

Cable accessories for power grids

High and extra high voltage



Catalog part 2 / 3



WELCOME!

For your sustainably successful work on high and extra high voltage grids, this second part of the accessories catalog offers further key components from PFISTERER for the many sensitive grid interfaces with XLPE and EPR cables:

- **Terminations** for the transition from cables to bare conductors or equipment outdoors and indoors
- **Connection joints** in many variants for all high and extra high voltage cables (HV/EHV) and diverse locations, with consistently advantageous slip-on technology
- **Link boxes** for all common earthing and cross-bonding methods as well as additional tools

The extensive range in this catalog exemplifies PFISTERER quality in a variety of products tailored to needs for optimized use:

At numerous points in the grid, from overhead power line towers, in cable runs, on gas-insulated switchgear (GIS) and transformers.

Under demanding environmental conditions at altitude, underground, in extreme and fluctuating temperatures.

For diverse markets and philosophies, compliant with international and world regional standards, exemplary state-of-the-art technology in proven traditional and modern designs.

Find out more about the quality and origin of PFISTERER accessories in section 1. This is followed immediately by detailed product information with data and pictures.

More advanced PFISTERER interface solutions for your high and extra high voltage applications appear in:

Catalog part 1 focusing on pluggable CONNEX components for transformers and GIS.

They enable flexibly interchangeable connection types in all practically relevant configurations – without intervention inside the equipment, thanks to the highly versatile connecting system.

The PFISTERER product portfolio is the result and subject of continuous development in line with customer requirements, practical values and research findings. At ever higher voltages. With benchmark technologies.

Milestones in technical development and possibilities for using the components in your projects are also presented in this catalog:

- **Insights into PFISTERER technologies.** They set standards in connecting different and complex cables by minimizing effort and risks in favor of efficient operational reliability and service life.
- **Application outlooks with PFISTERER solutions from all three HV accessories catalogs in use.** Individually or combined, they serve standard and special applications, enable value preservation and change. For pragmatic progress in power grids, PFISTERER is continuously developing dry-insulated and pluggable solutions for worldwide needs and new possibilities.

Would you like more information?

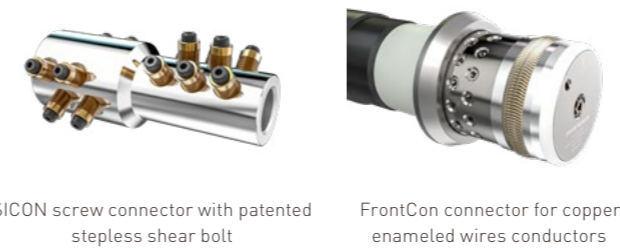
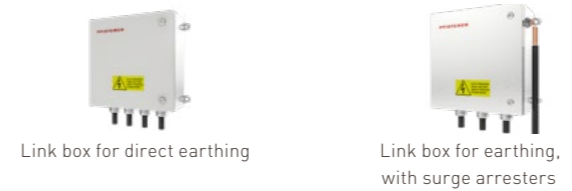
Send your request by email or give us a call: Contact details are on the last outer page. PFISTERER specialists for interface solutions will be happy to answer your questions.

On the following pages you will see: At PFISTERER, choice is not a chore, but an opportunity to realize the optimum for your requirements. Technically, economically, ecologically. With safety and sense.

Catalog part 3 with more CONNEX components using advantageous plug-in technology such as joints, extra tools and pre-assembled cable solutions, combinable and configurable on a custom basis for special permanent and temporary applications as a bypass, offshore, for revisions, remodelings, etc.

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This product catalog contains a representative selection of the most prevalent products from the PFISTERER range. Additional versions and custom applications can be available on request. Products described as optional extras are not included in the standard scope of supply and have to be ordered separately if required.

Cable accessories for high voltage grids



Solutions for high and extra high voltage grids. Tested quality from PFISTERER.

On the following pages you will find detailed product information on the wide range of terminations, connection joints and link boxes by PFISTERER for 72.5 kV to currently 550 kV in the form of:

- Product group features
- Component specifications
- Variant codes with technical details

PFISTERER solutions represent technical progress based on proven technologies and tested designs.

Designed with know-how gained from 100 years of experience in the transmission of high currents and insulation of high voltages.

Developed, manufactured and assembled to the highest quality standards using state-of-the-art processes at PFISTERER sites in Europe, certified to ISO standards for quality and environmental management as well as occupational health and safety, and also qualified under various well-known industry standards and special requirements of many customers from around the world.

Solutions from PFISTERER for high and extra high voltage are type-tested and individually tested based on various requirements of international standards (IEC, IEEE, etc.). Testing is carried out at PFISTERER high voltage lab and in end-of-line test fields, or at recognized external test institutes.

PFISTERER accessories also successfully complete system tests with various HV and EHV cables according to demanding customer specifications that exceed standard requirements. In addition, they prove their performance capability in prequalification tests lasting several months, which simulate decades of operation under real operating conditions. These additional tests are performed in cooperation with users and cable manufacturers, either internally or externally, in the laboratory or in the field, depending on testing requirements.

Terminations – At the start of all possibilities

The PFISTERER portfolio of terminations supports the reliable implementation of

- Transition points from bare conductors to XLPE and EPR cables and
- Cable connections on transformers and gas-insulated switchgear
- Indoors and outdoors

With a wide range for common applications:

- All high and extra high voltage cables (HV/EHV) for
- Voltages from 72.5 to currently 550 kV U_m
- Diverse cable types and all conductor designs with copper or aluminum conductors
- Various conductor and insulation diameters as well as cable cross-sections
- For earthing cable cross-sections up to approx. 630 mm²
- With link boxes for widely used earthing and cross-bonding methods (more in section 3) plus other component-specific extra tools

In proven designs from traditional to advanced for existing and new power grids, for classic and innovative concepts.

To meet increasing demands for safety, efficiency and flexibility, the following two continuously expanding product lines are recommended:

Dry, solid-insulated outdoor cable terminations (right, section 1.1) offer many valuable benefits: No laborious handling of liquid or gaseous insulating media, and no environmental risks during operation. Simpler installation with slip-on technology – a modern standard that PFISTERER has developed with variant-specific advantages: **ESF** can be used flexibly in testing and temporary site cables.

EST can be fitted without scaffolding in shorter working times and downtimes, and also be positioned with surge arresters in a compact design. Self-supporting **DOC** can be installed very quickly in internationally widespread outdoor applications thanks to the pre-assembled central unit.

Solid-insulated, pluggable CONNEX cable connectors also offer excellence in operational efficiency and value preservation when used on transformers and GIS: Thanks to a fixed, highly versatile interface, they can be installed without interventions in the equipment and swapped with other pluggable CONNEX components at any time. See catalog part 1 for an extensive description of how; basic details at the bottom of the next page and in section 1.3.

Whatever your choice: With every termination, you receive a well engineered product for trouble-free, maintenance-free use from the time of professional installation as trained by PFISTERER (see section 6).

Your choice of PFISTERER terminations at a glance: Product groups with technology features, application areas, product variants

Terminations for the transition from cable (XLPE and EPR) to bare conductor

Dry-insulated outdoor cable terminations Slip-on or plug-in installation (see section 1.1)

- Insulating elements and stress cone made of silicone
- Installation-friendly, without laborious handling of liquid or gaseous insulating materials
- No risk of leakage or explosion in the event of a short-circuit
- Slip-on technology up to currently 170 kV U_m
 - For testing and temporary site cables: Flexible ESF
 - For overhead line towers: Supported EST with special base plate and clamp
 - For substations: Supported EST-SUB, optionally with integrated surge arrester (SA)
 - For classic applications quickly installed: Self-supporting DOC

Oil-insulated outdoor cable terminations (see section 1.2)

- Insulator sheds optionally made of
 - Silicone for termination type ESS
 - Porcelain for termination type ESP
- Stress cone made of silicone surrounded by
- Oil-based insulating medium
- Up to 550 kV U_m in application-specific designs for:
 - Applications in the substation
 - Use on overhead line towers

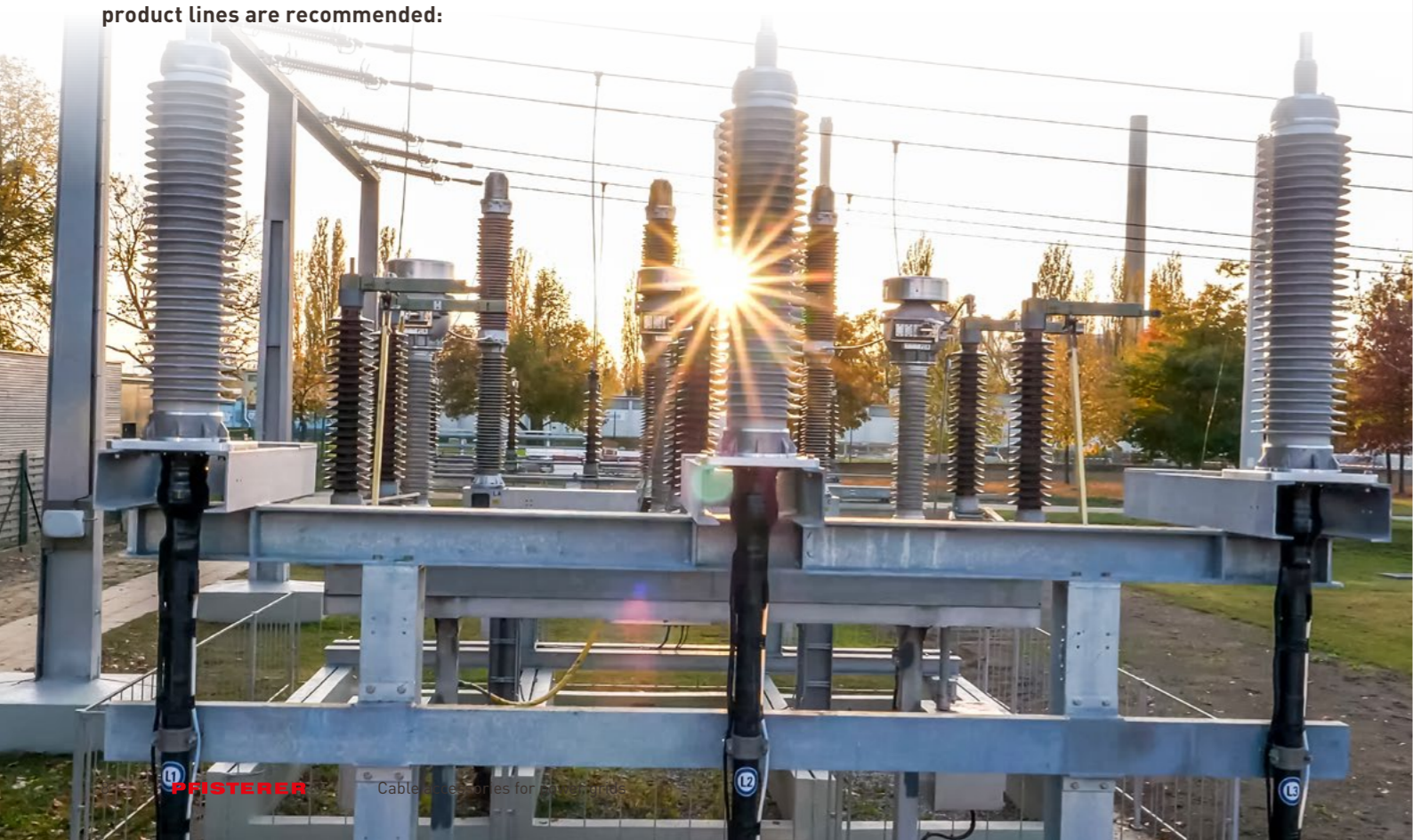
Connections for the transition from cable (XLPE and EPR) to transformer/GIS

