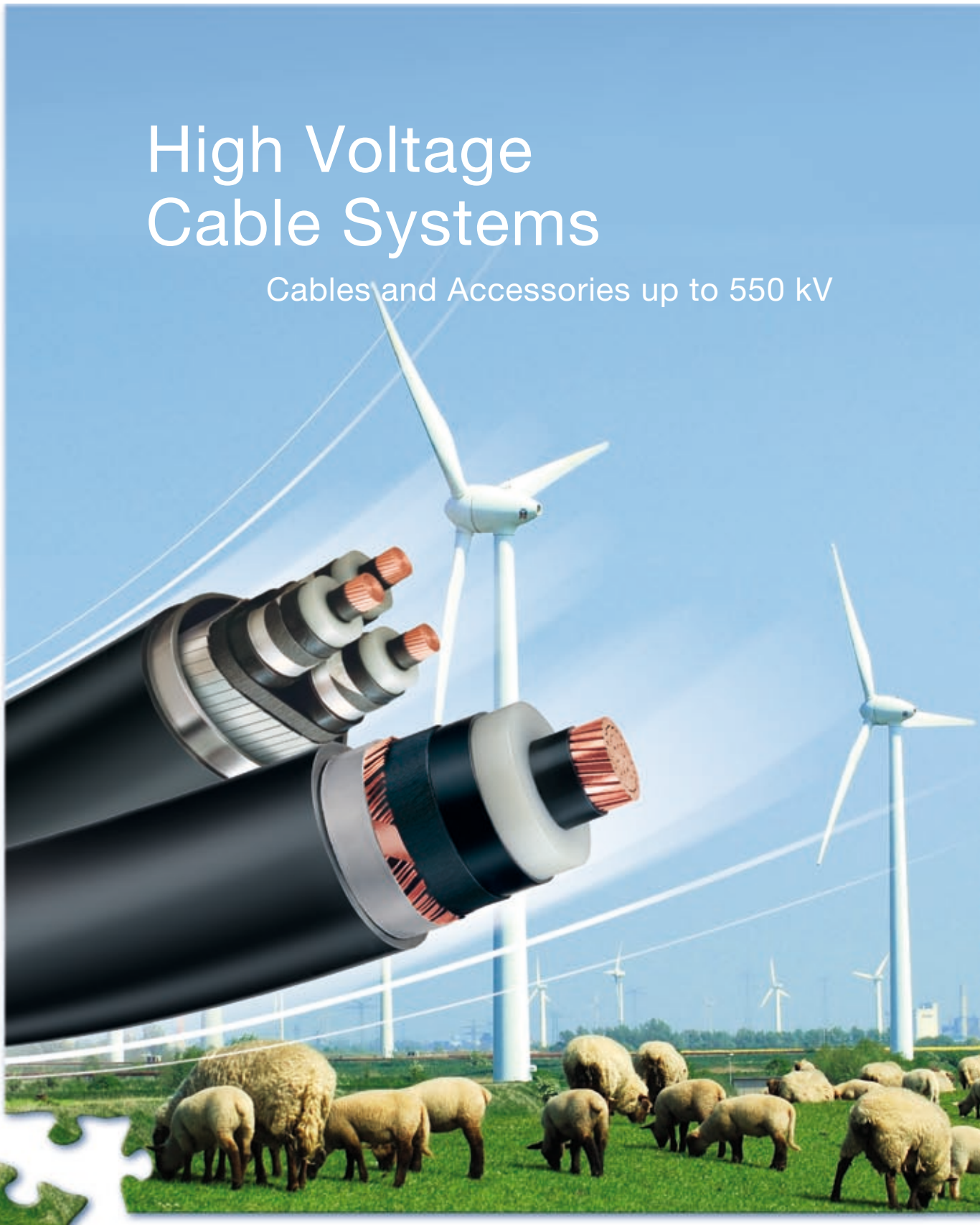
nkt cables

High Voltage Cable Systems

Cables and Accessories up to 550 kV



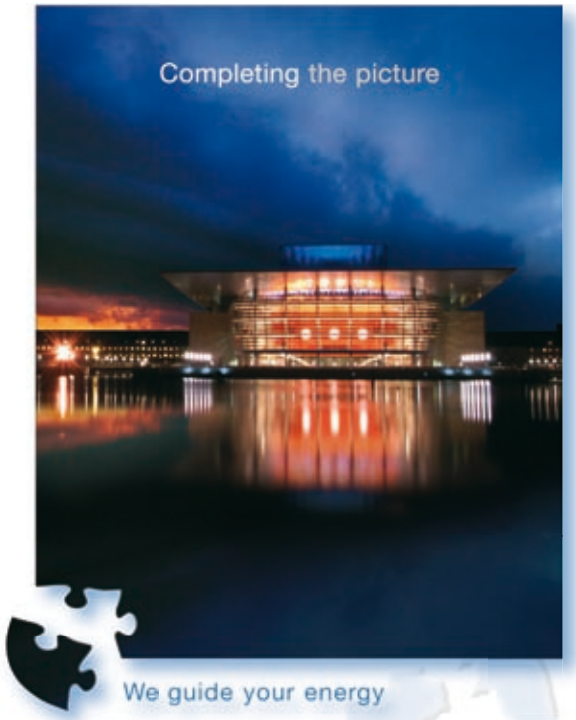
Completing the picture

nkt cables – part of a world, counting on reliable and available electrical power

Today a world without electrical power is unthinkable. Electricity belongs to life like the air we breathe. The way we take the use of electricity for granted day in, day out – in our homes, in traffic, at work, in the industry – it is extremely important to supply this “elixir of life” in a reliable and economic way.

We are aware of this responsibility. Therefore, you as our customer can expect the products supplied to you by nkt cables to be optimized to the task of being a reliable part of the “vital nerve” power transmission.

Take us at our word!



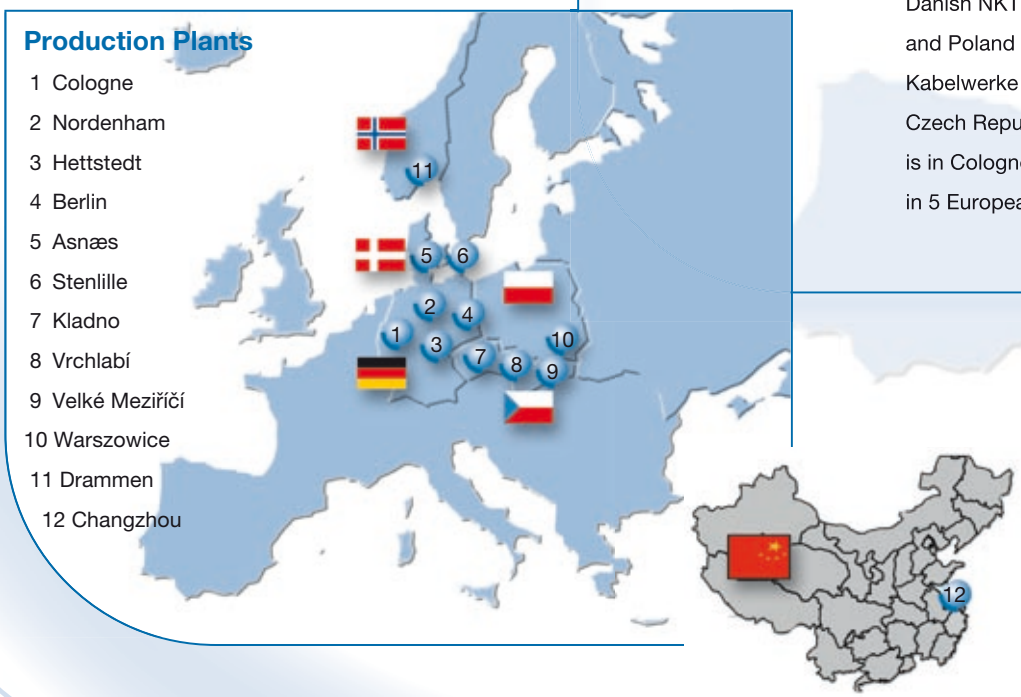
Take us at our word!

Who is nkt cables?

nkt cables GmbH is part of the nkt cables group GmbH, a group originated from the Danish NKT CABLES with plants in Denmark and Poland and the former Felten & Guilleaume Kabelwerke GmbH with plants in Germany, Czech Republic and China. The company seat is in Cologne and today it consists of 11 plants in 5 European countries and one plant in China.

Production Plants

1 Cologne
2 Nordenham
3 Hettstedt
4 Berlin
5 Asnæs
6 Stenlille
7 Kladno
8 Vrchlabí
9 Velké Meziříčí
10 Warszowice
11 Drammen
12 Changzhou



High Voltage and Extra-High Voltage, a speciality of the HV-team from Cologne

Development, consultancy, planning and design, cost-optimization, production, logistics, installation and service. With this all-round support the nkt cables HV-team will be at our customer's service in regard of the products high voltage and extra-high voltage cables and accessories. Optimized internal communication systems, specialized divisions and intensively trained team members are the power behind the customer-orientated installation solutions. With competence and know-how the nkt cables "Power Team" provides secure and reliable power supply wherever fully developed high-voltage power transmission is needed – whether in offshore areas for the connection of windfarms or in the middle of Jakarta or Dubai or with the installation of the first superconducting HV cable in New York.

The nkt cables HV-team has gained overall international experience. High voltage cable installations from Cologne take care of a reliable power supply in Europe as well as Asia or America. As the HV-team feels bound to always deliver the optimal tailor-made system solutions, no two installations are alike. And while doing so, security and economy always come first.

The Cables

Design and Manufacture

A wide variety of high voltage cable designs is offered by nkt cables to provide most economic solutions. Various types of conductors, insulation, metallic screening and sheathing, corrosion protective layers etc. are available.

Conductors

The cable conductors can be made of copper or aluminium. The choice is a matter of customer's preference or current carrying capacity. Large size solid conductors are made of aluminium.

Available conductor constructions:

- round solid conductors up to 2000 mm² (RE)
- circular stranded compacted conductors up to 1200 mm² (RM)
- circular conductors with shaped wires up to 2000 mm² (RM, Keystone conductors)
- segmental conductors up to 2500 mm² (RMS, Milliken conductors)
- oval shaped stranded compacted conductors up to 800 mm² for external gas pressure cables (OM)

The conductors are manufactured to meet the requirements of the relevant national and international standards. For special applications the conductors can be made watertight.

Insulation

The insulations for low pressure oil filled cables and for conventional pipe type cables are lapped from high quality insulating papers. Subsequently the paper insulated cable cores are impregnated in appropriate vessels with low viscous oil or high viscous compound.

For manufacture of XLPE insulated high voltage cables, nkt cables disposes of four extrusion lines. Highest quality standards together with latest process control equipment and combined with decades of experience ensure manufacture of cables meeting the highest requirements and enabling development of most advanced power cable systems.

Metallic Covering

Conventional paper insulated cables require a pressure proof and watertight metallic enclosure, acting also as metallic screen. At nkt cables both, extruded lead sheath as well as the aluminium sheath can be applied. These types of metal sheaths are, of course, also used on XLPE insulated cables. While the lead sheath leads to smaller dimensions, the aluminium sheath provides high short circuit current carrying capability and lower weight.

