

Annex A.1.11.
(Non-Confidential version)

Integrated solutions for transport and distribution overhead
networks (OPGW Brochure)

Fibre optic systems for OHTL

INTEGRATED SOLUTIONS FOR TRANSPORT
AND DISTRIBUTION OVERHEAD NETWORKS



Linking the future

As the worldwide leader in the energy and telecoms cable industries, Prysmian Group believes in the effective, efficient and sustainable supply of energy and information as a primary driver in the development of communities.

With this in mind, we provide major global organisations in many industries with best-in-class cable solutions, based on state-of-the-art technology. Through two renowned commercial brands – Prysmian and Draka – based in almost 100 countries, we're constantly close to our customers, enabling them to further develop the world's energy and telecoms infrastructures, and achieve sustainable, profitable growth.

Introducing fibre optic systems for OHTL

Overhead optical fibre cable systems have become a key factor in telecommunications networks used by operators and power utilities.

Due to the fact that no civil works are required and the rights of way have already been established, it is possible to minimise costs and, most importantly, the time required to begin network operation.

Prysmian offers its customers a complete range of overhead optical systems:

Optical ground wire system (OPGW)

Composite optical ground wire system for installation on high voltage electric lines.

Self-supporting cable system (ADSS)

Self-supporting optical cable system for all types of lines: transport electrical lines, distribution electrical lines, railways lines, etc.

All-dielectric longitudinally attached cable system (ADLA)

Robotised system to install fibre optic cables on ground wire or phase conductor of electrical lines.

Optical phase conductor system (OPPC)

Composite optical phase cable system, for high voltage electric lines up to 36kV.



What links communications to communities?

Cable solutions to support the world's telecoms infrastructure

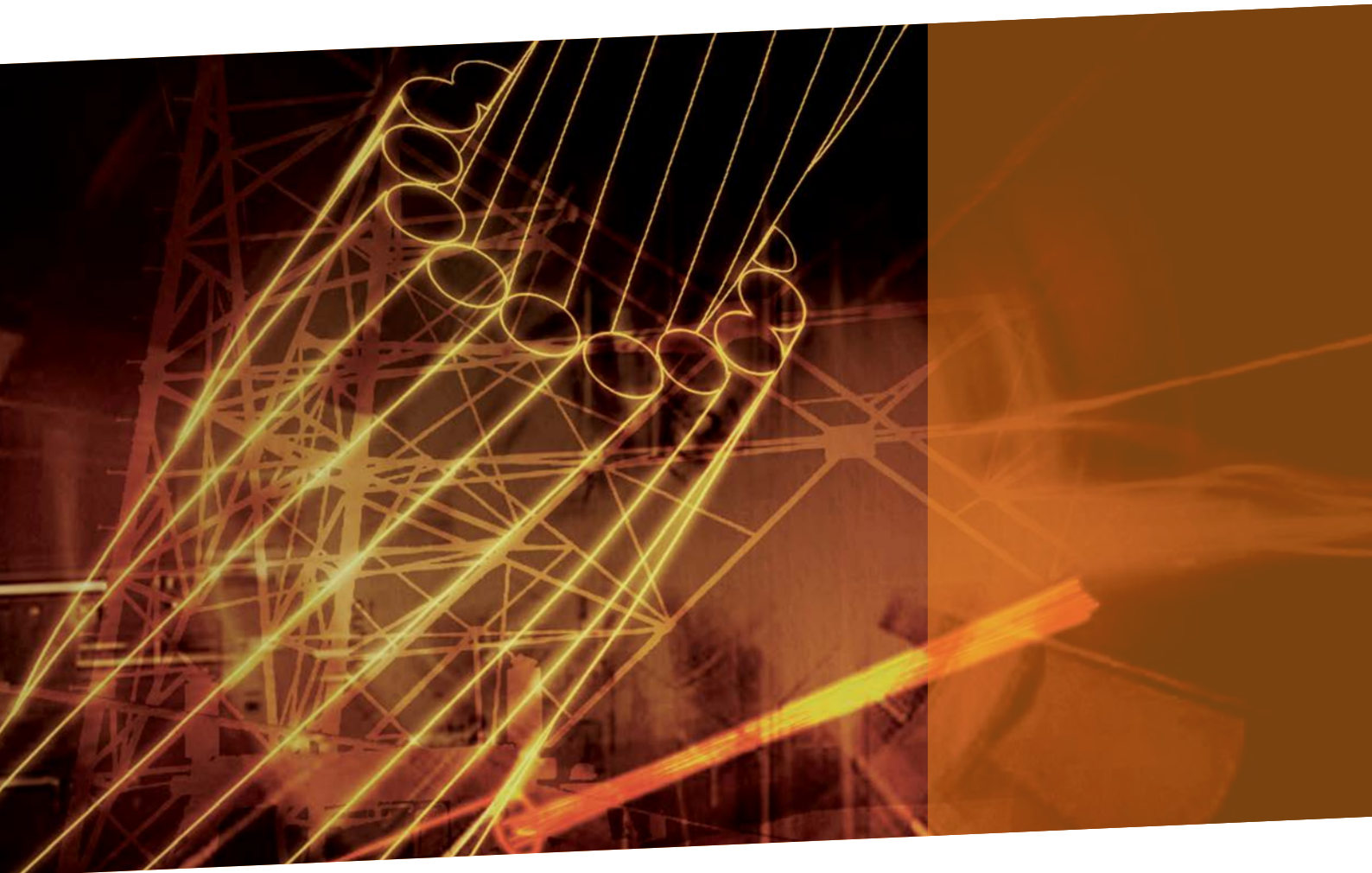
As the world's largest producer of telecoms cables, supporting the infrastructures of many of the world's leading telecoms operators, the Prysmian Group delivers optical fibre and copper cabling solutions that help link communications to communities around the globe.

