Flexible power and control cables

Manufactured by **Cavotec Group**

CAVOTEC

Flexible power cables
Flexible control cables

Who we are

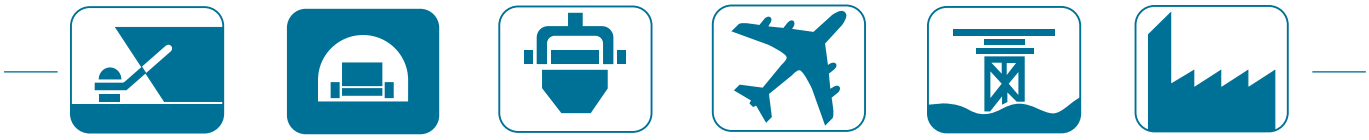
Cavotec is a multi-national group of companies serving the following industries: mining and tunnelling, ports and maritime, steel and aluminium, energy and offshore, airports, general industry and automation. In the early 1960's our main focus was the design and production of motorised cable reels primarily for manufacturers of tower cranes, harbour cranes and mining equipment.
Today, Cavotec is connecting mobile equipment around the world in many diverse applications.

Where we are

The Cavotec Group consists of 7 manufacturing "Centres of Excellence" located in Canada, France, Germany, Italy, Norway and Sweden and by 5 local manufacturing units located in Australia, China, Germany and the USA. For the distribution of products and providing support to customers Cavotec has 27 sales companies which, together with a network of distributors, serve more than 30 countries in five continents.
The ultimate objective is to be perceived as "local everywhere".

How we work

Our aim is to work closely with our customers in order to build long-term partnerships. To achieve this aim we have created a working environment that attracts the best people, encourages them to stay and brings out their best qualities. By producing totally reliable systems and backing them with efficient service, we strive to create true customer satisfaction.



Flexible power and control cables

To be able to offer a comprehensive selection of high quality cables to our customers, the Cavotec Group decided to select specialised manufacturing partners sharing our philosophy concerning the quality level and the service to the customer.
Concerning flexible cables our Group cooperates with partners like Amercable, Baude, Gore, Palazzo, Pirelli and Nexans.
The range of cables sold and serviced includes control cables, power cables, fiber optic cables and Kevlar reinforced cables for high stress applications.

Cavotec Group Organisation

As shown here the Cavotec Group is organised to support its customers around the world through its manufacturing units and sales companies.

Each Cavotec manufacturing company, no matter where it is located, aims at being a market leader in its field by providing innovative and reliable products to Group customers.

Each Cavotec sales company, in the 27 countries where they operate, aims at better serving its local market following the Group philosophy "to be local everywhere".

Manufacturing network

Centres of Excellence

France
Cavotec RMS
Spring Driven Reels

Germany
Cavotec Alfo
Spring Driven Reels
Slipring Columns

Cavotec Fladung
Aircraft Support Systems
Security Systems

Italy
Cavotec Specimas
Motorized Cable Reels
Panzerbelt Cable Protection
Slipring Columns

Norway
Cavotec Micro-control
Radio Remote Controls

Sweden
Cavotec Connectors
Electrical Plugs & Sockets

New Zealand
Cavotec MoorMaster
Automated Mooring Systems

Local Manufacturing

Australia
Cavotec Australia
Motorized Cable Reels

China
Cavotec China
Product Assembly

Germany
Cavotec Micro-control
Radio Remote Controls

Sweden
Cavotec Sweden
Product Assembly

USA
Cavotec USA
Product Assembly

Group Partners

Belgium
Gantry
Crane Rail Systems

Italy
Brevetti Stendalto
Cable Chains
Prysmian (Pirelli)
Flexible Cables
Tratos Cavi
Flexible Cables

Sales network

Cavotec Sales Companies

Cavotec Australia
Cavotec Belgium*
Cavotec BeNeLux
Cavotec Brazil*
Cavotec Canada
Cavotec Chile
Cavotec China
Cavotec Denmark
Cavotec Finland
Cavotec France
Cavotec Germany
Cavotec Hong Kong
Cavotec India
Cavotec Italy
Cavotec Korea
Cavotec Latin America
Cavotec Mexico
Cavotec Middle East
Cavotec Norway
Cavotec Russia*
Cavotec Singapore
Cavotec South Africa
Cavotec Sweden
Cavotec Turkey
Cavotec UK & Ireland
Cavotec USA

* Branch Office

Contents

How to choose the right cable for the job.

A large, high speed Cavotec Specimas cable reel mounted on a coil handler running at 180 m/minute.

To illustrate possible questions that arise from using cables in different types of applications we have included below a case study from Palazzo Pirelli. This study is based completely on their technical calculations and experience and is not automatically applicable to other types or brands of cable. In order to be sure of the latest information and any possible changes always contact your cable manufacturer.

Bending is not the only stress present with cables used for heavy duty applications. Mobile cables are subject to other stresses and strains (tensile, twisting etc.) resulting from forced guidance of the cable during the winding and unwinding phases. Consequently the correct choice is vital to ensure a long life of the cable.

Naturally other factors of primary importance must also be taken into consideration. These are:

- Minimum bending radius
- Tensile stress
- Operating speed & acceleration
- Installation height & length
- Ambient Temperature

The following paragraphs provide a detailed examination of these factors for accurate assessment of cable requirements.

Table 1: Palazzo type section

Main use · Suitable · Not suitable

TYPE OF CABLE	TYPE OF CABLE APPLICATION									
	Festoons	Cable winding reels				Cable tender systems	Guide pulley system	Pendant push buttons	Cable chains	Baskets
		Cable laid on ground or in conduit		with guide	Vertical cable					
Operating speed (m/min.max)*	180	180	120	120	120	240	120	—	120	120
PANZERFLEX ® PANZERFLEX ®- FO (minimum temp. - 20°C)	●	●	●	○	✕	✕	✕	✕	●	✕
PANZERFLEX ®- K (minimum temp. - 40°C)	●	●	●	○	✕	✕	✕	✕	●	✕
PANZERFLEX ®- VS (minimum temp. - 20°C)	✕	○	○	●	●	●	●	●	✕	✕
BASKETHEAVYFLEX® (minimum temp. - 20°C)	✕	✕	✕	✕	✕	✕	✕	✕	✕	●

Bending radius and overall diameters
Precise calculation of the bending radius is a determining factor for cable reliability. A decrease in minimum bending radius has a major effect on the life of a cable because it causes stretching and internal distortions. Another important factor is the frequency of the cable movements. If movement is slow and infrequent a tighter bending radius can be considered. Special attention should be taken for installations with pulleys or guide-rollers. Special attention should also be paid to installations where flexing and torsion is present due to the reels being parallel to the line of travel of the machine (see table 2).

Tensile strength
The maximum admissible continuous operating load is calculated by taking the sum of the cross sections of the power conductors (phases + earth of equal cross section) in the cable*. Greater loads will result in permanent elongation of the conductors, which would shorten the life of the cable considerably. For occasional or very infrequent stresses the calculated limit can be exceeded slightly. For control cables, where the resistant cross section consists of numerous small conductors, special types of cables are available. In special cases, where the pulling strength exceeds the resistance of the conductors, cables are used fitted with strainers or other means such as Kevlar reinforcement.

Operating speed
All cables in this catalogue have been designed, manufactured and tested for the operating speeds commonly in use today. Of course these speeds are only possible if the recommendations made concerning the choice of cable have been observed. Please note that high acceleration in combination with high operating speeds should be taken into account when calculating the tensile stress in the cable.

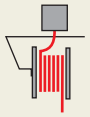
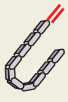
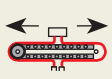
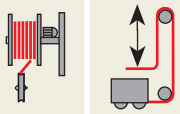
Coiling on cable reels

Monospiral reels
When using this type of reel the natural tendency of the cable is utilised. Alternatively it is also often possible to position the reel in order to eliminate the use of intermediate pulleys and any changes of direction. This increases the life of the cable and the operating speeds considerably.

Multi-spiral and multi-layer reels
These types of reels are normally used in cases of long cable length and large diameter cables. With this type of installation, attention must be paid to minimising the use of intermediate pulleys. The current capacity must also be carefully calculated using correction factors for layers and winding.

Spreader cables
Some cables have specially designed to be collected in baskets. With these types of applications a correct design is not only important for good cable treatment but also to avoid operating malfunctions. High stress applications will typically involve long vertical lengths, high speeds combined with lateral movement and a presence of strong winds (typical port conditions). In these cases attention should be paid to ensure that the coiling diameter is no less than 1.5 mtr. and that a guide cone is located in the basket for even coiling of the cable. The shape of the basket and the size and shape of the opening are also important factors. A conical opening at a minimum height of 2 mtr. is recommended. Periodic lubrication of the surface of the cable is necessary to facilitate entry into the basket. Lubricating products that do not cause excessive accumulation of dirt should be used (figure 1 - page 6).

Table 2: Minimum bending radius

OPERATING VOLTAGE	TYPE OF APPLICATION							
Overall diameter of cable DE	Fixed installation	Anchoring reel	Festoons	Cable	Baskets	Cable chains	Cable tender systems	Guide pulley systems
								
Voltage≤ 1000 V								
DE < 8.0 mm	3 x DE	3 x DE		5 x DE	—	4 x DE		7,5 x DE
DE < 12.0 mm	3 x DE	4 x DE		5 x DE	—	4 x DE		7,5 x DE
DE ≤ 20.0 mm	4 x DE	5 x DE		5 x DE	—	5 x DE		7,5 x DE
DE > 20.0 mm	4 x DE	5 x DE		6 x DE	15 x DE	5 x DE		7,5 x DE
Voltage > 1000 V	6 x DE	10 x DE		12 x DE	—	10 x DE		15 x DE

How to choose the right cable for the job.

Other systems of cable movement
The systems most frequently employed are perhaps cable tender systems, pulley systems and cable chains. The first two systems involve high tensile stress whereas the third on a whole does not. Particular attention must be paid to the minimum bending radius and to the distribution of loads between the cables and cable tenders. Cables with a greater cross section should bear the loads and not the control cables that may be present.

