High Voltage
Power Cables

Technical Catalogue

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HIGH VOLTAGE

Power Cables

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1. General Power Circuit Design

This catalogue deals with underground power circuits featuring three-phase AC voltage insulated cable with a rated voltage between 66 and 230 kV. These lines are mainly used in the transmission lines between two units of an electricity distribution grid, a generator unit and a distribution unit or inside a station or sub-station. These insulated cable circuits may also be used in conjunction with overhead lines.

The voltage of a circuit is designated in accordance with the following principles:

Example:
U_o /U (U_m) : 127/220 (245)

Where
U_o = 127 kV phase-to-ground voltage,
U = 220 kV rated phase-to-phase voltage,
U_m = 245 kV highest permissible voltage of the grid

Phase-to-ground voltage, designated U_o, is the effective value of the voltage between the conductor and the ground or the metallic screen.

Rated voltage, designated U, is the effective phase-to-phase voltage.

Maximum voltage, designated U_m, is the permissible highest voltage for which the equipment is specified.

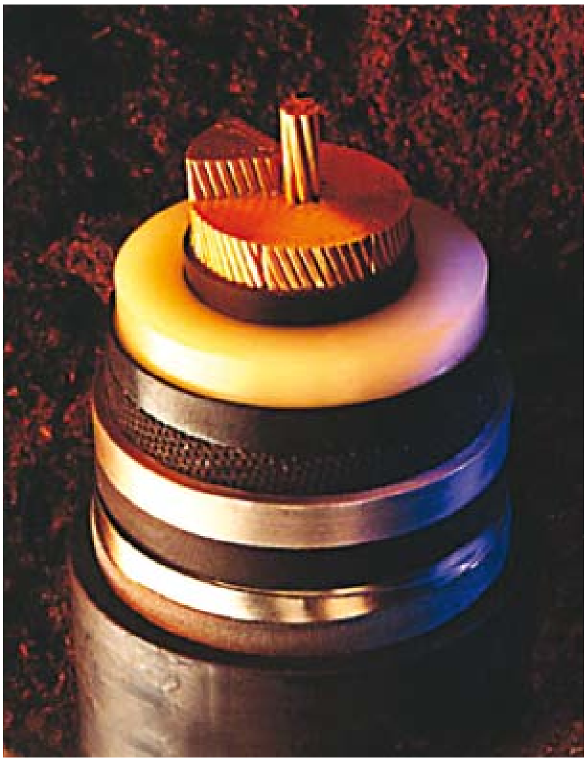
A high voltage insulated cable circuit consists of three single-core cables with High Voltage sealing ends at each end. These sealing ends are also called (terminations) or terminals.

When the length of the circuit exceeds the capacity of a cable reel, joints are used to connect the unit lengths.

The circuit installation also includes grounding boxes, screen earthing connection boxes (link boxes) and the related earthing and bonding cables.

2. XLPE Cable

2.1 Introduction



Cross-linked polyethylene (XLPE) has become the globally preferred insulation for power cables, both for distribution and transmission system applications. This insulation system provides cost efficiency in operation and procurement, as well as lower environmental and maintenance requirements when compared to older impregnated paper systems. XLPE cables have many excellent characteristics, especially for use in higher operating temperature.

The basic advantages of XLPE insulated power tcables may be summarized as follows:

Higher Ampacity Rating: Higher continuous operating temperature of 90 °C for conductor permits XLPE Cables to withstand higher current ratings than PVC or HPFF Cables.

Higher Emergency Rating: XLPE cables can be operated at 105 °C during emergency. Operation at this temperature should be for no more than 72 hours duration on average per year during the design life of the cable system, without exceeding 216 hours in any 12-month period and in any one event. Assuming a 40-year design life, this implies that the cable system should be able to withstand cumulative operation at 105 °C for a total of 2880 hours. Due to this, a higher current than the specific rating may be carried for this period.

Higher Short-Circuit Rating: Higher allowable temperature during short-circuit of 250 °C for conductor permits XLPE Cables to withstand higher short circuit ratings than PVC or PILC Cables.

Low Dielectric Losses: The dielectric loss angle of XLPE is much lower than conventional dielectric. The dielectric losses are quadratically dependent on the voltage. Hence use of XLPE Cables at higher voltages would generate considerable saving in costs.

Simple Accessories: The extruded insulation has excellent electrical properties which allow use of simplified solutions for joints and terminations compared to oil filled cables. Also, the ability to splice cables in discontinuous shifts permits cable splicing to occur during periods of low traffic.

Low Charging Currents: The charging currents are considerably lower than other dielectrics. This permits close setting of protection relays.

Ease of Installation: XLPE cable withstands smaller bending radius and is lighter in weight, allowing for easy and reliable installation. Furthermore, the splicing and terminating methods for XLPE cable are simpler in comparison with other kinds of cables.

Free from Height Limitation and Maintenance: XLPE cables can be installed anywhere without special consideration of the route profile (height limitations) since it does not contain oil and thus is free from failures due to oil migration in oil-filled cables.

These, along with better resistance to environmental stress cracking and low dielectric constant make XLPE Cables particularly suitable for power transmission in high and extra-high voltage systems.

2.2 Cable Design

High and extra-high voltage XLPE cables have common design features independent of the rated voltage and operating frequency. The components that essentially determine the electrical and thermal behavior of the cable are the conductor, the insulation with inner and outer field limitation layers and the metallic screen.

Insulation Thickness

The insulation thickness of high and extra-high voltage XLPE cables should be designed and calculated by the application of three independent design methods described by the following keywords:

- The mean ac field strength to be withstood for the duration of one hour (method A)
- The average lightning impulse field strength to be resisted (method B)
- The maximum impulse withstand field strength at the conductor (method C)

Methods A to C can be described by the following formulae. The largest value (derived from methods A to C) should be nominated as the minimum required nominal insulation thickness.

$$T_{Method\ A} = \frac{U_0}{E_{dac}}\ x\ k_T\ x\ k_o\ x\ k_t$$

Where,

$T_{method\ A}$	:	Insulation thickness derived from method A
U_0	:	Nominal phase voltage (kV)
E_{dac}	:	A.C withstand strength (1h) (kV/mm)
K_T	:	Temperature factor
K_o	:	Overvoltage factor
K_t	:	Ageing factor

$$T_{Method\ B} = \frac{U_{BIL}}{E_{\text{dimean}}}\ x\ k_T\ x\ k_f\ x\ k_s$$

Where,

$T_{method\ B}$	:	Insulation thickness derived from method B
U_{BIL}	:	Basic impulse level (BIL) (kV)
E_{dimean}	:	Mean impulse strength (kV/mm)
K_T	:	Temperature factor
K_f	:	Repetition factor
K_s	:	Safety factor

$$T_{Method\ C} = r\ x \left[e^{\left(\frac{U_{BIL}}{r\ x\ E_{\text{dimax}}}\ x\ k_T\ x\ k_f\ x\ k_s \right)} - 1 \right]$$

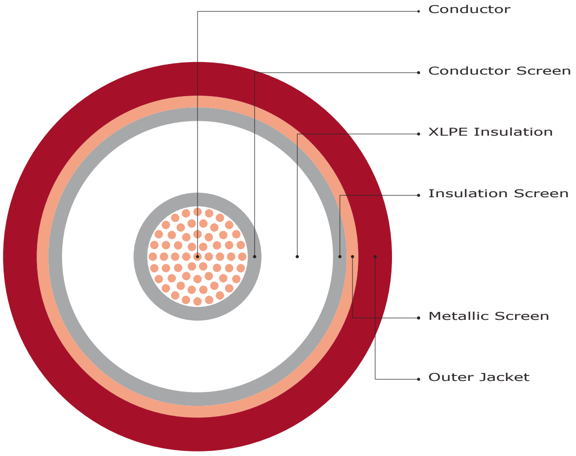
Where,

$T_{method\ C}$	:	Insulation thickness derived from method C
U_{BIL}	:	Basic impulse level (BIL) (kV)
E_{dimax}	:	Maximum impulse strength (kV/mm)
r	:	Radius of inner semi-conductive layer
K_T	:	Temperature factor
K_f	:	Repetition factor
K_s	:	Safety factor

2.3 Cable Structure

The following structure applies to high and extra-high voltage cable with synthetic cross-linked polyethylene (XLPE) insulation of rated voltage from 66 kV grade up to and including 230 kV grade. This structure represents our standard models of high and extra-high voltage cables, however any other models as per customer's standard are also available.

The structure of high and extra-high voltage cable with synthetic cross-linked polyethylene insulation will always involve the following items:



Conductor

The task of the conductor is to transmit the current with the lowest possible losses. The decisive properties for this function result in the first place from the conductor *material and design*. The conductor also plays a decisive part in the mechanical tensile strength and bending ability of the cable.

The conductor material shall be either of plain annealed copper or plain aluminum. The most important properties of the two conductor materials are compared in table here below.

Property	Copper	Aluminum
Density (g/cm^3)	8.89	2.703
Spec. resistance ($\Omega.mm^2/m$)	0.017241	0.028264
Tensile strength (N/mm^2)	200 ... 300	70 … 90

The conductor behavior is characterized by two particularly noteworthy phenomena: *the skin effect* and the *proximity effect.*

The *skin effect* is the concentration of electric current flow around the periphery of the conductors. It increases in proportion to the cross-section of conductor used.

The *proximity effect* is generated from the short distance separating the phases in the same circuit. When the conductor diameter is relatively large in relation to the distance separating the three phases, the electric current tends to concentrate on the surface facing the conductors. The wires of the facing surfaces indeed have a lower inductance than wires that are further away (the inductance of a circuit increases in proportion to the surface carried by the circuit). The current tends to circulate in the wires with the lowest inductance. In practice, the proximity effect is weaker than the skin effect and rapidly diminishes when the cables are moved away from each other.

The proximity effect is negligible when the distance between two single core cables in the same circuit or in two adjacent circuits is at least 8 times the outside diameter of the cable conductor.

There are two designs of conductor, compacted round stranded and segmental *"Milliken"* stranded.

Compacted round conductors composed of several layers of concentric spiral–wound wires. Due to the low resistance of electrical contact between the wires in the compacted round stranded conductors, the skin and proximity effects are virtually identical to those of solid plain conductor. This structure is reserved for cross-sections up to and including 800 mm^2, either for copper or aluminum.

Segmental conductors, also known as “Milliken” conductors are composed of several segment-shaped conductors assembled together to form a cylindrical core.

The large cross-section conductor is divided into several segment-shaped conductors. There are 5 of these conductors, which are known as segments or sectors. They are insulated from each other by means of non-conductive or insulating tapes.

The spiral assembly of the segments prevents the same conductor wires from constantly being opposite the other conductors in the circuit, thus reducing the proximity effect.

This structure is reserved for large cross-sections greater than 1200 mm^2 for aluminum and at least 1000 mm^2 for copper. The “Milliken” type structure reduces the highly unfavorable skin and proximity effects.

Conductor Screen

Conductor screen of an extruded super smooth semi-conducting compound shall be applied over the conductor to prevent the electric field concentration in the interface between the XLPE insulation and the conductor.

Insulation

As its name suggests, the insulation insulates the conductor when working at a certain high voltage from the screen working at earthing potential. The insulation must be able to withstand the electric field under rated and transient operating conditions. The insulation material is extruded dry-cured, dry-cooled and extra-clean cross-linked polyethylene with excellent electrical and physical properties.

Insulation Screen

This layer has the same function as the conductor screen, where it is a progressive transition from an insulating medium, where the electric field is non-null, to a conductive medium (the cable metallic screen) in which the electric field is null. The insulation screen shall be applied direct upon the insulation and shall consist of an extruded semi-conducting compound. The insulation screen shall be firmly and totally bonded to the insulation.
The conductor screen, XLPE insulation and the insulation screen are extruded simultaneously in one process using triple extrusion method (Continuous Vulcanization Line). Triple extrusion method not only assures clean interfaces between the insulation and stress control layers, but also assures a construction free of Partial Discharge with high operational reliability.

Metallic Screen

When the voltage reaches tens or even hundreds of kV, a metallic screen is necessary, and it is needed to connect it to earth at least at one point along the route.

Its main function is to nullify the electric field outside the cable. It acts as the second electrode of the capacitor formed by the cable.
In addition to the task of electrostatic screening already mentioned, the metallic screen also has to fulfill the following functions:

1. Draining the capacitive current that passes through the insulation.

2. Draining the zero-sequence short-circuit currents, or part of them. This function is used to determine the size of the metallic screen.

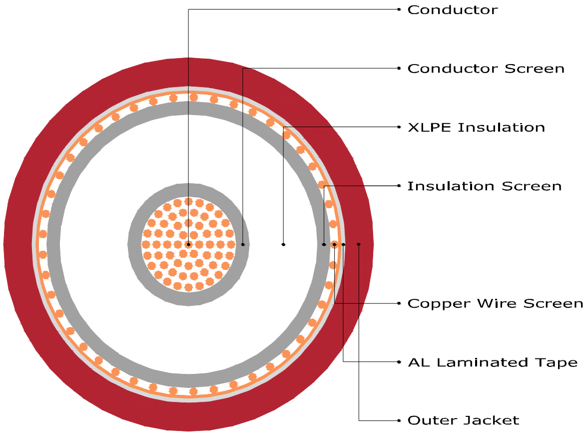
3. The circulation of the currents induced by the magnetic fields from other cables in the vicinity.

4. Reduction of the electrical influence on the cable surroundings in the case of an earth fault.

5. Provision of protection against accidental contact.

2.4 Different Types of Metallic Screen

Copper Wire Screen



Application

- Suitable for installation in tunnels, trenches or ducts

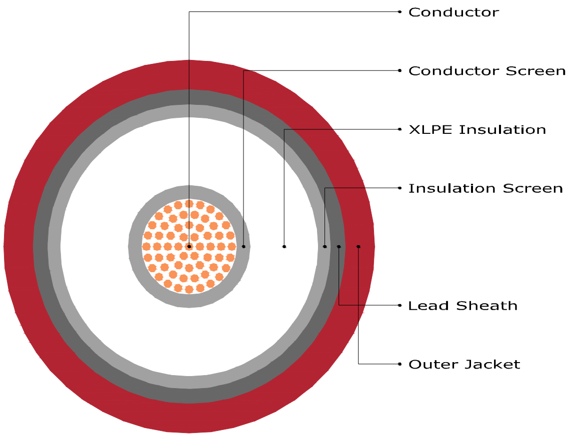
Advantages

- Light weight and cost effective design
- High short-circuit capacity
- Waterproofing guaranteed in radial direction by the aluminum laminated tape

Drawbacks

- Low resistance necessitating special screen connec tions in order to limit circulating current losses

Extruded Lead or Lead-Alloy Sheath



Application

- Suitable for all installations in soil

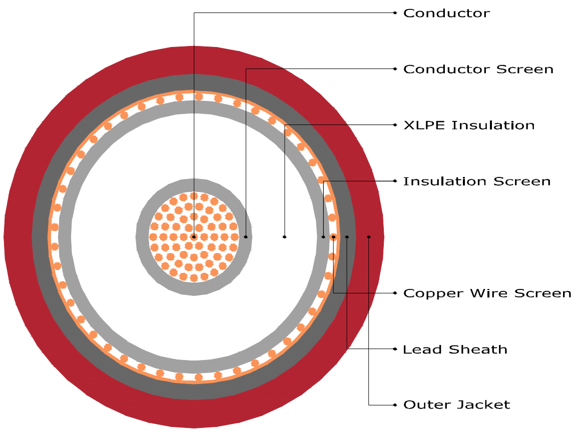
Advantages

- Waterproofing guaranteed by the manufacturing process
- High resistance, therefore minimum energy loss in continuous earthing links
- Excellent corrosion resistance

Drawbacks

- Heavy and expensive
- Lead is a toxic metal
- Limited short-circuit capacity

Lead Sheath with Copper Wire Screen



Application

- Suitable for all installations in soil

Advantages

- Waterproofing guaranteed by the manufacturing process
- High resistance, therefore minimum energy loss in continuous earthing links
- Excellent corrosion resistance
- Increased short-circuit capacity through additional copper wire screen

Drawbacks

- Heavy and expensive
- Lead is a toxic metal

2.5 Anti-Corrosion Protective Jacket (Outer Jacket)

Metallic screen or other metal sheaths require additional protection against mechanical damage and, above all, against corrosion caused by water in conjunction with electrolytically active components in the soil. Hence, the jacket is a covering that provides the following functions:

Mechanical Protection: Jackets provide a certain amount of protection to the cable core from mechanical abuse such as abrasion, scoring and impact and sidewall bearing pressures that occur during handling and installation.

