

# Brugg Cables High Voltage Accessories. Swiss solutions for independent applications.



Fact Book High Voltage Accessories  
Brugg Cables  
Business Unit High Voltage Accessories  
Dr. Ruben Vogelsang  
Head of Product and Technology Management  
2010  
© Brugg Cables

<b>Brugg Cables – products and services of the Business Unit High Voltage Accessories</b>	<b>3</b>
<b>Introduction</b>	<b>5</b>
Dear customer	5
Brugg Cables – reliable technology made in Switzerland	6
<b>High voltage accessories for polymer cables</b>	<b>7</b>
<b>Terminations for polymer cables</b>	<b>9</b>
Design of a termination for polymer cables	9
General	10
Outdoor terminations with porcelain insulator for polymer cables	11
Outdoor terminations with composite insulator for polymer cables	12
GIS terminations for polymer cables	13
Dry type plug-in terminations for polymer cables	14
Transformer terminations for polymer cables	15
<b>Joints for polymer cables</b>	<b>16</b>
Design of a joint for polymer cables	16
General	17
Slip-on joints for polymer cables up to 72.5 kV	19
Slip-on joints for polymer cables up to 145 kV	20
Slip-on joints for polymer cables up to 170 kV	21
Slip-on joints for polymer cables up to 245 kV	22
Slip-on joints for polymer cables up to 550 kV	23
<b>High voltage accessories for oil-filled cables</b>	<b>25</b>
<b>Terminations for oil-filled cables</b>	<b>27</b>
Design of a termination for oil-filled cables	27
General	28
Outdoor terminations with porcelain insulator for oil-filled cables	29
Outdoor terminations with composite insulator for oil-filled cables	30
GIS terminations for oil-filled cables	31
Transformer terminations for oil-filled cables	32
<b>Joints for oil-filled cables</b>	<b>33</b>
Design of a joint for oil-filled cables	33
General	34
Straight-through joints for oil-filled cables	35
Stop joints for oil-filled cables	37
<b>High voltage accessories for polymer and oil-filled cables</b>	<b>39</b>
<b>Transition joints</b>	<b>41</b>
Design of a transition joint	41
General	42
Transition joints for polymer and oil-filled cables	43
<b>Additional equipment</b>	<b>45</b>
<b>Earthing equipment</b>	<b>47</b>
General information	47
Earthing- and Cross-bonding boxes	48
<b>Tools</b>	<b>49</b>
Tools	49

## General information

51

### Our standards and services for reliable products

53

Our basis – advanced technology combining experiences with innovations

53

The basis of our quality – production at high standards

54

The guarantee for our quality – fully tested equipment

55

Quality beyond the factory – installation services

56

We offer more – after sales services, monitoring and diagnostics

57

Our know-how and experiences for your success – The Brugg Cables Academy

58

### Our Experience for your success

59

Brugg – a history of experiences in cable systems

59

References I

60

References II

61

Brugg markets – worldwide and close to you

62

**Brugg Cables – products and services of  
the Business Unit High Voltage  
Accessories**



## Dear customer

Thanks to your support, we've already succeeded in delivering over 40 000 accessories. The success of these products, which today covers a voltage range of 60 kV to 550 kV, enables us to provide consistent and reliable energy supplies on all five continents – day and night. We go beyond providing our customers with products of the highest Swiss quality. Our considerable experience within the global market allows us to deliver tailor-made products and, ultimately, electrical energy into millions of households. With your help, we've been able to create an effective and communicative business. This success is felt daily and makes our work all the more enjoyable.

So why do our products work so well? They're simple to produce and install, easy to connect, compatible with all types of energy cables and can cope with the wide range of defects and inconsistencies occurring in energy network systems. We welcome challenging projects and excel in finding solutions for those of a difficult or complex nature – technical, climatic or cultural. So don't hesitate to contact us. We're here to realise your project; simply, efficiently and to your outmost satisfaction.

We'd like to express our appreciation and thanks for your constant support and assistance in the continual improvement of our products and services, and hope that you will continue to accompany us now and into the future.

Yours sincerely,

Patrick Frei  
Head of Business Unit High Voltage Accessories.



Patrick Frei

# Brugg Cables – reliable technology made in Switzerland

A company that is known throughout the world for quality products and solutions.

## Brugg Cables' excellent track record

For more than 100 years, Brugg Cables has been a valued partner within the fields of power industry and utilities. We are well-known throughout the world for products and solutions that ensure long-lasting and reliable energy supplies.

## Specialised business units

Brugg Cables is a member of the BRUGG Group and has its core business in the cable and cable-related industry. We combine innovations and experiences in the specialised business units of Telecom, Industry, Security, High Voltage Systems, High Voltage Accessories, Power Cables (Medium and Low Voltage Products) and Compound.

## Bundled activities centralised at Brugg

We maintain a high standard of quality in our products and services by concentrating the relevant tasks of Strategy, Research & Development, Production and Testing at our headquarters in Brugg, Switzerland.

## Wide range of well-balanced products

Our customers profit from a wide range of products from complete cable systems of any type to single cables or accessories. To ensure a highly reliable system, we focus on excellent quality in all our products and services. Thus, our accessories work excellently with cables of other manufacturers throughout the world.

## All accessory products for your cable system

The business unit High Voltage Accessories provides everything you need for high voltage cables:

- Joints of any kind
- Terminations of any kind
- Additional equipment, such as earthing boxes, cable clamps or oil expansion tanks
- Installation services
- Tools of any kind

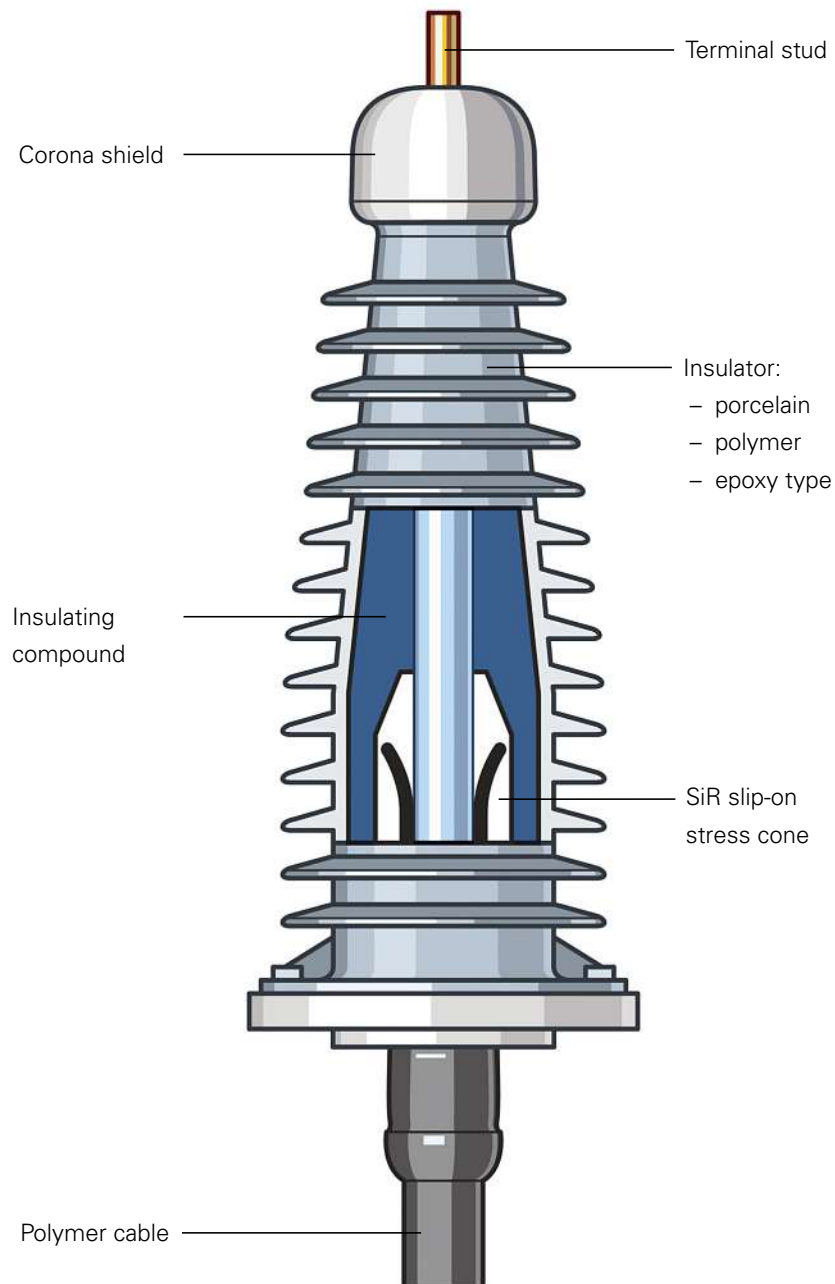


Headquarters of Brugg Cables

## **High voltage accessories for polymer cables**



## Design of a termination for polymer cables



## General

Our terminations for polymer cables are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

### Termination design

Terminations for polymer cables consist of a stress cone with the deflector, an insulating compound, an insulator, a corona shield and a terminal stud.

### Outstanding properties of the SiR stress cone

Stress cones are pre-moulded sleeves, which ensure field grading between the outer semiconducting layer and the insulation. Made of silicone rubber (SiR), they combine outstanding electrical and mechanical properties with excellent interface behaviour.

The electrical properties are designed to minimise stress, whilst mechanical properties ensure an optimum level of surface pressure on the cable which remains constant throughout the lifetime of the termination.

The deflectors are made of solid semiconducting material.

Although costly, this ensures that they function properly at all voltage loads and guarantees a long and reliable lifetime.

For optimum electrical stress distribution, the stress cones are designed with the help of computer simulations.

### Quality in production and testing for reliable devices

Our stress cones are one-piece and fabricated in-house in an extremely clean surrounding. To ensure best quality, the fabrication is made with computerised machines. For zero failure production, every part is tested several times in the fabrication process. The stress cones must pass a final acceptance test. Each device is certified individually. This ensures that every stress cone leaving our factory is 100% reliable.

### At a glance, the main advantages of the prefabricated and pretested SiR stress cones are:

- Very high breakdown strength of >23 kV/mm at 50/60 Hz
- Excellent temperature stability of between –50 and +180°C
- Very high life exponent of  $n \gg 40$
- Excellent field grading performance at high frequency with deflectors of solid material
- Optimum electrical stress distribution due to computer-based design
- Zero failure guarantee with final high voltage pretesting
- Void-free contact pressure on the cable surface at normal and elevated load conditions due to excellent elasticity of the SiR
- Easy installation due to excellent mechanical properties and elasticity, no high mechanical forces needed

### Five types of terminations for your applications

Five different types of terminations are available.

For outdoor applications we offer terminations with porcelain and composite insulators. Each type of termination has a specific insulating compound, which can be chosen according to customer specifications – oil or SF<sub>6</sub> gas.

