Dear Customers,

since 1910 we have been supplying the cables which help you to solve your problems through communication. Enclosed, please, find a new comprehensive catalogue containing the basic product line of our company.

We tried not only to include the standard products that you probably know very well, but some innovations and brand new products as well. Despite the catalogue is considered as a complete presentation of our production, not all variants can be published and included.

For some special products, please, contact our Sales Department that will provide you with any information requested. Let us advice you of the fact that all cable parameters in this catalogue are for information only.

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H t – Member of board

000325
СЛИЧНО С ОРИГИНАЛА
"КРАСНА" ООП СМОЛЯН
на основание чл. 2 от ЗЗЛД

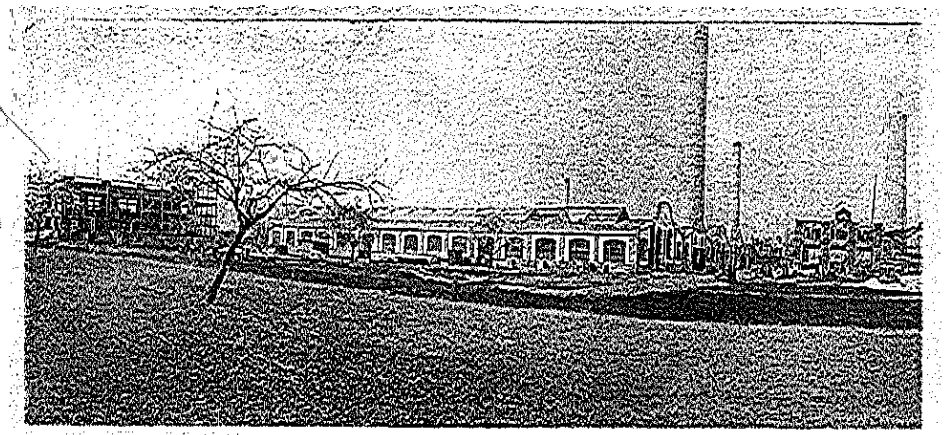
Summary

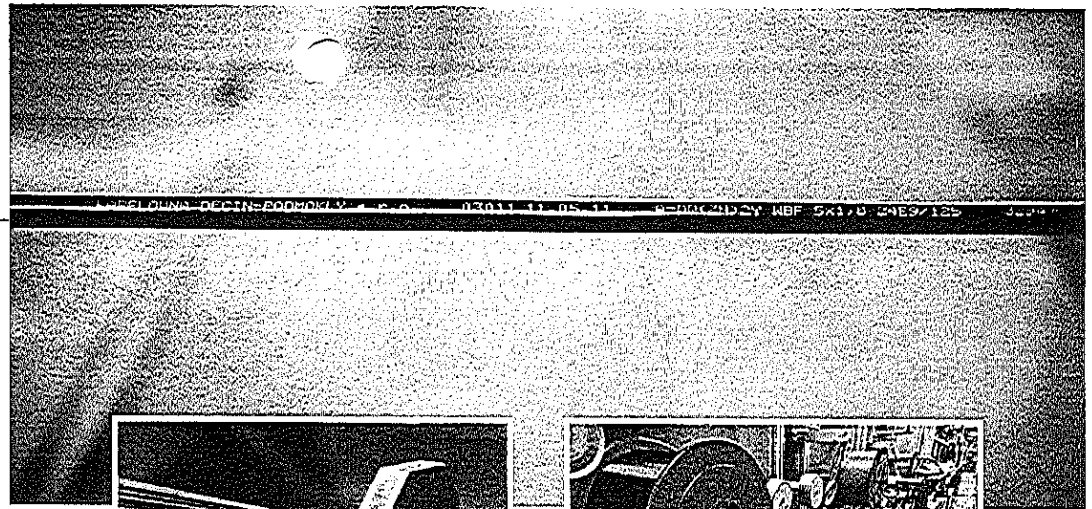
000326

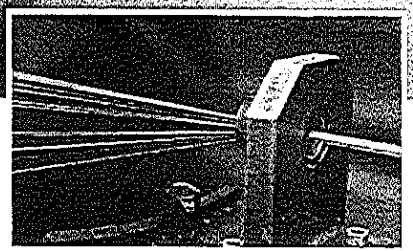
ООО "КРАСНАЯ СИБИРЬ"

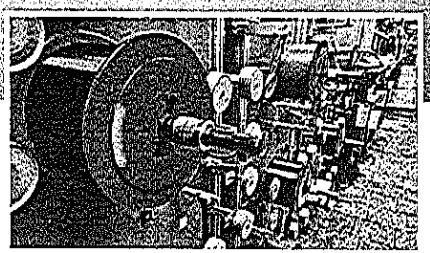
Index

History and present of **KABELOVNA** Děčín Podmokly



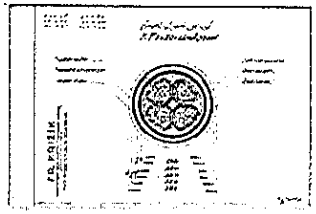


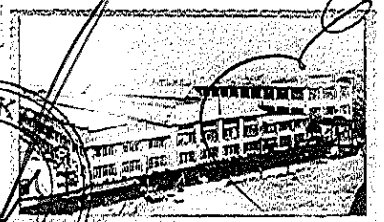


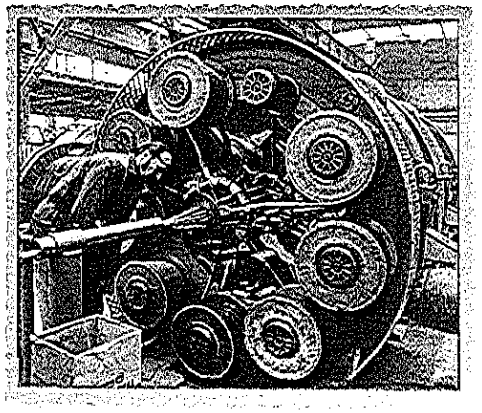


KDP was founded in 1909 and 1910 as a branch of the Bergmann cable plants in Berlin, the original name of the company being „Rakouské Bergmannovy závody spol. s r.o., Vídeň, továrna Podmokly".

From the very outset the plant manufactured all types of power and communications cables with lead casing and the relevant cable sets, as well as rubber-insulated conductors, dynamo wires and insulation pipes with accessories. Company activity at that time also included projects involving electrical equipment and its installation.



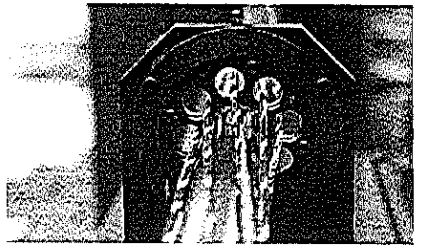




The cable factory came into the hands of Anglo-Pragobanka as part of Křížik a spol. Praha after the First World War and this company reconstructed the entire business. The production of trunk communications cables got underway at this time. The cable factory and neighbouring copper works were then merged in 1932 as the „Měďárna, kabelovna a elektrotechnické závody Křížik-Chaudoir, Praha". However, the production programme at the cable factory did not change too radically.

The company was nationalised after 1945. It was later incorporated as part of KABLO Kladno and its specialisation amplified. The main production programme became the manufacture of communications cables and in 1961 KABLO Děčín became the monopoly producer of cables for local and long-distance telecommunications networks using top-of-the-range technology. The company was privatised after 1990, became independent again and returned to its traditional name of KABELOVNA Děčín-Podmokly, a.s. SIEMENS AG then entered the company in 1992. The result of mutual cooperation here was considerable modernisation of production technology, the expansion of the range produced and the strengthening of KABELOVNA Děčín-Podmokly, a.s. on global markets.

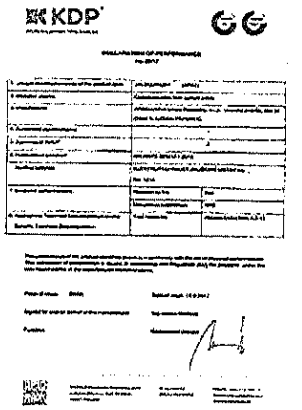
SIEMENS sold its share in KABELOVNA to American venture-capital fund Bancroft Eastern Europe Fund L.P. In July 2000, before this company in turn sold its share to American company CDT (Cable Design Technology) in December 2001. CDT then merged with American company BELDEN in 2004, the newly-founded company taking on the name of Belden CDT Inc. 2007 the cable works is sold to Wilms Gruppe, the company is divided into Kabelovna Děčín Podmokly, s.r.o. and KDP Assembly, s.r.o.



History

4. 9. 1909	Execution of contract on establishment of company „Rakouské Bergmanovy závody, Berlín, elektrotechnická společnost, s. r. o." with branch in Vienna.
27. 6. 1911	Launch of Production – 750 employees. Production of power and communication cables, cable sets and accessories, rubber wires and insulation tubes including accessories.
05/1919	The company was acquired by „Elektrotechnické závody František Křižík, Praha, a. s." Initiation of remote communication cables production.
03/1930	The company completely burnt down. Production restored at the end of year 1930.
05/1945	The company came under national control of Křižík a. s. corporation. Then it was nationalized and became a part of national company KABLO Bratislava. Production of power and communication cables with lead coating, rubberized wires and coil wires.
1. 1. 1950	Establishment of national company KABLO Děčín.
1959	Production of remote communication cables.
1961	KABLO Děčín became a monopoly producer of communication cables for local networks.
1982–1984	Construction of new hall to expand the production of communication cables.
1985	Termination of power cables production.
1988	Initiation of optic cables production.
31. 12. 1990	Privatization, establishment of incorporated company. The original name KABELOVNA Děčín Podmokly, a. s. was used.
1992	Company share acquisition by SIEMENS AG.
1994	Initiation of cable assemblies production.
1995	ISO 9001 certification completed.
1996	Initiation of installation cables production.
1996	Czech Republic Quality Award.
1998	ISO 14001 certification completed.
2000	Establishment of subsidiary company KDP Kabeltechnik Berlin, GmbH.
2000	Sale of SIEMENS AG share to investment fund BANCROFT CZ.
2001	CDT Pittsburgh becomes a majority owner of the company.
2002	Complete renewal of optic cable assortment.
2003	Initiation of data cable production.
2004	Merge with Belden company, Belden CDT Inc. was established.
2007	Wilms Gruppe becomes a new owner of KABELOVNA.
2010	KABELOVNA Děčín Podmokly, s.r.o. celebrates 100th Anniversary.
2015	New portfolio of cable constructions.
01. 1. 2016	KABELOVNA Děčín Podmokly, s.r.o. has become a member of FTTH Council.