Guide pulley and anchoring devices.
When designing these components, care must be taken to observe the recommended minimum bending radius and also the following factors:

Intermediate sheaves used for long cable lengths must be designed with a 'flat bottom profile' in order to avoid torsion. Small, light-weight rollers are preferred to sheave pulleys or wheels. With twin directional cable guides it is preferable to use light-weight, low friction rollers with a rounded bottom profile, as these types of rollers guide the cable in the centre without developing torsion stresses. If possible reduce the number intermediate pulleys and keep changes of direction to a minimum. Where possible rollers instead of pulleys should be used as these have considerably less contact area with the cable. Should the route of the cable require more than one change of direction, the distance between two sheaves or rollers must be greater than 25 times the overall diameter of the cable. The anchoring systems must be designed to distribute the tensile stress over a wide area of the outer cable sheath. This is in order to prevent localised faults or damage.
It is preferable to make the connections at both ends of the installation by using the same method normally adopted for installations with a central feeding point. Both the reel and the feeding point must have a few 'dead' turns of cable before the cable joint. Mobile anchoring points usually consist of ordinary terminals or 'cable grips'. In these cases it is recommended that the tensile load is distributed over a length of cable equal to 20-25 times the overall diameter of the cable. It is also recommendable that an additional loop of cable be left before entry into the terminal box to allow movement.

In any case it is absolutely essential for the design of the guide and pulley system to provide adequate protection and reduce effect of slacks and jerks during operation. The overall lifetime and reliability of the cable depends on these conditions being met.

Current carrying capacities for non-continuous operation
In some cases electrical operation is not continuous. In these cases it is therefore advisable to check the values of the operating times so as to determine if the cross section of the cable can be reduced. A typical example of intermittent operating with hoisting equipment consists of repeated cycles where, for example, an operating period of 10 minutes of full load is followed by a longer period without load. These 10 minutes, taken as a percentage of the total duration (DT) of the cycle, provide the load factor. Load factor ED% = (10/DT min) x 100. In this case the current carrying capacity (as calculated in the preceding paragraph) can be increased using the factors given in table 4. For further information and advice please consult our technical department.

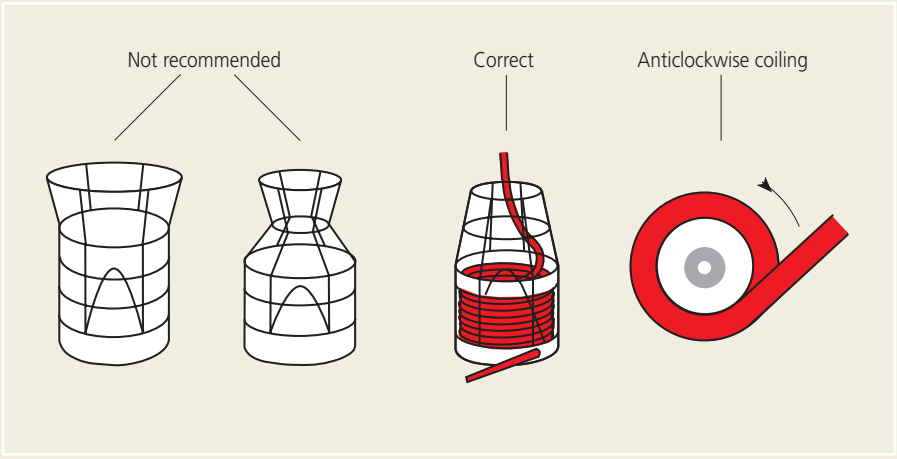
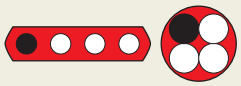


Figure 1. Shape of the basket and direction of coiling.

Table 3: Current carrying capacities for continuous operation

Type of cable	PANZERFLEX® FLEXIFLAT PANZERFLAT® BASKETHEAVYFLEX®	PANZERFLEX®-PANZERFLAT®	
Type of laying	1 cable in air  (for festoons)	1 cable laid on the ground  (for cable reels)	
Cross section mm²	Operating voltage Up to 10 kV A	A	Operating voltage Above 10 kV A
1,5	24	23	—
2,5	32	30	—
4	43	41	—
6	56	53	—
10	78	74	—
16	104	99	105
25	138	131	139
35	171	162	172
50	213	202	215
70	263	250	265
95	317	301	319
120	370	352	371
150	425	404	428
185	485	461	488
240	570	517	—

Insulation: EPR - Conductor temperature: 80°C Ambient temperature: 30°C

Current carrying capacity correction factors

For ambient temperatures other than 30°C

Ambient temperature (°C)	25	35	40	45	50	55	60	65	70	75
Correction factor	1,05	0,95	0,89	0,84	0,77	0,71	0,63	0,55	0,45	0,32

Reel type	Multi-spiral reels				Monospiral reels	
Number of layers on reel	1	2	3	4	Various	Various
Correction factor	0,80	0,61	0,49	0,42	0,8	0,5
Type of cable	Round cables				Round cables	Flat cables

For multi-core cables

Number of conductors loaded	5	7	10	14	19	24	40
Correction factor	0,75	0,65	0,55	0,50	0,45	0,40	0,35

Table 4: Correction factors for intermittent operation

Cross section of cable mm²			1,5	2,5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
Cycle duration		Load	Correction factors															
Load min.	Total DT min.	factor-ED%																
10	17	60%	1,00	1,00	1,00	1,00	1,03	1,07	1,10	1,13	1,16	1,18	1,20	1,21	1,22	1,23	1,24	1,25
10	25	40%	1,00	1,00	1,03	1,04	1,09	1,16	1,23	1,28	1,34	1,38	1,42	1,44	1,46	1,48	1,49	1,50
10	40	25%	1,00	1,02	1,05	1,13	1,21	1,34	1,45	1,53	1,62	1,69	1,74	1,78	1,81	1,82	1,85	1,87
10	50	20%	1,00	1,04	1,11	1,18	1,31	1,45	1,59	1,69	1,79	1,87	1,93	1,97	2,01	2,04	2,10	2,15
10	67	15%	1,00	1,08	1,19	1,27	1,44	1,62	1,79	1,90	2,03	2,13	2,21	2,26	2,30	2,32	2,36	2,39

How to choose the right cable for the job.

Voltage drop
The voltage drop should not only be checked for low voltage but also for medium voltage applications. The value is calculated by multiplying the factors K (mV/Am) given in table 5 with the current capacity I (A) of the cable and by the length of the connection L (km). This calculation is valid with sufficient approximation for all voltages where:
conductor temperature = 80C; cos φ 0,8; frequency = 50 Hz. Voltage drop (V) = I(A) x L (km) x K(mV/Am).
The factors have been calculated using the formula:
K(mV/Am) = 1,73 x (R cos φ X sen j)
where: R= Resistance of the conductor (Ω/km) at 50 Hz.
X = cable reactance (Ω/km) at 50Hz.
Values for electrical resistance R (80°C) and for reactance X (calculated for round cables, three phase cores plus earth, but it can also be applied to flat cables) are also given in table 5. It should be noted that for the conductor temperatures of 90°C the resistance R must be multiplied by 1,03 while for a frequency of 60 Hz the resistance X must be multiplied by 1,2 and the value for K (mV/Am) recalculated.

Table 5: Factors for calculation of voltage drop

Nominal cross section of cable	Operating electrical resistance (R) at 80°C, A.C. 50 Hz	Reactance (x) at 50 Hz for three core+earth cables at operating voltage of:						Voltage drop
		≤ 1 kV	3 kV	6 kV	10 kV	15 kV	20 kV	factor k (cosφ = 0,8)
mm²	Ω/ km	Ω / km	Ω / km	Ω / km	Ω / km	Ω / km	Ω / km	mV / Am
1,5	16,95	0,107						23,5
2,5	10,15	0,101						14,2
4	6,29	0,097						8,80
6	4,20	0,091						5,93
10	2,41	0,087	0,098					3,45
16	1,54	0,083	0,096	0,109	0,121			2,24
25	0,986	0,082	0,091	0,104	0,114	0,127		1,46
35	0,700	0,079	0,087	0,099	0,108	0,121	0,13	11,06
50	0,490	0,078	0,083	0,094	0,103	0,114	0,123	0,77
70	0,345	0,076	0,080	0,090	0,098	0,108	0,113	0,57
95	0,260	0,075	0,079	0,088	0,094	0,104		0,45
120	0,205	0,074	0,077	0,085	0,091			0,36
150	0,163	0,074	0,076	0,083	0,089			0,30
185	0,134	0,073	0,074	0,081				0,26
240	0,101	0,072	0,074					0,22

Table 6: Factors for calculation of voltage drop

Nominal cross section of cable	**1 second THERMAL LIMIT for all voltage**	**DYNAMIC LIMIT for three core cables operating voltage of:**					
		≤ 1 KV	3 KV	6 KV	10 KV	15 KV	20 KV
(mm²)	kA	(Indicative value) kA					
1,5	0,2						
2,5	0,32						
4	0,51						
6	0,77						
10	1,29						
16	2,06	30	40	45	50	55	
25	3,22	35	43	50	55	60	
35	4,50	40	48	53	60	65	75
50	6,43	45	50	58	63	70	80
70	9,00	50	55	63	68	75	83
95	12,2	55	60	70	75	80	
120	15,4	60	65	72	78		
150	19,3	65	68	75	80		
185	23,8	70	72	80	84		
240	31,0	80					

Thermal limit in case of short circuit
In accordance with VDE Standard 0250 c. 8/75 the admissible thermal limits for short circuit current in heavy cables must be calculated using the following reference values:

- Initial temperature: 80°C (cable under full load)
- final short circuit temperature: 200°C

The short circuit currents (thermal limit) given in table 6 have been calculated using these reference values and are valid for a base time of 1 second. For other time periods, taking into account the protection characteristics of the machine, the value in the table must be divided by the square root of the effective time (in seconds). For different initial and final temperatures (e.g. with 90°C and 250°C admissible according to the EPR norms) the short circuit current thermal limit can be calculated using the following formula:

$$Icc\ (Ka) = \frac{kcc \times \text{cross section } (mm^2)}{\sqrt{t\ (sec.)}}$$

Where the coefficient kcc assumes the following values:

Final S.C. temperature °C	Initial S.C. temperature (= of the conductor under normal operating condictions)						
	30°C	40°C	50°C	60°C	70°C	80°C	90°C
160°	143	136	129	122	115	107	100
200°	159	153	147	141	135	128	122
250°	176	170	165	159	154	148	143

Dynamic limit in case of short circuit
The electro-dynamic forces generated during short circuit tend to separate single core cables or the cores of three/four cables forcibly. To counteract these forces in single core cables, attention must be paid to the dimensions and spacing of cable brackets and supports. For multicore cables, used more frequently for heavy duty applications, the cable itself ensures this.