Terminations for transformers are made of cast epoxy resin insulators and can also be filled with silicone oil or SF<sub>6</sub> gas.

For gas insulated switchgears (GIS), we offer two different types of terminations, traditional terminations and dry type plug-in terminations.

### Our terminations for polymer cables are:

- Outdoor terminations with porcelain insulators
- Outdoor terminations with composite insulators
- Traditional GIS terminations
- Dry type plug-in GIS terminations
- Transformer Terminations

## Outdoor terminations with porcelain insulator for polymer cables

Porcelain insulators have the longest tradition.

### Their main advantages are:

- Excellent resistance against ultraviolet (UV) radiation
- Resistant against bird-picking
- Excellent track record in numerous countries and climate zones
- In service for more than 40 years at Brugg Cables with outstanding results

Terminations with porcelain insulators for polymer cables profit from the outstanding properties of our prefabricated, one-piece and pretested SiR slip-on stress cones.

The creepage distance of the insulators can be determined according to the application, the specifications of the customer or the necessities of different climate zones.

All terminations are designed and tested according to international standards, such as IEC 60840 ( $\leq 170$  kV), IEC 62067 ( $> 170$  kV), IEC 60815 (insulators), IEC 60071 (insulation coordination) or IEEE Std 48-1996.

Profit from the advantages of our outdoor terminations with porcelain insulators. All our terminations with porcelain insulators are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of outdoor terminations with porcelain insulators for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Creepage distance $mm$
72.5	2000	35 - 94	115	TE 1.72-01	2900
145	2500	57 - 110	150	TE 1.145-01	4700, 5950, 7290
170	2500	57 - 110	150	TE 1.170-01	5950, 7290
245	2500	76 - 110	150	TE 1.245-01	8800, 10000
300	2500	76 - 110	150	TE 1.300-01	8800, 10000
420	2500	76 - 115	170	TE 1.420-01	13020, 17500, 21000
550	2500	90 - 130	170	TE 1.550-01	17500, 21000

## Outdoor terminations with composite insulator for polymer cables

Composite insulators have been in growing demand over the past decades.

### Their main advantages are:

- Lightweight
- Easy to handle
- Resistant against ultraviolet (UV) radiation
- Excellent hydrophobic behaviour
- Explosion-proof
- Earthquake-proof
- Excellent track record in numerous countries and climate zones
- In service for more than 25 years at Brugg Cables with outstanding results

Terminations with composite insulators for polymer cables profit from the outstanding properties of the prefabricated, one-piece and pretested SiR slip-on stress cones.

The creepage distance of the insulators can be determined according to the application, the specifications of the customer or the necessities of different climate zones.

All terminations are designed and tested according to international standards, such as IEC 60840 ( $\leq 170$  kV), IEC 62067 ( $> 170$  kV), IEC 60071 (insulation coordination) or IEEE Std 48-1996.

Profit from the advantages of our outdoor terminations with composite insulators. All our terminations with composite insulators are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of outdoor terminations with composite insulators for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Creepage distance $mm$
72.5	1000	35 - 68	115	FR 1.72-01	2400
145	1200	57 - 80	115	FR 1.145-01	4790
	2500	57 - 110	150	FR 1.145-02	3890, 5580
170	2500	57 - 110	150	FR 1.170-01	3890, 5580
245	2500	76 - 110	150	FR 1.245-01	5350, 7820
300	2500	76 - 110	150	FR 1.300-01	6570, 9800
420	2500	76 - 115	170	FR 1.420-01	14100, 16800
550	2500	90 - 130	170	FR 1.550-01	16800, 18700

## GIS terminations for polymer cables

GIS terminations were developed for use in SF<sub>6</sub>-gas insulated switchgears (GIS). Made with a cast resin body, they are designed to fit perfectly into your GIS.

### Their main advantages are:

- Lightweight
- Easy to handle
- Classical tried and tested design with high tolerances for cables and applications
- Excellent track record in numerous countries and climate zones
- In service for more than 30 years at Brugg Cables with outstanding results

GIS terminations for polymer cables profit from the outstanding properties of the prefabricated, one-piece and pretested SiR slip-on stress cones.

All terminations are designed and tested according to international standards, such as IEC 62271-209 (GIS standard), IEC 60840 ( $\leq 170$  kV), IEC 60071 (insulation coordination) IEC 62067 ( $> 170$  kV) or IEEE Std 48-1996.

Profit from the advantages of our GIS terminations for polymer cables. All our GIS terminations are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of GIS terminations for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Creepage distance $mm$
72.5	1000	35 - 80	115	TF 1.72-01	500
145	1200	57 - 80	150	TF 1.170-11	690
	2500	80 - 110	150	TF 1.170-12	710
170	2500	57 - 110	150	TF 1.170-11	690, 710
245	2500	76 - 110	150	TF 1.245-11	900
300	2500	76 - 110	150	TF 1.300-11	300
420	2500	76 - 115	170	TF 1.420-11	1385
550	2500	90 - 130	170	TF 1.550-11	1385

## Dry type plug-in terminations for polymer cables

Dry type plug-in terminations have been in growing demand over the past years. Free of any insulating oil, they are with a cast resin body and designed to fit perfectly into your GIS.

### Their main advantages are:

- Lightweight
- Easy to handle
- Can be plugged into the GIS without need of additional work at the GIS itself (such as evacuation work at the GIS)
- Cable and termination can be installed independently of the erecting of the GIS

For dry type plug-in terminations, stress cones are very important for field grading, much more than for the traditional terminations. High quality stress cones are therefore vital if long-term reliability of the termination is to be achieved. The dry type plug-in terminations profit from the outstanding properties of the prefabricated, one-piece and pretested SiR slip-on stress cones of Brugg Cables.

A special feature of the dry type plug-in termination of Brugg Cables is their design, which allows them to fit into every type of GIS, independent of whether these were constructed according to the old- or new GIS standards. This gives you, our customer, even more flexibility in your application with our terminations.

All terminations are designed and tested according to international standards, such as IEC 62270-209 (GIS standard), IEC 60840 ( $\leq 170$  kV), IEC 62067 ( $> 170$  kV), IEC 60071 (insulation coordination) or IEEE Std 48-1996.

Profit from the advantages of our terminations for polymer cables. All our dry type plug-in GIS terminations are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 170 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of dry type plug-in GIS terminations for polymer cables

Operating voltage	Max. conductor cross-section (Cu/Al)	Ø over XLPE insulation	Max. Ø of outer sheath	Type
U <sub>max</sub> /kV	mm <sup>2</sup>	mm	mm	
170	2500	57 - 110	150	TFD 1.170-11

## Transformer terminations for polymer cables

Transformer terminations have a cast resin body and are designed to fit perfectly into your transformer.

**Their main advantages are:**

- Lightweight
- Easy to handle
- Classical tried and tested design with high tolerances for cables and their application
- Excellent track record in numerous countries and climate zones
- In service for more than 30 years at Brugg Cables with outstanding results

Transformer terminations for polymer cables profit from the outstanding properties of the prefabricated, one-piece and pre-tested SiR slip-on stress cones.

All terminations are designed and tested according to international standards, such as IEC 60840 ( $\leq 170$  kV), IEC 62067 ( $> 170$  kV), IEC 60071 (insulation coordination) or IEEE Std 48-1996.

Please note that the corona shield for transformer terminations are designed according to customer specifications and must be ordered separately.

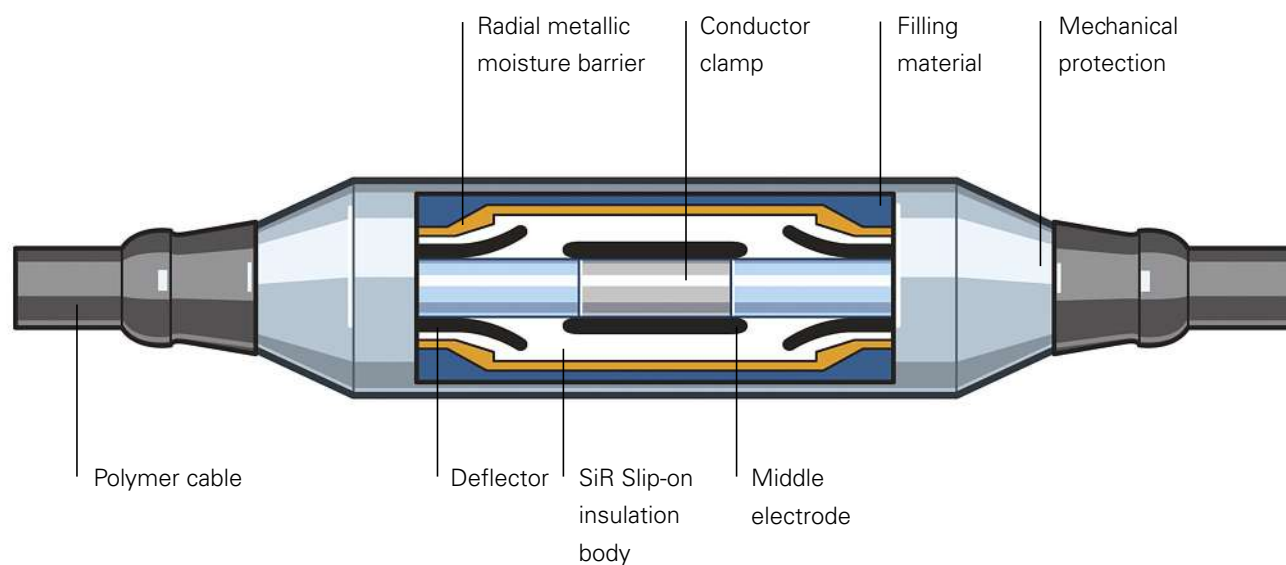
Profit from the advantages of our transformer terminations for polymer cables. All our transformer terminations are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of transformer terminations for poymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Creepage distance $mm$
72.5	1000	35 - 80	115	TT 1.72-01	500
145	1200	57 - 80	150	TT 1.170-11	690
	2500	80 - 110	150	TT 1.170-12	710
170	2500	57 - 110	150	TT 1.170-11	690, 710
245	2500	76 - 110	150	TT 1.245-11	900
300	2500	76 - 110	150	TT 1.300-11	300
420	2500	76 - 115	170	TT 1.420-11	1385
550	2500	90 - 130	170	TT 1.550-11	1385

## Design of a joint for polymer cables



## General

Our joints for polymer cables are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

### Joint design

Joints for polymer cables consist of a conductor clamp, an insulation body with semiconductive deflectors and middle electrode, a moisture barrier, a mechanical protection and the connections of the outer conductor.

### Variety of conductor clamps

Conductor clamps connect both conductor ends of the cable. Their main task is to ensure a low contact resistance during lifetime. Our joints are designed to suit all common types of conductor clamps. Due to their many advantages, such as being easy to apply, we recommend the use of screwed conductor clamps.