Covering voice, video and data transmission, our suite of telecoms solutions is the outcome of continuous multi-million Euro investment in R&D and production in more than 30 facilities worldwide.

Prysmian's fibre optic systems for OHTL – always the right decision

Because OHTL networks are critical assets in any country, the best-performing and safest materials must always be used in their creation.

Customers who choose Prysmian systems are choosing solutions that are proven to succeed in terms of installation and operation. In economic terms, that means no unexpected costs due to on-site delays, professional project management throughout the supply process and true longevity of the technology installed.



The main advantages of Prysmian's solutions include the following:

High reliability and proven experience

We have installed over 195,000km of highly reliable cable, with OPGW systems in operation since 1983 in more than 100 countries in all five continents.

Supply of all components, guaranteed system

Prysmian guarantees the compatibility of its systems, while supplying all materials from end to end:

- 100% Prysmian Group fibre
- Aerial cables and terminal cables
- Joint boxes, optical distribution frame and connection accessories
- Components for securing the cable to the towers/poles
- Engineering and installation services, with turn-key projects
- Robots and tools for installation
- Customised drum lengths

Manufacturing capabilities

Prysmian has a growing production capacity of more than 25,000km of OPGW cables per year in three different continents; Europe, America and Asia.

OHSAS 18001 and ISO 14001

Prysmian Group is involved in implementing management and production processes which help improve environmental sustainability and safety at work, in accordance with the guidelines of its HSE policy.

ISO 9001

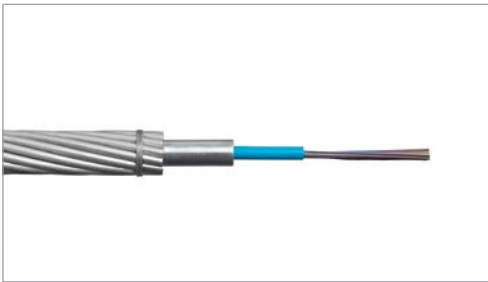
The Prysmian brand has always been a guarantee for the supply of products and services based on common worldwide quality standards. Prysmian has a built-in multi-step quality assurance programme, which covers the entire production process from cable design and raw materials purchasing, to final inspection and testing documentation.

Full range of technologies

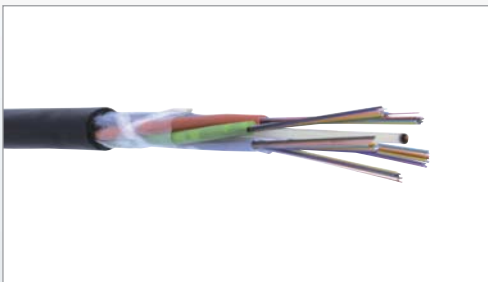
Because we own all of the required technology, we provide every customer with the most appropriate and relevant technical solution for any single project. Prysmian Group never has a pre-determined answer to a challenge – instead, we always recommend the best solution on a case-by-case basis.



