

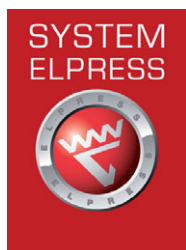


General information

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Some important points regarding crimping



System technique

The technique of crimping a terminal on to an electrical conductor has been used over 60 years and is the dominant connecting technique for power and signal transmission cables.

The most important reasons for the success of this system are **simplicity** and **safety**. Crimping is the **optimum technique** to provide both.

The system contains of, from the smallest to the largest cross section, a previously tested combination of terminal size and tool geometry related to the actual cross section of the conductor.

Different manufacturers choose to apply this combination in different ways. For example, a terminal with little material in the barrel can be crimped with a crimp die designed for this geometry. The same terminal crimped with another die from a different system, where the die is designed for a terminal with a larger barrel, would result in lower crimp reduction which could cause overheating due to poor electrical contact.

Therefore always check that the tools and terminals are tested together. This normally means choosing tools and terminals from the same manufacturer, and the same system.

System Elpress

In order to achieve a secure connection we offer certified solutions of the combination; cable, terminal and tool. This is so that you as customer can feel secure when you use our system and be sure that a safe connection will be made when our products are used correctly.

Variations in the material and crimp geometry

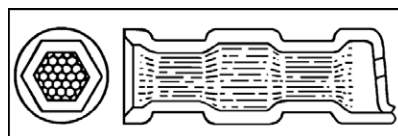
Another factor is variations in the construction and material of the conductor. Most, but not all, power conductors

which have a given size in mm² are designed to comply with IEC 60228 which is an international standard that gives the max conductor resistance per km for each cross section. The possible geometric variations within this standard can be rather large and may influence the final crimp result.

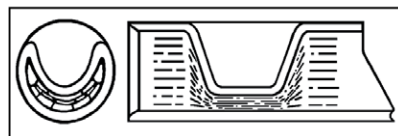
Elpress has considerable experience regarding these variations and of what special actions must be taken to achieve the best crimp quality. Contact us if a special conductor is to be used.

Different conductor materials are often crimped with completely different die geometries. For copper the most common is the **hexagonal crimp**. This shape gives a gentle and mechanically strong crimp with little risk of conductor strands being damaged. When crimping aluminium, it is important to break the layers of insulating oxide as efficiently as possible and the **indent crimp** is the most effective method.

On copper connections, by using simple analysis and tests, it is possible to establish if good results may be obtained on a previously un-tested non standard conductor size. These tests are based on comparison with a large number of existing test combinations. Elpress are happy to perform and discuss these tests together with the user.



Hexagonal crimping.



Indent crimping.

Educated operator

Probably the most important "system component" is the operator who must have the opportunity to learn and understand by themselves the simple but necessary conditions that provides a good crimp. A simple product labeling system, easy instructions, job aids and a good basic training must be available. We offer company specific courses in which both

theoretical and practical aspects are included. If possible, the training can be done in the field. We provide instructors and training materials.

Screw connectors

Connection to the conductors is achieved by tightening the screws in the through connector or terminal to a pre-determined torque. Through connectors and terminals are made of aluminium. The terminal palm is made of copper and the accompanying screws Elpress uses are made of brass to reduce friction and facilitate installation.

Tools for assembly can be a spanner/wrench or a battery-operated impact wrench which has a high torque force, > 100 Nm. To facilitate installation there is holding tool, ISL2201, to hold the screw connector in its right position during tightening of the screws. The screw connectors have a partition wall to enable jointing of oil-filled conductors to plastic-insulated XLPE conductors. The screw connectors meet the requirements of IEC 61238-1.

Handles multiple cross section areas

The installation of a screw connector can be done easily without heavy special tools and can withstand several area stages in the same connector, for instance 10-50 mm². The user gets a reduced range of products and a flexible solution.