Chemical Protection: Jackets can provide protection from certain chemicals that might be detrimental to the cable core.

Ion Filtration: Research has shown that many of the contaminants found in cable insulations have migrated into the cable from the surrounding soil. Jackets, though not typically designed for this, do filter out some of these ions as moisture migrates into the cable. As a general rule, the ability of the jacket to filter ions will increase as the thickness of the jacket wall increases.

Corrosion Resistance: Experience has shown that the metallic shields of un-jacketed cables will corrode in many types of soil. The application of a jacket can greatly reduce this corrosion.

Moisture Migration: Moisture penetration is a major contributor to the deterioration of cable insulation. Jackets can reduce the rate at which moisture migrates into the cable core.

Electrical: The jacket serves a very important electrical function in bonded cable system such as single-point bonding and cross bonding. To work properly and avoid rapid corrosion phenomena, these bonding systems require that the metallic shield of the cable and joint are electrically isolated from earth potential.

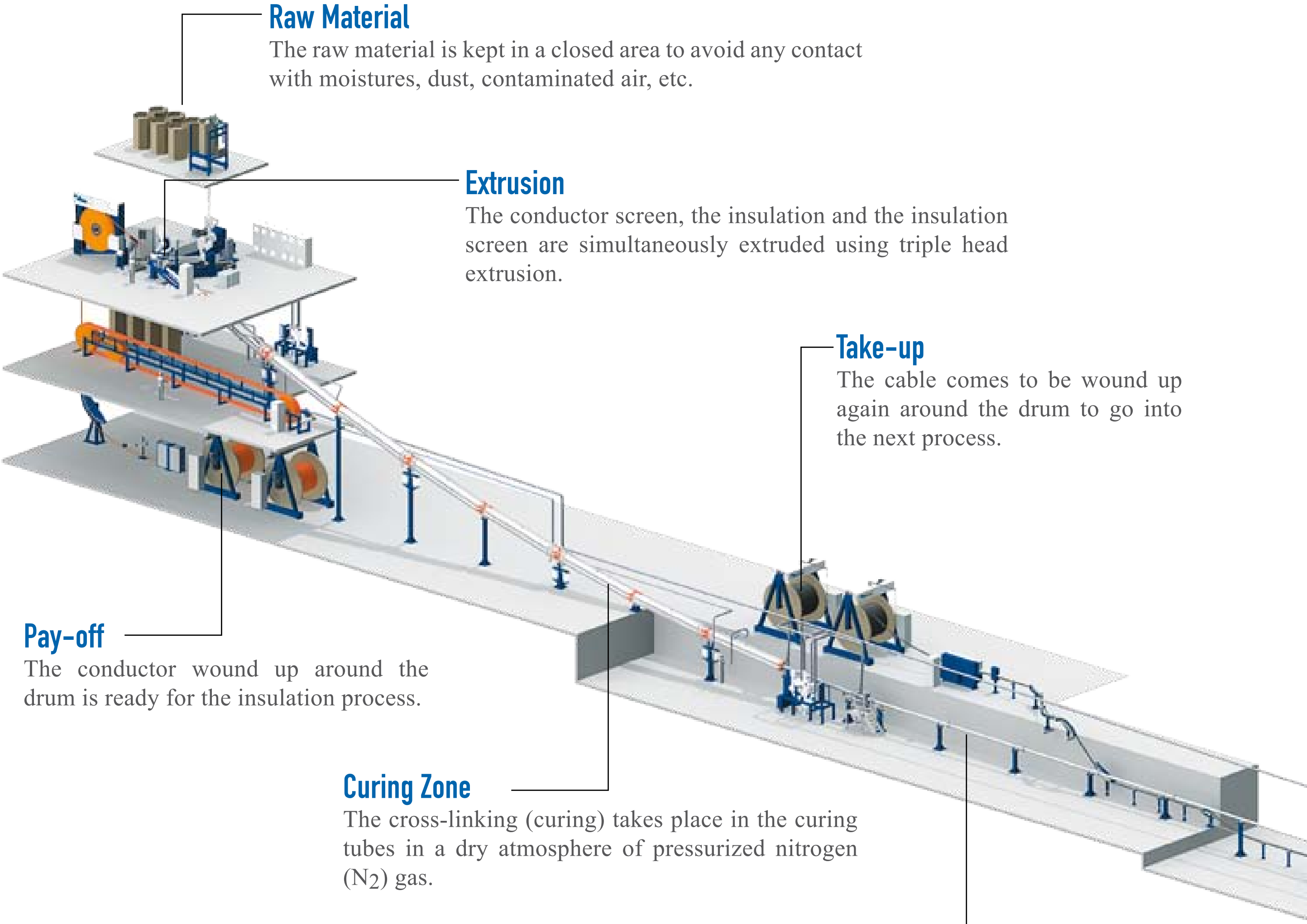
The jacket shall consist of a non-conducting thermoplastic material which should be compatible either with all cable components it contacts or with the maximum operating temperature of conductor during normal, emergency and short-circuit conditions. The outer jacket shall consist of a black, Polyvinyl Chloride (PVC) or Polyethylene (LDPE, LLDPE, MDPE and HDPE) compound suitable for exposure to sunlight.

Polyethylene jackets are preferred over PVC jackets due to PVC jackets undergoing some degradation after prolonged thermal cycling. In addition, Polyethylene jackets have the following advantages over PVC jackets:

- Much lower water vapor transmission rate
- Much lower water absorption
- Better physical, mechanical properties
- Improved toughness and abrasion resistance
- Wider use and installation temperature range
- Better environmental stress crack resistance
- Lighter weight
- Extends cable life effectively, and thus lowers overall cable-life costs

Unless specifically excluded by the purchaser, to verify the integrity of the outer jacket, a continuous graphite coating or extruded semi-conducting layer will be applied over the jacket to form an electrode for Production Tests, dc testing during installation, and for periodic maintenance testing after commissioning.

3. Manufacturing



3.1 Processing of XLPE Insulation

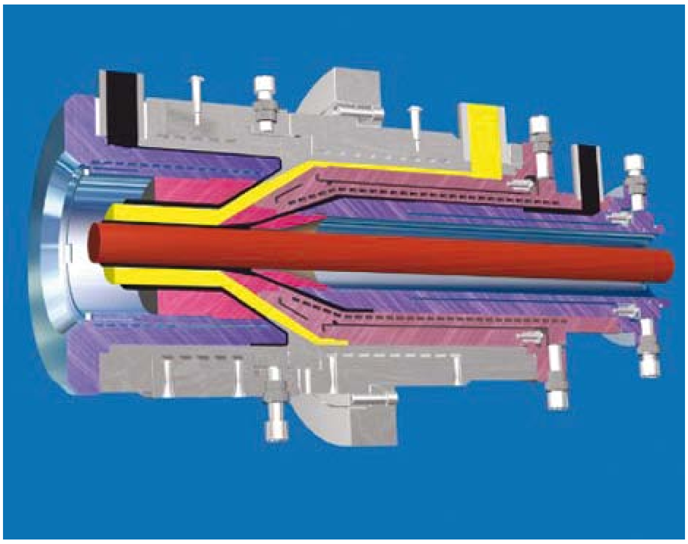
Manufacturing of XLPE high and extra-high voltage cables basically comprises four fabrication stages:
(1) Conductor manufacturing (wire drawing and stranding); (2) Core manufacturing (insulation layer extrusion and cross-linking); (3) Conditioning (degassing of gaseous reaction products); (4) Sheathing, with core screening taking place beforehand.

Without doubt, the most important manufacturing phase of these individual stages with regard to the electrical characteristics of the cable is core manufacturing. In other words, the key process in XLPE cable manufacture is the extrusion of the insulation system. This operation is carried out in a line which known as Continuous Vulcanizing Line (CV).

3.2 Triple Extrusion Process

Triple Extrusion Head

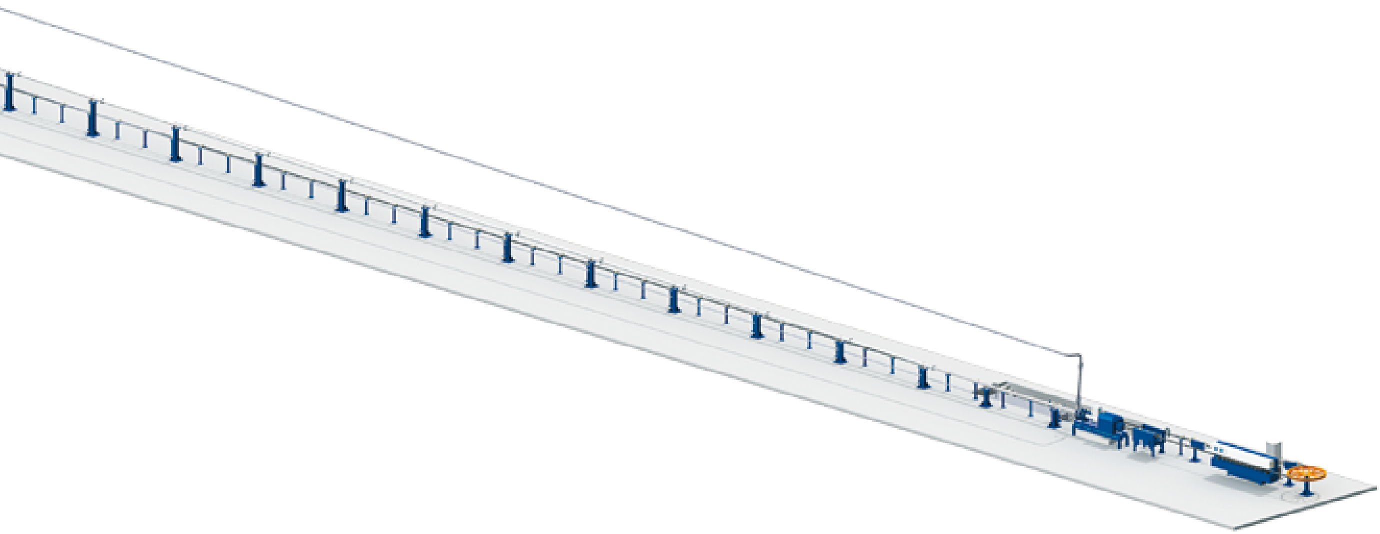
The interface between the insulation and the two screens is extremely important for the quality of the insulation system – the more so with increasing voltage levels. The interface must be smooth with a good bond between the layers. Even small protrusions may drastically reduce the electrical properties of the insulation system. The introduction of the triple extrusion tools together with optimal process control ensures smooth interface and thereby excellent electrical properties.



Material Handling

One of the most important quality criteria for XLPE insulation, when it is used in manufacturing of high and extra-high Voltage cables, is cleanliness.

Special attention is given to material handling, particularly as regards cleanliness and temperature during storage. A special super clean grade of material which is used to ensure the highest degree of purity, is fed to the extruders in a completely closed system.



3.3 CDCC System

Completely Dry Curing and Cooling Vulcanizing Method

We adopt CDCC system for vulcanizing XLPE insulation. CDCC system is a continuous vulcanizing and dry curing system using nitrogen gas. This system has been developed to produce high voltage and extra-high voltage cables and it shows excellent function to reduce faults and imperfections in the insulation.

In this system, extruded thermoplastic compounds are cured in the curing tube by thermal radiation through inert nitrogen gas; therefore there is no opportunity that the compounds can absorb any moisture during the vulcanization process. The insulated core may be cooled by water in the lower part of the tube as in case of medium voltage cables, but to obtain better quality in the absence of moisture, it is cooled by convection and radiation in a nitrogen gas atmosphere.

CDCC system is fully controlled by computer, so that manufacturing conditions and temperatures are controlled perfectly. This means that the quality of the insulation is uniform throughout the cross-section and the length of the manufactured cable. The whole process of this system is perfectly protected from outer atmosphere to prevent the insulation compounds and the insulated core from any contact with moistures, dust, contaminated air, etc.

3.4 Advantage of CDCC System

Water Content

Compared with the case of steam cured cables in which a large amount of water due to the saturated steam remains in the insulation, for CDCC cable, only 100 to 200 ppm moisture is detected in the insulation. Comparison of water Content in XLPE cable is shown in the below Table.