Handling of the cable
Storing and handling the cables on their original drums is recommended in order to prevent any defects. If possible the drums should not be rolled; either on level or uneven ground. If the type of installation and working conditions allow, it is good to roll out the cable along the line of movement of the machine before installation. By doing this you can check if there are any torsions or twist in the entire length of the cable. Appropriate equipment (rollers or pulley devices) should be used taking into account the slight tendency of round cables (especially multi-core ones) to spiral. During this stage any longitudinal twists should be taken out using appropriate actions in order to make sure the cable rewinds correctly on the reel or is properly festooned. The longitudinal reference markings on the cable make this operation easier.

Transfer onto reels
If working conditions do not allow the previous described method, the cable should be transferred directly from the original drum to the cable reel. Undesired twists and torsions that have a negative effect on the cable should be eliminated during this operation. The transfer must be direct with no intermediate guides (rollers, pulleys, twin-directional rollers etc.) and with no changes of direction or inversions of the original direction of winding on the delivery drum (see figure 3). Most cables are manufactured with right-hand lay-up of the conductors (both for power and control cables). It is important to remember therefore that when winding onto multi-spiral reels the first turn must be with the cable against the right flange of the reel. This will have the effect of exploiting the natural tendency of a cable under traction to move to the right and will keep subsequent turns close together (see figure 4).

Installation in spreader-baskets
With cables designed for installing in baskets, the right hand lay-up of the cores means that cables must be introduced into the bottom of the basket, coiling in an anticlockwise direction, unwinding from the outer layer of the original drum. In order to facilitate basket coiling and uncoiling operations, the outer surface of the cable should be periodically lubricated with a suitable product (such as silicone grease) designed to prevent any adhesion of dirt, dust or other matter.

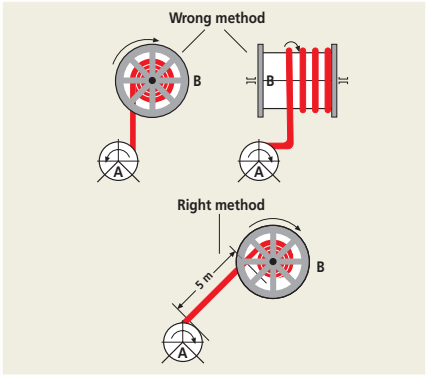


Figure 3. Transfer of cable from original delivery drum A to the cable winding reel B.

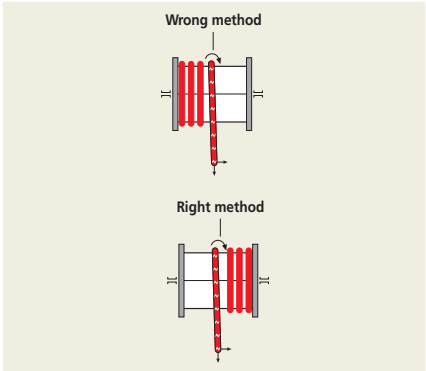
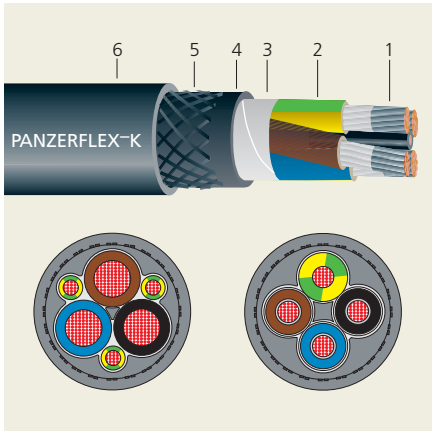


Figure 4. Winding of cable onto multi-spire reel.

Panzerflex® 1kV; low voltage power cable

Low Voltage



Construction & Characteristics PANZERFLEX® 1 kV

1 *Flexible tinned stranded copper conductor*
2 *EPR rubber compound insulation*
3 *Tape*
4 *Polychloroprene based compound inner sheath*
5 *Antitwisting protection of synthetic yarns*
6 *Black polychloroprene based compound outer sheath*

Applications

Panzerflex® special flexible heavy duty power cables have been developed for use on moving installations where there are high torsional and tensile stresses, ambient conditions are harsh or there is danger of abrasion and crushing. Typical applications for Panzerflex® are mobile installations on all types of harbour cranes, container cranes, ship-unloaders, mobile harbour cranes, deck cranes, stacker & reclaimers, trippers, mining & tunnelling equipment and mobile generator sets.

Ratings and Specifications

VDE 0250, Part 814

Rated and test voltages

Rated voltage Uo/U	0,6/1 kV A.C.
Max voltage Um	0,7/1,2 kV A.C.
Max voltage Um	0,9/1,8 kV D.C.
Test voltage	2,5 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 20°C Minimum conductor temperature

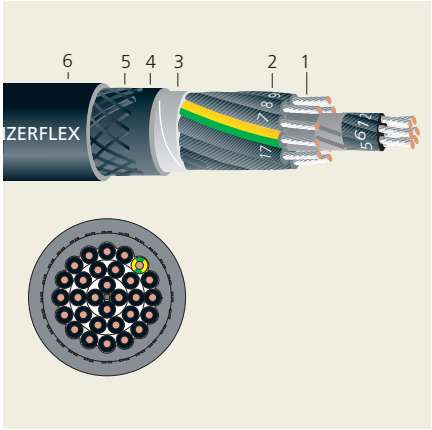
Dimensional data

	Number of cable cores 3 + 3		Number of cable cores 4		
Nominal cross section mm²	Max. overall diam. mm	Net weight kg/km	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
1,5	–	–	14,3	280	120
2,5	–	–	17,2	410	200
4	–	–	20,0	550	320
6	–	–	21,5	680	480
10	–	–	25,5	1030	800
16	–	–	30,0	1470	1280
25	–	–	35,0	2130	2000
35	–	–	39,0	2750	2800
50 (10)*	44,5	3310	44,5	3700	4000
70 (16)*	49,3	4340	49,0	4840	5600
95 (16)*	52,3	5500	56,5	6470	7600
120 (25)*	59,4	6970	63,2	8280	
150 (25)*	61,5	8130	68,7	9950	
185 (35)*	67,2	9820	74,9	11800	
240 (50)*	76,1	12680			
10 (2,5)*					
16 (2,5)*					
25 (2,5)*					
35 (2,5)*					

** The cross section indicated in the brackets is that of each minor conductor of 3 + 3.*

Panzerflex® 1kV; low voltage control cable

Low Voltage



Construction & Characteristics PANZERFLEX® 1kV (control)

1 *Flexible tinned stranded copper conductor*
2 *EPR rubber compound insulation*
3 *Tape*
4 *Polychloroprene based compound inner sheath*
5 *Antitwisting protection of synthetic yarns*
6 *Black polychloroprene based compound outer sheath*

Applications

Panzerflex® special, flexible control cables have been developed for use on moving installations where there are high torsional and tensile stresses and ambient conditions are harsh. Panzerflex® low voltage control cable has been especially designed for vertical reeling applications with high lifting heights. Typical applications for Panzerflex® control cables are mobile installations on all types of harbour cranes, container cranes, ship-unloaders, stacker & reclaimers, trippers, mobile generator sets and mining & tunnelling equipment, while Panzerflex® is especially suited for use on vertical reeling installations on mobile harbour cranes, ship-to-shore container cranes and large bridge cranes.

Ratings and Specifications

VDE 0250, Part 814

Rated and test voltages

Rated voltage Uo/o	0,6/1 kV A.C.
Max voltage Um	0,7/1,2 kV A.C.
Max voltage Um	0,9/1,8 kV D.C.
Test voltage	2,5 kV A.C.

Temperature ratings

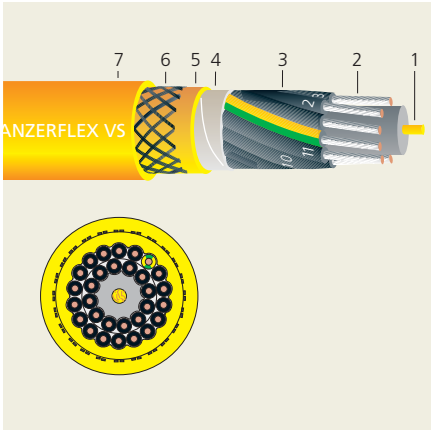
+ 90°C Maximum conductor temperature
– 20°C Minimum ambient temperature during work

Dimensional data

Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
7 x 1,5	19,1	490	158
12 x 1,5	22,3	680	270
18 x 1,5	25,3	890	405
24 x 1,5	29,4	1140	540
30 x 1,5	31,5	1360	675
36 x 1,5	33,5	1540	810
7 x 2,5	21,2	660	263
12 x 2,5	24,8	910	450
18 x 2,5	30,2	1270	675
24 x 2,5	33,6	1680	900
30 x 2,5	35,4	1890	1125
36 x 2,5	38,4	2250	1350
7 x 4	24,2	890	420
12 x 4	28,6	1280	720
18 x 4	34,3	1840	1080
19 x 2,5+5 x 1 (C)	34,0	1650	713
19 x 2,5+5 x 1,5 (C)	34,0	1680	713
25 x 2,5+5 x 1,5 (C)	36,0	1890	938

Panzerflex® VS; low voltage power cable vertical application

Low Voltage



Construction & Characteristics PANZERFLEX® VS

1 *Kevlar® central strainer*
2 *Very flexible tinned stranded copper conductor*
3 *EPR rubber compound insulation*
4 *Tape*
5 *Polychloroprene based compound inner sheath*
6 *Antitwisting protection of synthetic yarns*
7 *Yellow polychloroprene based compound outer sheath*

Applications

Panzerflex VS has been specially developed and designed in order to provide a specific solution for vertical applications where small dimensions and light weight are necessary. Typical applications for Panzerflex VS control cables are mobile installations on all types of harbour cranes, container cranes, ship unloaders, stackers & reclaimers, trippers, mobile generator sets and mining & tunnelling equipment. The Panzerflex VS is especially suited for use on vertical reeling installations on mobile harbour cranes, ship-to-shore container cranes and large bridge cranes.