Certificates and CPR



1. TIGHT BUFFERED CABLES

- SIMPLEX
- DUPLEX
- HEAVY DUPLEX
- BREAKOUT
- DISTRIBUTION

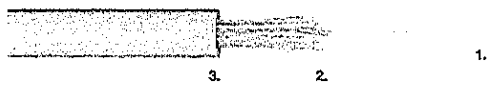
0000328

TIGHT BUFFERED

SIMPLEX

Specification: 16×1, 17×1, 11×1, 12×1, 14×1, 15×1, 18×1, 19×1, 13×1, Z026, Z174,

Indoor FTTx Data center Halogen free



Description of materials:

1. FR-LSZH buffered optical fiber. **2.** Waterblocking aramid yarn. **3.** FR-LSZH outer jacket.

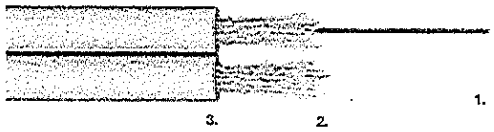
Temperature range	
Installation	-5 to +50 °C
Operation	-5 to +50 °C
Storage	-5 to +50 °C

Design code	Simplex diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
16×1	1.6	2.8	100	500
17×1	1.7	3.2	100	500
11×1	1.8	3.7	100	500
12×1	2.0	4.6	100	500
14×1	2.4	7.1	250	500
15×1	2.5	7.3	300	500
18×1	2.8	8.2	300	500
19×1	2.9	8.5	300	500
13×1	3.0	8.8	300	500
Z026	2.3	6.6	250	500
Z174	2.6	8.2	300	500

DUPLEX

Specification: 26×1, 21×1, 22×1, 24×1, 28×1, 23×1, Z175

Indoor FTTx Data center Halogen free



Description of materials:

1. FR-LSZH buffered optical fibers. **2.** Waterblocking aramid yarn. **3.** FR-LSZH outer jacket.

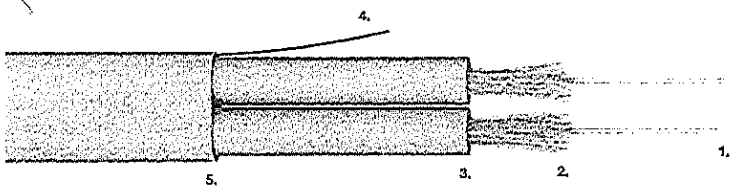
Temperature range	
Installation	-5 to +50 °C
Operation	-5 to +50 °C
Storage	-5 to +50 °C

Design code	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
26×1	1.6 × 3.4	5.8	200	1,000
21×1	1.8 × 3.8	7.4	200	1,000
22×1	2.0 × 4.3	9.3	200	1,000
24×1	2.4 × 5.1	11.9	500	1,000
28×1	2.8 × 5.9	17.0	500	1,000
23×1	3.0 × 6.3	19.7	500	1,000
Z175	2.6 × 5.6	14.4	500	1,000

TIGHT BUFFERED

HEAVY DUPLEX

Specification: 32×1, 34×1, 38×1, Z176, Z235, Z279



Description of materials:

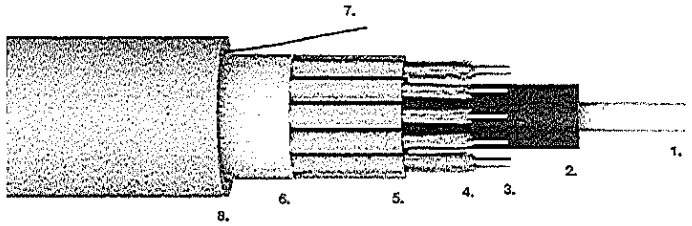
1. FR-LSZH buffered optical fibers. **2.** Waterblocking aramid yarn. **3.** FR-LSZH inner jacket. **4.** Rip-Cord. **5.** FR-LSZH outer jacket, UV stable.

Temperature range	32×1, 34×1, 38×1, Z176	Z235, Z279
Installation	0 to +50 °C	-15 to +50 °C
Operation	0 to +50 °C	-20 to +70 °C
Storage	0 to +50 °C	-20 to +70 °C

Design code	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
32×1	3.0 × 5.0	19.0	200	1,000
34×1	3.6 × 6.0	28.0	500	1,000
38×1	4.2 × 7.0	35.0	500	1,000
Z176	3.6 × 6.2	28.0	600	1,000
Z235	3.0 × 5.0	18.0	200	1,000
Z279	4.2 × 7.0	33.0	500	1,000

BREAKOUT STANDARD

Specification: 41×1, 42×1, 44×1, 49×1



Description of materials:

1. Central FRP strength member. **2.** PE coating for central FRP strength member when necessary. **3.** FR-LSZH buffered optical fibers. **4.** Waterblocking aramid yarn. **5.** Simplex cable. **6.** Water-swellable tape. **7.** Rip-Cord. **8.** FR-LSZH outer jacket, UV stable.

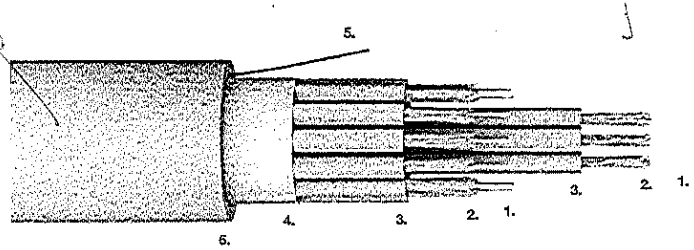
Temperature range	41×1, 49×1	42×1, 44×1
Installation	-5 to +40 °C	-5 to +50 °C
Operation	-5 to +60 °C	-20 to +60 °C
Storage	-25 to +60 °C	-20 to +60 °C

Design code	Max. fiber count	Simplex diameter [mm]	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
41×1	36	1.8	15.0	226.0	3,500	2,000
42×1	48	2.0	19.0	339.0	5,000	1,500
44×1	24	2.4	16.8	277.0	4,000	1,500
49×1	24	2.9	19.7	334.0	3,200	1,500

BREAKOUT NO CSM

Specification: 82×1

Indoor · FTTx · Data center · Halogen free



Description of materials:

1. FR-LSZH buffered optical fibers. **2.** Waterblocking aramid yarn. **3.** Simplex cable. **4.** Water-swellable tape. **5.** Rip-Cord. **6.** FR-LSZH outer jacket, UV stable.

Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

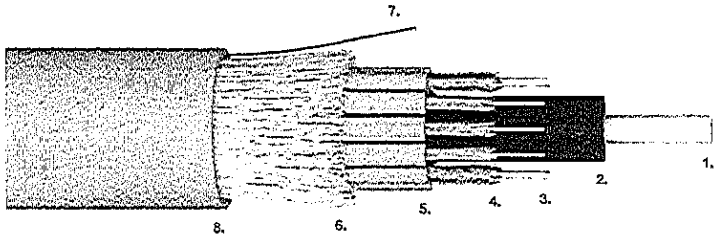
Design code	Max. fiber count	Simplex diameter [mm]	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
82×1	48	2.0	18.7	314.0	300	1,000

BREAKOUT IMPROVED

Specification: 42×8, 44×8

TIGHT BUFFERED

Indoor · FTTx · Data center · Halogen free · High tensile



Description of materials:

1. Central FRP strength member. **2.** PE coating for central FRP strength member when necessary. **3.** FR-LSZH buffered optical fibers. **4.** Waterblocking aramid yarn. **5.** Simplex cable. **6.** Waterblocking E-glass yarn. **7.** Rip-Cord. **8.** FR-LSZH outer jacket, UV stable.

Temperature range	42×8	44×8
Installation	-5 to +40 °C	-5 to +40 °C
Operation	-20 to +60 °C	-5 to +50 °C
Storage	-20 to +60 °C	-25 to +60 °C

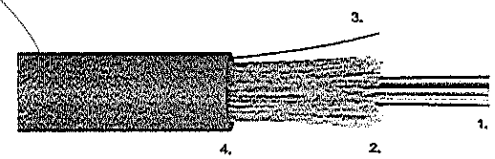
Design code	Max. fiber count	Simplex diameter [mm]	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
42×8	24	2.0	15.7	248.0	4,500	2,000
44×8	24	2.4	18.1	334.0	5,500	2,000

TIGHT BUFFERED

DISTRIBUTION STANDARD

Specification: 5Ex1

Indoor Outdoor FTTx Data center Halogen free



Description of materials:

1. FR-LSZH buffered optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH outer jacket, UV stable.

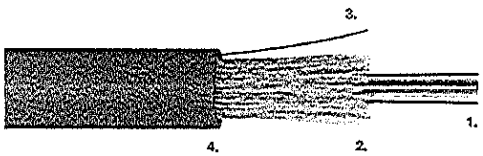
Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5Ex1	2	5.5	32.0	850	2,000
5Ex1	4	6.0	39.0	1,200	2,000
5Ex1	6	6.3	42.0	1,200	2,000
5Ex1	8	7.1	51.0	1,500	2,000
5Ex1	12	8.1	64.0	2,500	2,000
5Ex1	16	9.7	85.0	2,700	2,000
5Ex1	24	11.4	109.0	3,500	2,000

DISTRIBUTION STANDARD

Specification: 5Vx1

Indoor Outdoor FTTx Data center Halogen free



Description of materials:

1. FR-LSZH buffered optical fibers. **2.** Waterblocking aramid yarn. **3.** Rip-Cord.
4. FR-LSZH outer jacket, UV stable.

Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

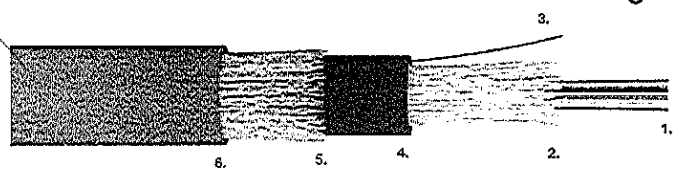
Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5Vx1	2	4.4	20.0	550	2,000
5Vx1	4	5.1	26.0	750	2,000
5Vx1	6	5.3	30.0	900	2,000
5Vx1	8	5.9	35.0	1,000	2,000
5Vx1	10	6.1	38.0	1,000	2,000
5Vx1	12	6.4	42.0	1,100	2,000
5Vx1	16	7.5	57.0	1,900	2,000
5Vx1	24	8.5	72.0	1,600	2,000

TIGHT BUFFERED

DISTRIBUTION IMPROVED

Specification: 5Ex8

Indoor · Outdoor · FTTx · Data center · Halogen free · High tensile



Description of materials:

1. FR-LSZH buffered optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord. **4.** FR-LSZH inner jacket. **5.** Waterblocking E-glass yarn. **6.** FR-LSZH outer jacket, UV stable.

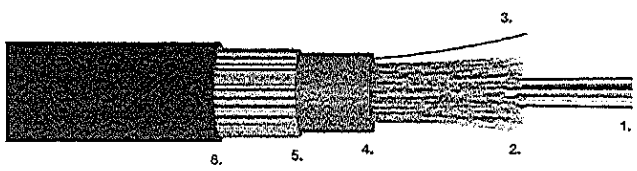
Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5Ex8	2	8.4	84.0	2,500	2,000
5Ex8	4	8.9	95.0	2,800	2,000
5Ex8	6	9.2	102.0	3,000	2,000
5Ex8	8	10.1	115.0	3,300	2,000
5Ex8	12	11.1	135.0	3,600	2,000
5Ex8	16	12.3	164.0	3,800	2,000
5Ex8	24	14.1	201.0	4,100	2,000

DISTRIBUTION SWA

Specification: 5Ax4, 5Ax5

Indoor · Outdoor · FTTx · Halogen free · High tensile · Antirodent · Armoured · Direct burial



Description of materials:

1. FR-LSZH buffered optical cable. **2.** Waterblocking aramid yarn. **3.** Rip-Cord. **4.** FR-LSZH inner jacket. **5.** Steel Wire Armour (SWA). **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

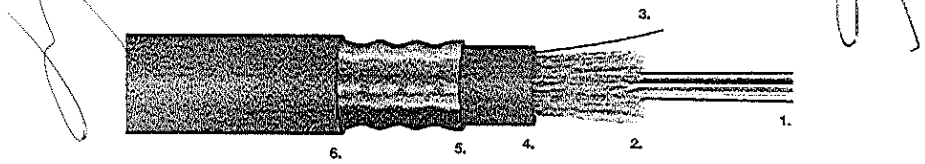
Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5Ax4	4	10.2	169.0	4,350	2,000
5Ax4	8	11.2	199.0	5,100	2,000
5Ax4	12	11.7	217.0	5,550	2,000
5Ax4	24	14.8	312.0	7,800	2,000
5Ax5	4	10.2	145.0	4,350	2,000
5Ax5	8	11.2	173.0	5,100	2,000
5Ax5	12	11.7	190.0	5,550	2,000
5Ax5	24	14.8	276.0	7,800	2,000

000334

TIGHT BUFFERED

DISTRIBUTION CST

Specification: 5S×0, 5S×1



Description of materials:

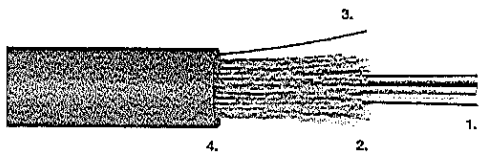
1. FR-LSZH buffered optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord. **4.** FR-LSZH inner jacket. **5.** Corrugated steel tape. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	+5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5S×0	4	10.5	107.0	800	5,000
5S×0	8	11.5	127.0	1,100	5,000
5S×0	12	15.5	134.0	1,200	5,000
5S×0	24	10.5	206.0	2,100	5,000
5S×1	4	11.5	131.0	800	5,000
5S×1	8	11.5	155.0	1,100	5,000
5S×1	12	15.5	161.0	1,200	5,000
5S×1	24	15.5	244.0	2,100	5,000

DISTRIBUTION ACRYLATE BUFFER

Specification: 5VA1

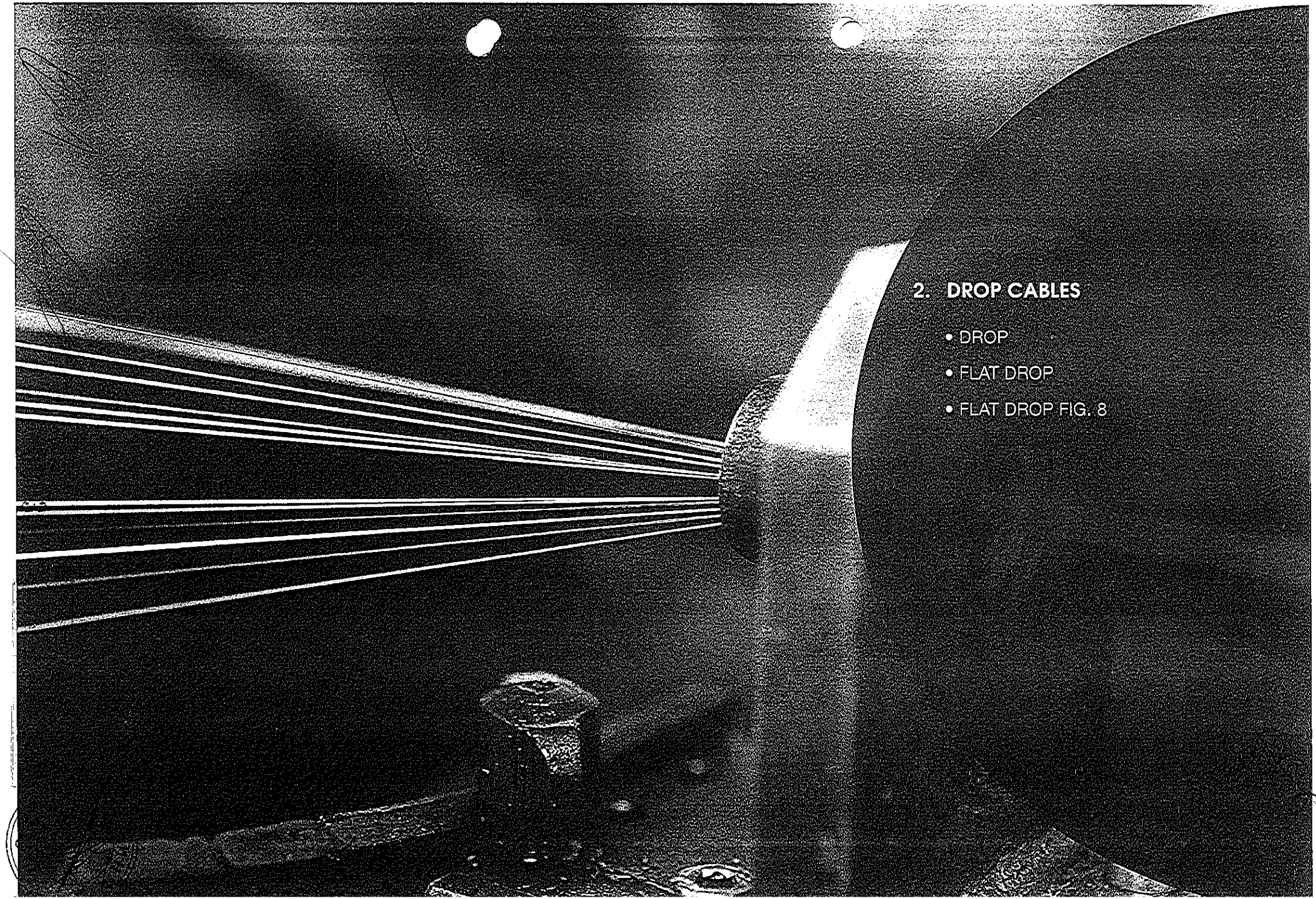


Description of materials:

1. Acrylate buffered optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord. **4.** FR-LSZH outer jacket, UV stable.

Temperature range	
Installation	-30 to +60 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

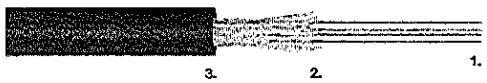
Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
5VA1	2	4.4	20.0	550	2,000
5VA1	4	5.1	25.0	750	2,000
5VA1	6	5.3	28.0	900	2,000
5VA1	8	5.9	33.0	1,000	2,000
5VA1	10	6.1	35.0	1,000	2,000
5VA1	12	6.4	38.0	1,100	2,000
5VA1	16	7.5	52.0	1,300	2,000
5VA1	24	8.5	64.0	1,600	2,000


2. DROP CABLES
• DROP
• FLAT DROP
• FLAT DROP FIG. 8

DROP

Specification: 7A01, Z236, Z237

Indoor · Outdoor · FTTx · Halogen free · Aerial



Description of materials:

1. Optical fibers. **2.** Aramid yarn. **3.** FR-LSZH outer jacket, UV stable.

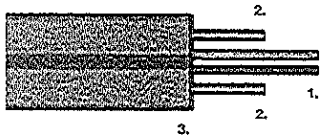
Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +60 °C
Storage	-20 to +60 °C

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
7A01	1–6	3.0	10.0	500	1,000
7A01	8–12	3.4	12.0	500	1,000
7A01	16	3.7	13.5	600	1,000
7A01	24	4.0	15.5	500	1,000
Z236	1–12	3.4	13.0	700	1,000
Z237	2	3.0	11.0	1,000	1,000
Z237	4	3.2	11.0	1,000	1,000
Z237	8	3.2	12.0	1,000	1,000
Z237	12	3.4	13.0	1,000	1,000

FLAT DROP

Specification: Z041, Z043

Indoor · Outdoor · FTTx · Halogen free · Aerial



Description of materials:

1. Optical fibers. **2.** Steel wire or FRP. **3.** FR-LSZH outer jacket, UV stable.

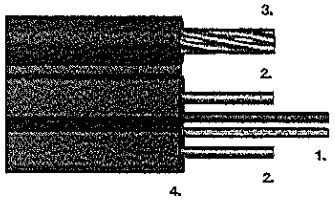
Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-30 to +70 °C

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z041	2	2 × 3.0	9.5	300	4,000
Z043	2	2 × 3.0	7.6	100	4,000

FLAT DROP FIG. 8

Specification: Z042, Z046

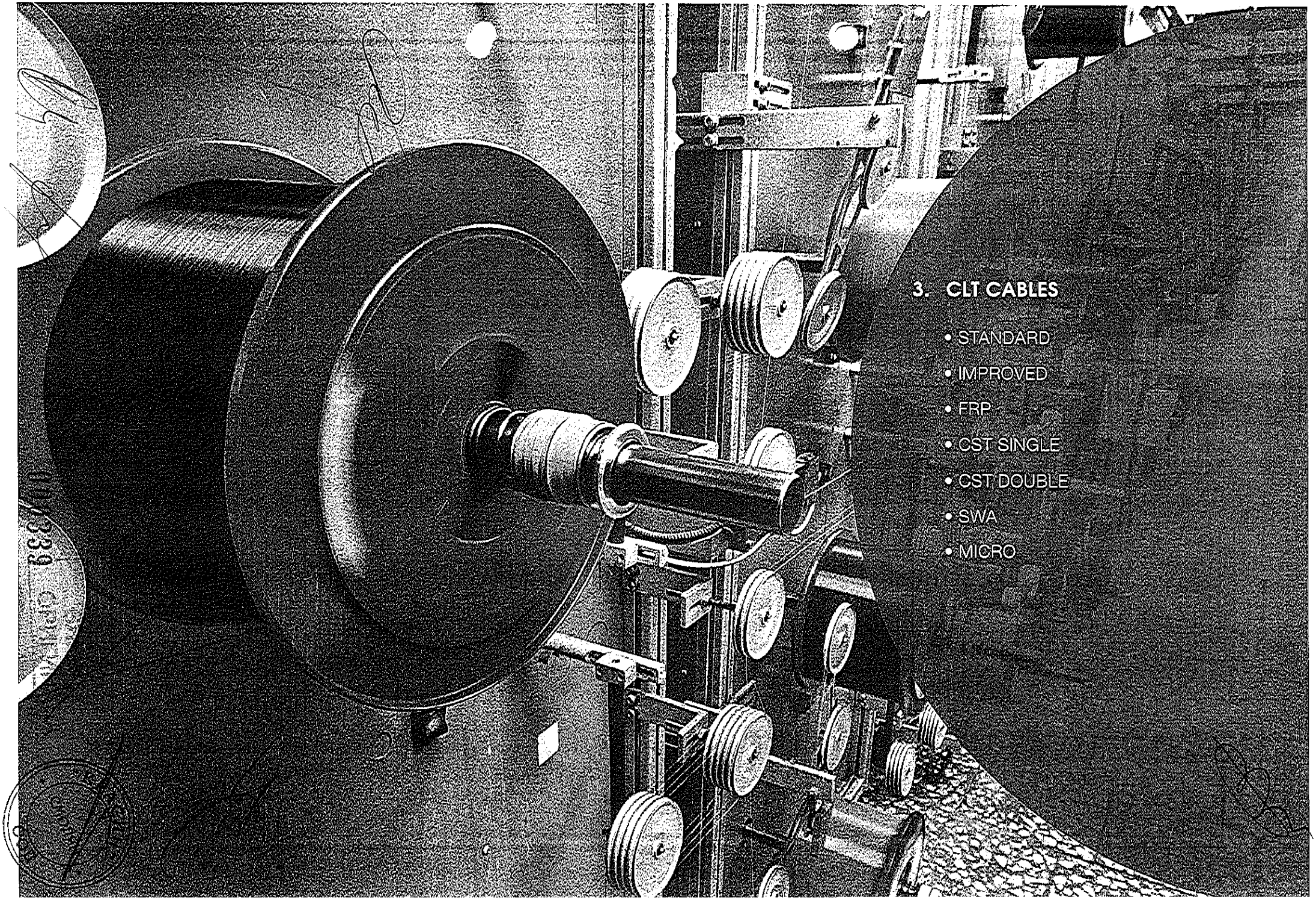
Indoor · Outdoor · FTTx · Halogen free · Aerial



Description of materials:

1. Optical fibers. **2.** Steel wire or FRP. **3.** Steel wire messenger Ø 1.0 mm.
4. FR-LSZH outer jacket, UV stable.

Design code	Fiber count	Cable outer diameter [mm]	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z042	2	2 × 5.2	20.0	800	4,000
Z046	2	2 × 5.2	18.0	800	4,000



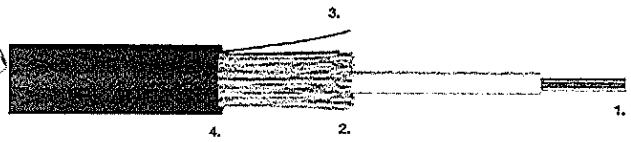
3. CLT CABLES

- STANDARD
- IMPROVED
- FRP
- CST SINGLE
- CST DOUBLE
- SWA
- MICRO

CLT STANDARD

Specification: AE00, BE00, AE02, BE02

Indoor Outdoor FTTx Halogen free



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH or PE outer jacket, UV stable.