Sample	Dry	Steam
Wt (%)	0.018	0.29

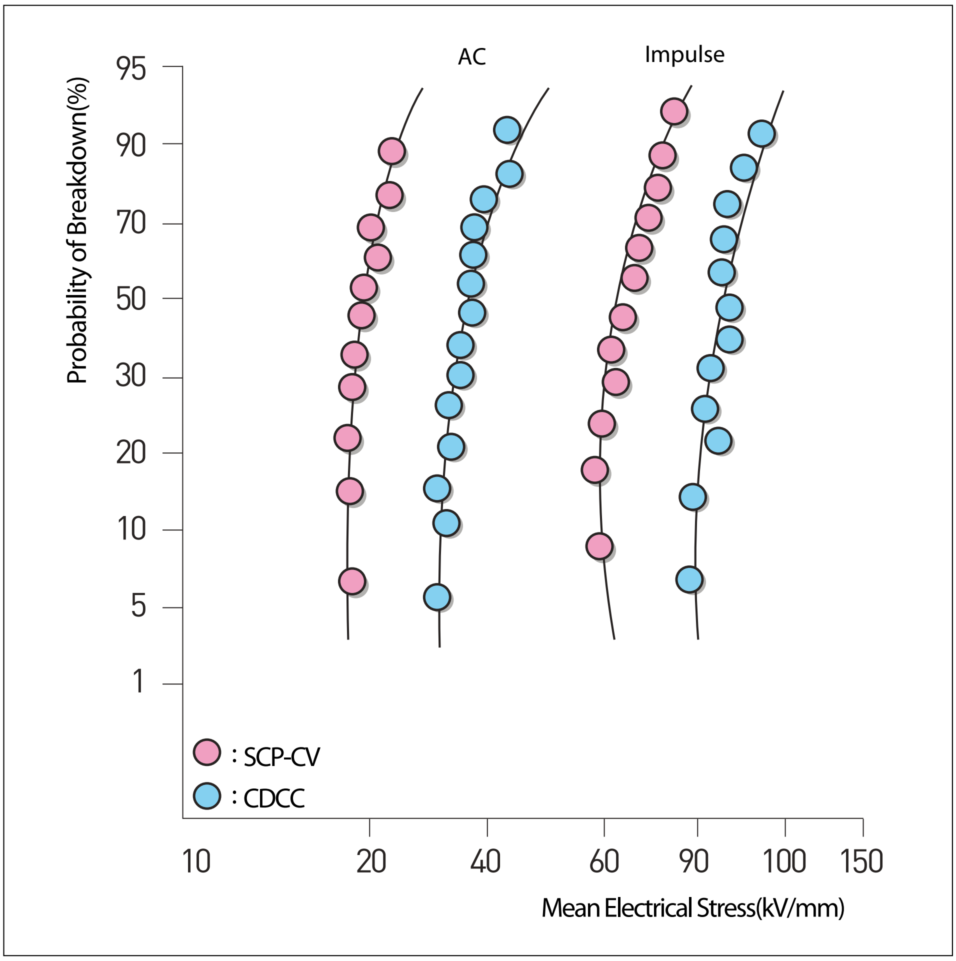
Micro-voids

The extremely small amount of residual water in dry cured insulation minimizes micro-voids. Comparison of voids in XLPE cable during curing process is shown in the below Table.

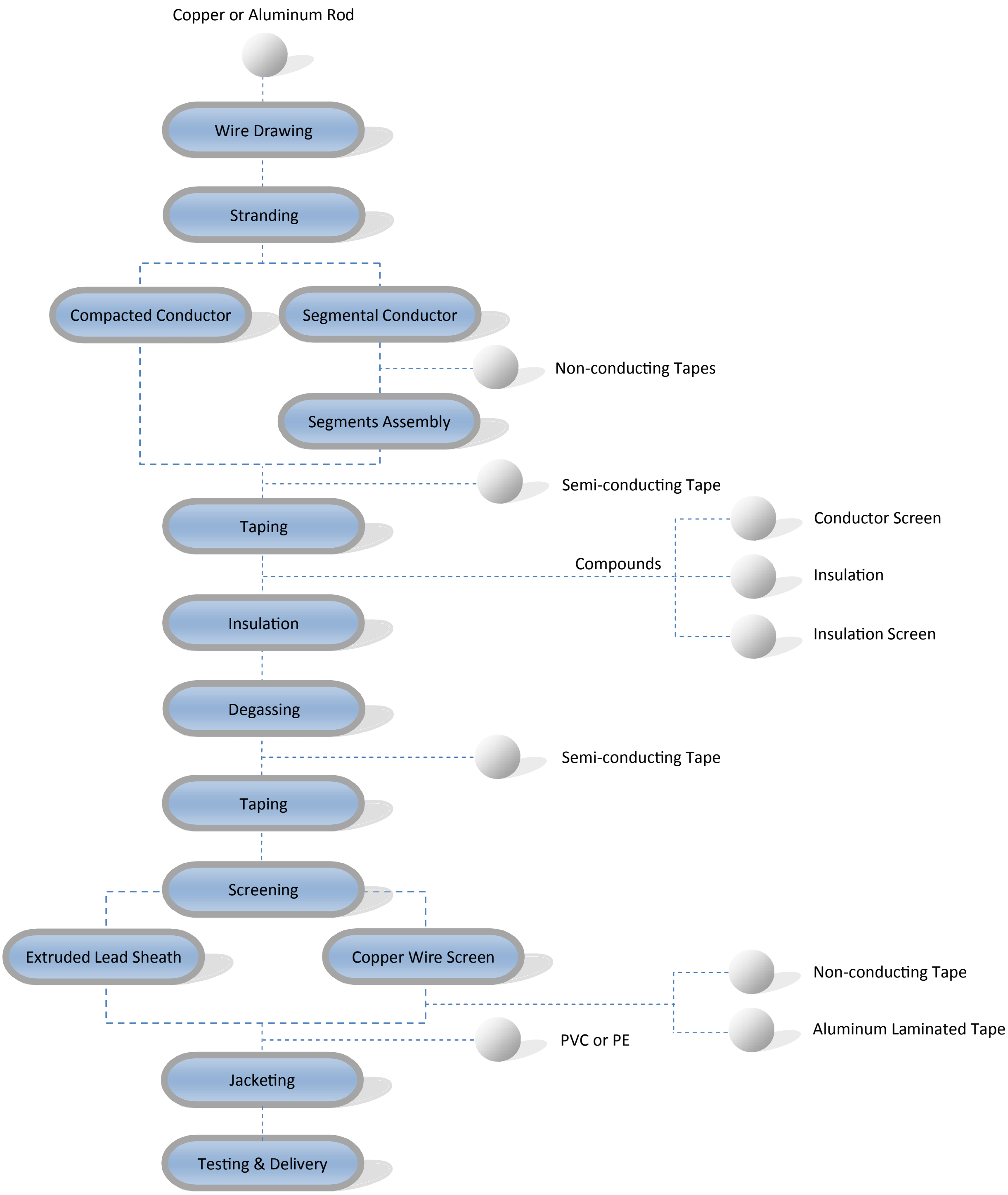
Curing Method	Voids			
	1~3 μm	4~5 μm	5~10 μm	>10 μm
Dry	120	3	0	0
Steam	>2,000	≈ 300	77	4

Electrical Strength

Both AC and impulse breakdown strengths have been remarkably improved for cables insulated using CDCC system when compared with that insulated using steam curing process. The facing figure shows the effect of different curing processes on the electrical behavior of the insulation under electrical stress.



3.5 Flow Chart



4. Testing

High voltage cable is one of the pillars of power transmission systems. Therefore, to ensure efficiency and reliability of the performance of high voltage cables is a fundamental requirement for ensuring the efficiency and reliability of the power transmission system as a whole.

To ensure the quality of our products of high voltage cables, we are not only focusing on the quality of the finished product, but it goes beyond that to include all the different manufacturing stages, starting from the inspection and selection of the finest raw materials, then through the different stages of the production of cable and ending with the performance of all tests required to ensure the conformity to all the requirements of international standards. All the materials and manufacturing processes are stringently controlled, tested and reported according to quality standards

At our plant the testing process of XLPE cables is subjected to the most stringent standards to ensure that our products meet the quality required for optimum problem free performance. In this respect our plant uses advanced state of the art testing equipment in a strict series of test processes to achieve the exacting quality standards.

5. Quality Assurance

5.1 Quality Management System

alfanar has established, documented and implemented the Quality Management System according to the ISO 9001:2008 standard. The management system covers the entire organizational structure of the Company, supporting the division of tasks, responsibilities and competences, and the breakdown of processes and resources, making it possible to maintain effective quality management. Our management system is certified by BASEC UK (British Approvals Services for Electric Cables), a specialist certification body in the cable industry.

alfanar strongly believes that the relentless pursuit of quality and continuous improvement are the only long-term route to success

Customer requirements are studied and care is taken to ensure that they are fulfilled through the provision of products that are in accordance with previously agreed specifications, of the highest quality, safe to use, reliable and delivered on time.

5.2 Health, Safety and Environment

Being a major manufacturer of power cables, alfanar recognizes the vital role it plays in the management of health and safety aspects in the workplace as well as protecting the environment. alfanar is therefore committed to the principles of risk reduction, pollution prevention and management of its operations as a responsible corporate member of society.

To achieve this policy, alfanar has developed an Environment, Health and Safety (EHS) management system certified to ISO14001 and OHSAS 18001 Standards. Through this system, alfanar endeavors to maintain comprehensive risk assessments, allowing it to evaluate health, safety and environmental (EHS) impacts and set clear objectives for improvements.

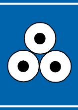
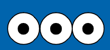
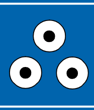
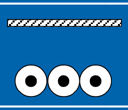
6. System Configuration

6.1 Choice of System Configuration

The term System Configuration refers to the arrangement of the three phases of a cable system relative to one another. The main distinction is between a flat formation and a trefoil layout; with both of these systems, the distance between the axes of the phases, the type of cable sheath and, above all, the grounding conditions are of the utmost importance. The system configuration has an effect both on the current-dependant losses of cables through the proximity effect and on sheath voltage induction, as well as on the so-called electromagnetic interference with other underground lines and possibly on people or animals in the vicinity of the cable system. To some extent the dissipation from the cable system also depend on its configuration.

The effects operate to a certain extent in opposition to one another, i.e. a configuration that has a positive effect on the sheath losses or electromagnetic interference can prove to be unfavorable in terms of current displacement and/or heat dissipation, and vice versa. The below table shows the effect of different system configurations on the following four operational characteristics of a cable system:

- Conductor losses through the proximity effect
- Sheath losses through induction current
- Heat dissipation into the surrounding soil
- Electromagnetic interference of the surrounding environment

Configuration Change			Effect on proximity effect	Effect on sheath losses	Effect on heat dissipation	Effect on interference
	Instead of		Unfavorable	Favorable	Unfavorable	Favorable
	Instead of		Favorable	Unfavorable	Favorable	Favorable
	Instead of		None	None	Indifferent	Favorable
Both end bonding	Instead of	Single point bonding	None	Unfavorable	None	Favorable
Cross bonding	Instead of	Both end bonding	None	Favorable	None	None

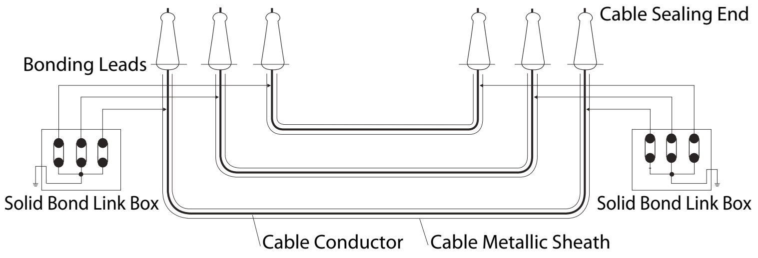
6.2 Metallic Screens Earthing

When an alternating current runs through the conductor of a cable, voltage that is proportional to the induction current, to the distance between phases and to the length of the line will be generated on the metallic screen. The end that is not earthed is subjected to an induced voltage that needs to be controlled.

Under normal operating conditions, this voltage may reach several tens of volts. Risks of electrocution can be prevented by using one of the following bonding methods.

Both Ends Bonding Method

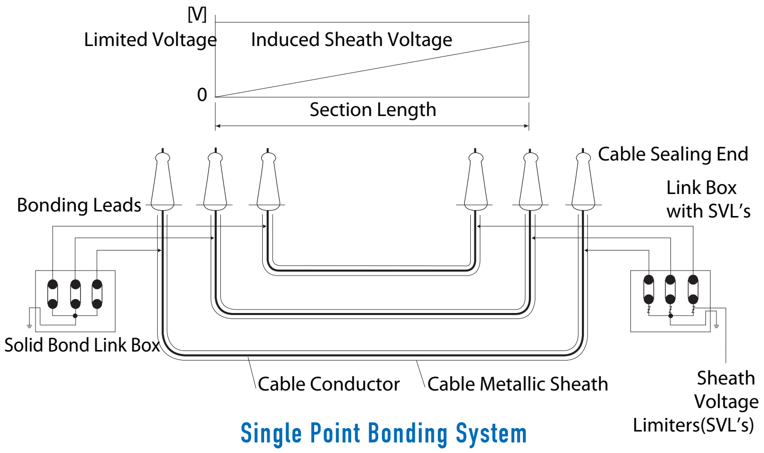
Both ends of the cable sheath are connected to the system earth. With this method no standing voltages occur at the cable ends, which makes it the most secure regarding safety aspects. On the other hand, circulating currents may flow in the sheath as the loop between the two earthing points is closed through the ground. These circulating currents are proportional to the conductor currents and therefore reduce the cable Ampacity significantly making it the most disadvantageous method regarding economic aspects.



Both Ends Bonding System

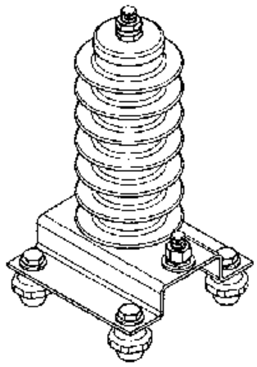
Single Point Bonding Method

One end of the cable sheath is connected to the system earth, so that at the other end (open end) the standing voltage appears, which is induced linearily along the cable length. In order to ensure the relevant safety requirements, the open end of the cable sheath has to be protected with a surge arrester (sheath voltage limiter SVL). In order to avoid potential lifting in case of a failure, both earth points have to be connected additionally with an earth continuity conductor (ECC).



Single Point Bonding System

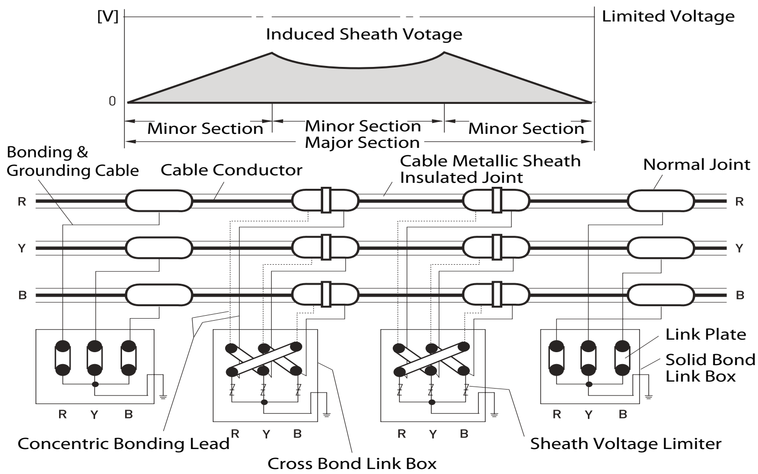
Sheath voltage limiters (SVL's) basically operate like non-linear electrical resistances. At low voltage (in the case of rated operating conditions), the sheath voltage limiters are extremely resistant and can be considered as non-conducting. In the event of lightening overvoltage or switching overvoltage, the sheath voltage limiters are subjected to extremely high voltage and become conducting and thus limit the voltage applied to the protective jacket. This limitation voltage is sometimes called flash-over voltage. It is important to ensure that, in the case of a short-circuit, the induction voltage in the screen is not higher than the flash-over voltage of the sheath voltage limiter. This final criteria determines the type of sheath voltage limiter to be used for a given power line.