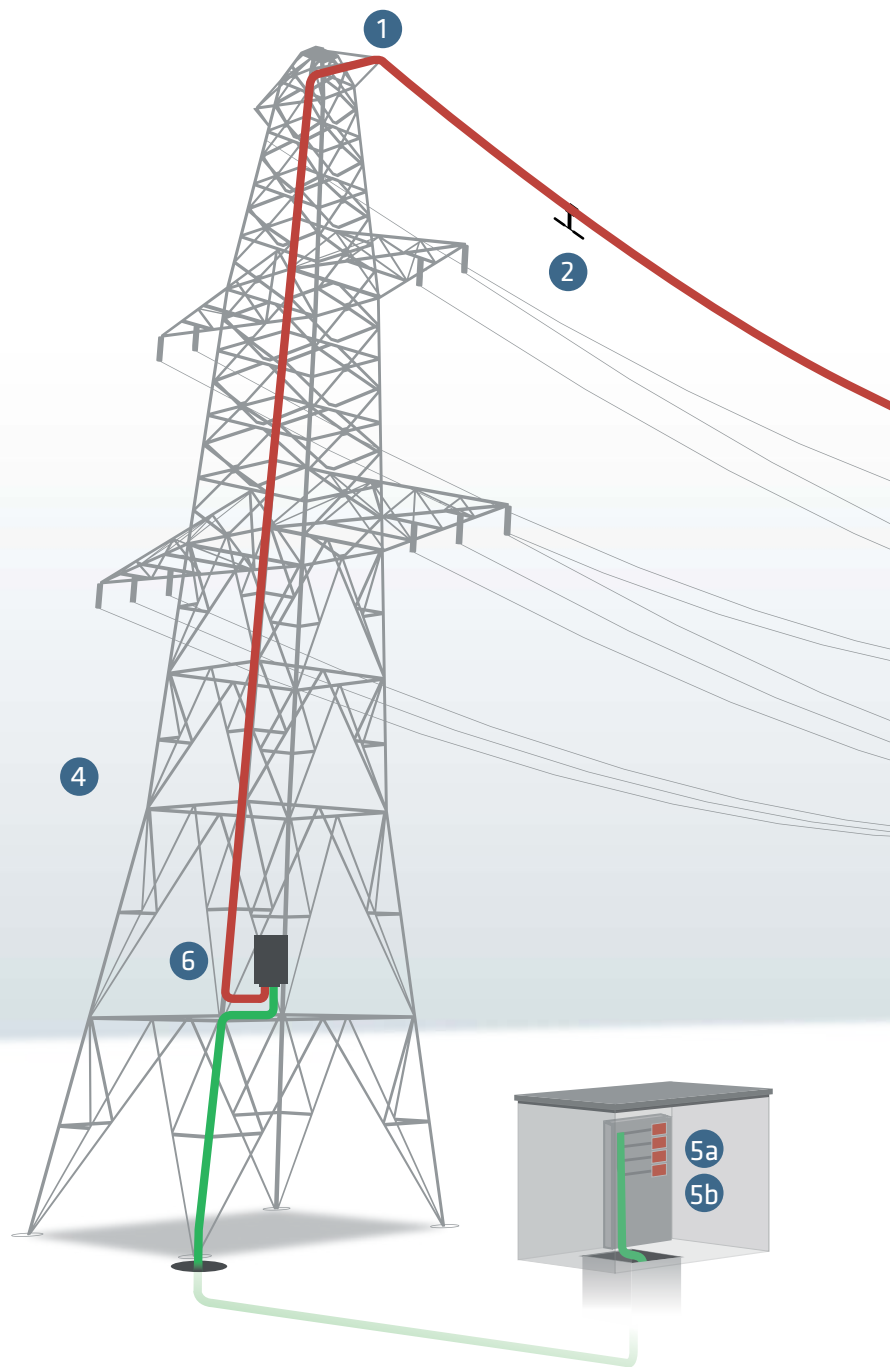
Complete solution for the integration of telecommunications networks on high voltage overhead lines