As the XLPE insulated cables do not require an internal overpressure, they are usually equipped with a copper wire screen. For radial moisture barrier a coated aluminium foil is longitudinally applied. The combination with the polyethylene oversheath is called aluminium polyethylene laminated (APL) sheath. This solution provides high short circuit capability and watertightness combined with lowest weight and smallest dimensions.

A combination of the copper wire screen with a metal sheath is also possible. For all XLPE insulated high voltage cables, the space between cable core and water barrier is made longitudinally watertight.

Product Scope

Besides XLPE insulated cables nkt cables still produces paper insulated cables.

U_m/kV	72,5	123	145	170	245	300	420	550
External Gas Pressure Cable	X	X	X	X				
Internal Gas Pressure Cable	X	X						
XLPE Cable	X	X	X	X	X	X	X	X
CityCable VALFIT®	X	X	X	X	X			

Technical Data

The following tables summarize several significant data of various cable types.

For other types and data please contact nkt cables.

The current ratings are calculated for standard conditions, which are:		
soil thermal resistivity, moist/dry	1,0/2,5	Km/W
soil temperature	15	°C
laying depth	1,2	m
for cables in touching trefoil formation, screens solidly earthed		
axial distance of two circuits	0,5	m
cables in flat formation, screens cross bonded		
axial distance between phases	0,2	m
axial distance of two circuits	0,9	m

Oversheath

An extruded polyethylene sheath is provided as the standard solution. With respect to its excellent mechanical strength it is the optimum for buried cables. If required, a conductive layer can be provided on the outside. For special applications different sheathing material may be used, optimized for the purpose.

Cabling and Armouring

For the conventional pipe type cables as well as for the CityCable, laying-up of the three cores and provision of the strong steel armour is an essential feature. Therefore, nkt cables disposes also of the appropriate machinery to carry out these production steps.

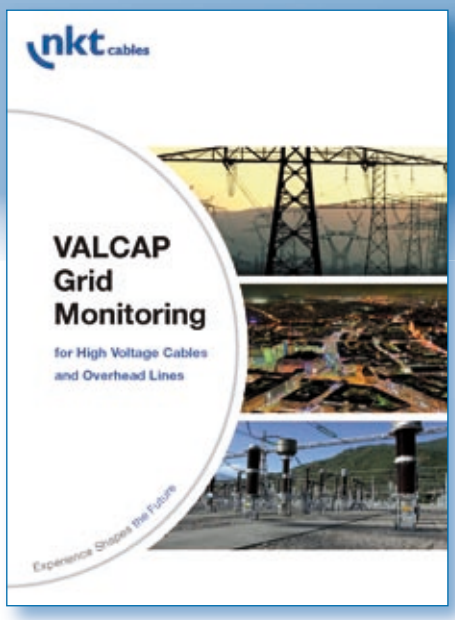
Integration of Optical Fibres and VALCAP Grid Monitoring

For distributed temperature measurement optical fibres can be integrated for both, three core and single core cables.

Today ampacity of your grid is restricted by thermal limits based on fixed and standardized parameters with high safety margins. It is not possible to control grids dynamically and in real time.

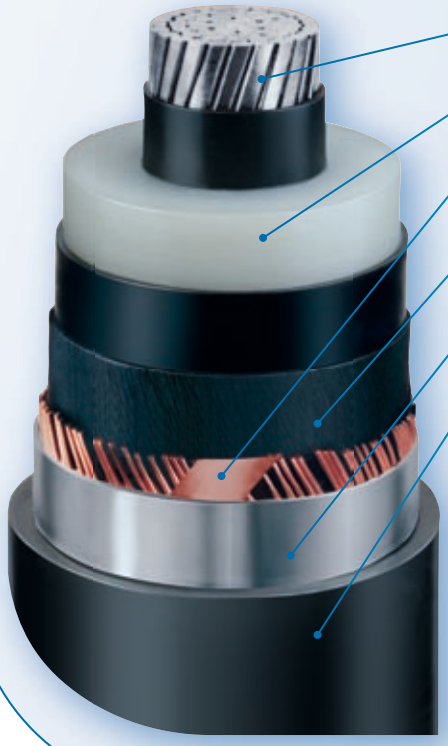
With VALCAP you can maximize the efficiency of your existing grid: continuous temperature monitoring and evaluation of the actual environment conditions along power cables and overhead lines allow you to decide precisely how much load your grid can transport safely.

And VALCAP will even do more for you: With its intelligent software companion ADAPPRO you get information of expected future loads, for every day and every hour. So you can pro-actively manage the energy load transmission of your grid.



For more information please request the brochure “VALCAP Grid Monitoring”.

Single Core XLPE Cables with Copper Wire Screen and APL Sheath



A	aluminium conductor
2X	XLPE insulation
S	copper wire screen
(F	watertight design
L)	radial water barrier (AL tape)
2Y	polyethylene sheath

construction code	A2XS(FL)2Y
for cable with Cu conductor	2XS(FL)2Y

These cables can be supplied in the standard design, i.e. with insulation thickness as already used for several decades.

Due to improvements in material and manufacture it was possible not only to develop XLPE cables for extra-high voltage, but also to reduce the insulation thickness of the established high voltage cables. The effects are smaller dimensions and weights, both enabling longer supply lengths on standard drums, resulting in a smaller number of joints which in turn means less installation work and less disturbance due to open joint bays. Overall, a significant cost saving is achieved with the XLPE cables of advanced design.

Based on experience gained from tests and long-term service, further tables present data of cables with optimized design.

132 kV Single Core XLPE Cables with Copper Wire Screen and APL Sheath (Standard Design)

Type (A)2XS(FL)2Y 1 x ..... RM/50 76/132 kV with stranded compacted conductor (RM)

Dimensions/Cross Sections			mm²	185	240	300	400	500	630	800
Conductor, Cu or Al, round, stranded, Ø		approx.	mm	16,1	18,3	20,7	23,4	26,5	30,0	34,2
XLPE insulation		nom.	mm	22,0	20,0	19,0	18,0	18,0	18,0	16,0
Screen, copper wire, cross section		nom.	mm²	50	50	50	50	50	50	50
Outer diameter		approx.	mm	74	72	72	74	77	81	82
Cable weight (Cu/Al)		approx.	kg/m	6,0/4,4	6,2/4,3	6,8/4,5	7,7/5,2	8,8/5,7	10,3/6,4	11,7/6,8
Permissible pulling force (Cu/Al)		max.	kN	9,3/5,6	12/7,2	15/9,0	20/12	25/15	32/19	40/24
Bending radius during laying		min.	m	1,85	1,80	1,80	1,85	1,90	2,00	2,05
at terminations		min.	m	1,10	1,10	1,10	1,10	1,15	1,20	1,20
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0991	0,0754	0,0601	0,0470	0,0366	0,0283	0,0221
Al conductor		max.	Ω/km	0,164	0,125	0,100	0,0778	0,0605	0,0469	0,0367
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,127	0,0973	0,0781	0,0618	0,0492	0,0393	0,0326
Al conductor		approx.	Ω/km	0,211	0,161	0,129	0,101	0,0791	0,0622	0,0500
Field strength at U_0 at conductor screen		approx.	kV/mm	6,9	6,9	6,9	6,8	6,5	6,3	6,6
at core screen		approx.	kV/mm	2,0	2,3	2,5	2,8	2,9	3,0	3,5
Capacitance per core		approx.	µF/km	0,107	0,121	0,134	0,151	0,163	0,177	0,212
Inductance		approx.	mH/km	0,49	0,46	0,44	0,42	0,40	0,39	0,36
Current Ratings/Power Ratings (continuous load)						**trefoil installation**				
Cu conductor cables	1 circuit		A/MVA	368/84	420/96	469/107	525/120	586/134	649/148	706/161
	2 circuits		A/MVA	314/72	358/82	398/91	444/102	493/113	545/125	591/135
Al conductor cables	1 circuit		A/MVA	289/66	332/76	371/85	420/96	474/108	533/122	591/135
	2 circuits		A/MVA	246/56	282/64	315/72	356/81	400/91	448/102	495/113

Type (A)2XS(FL)2Y 1 x ..... RMS/50 76/132 kV with segmental conductor (RMS)

Dimensions/Cross Sections			mm²	1000	1200	1400	1600	1800	2000	2500
Conductor, round, stranded, segmental, Ø		approx.	mm	39,0	42,0	45,3	48,5	51,3	54,3	60,9
XLPE insulation		nom.	mm	16,0	15,0	15,0	15,0	14,0	14,0	14,0
Screen, copper wire, cross section		nom.	mm²	110	110	110	110	110	110	110
Outer diameter		approx.	mm	93	94	98	101	102	106	113
Cable weight (Cu/Al)		approx.	kg/m	15/9,1	17/9,7	19/10	21/11	23/12	25/13	30/15
Permissible pulling force (Cu/Al)		max.	kN	50/30	60/36	70/42	80/48	90/54	100/60	125/75
Bending radius during laying		min.	m	2,30	2,35	2,45	2,50	2,55	2,65	2,80
at terminations		min.	m	1,40	1,40	1,45	1,50	1,55	1,60	1,70
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0176	0,0151	0,0129	0,0113	0,0101	0,0090	0,0072
Al conductor		max.	Ω/km	0,0291	0,0247	0,0212	0,0186	0,0165	0,0149	0,0119
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,0232	0,0201	0,0175	0,0156	0,0142	0,0129	0,0109
Al conductor		approx.	Ω/km	0,0375	0,0319	0,0275	0,0240	0,0213	0,0193	0,0156
Field strength at U_0 at conductor screen		approx.	kV/mm	6,3	6,5	6,5	6,4	6,7	6,6	6,5
at core screen		approx.	kV/mm	3,7	4,0	4,1	4,1	4,5	4,5	4,6
Capacitance per core		approx.	µF/km	0,245	0,271	0,286	0,301	0,332	0,346	0,378
Inductance		approx.	mH/km	0,56	0,55	0,53	0,52	0,51	0,50	0,47
Current Ratings/Power Ratings (continuous load)						**flat installation**				
Cu conductor cables	1 circuit		A/MVA	999/228	1074/246	1155/264	1226/280	1285/294	1346/308	1465/335
	2 circuits		A/MVA	852/195	915/209	984/225	1043/238	1091/249	1144/262	1244/284
Al conductor cables	1 circuit		A/MVA	791/181	859/196	929/212	997/228	1058/242	1114/255	1244/284
	2 circuits		A/MVA	675/154	732/167	791/181	849/194	900/206	947/217	1057/242

132 kV Single Core XLPE Cables with Copper Wire Screen and APL Sheath (Optimized Design)

Type (A)2XS(FL)2Y 1 x ..... RM/50 76/132 kV with stranded compacted conductor (RM)