Sheath Voltage Limiter (SVL)

Cross Bonding Method

Cross bonding single-conductor cables attempts to neutralize the total induced voltage in the cable sheaths to minimize the circulating current and losses in the cable sheaths, while permitting increased cable spacing and longer runs of cable lengths. Increasing cable spacing increases the thermal independence of each cable, thereby increasing its current-carrying capacity.



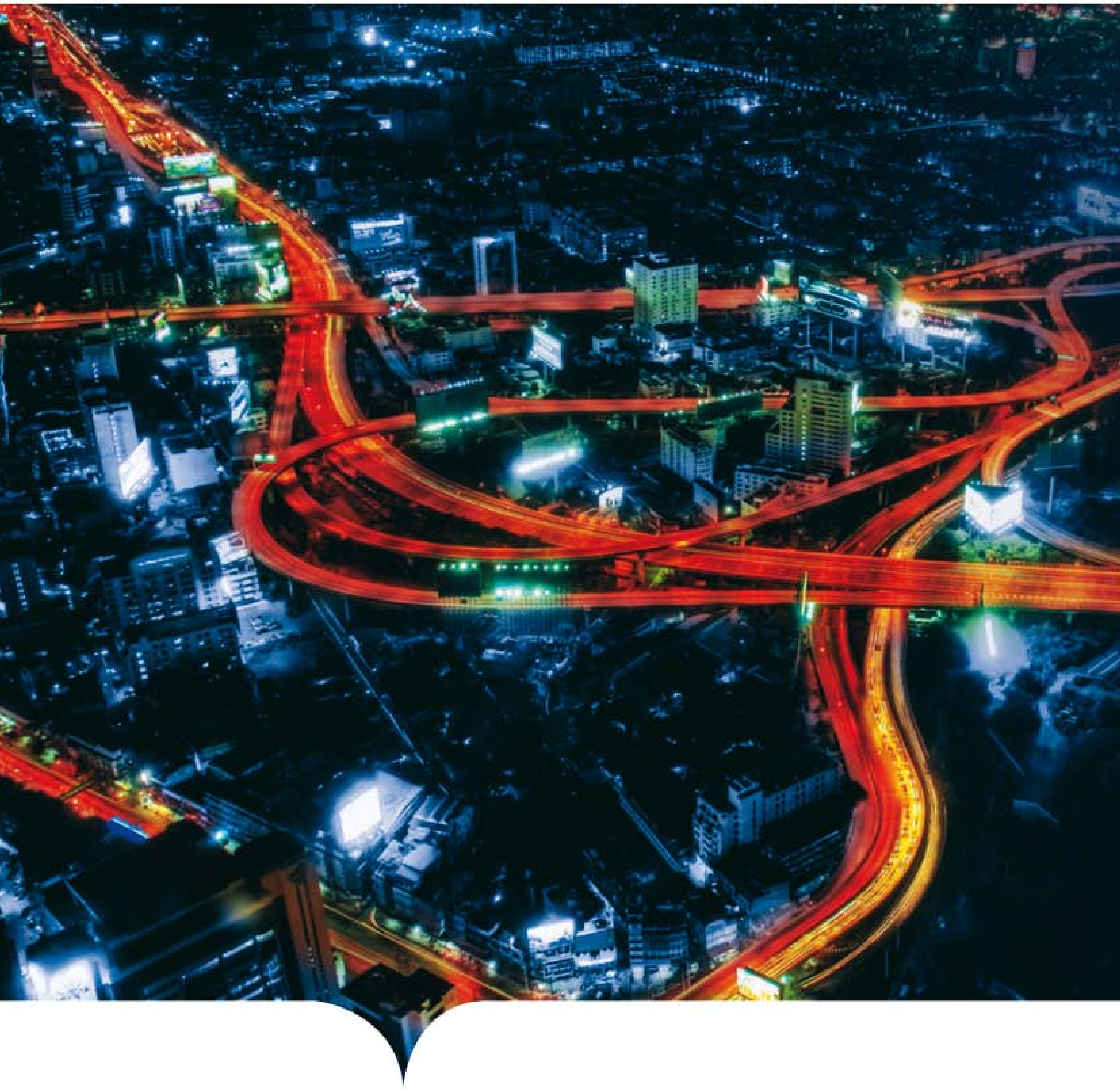
Cross-Bonding System

The most basic form of cross bonding consists of sectionalizing the cable into three minor sections of equal length and cross-connecting the sheaths at each minor section. Three minor cable sections form a major section. The sheaths are then bonded and grounded at the beginning and end of each major section. It is not possible to achieve a complete balance of induced voltages in the cable sheaths if the cables are not either transposed or laid in trefoil configuration. For this reason, cables laid in a flat configuration are transposed at each minor section. This neutralizes the induced sheath voltages, assuming the three minor sections are identical.

Longer cable circuits may consist of a number of major sections in series. When the number of minor sections is divisible by three, the cable circuit can be arranged to consist of more than one major section. In such a case, the cable circuit could consist of either sectionalized cross bonding or continuous cross bonding. In the case of sectionalized cross bonding, the cables are transposed at each minor section, and the sheaths are bonded together and grounded at the junction of two major sections and at the beginning and end of the cable circuit. In the case of continuous cross bonding, the cables are preferably transposed at each minor section and the sheaths are cross-bonded at the end of each minor section throughout the whole cable route. The three cable sheaths are bonded and grounded at the two ends of the route only.

7. High Voltage XLPE Insulated Single Core Power Cables

7.1 Cables Designed Generally to IEC 60840 and IEC 62067



alfanar الفنار

38/66 (72.5) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, non-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 60 kV grade up to and including 69 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Area of Copper Wires(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm²	Ω / km	Ω / km	mm	mm	mm	μF / km	mm²	kA	mm	mm	kg / m
240 R	0.0754	0.0979	1.0	11.0	1.0	0.190	95	15.3	3.5	57.1	5.03
300 R	0.0601	0.0789	1.0	11.0	1.0	0.205	95	15.3	3.5	59.5	5.71
400 R	0.0470	0.0629	1.0	11.0	1.0	0.222	95	15.3	3.5	62.1	6.61
500 R	0.0366	0.0505	1.0	11.0	1.0	0.245	95	15.3	4.0	66.5	7.94
630 R	0.0283	0.0411	1.0	11.0	1.0	0.268	95	15.3	4.0	70.0	9.32
800 R	0.0221	0.0343	1.0	11.0	1.0	0.293	95	15.3	4.0	74.0	11.22
1000 S	0.0176	0.0241	1.5	11.0	1.2	0.355	95	15.3	4.0	84.1	13.67
1200 S	0.0151	0.0212	1.5	11.0	1.2	0.381	95	15.3	4.5	89.1	15.86
1400 S	0.0129	0.0187	1.5	11.0	1.2	0.393	95	15.3	4.5	91.1	17.83
1600 S	0.0113	0.0170	1.5	11.0	1.2	0.419	95	15.3	4.5	95.1	19.51
2000 S	0.0090	0.0145	1.5	11.0	1.2	0.451	95	15.3	4.5	100.1	23.14

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)

Type of Sheath Bonding	Nominal Area mm²	Trefoil Formation: Buried Direct in Ground	Trefoil Formation: In Free Air (Shaded)	Type of Sheath Bonding	Nominal Area mm²	Flat Formation (2D Spaced): Buried Direct in Ground	Flat Formation (2D Spaced): In Free Air (Shaded)
Both end bonding(4)	240 R	386	572	Cross or single point bonding(5)	240 R	433	683
	300 R	428	648		300 R	490	785
	400 R	476	737		400 R	556	909
	500 R	526	835		500 R	631	1054
Cross or single point bonding(5)	630 R	664	1044		630 R	714	1218
	800 R	734	1180		800 R	798	1392
	1000 S	896	1497		1000 S	960	1742
	1200 S	964	1637		1200 S	1039	1912
	1400 S	1030	1765		1400 S	1118	2073
	1600 S	1091	1897		1600 S	1191	2245
	2000 S	1190	2107		2000 S	1315	2525

1. *Metallic screen cross-sectional area may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ℃
   b) Ambient ground temperature of 30 ℃
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

38/66 (72.5) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead sheath with suitable thickness to withstand the required earth fault current, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 60 kV grade up to and including 69 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Thickness of Lead Sheath(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm	kA	mm	mm	kg / m
240 R	0.0754	0.0979	1.0	11.0	1.0	0.190	2.1	7.6	3.5	56.9	7.54
300 R	0.0601	0.0789	1.0	11.0	1.0	0.205	2.2	8.4	3.5	59.5	8.58
400 R	0.0470	0.0629	1.0	11.0	1.0	0.222	2.3	9.2	3.5	62.3	9.87
500 R	0.0366	0.0505	1.0	11.0	1.0	0.245	2.3	9.8	4.0	66.7	11.47
630 R	0.0283	0.0410	1.0	11.0	1.0	0.268	2.4	10.8	4.0	70.4	13.35
800 R	0.0221	0.0343	1.0	11.0	1.0	0.293	2.5	12.0	4.0	74.6	15.82
1000 S	0.0176	0.0241	1.5	11.0	1.2	0.355	2.7	14.9	4.0	85.0	19.74
1200 S	0.0151	0.0212	1.5	11.0	1.2	0.381	2.8	16.3	4.5	90.2	22.61
1400 S	0.0129	0.0187	1.5	11.0	1.2	0.393	2.9	17.3	4.5	92.4	25.07
1600 S	0.0113	0.0169	1.5	11.0	1.2	0.419	3.0	18.7	4.5	96.6	27.47
2000 S	0.0090	0.0145	1.5	11.0	1.2	0.451	3.1	20.5	4.5	101.8	31.96

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area mm2	Trefoil Formation: Buried Direct in Ground	Trefoil Formation: In Free Air (Shaded)	Type of Sheath Bonding	Nominal Area mm2	Flat Formation (2D Spaced): Buried Direct in Ground	Flat Formation (2D Spaced): In Free Air (Shaded)
Both end bonding(4)	240 R	405	595	Cross or single point bonding(5)	240 R	433	687
	300 R	452	679		300 R	489	790
	400 R	508	777		400 R	555	914
	500 R	566	888		500 R	629	1059
Cross or single point bonding(5)	630 R	658	1043		630 R	711	1223
	800 R	724	1176		800 R	793	1397
	1000 S	870	1476		1000 S	948	1740
	1200 S	930	1605		1200 S	1022	1905
	1400 S	983	1717		1400 S	1094	2061
	1600 S	1030	1832		1600 S	1159	2224
	2000 S	1104	2009		2000S	1267	2485

1. *Thickness of lead sheath may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ℃
   b) Ambient ground temperature of 30 ℃
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

64/110 (123) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, non-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 110 kV grade up to and including 115 kV grade.

Constructional & Electrical Data												
Conductor			Insulation				Metallic Screen		Outer Jacket			
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers			Electro-static Capaci-tance	Nominal Area of Copper Wires(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight	
			Cond. Screen	XLPE	Ins. Screen							
mm²	Ω / km	Ω / km	mm	mm	mm	µF / km	mm²	kA	mm	mm	kg / m	
300 R	0.0601	0.0787	1.2	15.0	1.0	0.167	95	15.3	3.5	67.9	6.47	
400 R	0.0470	0.0627	1.2	15.0	1.0	0.180	95	15.3	3.5	70.5	7.41	
500 R	0.0366	0.0502	1.2	15.0	1.0	0.196	95	15.3	4.0	74.9	8.79	
630 R	0.0283	0.0407	1.2	15.0	1.0	0.213	95	15.3	4.0	78.4	10.21	
800 R	0.0221	0.0338	1.2	15.0	1.0	0.232	95	15.3	4.0	82.4	12.17	
1000 S	0.0176	0.0240	1.5	15.0	1.2	0.276	95	15.3	4.0	92.1	14.74	
1200 S	0.0151	0.0211	1.5	15.0	1.2	0.295	95	15.3	4.5	97.1	17.00	
1400 S	0.0129	0.0185	1.5	15.0	1.2	0.305	95	15.3	4.5	99.1	18.99	
1600 S	0.0113	0.0168	1.5	15.0	1.2	0.323	95	15.3	4.5	103.1	20.72	
2000 S	0.0090	0.0143	1.5	15.0	1.2	0.347	95	15.3	4.5	108.1	24.42	
2500 S	0.0072	0.0125	1.5	15.0	1.2	0.384	95	15.3	4.5	116.1	29.99	

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(4)	300 R	432	653	Cross or single point bonding(5)	300 R	490	771
	400 R	481	743		400 R	557	891
	500 R	533	843		500 R	633	1033
Cross or single point bonding(5)	630 R	668	1042		630 R	716	1193
	800 R	741	1178		800 R	801	1363
	1000 S	900	1485		1000 S	964	1700
	1200 S	970	1624		1200 S	1043	1865
	1400 S	1038	1751		1400 S	1122	2022
	1600 S	1100	1883		1600 S	1196	2188
	2000 S	1201	2094		2000 S	1320	2460
	2500 S	1302	2329		2500 S	1451	2776

1. *Metallic screen cross-sectional area may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

64/110 (123) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead sheath with suitable thickness to withstand the required earth fault current, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 110 kV grade up to and including 115 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electrostatic Capacitance	Nominal Thickness of Lead Sheath(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	µF / km	mm	kA	mm	mm	kg / m
300 R	0.0601	0.0787	1.2	15.0	1.0	0.167	2.4	10.6	3.5	68.3	10.40
400 R	0.0470	0.0627	1.2	15.0	1.0	0.180	2.5	11.5	3.5	71.1	11.78
500 R	0.0366	0.0502	1.2	15.0	1.0	0.196	2.6	12.6	4.0	75.7	13.70
630 R	0.0283	0.0406	1.2	15.0	1.0	0.213	2.7	13.8	4.0	79.4	15.70
800 R	0.0221	0.0338	1.2	15.0	1.0	0.232	2.8	15.1	4.0	83.6	18.29
1000 S	0.0176	0.0240	1.5	15.0	1.2	0.276	2.9	17.7	4.0	93.4	22.10
1200 S	0.0151	0.0210	1.5	15.0	1.2	0.295	3.0	19.2	4.5	98.6	25.09
1400 S	0.0129	0.0185	1.5	15.0	1.2	0.305	3.1	20.2	4.5	100.8	27.61
1600 S	0.0113	0.0168	1.5	15.0	1.2	0.323	3.2	21.8	4.5	105.0	30.12
2000 S	0.0090	0.0143	1.5	15.0	1.2	0.347	3.4	24.4	4.5	110.4	35.09
2500 S	0.0072	0.0125	1.5	15.0	1.2	0.384	3.6	27.8	4.5	118.8	42.39

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(4)	300 R	452	676	Cross or single point bonding(5)	300 R	490	775
	400 R	506	773		400 R	556	896
	500 R	564	882		500 R	634	1037
Cross or single point bonding(5)	630 R	660	1040		630 R	713	1197
	800 R	727	1172		800 R	795	1365
	1000 S	866	1456		1000 S	948	1694
	1200 S	924	1582		1200 S	1021	1854
	1400 S	980	1695		1400 S	1093	2005
	1600 S	1026	1808		1600 S	1158	2162
	2000 S	1097	1981		2000 S	1263	2414
	2500 S	1157	2161		2500 S	1366	2697