OPGW cable

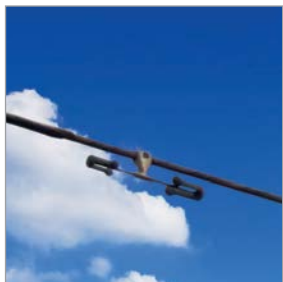


Approach cable





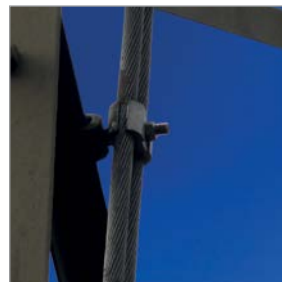
1 Tension assembly



2 Stockbridge damper



3 Suspension assembly



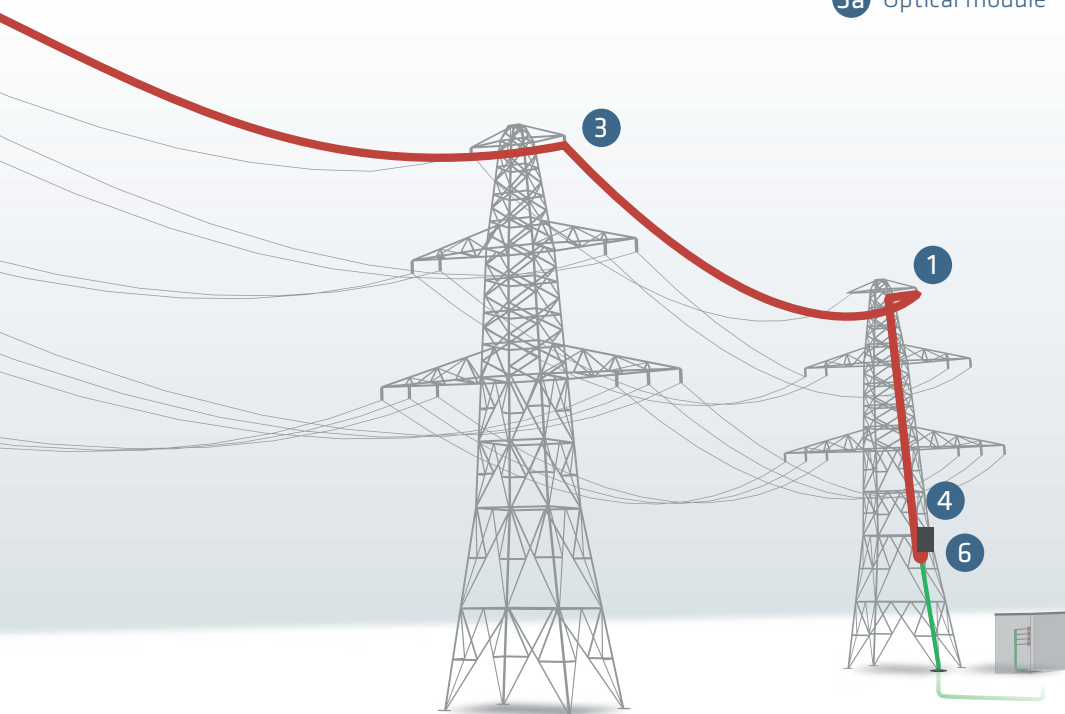
4 Downlead clamp



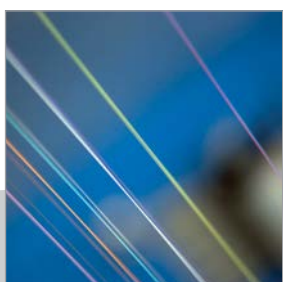
5a Optical module



5b Optical distribution frame (ODF)



6 Joint boxes



Optical fibres



Quality and testing



Engineering and installation

OPGW extruded aluminium cable

Superior corrosion resistance

- Meets IEEE construction guidelines for use in high corrosion sites

Superior electrical performance

- Aluminium core tube substantially increases conductor cross-section
- Improved short-circuit capacity

Superior lightning resistance

- Fewer Aluminium Alloy (AA) wires are needed to meet electrical specifications
- More/heavier duty ACS wires can be used
- AA wires can be completely replaced with ACS in some applications

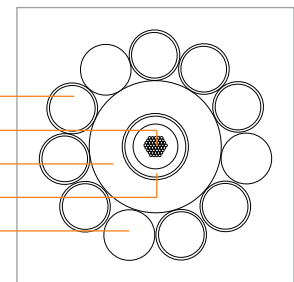
High performance in high fibre counts

- All fibres are housed in the core tube
- Core tubes are available in a wide range of inside diameters

- Armour wires are not replaced with fibre tubes in high count designs
- Electrical and mechanical properties can be maintained

Prysmian's extruded aluminium OPGW provides increased conductivity without sacrificing tensile performance, lightning resistance or fibre count.

Aluminium clad steel wires
Optical fibres
Aluminium extruded tube
PBT loose buffer tube
Aluminium alloy wires





OPGW stainless steel tube embedded in extruded aluminium technology

Aluminium-clad stainless steel core tube

- High crush resistance in a small form-factor

Superior corrosion resistance

- Dissimilar metals are prevented from reacting with one another
- Provides performance similar to stainless steel central tube, without the risk of galvanic corrosion
- Meets IEEE construction guidelines for use in high corrosion sites

Enhanced electrical performance

- Aluminium cladding contributes to overall conductivity
- Decreases resistance and increases fault current rating

Enhanced lightning resistance

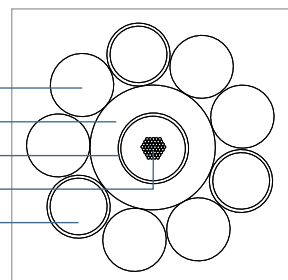
- Use of aluminium alloy wires can be decreased
- Replacement with ACS wires improves lightning resistance

Compact design

- Reduced weight
- Increased flexibility
- Smaller minimum bend radius
- Easier to handle and install
- Lower wind and ice loads put less load on structures

Prysmian's aluminium-clad stainless steel OPGW provides a compact design without sacrificing corrosion resistance. It is best suited to applications with moderate to low span and electrical requirements.

Aluminium alloy wires
Aluminium extruded tube
Stainless steel tube
Optical fibres
Aluminium clad steel wires



OPGW stranded stainless steel tube

Stranded stainless steel tube

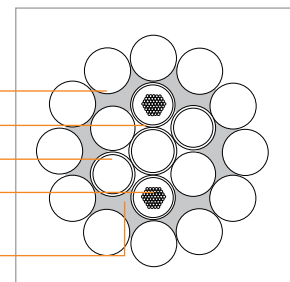
- Wire strands are replaced with fibre-filled stainless steel tubes
- Fibre tubes are helically stranded alongside the wires
- Fibre strain margin is increased relative to core tube designs
- Loaded sag can be increased without placing fibres under strain

Compact design

- Reduced weight
- Increased flexibility
- Smaller minimum bend radius
- Easier to handle and install
- Lower wind and ice loads put less load on structures

Prysmian's stainless steel OPGW cable with the SST in the lateral position allows cable elongation and sag to be increased without increasing fibre strain. It is best suited to applications where the ground wire will be replaced by an identical cable due to tower limitations. Because of this, OPGW contains exposed elements made of both stainless steel and aluminium. It should therefore not be used for high corrosion sites.