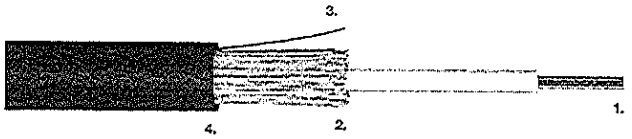
Temperature range	
Installation	-15 to +50 °C
Operation	-20 to +70 °C
Storage	-20 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
AE00	12	2.5	5.4	27.0	1,100	2,000
BE00	24	3.0	5.8	31.0	1,100	2,000
AE02	12	2.5	5.4	35.0	1,100	2,000
BE02	24	3.0	6.4	48.0	1,100	2,000

CLT IMPROVED

Specification: AR00, BR00, AR02, BR02

Indoor Outdoor FTTx Halogen free High tensile



Description of materials:

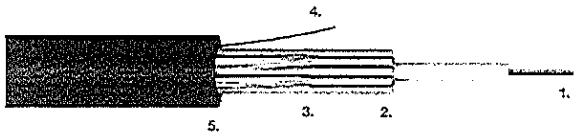
1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-20 to +70 °C
Storage	-20 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
AR00	12	2.5	6.5	39.0	2,000	2,000
BR00	24	3.0	7.7	51.0	2,500	2,000
AR02	12	2.5	6.5	50.0	2,000	2,000
BR02	24	3.0	7.7	68.0	2,500	2,000

CLT FRP

Specification: BF0I, BF02



Description of materials:

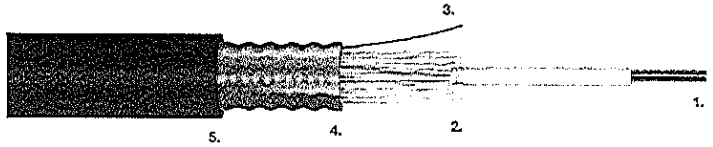
1. Gel filled PBT loose tube with optical fibers. **2.** FRP dielectric strength member.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
BF0I	24	3.0	7.4	58.0	2,300	3,000
BF02	24	3.0	7.4	65.0	2,300	3,000

CLT CST

Specification: BH0I, BH02, Z144, Z145



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. Corrugated steel tape. **5.** FR-LSZH or PE outer jacket, UV stable.

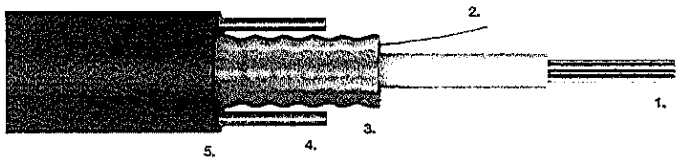
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
BH0I	24	3.0	9.9	98.0	2,500	10,000
BH02	24	3.0	10.1	120.0	2,500	10,000
Z144	24	3.0	7.7	70.0	1,100	10,000
Z145	24	3.0	7.9	87.0	1,100	10,000

CLT CST

Specification: X008

Outdoor · FTTx · Armoured · Duct · Antirodent



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Rip-Cord. **3.** Corrugated Steel tape. **4.** Steel Wire. **5.** PE outer jacket, UV stable.

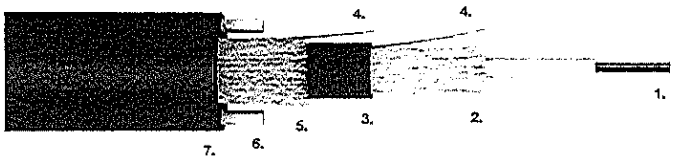
Temperature range	
Installation	-50 to +70 °C
Operation	-30 to +50 °C
Storage	-60 to +70 °C

Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/cm]
X008	12	8.3	83.0	2,700	500
X008	24	8.5	86.0	2,700	500

CLT FRP DOUBLE JACKET

Specification: X017

Outdoor · FTTx · Aerial · Dielectric



Description of materials:

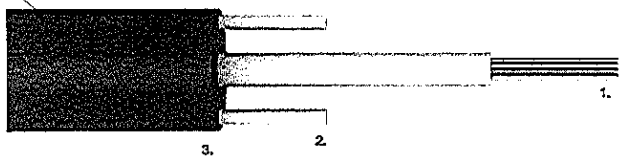
1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** FR-LSZH inner jacket. **4.** Rip-Cord. **5.** Waterblocking E-Glass yarn. **6.** FRP rods. **7.** PE outer jacket, UV stable.

Temperature range	
Installation	-40 to +70 °C
Operation	-30 to +50 °C
Storage	-60 to +70 °C

Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [kN]	Crush resistance [N/cm]
NEW X017	12	9.7	80.5	2	300

CLT DROP

Specification: X018



Description of materials:

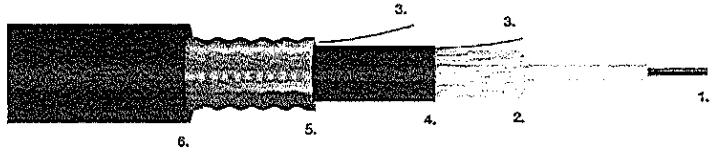
1. Gel filled PBT loose tube with optical fibers. **2.** FRP rods. **3.** PE outer jacket, UV stable.

Temperature range	
Installation	-50 to +70 °C
Operation	-10 to +50 °C
Storage	-50 to +50 °C

Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [N]
X018	12	5.2	22.4	550

CLT CST DOUBLE JACKET

Specification: BIPI, BIF2, BIP2



Description of materials:

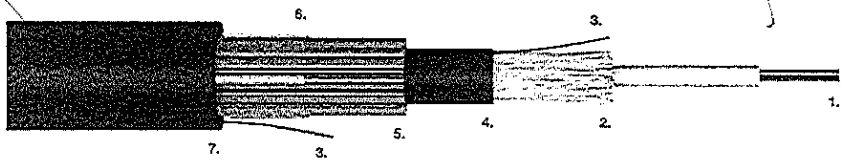
1. Gel filled PBT loose tube with optical fibres. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH or PE inner jacket. **5.** Corrugated steel tape. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
BIPI	24	3.0	10.5	106.0	1,100	6,000
BIF2	24	3.0	10.5	138.0	1,100	6,000
BIP2	24	3.0	10.5	131.0	1,100	6,000

CLT SWA

Specification: BWPI, BWP2, BWFI, BWF2



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH or PE inner jacket. **5.** Steel Wire Armour (SWA). **6.** Water-swellable tape.
7. FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-30 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
BWPI	24	3.0	10.7	157.0	8,000	4,000
BWP2	24	3.0	10.7	179.0	8,000	4,000
BWFI	24	3.0	10.7	166.0	8,000	4,000
BWF2	24	3.0	10.7	188.0	8,000	4,000

CLT MICRO

Specification: Z044, Z008, Z006, Z238

Description of materials:

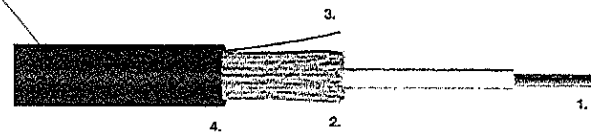
1. Optical fibres. **2.** Gell filled PBT loose tube. **3.** Low Friction Polymer.

Temperature range	
Installation	-5 to +50 °C
Operation	-20 to +70 °C
Storage	-20 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z044	4	2.0	2.0	4.0	70	1,000
Z008	12	2.5	2.5	6.0	70	1,000
Z006	12	2.8	2.8	8.0	70	1,000
Z238	24	3.2	3.2	10.0	70	1,000

CLT MICRO

Specification: AL00, Z339, Z366

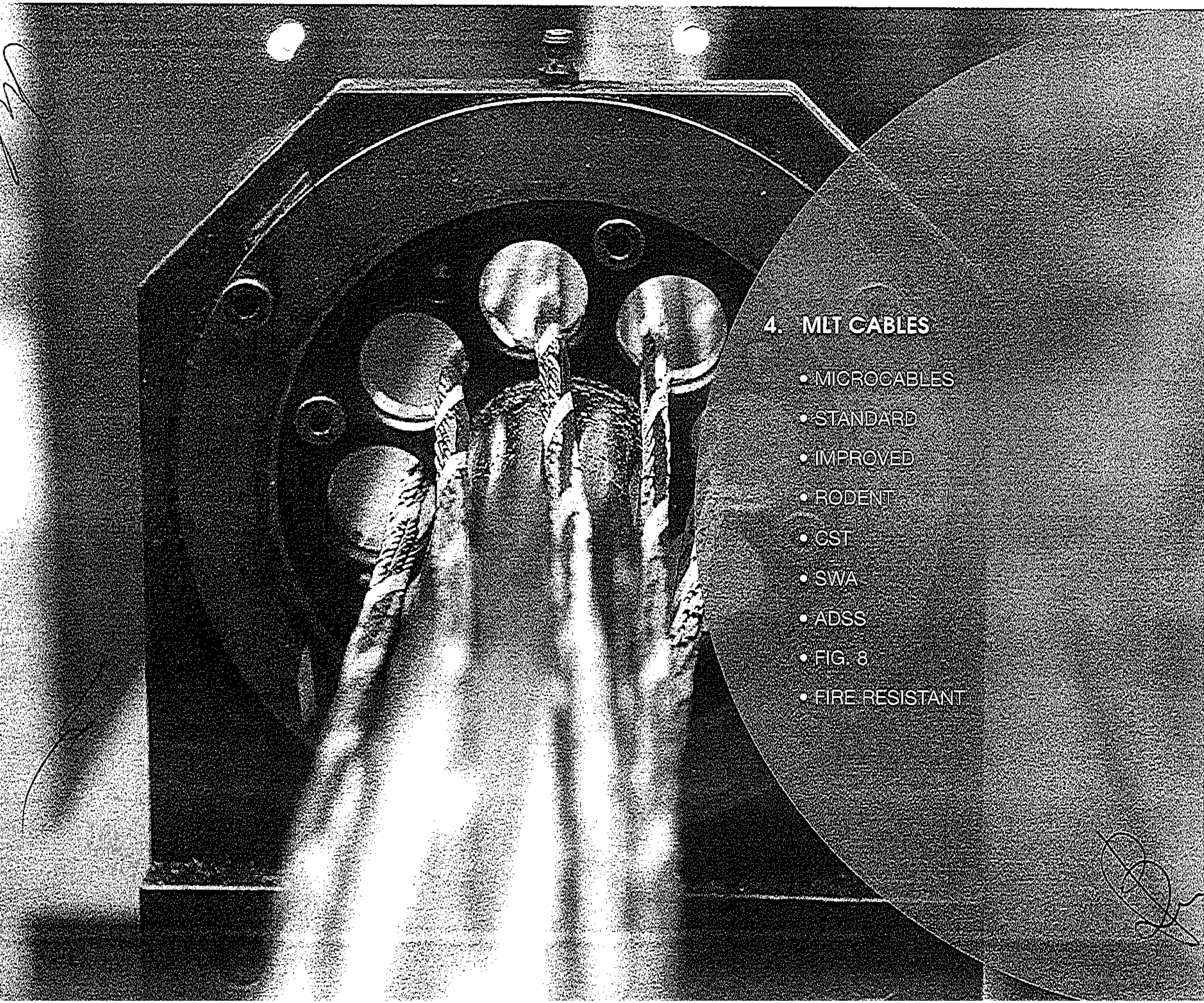


Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking aramid yarn. **3.** Rip-Cord.
4. PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-20 to +70 °C
Storage	-20 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
AL00	12	2.3	3.4	10	250	1,000
Z339	12	1.7	2.5	5	90	700
Z366	24	2.6	3.5	10	90	700



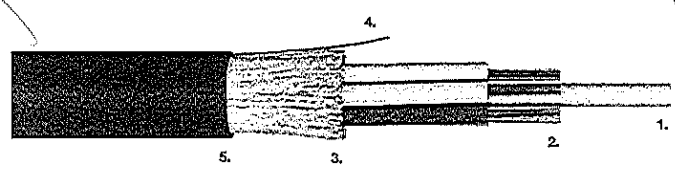
000346

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

MLT IMPROVED

Specification: CR0I, CR02, PR0I, PR02, RR0I, RR02, VR0I, VR02



Description of materials:

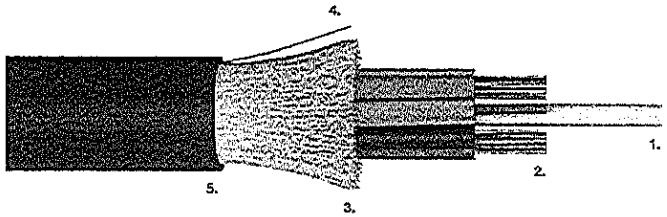
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +60 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
CR0I	72	1.7	9.4	81.0	4,600	3,000
CR02	72	1.7	9.4	101.0	4,600	3,000
PR0I	96	1.7	10.8	108.0	8,000	3,000
PR02	96	1.7	10.8	132.0	8,000	3,000
RR0I	144	1.7	12.8	150.0	13,000	3,000
RR02	144	1.7	12.8	179.0	13,000	3,000
VR0I	216	1.7	12.1	133.0	5,100	2,000
VR02	216	1.7	12.1	161.0	5,100	2,000

MLT IMPROVED

Specification: LR0I, LR02, FR0I, FR02, GR0I, GR02, HR0I, HR02



Description of materials:

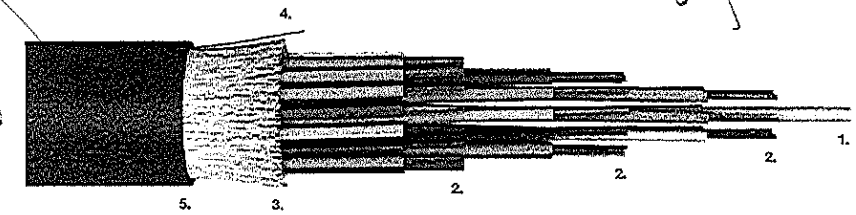
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
LR0I	48	2.3	9.2	74.0	2,600	2,000
LR02	48	2.3	9.2	95.0	2,600	2,000
FR0I	72	2.3	10.6	99.0	4,000	2,000
FR02	72	2.3	10.6	122.0	4,000	2,000
GR0I	96	2.3	12.0	131.0	7,000	2,000
GR02	96	2.3	12.0	158.0	7,000	2,000
HR0I	144	2.3	14.9	197.0	10,000	2,000
HR02	144	2.3	14.9	231.0	10,000	2,000

MLT IMPROVED

Specification: MR00, MR02



Description of materials:

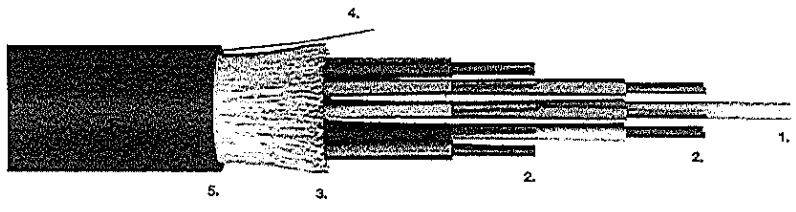
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
MR00	432	2.3	20.3	320.0	7,700	2,000
MR02	432	2.3	20.3	375.0	7,700	2,000

MLT IMPROVED

Specification: IR01, IR02



Description of materials:

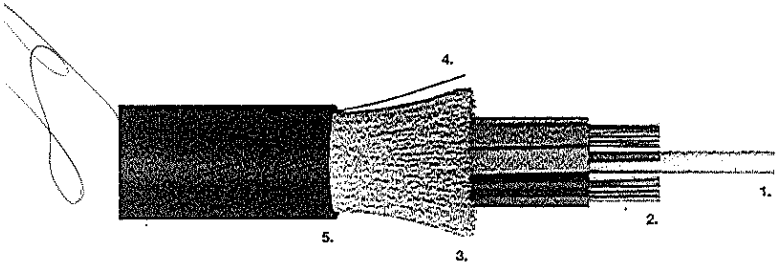
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
IR01	216	2.3	15.8	221.0	6,700	2,000
IR02	216	2.3	15.8	258.0	6,700	2,000

MLT IMPROVED

Specification: YR0I, YR02



Description of materials:

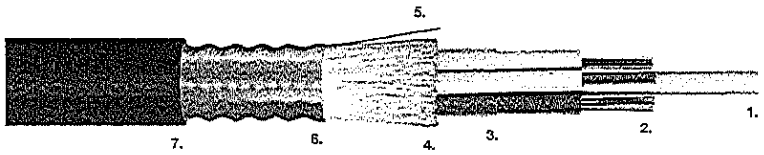
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-30 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
YR0I	288	2.8	17.6	257.0	10,000	3,000
YR02	288	2.8	17.6	298.0	10,000	2,000

MLT CST

Specification: CH0I, CH02, PH0I, PH02, RH0I, RH02



Description of materials:

1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking E-glass yarn. **5.** Rip-Cord. **6.** Corrugated steel tape.
7. FR-LSZH or PE outer jacket, UV stable.

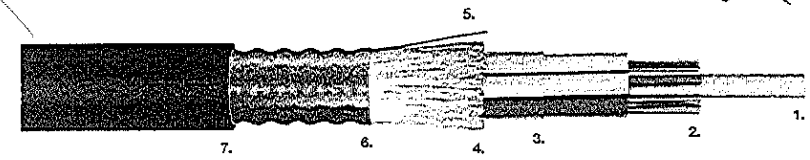
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
CH0I	72	1.7	10.2	107.0	2,600	10,000
CH02	72	1.7	10.2	126.0	2,600	10,000
PH0I	96	1.7	11.1	130.0	5,400	10,000
PH02	96	1.7	11.1	152.0	5,400	10,000
RH0I	144	1.7	14.1	186.0	6,600	10,000
RH02	144	1.7	14.1	214.0	6,600	10,000

000371

MLT CST

Specification: LH0I, LH02, FH0I, FH02, GH0I, GH02, HH0I, HH02



Description of materials:

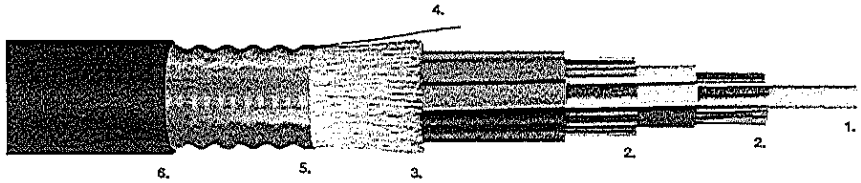
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking E-glass yarn. **5.** Rip-Cord. **6.** Corrugated steel tape.
7. FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
LH0I	48	2.3	11.5	125.0	1,200	10,000
LH02	48	2.3	11.5	151.0	1,200	10,000
FH0I	72	2.3	12.5	150.0	2,100	10,000
FH02	72	2.3	12.5	178.0	2,100	10,000
GH0I	96	2.3	14.5	185.0	2,600	10,000
GH02	96	2.3	14.5	219.0	2,600	10,000
HH0I	144	2.3	16.5	250.0	4,500	10,000
HH02	144	2.3	16.5	288.0	4,500	10,000

MLT CST

Specification: VH0I, VH02



Description of materials:

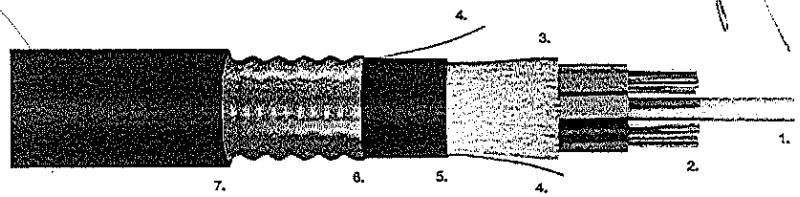
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** Corrugated steel tape. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-45 to +70 °C
Storage	-45 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
VH0I	216	1.7	14.5	193.0	3,000	10,000
VH02	216	1.7	14.5	228.0	3,000	10,000

MLT CST DOUBLE JACKET

Specification: LIPI, LIP2, LIF2, FIPI, FIP2, FIF2



Description of materials:

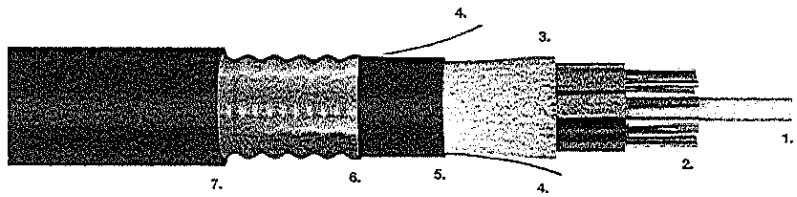
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE inner jacket.
6. Corrugated steel tape. **7.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-45 to +70 °C
Storage	-45 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
LIPI	48	2.3	13.5	165.0	1,500	10,000
LIP2	48	2.3	13.5	196.0	1,500	10,000
LIF2	48	2.3	13.5	209.0	1,500	10,000
FIPI	72	2.3	14.5	197.0	3,300	10,000
FIP2	72	2.3	14.5	230.0	3,300	10,000
FIF2	72	2.3	14.5	246.0	3,300	10,000

MLT CST DOUBLE JACKET

Specification: GIPI, GIF2, HIPI, HIF2



Description of materials:

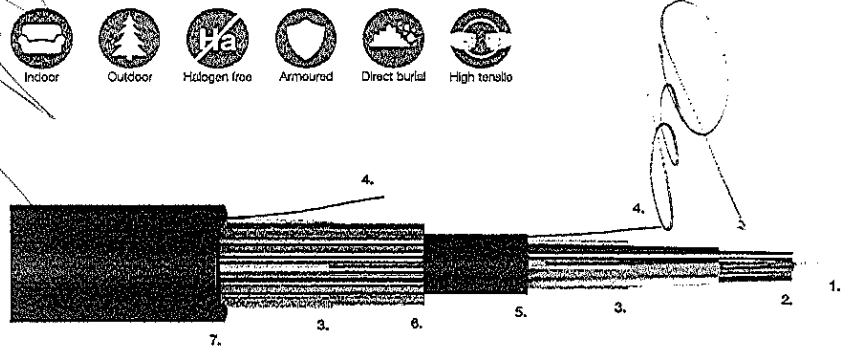
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE inner jacket.
6. Corrugated steel tape. **7.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-45 to +70 °C
Storage	-45 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
GIPI	96	2.3	16.5	240.0	4,800	10,000
GIF2	96	2.3	16.5	295.0	4,800	10,000
HIPI	144	2.3	19.5	323.0	10,000	10,000
HIF2	144	2.3	19.5	391.0	10,000	10,000

MLT SWA

Specification: LWPI, LWF2, FWPI, FWF2, GWPI, GWF2, HWPI, HWF2



Description of materials:

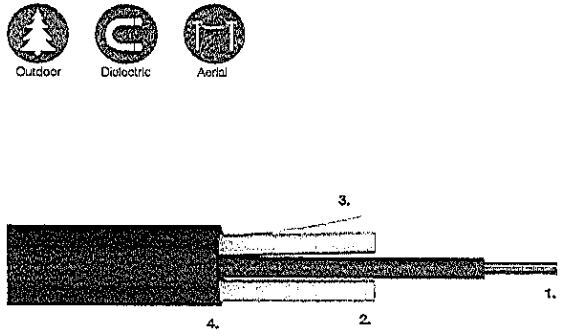
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Rip-Cord. **5.** FR-LSZH or PE inner jacket. **6.** Steel Wire Armour (SWA).
7. FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
LWPI	48	2.3	13.2	278.0	1,900	4,500
LWF2	48	2.3	13.2	317.0	1,900	4,500
FWPI	72	2.3	14.7	334.0	4,200	4,500
FWF2	72	2.3	14.7	380.0	4,200	4,500
GWPI	96	2.3	16.0	392.0	5,500	4,500
GWF2	96	2.3	16.0	443.0	5,500	4,500
HWPI	144	2.3	18.9	516.0	9,700	4,500
HWF2	144	2.3	18.9	579.0	9,700	4,500

ADSS

Specification: AS0I, Z159, Z194



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** FRP periferal strength member.
3. Rip-Cord. **4.** PE outer jacket, UV stable.