1. *Thickness of lead sheath may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

76/132 (145) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, non-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 132 kV grade up to and including 138 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electrostatic Capacitance	Nominal Area of Copper Wires(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
300 R	0.0601	0.0786	1.2	18.0	1.2	0.148	95	15.3	4.0	75.3	7.23
400 R	0.0470	0.0625	1.2	18.0	1.2	0.159	95	15.3	4.0	77.9	8.20
500 R	0.0366	0.0501	1.2	18.0	1.2	0.173	95	15.3	4.0	81.3	9.51
630 R	0.0283	0.0404	1.2	18.0	1.2	0.187	95	15.3	4.0	84.8	10.96
800 R	0.0221	0.0336	1.2	18.0	1.2	0.203	95	15.3	4.0	88.8	12.95
1000 S	0.0176	0.0239	1.5	18.0	1.2	0.240	95	15.3	4.0	98.1	15.55
1200 S	0.0151	0.0210	1.5	18.0	1.2	0.256	95	15.3	4.5	103.1	17.86
1400 S	0.0129	0.0184	1.5	18.0	1.2	0.264	95	15.3	4.5	105.1	19.86
1600 S	0.0113	0.0167	1.5	18.0	1.2	0.280	95	15.3	4.5	109.1	21.63
2000 S	0.0090	0.0142	1.5	18.0	1.2	0.299	95	15.3	4.5	114.1	25.37
2500 S	0.0072	0.0124	1.5	18.0	1.2	0.331	95	15.3	4.5	122.1	31.01

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(4)	300 R	434	653	Cross or single point bonding(5)	300 R	491	760
	400 R	484	743		400 R	558	878
	500 R	538	846		500 R	634	1018
Cross or single point bonding(5)	630 R	672	1039		630 R	718	1176
	800 R	746	1176		800 R	803	1342
	1000 S	903	1477		1000 S	965	1673
	1200 S	973	1614		1200 S	1045	1835
	1400 S	1043	1741		1400 S	1124	1989
	1600 S	1105	1872		1600 S	1198	2152
	2000 S	1208	2083		2000 S	1324	2419
	2500 S	1311	2318		2500 S	1455	2728

1. *Metallic screen cross-sectional area may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 °C
   b) Ambient ground temperature of 30 °C
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

76/132 (145) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead sheath with suitable thickness to withstand the required earth fault current, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 132 kV grade up to and including 138 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Thickness of Lead Sheath(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm	kA	mm	mm	kg / m
300 R	0.0601	0.0786	1.2	18.0	1.2	0.148	2.6	12.7	4.0	76.1	12.18
400 R	0.0470	0.0625	1.2	18.0	1.2	0.159	2.7	13.7	4.0	78.9	13.63
500 R	0.0366	0.0500	1.2	18.0	1.2	0.173	2.8	14.9	4.0	82.5	15.52
630 R	0.0283	0.0404	1.2	18.0	1.2	0.187	2.9	16.1	4.0	86.2	17.61
800 R	0.0221	0.0335	1.2	18.0	1.2	0.203	3.0	17.5	4.0	90.4	20.29
1000 S	0.0176	0.0239	1.5	18.0	1.2	0.240	3.1	20.2	4.0	99.8	24.17
1200 S	0.0151	0.0210	1.5	18.0	1.2	0.256	3.2	21.8	4.5	105.0	27.26
1400 S	0.0129	0.0184	1.5	18.0	1.2	0.264	3.3	22.9	4.5	107.2	29.83
1600 S	0.0113	0.0166	1.5	18.0	1.2	0.280	3.4	24.6	4.5	111.4	32.43
2000 S	0.0090	0.0142	1.5	18.0	1.2	0.299	3.6	27.3	4.5	116.8	37.53
2500 S	0.0072	0.0123	1.5	18.0	1.2	0.331	3.7	30.2	4.5	125.0	44.58

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings [3] (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding[4]	300 R	451	673	Cross or single point bonding[5]	300 R	491	763
	400 R	505	768		400 R	557	882
	500 R	562	877		500 R	632	1022
Cross or single point bonding[5]	630 R	661	1034		630 R	714	1179
	800 R	728	1165		800 R	796	1344
	1000 S	864	1443		1000 S	947	1666
	1200 S	921	1567		1200 S	1020	1822
	1400 S	975	1679		1400 S	1091	1970
	1600 S	1021	1791		1600 S	1155	2123
	2000 S	1091	1961		2000 S	1259	2369
	2500 S	1153	2142		2500 S	1363	2647

1. *Thickness of lead sheath may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 °C
   b) Ambient ground temperature of 30 °C
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. with induced current (circulating currents) in the metallic screen.*
5. *i.e. without induced current (circulating currents) in the metallic screen.*

127/220 (245) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, non-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar EHV Cables are designed and tested to meet or exceed the requirements of IEC 62067 standard.

alfanar EHV Cables are suitable for use in extra-high voltage transmission networks, in systems of rated voltages from 220 kV grade up to and including 230 kV grade.

Constructional & Electrical Data

Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electrostatic Capacitance	Nominal Area of Copper Wires(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
630 R	0.0283	0.0401	1.5	23.0	1.5	0.160	95	15.3	4.5	97.0	12.58
800 R	0.0221	0.0332	1.5	23.0	1.5	0.173	95	15.3	4.5	101.0	14.64
1000 S	0.0176	0.0238	1.5	23.0	1.5	0.200	95	15.3	4.5	109.7	17.30
1200 S	0.0151	0.0209	1.5	23.0	1.5	0.213	95	15.3	5.0	114.7	19.69
1400 S	0.0129	0.0183	1.5	23.0	1.5	0.219	95	15.3	5.0	116.7	21.73
1600 S	0.0113	0.0165	1.5	23.0	1.5	0.231	95	15.3	5.0	120.7	23.57
2000 S	0.0090	0.0140	1.5	23.0	1.5	0.247	95	15.3	5.0	125.7	27.40
2500 S	0.0072	0.0122	1.5	23.0	1.5	0.272	95	15.3	5.0	133.7	33.17

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Cross or single point bonding(4)	630 R	660	1023	Cross or single point bonding(4)	630 R	705	1140
	800 R	733	1158		800 R	789	1300
	1000 S	881	1446		1000 S	944	1617
	1200 S	948	1580		1200 S	1021	1773
	1400 S	1016	1705		1400 S	1098	1921
	1600 S	1076	1834		1600 S	1169	2077
	2000 S	1178	2041		2000 S	1290	2333
	2500 S	1277	2273		2500 S	1416	2628

1. *Metallic screen cross-sectional area may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ℃
   b) Ambient ground temperature of 30 ℃
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. without induced current (circulating currents) in the metallic screen.*

127/220 (245) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead sheath with suitable thickness to withstand the required earth fault current, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar EHV Cables are designed and tested to meet or exceed the requirements of IEC 62067 standard.

alfanar EHV Cables are suitable for use in extra-high voltage transmission networks, in systems of rated voltages from 220 kV grade up to and including 230 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Thickness of Lead Sheath(1)	Short Circuit Capacity (1 Sec.)(2)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm	kA	mm	mm	kg / m
630 R	0.0283	0.0401	1.5	23.0	1.5	0.160	3.2	20.4	4.5	99.0	21.31
800 R	0.0221	0.0331	1.5	23.0	1.5	0.173	3.3	22.0	4.5	103.2	24.15
1000 S	0.0176	0.0238	1.5	23.0	1.5	0.200	3.4	24.8	4.5	112.0	28.17
1200 S	0.0151	0.0208	1.5	23.0	1.5	0.213	3.5	26.5	5.0	117.2	31.42
1400 S	0.0129	0.0183	1.5	23.0	1.5	0.219	3.6	27.7	5.0	119.4	34.09
1600 S	0.0113	0.0165	1.5	23.0	1.5	0.231	3.7	29.6	5.0	123.6	36.84
2000 S	0.0090	0.0140	1.5	23.0	1.5	0.247	3.9	32.5	5.0	129.0	42.16
2500 S	0.0072	0.0121	1.5	23.0	1.5	0.272	4.1	36.5	5.0	137.4	49.93

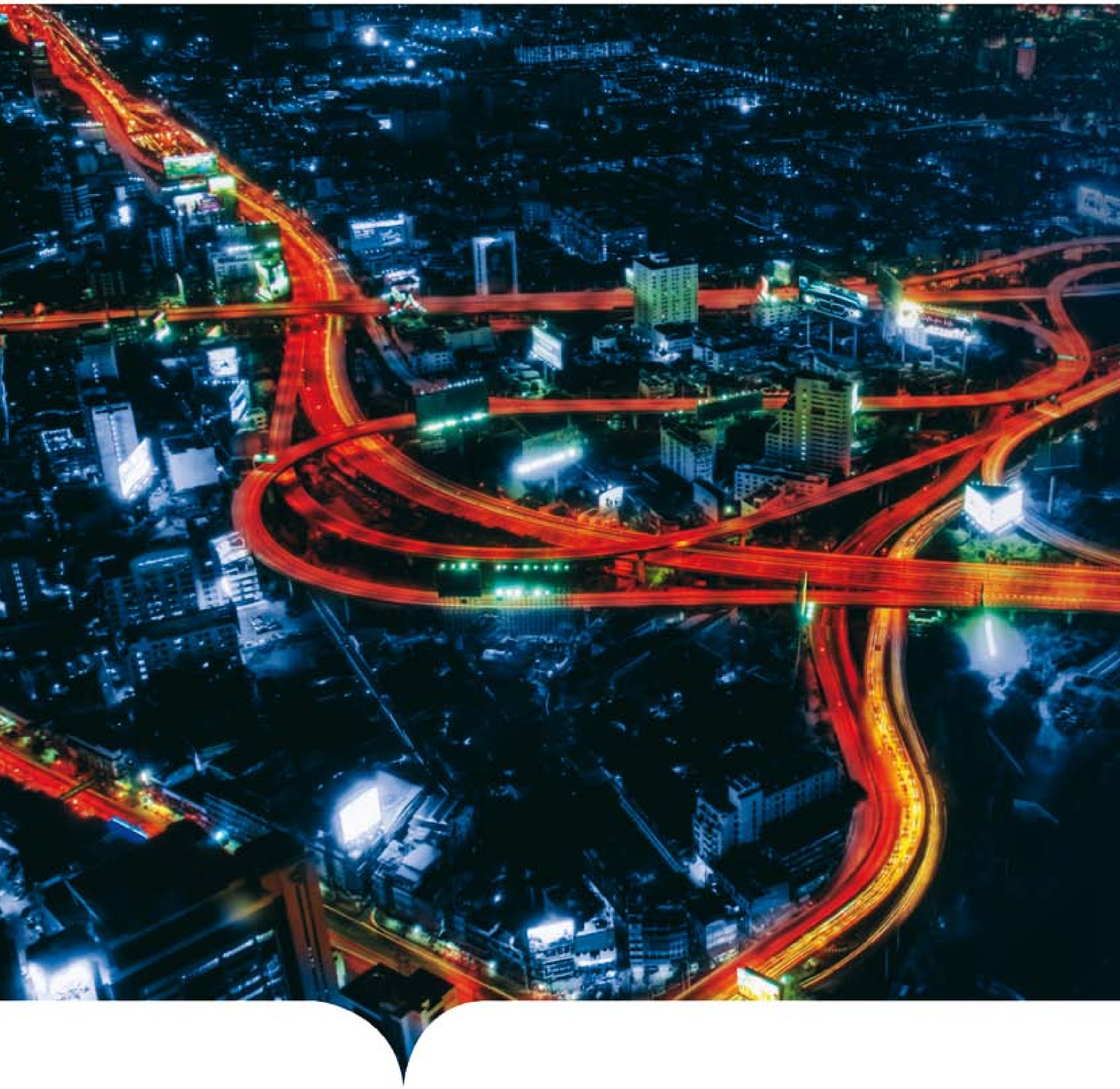
R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (3) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Cross or single point bonding(4)	630 R	645	1015	Cross or single point bonding(4)	630 R	700	1141
	800 R	710	1144		800 R	779	1299
	1000 S	835	1408		1000 S	923	1608
	1200 S	888	1528		1200 S	992	1757
	1400 S	940	1636		1400 S	1059	1898
	1600 S	981	1744		1600 S	1120	2044
	2000 S	1046	1909		2000 S	1219	2279
	2500 S	1099	2081		2500 S	1311	2541

1. *Thickness of lead sheath may vary according to the required short-circuit current.*
2. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
3. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ℃
   b) Ambient ground temperature of 30 ℃
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
4. *i.e. without induced current (circulating currents) in the metallic screen.*

7. High Voltage XLPE Insulated Single Core Power Cables

7.2 Cables Designed Generally to National Grid Company Specifications (11-TMSS-01 and 11-TMSS-02)



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40/69 (72.5) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, semi-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-01.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 60 kV grade up to and including 69 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Area of Copper Wires	Short Circuit Capacity (1 Sec.)(1)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
240 R	0.0754	0.0977	1.0	16.5	1.75	0.144	305	40.0	3.95	72.7	8.30
300 R	0.0601	0.0786	1.0	16.5	1.75	0.155	305	40.0	3.95	75.1	9.02
400 R	0.0470	0.0625	1.0	16.5	1.75	0.167	305	40.0	3.95	77.7	9.98
500 R	0.0366	0.0501	1.0	16.5	1.75	0.182	305	40.0	3.95	81.1	11.27
630 R	0.0283	0.0404	1.0	16.5	1.75	0.197	305	40.0	3.95	84.6	12.72
800 R	0.0221	0.0336	1.0	16.5	1.75	0.215	305	40.0	3.95	88.6	14.70
1000 S	0.0176	0.0239	1.5	16.5	1.75	0.257	305	40.0	3.95	97.7	17.28
1200 S	0.0151	0.0210	1.5	16.5	1.75	0.274	305	40.0	3.95	101.7	19.42
1400 S	0.0129	0.0185	1.5	16.5	1.75	0.282	305	40.0	3.95	103.7	21.42
1600 S	0.0113	0.0167	1.5	16.5	1.75	0.300	305	40.0	3.95	107.7	23.17
2000 S	0.0090	0.0142	1.5	16.5	1.75	0.321	305	40.0	3.95	112.7	26.89

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(3)	240 R	371	560	Cross or single point bonding(4)	240 R	437	668
	300 R	407	631		300 R	493	767
	400 R	447	710		400 R	560	887
	500 R	489	799		500 R	637	1029
Cross or single point bonding(4)	630 R	674	1048		630 R	720	1188
	800 R	748	1186		800 R	806	1357
	1000 S	904	1486		1000 S	967	1688
	1200 S	974	1626		1200 S	1046	1856
	1400 S	1043	1754		1400 S	1125	2012
	1600 S	1105	1887		1600 S	1200	2177
	2000 S	1208	2099		2000 S	1325	2447

1. *Maximum permissible short circuit current as per ICEA P-45-482.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit.
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