### Outstanding properties of the SiR insulation body

The insulation body consists of semiconductive deflectors at both sides, a semiconductive middle electrode and the insulation compound. It ensures field grading between the semiconducting layers of the cable and the conductor clamp. Made of silicone rubber (SiR), the insulation body combines outstanding electrical and mechanical properties with excellent interface behaviour.

The electrical properties are designed to minimise stress, whilst mechanical properties ensure an optimum level of surface pressure on the cable. The optimum surface pressure remains constant throughout the lifetime of the joint. The field grading deflectors and middle electrode are made of solid semiconducting material. Although costly, this ensures that they function properly at all voltage loads and guarantees a long and reliable lifetime.

For optimum electrical stress distribution, the insulation body is designed with the help of computer simulations.

### Quality in production and testing for failurefree devices

Our insulation bodies are one-piece and fabricated in-house in an extremely clean surrounding. To ensure best quality, the fabrication is made with computerised machines. For zero failure production, every part is tested several times in the fabrication process. The insulation bodies must pass a final acceptance test. Each device is certified individually. This ensures that every joint leaving our factory is 100% reliable.

### At a glance, the main advantages of the prefabricated and pretested SiR stress cones are:

- Very high breakdown strength of >23 kV/mm at 50/60 Hz
- Excellent temperature stability of between -50 and +180°C
- Very high life exponent of >>40
- Excellent field grading performances at higher frequency with deflectors and middle electrode of solid material
- Optimised electrical stress distribution due to computer-based design
- Zero failure guarantee with final high voltage pretesting
- Void-free contact pressure on the cable surface at normal and elevated load conditions due to excellent elasticity of the SiR
- Easy to install due to excellent mechanical properties and elasticity, no high mechanical forces needed

### 100% moisture protection with metal shield

Our standard joints are equipped with a real transverse moisture barrier made of a metal shield. This gives 100% moisture protection to the joint and results in a prolonged lifetime, making it highly reliable. In its basic version, the barrier is a metal sheet. In the more sophisticated version, the moisture barrier is a metal tube.

### Variety of designs for mechanical protection

High reliability and a long lifetime are further ensured by the first-rate mechanical protection of the joint. Suited to the diverse applications of the customer, we offer a wide variety of mechanical protection designs.

Basic protection is provided by a heat shrink cover. For a higher degree of protection, steel or copper (Cu) housing and/or a box of polyester can be chosen. This polyester protection box is filled with an insulating compound, giving excellent sealing to the joint.

The different designs of mechanical protection enable you to select the best technical and cost-efficient solution for your application.

### Our protection designs for polymer cable joints are:

- Metal sheet with heat shrink cover
- Metal sheet with protection box
- Cu-tube with coating of high density polyethylene (HDPE coating)
- Cu-tube with protection box
- Steel housing
- Steel housing with protection box



Joints with Cu-tube and HDPE coating in a concrete tunnel



Joints with polyester protection box in a concrete pit



Joints with polyester protection box in a concrete tunnel

All joints are designed and tested according to international standards, such as IEC 60840 ( $\leq 150$  kV), IEC 62067 ( $> 150$  kV) or IEEE Std 404-2000.

### Their main advantages are:

- Very compact dimensions
- 100% failurefree pretested one-piece SiR slip-on bodies
- Total moisture barrier with standard use of metal sheet
- High variety in application with different types of mechanical protection design
- Easy to handle and fast and easy to install
- No preload needed during transport or storage due to design with SiR slip-on bodies
- Excellent track record in all environments, laying conditions and climate zones
- In service for more than 20 years at Brugg Cables with outstanding results



Profit from the advantages of our slip-on joints for polymer cables. All our joints for polymer cables are designed to be used independently of any type of polymer cable or cable manufacturer from 72.5 to 550 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

# Slip-on joints for polymer cables up to 72.5 kV


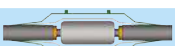

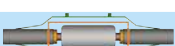
## Variety of joints for your individual application needs

To assist you in the selection of the appropriate type of joint for your application, we have compiled an application table as given below.




## High flexibility in earthing

Earthing of our joints can be made according to customer specifications. All joints are designed so that direct- or indirect earthing, straight through connection or cross bonding can be realised.

## Applications of joints for polymer cables

Type		Radial moisture barrier	Mechanical protection	Advantages	Application
MPAH		Metal sheet	Heat shrink cover	<ul style="list-style-type: none"> <li>Extremely compact dimensions</li> <li>Basic sealing against moisture</li> <li>Cost effective</li> </ul>	<ul style="list-style-type: none"> <li>For limited dimensions, such as small manholes</li> <li>In tunnels or concrete manholes without permanent water ingress</li> </ul>
MPAP		Metal sheet	Protection box	<ul style="list-style-type: none"> <li>Good mechanical protection in different environments</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In buried installations with humid soil</li> </ul>
MPCC		Cu-tube	Cu-tube with HDPE coating	<ul style="list-style-type: none"> <li>Compact dimensions</li> <li>High degree of mechanical protection</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In installations with permanent humidity or shallow water</li> </ul>
MPCP		Cu-tube	Cu-tube and protection box	<ul style="list-style-type: none"> <li>Highest degree of mechanical protection</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In installations with permanent humidity or shallow water</li> </ul>

## Types of earthing of joints for polymer cables

Type		Screen connection	Application
-21		Straight through connection, insulated to ground	Direct connection of cable screen without cross bonding
-21sp		Straight through connection with direct or indirect earthing	Connection of cable screen to earthing link
-31		Screen interruption, insulated to ground for cross bonding	Cross bonding of cable screen at the joint

## Technical data of joints for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Mechanical protection and radial moisture barrier
72.5	1000	46 - 101	155	MPAH 1.72-21/-31	Metal sheet with heat shrink cover
	2500	46 - 101	155	MPAP 1.72-21/-31	Metal sheet with polyester protection box
	2500	46 - 101	155	MPCC 1.72-21/-31	Cu-tube with HDPE coating
	2500	46 - 101	155	MPCP 1.72-21/-31	Cu-tube with protection box

# Slip-on joints for polymer cables up to 145 kV


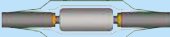


## Variety of joints for your individual application needs

To assist you in the selection of the appropriate type of joint for your application, we have compiled an application table as given below.




## High flexibility in earthing

Earthing of our joints can be made according to customer specifications. All joints are designed so that direct- or indirect earthing, straight through connection or cross bonding can be realised.

## Applications of joints for polymer cables

Type	Radial moisture barrier	Mechanical protection	Advantages	Application
MPAH 	Metal sheet	Heat shrink cover	<ul style="list-style-type: none"> <li>Extremely compact dimensions</li> <li>Basic sealing against moisture</li> <li>Cost effective</li> </ul>	<ul style="list-style-type: none"> <li>For limited dimensions, such as small manholes</li> <li>In tunnels or concrete manholes without permanent water ingress</li> </ul>
MPAP 	Metal sheet	Protection box	<ul style="list-style-type: none"> <li>Good mechanical protection in different environments</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In buried installations with humid soil</li> </ul>
MPCC 	Cu-tube	Cu-tube with HDPE coating	<ul style="list-style-type: none"> <li>Compact dimensions</li> <li>High degree of mechanical protection</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In installations with permanent humidity or shallow water</li> </ul>
MPCP 	Cu-tube	Cu-tube and protection box	<ul style="list-style-type: none"> <li>Highest degree of mechanical protection</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In installations with permanent humidity or shallow water</li> </ul>

## Types of earthing of joints for polymer cables

Type	Screen connection	Application
-21 	Straight through connection, insulated to ground	Direct connection of cable screen without cross bonding
-21sp 	Straight through connection with direct or indirect earthing	Connection of cable screen to earthing link
-31 	Screen interruption, insulated to ground for cross bonding	Cross bonding of cable screen at the joint

## Technical data of joints for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Mechanical protection and radial moisture barrier
145	2500	46 - 101	155	MPAH 1.145-21/-31	Metal sheet with heat shrink cover
	2500	46 - 101	155	MPAP 1.145-21/-31	Metal sheet with polyester protection box
	2500	46 - 101	155	MPCC 1.145-21/-31	Cu-tube with HDPE coating
	2500	46 - 101	155	MPCP 1.145-21/-31	Cu-tube with protection box

# Slip-on joints for polymer cables up to 170 kV

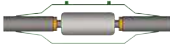
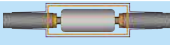
## Variety of joints for your individual application needs

To assist you in the selection of the appropriate type of joint for your application, we have compiled an application table as given below.




## High flexibility in earthing

Earthing of our joints can be made according to customer specifications. All joints are designed so that direct- or indirect earthing, straight through connection or cross bonding can be realised.

## Applications of joints for polymer cables

Type		Radial moisture barrier	Mechanical protection	Advantages	Application
MPP		Protection box	Protection box	<ul style="list-style-type: none"> <li>• Good mechanical protection in different environments</li> <li>• Good sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>• In buried installations with humid soil</li> </ul>
MP / MPCC		Cu-tube	Cu-tube with HDPE coating	<ul style="list-style-type: none"> <li>• Compact dimensions</li> <li>• High degree of mechanical protection</li> <li>• Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>• In installations with permanent humidity or shallow water</li> </ul>

## Types of earthing of joints for polymer cables

Type		Screen connection	Application
-21		Straight through connection, insulated to ground	Direct connection of cable screen without cross bonding
-21sp		Straight through connection with direct or indirect earthing	Connection of cable screen to earthing link
-31		Screen interruption, insulated to ground for cross bonding	Cross bonding of cable screen at the joint

## Technical data of joints for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Mechanical protection and radial moisture barrier
170	2500	56 - 113	150	MPP 1.170-21/-31	Polyester protection box
	2500	56 - 113	150	MPCC 1.170-21/-31	Cu-tube with HDPE coating

# Slip-on joints for polymer cables up to 245 kV

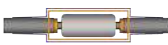
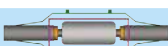
## Variety of joints for your individual application needs

To assist you in the selection of the appropriate type of joint for your application, we have compiled an application table as given below.


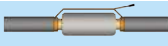

## High flexibility in earthing

Earthing of our joints can be made according to customer specifications. All joints are designed so that direct- or indirect earthing, straight through connection or cross bonding can be realised.