Pluggable dry CONNEX connections (see section 1.3)

- Two-part system: Cable connector and device-side-installed socket
- Installation by plugging cable connector into socket without interventions in the equipment and without laborious handling of liquid or gaseous insulating materials
- Stress cone and insulating elements made of solid materials
- No risk of leakage or explosion in the event of a short-circuit
- Up to currently 550 kV U_m
- Socket proven in conventional and also modern insulating materials, for example ester, environmentally friendly gases
- Cable connector interchangeable with CONNEX plug-in bushing or other pluggable CONNEX components

Oil-insulated cable terminations (see section 1.4)

- 1-piece termination for installation of high voltage cables inside GIS or transformers
- Stress cone made of silicone
- Insulating element made of cast resin
- Up to 300 kV U_m in two application-specific types:
 - ESU for oil-insulated transformers
 - ESG for gas-insulated switchgear



ESF termination

The dry-insulated and flexibly designed ESF is versatile: It can be integrated into existing and new support structures. For fast and multiple use without support elements, the ESF can be prefitted without a base plate on testing and temporary site cables.

At a glance

- Flexible, installation friendly and maintenance-free design
- Versatile use in substations and as a multiple solution:
- Can be pre-assembled on testing and temporary site cables
- Enables efficient retrofit, especially for changeover to dry, solid-insulated termination technology
- Oil and gas free, fully dry-insulated with solid materials, therefore:
- No handling of liquid or gaseous insulating materials during installation
- No leakage or environmental risks, explosion-proof
- Water and dirt repellent insulator sheds
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor

Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



ESF termination

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
52	45 - 47	250	95 - 1200	32.5 - 64.4	1500	III / d	ESF52-C15L
52	45 - 47	250	95 - 1200	32.5 - 64.4	1813	IV / e	ESF52-C19L
72.5	60 - 69	325	95 - 1200	32.5 - 64.4	1813	III / d	ESF72-C19L
72.5	60 - 69	325	95 - 2500	32.5 - 114.5	2248	IV / e	ESF72-C23L
123	110 - 115	550	150 - 2500	46 - 114.5	3075	III / d	ESF123-C31L
123	110 - 115	550	150 - 2500	46 - 114.5	3814	IV / e	ESF123-C39L
145	132 - 138	650	185 - 2500	46 - 114.5	3625	III / d	ESF145-C37L
145	132 - 138	650	185 - 2500	46 - 114.5	4495	IV / e	ESF145-C45L
170	150 - 161	750	240 - 2500	51.5 - 114.5	4250	III / d	ESF170-C43L
170	150 - 161	750	240 - 2500	51.5 - 114.5	5270	IV / e	ESF170-C53L

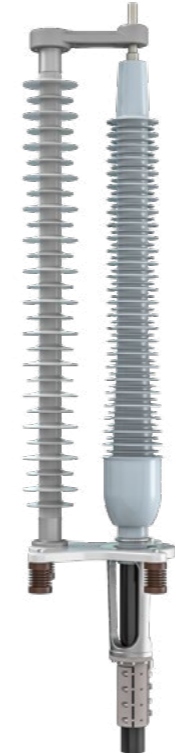
* Lightning impulse (withstand voltage)

EST termination

The solid-insulated EST is efficient in use on overhead line towers: The supported termination can be prefitted on the high voltage cable on the ground, and then lifted onto the tower together with the cable. Without the need for installation scaffolding, the overhead line's outage time is greatly reduced.

At a glance

- For maintenance-free use on overhead line towers
- Simple cable termination installation on the ground, no scaffolding required
- Can be mounted at different angles
- For efficient retrofit, especially for changeover to dry-insulated termination technology
- Oil and gas free, fully dry-insulated with solid materials, therefore:
- No handling of liquid or gaseous insulating materials during installation
- No leakage or environmental risks, explosion-proof
- Water and dirt repellent insulator sheds
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor



Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology

EST termination

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
123	110 - 115	550	150 - 2500	51.5 - 114.0	3075	III / d	EST123-C31L
123	110 - 115	550	150 - 2500	51.5 - 114.1	3814	IV / e	EST123-C39L
145	132 - 138	650	185 - 2500	51.5 - 114.2	3625	III / d	EST145-C37L
145	132 - 138	650	185 - 2500	51.5 - 114.3	4495	IV / e	EST145-C45L
170	150 - 161	750	240 - 2500	51.5 - 114.4	4250	III / d	EST170-C43L
170	150 - 161	750	240 - 2500	51.5 - 114.5	5270	IV / e	EST170-C53L

* Lightning impulse (withstand voltage)

1.1 EST-SUB termination

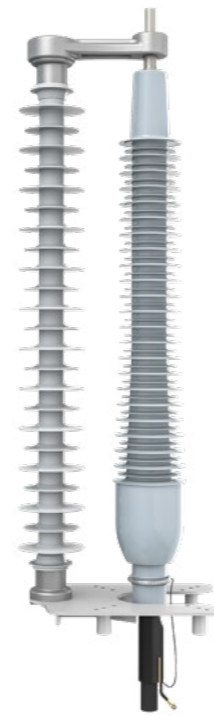
The dry-insulated EST-SUB is used in substations and on portal structures. The termination can be fitted to the cable separately on the ground, and then lifted up to the support structure and integrated into it. The support elements are attached independently of the cable connection.

At a glance

- For maintenance-free use in substations
- Simple cable termination installation on the ground
- Many different installation positions possible
- For efficient retrofit, especially for changeover to solid-insulated technology
- Oil and gas free, fully dry-insulated with solid materials, therefore:
 - No handling of liquid or gaseous insulating materials during installation
 - No leakage or environmental risks, explosion-proof
 - Water and dirt repellent insulator sheds
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor

Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



EST-SUB termination

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
72.5	60 - 69	325	95 - 1200	32.5 - 64.4	1813	III / d	EST72-C19-SUB
72.5	60 - 69	325	95 - 2500	32.5 - 114.5	2248	IV / e	EST72-C23-SUB
123	110 - 115	550	150 - 2500	46 - 114.5	3075	III / d	EST123-C31-SUB
123	110 - 115	550	150 - 2500	46 - 114.5	3814	IV / e	EST123-C39-SUB
145	132 - 138	650	185 - 2500	46 - 114.5	3625	III / d	EST145-C37-SUB
145	132 - 138	650	185 - 2500	46 - 114.5	4495	IV / e	EST145-C45-SUB
170	150 - 161	750	240 - 2500	51.5 - 114.5	4250	III / d	EST170-C43-SUB
170	150 - 161	750	240 - 2500	51.5 - 114.5	5270	IV / e	EST170-C53-SUB

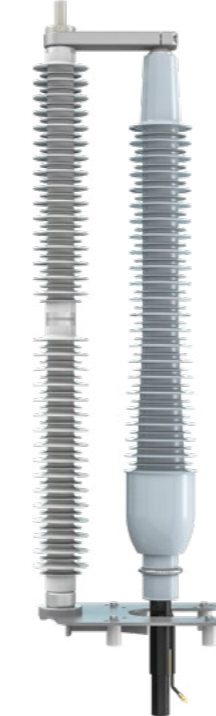
* Lightning impulse (withstand voltage)

1.1 EST-SUB SA termination

The EST-SUB SA for solidly grounded and compensated systems is also solid-insulated. Its integrated surge arrester cost-effectively fulfills two tasks: It serves as a bearing element for the termination and protects both cable and fitting in the event of a temporary overvoltage. Additional support elements for the termination and arrester are therefore not needed. Cable connection and surge arrester can be fitted independently of each other.

At a glance

- Termination combined with surge arrester
- Cost-effective and maintenance-free in use in substations
- Without additional support elements for termination and arrester
- Simple cable termination installation on the ground
- For efficient retrofit, especially for changeover to dry-insulated technology
- Oil and gas free, fully dry-insulated with solid materials, therefore:
 - No handling of liquid or gaseous insulating materials during installation
 - No leakage or environmental risks, explosion-proof
 - Water and dirt repellent insulator sheds
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor



Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology

EST-SUB SA termination

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
72.5	60 - 69	325	95 - 1200	32.5 - 64.4	1813	III / d	EST72-C19-SUB SA
72.5	60 - 69	325	95 - 2500	32.5 - 114.5	2248	IV / e	EST72-C23-SUB SA
123	110 - 115	550	150 - 2500	46 - 114.5	3075	III / d	EST123-C31-SUB SA
123	110 - 115	550	150 - 2500	46 - 114.5	3814	IV / e	EST123-C39-SUB SA
145	132 - 138	650	185 - 2500	46 - 114.5	3625	III / d	EST145-C37-SUB SA
145	132 - 138	650	185 - 2500	46 - 114.5	4495	IV / e	EST145-C45-SUB SA
170	150 - 161	750	240 - 2500	51.5 - 114.5	4250	III / d	EST170-C43-SUB SA

Integrated surge arrester

Rated voltage U_r [kV] **	Nominal discharge current [kA]	Line discharge class	Maximum thermal short-circuit current [kA]	Designation
54 - 114	10 or 20	3 or 4	Max. 63	EST72-C19-SUB SA
54 - 114				EST72-C23-SUB SA
96 - 114				EST123-C31-SUB SA
96 - 153				EST123-C39-SUB SA
120 - 180				EST145-C37-SUB SA
120 - 180				EST145-C45-SUB SA
144 - 228				EST170-C43-SUB SA

* Lightning impulse (withstand voltage)

** Each available in steps of 3 kV

DOC termination

Self-supporting and solid-insulated, the DOC outdoor cable termination is designed for all outdoor cable termination applications to meet modern requirements for ease of installation and environmental friendliness. Thanks to the pre-assembled central unit, comprising a hollow insulator, stress control element and base plate, installation and outage times are considerably shorter: The DOC simply slips onto the cable at the installation site – without gluing work.