40/69 (72.5) kV Aluminum Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted aluminum conductor, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, semi-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-01.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 60 kV grade up to and including 69 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Area of Copper Wires	Short Circuit Capacity (1 Sec.)(1)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
240 R	0.1250	0.1612	1.0	16.5	1.75	0.144	305	40.0	3.95	72.7	6.82
300 R	0.1000	0.1294	1.0	16.5	1.75	0.155	305	40.0	3.95	75.1	7.16
400 R	0.0778	0.1014	1.0	16.5	1.75	0.167	305	40.0	3.95	77.7	7.59
500 R	0.0605	0.0797	1.0	16.5	1.75	0.182	305	40.0	3.95	81.1	8.14
630 R	0.0469	0.0630	1.0	16.5	1.75	0.197	305	40.0	3.95	84.6	8.79
800 R	0.0367	0.0508	1.0	16.5	1.75	0.215	305	40.0	3.95	88.6	9.60
1000 S	0.0291	0.0382	1.5	16.5	1.75	0.257	305	40.0	3.95	97.7	10.97
1200 S	0.0247	0.0328	1.5	16.5	1.75	0.274	305	40.0	3.95	101.7	11.82
1400 S	0.0212	0.0285	1.5	16.5	1.75	0.282	305	40.0	3.95	103.7	12.52
1600 S	0.0186	0.0254	1.5	16.5	1.75	0.300	305	40.0	3.95	107.7	13.36
2000 S	0.0149	0.0210	1.5	16.5	1.75	0.321	305	40.0	3.95	112.7	14.86

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)							
Type of Sheath Bonding	Nominal Area mm²	Trefoil Formation: Buried Direct in Ground	Trefoil Formation: In Free Air (Shaded)	Type of Sheath Bonding	Nominal Area mm²	Flat Formation (2D Spaced): Buried Direct in Ground	Flat Formation (2D Spaced): In Free Air (Shaded)
Both end bonding(3)	240 R	301	448	Cross or single point bonding(4)	240 R	340	520
	300 R	334	508		300 R	384	597
	400 R	372	580		400 R	439	695
	500 R	414	663		500 R	503	812
Cross or single point bonding(4)	630 R	540	840		630 R	573	946
	800 R	608	965		800 R	649	1094
	1000 S	719	1181		1000 S	765	1335
	1200 S	785	1310		1200 S	837	1485
	1400 S	847	1425		1400 S	906	1620
	1600 S	907	1548		1600 S	974	1767
	2000 S	1010	1755		2000 S	1093	2018

1. *Maximum permissible short circuit current as per ICEA P-45-482.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

64/110 (123) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, semi-conductive swelling tape, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, semi-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-02.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 110 kV grade up to and including 115 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electrostatic Capacitance	Nominal Area of Copper Wires	Short Circuit Capacity (1 Sec.)(1)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
300 R	0.0601	0.0785	1.2	20.32	1.75	0.139	280	40.0	3.95	82.9	9.69
400 R	0.0470	0.0624	1.2	20.32	1.75	0.149	280	40.0	3.95	85.5	10.67
500 R	0.0366	0.0499	1.2	20.32	1.75	0.161	280	40.0	3.95	88.9	12.01
630 R	0.0283	0.0402	1.2	20.32	1.75	0.174	280	40.0	3.95	92.5	13.50
800 R	0.0221	0.0333	1.2	20.32	1.75	0.188	280	40.0	3.95	96.4	15.52
1000 S	0.0176	0.0239	1.5	20.32	1.75	0.219	280	40.0	3.95	105.1	18.15
1200 S	0.0151	0.0209	1.5	20.32	1.75	0.233	280	40.0	3.95	109.1	20.34
1400 S	0.0129	0.0184	1.5	20.32	1.75	0.240	280	40.0	3.95	111.1	22.36
1600 S	0.0113	0.0166	1.5	20.32	1.75	0.254	280	40.0	3.95	115.1	24.15
2000 S	0.0090	0.0141	1.5	20.32	1.75	0.272	280	40.0	3.95	120.1	27.93
2500 S	0.0072	0.0123	1.5	20.32	1.75	0.300	280	40.0	3.95	128.1	33.62

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(3)	300 R	411	632	Cross or single point bonding(4)	300 R	493	754
	400 R	453	714		400 R	560	871
	500 R	495	805		500 R	637	1010
Cross or single point bonding(4)	630 R	675	1040		630 R	721	1165
	800 R	750	1177		800 R	807	1330
	1000 S	907	1473		1000 S	969	1655
	1200 S	977	1611		1200 S	1048	1819
	1400 S	1047	1739		1400 S	1128	1971
	1600 S	1111	1871		1600 S	1203	2132
	2000 S	1215	2082		2000 S	1329	2396
	2500 S	1320	2318		2500 S	1461	2701

1. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

64/110 (123) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, semi-conductive swelling tape, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead alloy sheath with suitable thickness to withstand the required earth fault current, semi-conductive swelling tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-02.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 110 kV grade up to and including 115 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electrostatic Capacitance	Nominal Thickness of Lead Sheath	Short Circuit Capacity (1 Sec.)(1)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm	kA	mm	mm	kg / m
300 R	0.0601	0.0785	1.2	20.32	1.75	0.139	6.8	40.0	3.95	91.6	25.29
400 R	0.0470	0.0623	1.2	20.32	1.75	0.149	6.6	40.0	3.95	93.8	26.29
500 R	0.0366	0.0498	1.2	20.32	1.75	0.161	6.3	40.0	3.95	96.6	27.47
630 R	0.0283	0.0401	1.2	20.32	1.75	0.174	6.1	40.0	3.95	99.7	29.10
800 R	0.0221	0.0331	1.2	20.32	1.75	0.188	5.8	40.0	3.95	103.1	30.96
1000 S	0.0176	0.0238	1.5	20.32	1.75	0.219	5.3	40.0	3.95	110.8	33.54
1200 S	0.0151	0.0209	1.5	20.32	1.75	0.233	5.1	40.0	3.95	114.4	35.71
1400 S	0.0129	0.0183	1.5	20.32	1.75	0.240	5.0	40.0	3.95	116.2	37.70
1600 S	0.0113	0.0165	1.5	20.32	1.75	0.254	4.8	40.0	3.95	119.8	39.41
2000 S	0.0090	0.0140	1.5	20.32	1.75	0.272	4.6	40.0	3.95	124.4	43.20
2500 S	0.0072	0.0122	1.5	20.32	1.75	0.300	4.3	40.0	3.95	131.8	48.87

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm²	Buried Direct in Ground	In Free Air (Shaded)		mm²	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(3)	300 R	433	664	Cross or single point bonding(4)	300 R	495	763
	400 R	480	753		400 R	560	880
	500 R	531	853		500 R	634	1017
Cross or single point bonding(4)	630 R	652	1032		630 R	713	1170
	800 R	718	1159		800 R	794	1330
	1000 S	843	1420		1000 S	939	1639
	1200 S	897	1539		1200 S	1009	1793
	1400 S	949	1647		1400 S	1078	1936
	1600 S	995	1756		1600 S	1141	2084
	2000 S	1066	1925		2000 S	1245	2324
	2500 S	1134	2108		2500 S	1350	2596

1. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

76/132 (145) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, semi-conductive swelling tape, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, semi-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-02.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 132 kV grade up to and including 138 kV grade

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resistance at 20 °C	Max. AC Resistance at 90 °C	Nominal Thickness of Insulation Layers			Electrostatic Capacitance	Nominal Area of Copper Wires	Short Circuit Capacity (1 Sec.)(1)	Nominal Thickness	Approx. Overall Diameter	Approx. Overall Weight
			Cond. Screen	XLPE	Ins. Screen						
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
300 R	0.0601	0.0785	1.2	21.6	1.75	0.134	280	40.0	3.95	85.5	9.99
400 R	0.0470	0.0624	1.2	21.6	1.75	0.143	280	40.0	3.95	88.1	10.99
500 R	0.0366	0.0499	1.2	21.6	1.75	0.155	280	40.0	3.95	91.5	12.33
630 R	0.0283	0.0402	1.2	21.6	1.75	0.167	280	40.0	3.95	95.0	13.84
800 R	0.0221	0.0333	1.2	21.6	1.75	0.180	280	40.0	3.95	99.0	15.88
1000 S	0.0176	0.0238	1.5	21.6	1.75	0.210	280	40.0	3.95	107.7	18.54
1200 S	0.0151	0.0209	1.5	21.6	1.75	0.223	280	40.0	3.95	111.7	20.74
1400 S	0.0129	0.0183	1.5	21.6	1.75	0.229	280	40.0	3.95	113.7	22.76
1600 S	0.0113	0.0166	1.5	21.6	1.75	0.243	280	40.0	3.95	117.7	24.58
2000 S	0.0090	0.0141	1.5	21.6	1.75	0.259	280	40.0	3.95	122.7	28.37
2500 S	0.0072	0.0122	1.5	21.6	1.75	0.285	280	40.0	3.95	130.7	34.10

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)								
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(3)	300 R	412	633	Cross or single point bonding(4)	300 R	493	751
	400 R	454	715		400 R	561	867
	500 R	497	806		500 R	637	1004
Cross or single point bonding(4)	630 R	676	1038		630 R	722	1159
	800 R	752	1175		800 R	808	1323
	1000 S	908	1469		1000 S	970	1645
	1200 S	978	1607		1200 S	1049	1807
	1400 S	1049	1735		1400 S	1129	1959
	1600 S	1112	1866		1600 S	1204	2118
	2000 S	1218	2077		2000 S	1330	2380
	2500 S	1323	2312		2500 S	1463	2682

1. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

76/132 (145) kV Copper Conductor with Lead Sheath

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, semi-conductive swelling tape, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, extruded lead alloy sheath with suitable thickness to withstand the required earth fault current, semi-conductive swelling tape, extruded layer of PE compound as an outer jacket and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar HV Cables are designed and tested to meet or exceed the requirements of IEC 60840 standard and National Grid Company (NGC) Specification 11-TMSS-02.

alfanar HV Cables are suitable for use in high voltage transmission networks, in systems of rated voltages from 132 kV grade up to and including 138 kV grade.

Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	XLPE	Ins. Screen	Electro-static Capaci-tance	Nominal Thickness of Lead Sheath	Short Circuit Capacity (1 Sec.)(1)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	µF / km	mm	kA	mm	mm	kg / m
300 R	0.0601	0.0785	1.2	21.6	1.75	0.134	6.6	40.0	3.95	93.7	25.60
400 R	0.0470	0.0623	1.2	21.6	1.75	0.143	6.4	40.0	3.95	95.9	26.58
500 R	0.0366	0.0497	1.2	21.6	1.75	0.155	6.1	40.0	3.95	98.7	27.72
630 R	0.0283	0.0400	1.2	21.6	1.75	0.167	5.9	40.0	3.95	101.9	29.32
800 R	0.0221	0.0331	1.2	21.6	1.75	0.180	5.6	40.0	3.95	105.2	31.14
1000 S	0.0176	0.0238	1.5	21.6	1.75	0.210	5.2	40.0	3.95	113.1	34.02
1200 S	0.0151	0.0208	1.5	21.6	1.75	0.223	5.0	40.0	3.95	116.7	36.18
1400 S	0.0129	0.0183	1.5	21.6	1.75	0.229	4.9	40.0	3.95	118.5	38.17
1600 S	0.0113	0.0165	1.5	21.6	1.75	0.243	4.7	40.0	3.95	122.1	39.86
2000 S	0.0090	0.0140	1.5	21.6	1.75	0.259	4.5	40.0	3.95	126.7	43.63
2500 S	0.0072	0.0122	1.5	21.6	1.75	0.285	4.2	40.0	3.95	134.1	49.27

R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings (2) (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Both end bonding(3)	300 R	433	662	Cross or single point bonding(4)	300 R	495	759
	400 R	481	751		400 R	560	874
	500 R	531	852		500 R	633	1010
Cross or single point bonding(4)	630 R	652	1028		630 R	713	1162
	800 R	718	1156		800 R	794	1321
	1000 S	842	1415		1000 S	968	1628
	1200 S	896	1534		1200 S	1043	1781
	1400 S	949	1642		1400 S	1115	1923
	1600 S	995	1751		1600 S	1181	2071
	2000 S	1067	1920		2000 S	1289	2309
	2500 S	1135	2104		2500 S	1400	2580

1. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 ºC
   b) Ambient ground temperature of 30 ºC
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. with induced current (circulating currents) in the metallic screen.*
4. *i.e. without induced current (circulating currents) in the metallic screen.*

133/230 (245) kV Copper Conductor with Copper Wire Screen

Cable Construction

Stranded circular or segmental (Milliken) compacted copper conductor, semi-conductive swelling tape, extruded semi-conducting layer as a conductor screen, XLPE insulation, extruded semi-conducting layer as an insulation screen, semi-conductive swelling tape, helically applied copper wires as a metallic screen, semi-conductive swelling tape, aluminum laminated tape, extruded layer of PE compound as an outer jacket and and graphite coating or extruded semi-conducting layer as electrode for DC voltage sheath testing.

alfanar EHV Cables are designed and tested to meet or exceed the requirements of IEC 62067 standard and National Grid Company (NGC) Specification 11-TMSS-02.

alfanar EHV Cables are suitable for use in extra-high voltage transmission networks, in systems of rated voltages from 220 kV grade up to and including 230 kV grade.