Dimensions/Cross Sections		mm²	185	240	300	400	500	630	800
Conductor, Cu or Al, round, stranded, Ø	approx.	mm	16,1	18,3	20,7	23,4	26,5	30,0	34,2
XLPE insulation	nom.	mm	19,0	18,0	17,0	16,0	15,0	14,0	14,0
Screen, copper wire, cross section	nom.	mm²	50	50	50	50	50	50	50
Outer diameter	approx.	mm	68	68	68	69	71	72	77
Cable weight (Cu/Al)	approx.	kg/m	5,3/4,2	5,8/4,3	6,3/4,5	7,2/4,7	8,1/5,0	9,3/5,4	11,2/6,3
Permissible pulling force (Cu/Al)	max.	kN	9,3/5,6	12/7,2	15/9,0	20/12	25/15	32/19	40/24
Bending radius during laying	min.	m	1,70	1,70	1,70	1,75	1,75	1,80	1,95
at terminations	min.	m	1,00	1,00	1,00	1,05	1,05	1,10	1,15
Electrical Data									
Cu conductor DC resistance at 20°C	max.	Ω/km	0,0991	0,0754	0,0601	0,0470	0,0366	0,0283	0,0221
Al conductor	max.	Ω/km	0,164	0,125	0,100	0,0778	0,0605	0,0469	0,0367
Cu conductor AC resistance at 90°C	approx.	Ω/km	0,127	0,0973	0,0781	0,0618	0,0492	0,0393	0,0326
Al conductor	approx.	Ω/km	0,211	0,161	0,129	0,101	0,0791	0,0622	0,0500
Field strength at U_0 at conductor screen	approx.	kV/mm	7,5	7,4	7,4	7,3	7,4	7,6	7,3
at core screen	approx.	kV/mm	2,4	2,6	2,9	3,2	3,6	4,0	4,1
Capacitance per core	approx.	µF/km	0,116	0,129	0,144	0,164	0,185	0,212	0,235
Inductance	approx.	mH/km	0,48	0,45	0,43	0,41	0,38	0,36	0,35
Current Ratings/Power Ratings (continuous load)					**trefoil installation**				
Cu conductor cables	1 circuit	A/MVA	368/84	420/96	468/107	523/120	581/133	642/147	702/160
	2 circuits	A/MVA	314/72	358/82	397/91	442/101	490/112	540/123	587/134
Al conductor cables	1 circuit	A/MVA	289/66	332/76	370/85	418/96	471/108	533/121	588/134
	2 circuits	A/MVA	247/56	282/64	315/72	354/81	398/91	444/102	491/112

Type (A)2XS(FL)2Y 1 x ..... RMS/50 76/132 kV with segmental conductor (RMS)

Dimensions/Cross Sections		mm²	1000	1200	1400	1600	1800	2000	2500
Conductor, round, stranded, segmental, Ø	approx.	mm	39,0	42,0	45,3	48,5	51,3	54,3	60,9
XLPE insulation	nom.	mm	13,0	13,0	13,0	13,0	13,0	13,0	13,0
Screen, copper wire, cross section	nom.	mm²	110	110	110	110	110	110	110
Outer diameter	approx.	mm	86	89	93	96	100	103	110
Cable weight (Cu/Al)	approx.	kg/m	14,5/8,3	16,5/9,0	18,6/9,9	21/10,7	23/11,6	25/12,4	30/14,4
Permissible pulling force (Cu/Al)	max.	kN	50/30	60/36	70/42	80/48	90/54	100/60	125/75
Bending radius during laying	min.	m	2,15	2,20	2,30	2,40	2,50	2,60	2,75
at terminations	min.	m	1,30	1,35	1,40	1,45	1,50	1,55	1,65
Electrical Data									
Cu conductor DC resistance at 20°C	max.	Ω/km	0,0176	0,0151	0,0129	0,0113	0,0101	0,0090	0,0072
Al conductor	max.	Ω/km	0,0291	0,0247	0,0212	0,0186	0,0165	0,0149	0,0119
Cu conductor AC resistance at 90°C	approx.	Ω/km	0,0232	0,0201	0,0175	0,0156	0,0142	0,0129	0,0109
Al conductor	approx.	Ω/km	0,0375	0,0319	0,0275	0,0240	0,0213	0,0193	0,0156
Field strength at U_0 at conductor screen	approx.	kV/mm	7,4	7,3	7,2	7,2	7,1	7,0	6,9
at core screen	approx.	kV/mm	4,7	4,7	4,8	4,8	4,9	4,9	5,0
Capacitance per core	approx.	µF/km	0,289	0,304	0,322	0,338	0,353	0,368	0,402
Inductance	approx.	mH/km	0,56	0,55	0,53	0,52	0,51	0,50	0,47
Current Ratings/Power Ratings (continuous load)						**flat installation**			
Cu conductor cables	1 circuit	A/MVA	1007/230	1081/247	1160/265	1227/281	1284/294	1341/307	1447/331
	2 circuits	A/MVA	875/200	938/214	1005/230	1063/243	1110/254	1159/265	1248/285
Al conductor cables	1 circuit	A/MVA	795/182	863/197	932/213	998/228	1057/242	1110/254	1231/281
	2 circuits	A/MVA	691/158	750/171	808/185	864/198	915/209	960/219	1062/243

220 kV Single Core XLPE Cables with Copper Wire Screen and APL Sheath

Type (A)2XS(FL)2Y 1 x ..... RM/50 127/220 kV with stranded compacted conductor (RM)

Dimensions/Cross Sections			mm²	240	300	400	500	630	800	1000
Conductor, Cu or Al, round, stranded, Ø		approx.	mm	18,3	20,7	23,4	26,5	30,0	34,2	38,1
XLPE insulation		nom.	mm	25,0	24,0	22,0	22,0	22,0	19,0	19,0
Screen, copper wire, cross section		nom.	mm²	50	50	50	50	50	50	50
Outer diameter		approx.	mm	83	83	82	86	90	88	92
Cable weight (Cu/Al)		approx.	kg/m	7,4/5,9	8,0/6,1	8,6/6,2	9,9/6,8	11,4/7,5	12,5/7,5	14,6/8,4
Permissible pulling force (Cu/Al)		max.	kN	12/7,2	15/9,0	20/12	25/15	32/19	40/24	50/30
Bending radius during laying		min.	m	2,05	2,10	2,05	2,15	2,25	2,20	2,30
at terminations		min.	m	1,25	1,25	1,25	1,30	1,35	1,30	1,40
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0754	0,0601	0,0470	0,0366	0,0283	0,0221	0,0176
Al conductor		max.	Ω/km	0,125	0,100	0,0778	0,0605	0,0469	0,0367	0,0291
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,0972	0,0780	0,0617	0,0490	0,0391	0,0323	0,0273
Al conductor		approx.	Ω/km	0,161	0,129	0,101	0,0790	0,0621	0,0498	0,0407
Field strength at U_0 at conductor screen		approx.	kV/mm	10,2	9,9	10,0	9,5	9,2	9,8	9,5
at core screen		approx.	kV/mm	2,9	3,1	3,6	3,8	3,9	4,8	4,9
Capacitance per core		approx.	µF/km	0,106	0,116	0,133	0,143	0,155	0,187	0,201
Inductance		approx.	mH/km	0,49	0,47	0,44	0,42	0,41	0,38	0,36
Current Ratings/Power Ratings (continuous load)						**trefoil installation**				
Cu conductor cables	1 circuit		A/MVA	423/161	470/179	524/200	584/223	648/247	702/267	754/287
	2 circuits		A/MVA	357/136	396/151	440/168	489/186	540/206	582/222	623/237
Al conductor cables	1 circuit		A/MVA	333/127	372/142	420/160	473/180	531/202	587/224	642/245
	2 circuits		A/MVA	282/107	314/120	352/134	396/151	443/169	487/186	531/202

Type (A)2XS(FL)2Y 1 x ..... RMS/110 127/220 kV with segmental conductor (RMS)

Dimensions/Cross Sections			mm²	1000	1200	1400	1600	1800	2000	2500
Conductor, round, stranded, segmental, Ø		approx.	mm	39,0	42,0	45,3	48,5	51,3	54,3	60,9
XLPE insulation		nom.	mm	19,0	18,0	18,0	18,0	19,0	19,0	19,0
Screen, copper wire, cross section		nom.	mm²	110	110	110	110	110	110	110
Outer diameter		approx.	mm	98	100	103	108	113	116	123
Cable weight (Cu/Al)		approx.	kg/m	16/10,1	18/10,6	20/11,4	22/12,4	25/13,6	27/14,5	32/16,6
Permissible pulling force (Cu/Al)		max.	kN	50/30	60/36	70/42	80/48	90/54	100/60	125/75
Bending radius during laying		min.	m	2,45	2,50	2,60	2,70	2,80	2,90	3,05
at terminations		min.	m	1,50	1,50	1,55	1,60	1,70	1,75	1,85
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0176	0,0151	0,0129	0,0113	0,0101	0,0090	0,0072
Al conductor		max.	Ω/km	0,0291	0,0247	0,0212	0,0186	0,0165	0,0149	0,0119
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,0232	0,0201	0,0175	0,0156	0,0142	0,0129	0,0109
Al conductor		approx.	Ω/km	0,0375	0,0319	0,0275	0,0240	0,0213	0,0193	0,0156
Field strength at U_0 at conductor screen		approx.	kV/mm	9,3	9,5	9,3	9,2	8,7	8,6	8,5
at core screen		approx.	kV/mm	5,0	5,4	5,5	5,5	5,2	5,3	5,4
Capacitance per core		approx.	µF/km	0,215	0,236	0,248	0,260	0,260	0,270	0,294
Inductance		approx.	mH/km	0,56	0,55	0,53	0,52	0,51	0,50	0,47
Current Ratings/Power Ratings (continuous load)						**flat installation**				
Cu conductor cables	1 circuit		A/MVA	989/377	1060/404	1136/433	1201/458	1253/477	1308/498	1406/536
	2 circuits		A/MVA	857/327	917/349	981/374	1035/394	1080/412	1126/429	1207/460
Al conductor cables	1 circuit		A/MVA	782/298	849/324	915/349	979/373	1035/394	1086/414	1201/458
	2 circuits		A/MVA	678/258	734/280	790/301	844/322	892/340	935/356	1031/393

400 kV Single Core XLPE Cables with Copper Wire Screen and APL Sheath

Type (A)2XS(FL)2Y 1 x ..... RM/170 230/400 kV with stranded compacted conductor (RM)

Dimensions/Cross Sections		mm²	630	800	1000
Conductor, Cu or Al, round, stranded, Ø	approx.	mm	30,0	34,2	38,1
XLPE insulation	nom.	mm	33,0	31,0	29,0
Screen, copper wire, cross section	nom.	mm²	170	170	170
Outer diameter	approx.	mm	118	118	118
Cable weight (Cu/Al)	approx.	kg/m	17/13	18/13	20/14
Permissible pulling force (Cu/Al)	max.	kN	32/19	40/24	50/30
Bending radius during laying	min.	m	2,95	2,95	2,95
at terminations	min.	m	1,75	1,75	1,75
Electrical Data					
Cu conductor DC resistance at 20°C	max.	Ω/km	0,0283	0,0221	0,0176
Al conductor	max.	Ω/km	0,0469	0,0367	0,0291
Cu conductor AC resistance at 90°C	approx.	Ω/km	0,0393	0,0317	0,0276
Al conductor	approx.	Ω/km	0,0622	0,0500	0,0409
Field strength at U_0 at conductor screen	approx.	kV/mm	12,8	12,7	12,8
at core screen	approx.	kV/mm	4,2	4,7	5,2
Capacitance per core	approx.	µF/km	0,119	0,134	0,150
Inductance	approx.	mH/km	0,46	0,44	0,41
Current Ratings/Power Ratings (continuous load)				**trefoil installation**	
Cu conductor cables 1 circuit		A/MVA	594/412	636/441	671/465
2 circuits		A/MVA	481/333	512/355	538/373
Al conductor cables 1 circuit		A/MVA	499/346	545/378	587/407
2 circuits		A/MVA	406/281	440/305	471/326