At a glance

- Self-supporting and maintenance-free
- For ease of installation and environmentally friendly use in substations
- Extremely fast installation thanks to pre-assembled central unit
- Various installation angles possible

- Oil, gas and gel free, fully dry-insulated with solid materials, therefore:
- No handling of liquid or gaseous insulating materials during installation
- No leakage or environmental risks, explosion-proof
- Water and dirt repellent insulator sheds

- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor, arcing horn, corona ring

Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



Termination stand

The mobile, highly flexible stand serves as a temporary solution for easily setting up various PFISTERER outdoor cable terminations for up to 300 kV (listed in the first bullet point below). This versatility stems from the stand's universal mounting plate, which is compatible with common termination base plates in the PFISTERER portfolio without any modifications. Thanks to its casters, the stand can also be moved flexibly. Not suitable for prolonged outdoor use.

At a glance

- Mobile stand with universal mounting plate for various PFISTERER outdoor terminations up to 300 kV: DOC, EST, ESS, ESP
- For temporary applications, e.g. laboratory and on-site tests
- Height-adjustable cable holders to accommodate all common cable bending radii
- With a sturdy and palletizable transport box made of solid wood with a metal frame, ideal for storage and repeated transportation
- Not suitable for prolonged outdoor usage

- Article number: 880 283 970



DOC termination

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
123	110 - 115	550	150 - 2000	51 - 91	3890	IV / e	DOC123-C39
145	132 - 138	650	150 - 2000	51 - 91	4570	IV / e	DOC145-C45
170	150 - 161	750	150 - 2500	51 - 101	5920	IV / e	DOC170-C58

* Lightning impulse (withstand voltage)

This QR code takes you to a product video.



This QR code takes you to further product information on the PFISTERER website.



1.2 ESS termination

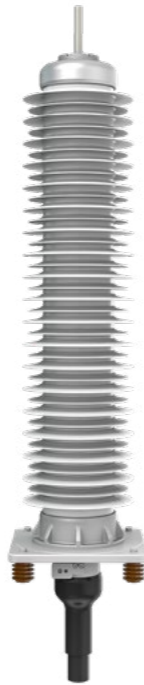
For voltages up to 550 kV, the self-supporting, oil-insulated ESS with modern composite technology is available in various creepage distance lengths. High mechanical strength is achieved by a GFRP tube, which is equipped with silicone sheds and filled with an oil-based insulating medium. The easy-to-install head fitting seals the ESS maintenance-free.

At a glance

- For high voltages up to 550 kV
- Available in various creepage distance lengths
- Maintenance-free composite insulator with water and dirt repellent silicone sheds
- High mechanical strength thanks to GFRP tube
- Stress control element made of silicone
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor, arcing horn, corona ring

Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



ESS termination

Highest voltage U _m [kV]	Nominal voltage U _n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
72.5	60 - 69	325	95 - 2000	37.8 - 84.0	2340	IV / e	ESS72-C23
123	110 - 115	550	120 - 1600	42.5 - 99.0	3890	IV / e	ESS123-C39
145	132 - 138	650	150 - 1200	48.4 - 84.00	4570	IV / e	ESS145-C45
145	132 - 138	650	150 - 2500	48.4 - 118.4	5000	IV / e	ESS145-C50
145	132 - 138	650	150 - 2500	48.4 - 118.4	7250	IV / e	ESS145-C72
170	150 - 161	750	150 - 2000	53.2 - 118.4	5920	IV / e	ESS170-C58
170	150 - 161	750	150 - 2500	53.2 - 118.4	7250	IV / e	ESS170-C72
245	220 - 230	1050	240 - 2500	66.0 - 118.4	9650	IV / e	ESS245-C97
245	220 - 230	1050	240 - 2500	71.7 - 118.4	13520	IV / e	ESS245-C135
300	275 - 287	1050	240 - 2500	71.7 - 118.4	9650	III / d	ESS300-C97
420	380 - 400	1425	630 - 2500	74.5 - 131.5	16600	IV / e	ESS420-C166
420	380 - 400	1425	630 - 2500	74.5 - 131.5	18805	IV / e	ESS420-C188
550	500	1550	630 - 2500	74.5 - 131.5	18805	IV / e	ESS550-C188
550	500	1550	630 - 2500	83.0 - 131.5	22000	IV / e	ESS550-C220

* Lightning impulse (withstand voltage)

1.2 ESP termination

The self-supporting, oil-insulated ESP termination with sheds made of porcelain is available for voltages up to 550 kV and with various creepage distance lengths. Porcelain is still valued today, particularly in some regions of the world, as a proven, robust material. The silicone stress cone is identical to that of the ESS.

At a glance

- For high voltages up to 550 kV
- Available in various creepage distance lengths
- High mechanical strength
- Stress control element made of silicone
- Routine tested before delivery
- Optional extras: Splice box, partial discharge sensor, arcing horn, corona ring

Contact technology

- Standard design: Head fitting with SICON shear-off bolt technology
- On request: Head fitting with compression technology
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



ESP termination

Highest voltage U _m [kV]	Nominal voltage U _n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Min. creepage distance [mm]	Pollution class IEC 60815-3	Designation
72.5	60 - 69	325	95 - 2000	37.8 - 84.0	2248	IV / e	ESP72-C23
72.5	60 - 69	325	95 - 2000	37.8 - 84.0	3852	IV / e	ESP72-C39
123	110 - 115	550	120 - 1600	42.5 - 84.0	3852	IV / e	ESP123-C39
123	110 - 115	550	120 - 1600	42.5 - 84.0	4496	IV / e	ESP123-C45
145	132 - 138	650	150 - 1200	48.4 - 84.0	4496	IV / e	ESP145-C45
145	132 - 138	650	150 - 2000	48.4 - 110.0	4945	IV / e	ESP145-C50
145	132 - 138	650	150 - 2000	48.4 - 110.0	5800	IV / e	ESP145-C58
145	132 - 138	650	150 - 2500	48.4 - 110.0	7250	IV / e	ESP145-C73
170	150 - 161	750	185 - 2000	53.2 - 99.0	5800	IV / e	ESP170-C58
170	150 - 161	750	185 - 2500	53.2 - 118.4	7250	IV / e	ESP170-C73
245	220 - 230	1050	400 - 2500	71.7 - 118.4	10230	IV / e	ESP245-C103
300	275 - 287	1050	400 - 2500	71.7 - 118.4	10230	IV / e	ESP300-C103
420	380 - 400	1425	630 - 2500	74.5 - 131.5	15515	IV / e	ESP420-C156
550	500	1550	630 - 2500	83.0 - 131.5	19600	IV / e	ESP550-C196

* Lightning impulse (withstand voltage)

1.3 CONNEX pluggable cable connector

The CONNEX cable connector is variably configurable and so can be used for any XLPE and EPR cable. Its advanced contact system technology offers mechanical and electrical reliability as well as a high degree of flexibility: After it has been prefitted to the cable, the connector simply plugs into the CONNEX socket – which is permanently mounted on transformers and GIS – to complete the installation. The cable connector is separable at any time and can be plugged into other equipment or components with a suitable CONNEX interface, such as the CONNEX outdoor cable termination (see section 1.1) or gas-insulated CONNEX joints (see catalog part 3). The cable connection is offshore certified and suitable for low temperature (optional).

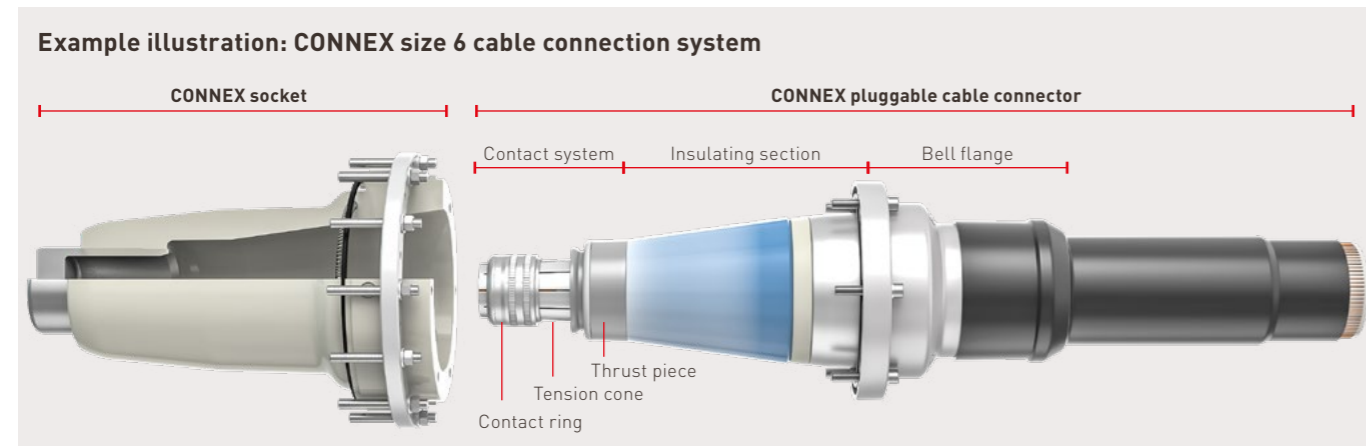
At a glance

- Considerably reduced installation time thanks to plug-in technology
- Horizontal, vertical and inclined arrangement possible, compact connector design
- Connector is separable and can be swapped at any time
- Touch-safe, floodable and maintenance free
- Oil and gas free as fully dry-insulated, no leakage or environmental risks
- Routine tested before delivery