## Applications of joints for polymer cables

Type	Radial moisture barrier	Mechanical protection	Advantages	Application
MPCC 	Cu-tube	Cu-tube with HDPE coating	<ul style="list-style-type: none"> <li>• Compact dimensions</li> <li>• High degree of mechanical protection</li> <li>• Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>• In installations with permanent humidity or shallow water</li> </ul>
MPSP 	Steel housing stainless steel	Steel housing and protection box	<ul style="list-style-type: none"> <li>• Highest degree of mechanical protection</li> <li>• Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>• In installations with permanent humidity or shallow water</li> </ul>

## Types of earthing of joints for polymer cables

Type	Screen connection	Application
-21 	Straight through connection, insulated to ground	Direct connection of cable screen without cross bonding
-21sp 	Straight through connection with direct or indirect earthing	Connection of cable screen to earthing link
-31 	Screen interruption, insulated to ground for cross bonding	Cross bonding of cable screen at the joint

## Technical data of joints for polymer cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Mechanical protection and radial moisture barrier
245	2500	68 - 115	150	MPCC 1.245-21/-31	Cu-tube with HDPE coating
	2500	68 - 115	150	MPCP 1.245-21/31	Cu-tube with protection box
	2500	68 - 115	150	MPSP 1.245-21/-31	Steel housing with protection box

# Slip-on joints for polymer cables up to 550 kV

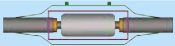
## Variety of joints for your individual application needs

To assist you in the selection of the appropriate type of joint for your application, we have compiled an application table as given below.


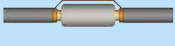

## High flexibility in earthing

Earthing of our joints can be made according to customer specifications. All joints are designed so that direct- or indirect earthing, straight through connection or cross bonding can be realised.

## Applications of joints for polymer cables

Type		Radial moisture barrier	Mechanical protection	Advantages	Application
MP / MPSP		Steel housing	Steel housing and protection box	<ul style="list-style-type: none"> <li>Highest degree of mechanical protection</li> <li>Total sealing against moisture</li> </ul>	<ul style="list-style-type: none"> <li>In all types of laying, such as in tunnels, concrete pits or directly buried installations</li> <li>In installations with permanent humidity or shallow water</li> </ul>

## Types of earthing of joints for polymer cables

Type		Screen connection	Application
-21		Straight through connection, insulated to ground	Direct connection of cable screen without cross bonding
-21sp		Straight through connection with direct or indirect earthing	Connection of cable screen to earthing link
-31		Screen interruption, insulated to ground for cross bonding	Cross bonding of cable screen at the joint

## Technical data of joints for polymer cables

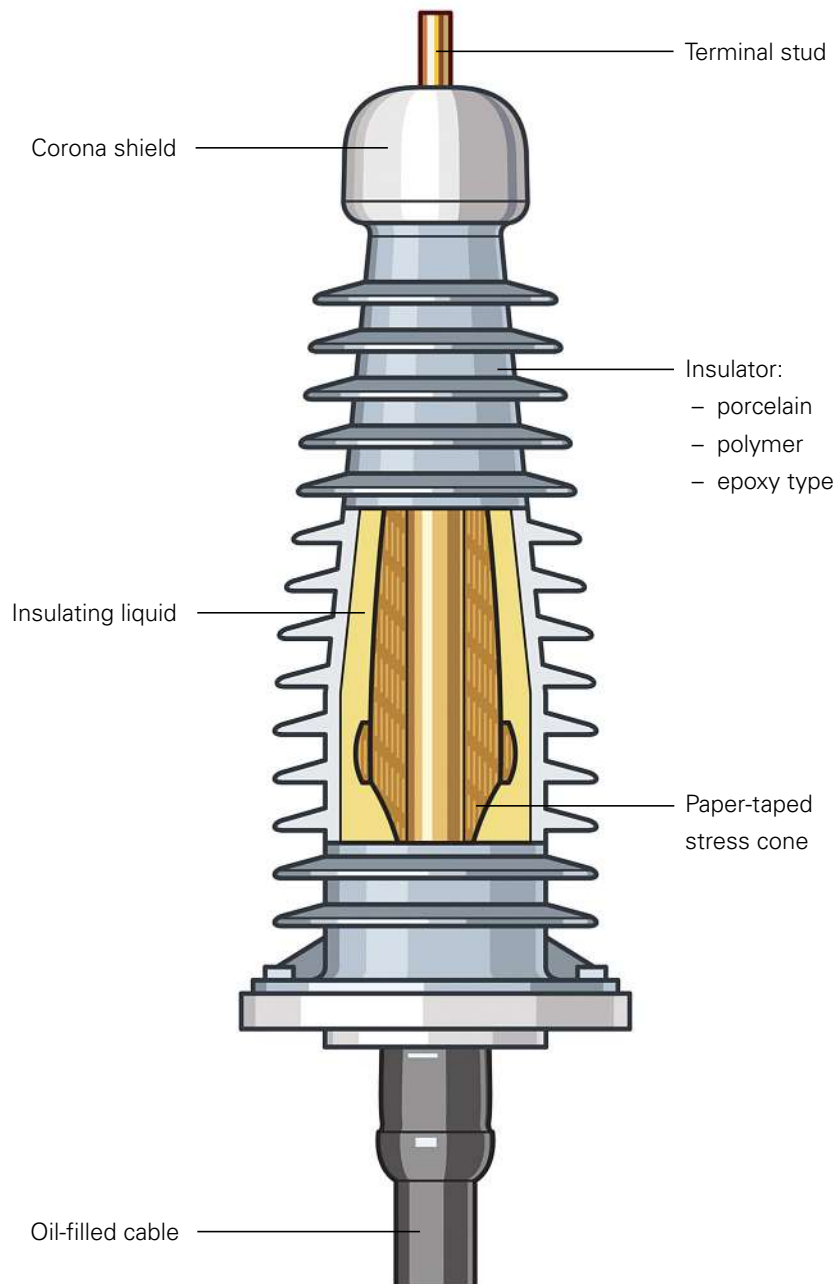
Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	$\varnothing$ over XLPE insulation $mm$	Max. $\varnothing$ of outer sheath $mm$	Type	Mechanical protection and radial moisture barrier
300	2500	68 - 115	150	MPSP 1.300-21/-31	Steel housing with protection box
420	2500	82 - 115	175	MPSP 1.420-21/-31	Steel housing with protection box
550	2500	100 - 129	175	MPSP 1.550-21/-31	Steel housing with protection box



## **High voltage accessories for oil-filled cables**



## Design of a termination for oil-filled cables



## General

Our terminations for oil-filled cables are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

### Termination design

Terminations for oil-filled cables consist of a paper-taped stress cone, an insulating liquid, an insulator, a corona shield and a terminal stud.

### Prefabricated stress cones

The prefabricated paper-taped stress cones are a tried and tested design that has been used for terminations of Brugg Cables for more than 75 years.

The main advantage of these products is that the coils for stress cones are prefabricated in a clean and dry environment at our factory.

After a high quality process of taping, drying and impregnation, the coils are stored and delivered in sealed and oil-filled containers. Consequently, the coils remain dry in any degree of humidity and oil-impregnated for the installation.

For the best solutions, our prefabricated stress cones are made according to customer specifications.

### The advantages of the prefabricated design are:

- High degree of quality and reliability due to production of prefabricated paper-taped coils in a clean and dry environment
- Very good thermal stability of up to 85°C
- Excellent field grading performances at normal frequency and higher frequency load
- Can be applied under supervision of Brugg personnel
- Excellent track record in all environment, laying conditions and climate zones
- In service for more than 75 years at Brugg Cables with outstanding results

### Four termination types available

Four types of terminations are available. For outdoor applications, we offer porcelain and composite insulators. Terminations for SF<sub>6</sub> gas insulated switchgears (GIS) or transformers are made of cast epoxy resin insulators. The insulating liquid for all oil-filled terminations is oil. The corona shield is designed to minimise electrical stress.

### Our terminations for oil-filled cables are:

- Outdoor terminations with porcelain insulators
- Outdoor terminations with composite insulators
- GIS terminations
- Transformer terminations

### All additional equipment available

We deliver all additional equipment required to operate an oil-filled cable system, such as oil expansion tanks or pressure control cabinets.

### Future delivery assurance

Our track record reflects our degree of commitment to quality, reliability and service. This means that our customers can rely on us to deliver cables, accessories and all other equipment for oil-filled cable systems for many years to come.

## Outdoor terminations with porcelain insulator for oil-filled cables

Porcelain insulators have the longest tradition.

### Their main advantages are:

- Excellent resistance against ultraviolet (UV) radiation
- Resistant against bird-picking
- Excellent track record in numerous countries and climate zones
- In service for more than 75 years at Brugg Cables with outstanding results

Terminations with porcelain insulators for oil-filled cables profit from the tried and tested Brugg design of prefabricated paper-taped coils.

The maximum design oil pressure of the termination is 10 bar. On specific customer demand, designs with higher pressure values can be supplied.

The creepage distance of the insulators can be determined according to the application, the specifications of the customer or the necessities of different climate zones.

All terminations are designed and tested according to international standards, such as IEC 60141-1 or IEC 60071 (insulation coordination).

Profit from the advantages of our outdoor terminations with porcelain insulators. All our terminations for oil-filled cables with porcelain insulators are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.



### Technical data of outdoor terminations with porcelain insulators for oil-filled cables

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) mm <sup>2</sup>	Type	Creepage distance mm
72.5	2000	OE 1.72-01	2900
145	2500	OE 1.145-01	4700, 5950, 7290
170	2500	OE 1.170-01	5950, 7290
245	2500	OE 1.245-01	8800, 10000
300	2500	OE 1.300-01	8800, 10000
420	2500	OE 1.420-01	13020, 17500

# Outdoor terminations with composite insulator for oil-filled cables

Composite terminations for oil-filled cables are the latest development of Brugg Cables. Composite insulators have been in growing demand over the past decades.

**Their main advantages are:**

- Lightweight
- Easy to handle
- Resistant against ultraviolet (UV) radiation
- Excellent hydrophobic behaviour
- Explosion-proof
- Earthquake-proof
- Excellent track record in numerous countries and climate zones

Terminations with composite insulators for oil-filled cables profit from the outstanding properties of the tried and tested Brugg design of prefabricated paper-taped coils. The maximum design oil pressure of the termination is 10 bar. On specific customer demand, designs with higher pressure values can be supplied. The creepage distance of the insulators can be determined according to the application, the specifications of the customer or the necessities of different climate zones. All terminations are designed and tested according to international standards, such as IEC 60141-1 or IEC 60071 (insulation coordination). Profit from the advantages of our terminations with composite insulators. All our terminations for oil-filled cables with composite insulators are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm².



Technical data of outdoor terminations with composite insulators for oil-filled cables

Operating voltage U <sub>max</sub> /kV	Max. conductor cross-section (Cu/Al) mm²	Type	Creepage distance mm
72.5	1000	OFR 1.72-01	2400
145	1200	OFR 1.145-01	4790
	2500	OFR 1.145-02	3890, 5580
170	2500	OFR 1.170-01	3890, 5580
245	2500	OFR 1.245-01	5330, 7820
300	2500	OFR 1.300-01	6570, 9800

## GIS terminations for oil-filled cables

GIS terminations were developed for use in SF<sub>6</sub> gas insulated switchgears (GIS). Made with a cast resin body, they are designed to fit perfectly into your GIS.