Aluminium alloy wires
Stainless steel tube
Aluminium clad steel wires
Optical fibres
Grease of high drop point as additional corrosion protection



OPGW – Spiral Space® technology

Superior corrosion resistance

- Dissimilar metals are prevented from reacting with one another
- Provides performance without risk of galvanic corrosion
- Meets IEEE construction guidelines for use in high corrosion sites

High performance in high fibre counts

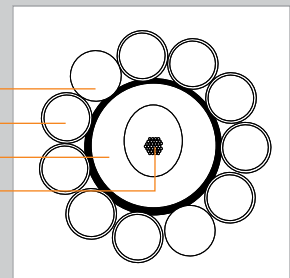
- All fibres are housed in the core tube
- Excellent heat protection of fibres
- Armour wires are not replaced with fibre tubes in high count designs. Electrical and mechanical properties can be maintained

Prysmian's OPGW cable with Spiral Space® technology consists of a unique Spiral Space unit for optical fibres. The fibres are loosely buffered in a tube containing an oval, spiralling, hollow channel filled with jelly. The loose tube

construction prevents fibre strain at any stage of installation or operation. This ensures a long, stress-free fibre life.

The Spiral Space® construction allows the use of a high fibre count in a single small-diameter tube.

Aluminium alloy wires
Aluminium clad steel wires
Spiral Space®
Optical fibres





Optical fibres

With over 20 years' experience of manufacturing optical fibres, Prysmian Group is able to offer an extensive product portfolio designed to achieve the highest levels of quality and performance. This is thanks to our unique position of having access to the major manufacturing processes: MCVD (Modified Chemical Vapor Deposition), OVD (Outside Vapor Deposition), VAD (Vapor Axial Deposition) and PCVD (Plasma-activated Chemical Vapor Deposition). This enables Prysmian Group to obtain an optimised range of products for different applications.

Single-mode fibre ITU-T G.652.A/B and IEC 60793-2-50 B 1.1

Single-mode fibre (SMF) provides optimum performance in both the 1310nm and 1550nm wavelength operation ranges (including the 1565 – 1625 nm L-band), with a low dispersion in the 1310nm window. It can be used in all cable constructions and supports long haul, metropolitan, access and premises applications in telecommunications, CATV, utility and intelligent traffic networks.

Single-mode fibre ITU-T G.652.C/D and IEC 60793-2-50 B 1.3

Enhanced single-mode fibre (ESMF) provides improved performance across the entire 1260nm to 1625nm wavelength spectrum. It has a low dispersion in the 1310nm window and low attenuation in the 1383nm water-peak region to allow use of the extended band (1360nm to 1460nm). With its wide operating spectrum, ESMF expands the future growth capability of the fibre and allows flexible configuration of voice, data, and video services within the fibre. It can be used in all cable constructions.

Single-mode fibre ITU-T G.652.C/D and IEC 60793-2-50 B 1.3, with lower cabled loss

Enhanced single-mode fibre (ESMF) with lower secured cabled loss in all the transmission bands, including the highest ones (L and U-bands), intrinsically more sensitive, provides further improved and secured performance across the entire spectrum; such premium attenuation levels inside the finished cable, even in demanding environments, are offered through superior microbending resilience of the fibres used while still preserving all parameters and characteristics of G.652.C/D fibres, made possible using a fine-tuned glass optimisation combined with the use of a highly performing protective coating.

Single-mode ITU-T G.655.C/D and IEC 60793-2-50 B 4_c/d

Non-Zero Dispersion Shifted Fibres (NZDSF) designed for DWDM applications. They are characterised by relatively lower dispersion values from 1530 to 1625nm, compared to G.652 fibres. They are available in two grades, to cover a variety of transmission challenge optimisations: one version with large effective area (NZDSF-LA) to contain the generation of non-linear effects during propagation, and another version with reduced chromatic dispersion slope (NZDSF-RS) to equip a broader range of channels with the benefits of a lower dispersion.

Single-mode ITU-T G.656 & G.655.C/E and IEC 60793-2-50 B 4_c/e & B5

NZDSF with Medium Dispersion values, as described by recommendation ITU-T G.656 and more recently G.655.E, have set the standard for high bit-rate, multi-wavelength transmission. Those fibres are designed with a global transmission optimisation in mind, aiming at containing the detrimental effects of chromatic dispersion whilst at the same time ensuring that the properties of such dispersion still contain the nonlinearities. They offer a unique trade-off between effective area, chromatic dispersion and dispersion slope thus providing an excellent transmission distortion management, cost-effectively; they secure operation at 10, 40 and 100Gbps per channel, tight channel spacing in C- and L-bands, and compatibility with the S-band; a definite step further for long-haul and ultra-long-haul applications.

Prysmian Group's fibre manufacturing process quality and performance coupled with Proprietary *COLORLOCK^{XS}*™ coating process further enhance the performance, durability and reliability of the fibre, even in the harshest environments.



Joint boxes

Stainless steel box

The XOK universal joint closures are designed to provide water and pressure-tight environmental protection for optical fibres and optical fibre splices regardless of the cable design. Application ranges from aerial, duct to buried installations. The closure has anchoring points for strength members and facilities for earthing of metallic elements.