CONNEX pluggable cable connector

Size	Highest voltage U_m [kV]	Nominal voltage U_n [kV]	Conductor to ground voltage U_0 [kV]	Nominal current ¹ I_n [A]	Conductor cross-section ^{2,3} [mm ²] RM	Conductor diameter ³ [mm] RM	Diameter over insulation [mm]	Article no. ⁴ (variants)
4	72.5	60 - 69	36	2,500	95 - 2000	9.3 - 55.9	33.0 - 78.5	849 999 999 XXXXX
5-S	145	132 - 138	76	2,500	95 - 2000	9.3 - 55.9	36.5 - 76.0	859 999 999 XXXXX
6	145	132 - 138	76	2,500	95 - 2500	9.3 - 65.0	36.0 - 113.5	866 999 999 XXXX
6	170	150 - 161	87	2,500	95 - 2500	9.3 - 65.0	36.0 - 113.5	866 999 999 XXXX
6-S	245	220 - 230	127	2,500	95 - 2500	9.3 - 65.0	36.0 - 113.5	866 999 999 XXXX
7	300	275 - 287	160	4,000	500 - 3000	24.8 - 72.5	75.0 - 131.0	877 999 999 XXXX
7-S	362	330 - 345	190	4,000	500 - 3000	24.8 - 72.5	75.0 - 131.0	877 999 999 XXXX
8	420	380 - 400	220	4,000	500 - 3000	24.8 - 72.5	65.0 - 144.0	889 999 999 XXXX
9	550	500	290	4,000	500 - 3000	24.8 - 72.5	65.0 - 144.0	899 999 999 XXXX



CONNEX socket 1.3

The CONNEX socket forms the device-side built-in interface between the transformer and GIS, and other pluggable CONNEX components. The socket can be installed in any position. The appropriate connection geometry is guaranteed by compliance with all current standards. Advantages result from the possibility to carry out the transformer and GIS installation in the factory. This enables complete factory testing of the devices. Only the plugging-in procedure is carried out during the connection installation on site, which greatly reduces the installation time.

At a glance

- More compact design than possible according to standard
- No restrictions with regard to installation positions
- Connection geometries and installation lengths for transformers in accordance with **EN 50299-1** and **EN 50299-2**, for GIS in accordance with **IEC 62271-209**
- Routine tested before delivery



CONNEX socket – transformer

Size	Highest voltage U_m [kV]	Nominal voltage U_n [kV]	Conductor to ground voltage U_0 [kV]	BIL* [kV]	Nominal current I_n [A]	Installation length ⁵ l_5 [mm]			Article no. (variants)
						Compact design	EN 50299-2	EN 50299-1	
4	72.5	60 - 69	36	325	2500	-	310	583	828 041 999 XXXXX
5-S	145	132 - 138	76	650	2500	410	470	757	828 051 999 XXXXX
6	145	132 - 138	76	650	2500	410	470	757	828 061 999 XXXXX
6	170	150 - 161	87	750	2500	410	470	757	828 061 999 XXXXX
6-S	245	220 - 230	127	1050	2500	470	620	960	828 066 999 XXXXX
7	300	275 - 287	160	1050	4000	470	620	960	828 071 999 XXXXX
7-S	362	330 - 345	190	1175	4000	505	960	1400	828 071 999 XXXXX
8	420	380 - 400	220	1425	4000	750	960	1400	828 081 999 XXXXX
9	550	500	290	1675	4000	750	960	1400	828 081 999 XXXXX

CONNEX socket – GIS

Size	Highest voltage U_m [kV]	Nominal voltage U_n [kV]	Conductor to ground voltage U_0 [kV]	BIL* [kV]	Nominal current I_n [A]	Installation length l_5 [mm]			Article no. (variants)
						Compact design	IEC 62271-209 Fig. 5	IEC 62271-209 Fig. 3	
4	72.5	60 - 69	36	325	2500	-	310	583	828 040 999 XXXXX
5-S	145	132 - 138	76	650	2500	410	470	757	828 050 999 XXXXX
6	145	132 - 138	76	650	2500	410	470	757	828 060 999 XXXXX
6	170	150 - 161	87	750	2500	410	470	757	828 060 999 XXXXX
6-S	245	220 - 230	127	1050	2500	410	620	960	828 065 999 XXXXX
7	300	275 - 287	160	1050	4000	505	620	960	828 070 999 XXXXX
7-S	362	330 - 345	190	1175	4000	505	960	1400	828 070 999 XXXXX
8	420	380 - 400	220	1425	4000	750	960	1400	828 080 999 XXXXX
9	550	500	290	1550	4000	750	960	1400	828 080 999 XXXXX

- I_n for cable fitting (depending on cable cross-section)
- The cross-section range is an indicative value only. The range can only be achieved if the min./max. diameter across conductor and the min./max. diameter across insulation are observed.
- Values shown in table are for round multiwire (RM) conductors. Values on request for round solid (RE) and round fine stranded (RF) as well as enameled wires conductors.
- Individual variant number specified with a configurator based on cable data.
- Values are based on the use of mineral oil as insulating medium. Installation lengths may differ when using ester.

* Lightning impulse (withstand voltage)

1.4 ESU termination for transformers

The type ESU termination for 72.5 kV to 300 kV is used for installation of high voltage XLPE cables inside oil-insulated transformers and is available with an almost identical design in vertical or horizontal versions. Its cast resin body filled with insulating oil surrounds the slide-on silicone stress cone and safely separates the inside of the equipment from the cable system.

At a glance

- Classic installation by cable entry into the transformer
- Stress control element made of silicone
- Insulating element made of cast resin, filled with insulating oil
- In vertical or horizontal versions
- Expansion box and piping supplied with horizontal version
- Optional extras: Adapter plate, shielding electrode
- Connection geometries and installation lengths in accordance with **EN 50299-1**
- Routine tested before delivery

Contact technology

- Standard design: Conductor connection using SICON shear-off bolt technology
- Alternatively with compression technology on request
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



ESU termination for transformers

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Installation length in transformer [mm]	Designation
72.5	60 - 69	325	120 - 2000	37.8 - 83.7	583	ESU72
123	110 - 115	550	150 - 2000	42.5 - 118.4	757	ESU123
145	132 - 138	650	185 - 2500	48.4 - 118.4	757	ESU145
170	150 - 161	750	240 - 2500	53.2 - 118.4	757	ESU170
245	220 - 230	1050	400 - 2500	71.7 - 125.1	960	ESU245

* Lightning impulse [withstand voltage]

1.4 ESG termination for GIS

The type ESG termination for 72.5 kV to 300 kV is used for installation of high voltage XLPE cables inside gas-insulated switchgear and is available with an almost identical design in vertical or horizontal versions. Its cast resin body filled with insulating oil surrounds the slide-on silicone stress cone and safely separates the inside of the equipment from the cable system.

At a glance

- Classic installation by cable entry into the switchgear
- Stress control element made of silicone
- Insulating element made of cast resin, filled with insulating oil
- In vertical or horizontal versions
- Expansion box and piping supplied with horizontal version
- Optional extras: Adapter plate
- Connection geometries and installation lengths in accordance with **IEC 62271-209**
- Routine tested before delivery

Contact technology

- Standard design: Conductor connection using SICON shear-off bolt technology
- Alternatively with compression technology on request
- Specially for copper enameled wires conductors: Head fitting with FrontCon technology



ESG termination for GIS

Highest voltage U_m [kV]	Nominal voltage U_n [kV]	BIL* [kV]	Conductor cross-section range [mm ²]	Ø over prepared insulation [mm]	Installation length in GIS [mm]	Designation
72.5	60 - 69	325	120 - 2000	37.7 - 83.7	583	ESG72
123	110 - 115	550	150 - 2500	42.5 - 118.4	757	ESG123
145	132 - 138	650	185 - 2500	48.4 - 118.4	757	ESG145
170	150 - 161	750	240 - 2500	53.2 - 118.4	757	ESG170
245	220 - 230	1050	400 - 2500	71.7 - 125.1	960	ESG245
300	275 - 287	1050	400 - 2500	71.7 - 125.1	960	ESG300

* Lightning impulse [withstand voltage]

Slip-on joints – For all cables. Each one individual.

Easier to install, works untouched for decades – PFISTERER meets today's demand for high voltage joints for permanent cable connections. Contemporary and pragmatic: With the many advantages of the versatile MSA joint family for voltages up to currently 550 kV.

All joints are designed as slip-on joints, representing excellence in this established state-of-the-art: Mainly consisting of a pre-assembled silicone joint body, they realize significant advantages **for lifelong strong jointing of identical or different types of high and extra high voltage cables (XLPE, EPR):**

Their one-piece and dry-insulated design enables **individual testing** of the joints before delivery and **easier installation** in the field.

An important benefit is that quality-manufactured and professionally installed slip-on joints achieve the lifetime of cables.

A wide range of variants for all common and also special requirements, **coupled with further advantages** of variant-specific features, **make PFISTERER slip-on joints particularly attractive for builders and operators of high and extra high voltage grids all over the world.**

PFISTERER slip-on joints are available:

- For all copper or aluminum cables with the common maximum cable cross-sections as well as conductor and insulation diameters
- With cable screen cross-sections up to 630 mm²
- For all common screen versions
- With diverse protective joint housings, outer and inner
- Available with splice box for joining fiber optic cables

All features for the selection and specification of your joints are shown in overview tables on the next two double pages, followed by various views of joints with all internationally common screen versions and housing variants.

Depending on the customer-specific joint design with plastic outer housing, variant-specific features can offer additional protection. For example the **bayonet lock with anti-rotation device:** For watertight closure of the two housing parts, this locks into place after turning through 30° without risk of over-compressing the housing seal. More details are shown in the **installation video linked in the QR code top right on the next page.**

Whatever the design of your joint variants, each represents PFISTERER quality. Tested to IEC 60840, IEC 62067 and British Standard.

Proven under extreme conditions worldwide: In deserts with large temperature fluctuations between blazing heat and sub-zero degrees. Buried directly without a protective chamber in soils with high groundwater levels.

2.2 Joint type MSA: Design and variants in detail

Joint code

The joint's variant designation consists of the abbreviations of the selection criteria for the joint. These are listed as "Versions" or "Identifiers" in the table on this and the previous page.