Ratings and Specifications

VDE 0250, Part 814

Rated and test voltages

Rated voltage Uo/U	0,6/1 kV A.C.
Max voltage Um	1,2 kV A.C.
Max voltage Um	1,8 kV D.C.
Test voltage	2,5 kV A.C.

Temperature ratings

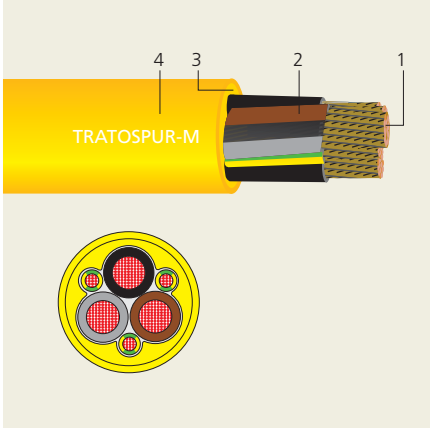
+ 90°C Maximum conductor temperature
– 20°C Minimum ambient temperature during work

Dimensional data

Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
7 x 1,5	20,4	600	2000
12 x 1,5	26,2	980	2000
18 x 1,5	26,4	1040	2000
24 x 1,5	30,5	1320	2000
30 x 1,5	34,1	1690	2000
36 x 1,5	34,8	1750	2000
7 x 2,5	22,9	790	2000
12 x 2,5	30,2	1300	2000
18 x 2,5	31,3	1500	2000
24 x 2,5	35,8	1920	2000
30 x 2,5	39,9	2360	2000
36 x 2,5	40,6	2530	2000
7 x 4	25,6	1020	2000
12 x 4	34,4	1750	2000
18 x 4	36,4	2050	2000

Tratospur-M; low voltage power cable

Low Voltage



Construction & Characteristics TRATOSPUR-M

1 *Bare annealead copper conductor (Cl.5 IEC60228)*
2 *XLPE or TPR insulation*
3 *Yellow thermoplastic compound*
4 *Yellow halogen free thermoplastic compound*

Applications

Tratospur cables are designed for power supply connections to all types of mobile equipment used in quarrying, open-cast mining and other applications in harsh working environments. The special polyurethane compound jacket offers a very good protection against hydrolysis and oils while the annealed copper conductor provides a very high degree of flexibility.

Rating and test voltages

Rated voltage Uo/U 0,6/1 kV A.C.
Max voltage Um 1,2 kV A.C.
Test voltage 2,5 kV A.C.

Temperature ratings

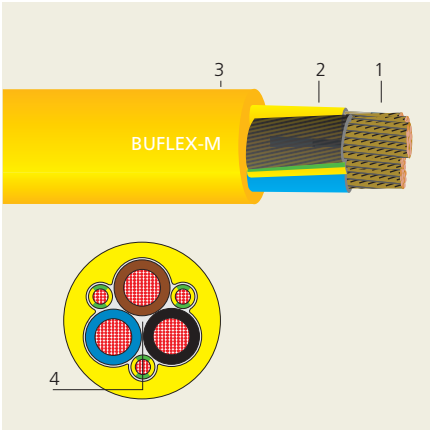
+ 90°C Maximum conductor temperature
– 30°C Minimum ambient temperature during work

Dimensional data

Nominal cross section n x mm2	Max. overall diam. mm	Max diameter wires mm	Net weight kg/m	Max. Contin. Safe Reeling Tension N
3 x 25 + 3G6	24,30	0,25/0,25	1,200	1500
3 x 35 + 3G6	27,00	0,25/0,25	1,550	2100
3 x 50 + 3G10	30,80	0,40/0,25	2,200	3000
3 x 70 + 3G16	35,30	0,40/0,25	3,050	4200
3 x 95 + 3G16	39,20	0,40/0,25	3,850	5700
3 x 120 + 3G25	44,00	0,40/0,25	5,000	7200
3 x 150 + 3G25	48,70	0,40/0,25	6,100	9000
3 x 185 + 3G35	54,30	0,40/0,25	7,650	11100
3 x 240 + 3G50	60,30	0,40/0,40	9,850	14400

Buflex-M; low voltage power cable

Low Voltage



Construction & Characteristics BUFLEX-M

1 Conductor
2 XLPE or TPR insulation
3 PUR outer sheath
4 PVC filler

Thanks to its high resistance to abrasion Buflex-M is used in many mining and tunneling applications.

Applications

Buflex-M cables are designed for power supply connections to all types of mobile equipment and vehicles used in quarrying, open-cast mining and other large scale civil engineering operations. The unique Buflex® cables diameter is achieved by splitting the earth conductor and laying it in the angles formed by the assembly of the three phase conductors. This original design results in a smaller diameter than a four cable conductors cable i.e. a cable 3 x 120 mm2 + 3 x 25 mm2 (earth conductors) has the same diameter as a 4 x 95 mm2 cable.

Rating and test voltages

Rated voltage Uo/U 0,6/1 kV A.C.
Max voltage Um 1,2 kV A.C.
Test voltage 3,5 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 30°C Minimum ambient temperature during work

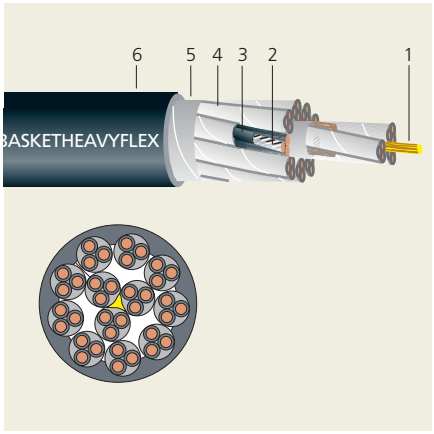
Dimensional data

Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
3x 25+3 G6	24,0	1200	1500
3x 35+3 G6	28,0	1600	2100
3x 50+3 G10	32,0	2100	3000
3x 70+3 G16	37,0	3000	4200
3x 95+3 G16	42,0	3900	5700
3x 120+3 G25	45,0	5000	7200
3x 150 + 3 G25	52,0	6000	9000
3x 185 + 3 G35	57,5	7600	11100
3x 240+ 3 G50	67,0	10200	14400

Note: Maximum tensile strength 20 N/mm2 x copper cross-section.

Basketheavyflex®; low voltage control cable

Low Voltage



Construction & Characteristics BASKETHEAVYFLEX®

1 *Kevlar® central strainer*
2 *Extrafine tinned stranded copper conductor*
3 *EPR rubber compound insulation*
4 *Three cores laid-up with fillers and tape*
5 *Tape around the core assembly with fillers*
6 *Black CSP based compound outer sheath*

Applications

BasketHeavyFlex® special, flexible control cables have been developed for use on spreader installations using baskets where there are high torsional stresses. Its particular design and the use of a rubber outer sheath makes the cable very suitable for these type of applications and gives a long life to the cable. Typical applications for BasketHeavyFlex® control cables are spreader installations on all types of harbour cranes, container cranes, mobile harbour cranes and large bridge cranes.

Rated and test voltages

Rated voltage Uo/U	0,3/0,5 kV A.C.
Max voltage Um	0,5 kV A.C.
Max voltage Um	0,8 kV D.C.
Test voltage	2 kV A.C.

Temperature ratings
+ 90°C Maximum conductor temperature
– 20°C Minimum ambient temperature during work

Dimensional conductor data

CORNDUCTOR

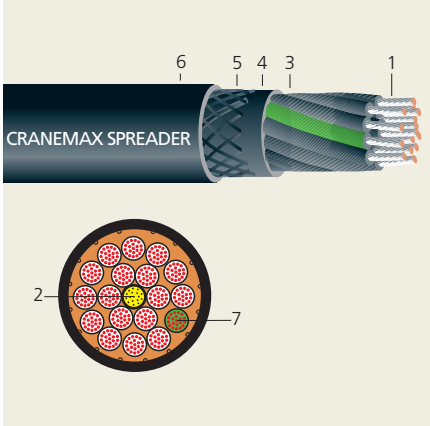
Nominal cross section mm²	Max D.C. electrical resistance at 20°C Ohm/km	Maximum strands diameter mm	Nominal conductor diameter mm	Nominal insulation diameter mm
2,5	8,21	0,16	2,0	3,8
3,3	6,11	0,16	2,5	4,0

BASKETHEAVYFLEX®

Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
8 x 3 x 2,5	41,0	2600	1200
12 x 3 x 2,5	44,5	3100	1800
14 x 3 x 2,5	50,4	3650	2100
16 x 3 x 2,5	51,5	4100	2400
8 x 3 x 3,3	41,0	2700	1584
12 x 3 x 3,3	44,5	3300	2376
14 x 3 x 3,3	50,4	3850	2772
16 x 3 x 3,3	51,5	4300	3168

CraneMAX; low voltage control cable

Low Voltage



Construction & Characteristics CORDAFLEX (SMK)

1 Conductor
2 Insulation
3 Inner sheath
4 Anti-torsion braid
5 Outer sheath

A Cavotec Specimas cable reel working at ± 200 m/min on a P&H log-handling crane for Federal Paper Board, in Augusta USA.

Applications

AmerCable's CraneMax Spreader cables are designed to deliver safe trouble free performance on vertical cable reels at temperatures from -40°C to +50°C at speeds up to 250 m/min. These multi-conductor cables are especially designed for use with monospiral and level wind reels on container cranes, log handling cranes, gantry cranes, stacker/reclaimers and other similar lifting equipment. They are suitable for outdoor use in ports, shipyards, lumber mills, steel mills and mines. Please note that this cable is designed and built according to US standards.

Ratings and Specifications

ASTM B-172; ASTM B-33

Rated and test voltages

Rated voltage Uo/U	0,6 kV A.C.
Max voltage Um	0,6 kV A.C.
Max voltage Um	0,9 kV D.C.
Test voltage	3 kV A.C.