The splice organiser trays offer holders for heat shrink splice protectors and sufficient space for storage of spare fibres. The closure is easily assembled and re-entered.

The closure is available in two sizes: XOK 103 series up to 192 splices and XOK 107 series up to 336 splices. By using extension collars and/or splice trays for fibre ribbons, the splicing capacity can be increased up to 1000 splices.

The closure is available in seven basic configurations with two, three or four cable entrances. XOK A3/A4 branch joint closures and extension collars for more cable outlets are also available. Closures can be delivered as complete installation packages up to 192 fibres.

Dimensions (excl. inlet tubes)

- XOK 103 series: 560 x 230 x 100mm
- XOK 107 series: 560 x 230 x 140mm
- XOK A3 and A4: 560 x 230 x 140mm

Inner diameter of entry ports

- XOK 103 series: round port 20mm, oval port 58 x 28mm
- XOK 107 series: round port 27mm, oval port 58 x 28mm
- XOK A3 and A4: oval port 58 x 28mm

Material

- Closure: acid proof stainless steel (AISI 316) 1.5mm
- Closure seal: chloroprene rubber

Splice tray capacity

- XOK 103 series:
4 trays XOKP 1024/48 with 48 splices each (192 splices)
- XOK 107 series:
7 trays XOKP 1024/48 with 48 splices each (336 splices)
- XOK A3 and A4:
4 trays XOKP 1024/48 with 48 splices each (192 splices)

IP rating: IP68

Aluminium joint box

EWMJ & EWJ joint boxes are specially designed to provide maximum versatility for OPGW cable splicing, which enables their use in OPGW and other optical cable systems. The joint box is made of aluminium alloy and has a maximum capacity of 240 fibre splices. A pre-moulded neoprene anti-ageing gasket, perfectly inserted in the groove of the cover, provides an excellent sealing against dust and water-jets.

An assembling plate prepared with fixing devices for the cable and for the splice trays is placed inside the box.

Cable glands and a heavy wall heat shrinkable tube are used for sealing the entries of the OPGW cables. The anchoring of the joint box to the tower is achieved with galvanized steel clamps allowing the fixation in all type of towers, and with stainless steel tape in all type of poles.

- Maximum number of cable entries: 4
- Maximum cable diameter (mm): 25
- Maximum number of splice trays: 8 (EWMJ) – 10 (EWJ)
- Maximum number of splices per tray: 24
- Maximum number of splices: 192 (EWMJ) – 240 (EWJ)
- IP rating: IP67
- Required space envelope (mm): (l) 319 x (w) 219 x (d) 110. (EWMJ) - (l) 319 x (w) 319 x (d) 175 (EWJ)
- Operating temperature: -40°C to + 85°C

Material

- Joint box: aluminium alloy with grey coated powder (RAL 7042)
- Fastening structure: aluminium and galvanized steel
- Nuts and bolts: stainless steel



Stainless steel box



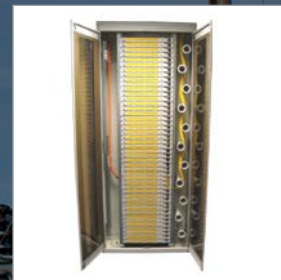
Aluminium joint boxes

Optical Distribution Frame (ODF)

The RS3000 Rack is a standard rack with 19" mounting rails, used to accommodate a range of SRS3000 shelves and sub-racks or any other 19" rack mounted products. The rack is 900mm wide by 300mm in depth and is available in 42U and 47U heights (2000 and 2200mm). The rack is supplied with side panels and transparent doors. Cable brackets are supplied in the left-hand side of the rack to enable a range of cable anchor brackets to be installed.

Mandrels are supplied in the right hand side of the rack to manage and store patchcords. The maximum capacity of the rack is 2160 fibres (based on the 47U rack on a splice + patch basis).

The SRS3000 Splice and Patch Shelf is a modular unit available in a variety of configurations for integration into 19" and ETSI racks, street side or wall-mounted cabinets. The product consists of a metal chassis, a plastic lightweight splice and patch module and a cable anchoring system. The product has a capacity of up to 48 fibres in a 1U unit for SC and LC type connectors, and up to 24 fibres for FC, ST and E2000 type connectors. The panel has in-built fibre management to ensure the product is installed correctly and the same every time by installers.



OPGW fittings

Download clamp

The download clamps are used to fix the cable to the tower in the download to the joint box.

Structure

- Clamp (aluminium)
- M12 rod (galvanized steel)
- Support body (galvanized steel)
- Lock screw (stainless steel)

Configuration

There are different types of clamps

- Individual clamp, for a single cable
- Standard clamp for two cables, adaptable to all diameters

Tension assembly

Preformed tension assembly especially designed for OPGW cables. Includes grounding clamps for tower connection. When the distance between two anchor towers is greater than the maximum length of OPGW cable drums, there are special tension assemblies for installation in suspension towers, allowing a cable joint to be included.