Type (A)2XS(FL)2Y 1 x ..... RMS/170 230/400 kV with segmental conductor (RMS)

Dimensions/Cross Sections		mm²	1000	1200	1400	1600	1800	2000	2500
Conductor, round, stranded, segmental, Ø	approx.	mm	39,0	42,0	45,3	48,5	51,3	54,3	60,9
XLPE insulation	nom.	mm	29,0	27,0	27,0	27,0	26,0	26,0	26,0
Screen, copper wire, cross section	nom.	mm²	170	170	170	170	170	170	170
Outer diameter	approx.	mm	121	120	123	127	128	131	138
Cable weight (Cu/Al)	approx.	kg/m	20/14	22/14	24/15	26/16	28/17	30/18	36/20
Permissible pulling force (Cu/Al)	max.	kN	50/30	60/36	70/42	80/48	90/54	100/60	125/75
Bending radius during laying	min.	m	3,00	3,00	3,10	3,15	3,20	3,25	3,45
at terminations	min.	m	1,80	1,80	1,85	1,90	1,90	1,95	2,05
Electrical Data									
Cu conductor DC resistance at 20°C	max.	Ω/km	0,0176	0,0151	0,0129	0,0113	0,0101	0,0090	0,0072
Al conductor	max.	Ω/km	0,0291	0,0247	0,0212	0,0186	0,0165	0,0149	0,0119
Cu conductor AC resistance at 90°C	approx.	Ω/km	0,0232	0,0201	0,0175	0,0156	0,0142	0,0129	0,0109
Al conductor	approx.	Ω/km	0,0375	0,0319	0,0275	0,0240	0,0213	0,0193	0,0156
Field strength at U_0 at conductor screen	approx.	kV/mm	12,5	12,9	12,6	12,4	12,6	12,4	12,0
at core screen	approx.	kV/mm	5,3	5,9	6,0	6,1	6,5	6,5	6,7
Capacitance per core	approx.	µF/km	0,156	0,171	0,180	0,188	0,201	0,209	0,226
Inductance	approx.	mH/km	0,56	0,55	0,53	0,52	0,51	0,50	0,47
Current Ratings/Power Ratings (continuous load)					**flat installation**				
Cu conductor cables 1 circuit		A/MVA	938/650	1001/694	1070/741	1125/779	1168/809	1212/840	1289/893
2 circuits		A/MVA	804/557	855/592	912/632	957/663	990/686	1026/711	1086/752
Al conductor cables 1 circuit		A/MVA	748/518	808/560	868/601	924/640	973/674	1016/704	1112/770
2 circuits		A/MVA	641/444	690/478	740/513	787/545	826/572	861/597	938/650

500 kV Single Core XLPE Cables with Copper Wire Screen and APL Sheath

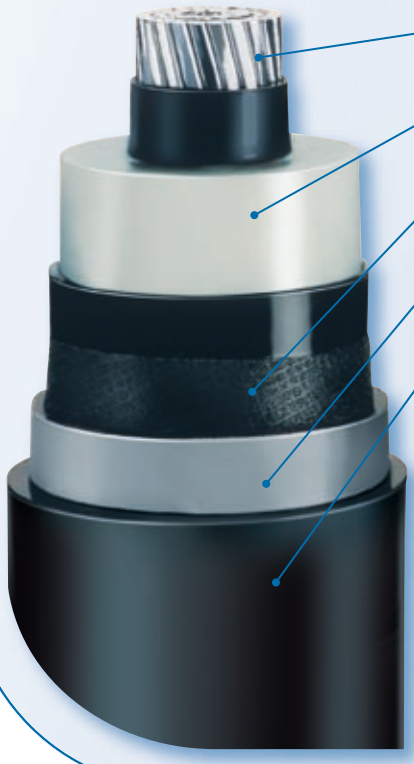
Type (A)2XS(FL)2Y 1 x ..... RM/170 290/500 kV with stranded compacted conductor (RM)

Dimensions/Cross Sections			mm²	800	1000
Conductor, Cu or Al, round, stranded, Ø		approx.	mm	34,2	38,1
XLPE insulation		nom.	mm	35,0	33,0
Screen, copper wire, cross section		nom.	mm²	170	170
Outer diameter		approx.	mm	126	126
Cable weight (Cu/Al)		approx.	kg/m	20 / 15	21 / 15
Permissible pulling force (Cu/Al)		max.	kN	40 / 24	50 / 30
Bending radius during laying		min.	m	3,15	3,15
at terminations		min.	m	1,90	1,90
Electrical Data					
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0221	0,0176
Al conductor		max.	Ω/km	0,0367	0,0291
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,0315	0,0265
Al conductor		approx.	Ω/km	0,0492	0,0401
Field strength at U_0 at conductor screen		approx.	kV/mm	14,9	14,8
at core screen		approx.	kV/mm	5,1	5,6
Capacitance per core		approx.	µF/km	0,124	0,137
Inductance		approx.	mH/km	0,45	0,43
Current Ratings/Power Ratings (continuous load)				trefoil installation	
Cu conductor cables	1 circuit		A/MVA	628/544	661/572
	2 circuits		A/MVA	498/431	520/450
Al conductor cables	1 circuit		A/MVA	537/465	577/500
	2 circuits		A/MVA	427/370	455/394

Type (A)2XS(FL)2Y 1 x ..... RMS/170 290/500 kV with segmental conductor (RMS)

Dimensions/Cross Sections			mm²	1000	1200	1400	1600	1800	2000	2500
Conductor, round, stranded, segmental, Ø		approx.	mm	39,0	42,0	45,3	48,5	51,3	54,3	60,9
XLPE insulation		nom.	mm	32,0	31,0	31,0	31,0	31,0	31,0	31,0
Screen, copper wire, cross section		nom.	mm²	170	170	170	170	170	170	170
Outer diameter		approx.	mm	128	130	133	136	139	143	150
Cable weight (Cu/Al)		approx.	kg/m	22 / 16	24 / 16	26 / 17	28 / 18	30 / 19	33 / 20	38 / 23
Permissible pulling force (Cu/Al) conductor		max.	kN	50 / 30	60 / 36	70 / 42	80 / 48	90 / 54	100 / 60	125 / 75
Bending radius during laying		min.	m	3,20	3,25	3,35	3,40	3,50	3,55	3,75
at terminations		min.	m	1,95	1,95	2,00	2,05	2,10	2,15	2,25
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0176	0,0151	0,0129	0,0113	0,0101	0,0090	0,0072
Al conductor		max.	Ω/km	0,0291	0,0247	0,0212	0,0186	0,0165	0,0149	0,0119
Cu conductor AC resistance at 90°C		approx.	Ω/km	0,0232	0,0201	0,0175	0,0156	0,0142	0,0129	0,0109
Al conductor		approx.	Ω/km	0,0375	0,0319	0,0275	0,0240	0,0213	0,0193	0,0156
Field strength at U_0 at conductor screen		approx.	kV/mm	14,6	14,6	14,3	14,1	13,9	13,6	13,3
at core screen		approx.	kV/mm	6,0	6,3	6,4	6,5	6,6	6,7	6,8
Capacitance per core		approx.	µF/km	0,149	0,159	0,167	0,174	0,180	0,187	0,202
Inductance		approx.	mH/km	0,56	0,55	0,53	0,52	0,51	0,50	0,47
Current Ratings/Power Ratings (continuous load)				flat installation						
Cu conductor cables	1 circuit		A/MVA	907/785	968/838	1031/896	1085/896	1124/973	1159/1004	1226/1062
	2 circuits		A/MVA	770/667	818/708	868/752	912/790	942/816	969/839	1019/882
Al conductor cables	1 circuit		A/MVA	725/628	782/677	838/726	893/773	939/813	976/845	1063/921
	2 circuits		A/MVA	615/533	661/572	707/612	751/650	787/682	816/707	884/766

Single Core XLPE Cable with Lead Sheath



- A — aluminium conductor
- 2X — XLPE insulation
- (F) — watertight design
- K — lead sheath
- 2Y — polyethylene sheath

construction code **A2X(F)K2Y**

Instead of copper wire screen and APL sheath, the XLPE insulated cables can also be equipped with a lead sheath, a design which has proven its suitability on power cables for more than a century.

NEW

up to 2000 mm²

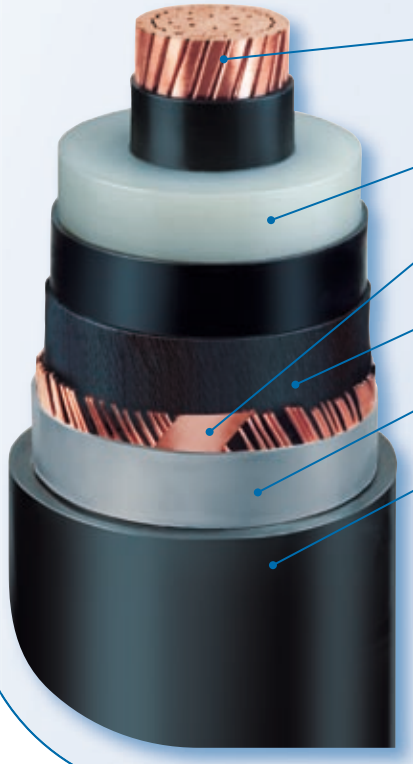
Single Core XLPE Cable with Solid Aluminium Conductor

- A — solid aluminium conductor
- 2X — XLPE insulation
- (F) — watertight design
- K — lead sheath
- 2Y — polyethylene sheath with extruded conductive layer

construction code **A2X(F)K2Y**

Large sized solid aluminium conductors provide an economic solution for power transmission.

Single Core XLPE Cable with Copper Wire Screen and Lead Sheath



	copper conductor
2X	XLPE insulation
S	copper wire screen
(F)	watertight design
K	lead sheath
2Y	polyethylene sheath

construction code **2XS(F)K2Y**

To improve the fault current carrying capability of the lead sheathed cable, an additional copper wire screen may be applied.