### Their main advantages are:

- Lightweight
- Easy to handle
- Classical tried and tested design with high tolerances for cables and applications
- Excellent track record in numerous countries and climate zones
- In service for more than 50 years at Brugg Cables with outstanding results

GIS terminations for oil-filled cables profit from the tried and tested Brugg design of prefabricated paper-taped coils. The maximum design oil pressure of the termination is 10 bar. On specific customer demand, designs with higher pressure values can be supplied.

All terminations are designed according to international standards, such as IEC 60141-1, IEC 62271-209 (GIS standard) or IEC 60071 (insulation coordination).

Profit from the advantages of our GIS terminations. All our GIS terminations for oil-filled cables are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2000 mm<sup>2</sup>.



### Technical data of GIS terminations for polymer cables

Operating voltage U <sub>max</sub> /kV	Max. conductor cross-section (Cu/Al) mm <sup>2</sup>	Type	Creepage distance mm
72.5	1000	OF 1.72-01	500
145	1200	OF 1.170-11	690
170	1200	OF 1.170-11	690
	2000	OF 1.170-12	710
245	2000	OF 1.245-11	900
300	2000	OF 1.300-11	900
420	2000	OF 1.420-11	1385

Transformer terminations for oil-filled cables

Transformer terminations have a cast resin body and are designed to fit perfectly into your transformer.

Their main advantages are:

- Lightweight
- Easy to handle
- Classical tried and tested design with high tolerances for cables and applications
- Excellent track record in numerous countries and climate zones
- In service for more than 60 years at Brugg Cables with outstanding results

Transformer terminations for oil-filled cables profit from the tried and tested Brugg design of prefabricated paper-taped coils.

The maximum design oil pressure of the termination is 10 bar. On specific customer demand, designs with higher pressure values can be supplied.

All terminations are designed according to international standards, such as IEC 60141-1, IEC 62271-209 (GIS standard) or IEC 60071 (insulation coordination).

Please note that corona shields for transformer terminations are designed according to customer specifications and must be ordered separately.

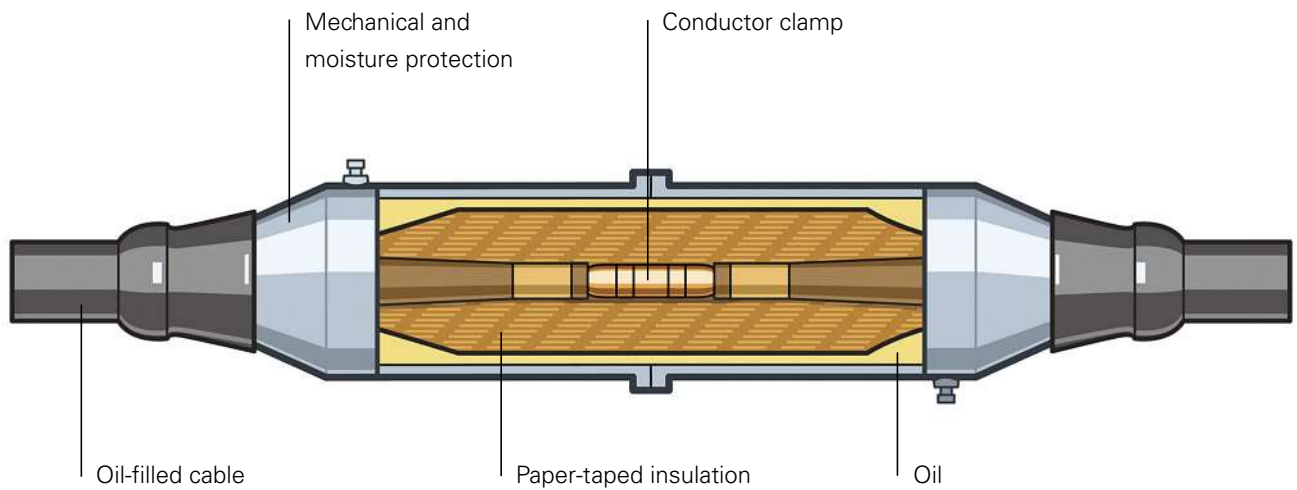
Profit from the advantages of our transformer terminations. All our transformer terminations for oil-filled cables are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm².



Technical data of transformer terminations for oil-filled cables

Operating voltage U <sub>max</sub> /kV	Max. conductor cross-section (Cu/Al) mm²	Type	Creepage distance mm
145	1200	OT 1.170-11	690
170	1200	OT 1.170-11	690
	2000	OT 1.170-11	710
245	2000	OT 1.245-11	900
300	2000	OT 1.300-11	900
420	2000	OT 1.420-11	1385

## Design of a joint for oil-filled cables



## General

Our joints for oil-filled cables are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

### Joint design

Joints for oil-filled cables consist of a conductor clamp, a paper-taped insulation, a moisture barrier, a mechanical protection and an earthing link.

### Variety of conductor clamps

Conductor clamps connect both conductor ends of the cable. Their main task is to ensure a low contact resistance during lifetime. Although all typical conductor clamps can be used, we recommend using pressed clamps for the conductor connection of joints for oil-filled cables.

### Prefabricated coils

The prefabricated paper-taped coils are a tried and tested design that has been used for Brugg Cables joints for more than 50 years.

The main advantage is that the coils are stored and delivered in sealed and oil-filled containers.

Consequently, the coils remain dry in any degree of humidity and oil-impregnated for taping during installation.

### The advantages of the paper-taped design are:

- High quality and reliability of the paper-taped coils
- Very good thermal stability of up to 85°C
- Excellent field grading performances at normal frequency and higher frequency load
- Can be applied under supervision of Brugg personnel
- Excellent track record in all environment, laying conditions and climate zones
- In service for more than 50 years at Brugg Cables with outstanding results

### Our joints for oil-filled cables are:

- Straight-through joints
- Stop joints

### All additional equipment available

We deliver all additional equipment that is needed to operate an oil-filled cable system, such as oil expansion tanks or pressure control cabinets.

### Future delivery assurance

Our track record reflects our degree of commitment to quality, reliability and service. This means that our customers can rely on us to deliver cables, accessories and all other equipment for oil-filled cable systems for many years to come.

### 100% moisture protection with metal housing

Joints for oil-filled cables come with a standard metal housing. This acts as a radial moisture barrier. Together with the mechanical protection of the joint, it guarantees a prolonged lifetime, making it highly reliable.

### Choice of mechanical protection design

The basic mechanical protection is provided by the metal housing. For additional protection, a box of polyester can be chosen. This polyester protection box is filled with an insulating compound giving excellent sealing to the joint.

### Our protection designs for oil-filled cable joints are:

- Metal housing
- Metal housing and protection box

# Straight-through joints for oil-filled cables

## Variety of joints for your individual application needs

Drawing upon a wealth of technological experience, Brugg Cables offers a wide range of straight-through joints for oil-filled cables.

The prefabricated paper-taped coils are a tried and tested design which has been used for Brugg Cables joints for more than 50 years.

All joints are designed according to international standards, such as IEC 60141-1.

## High flexibility in earthing

Earthing of joints can be made according to customer specifications. All joints are designed so that direct or indirect earthing, straight through connection or cross bonding can be realised.



## Their main advantages are:

- Tried and tested design
- Total moisture barrier due to metal shield
- Available with different types of mechanical protection
- Can be applied under supervision of Brugg personnel
- Usable with a standard pressure of 10 bar, higher pressure values for special applications possible
- Excellent track record in different laying and climate zones
- In service for more than 50 years with outstanding results




Profit from the advantages of our joints for oil-filled cables. All our joints for oil-filled cables are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2000 mm<sup>2</sup>.



## Applications of straight-through joints for oil-filled cables

Type		Radial moisture barrier	Mechanical protection	Advantages	Application
OM...-01 or -11		Steel housing	Steel housing	<ul style="list-style-type: none"> <li>• High degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In concrete tunnels or concrete pits</li> <li>• In insulated formations</li> </ul>
OM...-21 or -31		Steel housing	Steel housing with protection box	<ul style="list-style-type: none"> <li>• Highest degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete pits or buried installations</li> <li>• In installations with permanent humidity or temporary flooding</li> </ul>

## Types of earthing of joints for oil-filled cable joints

Type		Screen connection	Application
-21/-01		Straight through connection, either insulated to ground (-21) or not insulated to ground (-01)	Direct connection of cable screen without cross bonding
-21sp		Straight through connection with direct or indirect earthing, insulated to ground	Connection of cable screen to earthing link
-31/-01		Screen interruption and interruption of metal housing for cross bonding, insulated to ground (-31) or not insulated to ground (-11)	Cross bonding of cable screen at the joint

**Technical data of straight-through joints for oil-filled cables**

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) $mm^2$	Type	Mechanical protection
72.5	630	OM 1.72-01	Metal housing or Metal housing and protection box
	3 x 400	OM 3.72-01	Metal housing or Metal housing and protection box
145	1000	OM 1.145-01	Metal housing or Metal housing and protection box
	1000	OM 1.145-11	Metal housing or Metal housing and protection box
	1000	OM 1.145-21	Metal housing or Metal housing and protection box
	1000	OM 1.145-31	Metal housing or Metal housing and protection box
170	800	OM 1.170-01	Metal housing or Metal housing and protection box
	800	OM 1.170-11	Metal housing or Metal housing and protection box
	800	OM 1.170-21	Metal housing or Metal housing and protection box
	2000	OM 1.170-22	Metal housing or Metal housing and protection box
	800	OM 1.170-31	Metal housing or Metal housing and protection box
	2000	OM 1.170-32	Metal housing or Metal housing and protection box
245	2000	OM 1.245-21	Metal housing or Metal housing and protection box
	2000	OM 1.245-31	Metal housing or Metal housing and protection box
300	2000	OM 1.300-21	Metal housing or Metal housing and protection box
	2000	OM 1.300-31	Metal housing or Metal housing and protection box
420	2000	OM 1.420-01	Metal housing or Metal housing and protection box

## Stop joints for oil-filled cables

Stop joints are used to limit the oil pressure of cables that have to overcome differences in height.

Brugg Cables draws on a wealth of technological experience when designing such joints.

All joints are designed according to international standards, such as IEC 60141-1.

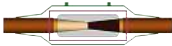

### Their main advantages are:

- Tried and tested design
- Total moisture barrier due to metal shield
- 100 % oil stop at the joint
- Usable with a standard pressure of 10 bar, higher pressure values for special applications possible

- Available with different types of outer mechanical protection
- Excellent track record in different surroundings and climate zones
- In service for more than 40 years with outstanding results

Profit from the advantages of our stop joints. All our stop joints are designed to be used independently of any type of oil-filled cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2000 mm<sup>2</sup>.