Identifiers		Description
MSA		Type
	kV	Voltage (from 72.5 - 550 kV)
1	DO	Screen transition
	DE	Screen transition with 1 bonding cable
	XL	Screen interrupted with 2 bonding cables (cross-bonding)
	XK	Screen interrupted with 1 concentric bonding cable (cross-bonding)
2	M	Metallic housing Cu
	F	Alu foil
	G	PE/PP housing
	S	Shrink sleeve covering
3	R	Glas fibre-reinforced shrink sleeve covering
	OP	Splice box for joining fiber optic cables

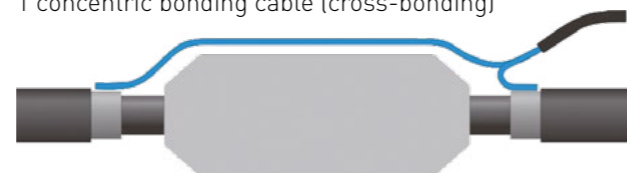
1 Cable screen treatment

The right screen connection for all earthing concepts:

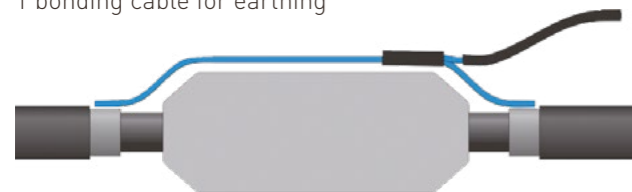
MSA DO Screen transition



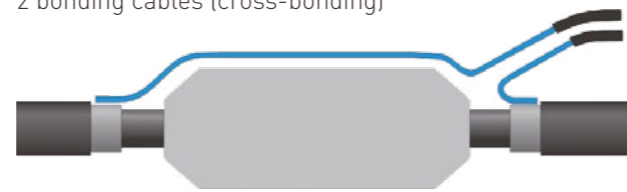
MSA XK Screen interrupted with 1 concentric bonding cable (cross-bonding)



MSA DE Screen transition with 1 bonding cable for earthing



MSA XL Screen interrupted with 2 bonding cables (cross-bonding)



2 Housing variants

Below is a detailed overview of the housing variants:

Inner housing, two options:

- Metallic housing (Cu)
- Alu foil



MSA 123 XKMG

The illustration shows the metallic housing, and also a cutaway view of the outer PE/PP housing, see next bullet point

Outer housing:

- PE/PP housing



MSA 123 XLG

- Glas fibre-reinforced shrink sleeve covering



MSA 123 XKR

- Shrink sleeve covering



MSA 123 DOS

3 Optional extras: Splice boxes for fiber optic cables

PFISTERER will be pleased to supply splice boxes for joining fiber optic cables inside cable joints on request, including installation materials.





Link boxes – An exact fit in assured quality

Every power grids component has its significance and importance for the reliable flow of electricity. So do link boxes from PFISTERER – tailor-made for all types and versions of terminations and connection joints for HV and EHV.

PFISTERER link boxes provide **optimally connected and arranged connection points**

- Between termination and joint cable screens and the earthing system of cable installations
- Or between joint cable screens in cross-bonding concepts

With benchmark SICON technology by PFISTERER:

The first of all connection systems with stepless shear bolt ensures **optimum electrical contact for any cable, with simplified installation and higher quality** favoring contact longevity. To find out how, see the technology insights in section 4.1.

PFISTERER link boxes are available for every requirement. Precisely tailored to your specifications.

- For single-core cables or coaxial cables with cable cross-sections up to 630 mm²
- For all common earthing systems and cross-bonding methods
- For diverse locations and mounting types: Wall, pillar, underground
- Plastic or stainless steel box material
- With protection against dust and water to IEC 60529 with IP66 or IP68 rating
- With integratable surge arresters
- Available with partial discharge sensors on request*
- With filling compound or with lock on request*

Criteria for selecting and specifying your link boxes

are shown in overview tables on the following pages, together with views of classic designs for terminations and joints. To find out what your link box could look like, you can **select it in the PFISTERER online catalog** – also accessible via QR codes on the next double pages.

* These options cannot be selected online.

With a wide range of variants in consistent quality, the use of PFISTERER link boxes supports key functions for power grids operation:

- **Earthing of cable systems according to various concepts to protect equipment and people** from destructive currents and overvoltages, **or also to limit electromagnetic interference.**
- **Cross-bonding of connection joints to reduce transmission losses due to induced currents** in longer AC cable runs with at least six joints. The joint cable screens of each phase are separated at certain points, routed out of the joint and connected to the cable screens of the same phase of other joints.

PFISTERER link boxes also enable:

- **Placement of surge arresters effectively close to equipment.** This is commonly done for example with single-point bonding to protect against excessive voltages on the cable screen. These can occur on the unearthed side as a result of brief flashovers between the cable sheath and earth.
- **Easy access to cable screens** for testing, fault location and partial discharge measurements.

Whichever of these tasks you choose PFISTERER link boxes for, you can do so with maximum flexibility and safety. Their functional properties, in particular impermeability of the housing as well as short-circuit and dielectric strength are **tested to IEC standards.**

In addition, PFISTERER link boxes have already **successfully passed very many qualification tests** with users from all over the world according to their special requirements.

3.1 Link boxes for terminations

Customized PFISTERER link boxes for terminations reliably deliver what cable systems for HV and EHV require: Optimum protection and good accessibility for all types of equipment and cable earthing configurations. They also enable the integration of surge arresters as part of a system solution.

So that your link boxes for terminations are a precise fit, PFISTERER offers a comprehensive range of single-phase and three-phase boxes for single-core cables up to 500 mm². They are available for all common ways of treating cable screens and can be designed to suit the application according to numerous other configuration characteristics (details are shown on the following page).

Depending on the termination earthing system, link boxes are available on request with:

- Detachable disconnecting links
- Special ZnO surge arresters (SVL – DH (ex Class 1) and SL (ex Class 2) according to IEC 60099-4)
- Locking

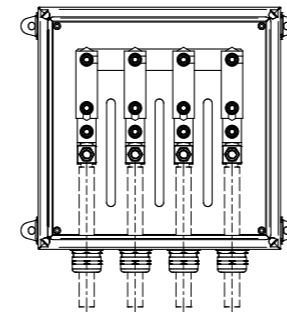
All boxes meet the requirements of IEC 60529 for wall mounting with IP66 rating and are optionally available in:

- Stainless steel (AISI 304) or
- Stainless steel for offshore use (AISI 316L) or
- Robust polyester

Example: Termination link box for direct earthing
LINKBOX W.X.8.1.S3.E1.0000.M40.M40.x

Technical characteristics (excerpt):

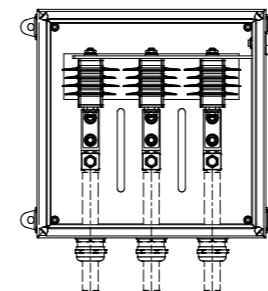
- For wall mounting, box with IP66 rating as standard
- Treating of cable screens at direct earthing
- For single-core cable
- Earthing cable connected inside the box



Example: Termination link box with surge arresters
LINKBOX W.X.8.1.S3.E0.060A.M40.000.x

Technical characteristics (excerpt):

- For wall mounting, box with IP66 rating as standard
- Cable screen insulated and additionally protected with surge arresters
- For single-core cable
- Earthing cable connected outside the box



You can find a complete overview of link boxes in the PFISTERER online catalog.



Wall mounting	Box material AISI 304	Direct earthing	Single-core cable	Three cables connected to the cable screen	Earthing cable connected inside the box	No surge arrester	Bonding cable gland M16 (4,5 - 10 mm)	Earthing cable gland M16 (4,5 - 10 mm)	Bonding cable conductor diameter
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Example article designation: LINKBOX W. X. 8. 1. S3. E1. 0000. M40. M40. x

Installation type									
Wall mounting (IP66)		W							
Cabinet version		P							
Box material									
Polyester		P							
Stainless steel AISI 304		X							
Stainless steel AISI 316L		Y							
Treating of cable screen									
Surge arrester		7							
Direct earthing		8							
Bonding cable type									
Single-core cable		1							
Number of bonding cable entries									
1 cable			S1						
3 cables			S3						
Type of earthing cable connection									
Outside the box				E0					
Inside the box				E1					
Nominal voltage of surge arresters									
No surge arrester				000 0					
Line discharge class 1 (for distribution)				a					
Line discharge class 2 (for stations)				b					
U _r = 1.2 kV U _c = 1.0 kV				012 a					
U _r = 1.3 kV U _c = 1.0 kV				013 b					
U _r = 2.5 kV U _c = 2.0 kV				025 a					
U _r = 3.0 kV U _c = 2.4 kV				030 a					
U _r = 3.1 kV U _c = 2.5 kV				031 b					
U _r = 4.0 kV U _c = 3.2 kV				040 a					
U _r = 5.0 kV U _c = 4.0 kV				050 a/b					
U _r = 6.0 kV U _c = 4.8 kV				060 a/b					
U _r = 7.0 kV U _c = 5.6 kV				070 a/b					
U _r = 8.0 kV U _c = 6.4 kV				080 a					
U _r = 9.0 kV U _c = 7.2 kV				090 a/b					
U _r = 10.5 kV U _c = 8.4 kV				105 a/b					
U _r = 12.0 kV U _c = 9.6 kV				120 a/b					
Cable gland size for bonding cable / earthing cable									
				Bonding		Earthing			
No cable gland, earthing cable outside						000			
M16 (4.5 - 10 mm)				M16		M16			
M25 (10 - 17 mm)				M25		M25			
M40 (13 - 28 mm)				M40		M40			
M50 (20 - 35 mm)				M50		M50			
M63 (27 - 45 mm)				M63		M63			
M68 (42 - 50 mm)				M68		M68			
M70 (49 - 59 mm)				M70		M70			
Bonding cable conductor diameter									to define
Ø 6 - 9 mm [- up to 70 mm ²]									
Ø 10 - 12 mm [- up to 120 mm ²]									
Ø 13 - 14 mm [- up to 150 mm ²]									
Ø 15 - 17 mm [- up to 185 mm ²]									
Ø 18 - 21 mm [- up to 300 mm ²]									
Ø 22 - 24 mm [- up to 400 mm ²]									
Ø 25 - 27 mm [- up to 500 mm ²]									

The letter of the bonding cable identifier depends on mounting type, cable type and conductor diameter. Therefore, this letter is assigned dynamically.

Top technologies for electrical contact. For lifelong reliable electricity flow.

Responsibility for supply security is placing growing demands on power grid technologies.