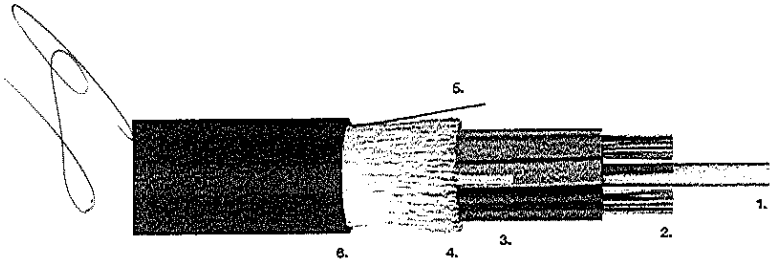
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
AS0I	12	2.0	4.2 × 7.8	37.0	1,600	4,000
Z159	24	1.7	9.1 × 3.8	36.0	1,300	4,000
Z194	48	3.5	12.5 × 5.5	72.0	2,500	2,500

ADSS

Specification: N3XI, N4XI, N5XI, N6XI

Outdoor Duct Dielectric Aerial



Description of materials:

1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking aramid yarn. **5.** Rip-Cord. **6.** PE outer jacket, UV stable.

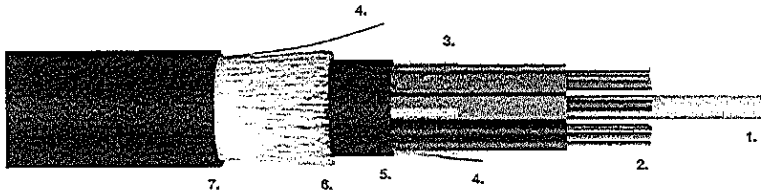
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
N3XI	48	2.5	10.2	79.0	3,000	3,000
N4XI	72	2.5	11.9	110.0	3,000	3,000
N5XI	96	2.5	13.3	133.0	3,000	3,000
N6XI	144	2.5	16.4	200.0	3,000	3,000

ADSS

Specification: N3YI, N4YI, N5YI, N6YI

Outdoor Duct Dielectric Aerial



Description of materials:

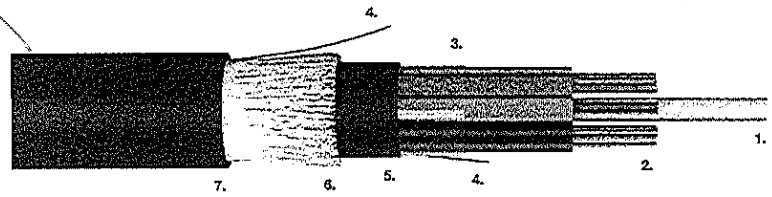
1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Rip-Cord. **5.** PE inner jacket. **6.** Waterblocking aramid yarn.
7. PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
N3YI	48	2.5	12.2	115.0	6,000	3,000
N4YI	72	2.5	13.8	149.0	6,000	3,000
N5YI	96	2.5	15.3	178.0	6,000	3,000
N6YI	144	2.5	18.4	255.0	6,000	3,000

ADSS

Specification: N4ZI, N5ZI, N6ZI



Description of materials:

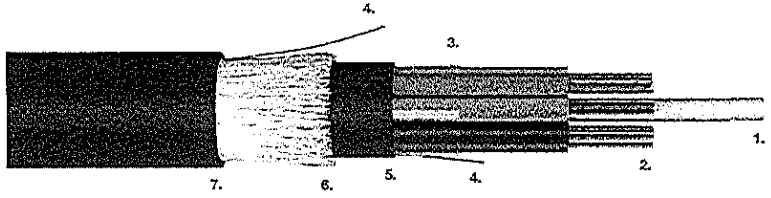
1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers. **3.** Water-swellable tape. **4.** Rip-Cord. **5.** PE inner jacket. **6.** Waterblocking aramid yarn. **7.** PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
N4ZI	72	2.8	15.5	192.0	10,000	3,000
N5ZI	96	2.8	17	221.0	10,000	3,000
N6ZI	144	2.8	20.5	312.0	10,000	3,000

ADSS

Specification: N4RI, N5RI, N6RI, N7RI, N7SI, N9ZI



Description of materials:

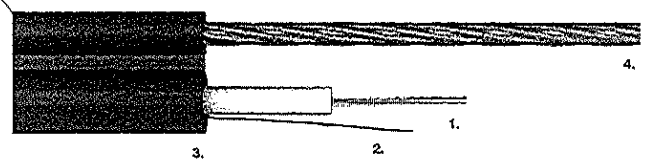
1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers. **3.** Water-swellable tape. **4.** Rip-Cord. **5.** PE inner jacket. **6.** Waterblocking aramid yarn. **7.** PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
N4RI	72	2.8	15.6	200.0	15,000	3,000
N5RI	96	2.8	17.3	236.0	15,000	3,000
N6RI	144	2.8	20.9	341.0	15,000	3,000
N7RI	216	2.8	21.2	343.0	15,000	3,000

FIG.8

Specification: A860, A862, Z187



Description of materials:

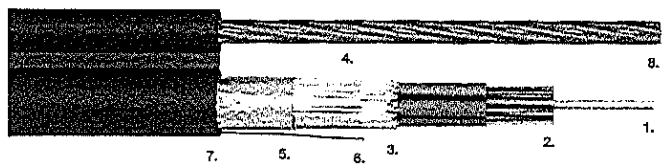
1. Gel filled PBT loose tube with optical fibers. **2.** Rip-Cord. **3.** FR-LSZH or PE outer jacket, UV stable.
4. Steel wire messenger.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-30 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
A860	12	2.3	5.9 x 11.5	55.0	1,000	1,000
A862	12	2.3	5.9 x 11.5	78.0	1,000	1,000
Z187	24	4.5	8.5 x 18.0	140.0	3,000	2,000

FIG.8

Specification: L83A, F83A, G83A, H83A



Description of materials:

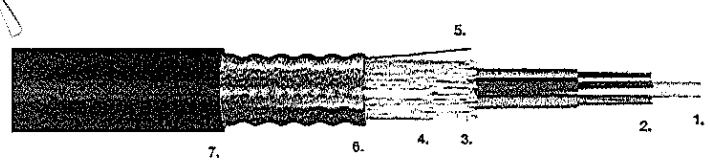
1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Water-swellable tape. **5.** Moisture barrier. **6.** Rip-Cord.
7. PE outer jacket, UV stable. **8.** Steel wire messenger.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-30 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
L83A	48	2.3	11.1 x 20.7	162.0	5,000	2,000
F83A	72	2.3	13.1 x 22.7	192.0	5,000	2,000
G83A	96	2.3	14.1 x 23.7	219.0	5,000	2,000
H83A	144	2.3	17.1 x 26.7	285.0	5,000	2,000

FIRE RESISTANT – FSC 90 min.

Specification: CLT – Z297; MLT – Z298, Z299, Z300



Description of materials:

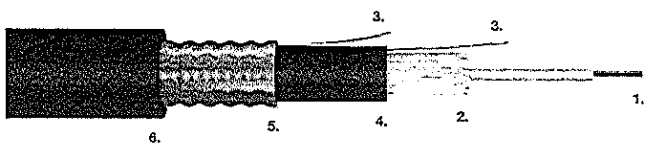
1. FRP dielectric central strenght member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Water-swellable tape. **5.** Rip-Cord. **6.** Corrugated steel tape.
7. FR-LSZH outer jacket, UV stable.

Temperature range	Z297	Z298, Z299, Z300
Installation	-15 to +50 °C	-15 to +50 °C
Operation	-30 to +70 °C	-40 to +70 °C
Storage	-30 to +70 °C	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z297	24	3.0	8.9	108.0	1,500	10,000
Z298	72	1.7	12.1	171.0	3,000	10,000
Z299	96	1.7	13.1	203.0	6,000	10,000
Z300	144	1.7	15.1	272.0	12,000	10,000

FIRE RESISTANT – FSC 180 min.

Specification: CLT – Z281; Z285 – distribution cable; MLT – Z282, Z283, Z284



Description of materials:

1. Gel filled PBT loose tube with optical fibers. **2.** Waterblocking E-glass yarn. **3.** Rip-Cord.
4. FR-LSZH inner jacket, UV stable. **5.** Corrugated steel tape. **6.** FR-LSZH outer jacket, UV stable.

Temperature range	Z281	Z285	Z282, Z283, Z284
Installation	-15 to +50 °C	-15 to +50 °C	-15 to +50 °C
Operation	-30 to +80 °C	-20 to +80 °C	-40 to +80 °C
Storage	-40 to +80 °C	-20 to +80 °C	-40 to +80 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z281	24	3.2	12.5	201.0	2,000	10,000
Z285	24	-	17.5	332.0	3,000	8,000
Z282	72	1.7	14.5	260.0	2,900	10,000
Z283	96	1.7	15.5	301.0	5,700	10,000
Z284	144	1.7	17.5	362.0	10,200	10,000

KABELOUNA DECIN-PODMOKLY s.r.o. 03011 11 05 11

000365

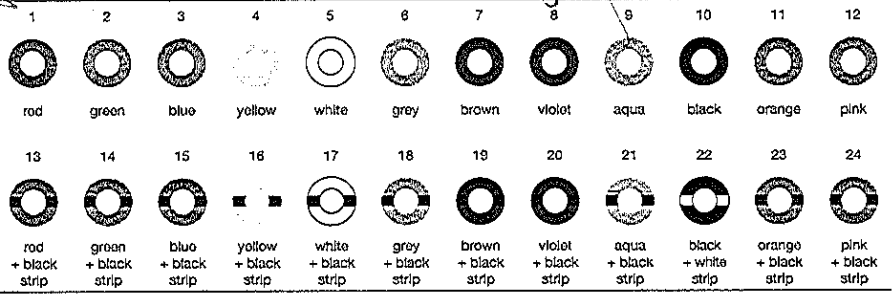
5. GENERAL SPECIFICATION

- COLOUR CODE CHARTS
- CODE TABLE
- STRIPABILITY OF THE TIGHT BUFFERED FIBER
- USED ABBREVIATIONS
- PROPERTIES OF THE CABLE SHEATH
- CHEMICAL RESISTANCE TABLE
- FIRE PROPERTIES

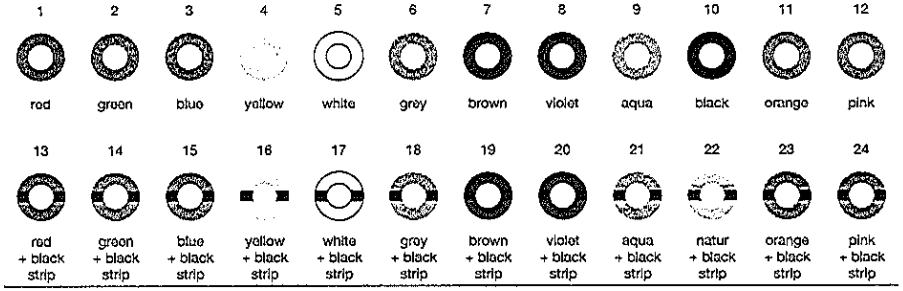
Colour Code Charts

IEC 60304 (Standard)

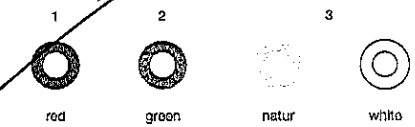
Tight Buffer



Loose Tube



Multi Loose Tube – Tubes Colour Code

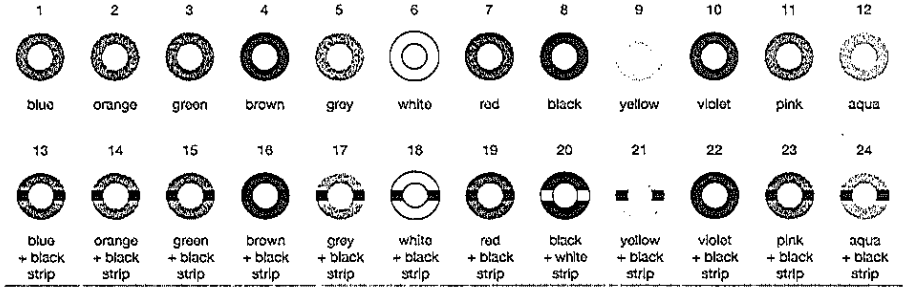


Note: Different colour sequences available on request.