Temperature ratings

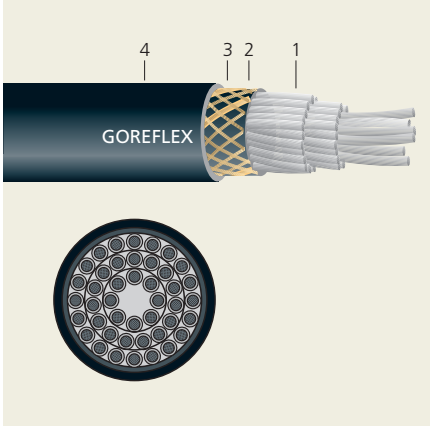
+ 90°C Maximum conductor temperature
– 40°C Minimum ambient temperature during work

Dimensional data

AWG	Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/Km	Max. Continuous Safe Reeling Tension N
14	18 x 2,5	25,3	966	6200
14	24 x 2,5	28,0	1057	7200
14	37 x 2,5	32,5	1726	8000
14	44 x 2,5	35,2	2329	8800
12	18 x 4	27,7	1292	6600
12	24 x 4	30,4	1629	7500
12	37 x 4	34,3	2366	8300
12	44 x 4	38,9	2769	9300

Goreflex; low voltage control cable

Low Voltage



Construction & Characteristics GOREFLEX

1 Flexible copper conductor
2 Inner sheath
3 Polymere braid
4 Outer sheath

A typical application port for high strength Goreflex cables.

Applications

Goreflex low voltage control cables for spreader applications are subjected to harsh operating conditions, extreme mechanical loading and very diverse ambient conditions. Goreflex spreader cables have an acceleration of 2,5 m/sec and a speed of > 200m/min. In addition they have a high tensile strength with an extreme low elongation (> 10 specific insulation resistance) while remaining very low in weight due to their innovative design. Goreflex cables are suited to a wide range of applications and are in use at ports and terminals world-wide.

Rating and test voltages

Rated voltage Uo/U 0,6 kV A.C.
Test voltage 3,5 kV D.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 30°C Minimum ambient temperature during work

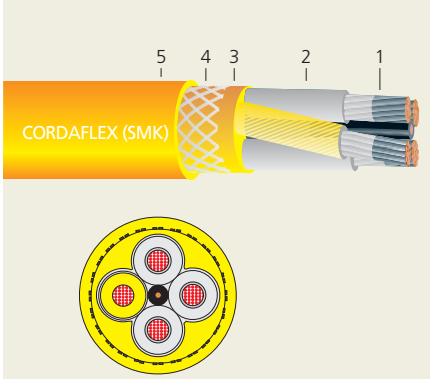
Dimensional data

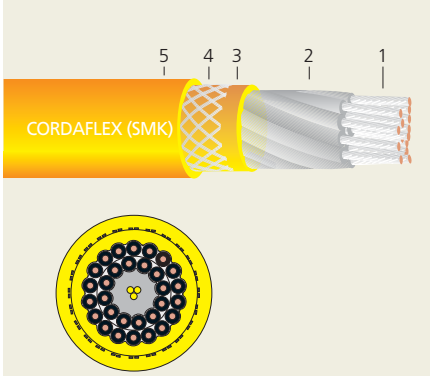
Nominal cross section n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
18 x 2,5	23,5	0,7	3000
30 x 2,5	27,5	1,18	4000
36 x 2,5	29,5	1,40	6500
44 x 2,5	31,8	1,70	6500

** All standard bus cables can be implemented*

Cordaflex™ (SMK); low voltage control cable

Low Voltage





Construction & Characteristics CORDAFLEX (SMK)

1 Conductor
2 Insulation
3 Inner sheath
4 Anti-torsion braid
5 Outer sheath

Applications

The CORDAFLEX™ (SMK) is a flexible reeling cable, specifically designed to address the high mechanical stress associated with high speed operation and/or multiple cable deflection in the cable payout. Applications include monospiral reels, level wind reels, cable tenders, sheave guided systems etc. for use on container cranes, RMG's, magnet cranes, stacker/reclaimers and much more.
This cable is also suited for use in mines on shuttle cars, excavators or other harsh applications. For vertical reeling applications we recommend a special design, CORDAFLEX™ (SMK)-V, which is available with an integrated central messenger increasing the maximum continuous safe reeling tension.

Ratings and Specifications

VDE 250, Part 814

Rating and test voltages

Rated voltage Uo/U	0,6/1 kV A.C.
Max voltage Um	0,7/1,2 kV A.C.
Max voltage Um	0,9/1,8 kV D.C.
Test voltage	2,5 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 35°C Minimum ambient temperature during work (flexible)
– 50°C Minimum ambient temperature during work (fixed)

Dimensional data

CORDAFLEX™ (SMK)

Nominal cross n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
12 x 1,5	23,4	710	540
18 x 1,5	23,3	760	810
24 x 1,5	26,8	990	1080
30 x 1,5	29,6	1220	1350
36 x 1,5	29,5	1260	1620
44 x 1,5	32,5	1530	1980
56 x 1,5	37,9	2050	2520
18 x 2,5	25,3	1005	1350
24 x 2,5	29,2	1320	1800
30 x 2,5	32,4	1660	2250
36 x 2,5	32,3	1720	2700
44 x 2,5	37,1	2230	3300
56 x 2,5	43,1	2940	4200

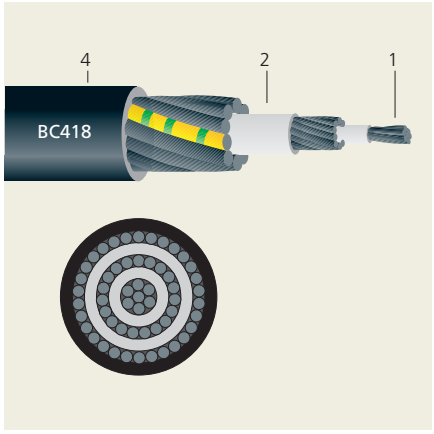
CORDAFLEX™ (SMK)-V Reinforced

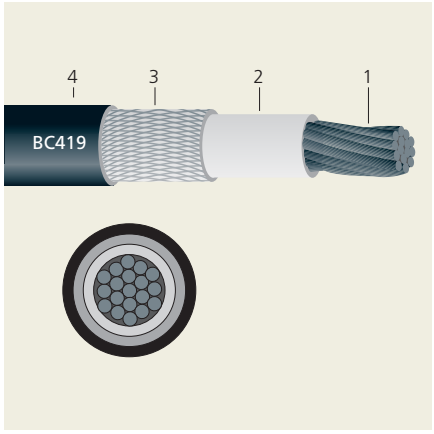
Nominal cross n x mm²	Max. overall diam. mm	Net weight kg/km	Max. Contin. Safe Reeling Tension N
49 x 1 (20kN)	29,6	1260	3200
24 x 2,5 (20kN)	29,2	1340	3600
30 x 2,5 (20kN)	32,4	1680	4100
44 x 2,5 (20kN)	37,1	2280	5100
56 x 2,5 (20kN)	43,1	3030	6000
48 x 1,5 (50kN)	40,3	2060	4860
48 x 2,5 (50kN)	46,1	3000	6300

Note: Cordaflex (SMK) is also available in other control cable designs and in a full range of 1kV power cables

BC418/419; low voltage control and power cables (only for cable chain applications)ower cable

Low Voltage





Construction & Characteristics BC418/419

1 *Flexible tinned stranded copper conductor (TPE-E insulation)*
2 *Tape*
3 *Tinned copper braid shielding (only on BC419)*
4 *Polyurethane jacket*

Applications

The BC418/419 has a small outer dimension, with a low minimum bending radius. The polyurethane jacket offers a very good resistance to hydrolysis and oils. These characteristics make this cable very suitable for outdoor applications in harsh working environments.

Ratings and Specifications

VDE 0472-804

Rating and test voltages

Rated voltage Uo/U 0,6 kV A.C.
Test voltage 3 kV A.C.

Temperature ratings

+ 80°C Maximum conductor temperature
– 30°C Minimum ambient temperature during work