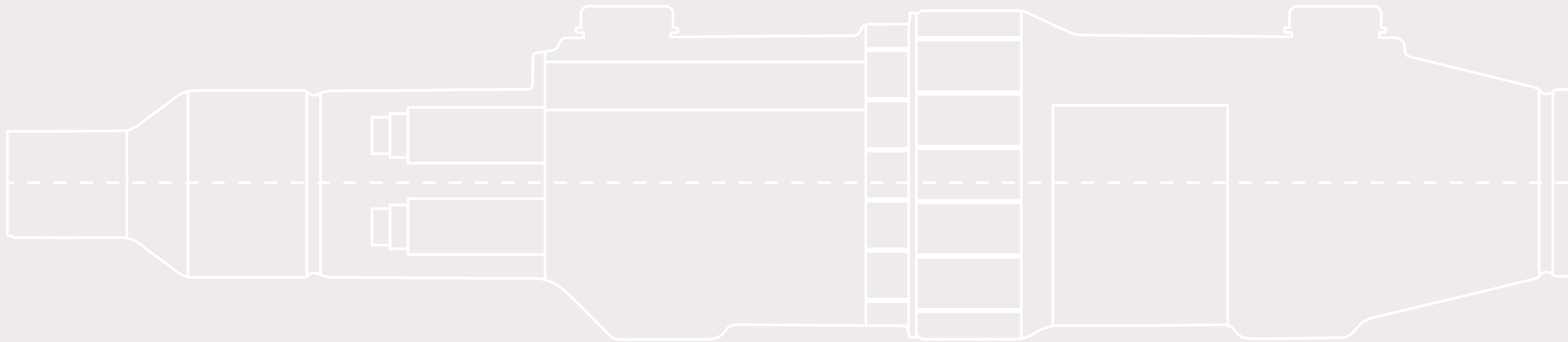
Solutions developed by PFISTERER offer reliability and enable change.

Based on proven expertise and tested quality. With enthusiasm for progress in technology for a safe and steady flow of electricity. **From experience that the tried and tested can be made even better.**

On the next double pages, **insights into two innovative PFISTERER technologies for contacting HV and EHV cables show you exactly how we do this.**

SICON came onto the market more than 15 years ago as the first cable connector system of its kind: With a stepless shear bolt, it has ensured **optimum electrical contact with every conductor ever since – with simpler installation and in higher quality.** Today, SICON shear bolt technology is the industry standard worldwide.

For over five years, **FrontCon** has also demonstrated its potential in use as a benchmark technology: **Even enameled wires conductors can now be connected quickly** – thanks to an innovative contact principle with balls and springs for perfect contact force, consistently strong and constant for life.

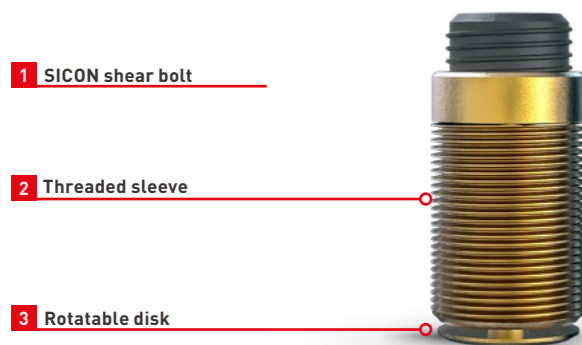


4.1 The perfect turn with SICON: Optimal contact for any conductor

Optimal contact force with easy installation. Proven worldwide and continuously optimized. SICON shear-off bolt technology from PFISTERER is an internationally recognized standard for cable connections, with good reason. Also in HV and EHV. With numerous customer-specific variants. In every version, interaction between SICON connector and fitting is precisely matched. Also for your terminations and connection joints from PFISTERER! Here we show you what key SICON elements do and how they work.

The core

PFISTERER developed the patented SICON shear bolt [1] as the first of its kind without fixed predetermined breaking points. This means that the full load-bearing capacity of the screw thread can be used to produce the perfect clamping force to make electrical contact. SICON enables an ideal interaction of opposite forces: The contact force exerted on the conductor when turning the screw, and the opposing tensile stress on the SICON threaded sleeve [2]. As soon as a tensile stress corresponding to the optimal contact force builds up, the screw breaks off. Simple installation, without risk of error, perfect result.



The torque of the screw is always converted into optimal contact force, irrespective of the conductor material. At the same time, the rotatable disk prevents rotational forces from acting directly on the conductor, protecting it from damage.

Smart contacting

Tightening the SICON screws presses the conductor against the transverse grooves in the conductor channel [4], which break through any oxide layers on the conductor surface. This results in linear electric contact points. Precisely defined, they add up to a determinable effective contact area with constantly low contact resistance – a basic requirement for permanently reliable current flow between connector and conductor.

Continuous optimizations of the SICON design reinforce further positive effects of the transverse grooves. Two examples: After installation, tensile forces may act on the conductor. SICON holds the conductor securely in place – with conductor pull-out forces even higher than required by standards. When connecting stranded conductors, their individual strands are gripped and contact is made even more precisely, which further increases the conductivity between strands.

Smoothly closed

Once electrical contact has been made, cover caps [5] are fitted over the screw shear-off points. They completely cover the countersinks in the connector body and restore its cylindrical shape without edges or seams. Shrink sleeve and the joint body can be fitted over the connector without risk of injury.

Well thought out

The rotatable disk [3] at the base of the SICON screw additionally optimizes the force exerted during installation. When the SICON screw is tightened, the rotatable disk detaches while the screw continues to turn on the rotatable disk. As a result, friction occurring between the functional elements of the screw and the conductor can be advantageously controlled:

Your advantages with SICON

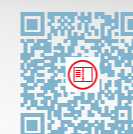
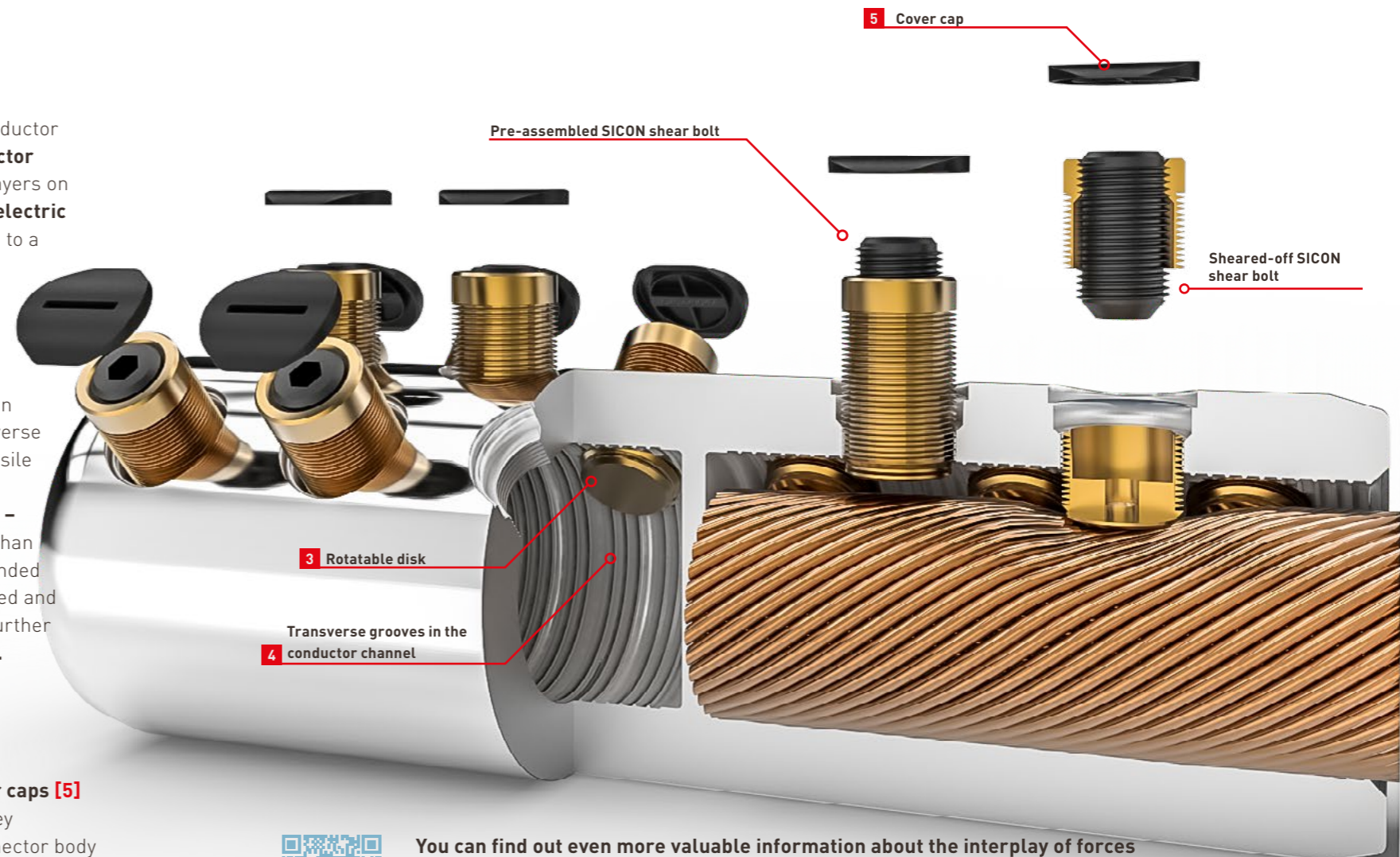
- Lifelong reliable electrical contact
- Easy to install using standard tools
- Optimal contact force
- Without damage to individual strands
- Proven in worldwide use for more than 15 years
- Continuously optimized in line with practical experience
- Suitable for all fitting types
- Large and growing portfolio of product and project-specific variants

A perfect match for your HV and EHV accessories

SICON customized connectors are designed on a product and project-specific basis. Firstly according to the fitting technology of termination and joint, secondly according to the cable specification. Examples:

- Conductor type (Al and Cu)
- Conductor and insulation diameter, cable cross-section
- Current rating of the fitting
- And further design criteria

SICON specialists at PFISTERER will be pleased to explain the details to you.