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Constructional & Electrical Data											
Conductor			Insulation				Metallic Screen		Outer Jacket		
Nominal Area	Max. DC Resis-tance at 20 °C	Max. AC Resis-tance at 90 °C	Nominal Thickness of Insulation Layers: Cond. Screen	Nominal Thickness of Insulation Layers: XLPE	Nominal Thickness of Insulation Layers: Ins. Screen	Electro-static Capaci-tance	Nominal Area of Copper Wires	Short Circuit Capacity (1 Sec.)(1)	Nominal Thick-ness	Approx. Overall Diameter	Approx. Overall Weight
mm^2	Ω / km	Ω / km	mm	mm	mm	μF / km	mm^2	kA	mm	mm	kg / m
630 R	0.0283	0.0400	1.5	24.0	2.0	0.157	448	63.0	3.95	102.1	16.29
800 R	0.0221	0.0331	1.5	24.0	2.0	0.169	448	63.0	3.95	106.1	18.36
1000 S	0.0176	0.0238	1.5	24.0	2.0	0.194	448	63.0	3.95	114.2	20.99
1200 S	0.0151	0.0208	1.5	24.0	2.0	0.206	448	63.0	3.95	118.2	23.23
1400 S	0.0129	0.0183	1.5	24.0	2.0	0.212	448	63.0	3.95	120.2	25.27
1600 S	0.0113	0.0165	1.5	24.0	2.0	0.224	448	63.0	3.95	124.2	27.11
2000 S	0.0090	0.0140	1.5	24.0	2.0	0.239	448	63.0	3.95	129.2	30.95
2500 S	0.0072	0.0121	1.5	24.0	2.0	0.263	448	63.0	3.95	137.2	36.73

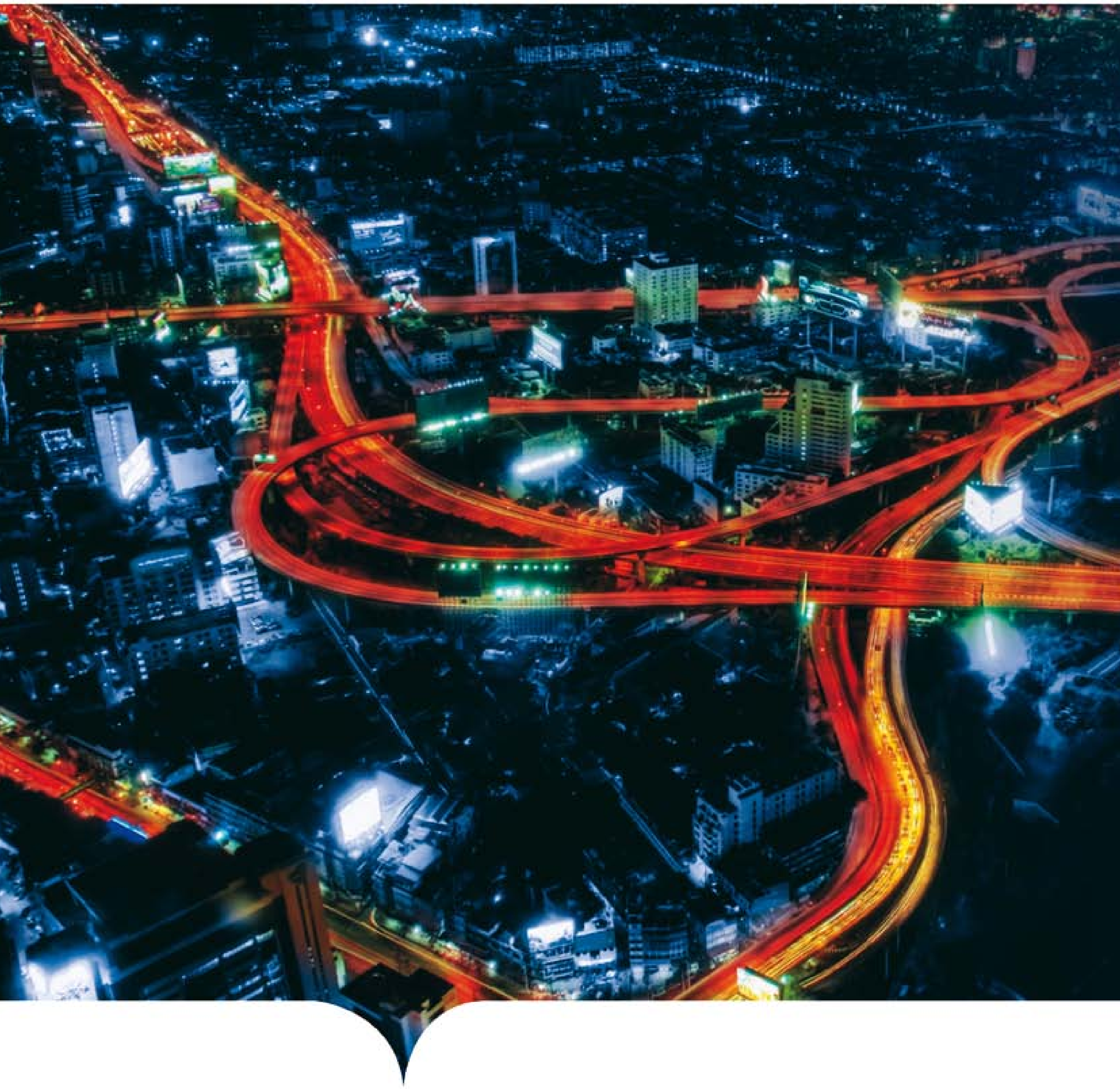
R: Circular Compacted, S: Segmental Compacted (Milliken),D: Distance between cables

Continuous Current Ratings [2] (Amperes)							
Type of Sheath Bonding	Nominal Area	Trefoil Formation		Type of Sheath Bonding	Nominal Area	Flat Formation (2D Spaced)	
	mm^2	Buried Direct in Ground	In Free Air (Shaded)		mm^2	Buried Direct in Ground	In Free Air (Shaded)
Cross or single point bonding[3]	630 R	662	1027	Cross or single point bonding[3]	630 R	708	1140
	800 R	735	1163		800 R	791	1301
	1000 S	883	1451		1000 S	947	1616
	1200 S	951	1586		1200 S	1023	1776
	1400 S	1018	1713		1400 S	1100	1924
	1600 S	1079	1842		1600 S	1172	2080
	2000 S	1181	2051		2000 S	1293	2336
	2500 S	1281	2284		2500 S	1419	2632

1. *Maximum permissible non-adiabatic short circuit current as per IEC 60949.*
2. *The continuous current ratings are calculated in accordance with IEC 60287 assuming the following laying conditions.*
   a) Ambient air temperature of 40 °C
   b) Ambient ground temperature of 30 °C
   c) Soil thermal resistivity of 1.5 K.m/W
   d) Depth of laying of 1.5 m
   e) Frequency of 60 Hz
   f) Load factor of 100%
   g) Single circuit
3. *i.e. without induced current (circulating currents) in the metallic screen.*

8. Technical Data

High Voltage Power Cables



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Annex A : Continuous Current Ratings

A.1 General

This annex deals solely with the steady-state continuous current ratings of High and Extra-high voltage single-core cables having extruded insulation. The tabulated current ratings provided in this catalogue have been calculated assuming single circuit with 100% load factor for cables having rated voltages and constructions as detailed for each relevant cable type.

The tabulated current ratings in this catalogue have been calculated using the methods set out in IEC 60287.

A.2 Cable constructions

The cables constructions and dimensions for which current ratings have been tabulated in this catalogue are based on those given in the constructional data for each cable type.

A.3 Temperatures

The maximum conductor temperature for which the tabulated current ratings have been calculated is 90 °C.

The reference ambient temperatures assumed are as follows:

– For cables in free air: 40 °C
– For cables buried direct in the ground: 30 °C

Derating factors for other ambient temperatures are given below in Tables A.1 and A.2.

The current ratings for cables in air do not take account of the increase, if any, due to solar or other infra-red radiation. Where the cables are subjected to such radiation, the current rating should be derived by the methods specified in IEC 60287.

Table A.1: Derating factors for ambient ground temperature

Max. Conductor temperature °C	Ambient ground temperature °C								
	10	15	20	25	30	35	40	45	50
90 °C	1.15	1.12	1.08	1.03	1.00	0.96	0.91	0.86	0.82

Table A.2: Derating factors for ambient air temperature

Max. Conductor temperature °C	Ambient air temperature °C								
	20	25	30	35	40	45	50	55	60
90 °C	1.19	1.14	1.10	1.05	1.00	0.96	0.90	0.84	0.78

A.4 Depth of laying

The tabulated current ratings in this catalogue for cables buried direct in the ground relate to a laying depth of 1.5 meter. Derating factors for other values of depth of laying are given below in Table A.3.

Table A.3: Derating factors for depth of laying

Derating factor	Depth of laying mt.										
	1.0	1.2	1.3	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	1.05	1.03	1.02	1.00	0.97	0.95	0.93	0.91	0.90	0.89	0.88

A.5 Soil thermal resistivity

The tabulated current ratings in this catalogue for cables laid direct in the ground relate to a soil thermal resistivity of 1.5 K.m/W. Information on the likely soil thermal resistivity in various countries is given in IEC 60287-3-1. Derating factors for other values of thermal resistivity are given below in Table A.4. It is assumed that the soil properties are uniform; no allowance has been made for the possibility of moisture migration, which can lead to a region of high thermal resistivity around the cable. If partial drying-out of the soil is foreseen, the permissible current rating should be derived by the methods specified in IEC 60287.

Table A.4: Derating factors for soil thermal resistivity

Derating factor	Soil thermal resistivity K.m/W							
	0.7	0.8	0.9	1.0	1.5	2.0	2.5	3.0
	1.37	1.3	1.24	1.19	1.00	0.88	0.79	0.73

Annex A : Continuous Current Ratings

A.6 Methods of installation

Current ratings are tabulated in this catalogue for cables installed in the following conditions.

A.6.1 Cables in free air

The cables are assumed to be spaced at least 0.5 times the cable diameter De from any vertical surface and installed on brackets or ladder racks as follows:

1. **Three cables in trefoil formation touching throughout their length Fig. (a).**
2. **Three cables in horizontal flat formation with axial spacing 2De Fig. (b).**

Fig. (a)

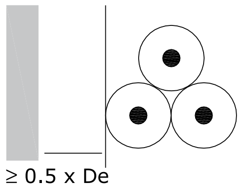
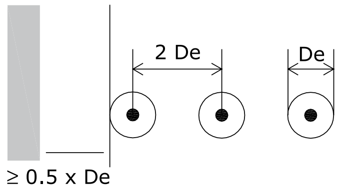


Fig. (b)



A.6.2 Cables buried direct in ground

Current ratings are given for cables buried direct in the ground at a depth of 1.5 m under the following conditions:

1. **Three cables in trefoil formation touching throughout their length Fig. (c).**
2. **Three cables in horizontal flat formation with axial spacing 2De Fig. (d).**

Fig. (c)

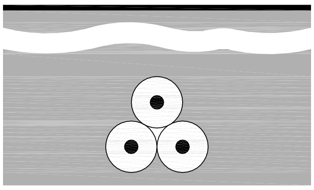
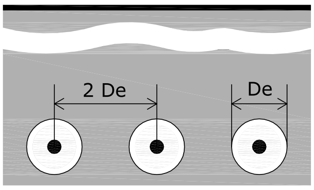


Fig. (d)



The cable depth is measured to the cable axis or to the centre of the trefoil group.

A.7 Cable loading

The tabulated ratings relate to circuits carrying a balanced three-phase load at a rated frequency of 60 Hz. However, the tabulated ratings can be safely used with circuits carrying a balanced three-phase load at a rated frequency of 50 Hz, where the continuous current rating values are slightly higher in case of rated frequency of 50 Hz.

Annex B : Short-circuit Capacity

B.1 Permissible short-circuit current

Short-circuit currents in an electric network are a result of the accidental connecting of one or more phase conductors, either together, or with ground. It happens frequently that the conductor size necessary for an installation is dictated by its ability to carry short-circuit current rather than sustained current. There are two types of short-circuit current:

a. Symmetrical short-circuits: (3-phase short-circuits) where the currents in the three phases form a balanced system. These currents therefore only circulate in the main conductors (cores) of the cables.

b. Asymmetrical short-circuits: (Zero-sequence short-circuits) result from an asymmetrical, i.e. unbalanced current system. Zero-sequence currents return via the ground and/or by the conductors that are electrically parallel to ground, i.e. ground conductors, metallic screens and the ground itself.

The short-circuit capacity of a current carrying component of a cable is determined by the following factors:

- The temperature prior to the short-circuit, generally taken to be that corresponding with the maximum conductor operating temperature under normal conditions
- The energy produced by the short-circuit, a function of both the magnitude and the duration of the current
- The limiting final temperature, generally determined by all materials in direct contact with the conducting component

In accordance with IEC 60949 standard, short-circuit ratings can be calculated using either:

a. The adiabatic method, which assumes that all of the heat generated remains trapped within the current car rying component.

b. The non-adiabatic method, which allows for heat transfer from the current carrying component to adjacent materials.

The short circuit-current ratings given below in Tables B.1 and B.2 are calculated in accordance with the following formula as given in IEC 60949, assuming adiabatic conditions (i.e. neglecting heat loss):

$$I_{AD} = \frac{K \times S}{\sqrt{t}} \sqrt{\mathrm{Ln}\left(\frac{\theta_f + \beta}{\theta_i + \beta}\right)}$$

Where,

I_{AD}	:	Permissible adiabatic short circuit current (A)
t	:	Duration of short circuit (seconds)
S	:	Cross-sectional area of the current-carrying component (mm^2)
K	:	Constant depending on the material of the current-carrying component ($As^{½} / mm^2$)
θ_i	:	Initial temperature before short circuit in (°C)
θ_f	:	Final temperature at short circuit in (°C)
β	:	Reciprocal of temperature coefficient of resistance of the current carrying component at 0 °C

Annex B : Short-circuit Capacity

Table B.1

Short-circuit current (kA) - Copper conductor - XLPE Insulated

Nominal area of conductor	Short-circuit duration Sec.									
mm^2	0.1	0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0
25	11.3	8.0	6.5	5.7	5.1	3.6	2.5	2.1	1.8	1.6
35	15.8	11.2	9.1	7.9	7.1	5.0	3.5	2.9	2.5	2.2
50	22.6	16.0	13.1	11.3	10.1	7.2	5.1	4.1	3.6	3.2
70	31.7	22.4	18.3	15.8	14.2	10.0	7.1	5.8	5.0	4.5
95	43.0	30.4	24.8	21.5	19.2	13.6	9.6	7.8	6.8	6.1
120	54.3	38.4	31.3	27.1	24.3	17.2	12.1	9.9	8.6	7.7
150	67.9	48.0	39.2	33.9	30.4	21.5	15.2	12.4	10.7	9.6
185	83.7	59.2	48.3	41.9	37.4	26.5	18.7	15.3	13.2	11.8
240	108.6	76.8	62.7	54.3	48.6	34.3	24.3	19.8	17.2	15.4
300	135.7	96.0	78.4	67.9	60.7	42.9	30.4	24.8	21.5	19.2
400	181.0	128.0	104.5	90.5	80.9	57.2	40.5	33.0	28.6	25.6
500	226.2	160.0	130.6	113.1	101.2	71.5	50.6	41.3	35.8	32.0
630	285.1	201.6	164.6	142.5	127.5	90.1	63.7	52.0	45.1	40.3
800	362.0	256.0	209.0	181.0	161.9	114.5	80.9	66.1	57.2	51.2
1000	452.5	319.9	261.2	226.2	202.4	143.1	101.2	82.6	71.5	64.0
1200	543.0	383.9	313.5	271.5	242.8	171.7	121.4	99.1	85.9	76.8
1400	633.5	447.9	365.7	316.7	283.3	200.3	141.6	115.7	100.2	89.6
1600	724.0	511.9	418.0	362.0	323.8	228.9	161.9	132.2	114.5	102.4
1800	814.4	575.9	470.2	407.2	364.2	257.6	182.1	148.7	128.8	115.2
2000	904.9	639.9	522.5	452.5	404.7	286.2	202.4	165.2	143.1	128.0
2500	1131.2	799.9	653.1	565.6	505.9	357.7	252.9	206.5	178.9	160.0