### Applications of stop joints

Type		Description	Radial moisture barrier	Mechanical protection	Advantages	Application
OS		Standard stop joint	Steel housing	Metal housing or Metal housing and protection box	<ul style="list-style-type: none"> <li>• Highest degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete or buried installations</li> <li>• In installations with permanent humidity or temporary flooding</li> </ul>
OSF		Stop joint with back-to-back design	Steel housing	Steel housing	<ul style="list-style-type: none"> <li>• High degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In laying with concrete, such as in tunnels or concrete pits</li> <li>• In insulated formations</li> </ul>

### Technical data of stop joints

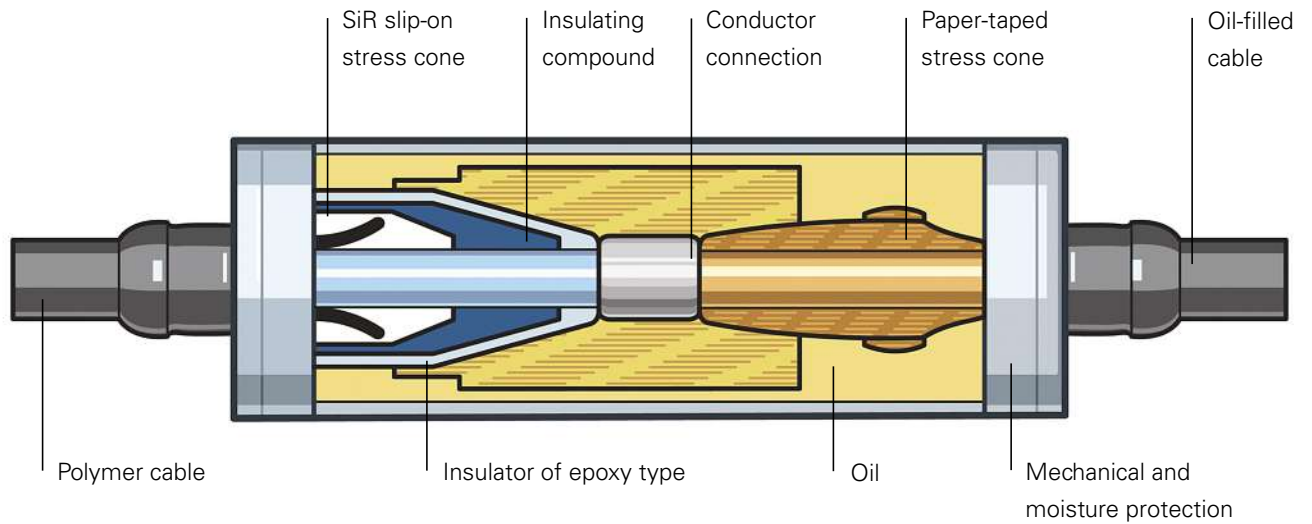
Joint	Operating voltage  U <sub>max</sub> /kV	Max. conductor cross-section (Cu/Al) mm <sup>2</sup>	Type	Mechanical protection
Standard stop joint	170	1200	OS 1.170-11	Metal housing or Metal housing and protection box
Standard stop joint	245	2000	OS 1.245-31	Metal housing or Metal housing and protection box
Standard stop joint	300	2000	OS 1.245-31	Metal housing or Metal housing and protection box
Stop joint with back-to-back design	420	2000	OSF 1.420-11	Metal housing or Metal housing and protection box



## **High voltage accessories for polymer and oil-filled cables**



## Design of a transition joint



## General

Our transition joints are designed to be used independently of any type of cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>.

### Joint design

Transition joints are used to connect polymer- with paper-insulated cables.

They consist of a conductor clamp, SiR stress cones with an insulator for the polymer cable side and paper-taped coils for the paper-insulated cable side. Transition joints are covered by a moisture and a mechanical protection, and have an earthing link.

### Variety of conductor clamps

Conductor clamps connect both conductor ends of the cable. Their main task is to ensure a low contact resistance during lifetime.

### Outstanding properties of the SiR stress cone and insulator of the polymer cable side

The stress cone and insulator of the polymer cable side are the same as those used for conventional GIS or transformer terminations. Thus, the transition joint profits from the well proven, prefabricated and pretested silicone slip-on stress cones of Brugg Cables.

The hydraulic oil-barrier is achieved with the epoxy insulator of the polymer cable side. All components within the insulator are completely separated and connected to an external stainless steel expansion tank.

### Reliable technology of paper-taped coils for the oil-filled cable side

Stress cones for the paper-taped cable side are of the same reliable and qualitative design as those for paper-taped joints or terminations. Thus, the transition joints profit from the well proven, paper-taped coils of Brugg Cables.

### Flexible application of Brugg transition joints

The main advantage of our transition joints is their excellent quality and enduring reliability. They can be installed independently of any type of low-pressure oil-filled (LPOF) or high-pressure pipe type (HPPT) cable.

### Designed for very high pressure values

Our transition joints can be designed for operating pressures up to 14 bar – hydraulic or pneumatic – and emergency pressures up to 24 bar. This is achieved by means of reinforced casing that can be individually designed according to customer specifications.

### Single and three core transition joints

We offer two different types of transition joints, single core and three core transition joints.

Single core transition joints are used to connect single core polymer-insulated cables to different types of single core paper-insulated, or paper/polypropylene-insulated cables.

Three core transition joints are used to connect a three core polymer-insulated cable with three single core paper-insulated or paper/polypropylene-insulated cables.

### Choice of mechanical protection design

A stainless steel casing covers the whole arrangement. This gives an electrical connection of the metallic sheath between both cables and ensures that moisture and a strong mechanical protection is maintained. For additional protection, a box of polyester can be chosen. The box is sealed with an insulating compound of epoxy type, giving excellent sealing to the joint.

### High flexibility in earthing

Our transition joints can either be chosen with straight through connection or with screen interruption for cross-bonding.

### Wealth of experiences

The prefabricated stress cone on the polymer cable side and the paper-taped stress cone on the oil-filled cable side are tried and tested designs, which have been used for these types of joints for more than 20 years.

### Our protection designs for transition joints are:

- Steel housing
- Steel housing and protection box

# Transition joints for polymer and oil-filled cables

Drawing upon a wealth of technological experience, Brugg Cables offers a wide range of transition joints.

## Variety of joints for your individual application needs

Our joints are designed according to international standards, such as IEC 60141-1 or IEC 62271-209 (GIS standard).

### Their main advantages are:

- Outstanding properties and hence reliability of the prefabricated and pretested slip-on stress cones at the polymer cable side
- Reliable technology of prefabricated paper-taped coils at the oil-filled cable side
- Total moisture barrier with steel housing
- 100% oil stop at the joint
- Usable with a design pressure of 10 bar
- Higher pressure values for special applications of up to 14 bar possible

- Can be installed independently of any sort of oil in the LPOF or HPPT circuit
- Can be applied under supervision of Brugg personnel
- Excellent track record in different laying and climate zones
- In service for more than 20 years with outstanding results

Profit from the advantages of our transition joints. All our transition joints are designed to be used independently of any type of cable or cable manufacturer from 72.5 to 420 kV and up to a conductor cross-section of 2500 mm<sup>2</sup>



## Applications of transition joints

Type		Radial moisture barrier	Mechanical protection	Advantages	Application	Earthing
TOS...-11/-12		Steel housing	Steel housing	<ul style="list-style-type: none"> <li>• High degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In laying with concrete, such as in tunnels or concrete pits</li> <li>• In insulated formations</li> </ul>	Straight through connection, not insulated to ground
TOS...-31/-32		Steel housing	Steel housing with protection box	<ul style="list-style-type: none"> <li>• Highest degree of mechanical protection in different environments</li> <li>• Total sealing against moisture penetration</li> </ul>	<ul style="list-style-type: none"> <li>• In all types of laying, such as in tunnels, concrete or buried installations</li> <li>• In installations with permanent humidity or temporary flooding</li> </ul>	Straight through connection, insulated to ground

## Technical data of transition joints

Operating voltage $U_{max}/kV$	Max. conductor cross-section (Cu/Al) mm <sup>2</sup>	Ø over XLPE insulation mm	Max. Ø of outer sheath mm	Type	Mechanical protection
72.5	1200	< 80	115	TOS 1.72-11	Steel housing
	1200	< 80	115	TOS 1.72-31	Steel housing with protection box
145	1000	56 - 80	115	TOS 1.145-11	Steel housing
	1000	56 - 80	115	TOS 1.145-31	Steel housing with protection box
	2000	56 - 110	150	TOS 1.145-12	Steel housing
	2000	56 - 110	150	TOS 1.145-32	Steel housing with protection box
170	1000	56 - 80	115	TOS 1.170-11	Steel housing
	1000	56 - 80	115	TOS 1.170-31	Steel housing with protection box
	2500	56 - 110	150	TOS 1.170-12	Steel housing
	2500	56 - 110	150	TOS 1.170-32	Steel housing with protection box
245	2000	70 - 117	150	TOS 1.245-11	Steel housing
	2000	70 - 117	150	TOS 1.245-31	Steel housing with protection box
300	2000	70 - 117	150	TOS 1.300-11	Steel housing
	2000	70 - 117	150	TOS 1.300-31	Steel housing with protection box
420	2500	80 - 117	160	TOS 1.420-11	Steel housing
	2500	80 - 117	160	TOS 1.420-31	Steel housing with protection box



## **Additional equipment**



## General information

As a partner for complete solutions, Brugg Cables delivers all additional accessories and equipment needed for the optimum functioning of your cable system.

### All additional equipment from one source

Brugg Cables supplies all additional equipment for your cable system such as:

- Cable clamps
- Earthing equipment for terminations
- Earthing equipment for joints
- Expansion tanks and pressure control cabinets for oil-filled cables and accessories

### All types of cable clamps

Cable clamps are necessary devices, as they fix the cable to encourage proper functioning during normal conditions and faults. We offer a wide range of cable clamps depending on the cable type, its application and surrounding.

If you require detailed information on these items, just contact our experts for a separate offer.

### Wide range of necessary earthing equipment

We provide a wide range of earthing equipment as shown in the tables below. Choose from a variety of these earthing device applications for all accessories.

### All equipment needed for oil-filled cable systems

Expansion tanks and pressure control cabinets belong to an oil-filled cable system and transition joints. They are designed according to your cable system. If you require a detailed list of these items, just contact our experts for a separate catalogue or offer.

### And more

Should you need additional and/or other specialised equipment, our experts will be pleased to help.