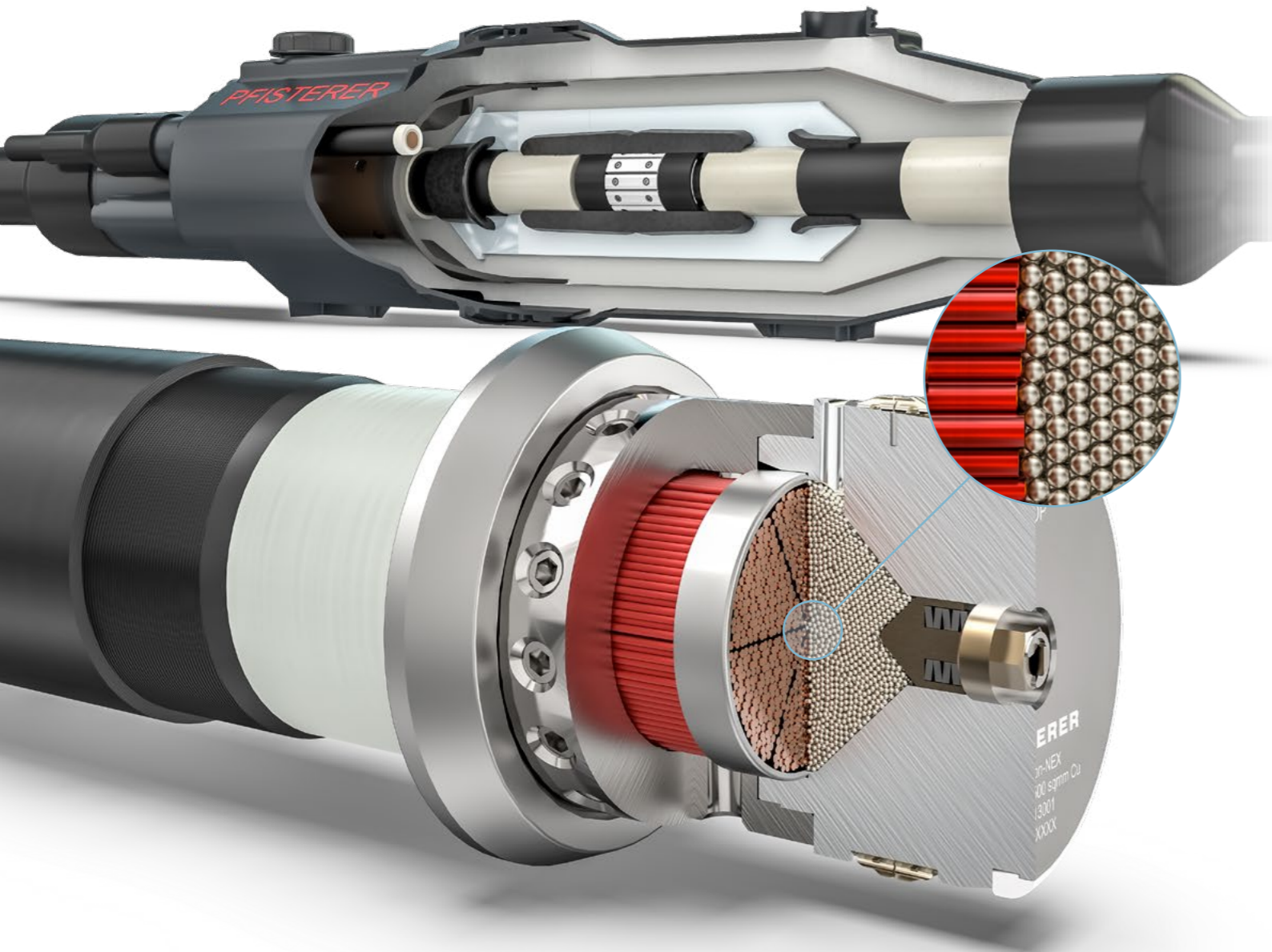
You can find out even more valuable information about the interplay of forces in screw connections and about the history of SICON in the product flyer. Simply scan the QR code and download the document.

4.2 Uniquely efficient with FrontCon: Connecting complex cable

With PFISTERER accessories, specialist fitters install any XLPE cable faster and more safely. Even complexly structured enameled wires conductors – thanks to FrontCon technology.

FrontCon is an innovative contact technology from PFISTERER specifically for enameled wires conductors. It can be integrated into joints, cable connectors and terminations instead of SICON contact system elements, which are described in section 4.1.

FrontCon considerably simplifies cable connector installation. Extremely time-consuming work steps are completely eliminated, as are associated risks of installation errors. **Instead of entire days, installation takes only about two hours per cable connection** – the same as for conventional cables with standard connectors.



80% faster installation with minimized risk of errors

Conventional connection of an enameled wires conductor requires a lot of patience and very detailed work: After stripping the cable, you have to spread out the conductor, remove the insulation from its wires individually, sand them bright and then restore them to approximately their original shape and position.

Better with FrontCon.

The contact system involves comparatively simple installation steps:

- Saw off the cable end squarely
- Remove outer cable insulation (stripping)
- Clamp the FrontCon contact system centrally and with stable pressure onto the exposed enameled wires bundle
- Pour FrontCon contact balls into the connector
- Tighten the pressure screw

Smart contacting – with balls and springs

The pressure screw presses the FrontCon contact balls against the enameled wire conductors, thus establishing electrical contact. Power flows via the front faces of the conductor wires and the contact balls.

Together, the balls behave like a liquid: They compensate for slight unevenness at the conductor ends, thus ensuring consistently strong contact forces across the whole conductor cross-section.

A built-in spring mechanism plays a supporting role. It compensates for settling losses caused by expansion and contraction of the cable due to operational and environmental temperature fluctuations, with important long-term effects for lifelong reliable operation: low contact resistances and stable contact forces over the entire service life.



Conclusion: With FrontCon, you considerably reduce the time, effort, risks and costs of installation, and get higher operational reliability plus reliable longevity.

Equipped for many cases and locations. With quality in variety from a single source.

Lifelong high-performance and safe power grids for supply security – a goal that unites planners, builders and operators worldwide.

PFISTERER solutions make an impressive contribution to this goal: At millions of interfaces of XLPE cables for high and extra high voltage in grids all over the world. **And here on the next five pages. They show PFISTERER products** from all three catalog parts individually or in combination, in use **in three common practical scenarios.**

With **proven and innovative technologies** for connection, insulation and installation. Connectable to **traditional and modern power grid systems.** Geared to their **future development**, with **many variable designs** providing room for maneuver – during times of change and increasing environmental awareness in the energy supply industry.

They reflect **PFISTERER's self-image as a strong partner** putting in-depth expertise into practice with a broad portfolio **for every philosophy and sustainable progress. We would be pleased to do the same for you!** For example, as follows – and always in the best way for your project.

Sustainably fit for the future. **5.1** Always efficient with PFISTERER retrofit.

Use existing equipment for necessary modernization and far-sighted realignment – with dry-insulated PFISTERER terminations you can do both. Easy, efficient, sustainable. For lifelong rewarding technology change.

The service life of terminations is often shorter than that of their upstream installations and equipment. Tried-and-tested type EST and ESF retrofit terminations for up to 170 kV are predestined for pragmatic modernization (left and center in the image below).

All these terminations can be fitted without having to replace existing cables. Easy to install and with many advantages for lifelong environmentally and cost-friendly operation.

All are dry-insulated with silicone – a material that is increasingly valued worldwide – resulting in significant advantages. It supports efficiency and sustainability in all phases of the component's use:

PFISTERER terminations are easier and quicker to install – without the need for laborious handling of gaseous or liquid insulating materials. EST and ESF are also lighter than comparable terminations.

Free of oil and gas, they are explosion-proof in the event of a fault, and always leak-proof, so they are never a potential environmental risk. In addition, they are maintenance-free for life – also thanks to the water and dirt repellent silicone shed surface.

As retrofit terminations, EST and ESF are mostly suitable for all XLPE cables with conductor cross-sections up to 2500 mm² and can be individually adapted to other cable types. Available as self-supporting versions or integratable into existing support structures, they cover all common applications with four basic variants: in substations, with or without integrated surge arrester, as a flexible solution or on the transmission tower.

CONNEX is equally advantageous for GIS and transformers: Newly equipped with CONNEX interfaces, equipment can be variably connected to cables or bare conductors throughout its life without interventions, and therefore used flexibly indoors and outdoors. More in catalog part 1.

5.2 Strong all the way. Safe for the long term. Cable systems with PFISTERER components.

Permanent underground cable runs either have no alternative or they open up new possibilities for a modern power supply in transition.

They can be optimally implemented for every scenario and every requirement with connection joints and link boxes from PFISTERER for HV and EHV.

Tailor-made to customer specifications and accurately matched on the basis of reliable, globally proven technologies and design variants.

Cable systems have always been laid where the reasonable feasibility of overhead lines comes up against natural, economic and technical limits. Often, for example, when extreme conditions of mountainous terrain, expansive bodies of water, or steep gradients force a diversion underground.

In recent years, opposition to additional or new overhead lines has increasingly been voiced by the public and by organizations for various reasons of environmental protection, nature conservation and animal welfare. Esthetic aspects are also becoming more important, especially when the unobstructed appearance of natural and cultural landscapes is considered to be of particular additional value.

A classic application area for cables is growing strongly where overhead lines have to make way due to lack of space and for safety reasons: in urban areas.

In 2008, for the first time, more people lived in towns and cities than in rural areas. And urbanization is continuing apace. To supply electricity to urban structures with low losses, more high voltage will have to be routed into and through their sensitive areas in the future – with cables that have so far been used primarily in industrial applications. This long-term trend will be reinforced everywhere in the world that loads are increasing in distribution power grids due to the growing use of volatile electricity from renewable energy sources and the spread of e-mobility.

Lifelong high performance under all conditions

The longer a cable route is, the more likely it is to pass through heterogeneous environments with changing features such as altitude differences and subsoils with different properties – from dry to moist; loose sandy to rock solid. But even over shorter distances, conditions can vary widely, for example when cable lines connect rural and urban areas or when they go onshore from offshore and vice versa.

In contrast, the requirements remain always high: Underground cable lines must transmit high power constantly and reliably for decades.

To achieve this under all conditions, it may be necessary to design a cable route with variations in the form of several subsections, each with different conductor cross-sections and varying earthing and cross-bonding methods. PFISTERER provides customized solutions for each cable section with variable connection joints and link boxes, perfectly matched to each other and optimally geared to your specific application.

With optimally configurable joints and link boxes

Proven in use worldwide, PFISTERER type MSA joints guarantee lifelong strong connections of different or identical HV and EHV cables in individually tested quality. Thanks to the wide range of variants, they can be configured for every application and requirement, for example with diverse protective housings depending on the subsoil and many other selectable features (see section 2).