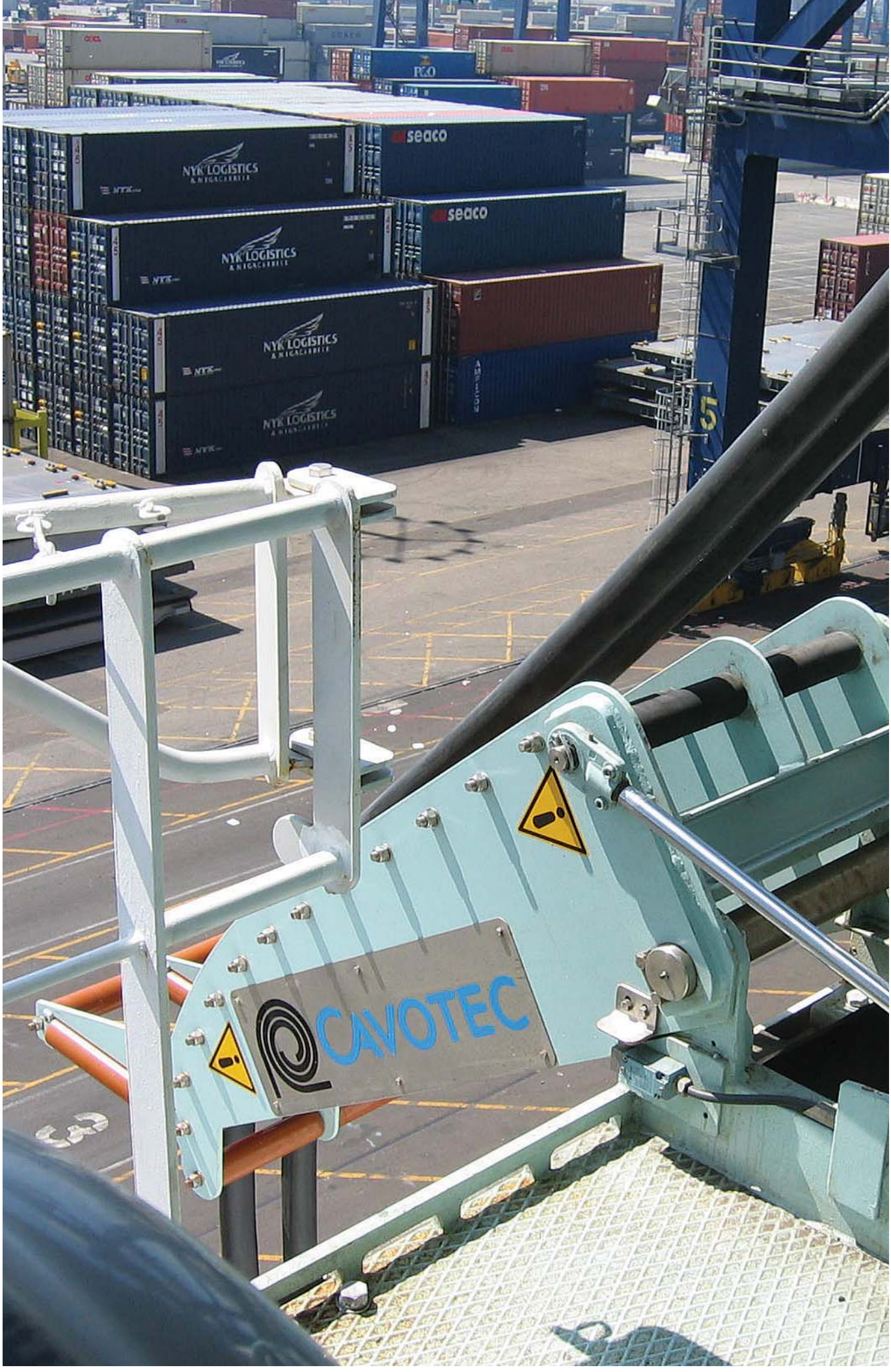
Dimensional data

BC418

Nominal cross section mm²	Max. overall diam. mm	Bending radius mm	Net weight kg/km
4 x 1,5	8,35	42	100
5 x 1,5	9,05	45	128
7 x 1,5	10,44	52	177
12 x 1,5	12,43	62	275
18 x 1,5	14,65	73	405
25 x 1,5	17,30	97	565
4 x 2,5	10,5	53	150
7 x 2,5	12,10	61	238
12 x 2,5	16,10	81	422
18 x 2,5	18,70	140	650
25 x 2,5	26,00	208	910

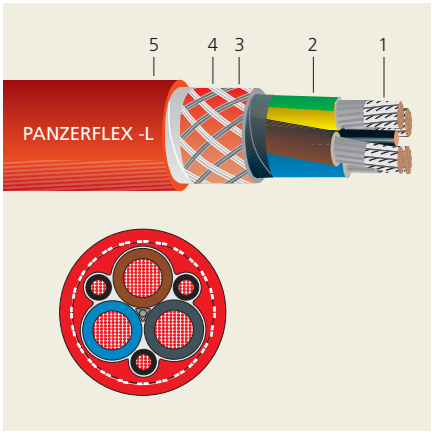
BC419

Nominal cross section mm²	Max. overall diam. mm	Bending radius mm	Net weight kg/km
4 x 1,5	8,75	44	136
5 x 1,5	9,45	47	198
7 x 1,5	11,00	55	254
12 x 1,5	13,00	65	416
18 x 1,5	15,20	76	564
25 x 1,5	19,90	100	811
4 x 2,5	11,50	70	203
7 x 2,5	14,40	90	343
12 x 2,5	17,10	105	499


NYK LOGISTICS
seaco
P&O
CAVOTEC

Panzerflex®-L; medium voltage power cable

Medium Voltage



Construction & Characteristics
PANZERFLEX® - L

1 *Phase conductor*
2 *Earth conductor*
3 *PCP inner sheath*
4 *Textile Anti-twisting braid*
5 *PCP outer sheath*

Applications

The new Panzerflex®-L* medium voltage cable has been developed and designed to meet the ever increasing demanding needs of the market in terms of reliability, speed and performance. The increase of the lengths, speed and acceleration requires more robust and at the same time lighter cables, whilst the smaller dimension can result in savings on equipment costs, transport and operating space. Typical applications for this cable are mobile installations on all types of harbour cranes, container cranes, ship unloaders, stackers & reclaimers, trippers, mobile generator sets and mining & tunnelling equipment.

Ratings and Specifications

VDE 0250 part 814

Rated and test voltages

Rated voltage Uo/U	3,6/6 kV A.C.
Max voltage Um	7,2 kV A.C.
Test voltage	11 kV A.C.
Rated voltage Uo/U	6/10 kV A.C.
Max voltage Um	12 kV A.C.
Test voltage	17 kV A.C.
Rated voltage Uo/U	8,7/15 kV A.C.
Max voltage Um	18 kV A.C.
Test voltage	24 kV A.C.
Rated voltage Uo/U	12/20 kV A.C.
Max voltage Um	24 kV A.C.
Test voltage	32 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 25°C Minimum ambient temperature during work

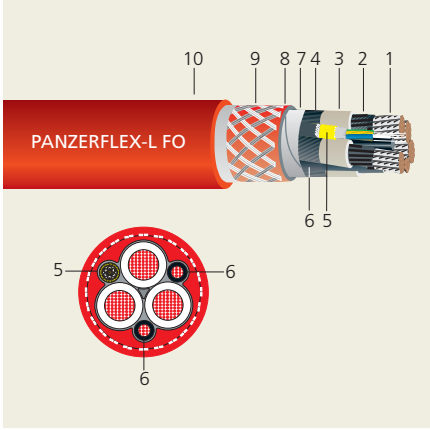
Dimensional data

	A.C. Rated voltage 6 kV		A.C. Rated voltage 10 kV		A.C. Rated voltage 15 kV		A.C. Rated voltage 20 kV		
Nominal cross section n x mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
3 x 25 + 3 x 10	45,90	2742	47,6	2915	52,4	3377	58,0	3989	1500
3 x 35 + 3 x 10	48,90	3317	50,6	3484	56,6	4124	61,0	4638	2100
3 x 50 + 3 x 10	51,70	3845	54,7	4166	59,5	4697	63,9	5236	3000
3 x 70 + 3 x 16	57,00	5024	58,9	5220	63,7	5807	69,7	6610	4200
3 x 95 + 3 x 16	61,00	6041	62,8	6250	69,3	7101	73,7	7703	5700
3 x 120 + 3 x 25	67,00	7588	68,8	7819	73,7	8480	79,5	9370	7200
3 x 150 + 3 x 25	71,20	8793	73,0	9033	–	–	–	–	–
3 x 185 + 3 x 35	74,30	10078	77,4	10574	–	–	–	–	–

** Old version of PANZERFLEX is available on request.*

Panzerflex®-L FO; medium voltage power cable with optical fibre

Medium Voltage



Construction & Characteristics PANZERFLEX®- L FO

1 Flexible tinned stranded copper conductor
2 Semiconducting tape or layer
3 EPR core insulation
4 Semiconducting layer
*5 Fibre optic element**
6 Ground conductor
7 Tape
8 PCP Inner sheath
9 Textile braid
10 PCP outer sheath

Applications

Panzerflex®-L FO medium voltage flexible power cables with optical fibres have been developed for use on moving installations where there are high torsional and tensile stresses ambient conditions are harsh and where there is a need to transmit data and signals through optical fibres.
Typical applications for Panzerflex®-L FO cables are reeling installations on ship-to-shore container cranes, ship-unloaders, stacker & reclaimers, heavy mining & tunnelling equipment and other large electrical machines.

Rating and test voltages

Rated voltage Uo/U	6/10 kV A.C.
Max voltage Um	12 kV A.C.
Test voltage	17 kV A.C.
Rated voltage Uo/U	8,7/15 kV A.C.
Max voltage Um	18 kV A.C.
Test voltage	24 kV A.C.
Rated voltage Uo/U	12/20 kV A.C.
Max voltage Um	24 kV A.C.
Test voltage	32 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 20°C Minimum ambient temperature during work

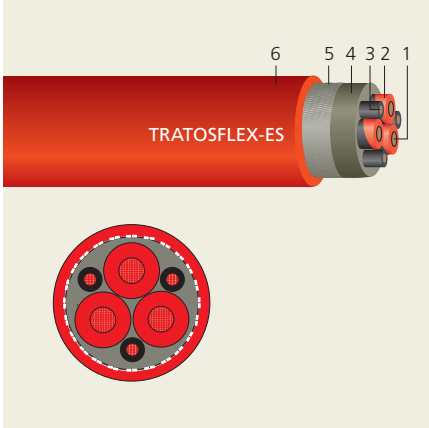
Dimensional data

	A.C. Rated voltage 10 kV		A.C. Rated voltage 15 kV		A.C. Rated voltage 20 kV		
Nominal cross section	Max. overall diam.	Net weight	Max. overall diam.	Net weight	Max. overall diam.	Net weight	Max. continuous safe reeling tension
n x mm²	mm	kg/km	mm²	kg/km	mm²	kg/kmN
3 x 25 + 2 x 16 + 6FO	50,0	2975	52,4	3365	58,0	4138	1500
3 x 35 + 2 x 16 + 6FO	50,6	3472	56,6	4112	61,0	4803	2100
3 x 50 + 2 x 16 + 6FO	54,7	4164	59,5	4695	63,9	5411	3000
3 x 70 + 2 x 25 + 6FO	58,9	5190	63,7	5777	69,7	6814	4200
3 x 95 + 2 x 25 + 6FO	62,8	6219	69,3	7070	–	–	5700
3 x 120 + 2 x 35 + 6FO	68,8	7755	73,7	8378	–	–	7200
3 x 150 + 2 x 35 + 6FO	73,0	8969	79,2	9882	–	–	9000
3 x 185 + 2 x 50 + 6FO	77,4	10343	82,3	11091	–	–	11100

** Fibre optic elements are available in sizes 62,5/125 and 50/125*
Note: attenuation on PANZERFLEX®-L FO complete at 850 nm: ≤ 5 dB/km

Tratosflex - ES; medium voltage power cable

Medium Voltage



Construction & Characteristics
PANZERFLEX® - L

1 *Phase conductor*
2 *Earth conductor*
3 *PCP inner sheath*
4 *Textile Anti-twisting braid*
5 *PCP outer sheath*

Applications

The Tratosflex – ES medium voltage power cable has been developed and designed to meet the increasing demand for reliable, high performance power cables. Increases in length, speed and acceleration require cables to be become stronger but at the same time, concerns over costs forces them to become lighter. Typical applications for the Tratosflex – ES cable are harbour cranes, container cranes, stackers & reclaimers, mobile generator sets and various mining & tunneling equipment.