Cable clamp



Single pole disconnecting link box with surge voltage arrester



Three pole disconnecting link box



Cross-bonding box

## Earthing- and Cross-bonding boxes

### Disconnecting link boxes for all types of terminations

Type	Application with surge arrester	Drawing no.	IP degree	Remarks
Disconnecting link box		S 1345-4	54	Single pole
Disconnecting link box		S 1344-4	54	With disconnecting knife
Disconnecting link box		S 1419-4	54	With disconnecting knife
Disconnecting link box		S 1107-4	54	Three pole
Disconnecting link box		S 1167-4	54	Three pole
Disconnecting link box		S 1660-4	65	With disconnecting knife

### Devices for earthing of outdoor terminations

Type	Application with surge arrester	Drawing no.
Disconnecting link		S 1264-4
Disconnecting link		S 1406-4
Surge voltage arrester		S 1407-4
Disconnecting element		S 1408-4
Supporting insulator		S 1409-4

### Devices for earthing of GIS and transformer terminations

Type	Application with surge arrester	Drawing no.	Remarks
Disconnecting element		S 1503-4	72.5 - 170 kV
Disconnecting element		S 1504-4	170 kV
Disconnecting element		S 1505-4	245 kV
Disconnecting element		S 1506-4	72.5 - 170 kV
Disconnecting element		S 1509-4	170 kV
Disconnecting element		S 1508-4	245 kV

### Disconnecting link boxes for all joints

Type	Cross bonding	Drawing no.	IP degree	Remarks
Disconnecting link box		S 1479-4	54	Three pole
Disconnecting link box		S 1431-4	68	Three pole
Disconnecting link box		S 1348-4	54	Three pole
Cross-bonding box		S 1599-4	54	Three pole
Cross-bonding box		S 1600-4	54	Three pole
Cross-bonding box		S 1601-4	68	Three pole

### Oil expansion tanks

Type	Drawing no.	Oil volume l	Weight with oil kg
AG 2.5	S 1456-4	2.5	6
AG 5	S 1483-4	5.0	17
AG 8	S 1288-4	8.0	18

## Tools

We provide you with all the necessary tools to guarantee quality installation.

### Complete set of tools

In order to provide you with high quality installation, we offer the necessary tools for the installation of high voltage accessories. Our tools can be bought or rented.

If you require detailed information concerning these items, just contact our experts for a separate catalogue and offer.



Cutting and peeling device



Peeling and stripping tool



Press head of 60 t



## General information



## Our basis – advanced technology combining experiences with innovations

Products that ensure a long-lasting energy supply are the result of extensive research and development.

### Research and development for products and production

Long-lasting reliable energy supplies are vital for our society. That's why, Brugg Cables is constantly investing in research and development (R&D) of products and production. The latest innovative technology is combined with the experience of more than 100 years. This fruitful combination is realised from the development of new materials and techniques, through to extensive tests and scientific surveys and on to the whole production process.

### Products with excellent properties

Our extensive commitment is to R&D results for products with the best electrical, thermal, mechanical and chemical properties. This balanced design ensures that all our accessories are highly reliable and can be used for cables of any manufacturer. All products are well proven and tested before being introduced into the market and finally delivered to you.

### High quality products through:

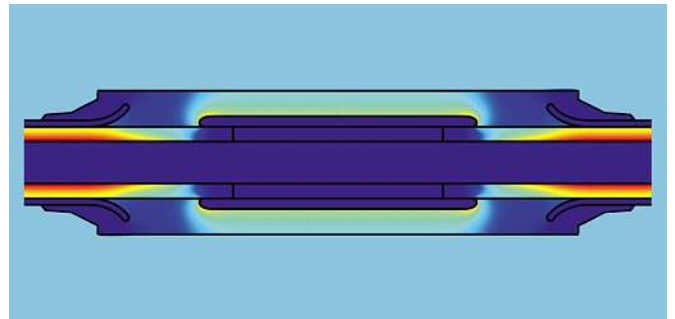
- Tests in our on-site materials laboratory
- Advanced material analysis and diagnostics technology
- Application of modern simulation tools
- Experienced staff
- On-site prototype factory for all types of parts concerning accessories, such as stress-grading parts, silicone parts etc.
- Intensive tests in our own high voltage laboratories
- Constant cooperation with universities and research laboratories



Microscopic inspection in the materials laboratory



Mechanical tests in the materials laboratory



Simulation of the electrical field in a joint body



High voltage laboratory at Brugg Cables

## The basis of our quality – production at high standards

Quality is an attitude that influences every single production step.

### Production for high reliability products

In order to ensure that your cable system operates reliably, we have made quality our priority. This dictates every single process step from the selection of raw materials, through to production and continuous testing.

The key components of high voltage accessories, the slip-on bodies and stress cones, are made in-house and by our experts. In order to ensure that the quality of these products remains constant, the production process of the SiR slip-on bodies and stress cones is fully automatic.

For zero failure production, our products are continuously tested after every production step.

### The main advantages of our high-quality production are:

- Production of one-piece SiR slip-on bodies and stress cones in-house at our factory in Brugg, Switzerland
- Experienced experts
- Use of best materials
- Tests of procurement parts
- Automatic computer-based production
- Zero failure production due to single control of every component after each production step

### Officially proven quality

Our constantly applied quality processes are confirmed and certified according to:

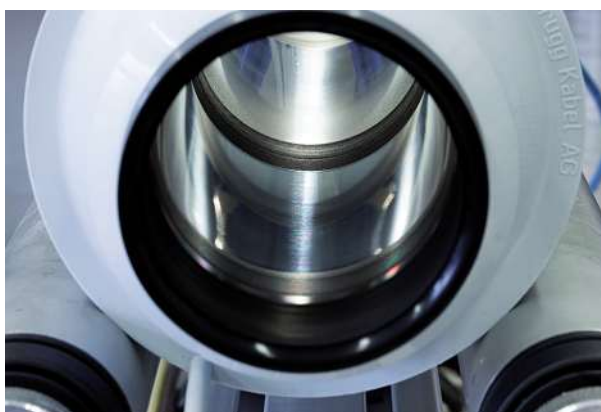
- Quality Management Certificate SN EN ISO 9001: 2000 (since 1986)
- Environmental Management Certificate SN EN ISO 14001: 1996



Production of silicon parts in a very clean surrounding



Single control of the surface of a SiR slip-on joint body after production



Clean surface in the SiR slip-on joint body

# The guarantee for our quality – fully tested equipment

Testing is essential to us, guaranteeing high reliability products.

## Tests for guaranteed quality

At Brugg Cables, all equipment is tested several times before being delivered to the customer.

Our key tests at a glance are:

- **Development tests** at our high voltage laboratory
- **Type tests** for all accessories up to 550 kV according to IEC 60840, IEC 62067, IEEE Std 48-1996 and IEEE Std 404-2000.
- **Prequalification tests** for all accessories up to 550 kV according to IEC 62067
- **Routine tests** of all prefabricated silicone stress cones and slip-on bodies according to IEC 60840 and IEC 62067 in-house in a modern fully screened test room.

## Development tests

All accessories have to pass several tests during their development. These development tests apply stresses far above those occurring during normal operating conditions. The extensive tests ensure reliable and long-lasting products and are carried out in-house at our high voltage laboratory.

## Type tests

As a matter of course, our accessories have passed all relevant type tests in accordance with international standards, such as IEC 60840 or IEC 62067. The type test applies electrical and thermal loads as well as water ingress above those occurring during normal conditions and lasts for a period of 20 days. This is followed by a watertightness test. Type tests are carried out under the supervision of experts from independent test laboratories.

## Prequalification tests

In addition to the above, the high voltage accessories of Brugg Cables must pass a prequalification test according to IEC 62067. This test requires one year of operation at cyclic temperature load and elevated voltages. Brugg accessories have successfully completed these tests up to a voltage of 420 kV and will soon extend this up to 550 kV.

## Routine tests

All one-piece, prefabricated SiR slip-on bodies receive a final routine test in accordance with IEC 60840 and IEC 62067. At a higher voltage load, the products are shown to be completely free of partial discharges. Our pass rate for these tests is set higher than required by the standards. The delivery of 100% quality products from our factory is guaranteed as every piece undergoes a final test and is certified individually.



Prequalification test of 550 kV equipment



Prequalification test of 220 kV equipment at an independent test laboratory



Preparation for a routine test of a SiR slip-on body at our fully screened routine test room

## Quality beyond the factory – installation services

An optimum performance of your cable system from day one can be guaranteed by the use of our installation services.

### High quality installation

The quality of installation is vital for the reliable running of your cable system.

In order to ensure top performance of our products in the field, Brugg Cables operates with its own installation department.

This means that the installation of our accessories is carried out by specially trained personnel with extensive experience.

Our installation services include:

- Polymer cables and accessories up to 550 kV
- Oil-filled cables and accessories up to 420 kV
- Transition joints up to 420 kV
- Underwater installations

Profit from our services with an economic solution suited to your needs. Our experts provide complete or supervised installation services.

In addition we also offer training courses for your teams. If you require detailed information about the courses, just contact our experts for a separate catalogue and offer.

### The main advantages of our installation services are:

- Own installation department with well educated, trained, and experienced personnel
- Training of your installation teams
- Supervision of your teams
- Assembly-friendly installation sets
- Full supply of all tools, either on sale or on rental basis
- Installation services that are independent of the cable manufacturer

### Support in commissioning testing

We offer commissioning tests after installation at your request. This service is offered by working closely together with different specialised testing companies and institutes. All commissioning tests are carried out according to international standards, such as IEC 60840, IEC 63067 and IEC 60141.



Preparation of the conductor connection for a polymer joint



Assembling-friendly installation of a slip-on joint by "air cushion" method



Commissioning test on-site at 420 kV porcelain terminations in Germany

## We offer more – after sales services, monitoring and diagnostics

Our support goes beyond delivery and installation.

### Customer service support

Our customer service is there for all questions concerning your cable and/or accessories project before, during and after installation. A team of engineers and specialists is available at Brugg Cables to provide you with the necessary help. Should you be interested in any service, just contact our experts.

### Monitoring and diagnostics support

Following a full system approach, we also offer you devices, tools and know-how for monitoring and diagnostics. We work closely together with different specialised companies and research institutes, enabling us to provide you with a wide range of monitoring and diagnostics services.

This includes:

- Temperature monitoring
- Partial discharge (PD) measurement and monitoring
- Humidity measurement and monitoring
- Condition assessment of service-aged cable systems
- Measurement of all relevant cable data, such as insulating resistance, impedance, conductor resistance measurements etc.
- Failure localisation and repair

### Wide range of other testing means

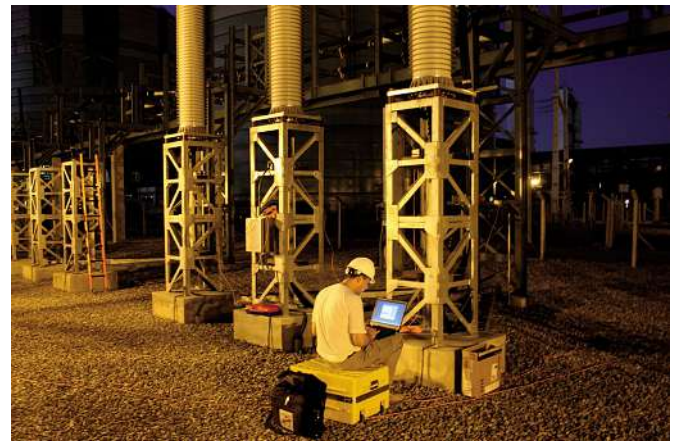
Brugg Cables offers a wide range of testing means, depending on your requirements. This is achieved by working closely together with different specialised testing companies and institutes. The tests include:

- AC and DC voltage tests
- Partial discharge measurements
- Hydraulic measurements on pressurised oil-filled cables and accessories

Should you be interested in any device or service, just contact our experts.