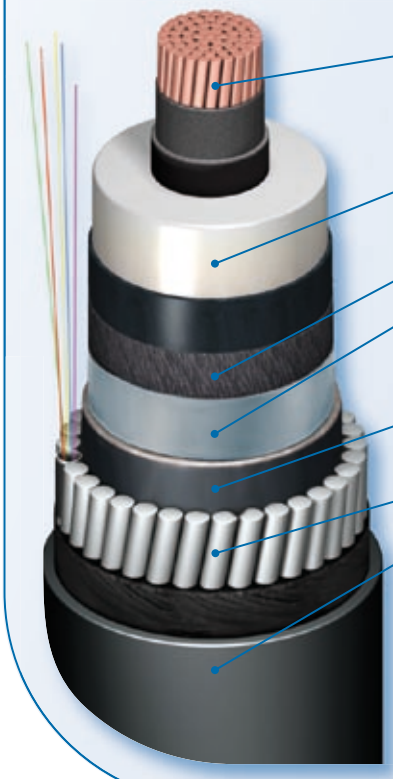
Single Core XLPE Cable with Aluminium Sheath

	segmental copper conductor (Milliken conductor)
2X	XLPE insulation
(F)	watertight design
KL	aluminium sheath
2Y	polyethylene sheath

construction code **2X(F)KL2Y**

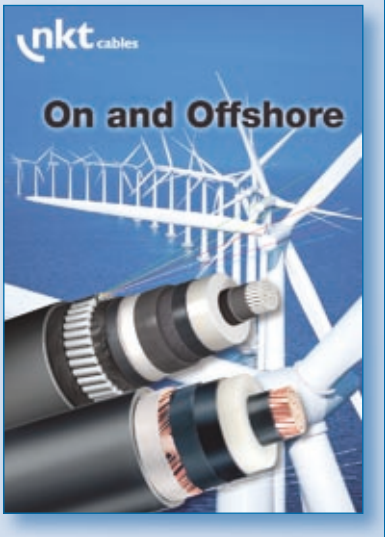
Single Core XLPE Submarine Cable with Integrated Optical Fibres

NEW



	copper conductor with blocking compound
2X	XLPE insulation
(F)	semiconducting swelling tape
K	lead sheath
	bedding
R	armouring of galvanized steel wires
AA	polypropylene yarn and asphalt

construction code **2X(F)KRAA**



For more information please request the brochure “On and Offshore”.

Three Core XLPE Cables in Steel Pipe – CityCable VALFIT®

NEW up to 220 kV

	copper conductor
2X	XLPE insulation
(F	watertight design
L)	radial water barrier (Al tape)
2Y	polyethylene sheath
V	laid-up cable cores
F	flat steel wire armour
ST	steel pipe
2Y	polyethylene covering

construction code **2X(FL)2YVF ST2Y**

With the CityCable the advantages of pipe type cables and XLPE cables are combined. The cable has been developed especially for use in urban cable networks for retrofitting and new installations. Major design details have been determined to take account of the use of existing cable pipe lines. The CityCable concept of nkt cables allows the cheap reconstruction of old pipe type cable circuits and the economical and safe installation of new cable connections in crowded city areas.

This provides:

- fast and cheap cable replacement by pulling the cable into the existing pipe
- compact and strong three core design
- maintenance-free service
- no risk of environmental pollution
- the possibility of pipe monitoring

New generation: cable with integrated electromagnetic shielding for significantly reduced electromagnetic interference.

1st generation

2nd generation

3rd generation

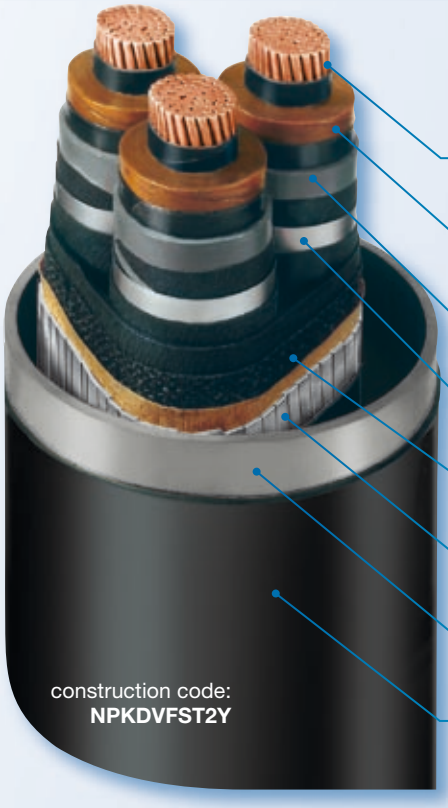
132 kV CityCables

Type designation 2X(FL)2YVF ST2Y 3 x ..... RM 76/132 kV

Dimensions/Cross Sections		mm²	95	120	150	185	240
Conductor, Cu, round, stranded, Ø	approx.	mm	11,5	13,1	14,3	16,1	18,3
XLPE insulation	nom.	mm	14,0	13,0	12,5	12,0	11,0
Diameter above 2,0 mm APL-sheath	approx.	mm	48	47	47	48	49
Diameter above flat steel wire armouring	approx.	mm	108	107	108	110	111
Weight, cable only	approx.	kg/m	11,1	11,5	12,0	13,1	14,9
Steel pipe (minimum dimension)		mm mm	133 x 4	133 x 4	133 x 4	133 x 4	133 x 4
Permissible pulling force	max.	kN	51	51	51	52	52
Bending radius during laying	min.	m	2,70	2,70	2,70	2,75	2,75
of phase core at terminations	min.	m	0,70	0,70	0,70	0,70	0,75
Electrical Data							
Conductor DC resistance at 20°C	max.	Ω/km	0,193	0,153	0,124	0,0991	0,0754
Conductor AC resistance at 90°C	approx.	Ω/km	0,247	0,196	0,159	0,127	0,0975
Field strength at U_0 at conductor screen	approx.	kV/mm	10,3	10,3	10,2	10,1	10,3
at core screen	approx.	kV/mm	3,2	3,6	3,9	4,2	4,9
Capacitance per core	approx.	µF/km	0,114	0,129	0,139	0,153	0,177
Inductance	approx.	mH/km	0,47	0,44	0,43	0,41	0,38
Transmission Capacity							
Current rating (continuous) 1 circuit		A	256	288	319	357	406
Power rating		MVA	59	66	73	82	93
Current rating (continuous) 2 circuits		A	223	250	277	309	351
Power rating		MVA	51	57	63	71	80

Dimensions/Cross Sections		mm²	300	400	500	630	800
Conductor, Cu, round, stranded, Ø	approx.	mm	20,7	23,4	26,5	30,0	34,2
XLPE insulation	nom.	mm	11,0	11,0	11,0	11,0	11,3
Diameter above 2,0 mm APL-sheath	approx.	mm	51	54	57	61	67
Diameter above flat steel wire armouring	approx.	mm	116	123	129	137	149
Weight, cable only	approx.	kg/m	16,5	19,4	22,9	27,4	33,6
Steel pipe (minimum dimension)		mm mm	139,7 x 4	146 x 4,5	159 x 4,5	159 x 4,5	168,3 x 4,5
Permissible pulling force	max.	kN	55	59	62	66	71
Bending radius during laying	min.	m	2,90	3,10	3,20	3,40	3,70
of phase core at terminations	min.	m	0,75	0,80	0,85	0,90	1,00
Electrical Data							
Conductor DC resistance at 20°C	max.	Ω/km	0,0601	0,0470	0,0366	0,0283	0,0221
Conductor AC resistance at 90°C	approx.	Ω/km	0,0785	0,0624	0,0500	0,0404	0,0335
Field strength at U_0 at conductor screen	approx.	kV/mm	10,0	9,6	9,4	9,1	8,7
at core screen	approx.	kV/mm	5,0	5,1	5,2	5,4	5,3
Capacitance per core	approx.	µF/km	0,192	0,211	0,231	0,252	0,275
Inductance	approx.	mH/km	0,37	0,36	0,34	0,33	0,32
Transmission Capacity							
Current rating (continuous) 1 circuit		A	454	508	569	624	679
Power rating		MVA	104	116	130	143	155
Current rating (continuous) 2 circuits		A	391	436	486	532	576
Power rating		MVA	89	100	111	122	132

External Gas Pressure Cable



NP	external gas pressure cable according to VDE standard
	copper conductor
	paper insulation
K	lead sheath
D	reinforcing tapes
V	laid-up cable cores
F	flat steel wire armour
ST	steel pipe
2Y	polyethylene covering

The external gas pressure cables have been developed in the early 1930ies. They have proven their reliability in many decades. Thousands of kilometres are in satisfactory service in European high voltage networks.

The conductors are insulated with a lapped and mass impregnated paper insulation. Each insulated core is separately lead sheathed. Three cores are cabled together. Over a suitable bedding an armour of flat steel wires is applied. The three core cable is pulled into a steel pipe which is filled with nitrogen gas at 15 bar overpressure. With the gas pressure acting on the oval shaped cable cores, formation of voids is prevented, giving the cable the required electrical strength.

Although the demand for paper insulated cables has decreased, for re-routing and repair it is often desirable to install cables of the same type. For this purpose, nkt cables has kept the manufacturing facilities and know-how to provide the optimum solution.

Internal Gas Pressure Cable

NI	internal gas pressure cable according to VDE standard
	copper conductor
	paper insulation
V	laid-up cable cores
F	flat steel wire armour
ST	steel pipe
2Y	polyethylene covering

Similar to the external gas pressure cables service experience with the internal gas pressure cables is also very satisfactory. In deviation to the external gas pressure cable the nitrogen gas forms part of the cable insulation. As there is no metal sheath, the gas penetrates into the voids present in the mass impregnated insulation and prevents electrical discharges. A considerable number of installations with this cable type is in service today.

Like the external gas pressure cables, the demand for new installations has decreased significantly. Despite of that, for re-routing and repair it is often desirable to install cables of the same type. For this purpose, nkt cables has kept the manufacturing facilities and know-how to provide the optimum solution.

110 kV External Gas Pressure Cables to DIN VDE 0276-635

Table 1: Type designation NP(A)KDVFST2Y 3 x ..... OM 64/110 kV

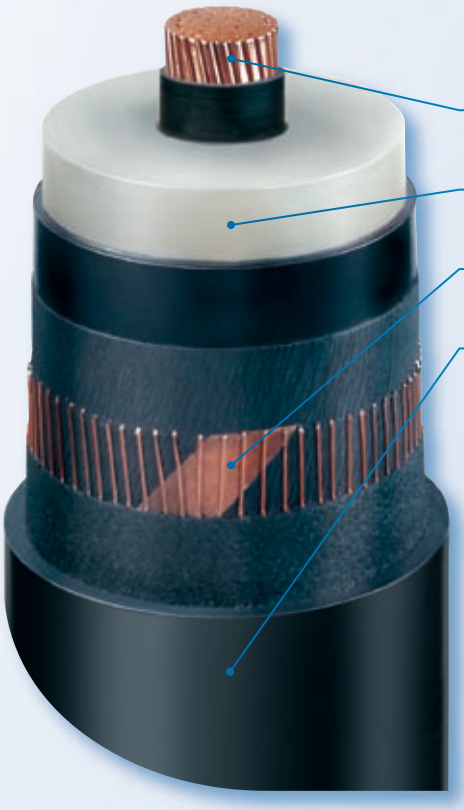
Dimensions/Cross Sections			mm²	185	240	300	400	500	630	800
Conductor, Cu or Al, oval, stranded, Ø		approx.	mm	16,6	19,1	21,3	24,0	27,0	30,6	34,5
Paper insulation, impregnated		min.	mm	10,2	9,7	9,7	9,7	8,7	8,2	8,2
Lead sheath, thickness		nom.	mm²	1,6	1,7	1,7	1,8	1,9	2,0	2,1
Diameter above lead sheath		approx.	mm	42	44	46	49	50	53	57
Diameter above flat steel wire armouring		approx.	mm	102	106	110	117	119	128	137
Cable Weight Cu/Al		approx.	kg/m	19,3/16,0	21,9/17,5	24,4/18,8	28,2/21,1	31,8/22,6	37,2/25,2	44,3/28,8
Steel pipe dimensions		min.	mm mm	133 x 4	133 x 4	139,7 x 4	146 x 4,5	146 x 4,5	159 x 4,5	168,3 x 4,5
PE-Oversheath, thickness		nom.	mm	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Bending radius during laying		min.	m	2,55	2,65	2,75	2,90	3,00	3,20	3,40
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0991	0,0754	0,0601	0,0470	0,0366	0,0283	0,0221
Al conductor		max.	Ω/km	0,164	0,125	0,100	0,0778	0,0605	0,0469	0,0367
Cu conductor AC resistance at 85°C		approx.	Ω/km	0,126	0,0968	0,0782	0,0627	0,0509	0,0420	0,0359
Al conductor		approx.	Ω/km	0,208	0,159	0,128	0,100	0,0795	0,0633	0,0517
Field strength at U_0 at conductor screen		approx.	kV/mm	9,4	9,4	9,1	8,8	9,3	9,5	9,2
Capacitance per core		approx.	µF/km	0,264	0,301	0,324	0,353	0,420	0,486	0,534
Inductance		approx.	mH/km	0,38	0,36	0,35	0,34	0,32	0,31	0,30
Transmission Capacity (continuous load)										
Cu conductor cables	1 circuit		A/MVA	340/65	390/74	430/82	480/92	525/100	570/109	605/115
	2 circuits		A/MVA	290/55	330/63	365/70	405/77	440/84	470/90	500/95
Al conductor cables	1 circuit		A/MVA	270/51	305/58	345/66	390/74	430/82	480/92	525/100
	2 circuits		A/MVA	230/44	265/51	295/56	330/63	360/69	400/76	435/83