Washer solution

To reduce the number of variants of the terminals, washers are delivered with the terminals. A washer is always required for connection of the terminal palm to a bus bar with a screw.



Bolts are tightened using a wrench. It is also possible to use a battery operated wrench.



Standards for crimped connections



Electrical standards

There are many different standards within the electrical industry. **IEC** - the International Electrotechnical Commission - issues international standards which, although not always compulsory, do have strong influence and are used as a basis within the international terminal trade. In Europe, standards are issued by **CENELEC** and they directly replace the various national standards which may have existed previously. For crimp connections a Cenelec standard was issued during 2003.

In many countries national standards have been in force over a long time. In UK the electrical standards are issued by **BSI** - the British Standards Institution - and are called **BS standards**. In Germany there are the well known **DIN** and **VDE** standards. In Sweden they are called **SEN** standards and in France **NF**, etc. Even if the new Cenelec standard has been issued, these old standards will still be referred to over many years.

The application of different standards also varies. In some cases a standard must be followed according to instructions from an authority concerned. In some cases there is an agreement between buyer and seller to follow a special standard, while in other instances the user may have an expectation that a relevant standard is complied with.

Within crimping there are many standards all over the world and many of

them have an established position in their home market. Due to the high costs of testing to all these standards, most products are tested only to the standard of the country of origin and it is therefore important to know what that standard contains.

Standards for cross section area range above 10 mm²

Prior to August 1993, there were no international testing norms for terminals designed for **cable sizes above 10 mm²**. Then **IEC 61238:1** was issued which states how both crimped and screwed terminals and connectors on power cables should be tested. Because it is relatively new, it will take several years before there is extensive testing carried out according to the requirements of this standard and its **update from 2003**. Until then one has to rely on the national standards against which there is also considerable practical experience which verifies their validity.

The following testing standards are some examples of old standards now to be replaced by **EN -IEC61238-1**.

Country	Copper terminals	Aluminium terminals
SE	SEN 245010	SEN 245012
FI		SFS 2663 T2
DE	VDE 0220:1	VDE 0220:2
GB	BS 4579:1	BS 4579:3
FR	NF C20-130	NF C63-061/A

In addition to these performance **standards**, which typically involve testing by pull-out, temperature cycling and short-circuiting, there are **standards based on dimension** of the products which mainly apply in Germany and France.

Standards for cross section area range below 10 mm²

Within the cross section area range below 10 mm², there are a great number of standards based on dimension, especially

within DIN. Testing standards exist for some terminal types, for example **DIN 46249** for roll crimped receptacles or **SEN 245010** for tube and sheet-metal terminals from 0.75 mm².

Especially within the pre-insulated terminal group, American norms from the Underwriters Laboratories, UL, are sometimes applied such as UL 310, UL 486.

Elpress experience to choose of standard

It is in many cases acceptable for a supplier and a user to state what standard a terminal should completely or partly comply with. Elpress normally comply with Swedish, German, US and UK standards depending on what market the product is designed for and Elpress has therefore had vast experience when it comes to choice of standard. Contact us for further information.





Instructions for operation and safety

The method of crimping requires very high forces. Elpress hydraulic and mechanical tools provide these in the safest way. Without proper instructions being available and carefully followed, full safety can however not be achieved. Every Elpress tool is accompanied by detailed instructions of how to use the tool. Read these instructions very carefully prior to use.

Correct use of the tools:

- increases productivity
- increases life expectancy
- ensures the quality of the operations
- minimizes the risk for accidents

Safety rules

Here are some simple and common rules which Elpress recommend all users to apply:

- Before crimping, a careful **visual inspection** of the tool should be performed. Pump, crimp tool, presshead, forks, connections, hoses and other accessories are checked to ensure that they are clean and without defects. Check that the accessories are correctly inserted into the tool before use.
- All operators must wear **safety equipment** such as protective goggles, gloves and safety shoes. This is a general precaution against working injuries and is normally a requirement according to the local industrial safety rules.
- The pressure in the hydraulic pumps must be checked regularly.
- Hydraulic pressure should not be applied in a hose which is sharply bent. The hose is specially made for high operational pressure and **cannot be replaced** by any other type.
- The tools must be calibrated at usage related intervals (at least yearly), for example with a gauge. Contact Elpress for more information.
- Check that the right tool and die-set combination have been chosen for the terminal and conductor which is to be crimped.
- Hydraulic tools must never be carried by the hose or coupling.
- Be careful, do not drop heavy objects on the hydraulic hose. It can damage the reinforcement and cause leakage. If a leakage occurs, oil at high pressure can pierce

the skin with resulting internal injuries. In such cases always seek medical advice at once.

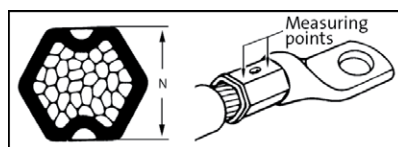
- Check that the work object is electrically switched off before the crimping starts. The tools are not designed for use on live circuits.
- Remember that all crimping tools deliver high forces. Do not stand in front of a tool in the direction of the pressforce.
- Be aware of the risk of pinch and cut injuries when operating. This includes all types of crimp tools and cable cutters.
- If there is a suspected defect on a crimping system, always contact Elpress authorized service department. Do not use the part in question until serviced.

Checking crimp results

Ensure that a tool has performed the correct crimp and the desired deformation is achieved. This deformation provides mechanical resistance as well as excellent electric characteristics.

The following is considered for copper **terminals and connectors**:

- Inspect the measure "N" on the hexagonal faces where the impressions of the crimp dies are made. See measuring points on table below.
- Measure with a sliding caliper on either side of the impression and compare with the "N"-dimension in the table. In the cases where the impression is missing, the "N"-dimension is measured in the direction of the crimp force. Note that the hexagon is often not symmetric.
- If the result of measuring exceeds the "N"-dimension (according to the table on the next page) after a correctly performed crimp, contact Elpress authorized service department.



KRF/KSF types

Cu conductor mm²	Crimp dies No.	max N mm
10	8	6,3
16	9	7,3
25	11	8,8
35	13	10,2
50	14,5	11,4
70	17	13,4
95	20	16,4 (B-dies)
95	20	15,8 (TB-dies)
120	22	16,3
150	25	20,3
185	27	20,5
240	30	23,3
300	32	24,5
400	38	30,5
500	42	30,5
630	53	38,5
800	53	38,5

Type KRF/KSF with DUAL-dies

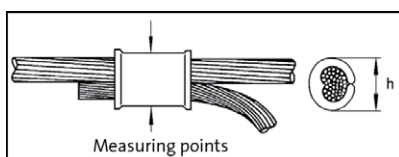
Cu conductor mm²	DUAL-dies No.	max N mm
10	DB/DCB8	6,7
16	DB/DCB 9	7,7
25	DB/DCB11	9,2
35	DB/DCB13	10,8
50	DB/DCB14,5	11,8
70	DB/DCB17	13,8
95	DB/DCB20	16,0
120	DB/DCB22	17,9
150	DB/DCB25	20,3
185	DB/DCB27	21,9
240	DB/DCB30	24,1
300	DB/DCB32	25,9
400	DB2538	30,4

KRD/KSD types

Cu conductor mm²	Crimp dies No.	max N mm
10	-	-
16	8	6,3
25	9	7,3
35	11	8,8
50	12	10,2
70	14	11,6
95	16	13,2
120	19	15,4 (B-dies)
120	19	15,2 (TB-dies)
150	22	16,3
185	25	20,3
240	27	20,5
300	30	23,3
400	32	24,5