Preparation for PD measurements at terminations for a customer in Switzerland



PD measurement for a customer in South America



Temperature monitoring along a cable system

## Our know-how and experiences for your success – The Brugg Cables Academy

Know-how is at the heart of all functioning industrial applications. That's why Brugg Cables offers its customers continued quality education. Profit from the Brugg Cables Academy.

### Know-how and experiences available for your needs

Reliable and functioning cable systems are influenced by a number of factors. These may range from choosing the right design of cables and accessories, considering the influences of thermal load conditions, selecting the appropriate earthing design or posing the right questions concerning installation tests, monitoring and diagnostic tools.

Brugg Cables has extensive knowledge in all these fields and wants to share this with you, our customers, helping you to stay constantly "Well connected".

### Five central topics of the Brugg Cables Academy

The target of our education program is to provide you with relevant knowledge within your specific field. Brugg Cables Academy supports your need for specialization by offering courses in five central topics, which are:

- **High voltage oil cable systems**
- **High voltage polymeric cables**
- **High voltage accessories for polymeric cables**
- **Partial discharge measurements & monitoring**
- **Diagnostics for cable systems**

Typical course participants include engineers and utility technicians as well as project managers or persons involved within the relevant fields.

### Standard or individual courses according to your needs

Standard courses are held in Brugg, Switzerland each year; in an autumn session in October and in a spring session in March. Courses can also be taken individually. Customers decide whether the courses are held in Switzerland or in their home country. For more information, contact our personnel or apply at [info.hvaccessories@brugg.com](mailto:info.hvaccessories@brugg.com).



New facilities in Brugg, Switzerland, with the rooms of the Brugg Cables Academy



Annual engineering training course in Brugg



Education by one of our experts at a customer meeting

## Brugg – a history of experiences in cable systems

The history of cable systems is closely related to the history of our company. For decades, Brugg has been a leading company in cables, accessories, equipment, and all products and services around cable systems.

- 1896 founded by Gottlieb Suhner, Brugg begins delivering cables and wires. First customers are major Swiss utilities.
- 1900 Swiss utilities place large orders for paper-insulated lead sheathed power cables by Brugg.
- 1918 Brugg begins delivering large quantities of communication and power cable systems to support the Swiss railway company "SBB" in its electrification.
- 1928 Brugg delivers and installs the first Swiss underwater cable across Lake Lugano.
- 1934 Brugg already delivers a 150 kV oil-filled cable allowing higher power transmission.
- 1942 4500 m long low-pressure oil-filled cable system is delivered and installed for a Swiss customer.
- 1955 Brugg is once again ready on the market, introducing its first cable with synthetic insulation at 20 kV, allowing its customers to make use of the advantages of polymer insulations.
- 1960 Brugg develops a 420 kV oil-filled cable system suited to increasing power demands.
- 1974 Brugg develops polymer joints for voltages up to 72.5 kV, coinciding with new requirements of long-distance cable systems and newly introduced polymer insulations.
- 1980s Brugg leads in the development of polymer cables and accessories of up to 220 kV, as power demands increase.
- 1997 Brugg delivers polymer cable systems of 420 kV, ensuring a powerful and reliable energy supply.
- 2008 Brugg develops a complete 550 kV polymer cable system with all types of terminations and joints suited to increasing power needs. Once again Brugg Cables places itself amongst the premier league of its field.
- 2010-1 New production and office facilities were opened in the center of Brugg. Beside the Business Unit High Voltage Accessories, also the board of the BRUGG-Group moved into the new facilities.
- 2010-2 Education towards its customers is brought to a new level. In the new facilities, the "Brugg Cables Academy" was founded, providing courses concerning all issues around cable systems. The first courses were held in October 2010 and were highly requested.



Production facilities of Brugg around 1900



Laying of 420 kV oil-filled cables in Switzerland in the 1960s



Product facilities at Brugg in the late 1970s



Brugg Cables' modern, fully screened test room for AC voltages up to 600 kV



New office and production facilities in Brugg and home of the "Brugg Cables Academy"

## References I

From the 75 years of delivering high voltage accessories, we have a reference list that is far too large to be listed here in detail.



Installation of joints in Abu Dhabi



Outdoor terminations with porcelain insulators in the USA



Outdoor terminations with composite insulators in Switzerland



Installation of transition joints in Germany



Outdoor terminations with composite insulator in Brazil



GIS-terminations of the highest voltage level (550 kV) in Egypt

## References II

We are pleased that we could carry out projects that have lead to more than 40'000 references with different cable designs in all climate zones in 66 countries on 5 continents.



Transformer terminations in outdoor application in Jordan



Tests of outdoor terminations in Switzerland



Transformer terminations in indoor application in South Africa



Checking of delivery of transition joints in the USA



Discussion of technical details at a joint bay in Qatar



Preparation for the installation of outdoor terminations in Norway

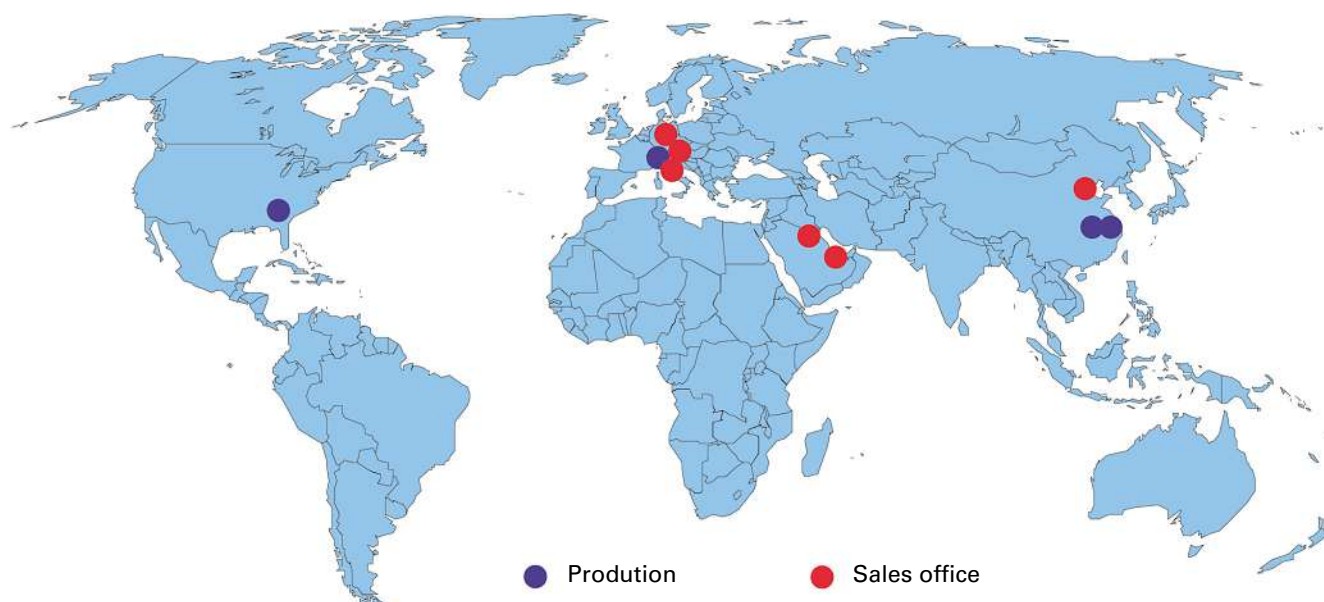
## Brugg markets – worldwide and close to you

In addition to our headquarters in Switzerland, we also have representatives in:

- **Sozhou, Shanghai and Beijing, China**
- **Prague, Czech Republic**
- **Schwieberdingen (Stuttgart), Germany**
- **Milano, Italy**
- **Salmiya, Kuwait**
- **Dubai, United Arab Emirates**
- **Rome, GA, USA**

### Our main advantages are:

- Competent and local language speaking agents near you
- Delivery in all climate zones
- Delivery of accessories to all cable manufacturers



Worldwide representatives of Brugg Cables



For further information  
please contact us.

## Our head office

### Switzerland

Brugg Kabel AG  
Klosterzelgstrasse 28  
CH-5201 Brugg  
Phone +41 (0)56 460 33 33  
Fax +41 (0)56 460 35 36  
info@brugg.com  
www.bruggcables.com

Sales infrastructure:

Fax +41 (0)56 460 32 98  
info.havaccessories@brugg.com

### China

Brugg Cables (Shanghai) Co., Ltd.  
Building No.7 Sai Te Industrial Park  
No.1300 Jun Gong Road  
CN-Shanghai  
Phone +86 21 5506 2530  
Fax +86 21 5506 2533  
info@brugg-cables.com.cn  
www.brugg-cables.com.cn

### Kuwait

Brugg Cables  
Salwa, Block 12  
Street No 7, House No 76  
Floor No 1, Flat No 1  
P.O. Box 2191  
KW-22022 Salmiya  
Phone +965 2566 32 71  
Fax +965 2566 32 73  
info.kw@brugg.com  
www.bruggcables.com

## Our branches

### Germany

Brugg Kabel GmbH  
Daimlerstrasse 8  
DE-71701 Schwieberdingen  
Phone +49 7150 91635 0  
Fax +49 7150 91635 55  
info.de@brugg.com  
www.bruggcables.com

### Italy

Brugg Cables Italia srl  
Via Palermo, 20  
Sesto San Giovanni  
IT-20099 Milano  
Phone +39 02 22 47 00 48  
Fax +39 02 24 86 28 93  
info.it@brugg.com  
www.bruggcables.com

### USA

Brugg Cables, LLC  
25 Anderson Road  
P.O. Box 5231  
US-Rome, GA 30162-5231  
Phone +1 706 235 8755  
Fax +1 706 235 7635  
info.usa@brugg.com  
www.bruggcables.com

### United Arab Emiraates

Brugg Cables, LLC  
P.O. Box 28896  
AE-Dubai  
Phone +971 4 334 55 40  
Fax +971 4 334 41 18  
info.ae@brugg.com  
www.bruggcables.com

You will find further sales partners in your region on [www.bruggcables.com](http://www.bruggcables.com). A company of the Brugg Group.

[www.electricamaya.com.mx](http://www.electricamaya.com.mx)

(55)5384-1145