110 kV Internal Gas Pressure Cables to DIN VDE 0276-634

Table 2: Type designation NI(A)VFST2Y 3 x ..... RM 64/110 kV

Dimensions/Cross Sections			mm²	185	240	300	400	500	630	800
Conductor, Cu or Al, round, stranded, Ø		approx.	mm	16,0	18,3	20,7	23,4	26,5	30,0	34,2
Paper insulation, impregnated		min.	mm	10,7	10,2	9,7	9,7	9,7	9,2	8,7
Diameter above flat steel wire armouring		approx.	mm	91	94	97	103	110	115	123
Cable Weight Cu/Al		approx.	kg/m	12,0/8,6	13,8/9,3	15,6/9,9	18,3/11,1	21,9/12,7	26,1/14,1	31,5/16,2
Steel pipe dimensions		min.	mm mm	133 x 4	133 x 4	133 x 4	133 x 4	139,7 x 4	146 x 4,5	159 x 4,5
PE-Oversheath, thickness		nom.	mm	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Bending radius during laying		min.	m	2,30	2,35	2,40	2,60	2,75	2,90	3,10
Electrical Data										
Cu conductor DC resistance at 20°C		max.	Ω/km	0,0991	0,0754	0,0601	0,0470	0,0366	0,0283	0,0221
Al conductor		max.	Ω/km	0,164	0,125	0,100	0,0778	0,0605	0,0469	0,0367
Cu conductor AC resistance at 85°C		approx.	Ω/km	0,126	0,0970	0,0786	0,0631	0,0513	0,0427	0,0368
Al conductor		approx.	Ω/km	0,208	0,159	0,128	0,101	0,0797	0,0638	0,0524
Field strength at U_0 at conductor screen		approx.	kV/mm	9,2	9,1	9,2	8,9	8,6	8,8	9,0
Capacitance per core		approx.	µF/km	0,230	0,260	0,294	0,320	0,351	0,402	0,463
Inductance		approx.	mH/km	0,37	0,35	0,33	0,32	0,31	0,29	0,28
Transmission Capacity (continuous load)										
Cu conductor cables	1 circuit		A/MVA	340/65	390/74	435/83	480/92	535/102	580/111	625/119
	2 circuits		A/MVA	295/56	335/64	370/71	410/78	450/86	490/93	525/100
Al conductor cables	1 circuit		A/MVA	270/41	310/59	345/66	385/73	435/83	485/92	540/103
	2 circuits		A/MVA	230/44	265/51	295/56	330/63	370/71	410/78	450/86

Emergency Cable (110 kV ... 300 kV)



S	special cable
	copper conductor
2X	XLPE insulation
S	copper wire screen
2Y	polyethylene sheath
FUG	first made by F&G

construction code **S2XS2YFUG**

The so-called emergency cables have been developed for use in high voltage networks up to 300 kV. They are supplied on special drums containing cable lengths of up to 500 m. The cables are provided with factory-jointed terminations for outdoor use. The terminations are of dry and flexible type. The cables are lightweight and flexible to permit easiest transport, installation and operation.

Maintaining power supply via an overhead line or within a switchyard can be of high importance. While it would be necessary to switch off because of working in the vicinity of the overhead conductors, the relevant sections can be bridged using the emergency cables.

The emergency cables have demonstrated their advantages in temporary connections in outdoor switchyards or between overhead line towers.

The cables can be installed and dismantled within the shortest time. Wound up again on their special steel drums, they can be used for the next operation at any time.

Test Cable (230 kV ... 350 kV)

Special versions of this type of cable are used for high voltage testing. Equipped with the suitable termination at one end, the test cable can be directly inserted into the gas filled compartment of the gas insulated switchgear to be tested.

Emergency Cables

Type designation S2XS2YFUG 1 x …… RM .../... kV

Version				1	2	3	4
Rated voltage U_0/U			kV	64/110	76/132	127/220	160/275
Max. working voltage U_m			kV	123	145	245	300
Impulse withstand voltage			kV	450	450	850	850
Dimensions							
Conductor, Cu	cross section	nom.	mm²	120	120	240	240
	diameter	approx.	mm	12,8	12,8	18,3	18,3
XLPE insulation		nom.	mm	15	15	18	18
Screen, Cu wires		nom.	mm²	25	25	35	35
Outer diameter		approx.	mm	59	59	69	69
Weight		approx.	kg/m	3,5	3,5	5,6	5,6
Bending radius		min.	m	1,2	1,2	1,4	1,4
Electrical Data							
Conductor resistance	DC at 20°C	max.	Ω/km	0,153	0,153	0,0754	0,0754
	AC at 90°C	approx.	Ω/km	0,196	0,196	0,0971	0,0971
Capacitance per core		approx.	µF/km	0,126	0,126	0,134	0,134
Transmission Capacity				**laid on ground, 7 cm spacing between cables**			
Current rating (continuous)/Power rating			A/MVA	420/80	420/96	650/248	650/310

For the smaller cables, three phases (max. 140 m long) can be supplied on one special drum.

Contact **nkt cables** for more information.

HTS Cable from nkt cables – already in its second generation

NEW

HTS Cables and Accessories

High-temperature superconductor technology (HTS) is the key technology for tomorrow's electricity market. Compared with copper conductors, HTS ceramic cables have a number of significant advantages. Transmission capacity is five times higher than of conductors made of copper, while current loss is reduced to one tenth.

The development of HTS cables is inseparably linked to the name nkt cables who has led the market in researching and producing superconductive cables from the very beginning. As early as 2001 the first superconductive cable was put into operation in a public power supply network, thanks to nkt cables in Copenhagen.

Impressive progress has been made in the development of fully functioning and economical systems for energy transmission with HTS cables.

The Triax HTS cable already represents the second generation of superconductor cables. It has a three-core design with central cooling and three phases one above the other.

The result is drastic reduction on cooling material, assembly work and accessories.

Energy suppliers can now rely on nkt cables for a considerable range of high-capacity, profitable and environmentally friendly HTS cables.

Design and Manufacture

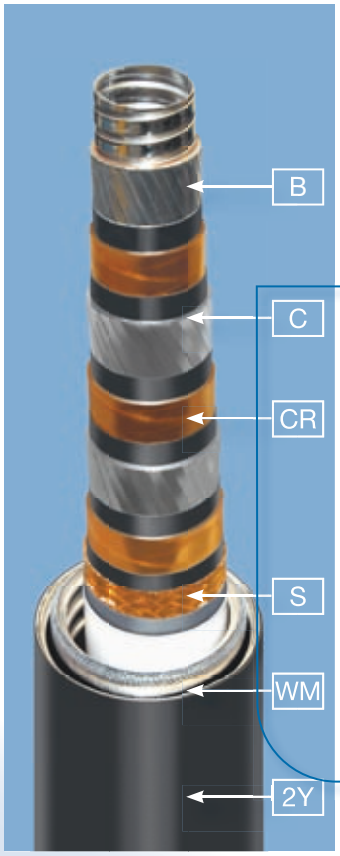
A standard selection of HTS cable designs are provided. Custom amperage ratings and voltage ratings can be achieved through the modular build-up of our HTS cables.

HTS Conductors

The HTS cables are manufactured from premium-quality HTS tapes in order to provide our customers with the most economic solution.

Electrical Insulation

The electrical insulation can be selected as standard extruded polyethylene (PE) for cables without EMF screening or our high-performing and well-tested cryogenic dielectric material Cryoflex® for cables with zero EMF emissions. The extruded PE dielectric uses our standard proven triple-extrusion techniques. The cross-linking process is optional, since the operating temperature of the dielectric is low. The Cryoflex® material is lapped tape dielectric. Here, we rely on a 100-years long tradition of manufacturing paper-lapped insulation. Since the Cryoflex® is cooled to the same low temperature as the HTS conductor, the thermal ageing of the dielectric is virtually eliminated. The electrical insulation is tested to IEC and ANSI specifications including impulse testing, AC withstand, and long-term ageing tests.



Codes

HT:	HTS Triaxial cable design
B:	BSCCO-type HTS conductor laminated with a metal sheath
C:	Added copper stabiliser for over-current protection
CR:	Cryoflex® electrical insulation
S:	Copper wire or tape screen
(WM):	Corrugated "wellmantel" semi-flexible thermal insulation
2Y:	polyethylene outer sheath

Construction code: HT-BC-CRS(WM)2Y

Construction code with rigid thermal insulation: HT-BC-CRS(RL)2Y

Construction code with YBCO-type HTS conductor: HT-YC-CRS(WM)2Y

Type HT-BC-CRS(WM)2Y 7.6/13.2 kV HTS Triax cable with BSCCO tapes, copper stabiliser, Cryoflex® dielectric, semi-flexible cryostat

Dimensions/Ampacity, 3x	kA	1.25	2.00	2.5	3.0	3.4
Cable Core						
Conductor, BSCCO laminated, hollow ID	mm	25	29	35	41	41
Copper stabiliser, cross section	mm^2	40	40	55	60	60
Cryoflex® insulation	mm	2,1	2,1	2,1	2,1	2,1
Screen, copper tape, cross section	mm^2	80	80	110	120	120
Outer cable core diameter	mm	45	49	62	68	68
Weight, HTS cable core, 3 phases	kg/m	3,5	4,8	5,5	6,5	7
Permissible pulling force	kN	10	15	20	20	20
Bending radius during laying/at terminations (min)	m	3/1,5	3/1,5	3/1,5	3/1,5	3/1,5
Thermal Insulation						
Semi-rigid corrugated duct, ID/OD	mm	60/110	60/110	84/143	84/143	84/143
PE outer sheath thickness	mm	2	2	3	3	3
Total OD		114	114	150	150	150
Termination OD	mm	124	124		160	160
Permissible pulling force	kN	10	10	15	15	15
Bending radius during laying/at terminations (min)	m	3/1,5	3/1,5	3/1,5	3/1,5	3/1,5
Heat leak, duct section	W/m	1,2	1,2	1,5	1,5	1,5
Heat leak, joints	W/ea.	10	10	15	15	15
Electrical Data						
Conductor DC resistance at P_{nom}	µOhm/m	<10	<10	<10	<10	<10
Conductor AC loss at P_{nom}	W/m/ph	0,2	0,3	0,3	0,4	0,5
AC loss power factor, n	$P=k*I^n$	3	3	3	3	3
Capacitance, eqv. phase-to-ground	µF/km	3,3	3,7	4,6	5,2	5,2
Inductance, eqv. single phase	mH/km	0,026	0,024	0,019	0,017	0,017
Power Rating (continuous load) at 13,2 kV						
1 circuit/2 circuits	MVA	29/57	46/91	57/114	69/137	78/155