Ratings and Specifications

VDE 0250 part 813

Rated and test voltages

Rated voltage Uo/U	3,6/6 kV A.C.
Max voltage Um	7,2 kV A.C.
Test voltage	11 kV A.C.
Rated voltage Uo/U	6/10 kV A.C.
Max voltage Um	12 kV A.C.
Test voltage	17 kV A.C.
Rated voltage Uo/U	8,7/15 kV A.C.
Max voltage Um	18 kV A.C.
Test voltage	24 kV A.C.
Rated voltage Uo/U	12/20 kV A.C.
Max voltage Um	24 kV A.C.
Test voltage	32 kV A.C.

Installation Temperature

+90 C Maximum conductor temperature
–35 C Minimum ambient temperature during work (fixed)
–25 C Minimum ambient temperature during work (flexible)

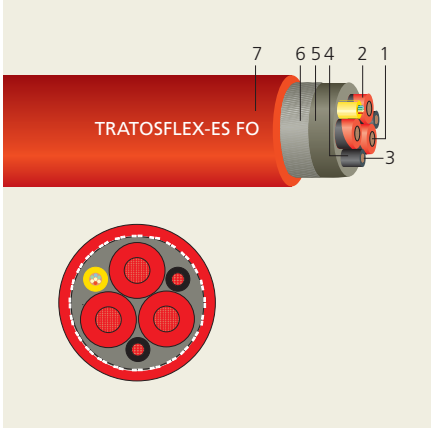
Dimensional data

	A.C. Rated voltage 6 kV		A.C. Rated voltage 10 kV		A.C. Rated voltage 15 kV		A.C. Rated voltage 20 kV		
Nominal cross section n x mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
3 x 25 + 3 x 10	40,5	2400	44,0	2800	48,0	3100	55,0	3700	1500
3 x 35 + 3 x 10	43,3	2900	47,0	3300	51,0	3750	56,7	4200	2100
3 x 50 + 3 x 10	47,7	3600	51,0	3950	55,5	4450	60,2	4880	3000
3 x 70 + 3 x 16	52,5	4670	56,0	5000	61,0	5600	65,0	6000	4200
3 x 95 + 3 x 16	57,0	5800	61,0	6000	66,0	6800	71,0	9000	5700
3 x 120 + 3 x 25	60,5	7000	65,5	7300	–	–	–	–	7200

Cables for rated voltage >= 18/30 kV are produced upon request.

Tratosflex-ES FO; medium voltage power cable with optical fibre

Medium Voltage



Construction & Characteristics
PANZERFLEX®- L FO

1 *Flexible tinned stranded copper conductor*
2 *Semiconducting tape or layer*
3 *EPR core insulation*
4 *Semiconducting layer*
5 *Fibre optic element**
6 *Ground conductor*
7 *Tape*
8 *PCP Inner sheath*
9 *Textile braid*
10 *PCP outer sheath*

Applications

The Tratosflex – ES FO cable is a medium voltage cable fitted with optical fibres. The cable has been specifically designed for use on mobile installations with high torsional and tensile stresses. Its robust design makes this cable ideal for applications in harsh working environments and is often used on reeling installations on ship-to-shore cranes, stackers and reclaimers, mining and tunneling equipment and other large electrical machinery.

Ratings and Specifications

VDE 0250 part 813

Rated and test voltages

Rated voltage Uo/U	3,6/6 kV A.C.
Max voltage Um	7,2 kV A.C.
Test voltage	11 kV A.C.
Rated voltage Uo/U	6/10 kV A.C.
Max voltage Um	12 kV A.C.
Test voltage	17 kV A.C.
Rated voltage Uo/U	8,7/15 kV A.C.
Max voltage Um	18 kV A.C.
Test voltage	24 kV A.C.
Rated voltage Uo/U	12/20 kV A.C.
Max voltage Um	24 kV A.C.
Test voltage	32 kV A.C.

Temperature ratings

+90 C Maximum conductor temperature
–35 C Minimum ambient temperature during work (fixed)
–25 C Minimum ambient temperature during work (flexible)

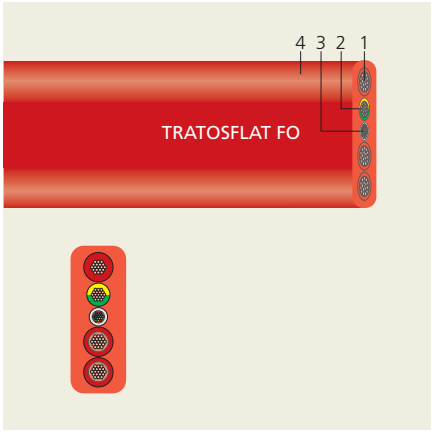
Dimensional data

	A.C. Rated voltage 6 kV		A.C. Rated voltage 10 kV		A.C. Rated voltage 15 kV		A.C. Rated voltage 20 kV		
Nominal cross section n x mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
3x25 + 2x25/2 + 6FO(1)	40,5	2400	44,0	2800	48,0	3100	55,0	3700	1500
3x35 + 2x25/2 + 6FO	43,3	2900	47,0	3300	51,0	3750	56,7	4200	2100
3x50 + 2x25/2 + 6FO	47,7	3600	51,0	3950	55,5	4450	60,2	4880	3000
3x70 + 2x35/2 + 6FO	52,5	4670	56,0	5000	61,0	5600	65,0	6000	4200
3x95 + 2x50/2 + 6FO	57,0	5800	61,0	6000	66,0	6800	71,0	7300	5700
3x120 + 2x70/2 + 6FO	60,5	7000	65,5	7300	–	–	–	–	7200

(1) Note: Standard fibres type 62,5/125 or 50/125 and 9/125 on request.
Cables for rated voltage >= 18/30 kV are produced upon request.

Tratosflat FO; flat medium voltage power cable with optical fibre

Medium Voltage



Construction & Characteristics TRATOSFLAT-FO

1 Screened phase conductors
2 Ground conductor
3 Optical fibre cable
4 Red polychloropene 5GM3 outer sheath

Applications

The Tratosflat FO medium voltage power cable with fibre optics has been developed and designed to meet the increasing demand for reliable, high performance flat power cables. Increases in length, speed and acceleration require cables to be become stronger but at the same time, concerns over costs forces them to become lighter. Typical applications for the Tratosflat FO cables are harbour cranes, container cranes, stackers & reclaimers, mobile generator sets and various mining & tunneling equipment.

Rated and test voltages

Rated voltage Uo/U	1,8/3 kV
Max voltage Um	3,6 kV
Test voltage	8 kV A.C.
Rated voltage Uo/U	3,6/6 kV
Max voltage Um	7,2 kV
Test voltage	11 kV A.C.

Installation Temperature

+90 C Maximum conductor temperature
–35 C Minimum ambient temperature during work (fixed)
–25 C Minimum ambient temperature during work (flexible)

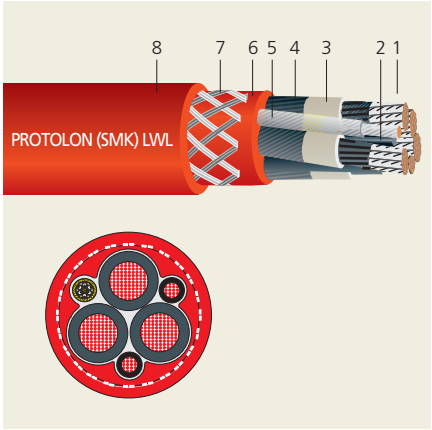
Dimensional data

	A.C. Rated voltage 3 kV		A.C. Rated voltage 6 kV		A.C. Rated voltage 6 kV		
Nominal cross section	Max. overall diam.	Net weight	Max. overall diam.	Net weight	Max. overall diam.	Net weight	Max. continuous safe reeling tension
n x mm²	kg/km	mm²	kg/km	mm²	kg/km	mm²	kg/kmN
4 x 35	72 x 29	4000	89 x 32	4500	–	–	2100
4 x 50	78 x 31	4800	96 x 33	5300	–	–	3000
4 x 70	86 x 32	5900	102 x 35	6700	–	–	4200
4 x 35 + 6FO(1)	–	–	–	–	97 x 32	4700	2100
4 x 35 + 6FO	–	–	–	–	103 x 34	5700	3000

(1) Note: standard fibres type 62,5/125 or 50/125 and 9/125 on request

Protolon™ (SMK) LWL; medium voltage power cable with optical fibre

Medium Voltage



Construction & Characteristics
PROTOLON (SMK) LWL

1 *Conductor*
2 *EPR cradle separator*
3 *Insulation*
4 *Outer semiconductive layer*
5 *Fibre-optic element**
6 *Inner sheath*
7 *Anti-torsion braid*
8 *Outer sheath - Sandwich system*

Applications

The PROTOLON™ (SMK) LWL is a medium voltage reeling cable, specifically designed to withstand extremely high mechanical stresses associated with high travel speed, dynamic tensile loads or torsional stresses.
PROTOLON™ (SMK) LWL features an integrated fiber optic element consisting of 6 or 18 optical fibers for transmission of control signals, voice, video and other data signals. Applications include container cranes, shiploaders, stacker/reclaimers, RMG's, log handling cranes and much more. PROTOLON™ (SMK) LWL is also suitable for mining applications like bucket wheel excavators and tunneling equipment. If PROTOLON™ (SMK) LWL cables are damaged they are easily repaired by qualified personnel, so it can be used again within its nominal parameters without restrictions.
If application parameters exceed specified values in the technical tables, please consult your local Cavotec office.