Table B.2

Short-circuit current (kA) - Aluminum conductor - XLPE Insulated

Nominal area of conductor	Short-circuit duration Sec.									
mm²	0.1	0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0
25	7.5	5.3	4.3	3.7	3.3	2.4	1.7	1.4	1.2	1.1
35	10.5	7.4	6.0	5.2	4.7	3.3	2.3	1.9	1.7	1.5
50	14.9	10.6	8.6	7.5	6.7	4.7	3.3	2.7	2.4	2.1
70	20.9	14.8	12.1	10.5	9.4	6.6	4.7	3.8	3.3	3.0
95	28.4	20.1	16.4	14.2	12.7	9.0	6.3	5.2	4.5	4.0
120	35.9	25.4	20.7	17.9	16.0	11.3	8.0	6.5	5.7	5.1
150	44.8	31.7	25.9	22.4	20.0	14.2	10.0	8.2	7.1	6.3
185	55.3	39.1	31.9	27.6	24.7	17.5	12.4	10.1	8.7	7.8
240	71.7	50.7	41.4	35.9	32.1	22.7	16.0	13.1	11.3	10.1
300	89.6	63.4	51.8	44.8	40.1	28.3	20.0	16.4	14.2	12.7
400	119.5	84.5	69.0	59.8	53.4	37.8	26.7	21.8	18.9	16.9
500	149.4	105.6	86.3	74.7	66.8	47.2	33.4	27.3	23.6	21.1
630	188.2	133.1	108.7	94.1	84.2	59.5	42.1	34.4	29.8	26.6
800	239.0	169.0	138.0	119.5	106.9	75.6	53.4	43.6	37.8	33.8
1000	298.8	211.3	172.5	149.4	133.6	94.5	66.8	54.6	47.2	42.3
1200	358.5	253.5	207.0	179.3	160.3	113.4	80.2	65.5	56.7	50.7
1400	418.3	295.8	241.5	209.1	187.1	132.3	93.5	76.4	66.1	59.2
1600	478.1	338.0	276.0	239.0	213.8	151.2	106.9	87.3	75.6	67.6
1800	537.8	380.3	310.5	268.9	240.5	170.1	120.3	98.2	85.0	76.1
2000	597.6	422.5	345.0	298.8	267.2	189.0	133.6	109.1	94.5	84.5
2500	747.0	528.2	431.3	373.5	334.1	236.2	167.0	136.4	118.1	105.6

Note 1: The short-circuit current ratings given in Tables B.1 and B.2 are the symmetrical currents which will cause the conductor temperature to rise from the normal operating value of 90 °C to the maximum short circuit temperature of 250 °C in the time stated, assuming adiabatic conditions (i.e. neglecting heat loss).
Note 2: The metallic screens short-circuit current ratings are calculated in accordance with IEC 60949 or ICEA P-45-482 (when required), and they are the asymmetrical currents which will cause the screen temperature to rise from the normal operating value to the maximum short-circuit temperature. The final temperature used in the calculation varies depending upon the nature of the screen material itself and also on the other materials in direct contact with the screen.

The screen constructions detailed in this catalogue represent the nationalized standard but can be tailored in size to meet the specific fault requirements of any operating system.

Annex C : Cable Installation

C.1 General

The quality of the cable system at the site depends mainly on cable laying work, and jointing and terminating works. The installation of high voltage cable system requires a staff of experienced engineers and teams of qualified jointers with specialised tools and equipment for the job.

C.2 Protection of the cable

To ensure long service life of the installation, the cable protection is dependent on the cable laying conditions. In general, cables should be installed in such a way as to avoid any mechanical aggression, both on laying and during its service life.

Corrosion is another factor that affects cable service life. Corrosion may be of chemical or electrochemical origin, or from sulphate reducing bacteria. In direct current supply areas, the presence of stray-currents can give rise to extremely violent and rapid corrosion.

Some structures such as pipe lines and ducts require particular precautions when installed near to a high voltage line. The terrain (coastal area, water table, mining area, for example) and such natural obstacles as tree roots may also present further constraints.

C.3 Choice of cable route

The first step when installing a new cable system is to define the route. In order to minimize the cost it is desirable to link the start and end points of the cable system by the shortest possible route. However, in the usual environment for high voltage and extra-high voltage cable runs, i.e. in cities or other densely populated areas, compromises generally need to be made in the pursuit of this goal since the shortest possible link (a straight line from the start point to the end point of the route) is usually impossible because of the strucatural obstacle.

Another factor that generally excludes the shortest route when planning a cable connection is the legal aspect in terms of property ownership; planners therefore favor the courses of public roads and paths, which very rarely enable the link to follow a straight line. Other factors that affecting the choice of the cable route can be summerized as follows:

- Width of the available land,
- Sub-soil conditions,
- Particular features (drains, bridges, etc.),
- Proximity of heat sources (other cables, district heating systems).

In addition, the location of the joint chambers must take into consideration:

- The maximum production lengths of cable,
- The maximum pulling lengths,
- The grounding technique used (cross-bonding).

Proximity of telecommunications cables (other than those included in the cable installation, whose protection is integrated) and hydro-carbon pipes must be avoided owing to the problems caused by induction.

C.4 Recommendations

C.4.1 Minimum installation bending radius

None of high or extra-high voltage cables should be bent during installation to a radius smaller than 20 Ø, Where Ø is the overall diameter of the cable. Wherever possible, larger installation radius should be used, except that the minimum bending radius where the cables are placed in position adjacent to joints and terminations may be reduced to 15 Ø, provided that the bending is carefully controlled, e.g. by the use of a former.

C.4.2 Minimum temperature during installation

It is recommended that the cables should be installed only when both the cable and ambient temperature are above 0 °C and have been so for the previous 24 hours, or where special precautions have been taken to maintain the cable above this temperature.

C.4.3 Prevention of moisture ingress

Care should be exercised during installation to avoid any damage to cable coverings. This is important in wet or other aggressive environments. The protective end cap should not be removed from the ends of the cable until immediately prior to termination or jointing. When the caps have been removed, the unprotected ends of the cable should not be exposed to moisture.

C.4.4 Maximum pulling tension

The maximum pulling tension is depending on the cable design, the mechanical limitations, the conductor material, and the method of laying and pulling the cables. For pulling eye attached to the conductor, the maximum pulling tension for copper conductors (T_m) should not exceed 50 times the area of conductor (A). In case of aluminum conductors, the maximum pulling tension should not exceed 30 times the area of conductor (A). Or in other words

$T_m = 50 \ X \ A \ (mm^2)$ *Newtons* *(for copper conductors)*

$T_m = 30 \ X \ A \ (mm^2)$ *Newtons* *(for aluminum conductors)*

When the calculated pulling tension is close to (or within 10 % of) the maximum pulling tension, the use of a tension gauge during the pulling is recommended.

C.4.5 Sidewall pressure

One of the limitations to be considered in the installation of electrical cables is sidewall pressure. The sidewall pressure is the force exerted on the insulation and sheath of the cable at a bend point when the cable is under tension, and is normally the limiting factor in an installation where cable bends are involved. The sidewall pressure (P) in general is expressed as the tension out of a bend (T_o) expressed in newtons divided by the inside radius of the bend (r) expressed in meters.

$$P = \frac{T_o}{r}$$

In order to minimize cable damage because of excessive sidewall pressure, the installer should check the proper recommendations for each type of cables to be installed.

Annex C : Cable Installation

C.5 Laying methods

The best method of laying a cable depends on the type of cable and working conditions. The following methods are the most common cable laying methods.

C.5.1 Direct burial in the ground

This method is shown in the figure below, and is employed in following cases;

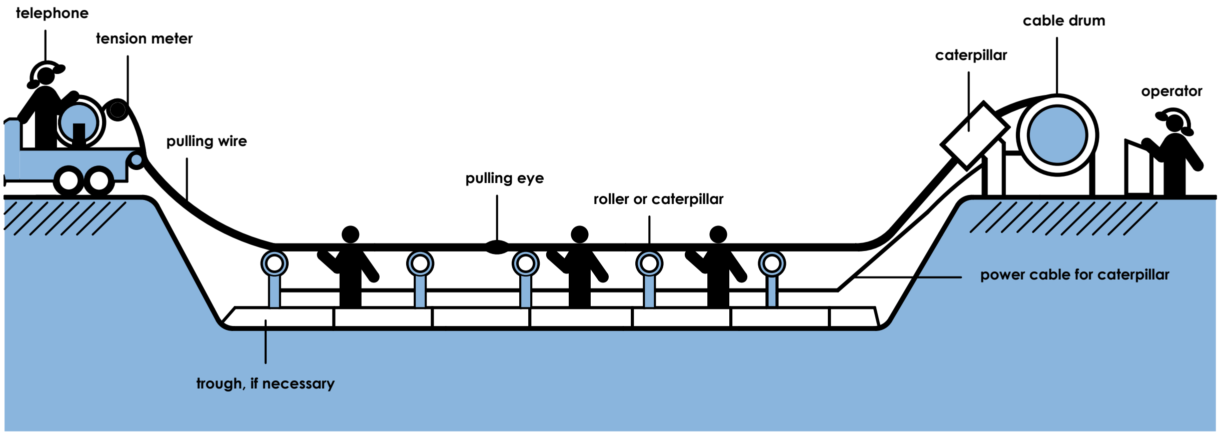
- Where road is narrow so the construction of conduit under the road is not permitted,
- Where the number of cables is few and no future increase is expected,
- Where the road digging is easy.

C.5.2 Underground tunnels or ducts

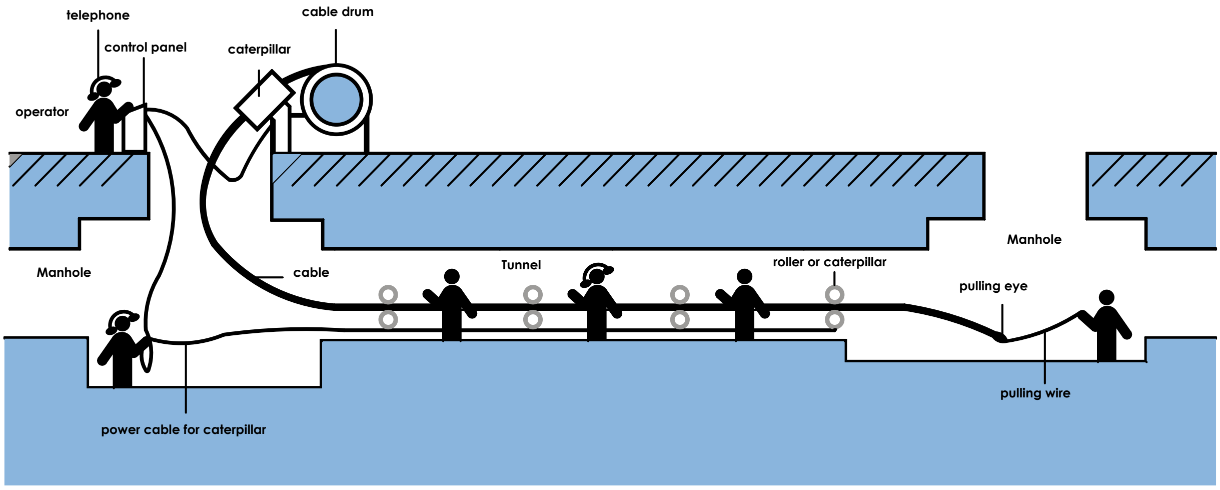
This method is shown in the figures below, and is employed in following cases;

- The case of main underground transmission line where the number of cables is many or expected to be increased in near future,
- The case of hard pavement or where hard pavement will be constructed in future,
- Where digging is difficult due to heavy traffic.

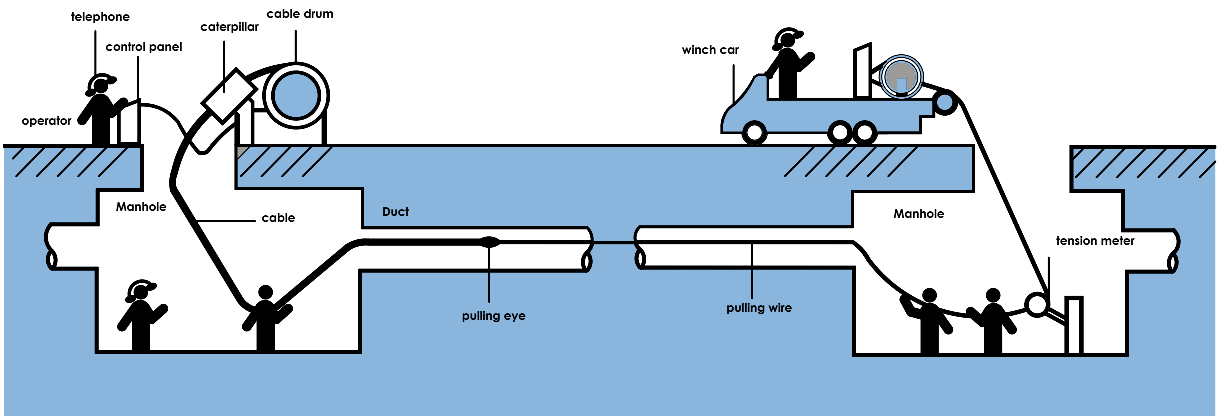
Direct burial



Cable laying at tunnel



Cable laying at duct



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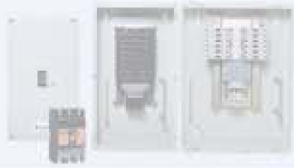
POWER & CONTROL

Low Voltage Products

- Load Center
- Circuit Breaker Enclosures
- Busbar Chamber
- Breakers



Low Voltage Systems

- Switch Boards – MF Type
- Distribution Boards – MB Type
- Motor Control Centres
- Capacitor Banks – Power Factor Correction Panels
- Automatic Transfer Switch (ATS Panels)
- Distribution Boards for Substations
- Synchronizing Panels
- Control & Automation Panels

Package & Unit Substations

- Indoor Package Substation
- Outdoor Package Substation
- Indoor Unit Substation
- Outdoor Unit Substation

Medium Voltage Systems

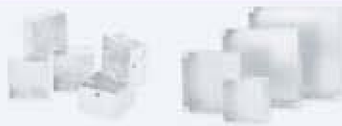
- Switchgear (Metal clad, Metal enclosed)
- Control gear
- Ring Main Unit (RMU)
- Retrofit solution

METAL ENCLOSURES

Metal Enclosures IP65
Modular Enclosures
Extendable Cubicles
Telephone Box

METAL ACCESSORIES

Switch Boxes
Junction Boxes



CABLES & WIRES

Building Wires

- American Standards (UL) Wires
- British Standards (BS) Wires
- International Electro-technical Commission Standards (IEC) Wires
- Low Smoke, Halogen Free Wires

Overhead conductors

- Bare Stranded Soft Drawn Copper Conductors (SDC)
- Bare Stranded Hard Drawn Copper Conductors (HDC)
- All Aluminum Conductors (AAC)
- All Aluminum Alloy Conductors (AAAC)
- Aluminum Conductors, Steel Reinforced (ACSR)
- Aluminum Conductors, Aluminum-Clad Steel Reinforced (ACSR / AW)
- Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR)
- Weather Resistant XLPE Insulated Service Drop Cables

Power Cables

- Low Voltage Power & Control Cables
- Medium Voltage Power Cables
- High Voltage Power Cables
- Low Smoke, Halogen Free Cables
- Cables for Special Applications

Signal, Communication & Data Cables

- Telephone Cables
- Coaxial Cables (RG6 / U)
- Local Area Network Cables (LAN)

LIGHTING

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Fluorescent
Energy Saving

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