Type HT-BC-CRS(WM)2Y 42/72 kV, HTS Triax cable with BSCCO tapes, copper stabiliser, Cryoflex® dielectric, semi-flexible cryostat

Dimensions/Ampacity, 3x	kA	1.25	2.00	2.5	3.0	3.4
Cable Core						
Conductor, BSCCO laminated, hollow ID	mm	25	29	35	41	41
Copper stabiliser, cross section	mm^2	40	40	55	60	60
Cryoflex® insulation	mm	4,7	4,7	4,7	4,7	4,7
Screen, copper tape, cross section	mm^2	120	120	120	120	120
Outer cable core diameter	mm	65	69	75	81	81
Weight, HTS cable core, 3 phases	kg/m	4,5	5,8	6,5	7,5	8
Permissible pulling force	kN	10	15	20	20	20
Bending radius during laying/at termination (min)	m	3/1,5	3/1,5	3/1,5	3/1,5	3/1,5
Thermal Insulation						
Semi-rigid corrugated duct, ID/OD	mm	84/143	84/143	84/143	98/163	98/163
PE outer sheath thickness	mm	3	3	3	3	3
Total OD		150	150	150	170	170
Termination OD	mm	160	160	160	180	180
Permissible pulling force	kN	15	15	15	20	20
Bending radius during laying/at termination (min)	m	3/1,5	3/1,5	3/1,5	4/2	4/2
Heat leak, duct section	W/m	1,5	1,5	1,5	1,7	1,7
Heat leak, joints	W/ea.	10	10	15	15	15
Electrical Data						
Conductor DC resistance at P_{nom}	µOhm/m	<10	<10	<10	<10	<10
Conductor AC loss at P_{nom}	W/m/ph	0.2	0.3	0.3	0.4	0.5
AC loss power factor, n	$P=k*I^n$	3	3	3	3	3
Capacitance, eqv. phase-to-ground	µF/km	1,6	1,7	2,0	2,2	2,2
Inductance, eqv. single phase	mH/km	0,039	0,036	0,031	0,028	0,028
Power Rating (continuous load) at 50 kV						
1 circuit/2 circuits	MVA	108/217	173/346	217/433	260/520	294/589

The Accessories

Product Scope

Besides the accessories for XLPE insulated cables, nkt cables also produces and installs accessories for the paper insulated high voltage cables, e.g. for re-routing, repair and renovation.

U_m/kV	72,5	123	145	170	245	300	420	550
Outdoor termination	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D/P	X/O	X/O	X/O	X
Switchgear termination	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D	X/O/D	X/O	X
Transformer termination	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D	X/O/D	X/O	X
Straight joint	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D/P	X/O/D	X/O/D	X/O/D	X
Stop joint	O	O	O	O	O	O	O	
Transition joint	X/O/P	X/O/P	X/O/P	X/O/P	X/O	X/O	X/O	

X for XLPE cable O for oil filled cable D dry type for XLPE cable P for gas pressure cable

The following pages present an overview and basic information to most of the accessories. Other types and versions may also be available on request. Please contact nkt cables in case of special needs. Detailed information on the accessories for XLPE insulated cables for voltages up to 170 kV is given in a separate catalogue.

Design and Manufacture

The accessories are designed by experienced personnel using state-of-the-art CAD and CAE. They are made in-house and selected components are procured from approved sub-suppliers only.

The metallic parts of the accessories are made of copper, copper alloy or corrosion resistant aluminium. All fixing bolts, nuts and washers are made of stainless steel. Hence, the accessories of nkt cables are made for real long-term service, as it is expected from the cables.

Prefabricated stress cones and insulating sleeves are made of silicone rubber. This type of material is in use for several decades and has proven its high reliability due to excellent electrical and mechanical properties. Most of these components can be applied by hand minimizing the requirements for special tools. For cables with integrated optical fibres, the accessories are provided with appropriate splice and termination housings. Accessories for EHV cables with XLPE insulation can be equipped with sensors for partial discharge measurement on site.

Outdoor Termination with Composite Insulator FEV 420-V

Outdoor Terminations

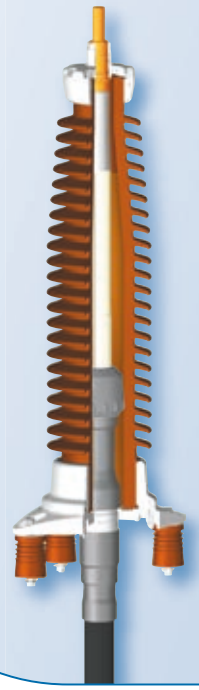
The different versions of the terminations are designed for operation under severe outdoor conditions and operation voltage up to 550 kV. The terminations can also be used indoor where appropriate space is provided. Standard versions are designed for pollution level III or IV. For use in higher polluted areas, insulators with longer creepage distances are available.

Technical Data

Highest voltage U_m	kV	72,5	145	170	245	300	420	550
Lightning impulse voltage	kV	350	650	750	1050	1050	1425	1550
Conductor Cu/Al (max.)	mm^2	2500	2500	2500	2500	2500	2500	2500
Length (approx.)	mm	1400	1900	2100	2800	3200	4200	5000

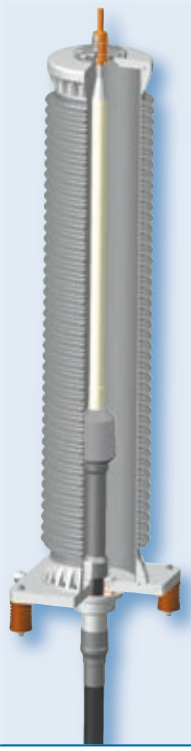
Outdoor Termination with Porcelain Insulator

This termination type covers the full range from 72,5 kV to 420 kV. It is available for gas pressure cables, oil filled cables and for XLPE cables. It is in use for many years and has the longest and satisfactory service history. The insulator may be supplied in brown or grey colour. Protective spark gaps are available as an option.



Outdoor Termination with Composite Insulator

This termination type is available for XLPE cables. The basic design is identical with that of the porcelain termination. The composite insulator, however, is of much lower weight. This is advantageous with respect to lifting equipment needed for installation and also for supporting constructions, e.g. on OHL towers.



Dry Type Outdoor Termination

The dry type termination for XLPE cables is completely free from any liquid or gaseous filling medium. Apart from the environmental aspect, the dry design provides further advantages like easier installation and no need for filling equipment, both contributing to significant savings for installation of the terminations.

Contact **nkt cables** to check whether the dry termination is available for your application.

Switchgear Terminations and Transformer Terminations

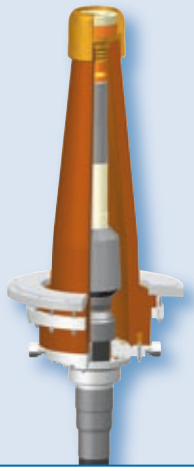
The different versions of the switchgear and transformer terminations are designed for operation voltage up to 550 kV. The terminations comply to the standards where dimensions and scope of supply are specified, i.e. IEC 60859 for the switchgear termination and EN 50299 for the transformer termination. Upon request the terminations can be adapted to fit into existing housings not in compliance with these standards.

Technical Data

Highest voltage U_m	kV	72,5	145	170	245	300	420	550
Lightning impulse voltage	kV	350	650	750	1050	1050	1425	1550
Conductor Cu/Al (max.)	mm^2	1000	2500	2500	2500	2500	2500	2500
Length (approx.)	mm	950	1150	1150	1400	1400	2200	2200

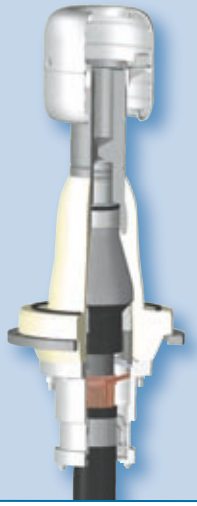
Liquid Filled Termination

The termination is equipped with an epoxy resin insulator. Like the outdoor terminations, the same prefabricated stress cone made of silicone rubber is used. Also in this case the interior of the insulator is filled with silicone oil. The epoxy resin insulator is cast in one piece with an integrated insulating ring at the bottom. In this way it is possible to isolate the cable metal screen from earth. An additional insulating ring is not needed. Thus, the overall size of the termination is compact allowing installation even in confined space.



Dry Type Termination

Also switchgear and transformer terminations are available in the dry type design being completely free from any liquid or gaseous filling medium. Apart from the environmental aspect, the dry design provides further advantages like easier installation and no need for filling equipment, both contributing to significant savings for installation of the terminations. The dry type termination do also comply to the dimensions stated in the relevant standards. Therefore, they can replace liquid filled terminations installed in a GIS housing or in the oil filled cable box of a transformer.



KSEV 145: dry type switchgear termination

Contact nkt cables to check whether the dry termination is available for your application.

Prefabricated Joints for XLPE Cables

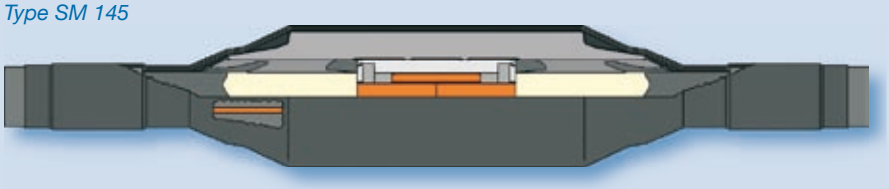
The full range up to 550 kV of prefabricated joints is offered by nkt cables. Due to optimized shapes and electrodes the joints come along with compact dimensions. The insulation parts of the joint, i.e. cable adapters and main joint sleeve, are made of silicone rubber of the highest quality. The three-piece design of the insulation has proven to be reliable and economic. It results in less work, less special tools and less mechanical stressing. On top of all that, the use of adapters allows connection of cables of different diameters, thus enabling for example the jointing of cables with completely different conductor size.

Technical Data

Highest voltage U_m	kV	72,5	145	170	245	300	420	550
Lightning impulse voltage	kV	350	650	750	1050	1050	1425	1550
Conductor Cu/Al (max.)	mm^2	2500	2500	2500	2500	2500	2500	2500
Length (approx.)	mm	1000	1200	1500	1500	1700	1900	2000

Components of Straight Joint

Normal Straight Joint
Type SM 145



from 72,5 kV to 550 kV

Main Components
of Straight Joint SM 145

The joint can be equipped with screen sectionalizing insulation. Two options are available, the compact design with heat shrinkable coverings like the normal joint and also the design with compound filled housings.