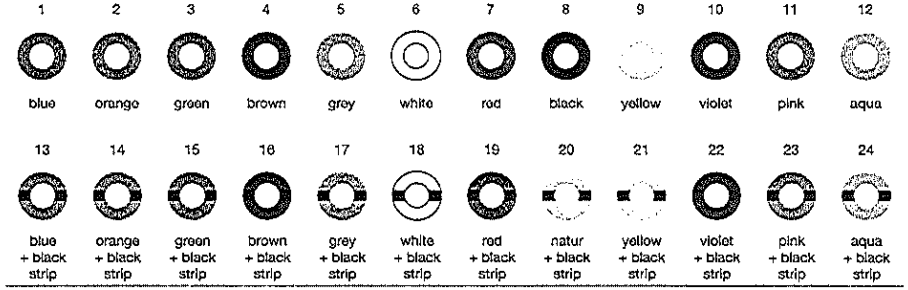
Colour Code Charts

TIA/EIA 598

Tight Buffer

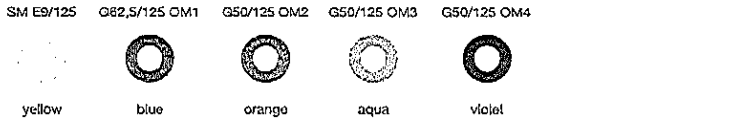


Loose Tube



Loose Tube Cables – Sheath Colour

Tight Buffer Cables – Sheath Colour



Note: Different sheath colour available on request.

000369

Code table

TIGHT BUFFER CABLES

Position	1 Character	2 Character	3 Character	4 Character
	0 Fiber in tight SP	0 Buffer only	A Acrylate buffer	0 LDPE jacket
	1 Simplex cable	1 Ø simplex 1.8 mm	B	1 LSZH jacket
	2 Duplex cable	2 Ø simplex 2.0 mm	C –	2 LSZH jacket + FRP members in jacket
	3 Heavy-duplex cable	3 Ø simplex 3.0 mm	D –	3 LDPE jacket + FRP members in jacket
	4 Break-out cable	4 Ø simplex 2.4 mm	E –	4 LSZH / SWA / LSZH
	5 Distribution cable	5 Ø simplex 2.5 mm	F LSZH Free-tight buffer	5 LSZH / SWA / HDPE
	6 Multi-distribution cable	6 Ø simplex 1.6 mm	G –	6 PVC jacket – inner / universal cable
	7 Drop cable	7 Ø simplex 1.7 mm	H –	7 PUR jacket – inner / outdoor
	8 Break-out cable without central strenght member	8 Ø simplex 2.8 mm	– –	8 LSZH / glass yarn / LSZH
	9 Quadplex cable	9 Ø simplex 2.9 mm	– –	9 PUR jacket outdoor only
		A Distribution cable – Aramid	S LSZH Free-strip (semi-tight) buffer	A HDPE jacket
		D Distribution cable – Standard		
		E Distribution cable – E-glass	T LSZH Tight buffer	B Buffer
		S Distribution cable – CST	– –	S E-glass yarn under jacket
		V Distribution cable – waterblocking Aramid		K Aramid yarn under jacket
		U Subunits with fibers	X LSZH Shielded buffer	– –
		Y –	Y –	Y HDPE jacket + FRP elements in jacket
		Z –	Z –	Z –
	Z (+number) custom designs		9 Fiber without buffer	

LOOSE TUBE CABLES

Position	1 Character	2 Character	3 Character	4 Character
	A CLT max. 12 fibers	0 –	0 –	0 LDPE outer jacket, dry core
	B CLT max. 24 fibers	1 FIG.8 + CST one jacket	1 –	1 LDPE outer jacket, filled core
	C MLT 6 x 1.7 mm [6x12] – 72	2 FIG.8 + CST two jackets	2 Messenger 2.0 mm	2 LSZH outer jacket, dry core
	D MLT 6 x 2.3 mm [6x24] – 144	3 4 x 12 in relation to „N" in the column 1	3 Messenger 3.0 mm	3 LSZH outer jacket, filled core
	E MLT 18 x 1.5 mm [18x12] – 216	4 6 x 12 in relation to „N" in the column 1	4 Messenger 4.5 mm	4 PA outer jacket, dry core
	F MLT 6 x 2.3 mm [6x12] – 72	5 8 x 12 in relation to „N" in the column 1	5 Grounding conductor in core	5 PA outer jacket, filled core
	G MLT 8 x 2.3 mm [8x12] – 96	6 12 x 12 in relation to „N" in the column 1	6 Messenger 1.6 mm	6 PE / PA outer jacket, dry core
	H MLT 12 x 2.3 mm [12x12] – 144	7 18 x 12 in relation to „N" in the column 1	7 FRP messenger	7 PE / PA outer jacket, filled core
	I MLT 18 x 2.3 mm [18x12] – 216	8 FIG. 8	8 FRP members in core	8 LSZH / PA outer jacket, dry core
	J MLT 5 x 2.3 mm [5x12] – 60	9 24 x 12 in relation to „N" in the column 1	9 FeZn wires in jacket	9 LSZH / PA outer jacket, filled core
	K MLT 8 x 2.3 mm [8x24] – 192	A Aramid (WB)	A –	A AL + PE outer jacket, dry core
	L MLT 4 x 2.3 mm [4x12] – 48	B –	B Inner PA jacket	B AL + PE outer jacket, filled core
	M MLT 36 x 2.3 mm [36x12] – 432	C CST one jacket with aramid under jacket	C Inner PVC jacket	C –
	N ADSS	D CST two jacket with aramid under jacket	D Supporting element FeZn wire	D –
	P MLT 8 x 1.7 mm [8x12] – 96	E E-glass	E –	E –
	Q MLT 8 x 1.5 mm [8x12] – 96	F FRPA	F Inner FRNC jacket	F –
	R MLT 12 x 1.7 mm [12x12] – 144	G –	G –	G PUR outer jacket, dry core
	S MLT 12 x 2.3 mm [12x24] – 288	H CST one jacket with E-glass yarns under jacket	H –	H PUR outer jacket, filled core
	T MLT 6 x 1.5 mm [6x12] – 72	I CST two jackets with E-glass yarns under jacket	I –	I HDPE outer jacket, dry core
	U MLT 5 x 1.7 mm [5x12] – 60	J –	J –	J –
	V MLT 18 x 1.7 mm [18x12] – 216	K –	K –	K HDPE outer jacket, filled core
	W MLT 12 x 1.5 mm [12x12] – 144	L Attenuated (lower tensile strenght and jacket)	L Inner AVPE	L –
	X New custom designs	M Micro cable (without strenght members)	M –	M –
	Y MLT 12 x 2.8 mm [12x24] – 288	N –	N –	N –
	Z (+number) custom designs	P (jacket – aramid – jacket)	P Inner PE jacket	P PVC outer jacket, dry core
		Q (jacket – E-glass – jacket)	Q –	Q PVC outer jacket, filled core
		R Improved resistence	R 15 kN – 2 jackets	R –
		S Self-supporting nonmetallic strength member	S –	S –
		T Self-supporting dielectric member – two jackets	T –	T Track resistant HDPE
		U –	U	U –
		V –	V	V –
		W SWA two jackets – without strenght members	W	W –
		X SWA two jackets – aramid on core	X 3 kN – 1 jacket	X –
		Y SWA two jackets – E-glass on core	Y 6 kN – 2 jackets	Y –
		Z –	Z 9 kN – 2 jackets	Z –

Stripability of the Tight Buffered Fiber

TIGHT (CODE T)	stripability up to 10 cm
FREE (CODE F)	stripability more than 100 cm

Used Abbreviations

LSZH	LOW SMOKE, ZERO HALOGEN
LS0H	LOW SMOKE, ZERO HALOGEN
LSHF	LOW SMOKE, HALOGEN FREE
HFFR	HALOGEN FREE, FLAME RETARDANT
FRNC	FIRE RETARDANT, NON-CORROSIVE
FR-LSZH	FIRE RETARDANT – LOW SMOKE, ZERO HALOGEN

Properties of the Cable Sheath

	LDPE	HDPE	PA	FR-LSZH	PUR
Flexibility	Medium	Low	Low	High	Very High
Water Resistance	High	High	Medium	Medium	Medium
Abrasion Resistance	High	High	High	Low	High
UV Radiation Resistance	High	High	Low	High	High
Brittleness in Low Temperature	Medium	Medium	Low	Medium	Very Low

Chemical Resistance Table (@ 20 °C)

	LDPE	HDPE	PA	FR-LSZH	PUR
Acids, Dilute or Weak	E	E	F	N	G
Acids*, Strong or Concentrated	E	E	N	N	F
Alcohols, Aliphatic	E	E	N	N	F
Aldehydes	G	G	F	F	G
Bases	E	E	F	G	N
Esters	G	G	E	N	N
Hydrocarbons, Aliphatic	F	G	E	F	E
Hydrocarbons, Aromatic	F	G	E	N	N
Hydrocarbons, Halogenated	N	F	G	N	N
Ketones	G	G	E	N	N
Oxidizing Agents, Strong	F	F	N	N	N
Salts	E	E	E	G	E
Crude Oil	N	N	G	F	F
Kerosene	F	F	E	N	F
Mineral Oil	G	G	E	N	F

* For oxidizing acids, see „Oxidizing Agents, strong".

E	30 days of constant exposure causes no damage. Plastic may tolerate for years.
G	Little or no damage after 30 days of constant exposure to the reagent.
F	Some effect after 7 days of constant exposure to the reagent. The effect may be crazing, cracking, loss of strength or discoloration, depending on the plastic.
N	Not recommended. Immediate damage may occur. Depending on the plastic, the effect may be severe crazing, cracking, loss of strength, discoloration deformation, dissolution or permeation loss.

Note: This table must be considered as an orientation.

Fire properties

		METHOD	COMMENT
Fire properties – Flammability	pass	EN 60332-3-22 (cat. A) EN 50266-2-2	- 40 min exposure to flame - length of the burned sample max. 2.5 m
Fire properties – Acid gases	pass	EN 60754-1 EN 60754-2	- min. pH 4.3 - max. 10 µS/mm
Fire properties – Smoke density	pass	EN 61034-1 EN 61034-2	- min. 60 %

Note: Valid for all FR-LSZH sheaths.

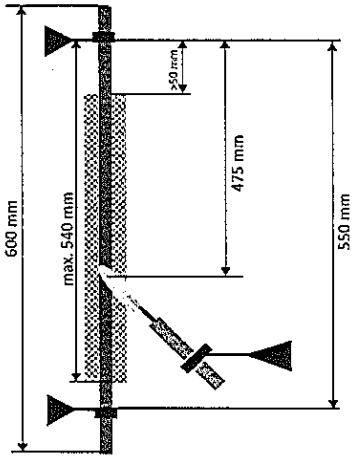
Fire Properties

FLAME-RETARDANT

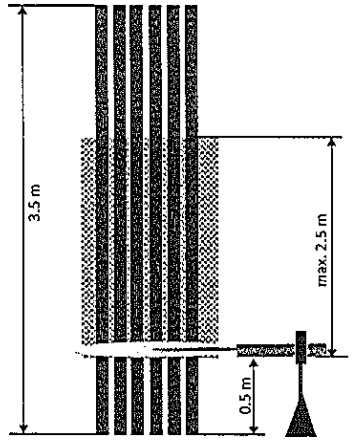
The cable must meet the requirements of the test specified in IEC standard 60332-3 or IEC 60332-1. The cable does not propagate fire and is self-extinguishing.

