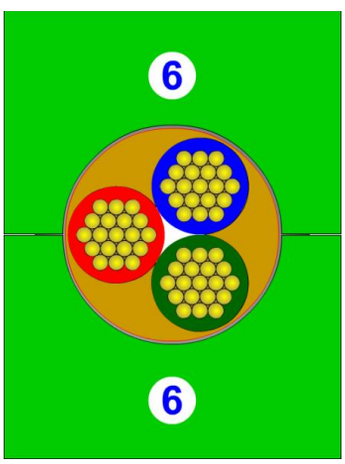
(1) Outer sheath
(2) Inner conductor



(3) Inner conductor
(4) Non-cuttable sheath
(6) Stripping blade (closed)

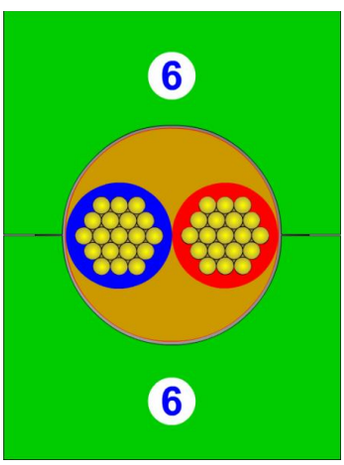
The dimensioning of the stripping blades depends on the arrangement of the inner conductors in the sheathed cable. The aim is to cut into as much of the insulation of the sheath as possible.

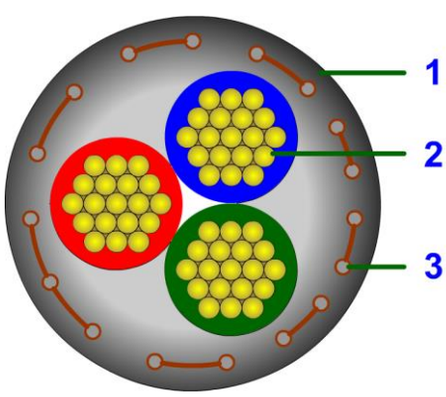




In this example, radius stripping blades (6) were selected. The diameter here is matched to the arrangement of the inner conductors.

Disadvantage: These stripping blades can only be used for this geometry and are only suitable for stripping the outer sheath.





(1) Outer sheath
(2) Inner conductor
(3) Reinforcement of the outer sheath e.g. by fabric

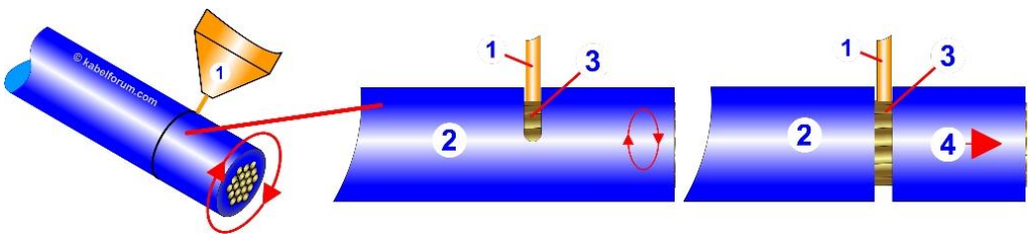
If the outer sheath of a cable is additionally reinforced with fabric, it is often no longer possible to cut through this fabric with conventional stripping blades. The reason for this is that the fabric is pressed to the side by the stripping blades. This is possible because the insulation material surrounding the fabric offers no or too little resistance. Increasing the time during which the blades are closed can improve the cutting result.

A stripping unit with rotating stripping blades provides an improved cutting result for such sheathed cables in any case. (See also chapter: Rotative Stripping)

10. *LASER STRIPPING TECHNOLOGY - AN INTRODUCTION*

Important: This simplified description deals with the general possibilities of stripping with a laser, the basic operation of the laser and the laser control.
This general description does not replace in any case the operating instructions of the machine manufacturer and serves only as a simplified description of the basic technique "laser stripping".
This introduction was created with the support of the company AAC Kabelbearbeitungssysteme GmbH (https://www.aac-kabelbearbeitung.de/) and Laser Wire Solutions (https://www.laserwiresolutions.com).

10.1 WHAT IS LASER STRIPPING?

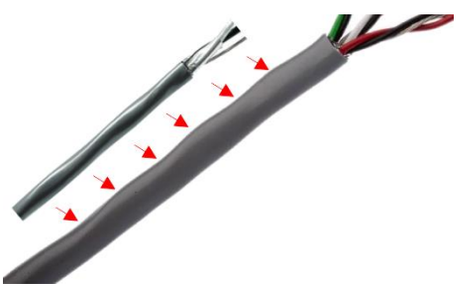


Laser stripping, compared to more conventional stripping techniques, is a non-mechanical process for removing insulation from a stranded conductor, shielded sheathed cable, enameled wire, etc.

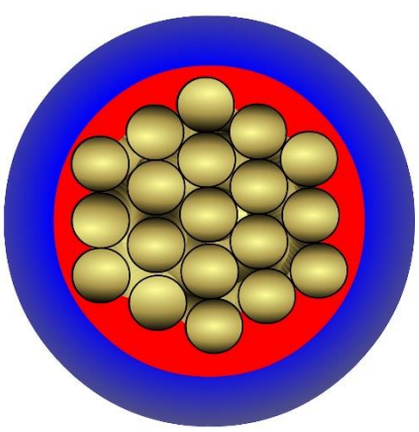
At the point where the laser beam (1) hits the absorbing material (insulation (2)), the material is "vaporized". This physical process is also called laser ablation. Surfaces reflecting the laser beam (copper (3)) are not damaged. Unlike the cutting of insulation by stripping blades, no cutting process takes place. The insulation (2) is vaporized in the area of the laser beam, and the insulation of the cable is opened.

The use of laser gives a stripping result with clean edges of the insulation. There is no damage to individual wires in the stranded conductor compound, as can occur with mechanical stripping processes using stripping blades. Of course, laser technology can also be used to separate metals (e.g. shields, wire braids).

10.2 THE TASK



In cable processing, we are familiar with many cable types that cannot be stripped using conventional stripping techniques, or only with sometimes considerable losses in quality. In addition to the thickness of the insulation, the geometry of the cable determines how well a mechanical stripping process actually works. Especially shielded sheathed cables with twisted inner conductors and an asymmetrical outer geometry pose a major problem in this respect.
Only if the stripping blade can cut the insulation deep enough, the stripping residue can be pulled off.



In addition, in the case of stranded conductors, the insulation cannot be cut 100% with the stripping blades; this is prevented by the geometry of the twisted individual wires of a stranded composite. If we cut too deep, we damage single wires and this is not permissible. As shown in the graphic on the right, the blue area can be cut without any problems. The red area is insulation material that cannot be cut into and must be torn off when the stripping residue is removed.

If the insulation is too thin, the stripping residue offers too little resistance to allow the uncut insulation to be torn off. The result: The insulation slips completely or partially through the closed stripping blades and is torn off in an undefined manner.

These general problems are of course also known for shielded cables with a very thin outer sheath.
In this case, laser stripping offers enormous advantages, if only because the cable is not subjected to any mechanical stress during the stripping process. Almost 100% of the insulation can be cleanly stripped without damaging the individual wires in the stranded conductor or the shielding. The stripping residue can subsequently be removed without any problems.