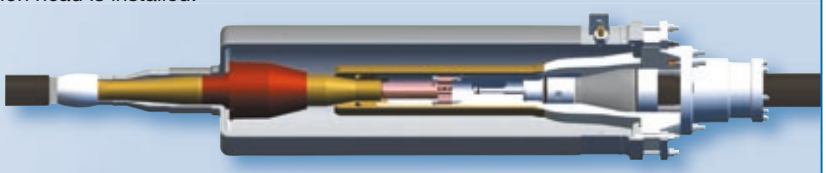
Transition Joints

Meanwhile XLPE cables have increased their share also in high voltage and extra-high voltage applications. This leads more and more to the need of connecting new XLPE cables to existing paper insulated cables. Special joints for this purpose have been developed and installed by nkt cables.

NEW 145 kV

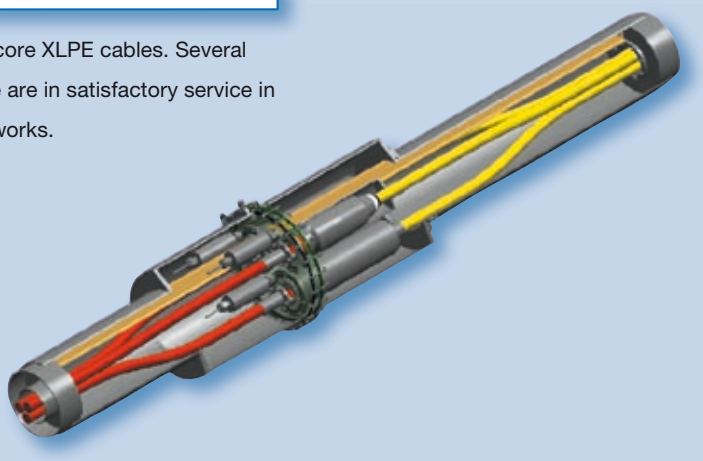
Single Phase Transition Joint USM 72 ... USM 420

The transition joint for single core cables, Type USM ..., is based on the use of a modified oil immersed termination. The termination is installed in a metal housing also comprising the field control lapping or stress cone of the opposite cable. In this way, all types of cables can be connected. The first applications were needed for transition from low pressure oil filled cables to external gas pressure cables. The gas pressure cables are always installed at the insulator side because of the high overpressure involved. Low pressure oil filled cables and XLPE cables can be connected to either side of the transition joint. For three core cables a distribution head is installed.



Three Phase Transition Joint KUSM 145

In connection with the development of the CityCable, a three phase transition joint has been created for connection of the XLPE insulated cables with the three core gas pressure cables. The construction of the joint is based on the use of components of the standard XLPE joint as well as on parts used for decades on straight joints for gas pressure cables. The joint is also available for the transition from three core gas pressure cables to single core XLPE cables. Several joints of this type are in satisfactory service in high voltage networks.



Besides the accessories for transition to XLPE cables, nkt cables also delivers and installs the accessories for paper insulated high voltage cables, i.e. for the low pressure oil filled cables and for the gas pressure pipe type cables. For more details, please contact nkt cables.

Other Accessories

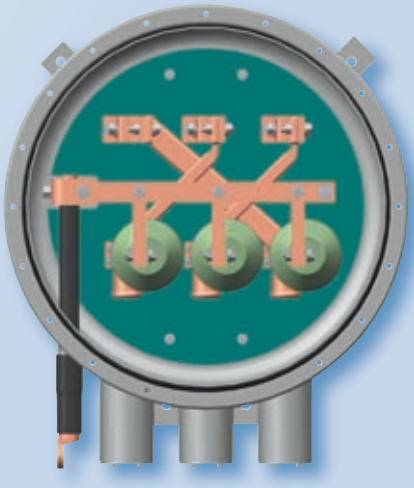
Link Boxes

For earthing connections or special bonding of cable screens, nkt ca bles offers a wide range of link boxes. These boxes are made of stainless steel, designed for gantry mounting and also for underground installation. Boxes of single phase and of three phase design are available.

Depending on the purpose, the links inside the box can be provided in different arrangements. In the cross bonding box and in the boxes for single point bonding, up to six sheath voltage limiters can be installed.

Link Box for Single Point Earthing Installed at Transformer Terminations

Link Box for Cross Bonding



Other Accessories

Of course, all necessary accessories for the paper insulated cables can be supplied. This includes oil feeding tanks, pressure equalizing vessels, gauges, valves and all necessary pipework.

Pressure Equalizing Vessels at Terminations of External Gas Pressure Cables

Oil Feeding Tanks for Low Pressure Oil Filled Cables

Installation and Services

Taking care ...
is the driving force of nkt cables' activities in this field. Starting in the earliest stages of a project, we are focussed on the customer's benefit, to provide him with solutions tailored just to what is actually needed, to assist in modification of existing systems, always keeping an eye on technically most feasible and economic solutions. In this way nkt cables can efficiently contribute to reliability and longevity of your electricity transmission and distribution system. Installation and services are available for...

- oil filled cables
- gas pressure cables
- XLPE cables and
- submarine cables

by our own serviceteam.

Engineering Works

The services of nkt cables include various tasks beginning with consultation of the clients. Design and calculations are made to prepare a solid basis for selection of the optimum version.

For example, current rating calculations are performed considering special conditions of the individual case. Options are worked out to allow assessment of special measures which might be taken.

Adding additional cable circuits to existing systems may require re-calculation of the transmission capacity of the complete arrangement. To avoid bottlenecks, improvement of thermal conditions might be necessary, the effect of which can be checked by calculations.

Furthermore, calculations are performed of pulling forces and mechanical stresses on the cables during laying. Based on that, decisions can be made on supply lengths of cables and most suitable joint positions. Measurements are made on site to allow for consideration of the actual conditions. Of course, induced screen voltages for normal operation and under short circuit conditions are calculated and considered in this context.

Re-routing and looping-in of oil filled cable circuits often requires re-checking of the oil feeding systems. Hydraulic calculations are to be made for selection of feeding tanks and oil pressure settings. The relevant calculations can also be made by nkt cables' personnel.

To sum it up: Making use of nkt cables' expertise and engineering assistance already in the design stage, is the first step for smooth realization of the project.

Installation Works

From the very beginning both companies, NKT CABLES in Denmark and Felten & Guilleaume in Germany, had their own skilled personnel and appropriate installation equipment in-house. Today nkt cables disposes of installation departments in Copenhagen and in Cologne, both with full ability to install and maintain high voltage cable systems, be it paper insulated cables or XLPE cables of most advanced design.

Not only installing new systems is our business:
With respect to the life span elapsed for many cable installations, nkt cables' personnel is well experienced for example in refurbishing of terminations deteriorated by corrosion. Re-routing and looping-in of all kinds of existing high voltage cables is our daily business.

Service Contracts

Service contracts are offered to our clients, transferring the task of maintaining the cable installations in good conditions to our shoulders. With this offer it is ensured that skilled personnel takes care of the high voltage cables. Regular checks of the conditions and, if necessary, initiation of remedial action at an early stage guarantee the value of the assets.

Jointing Courses

Educational courses for cable jointers can be carried out, be it at our premises or at the customers' facilities. Another, usually most fruitful, option is the training on site. During execution of the installation works, customers' jointing personnel is informed and trained on general skills as well as on specialities valid for the high voltage products of nkt cables.

Special courses can be held for training of operating and maintenance personnel not only for XLPE cables, but also in the field of paper insulated high voltage cables, be it of liquid filled or gas pressure types. Besides teaching of practical skills it can also comprise the provision of the theoretical knowledge.

Testing

Testing of cables and accessories comprises routine and special tests performed in the factory as well as tests on site after completion of the installation. These tests are performed in compliance with customer standards and various national and international standards like IEC, EN, VDE, NF, BS, NEN, AEIC and others.

Type tests and long-term tests have been made on components and also for qualification of complete cable systems. New developed cables and accessories were subjected to tests in the field lasting several years and comprising electrical and thermal stressing far beyond of what can be expected during normal operation.

Research & Development & Innovation

We know how

nkt cables' laboratory researches in and develops environmentally sustainable plastic materials for cables and leads and also handles quality control of raw materials and finished goods. The HV laboratories perform electrical tests of the cables.

nkt cables' technicians are internationally recognized for their specialized knowledge in compound development. nkt cables was the first company in the world to introduce lead-free PVC cables in which the poisonous lead stabilizers had been replaced by the relatively harmless calcium and zinc stabilizers. The idea was so good that the Danish Minister for Environment and Energy prohibited marketing cables with leaded PVC after December 1, 2001. Research plays an important role in all parts of nkt cables. Recently, NKT Research, nkt cables' sister company, carried out revolutionary research in materials technology, etc. This research enabled nkt cables to begin the production of fibre optical cables as early as in 1980 and to put the world's first superconducting HV cable in a public network in 2001.

A complete recycling concept for all recyclable cable types

By virtue of 40 years of experience within cable recycling, we are the only European cable manufacturer with a complete recycling concept for all recyclable cable types. We recycle cable waste at our environmentally approved recycling plant in Stenlille. Our plant in Stenlille is among the first 100 Danish companies with DS/EN ISO 14001 certification.

We take our environmental responsibility seriously, for which reason environmental considerations play an important role in all departments of our company, irrespective of it being a question of product development, production or working processes or removal of worn-out products.

For us it is not only a question of considering environment when recycling and recovering cable waste. Environmental considerations are also decisive in our selection of materials and suppliers as well as in the planning of production processes. In this way we mini-mize the environmental impact related to the product life cycle: production - use - removal.

This is what we mean when we say that environment is always in our mind for the benefit of future generations.

Of course we also assist our customers to act in the best interest of environment. Please contact us to learn how you can best dispose of your cable waste.

Quality from beginning to end

Quality from beginning to end is an essential part of nkt cables' manufacturing philosophy.

This is ensured by a combination of certified quality control throughout the production process and the use of raw material from approved sub-suppliers only. This places nkt cables in a fine position in international competition and secures flexibility to adapt rapidly to changing market requirements.

nkt cables is of course certified according to ISO 9001.

Quality Assurance and Environmental Responsibility

TÜV CERT

CERTIFICATE

The TÜV CERT Certification Body
of TÜV Rheinland Cert GmbH
certifies in accordance with
TÜV CERT procedures that

nkt cables

nkt cables GmbH
Schanzenstraße 6-20
D - 51063 Köln

has established and applies a quality management system for

development, production and sales of power
fibre optic cable systems, metal pr

An audit was performed, Report No. 303
Proof has been furnished that the requirements ac

DIN EN ISO 9001:2000

are fulfilled.

The certificate is valid until 2010-12-31.

Certificate Registration No. 09 100 3032

Bedford, 2008-01-31

First certification 1993

TÜVRheinland

TÜV CERT

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The TÜV CERT Certification Body
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certifies in accordance with
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nkt cables

nkt cables GmbH
Schanzenstraße 6-20
D - 51063 Köln

has established and applies an environmental management system for

development, production, and sales of power cable systems and
fibre optic cable systems, metal products

An audit was performed, Report No. 8221
Proof has been furnished that the requirements according to

ISO 14001:2004

are fulfilled.

The certificate is valid until 2010-12-31.

Certificate Registration No. 01 104 8221

TÜVRheinland®

TÜV CERT Certification Body of
TÜV Rheinland Cert GmbH

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