Structure

- Straight shackle (galvanized forged steel)
- Extension link (galvanized laminated steel)
- Dead end (compression aluminium clad steel)
- Thimble (cast galvanized steel)
- Protection splice (compression aluminium clad steel)
- Grounding clamp (aluminium)

Configuration

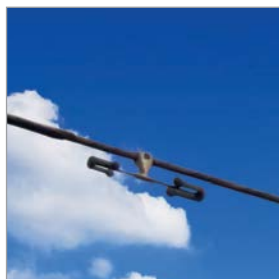
There are three types of assemblies for installation in tension towers

- Passing tension assembly: for intermediate towers
- Splicing tension assembly: for towers with joint boxes
- Final tension assembly: for final towers
- Tension assemblies for suspension towers: splicing tension assembly, for towers with joint boxes

The assembly components can be provided with customised features in accordance with client requirements.



Tension assembly



Stockbridge damper

Suspension assembly

Assembly with reinforced suspension clamp and neoprene inner covering, especially designed for OPGW cables. Includes grounding clamps for tower connection.

Structure

- Straight shackle (galvanized forged steel)
- Twisted link (galvanized forged steel)
- Parallel connection clamp (aluminium)
- Armour grid suspension clamp (aluminium)
- Preformed rods (aluminium alloy)
- Grounding clamp (aluminium)

Configuration

According to the environmental conditions, length of span and types of cables it may be necessary to use extra protection rods (reinforced suspension assembly).

The assembly components can be provided with optimum features in accordance with client requirements.

Stockbridge Damper

The dampers are used to absorb the cable vibrations.

The number of dampers is determined by the environmental conditions, the distance between towers, the type of OPGW cable and the installation parameters. On request, Prysmian can calculate a customised vibration study.

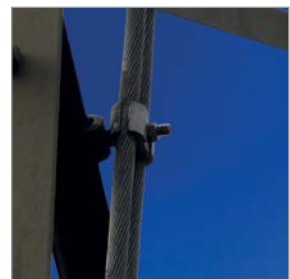
Structure

- Securing clamp (aluminium alloy)
- Messenger cable (galvanized steel wire)
- Counterweights (galvanized forged steel)

All assembly components and other items can be provided with customised features in accordance with client requirements.



Suspension assembly



Download clamp

Approach cable

These cables are used to connect the optical fibres of the OPGW cable at the end of the high voltage line to the optical distribution frame in the substation.

- Fibre compatible with the OHTL cable
- Fully dielectric cable that avoids any interference with electromagnetic fields
- Fibre core protected against moisture penetration and longitudinal water propagation
- Easy handling, small and lightweight

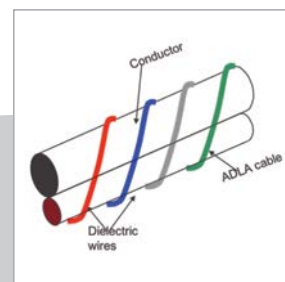
Performance and testing

- According to IEC 60794
- When Halogen-free and flame-retardant cable is required, IEC 60332 – IEC60754-1 IEC 61034-1,2 applies

Design

Optionally, different additional protections can be applied over the cable core depending on the requirements.

- High tensile strength dielectric reinforcement with aramid or glass yarns
- Rodent protection with glass yarns/tape
- Halogen-free and flame-retardant jacket materials (Afumex™)
- High crush and impact resistance with double polyethylene jacket
- Termite resistance



Alternative solutions to OPGW when there is no groundwire

ADLA (All Dielectric Longitudinally Attached)

ADLA is a robotised cost-effective installation system that means optical cable can be installed attached to a phase conductor or a ground wire.

Prysmian's ADLA system provides a complete solution, including robust dielectric cable, installation machinery and accessories that allow efficient installation on distribution lines.

OPPC

Prysmian offers another solution for deploying fibre on distribution lines with no ground wire – the optical phase conductor (OPPC).

Prysmian's OPPC system provides a complete solution, including cable and accessories that allows efficient installation on distribution lines.

ADSS (All-Dielectric Self Supporting)

ADSS is a completely non-metallic cable in which the tensile load bearing elements are integral within the circular design of the cable – usually in the form of aramid yarns or stranded glass reinforced plastic rods. The fibres can be packaged in a variety of ways but are usually placed in polymer tubes which are then protected within the overall cable construction.





Quality and testing

With more than 110 OPGW cable designs successfully type-tested, Prysmian has extensive experience in OPGW qualification.

Additionally, our in-house laboratories certify that all cables are manufactured in compliance with the design specifications. Prysmian's manufacturing plants are fully ISO certified.

Prysmian has the following in-house OPGW testing facilities:

- Tensile machine (20t)
- Sheave
- Crush
- Impact
- CW Lightning test (400°C)
- Salt fog test chamber
- (-40/85°C) Climatic chamber

Optical fibre parameters, such as cut-off wavelength, MFD, spectral attenuation, chromatic dispersion and PMD, can be measured.

The laboratory is also equipped with tensile machines for the characterisation of metallic wires and plastic sheathing.

Agreements with international laboratories allow us to achieve cable qualification according to IEEE 1138 and/or IEC 60794.

Prysmian OPGW manufacturing plants are ISO 9001 and 14001 certified and the quality assurance systems are managed accordingly.