Matching link boxes make important contributions to the efficient and safe operation of the cable system: As optimal connection points for all commonly used earthing methods, including protection against destructive currents and overvoltages. Likewise for various cross-bondings of connection joints to reduce transmission losses due to induced currents in longer AC cable runs. Also as easy access points to cable screens for testing, fault location and partial discharge measurements. For convenient placement of surge arresters. Tailor-made in every case – also available for terminations, more about this from section 3 onwards.



5.3 Steady current flow in all scenarios. With PFISTERER system solutions for all situations.

PFISTERER equips you with effective resources in the event of all conceivable system failures, with individually designed cable systems for HV and EHV. In well-thought-out variants to cover all applications in an area. Each individual system can be deployed rapidly and safely as a reliable bypass. For immediate response to a sudden fault. For uninterrupted operation during planned work. Because all time with or without power counts.

Ensuring supply security also means anticipating the failure of operating resources. The number and variety of resources required for suitable countermeasures or replacements can often reach great proportions. The larger and longer a power grid has grown, the more equipment, connections and links of various types and makes it contains.

Each procurement costs valuable response time. Having a lot of stock ties up resources, but does not necessarily mean that the exact items required will be available immediately when needed. A dilemma that PFISTERER knows how to solve.

Bridge bottlenecks the smart way

With turnkey HV and EHV cable systems for the fast and safe installation of short or longer term bypasses in varying lengths between different devices with diverse connections and voltages. Tailor-made according to these variables and supplied from a single source, cable systems from PFISTERER form an effective overall package for all relevant application scenarios, as determined for a defined area of use, whether two or three within a substation or ten, twenty and more in entire power grids.

PFISTERER develops cable system solutions individually and economically for grid operators all over the world. With in-depth design know-how following the characteristics and specific features of national, regional and local supply structures. With a broad portfolio of proven and standardized components, modularly combinable and precisely configurable for all specified applications.

Fast, flexible and safe in use

The central system elements are various PFISTERER components for connecting cables to bare conductors or enclosed systems. Their common denominator and key advantage: They are dry-insulated and simple to install – without time-consuming, environmentally hazardous handling of liquid or gaseous insulating media. With a wide range of product families to choose from, they allow flexibility in use as required, with safety in all situations:

The terminations of the types ESF, EST-SUB and EST-SUB SA can be used as required in substations: The flexible ESF (pictured in the bottom center) can be installed in existing support structures. The EST-SUB (left) has its own support element. With the EST-SUB SA, the integrated surge arrester ensures stability and continuous equipment protection even during construction work or repairs.

CONNEX cable connectors (on the ground next to the cable drum in the image below) give you even more flexibility. Prefitted on the cable, they can be plugged without interventions into transformers or GIS with matching permanently installed CONNEX sockets. The cable connectors can be detached and plugged in again at any time on all devices with suitable CONNEX sockets, and – for the installation and removal of temporary cable routes – into the new CONNEX outdoor cable termination (see sections 1.1. and 5.1) as well as CONNEX joints (catalog part 3).

Ready for transportation and installation

Depending on the type of devices and their connections, as well as the distances between them in the area of use, PFISTERER terminations and cable connectors can be combined and pre-assembled on HV and EHV cables in various lengths. Their easy transportation and use is assisted by motorized cable drums (pictured below). These allow the cables to be simply unrolled at the place of use. Once work has been completed, they can be wound back onto the drum – ready for next time.

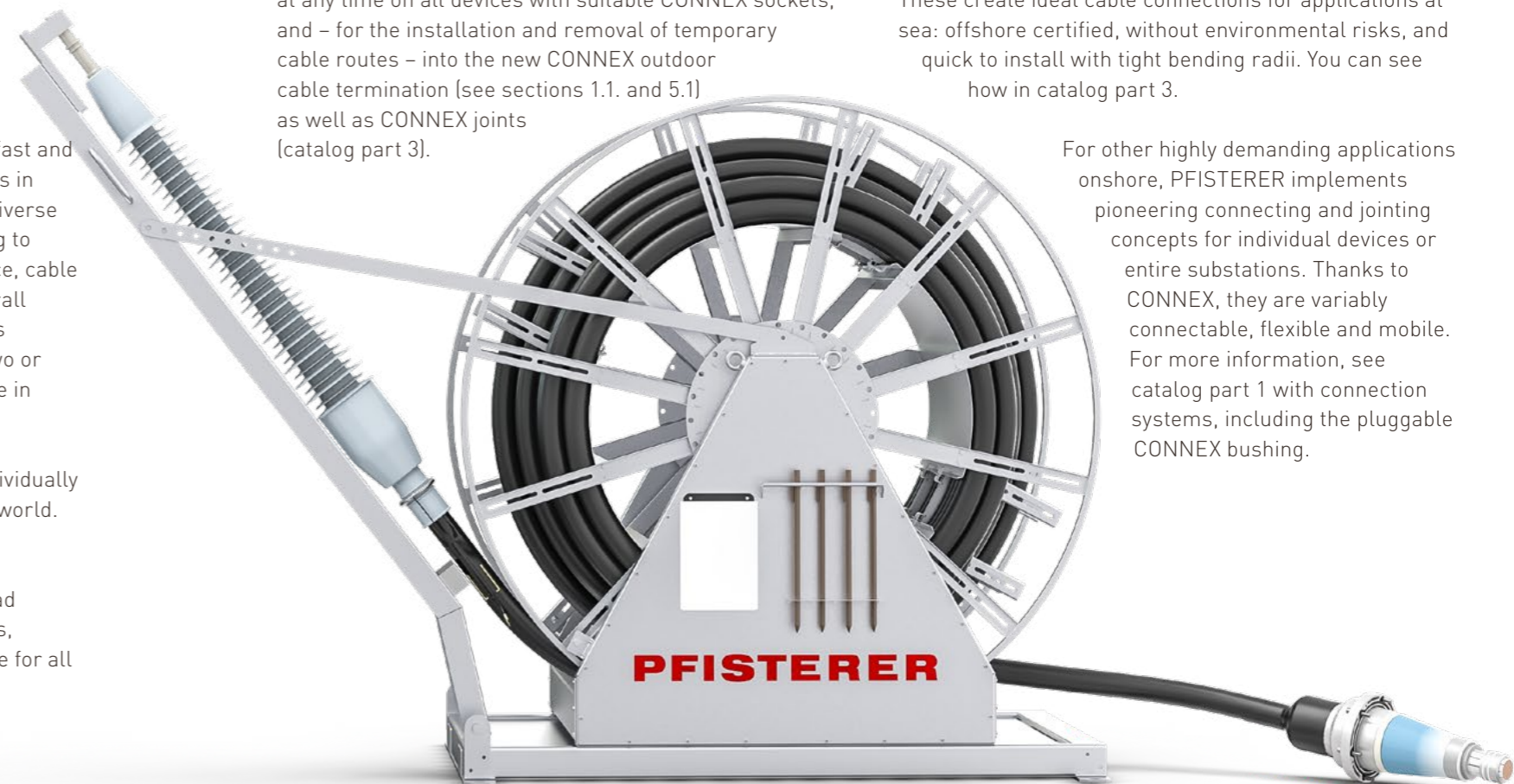
PFISTERER teaches the proper handling of the cable systems on installation training courses. Each installation step and helpful tips are illustrated in a manual that PFISTERER supplies with every cable system.

Even more possibilities for your projects

Many more application options are opened up by fully pluggable complete solutions based on CONNEX, the world's first inner cone system with plug-in technology and the largest selection of components to date.

These create ideal cable connections for applications at sea: offshore certified, without environmental risks, and quick to install with tight bending radii. You can see how in catalog part 3.

For other highly demanding applications onshore, PFISTERER implements pioneering connecting and jointing concepts for individual devices or entire substations. Thanks to CONNEX, they are variably connectable, flexible and mobile. For more information, see catalog part 1 with connection systems, including the pluggable CONNEX bushing.



Installation know-how for safe initial operation

High voltage places the highest demands on the safety and reliability of systems as well as connecting components and complementary tools. Their quality is not the only deciding factor. Professional installation is equally important – based on practical experience. HV components from PFISTERER are therefore installed exclusively by specialist personnel who have received product-specific training and certification. For the sake of lifelong operational reliability. And also important to maintain the warranty.

To this end, PFISTERER provides comprehensive know-how transfer in practice and theory:

Installation service

PFISTERER supports you worldwide at regional level with installation services. Provided by our own installation teams or partner firms certified according to strict PFISTERER criteria. With experience of working in a variety of conditions. In a cable trench. In a dry dock. On offshore platforms. With expert knowledge and a precise feel for a wide variety of cable technologies and grounding concepts, all the way to connecting fine fiber optic cables to monitoring boxes. In every situation, competent and efficient in tried-and-tested work steps for safe and professional installation.

Installation training

For the qualification of your fitters, PFISTERER arranges the obligatory high voltage installation trainings in the company's own training centers worldwide or also individually on your premises.

All training courses include detailed product training as well as requirements, preparations and carrying out the installation, with practical exercises and tasks. The training content can be adapted to specific training needs, for example the process of plugging in a CONNEX bushing, cable connector installation in confined spaces with the aid of an assembly cap, or the installation of mobile interim solutions.

Upon successful completion of the course, each participant receives a time-limited certificate. This authorizes them to work independently with the product system they were trained in.

The standard training courses, which can be extended, include:

- Safety briefing
- General production and application knowledge
- Overview of installation procedure and installation instructions
- Design and components of the fitting
- Cable preparation
- Installing the fitting on the cable
- Installing the fitting on the equipment or in the cable route, if necessary with grounding system

Installation instructions

The safe and proper installation for PFISTERER accessories is described in detail with text and illustrations in product-specific installation instructions. They are enclosed with each delivery as part of the product. Each set of instructions must be read in full before starting work, followed step by step, and kept accessible at all times in the immediate vicinity of the product, for example in the control center or switch room.



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PFISTERER is a globally leading and independent technology company with head offices in Winterbach near Stuttgart, Germany. We develop, produce and sell technology for insulating and connecting electrical conductors for power grid interfaces - from the generation and transmission to the distribution of electrical energy. With state-of-the-art production facilities, high quality standards, and technological expertise, we contribute to a safe and reliable energy supply for the future.