Ratings and Specifications

VDE 0250 part 813
VDE 0168/0118

Rating and test voltages

Rated voltage Uo/U	3,6/6 kV A.C.
Max voltage Um	4,2/7,2 kV A.C.
Test voltage	11 kV A.C.
Rated voltage Uo/U	6/10 kV A.C.
Max voltage Um	7,2/12 kV A.C.
Test voltage	17 kV A.C.
Rated voltage Uo/U	8,7/15 kV A.C.
Max voltage Um	10,4/18 kV A.C.
Test voltage	24 kV A.C.
Rated voltage Uo/U	12/20 kV A.C.
Max voltage Um	13,9/24 kV A.C.
Test voltage	29 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 35°C Minimum ambient temperature during work (flexible)
– 50°C Minimum ambient temperature during work (fixed)

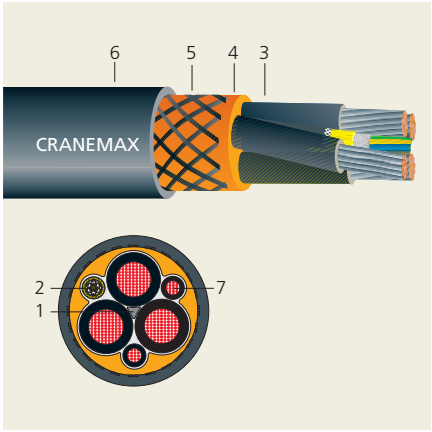
Dimensional data

	A.C. Rated voltage 3,6/6 kV		A.C. Rated voltage 6/10 kV		A.C. Rated voltage 8,7/15 kV		A.C. Rated voltage 12/20 kV		
Nominal cross section n x mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
3x25 + 2x25/2 + 6 LWL	43,7	2610	43,7	2610	46,5	2860	49,6	3150	1500
3x35 + 2x25/2 + 6 LWL	45,7	3010	45,7	3010	49,1	3330	54,1	3810	2100
3x50 + 2x25/2 + 6 LWL	49,1	3680	49,1	3680	54,5	4210	58,1	4610	3000
3x70 + 2x35/2 + 6 LWL	55,1	4810	55,1	4810	59,2	5270	62,2	5640	4200
3x95 + 2x50/2 + 6 LWL	60,1	6000	60,1	6000	64,9	6640	68	7050	5700
3x120 + 2x70/2 + 6 LWL	64,9	7410	64,9	7410	68,4	7870	72	8360	7200
3x150 + 2x70/2 + 6 LWL	68,8	8570	68,8	8570	72,8	9130	77,3	9840	9000
3x185 + 2x95/2 + 6 LWL	73,3	10160	73,3	10160	78,1	10920	81,2	11410	11100

** Fibre optic elements are available in size 62,5/125µ, 50/125µ and E9/125µ*

CraneMAX; medium voltage power cable

Medium Voltage



Construction & Characteristics CRANEMAX

1 *Filler*
2 *Conductor*
3 *Insulation & Extruded conductive shield*
4 *Inner jacket*
5 *Aramid reinforcement*
6 *Outer jacket*
7 *Ground conductor*
8 *Ground check*

Applications

AmerCable's High Speed Reeling Cables are designed to provide safe and optimum performance on cable reels operating worldwide at temperatures from -40°C to +50°C at speeds up to 305 m./min. These three conductor cables are specially designed for use with monospiral, level wind and random wind reels on gantry cranes, container cranes, log handling cranes, stacker/reclaimers and other similar lifting equipment. They are suitable for outdoor use in ports, shipyards, lumber mills, steel mills and mines. Please note that this cable is designed and built according to US standards.

Ratings and Specifications

ASTM B-172; ASTM B-33

Rating and test voltages

Rated voltage Uo/U	1,2/2,1 kV to 9,0/15 kV A.C.
Max voltage Um	1,2/2,1 kV to 9,0/15 kV A.C.
Max voltage Um	1,5/3,2 kV to 11,3/22,5 kV D.C.
Test voltage	18 to 27 kV A.C.

Temperature ratings

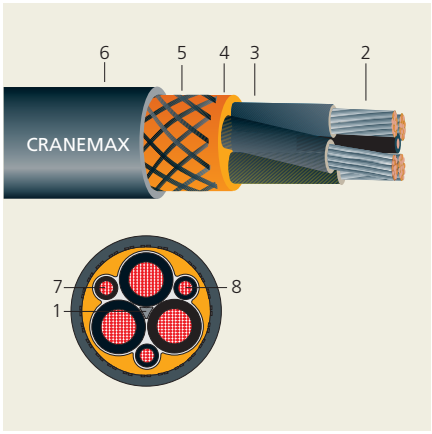
+ 90°C Maximum conductor temperature
– 40°C Minimum ambient temperature during work

Dimensional data

		A.C. Rated voltage 2,1/6 kV		A.C. Rated voltage 6,1/10 kV		A.C. Rated voltage 10,1/15 kV		
AWG	Nominal cross section mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
4	21,5	38,9	2149	40,5	2223	45,6	2609	3780
2	33,6	42,4	2707	44,0	2838	49,0	3256	3780
1	42,4	45,0	3144	46,6	3283	51,7	3720	4670
1/0	53,5	47,7	3653	49,3	3799	55,6	4512	5560
2/0	67,4	50,9	4360	52,5	4444	58,7	5202	6450
3/0	85	53,8	5315	55,4	5483	61,5	6029	7339
4/0	107,2	57,6	6330	59,2	6522	–	–	8229

CraneMAX FO; medium voltage power cable with optical fibre

Medium Voltage



Construction & Characteristics CRANEMAX

1 Filler
2 Fiber optic element
3 Insulation & Extruded conductive shield
4 Inner jacket
5 Aramid reinforcement
6 Outer jacket
7 Ground conductor

Applications

AmerCable's High Speed Reeling Cables are designed to provide safe, optimum performance on cable reelers operating worldwide at temperatures from -40°C to +50°C at speeds up to 260 m/min. These cables are for the combined transmission of power and data and are specially designed for use with monospiral, level wind and random wind reelers on gantry cranes, container cranes, log handling cranes, stacker/reclaimers and other similar lifting equipment. They are suitable for outdoor use in ports, shipyards, lumber mills, steel mills and mines. Please note that this cable is designed and built according to US standards.

Ratings and Specifications

ASTM B-172; ASTM B-33

Rating and test voltages

Rated voltage Uo/U	1,2/2,1 kV to 9,0/15 kV A.C.
Max voltage Um	1,2/2,1 kV to 9,0/15 kV A.C.
Max voltage Um	1,5/3,2 kV to 11,3/22,5 kV D.C.
Test voltage	18 to 27 kV A.C.

Temperature ratings

+ 90°C Maximum conductor temperature
– 40°C Minimum ambient temperature during work

Dimensional data

		A.C. Rated voltage 2,1/6 kV		A.C. Rated voltage 6,1/10 kV		A.C. Rated voltage 10,1/15 kV		
AWG	Nominal cross section mm²	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. overall diam. mm²	Net weight kg/km	Max. continuous safe reeling tension N
4	21,5	38,9	2127	40,5	2201	45,6	2586	3780
2	33,6	42,4	2685	44,0	2816	49,0	3234	3780
1	42,4	45,0	3122	46,6	3261	51,7	3698	4670
1/0	53,5	47,7	3631	49,3	3777	55,6	4490	5560
2/0	67,4	50,9	4289	52,5	4421	58,7	5181	6450
3/0	85	53,8	5295	55,4	5406	61,5	6007	7339
4/0	107,2	57,6	6305	59,2	6501	–	–	8229

* *Fibre optic elements are available in size 62,5/125. 6 fiber bundle is standard. 12 & 18 fiber bundles available on special order*

Comparison chart
Metric cross-section – AWG* numbers

To ensure accurate translation between metric cross-sections and American Wire Gauge (AWG) numbers we have included this comparison chart. We do advise however to contact your local Cavotec office in the case of any uncertainty.

Metric nominal cross-section mm²	mm²	AWG number
0.75	0.653	19
	0.823	18
	1.04	17
	1.31	16
1.5	1.65	15
	2.08	14
2.5	2.62	13
	3.31	12
4.0	4.17	11
	5.26	10
6.0	6.63	9
	8.37	8
	10.55	7
10.0	13.30	6
16.0	16.77	5
	21.15	4
25.0	26.27	3
	33.63	2
35.0	42.41	1
	53.48	1/0
50	67.43	2/0
70.0	85.03	3/0
95.0	107.20	4/0
120.0	126.64	250 MCM
150.0	152.00	300 MCM
	177.35	350 MCM
185.00	202.71	400 MCM
240.0	253.35	500 MCM
300.0	380.00	750 MCM
400.0		
500.0	506.71	1000 MCM
625.0		

**AWG American Wire Gauge*

Head Office

Cavotec MSL Holdings Ltd.
Cavotec MSL is listed on the NZX

Corporate Office

Cavotec (Swiss) SA
Via Serafino Balestra 27
CH-6900 Lugano, Switzerland

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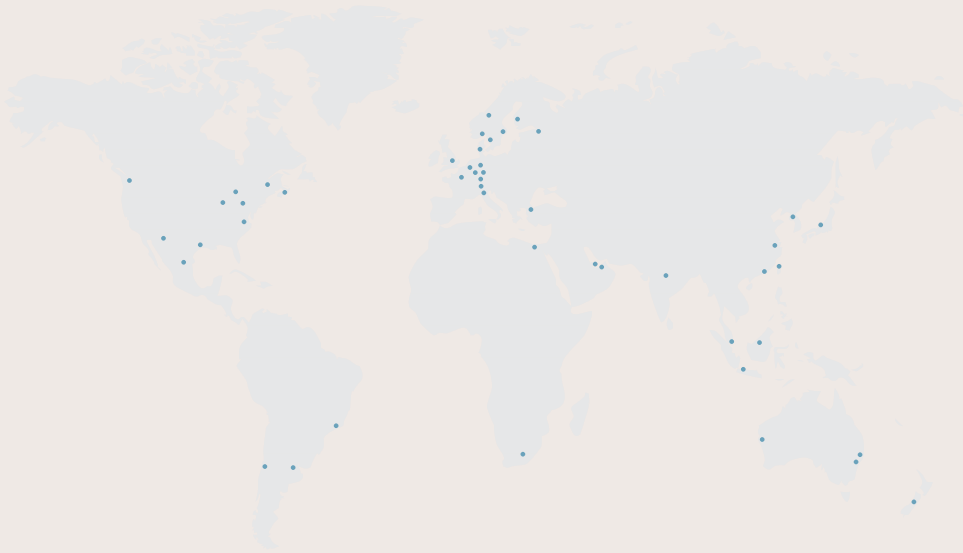

For more information please visit our website **www.cavotec.com**
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