KRT/KST types		
Cu conductor mm ²	Crimp dies No.	max N mm
10	7	5,9
16	8,5	7,5
25	10	8,2
35	12	10,2
50	14	11,6
70	16	13,2
95	18	14,0 (B-dies)
95	18	14,0 (TB-dies)
120	19	15,4 (B-dies)
120	19	15,2 (TB-dies)
150	22	16,3
185	24	17,7
240	26	19,5
300	30	23,3
400	32	24,5



Oval crimping

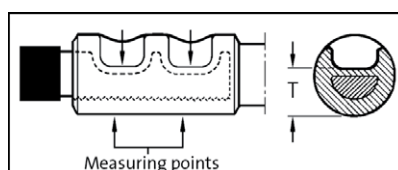
For **Cu branch connectors**, the "h"-dimension must be measured. This is made on the maximum height of the crimped oval, preferably with a sliding caliper. The dimensions are compared with the table below.

If the result of measuring exceeds the "h"-value after a correctly performed crimp, contact Elpress authorized service department.

See measuring points on above picture.

Crimp dies No.	C sleeve	max h mm
C4	C4	9,6
MBC4	C4	9,5
C5	C5	12,2
C6	C6	15,2
C8-9	C89	21,2
C11	C11, C11-8 and 11-9	22,2
C13	C13, C13-8, C13-9 and C13-11	25,8
C15	C15, C15-8, C15-9, C15-11 and C15-13	29,2
C16 25C16	C16, C16-9 and C16-13	37,6
40C18 25C18	C18, C18-8, C18-9, C18-11, C18-13, C18-15, C18-16, C21-8, C21-9, C21-11, C21-13 and C21-15	43,6
40C21 25C21	C21, C21-18, C23 and C23-16	53,6

IMPORTANT! When using Cu branch connectors the tap off conductor shall always pass through and project to a length of more than 60 % of the Cu conductor diameter.



Punch crimping

For Al-terminals the "T"-dimension should be checked. It is measured at the bottom of the indent that the punch has made. This is most suitably done with a special caliper which can be ordered from the nearest Elpress retailer. Compare measurement with "T"-dimensions in the table below.

If the result of measuring exceeds the "T"-value after a correctly performed crimp, contact Elpress authorized service department. See measuring points on previous picture.

Al conductors mm ²		Tools		max T mm
Str.	Sol.	Matrix	Punch	mm
16	25	P13M	P13D	6,8
25	35	P13M	P13D	6,8
35	50	P20M	P20D	10,8
50	70	P20M	P20D	10,8
70	95	P20M	P20D	10,8
95	120	P25M	P25D	13,5
120	150	P25M	P25D	13,5
150	185	P25M	P25D	13,5
185	240	P32M	P32D	18,4
240		P32M	P32D	18,4
300		P36M	P36-40-44D	21,0
300B		13P37M	13P37D	22,0
400		P40M	P36-40-44D	22,8
400B		13P37M	13P37D	22,0
500A		P52M/ P2552M	P52D- P2552D	31,0
500B		P44M	P36-40-44D	24,5
630A		P52M/ P2552M	P52D- P2552D	31,0
630		W60M	W60D	36,0
800		W60M	W60D	36,0
1000		W60M	W60D	36,0
1200		W70M	W70D	41,0

Str. = Stranded Sol. = Solid

Palm bolt torques

Recommended torques for nuts and bolts, electro-plated type, lubricated threads, strength class 8.8, which are used with suitable washer, to connect cable lugs, are found below.

Stud-size	Torque (Nm)	Stud-size	Torque (Nm)
M5	5	M12	70
M6	9	M14	110
M8	21	M16	170
M10	41	M20	340

For the other stud types, contact Elpress.



Inspection/certification agreement regarding crimp tools

General

To safeguard the tool quality, Elpress can offer our customers maintenance and certification agreements. In such an agreement the inspection intervals, based on use, are established. Thereafter we call in the tools and perform the necessary actions to achieve a trouble-free function. These actions are recorded and a certificate is sent back with the tool.

The inspections may also be performed at the customers premises.