Services

Engineering and installation

To ensure that the OPGW cables will operate successfully in a high-voltage network, all aspects associated with the implementation of the technology must be correctly analysed.

Prysmian offers its customers the following services;

- Optimised design of cables and accessories
- Project engineering (calculation of spans, drum lengths, etc.)
- Definition of optical fibre type and quantity
- Line survey - the cable drums, type and quantity of accessories, splice points, etc. are determined at this time
- Supervision of installation, to ensure correct cable stringing and splicing
- Jointing of the drums
- Final commissioning of a line
- Maintenance services, providing the material required (instruments, repair units, etc.)

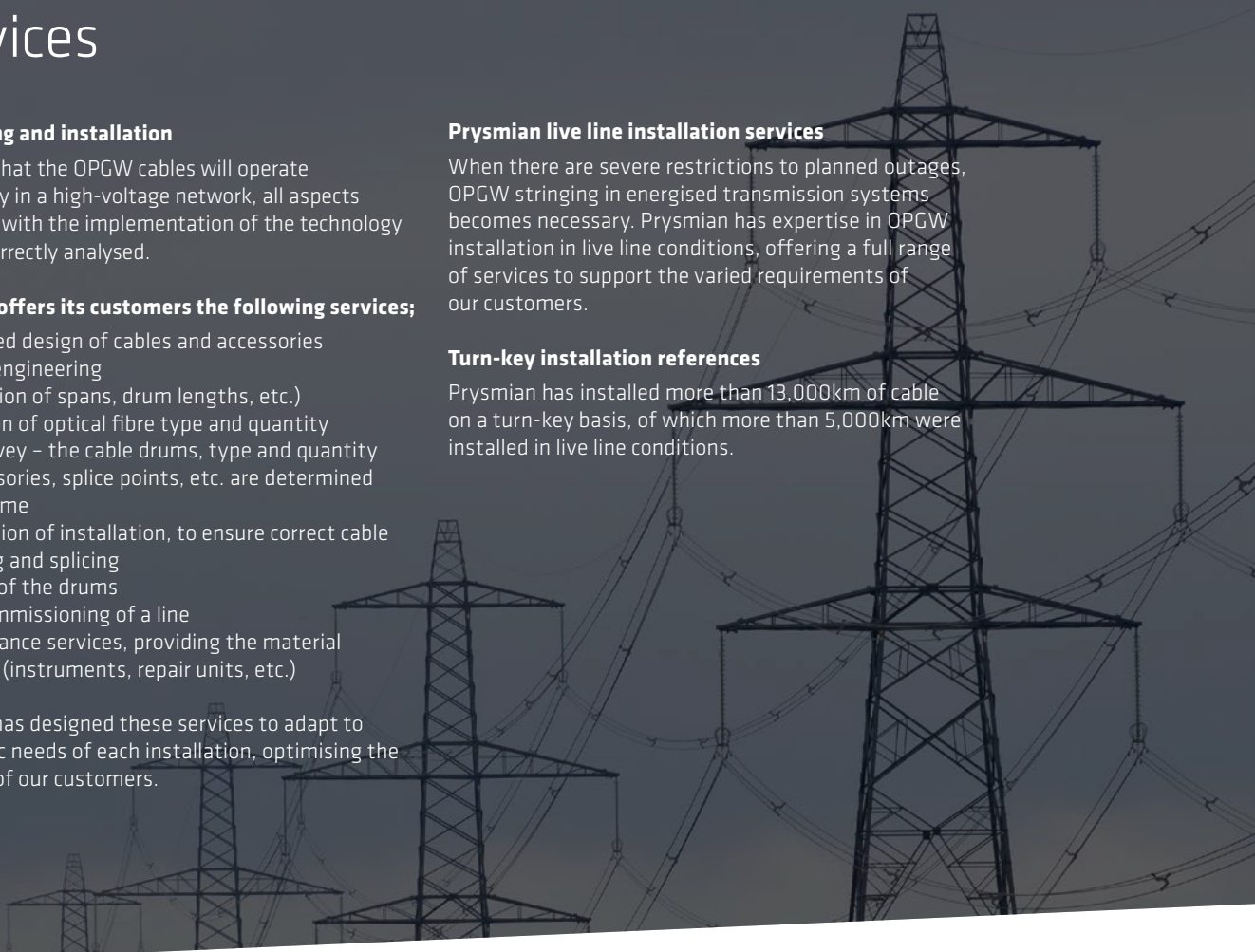
Prysmian has designed these services to adapt to the specific needs of each installation, optimising the resources of our customers.

Prysmian live line installation services

When there are severe restrictions to planned outages, OPGW stringing in energised transmission systems becomes necessary. Prysmian has expertise in OPGW installation in live line conditions, offering a full range of services to support the varied requirements of our customers.

Turn-key installation references

Prysmian has installed more than 13,000km of cable on a turn-key basis, of which more than 5,000km were installed in live line conditions.



References

The Prysmian Group began installation of OPGW systems in 1983. Since then our technology has been used in more than 100 countries with complete customer satisfaction.



Linking communications to communities

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Prysmian
Group