Certifikat		Certificate	
<p>Detta certifikat anger de viktiga utgångsvärdena för det aktuella verktygets pressningsmätt och handtagspåslastning. Dessa värden bör fortgående kontrolleras under verktygets användning.</p> <p>This certificate states the important initial values for the crimp nest heights and the handle pre-load of this tool. These values should be regularly checked during the use of the tool.</p>			
Verktyg	Typ	GSAB760	Tool
Serinummer		T154545	Serial number
Handtagspåslastning	Mått/Messwert	Tillåtet/Accepted	
	217 N	170 - 230 N	
Presshöjdhöjst			
Röd	2.26 mm	2.30 - 2.40 mm	Red
Blå	2.70 mm	2.65 - 2.85 mm	Blue
Gult	3.38 mm	3.35 - 3.50 mm	Yellow
SPECIFIKATIONER OCH MÄTNING		SPECIFICATIONS AND MEASURING	
<p>1. Förlängningen mäts 40 mm från handtagssidan. Måttutrustningen kalibreras löpande spårbart mot internationell normal, certifikat nr H177080130.</p> <p>2. Presshöjdhöjden mäts mitt i det förlängda uttaget. Måttutrustningen kalibreras löpande spårbart till internationell normal, certifikat nr H177080130.</p>		<p>1. The handle pre-load is measured 40 mm from handle end. The measuring equipment is regularly calibrated against an internationally traceable standard, Certificate No. H177080130.</p> <p>2. The crimp nest height is measured in the middle of the pre-loaded nest. The measuring equipment is regularly calibrated against an internationally traceable standard, Certificate No. H177080130.</p>	
Datum/date		Signature/signature	
Solveig Mattsson		Solveig Mattsson	
Kvalitet/Kvalitet		Kvalitet/Kvalitet	
10/2008004			
ELPRESS AB		Tel: +46 (0)8 71 71 00	
P.O. Box 186		Fax: +46 (0)8 71 71 11	
SE-87224 Kramfors		E-mail: info@elpress.se	
Sweden		Webb: www.elpress.se	

Elpress certificate.

Certification scope

The inspection/certification is done in accordance with Elpress' current instructions for the tool in question and forms a part of Elpress' ISO 9001 certification. After acceptance a certificate is issued. All inspected tools have signed acceptance labels.

Dies are marked with colours and number to indicate last month for next inspection/calibration. Alternative marking to customer specifications can be done. Non-functioning and/or inspectable tools are repaired after customers agreement.

Preventive maintenance may comprise:

Elpress Basic

Elpress Basic service agreement includes following points:

- Preventive maintenance, calibration with certification
- General inspection of the tool
- Safety aspects in accordance with declaration of conformity (Compliance with Machine Safety Directive, Low Voltage Directive, EMC Directive)
- Function test
- Checking of accessories, e.g. crimp dies etc.
- Issue of Certificate

The inspection follows Elpress final inspection and acceptance inspection requirements.

Elpress Advance

Elpress Advance service agreement includes following points:

- Elpress Basic + corrective maintenance
- Includes the Calibration/certification and wear & tear repairs at a fixed price.

Spare parts

Exchange spare parts deemed by our service staff to be necessary to bring the tool to a functional state are charged in accordance with current price lists.

Before significant repairs are done, the customer is contacted. Note that only authorised service units, with access to technical information, may repair Elpress products.

All hydraulic tools works with high pressure technology, which requires special knowledge.

More information

For more information, contact your nearest Elpress representative. Elpress own service units are located at:

Elpress AB, Kramfors (HQ)
P.O.Box 186
SE-87224 Kramfors, Sweden
Telephone +46 612 71 71 00
service@elpress.se

Elpress Germany, Viersen
Telephone +49 2162 9319-0
sales@elpress.de

Elpress Denmark, Silkeborg
Telephone +45 86 81 61 11
salg@elpress.dk

Elpress China, Beijing
Telephone +86 10 65005642
info@elpress.com.cn

Contact Elpress for information about your nearest Elpress authorized service partner or see our homepage for latest information.



Technical information

Materials for connections

Elpress uses copper, brass and aluminium as termination materials. The copper and brass products are in most cases electroplated with tin to achieve increased protection against corrosion. The copper in a bimetallic (copper-aluminium) terminal is left unplated on the palm. As insulation material for the pre-insulated terminals, polycarbonate is mainly used.

Brass

Brass is mainly used for connections in the cross-section area up to 6 mm², where good spring properties are required. Brass is an alloy metal comprising 70 % copper and 30 % zinc with excellent cold forming property.

Copper

Copper has always been used in electrical connections. Elpress uses copper of at least 99,9 % purity in the terminals. The advantages of such copper are,

- high conductivity
- high corrosion resistance
- good deformation properties
- good jointing ability

During manufacturing, the crimp barrel is annealed to achieve a good deformation around the conductor when crimping. This gives a crimped connection with low contact resistance and good mechanical characteristics.

Aluminium

Aluminium used for connectors and terminals has a purity of at least 99,7 % and its good characteristics are as follows,

- low weight
- strong, in relation to its weight
- good conductivity, around 60 % of that of copper
- easy to work

Conductor design

Below please find references to information from standards in force which might be of interest.

IEC 60228, which gives:

Information about materials, constructions and resistance values for both copper and aluminium conductors.

Class 1: solid conductors

Class 2: stranded conductors

Class 5: flexible conductors

Class 6: high flexible conductors

Cross-reference table for AWG/MCM to corresponding cross section in mm²

AWG No	Area mm ²	MCM No	Area mm ²
36	0,013	250	127
34	0,020	300	152
32	0,032	350	177
30	0,051	400	203
28	0,080	450	228
26	0,13	500	253
24	0,20	550	279
22	0,33	600	304
20	0,56	650	329
19	0,65	700	355
18	0,82	750	380
17	1,04	800	405
16	1,31	850	431
15	1,65	900	456
14	2,08	1000	507
13	2,62	1100	557
12	3,31	1200	608
11	4,17	1300	659
10	5,26	1400	709
9	6,63	1500	760
8	8,37	1600	811
7	10,6	1700	861
6	13,3	1800	912
5	16,8	1900	963
4	21,2	2000	1013
3	26,4		
2	33,6		
1	42,4		
1/0	53,5		
2/0	67,4		
3/0	85,0		
4/0	107		

Notes

1. The information in this table is derived from catalogues distributed by cable suppliers and does not relate to official standards.

2. The cross sections that relate to AWG vary depending on different designs of the conductors, ie number of strands.

AWG > 20 relates to solid conductors.

AWG ≤ 20 relates to multi-strand conductors.

The exact cross sections for specific number of strands can be found in cable-supplier catalogues.



Development - Technical services

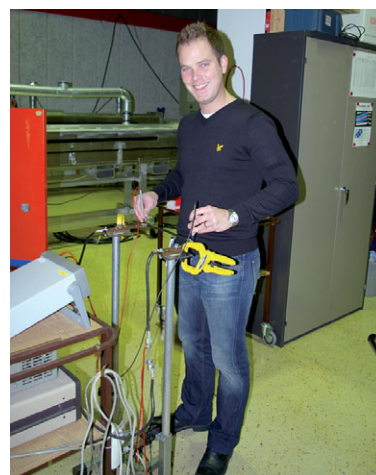
Elpress is one of Europe's leading manufacturers of electrical connection crimping systems and has more than 50 years experience of applications, from nuclear power plants to small electrical units.

Exposure to mechanical and thermal loads is especially relevant to electrical connections.

Therefore Elpress devotes large resources to achieve commercial and technical success through an ongoing product development towards better user economy, quality and performance.

The laboratory function also includes theoretical studies, prototype generation, technical documentation and advice.

The skill of the staff together with good laboratory and computer equipment form strong competitive advantages both when it comes to consulting services and developing projects.



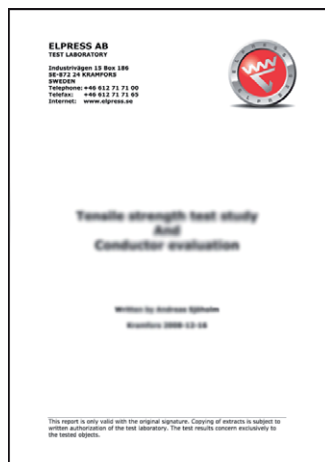
Measuring of resistance in Elpress laboratory.



Testing of connections at the Elpress laboratory.

For this purpose Elpress have a modern laboratory with equipment to perform:

- High current load tests
- Mechanical tensile strength tests
- Cyclical thermal load tests
- Vibration tests
- Corrosion cabinet tests
- Resistance measurements etc.
- Hydraulic impulse test



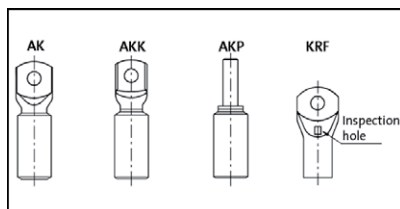
Laboratory report.



General points when using Elpress terminals and connectors at high voltages

Terminations

The modern and easy to use termination kits for 12 to 36 kV XLPE-insulated cable, which consist of prefabricated modules or even complete terminations, give no or very few restrictions in using terminal lugs of AK, AKK or KRF types. Included are also the so called "pins" of type designation AKP.



An important consideration when terminating an outdoor copper cable with a copper terminal: The KRF type has an inspection hole which after assembly preferably should be made watertight. Your supplier of termination kits can give you his specific solution.

When using terminals of AK, AKK or AKP types at high voltages, there are today complete solutions for end terminations up to 84 kV both of heat shrink and push-on types.

When in doubt, always consult your supplier of end terminations for his specific solution in matters related to technical details upon performance.

When performing an end termination for oil impregnated paper cable where an oil tank is used, most often the supplier has his specially designed solution.

Elpress terminal lugs of AK and AKK are used with a so called "dry" end termination.

Connections

XLPE to XLPE

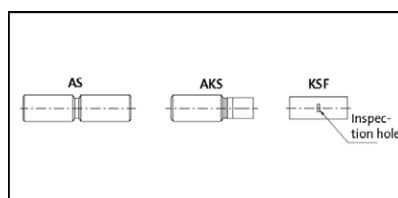
Today there are commonly four types of connections used within voltage area 12 to 36 kV. These are: tape, heat shrink, cold shrink, and pre-fabricated (push on) connections. Most of these connections can use Elpress through connectors of the AS, AKS and KSF/KSD/KST types.

Special connectors with cone shaped ends are normally not required today within these voltages.

Different connection kit suppliers recommend different techniques to deal with indent cavities, space between cable insulation and connector and etc.

It is important to follow the supplier instructions when carrying out these assemblies. If you are uncertain, or if the assembly instructions do not give you answers to your questions, consult your supplier.

At higher voltages, for example 52 and 84 kV, there are other requirements on the connectors depending on the connection design. There are, however, solutions where "normal" connectors are used together with additional materials in the voltage range up to 145 kV.



Through connectors for XLPE paper insulation

When making a connection between cables with oil impregnated paper insulation and XLPE insulation at 12 kV and above, through connectors **with partition** should be used, irrespective of connecting method or manufacture. The through connectors of **AS, AKS and KSF** types always have this partition.

Through connectors for paper insulation to paper insulation

When connecting two cables with oil impregnated paper insulations against each other, through connectors of AS, AKS and KSF/KSD/KST types can be used both in case of an oil tube connection or a heat shrink connection.

Notes

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.