Notice: You can not assume that if the cable passes the test according 60332-1, a bundle of such cables passing a test 60332-3.

TEST ACC. TO IEC 60332-1



TEST ACC. TO IEC 60332-3



Charred part of the cable

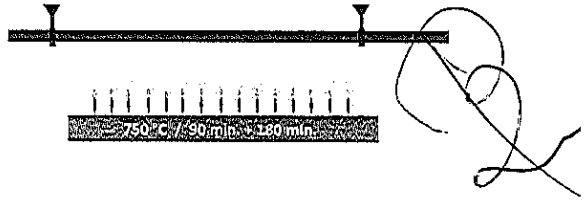
Cable Diameter	Burning Time
≤ 25 mm	60 sec
≥ 25 mm; ≤ 50 mm	120 sec

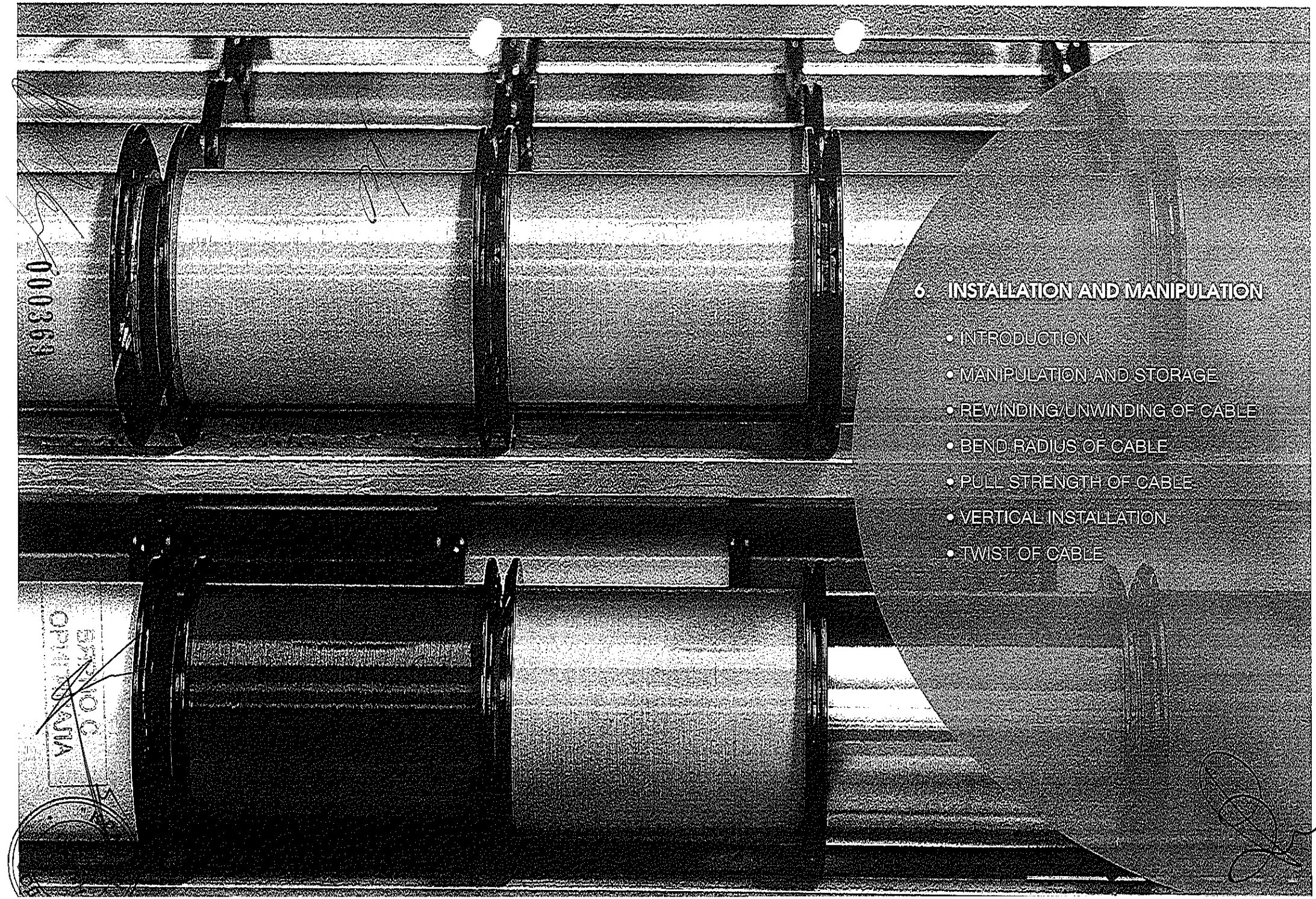
Category	Amount of Burning Material	Burning Time
A*	7.0 lt/m	40 min
B	3.5 lt/m	40 min
C	1.5 lt/m	20 min
D	0.5 lt/m	20 min

* KDP Cables

FIRE-RESISTANT

The cable must meet the requirements test specified in standard IEC 60331-11 and 25. The cable must be functional a minimum of 90 minutes in direct fire.





6. INSTALLATION AND MANIPULATION

- INTRODUCTION
- MANIPULATION AND STORAGE
- REWINDING/UNWINDING OF CABLE
- BEND RADIUS OF CABLE
- PULL STRENGTH OF CABLE
- VERTICAL INSTALLATION
- TWIST OF CABLE

000369

Introduction

It is very easy to damage optical cables if manipulation with them is incorrect or if important installation procedures are not followed.

The information stated below should be taken into consideration when installing and manipulating with optical cables. Violating any of the basic rules can result in worsening of the cable's transfer characteristics or it can permanently damage it and shorten its lifetime. The handbook can also serve as a guideline for solving problem not only related to the installation of new cables but also for possible problems of cables, which have already been installed.

There is an assumption that the customer has general knowledge about the design of optical cables and the terminology related to it. If necessary, please contact KDP.

Symbols Used:

✔ RECOMMENDED

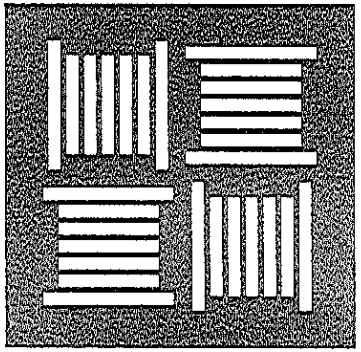
✘ NOT RECOMMENDED

000370

ООО "КРАСНИН" СМОЛЯН

Manipulation and Storage

The drums with the cables cannot be thrown from any heights! The drums with optical cables have to always stand on the edges of the head, secured with a wedge to prevent movement. The only time when it is not necessary to secure the drums with a wedge is when the drums are mutually secured between each other by standing them crosswise. /Pic. 1

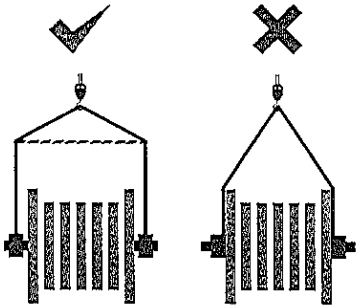


Pic. 1

It is possible to store HEAVYDUPLEX, SIMPLEX, DUPLEX type cables and coils with cables up to 4mm in diameter by laying them on the head. However, the cable has to be fastened by shrink wrap to prevent the loosening of individual cable coils.

Cables intended for internal use can only be stored in closed areas without humidity. Cables for universal and outdoor use can be stored in outdoor conditions. However, the cable ends have to be waterproof. However, if the cable is on a plywood spool, it has to be stored in such a manner so as to prevent the effects of water on the spool.

When manipulating with the drums using a crane, a spacer rod has to be placed between the load bearing ropes, so that the ropes do not exert pressure on the cable through the side drums. /Pic. 2



Pic. 2

When lifting the drums using a forklift, the drums can only be gripped from the sides and only when the skids of the forklift are long enough for the head of the drum to be positioned on it with a safe overhang. /Pic. 3

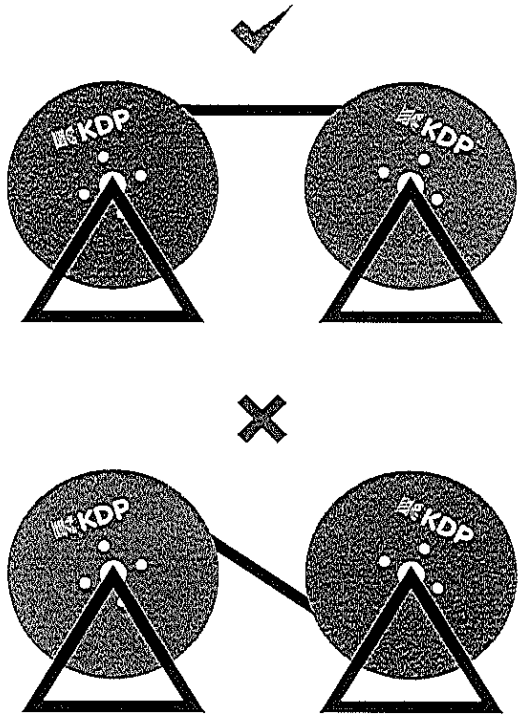
It is only possible to roll the drums short distances and only on a hard and flat surface.

Pic. 3

Rewinding/Unwinding of Cable

The rewinding and unwinding of cables is only possible in temperature above 5 °C. If for any reason, it is necessary to unwind the cable in a lower temperature, the cable has to be left at a minimum temperature of 20 °C for at least 24 hours beforehand. For rewinding the cable, the winding (bending) direction of the cable has to be maintained, unwinding cannot form an "S" shape. /Pic. 4

When unwinding the cable, it is necessary to maintain continuous pull without variation. Unwinding without pull can then lead to the loosening of individual rolls and to the consequent mutual under pull, possibly to the uncontrolled, sharp tugging of the cable, resulting in the damaging of the optical fibers.



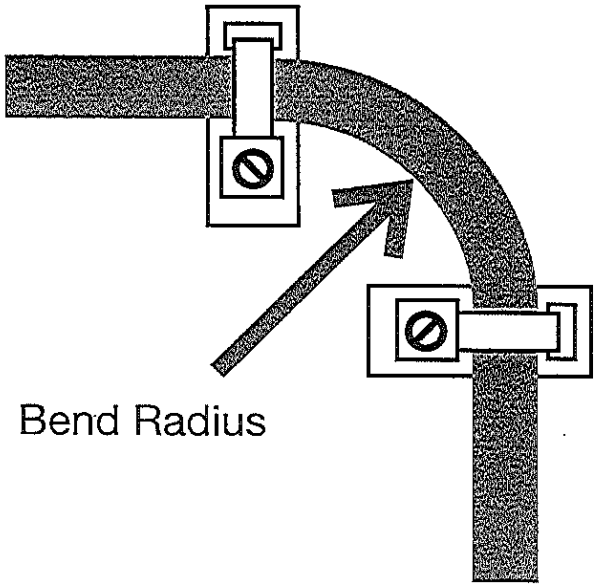
Pic. 4

0003771

ООО "КРАСНИН" СМОЛЯН

Bend Radius of Cable

This value is defined by the cable manufacturer and exceeding this value can cause invisible fiber damage, which does not have to be evident immediately following installation, but later on. Therefore, it is important to follow the minimum bend diameter not only during in-stallation but also for a cable, which has already been installed.



Pic. 5

Pull Strength of Cable

Unless stated otherwise, all optical cables manufactured at KDP are designed for conditions under which there is not pull strain exerted during operations, or only such a pull that the fiber in the cable is not strained (such an option is stated in the cable specification). If the straining of cables takes place in operations, we recommend consulting such situation with KDP prior to cable installation.

The maximum pull defined is for the purpose of cable installation and this value should never be exceeded! It is not force that snaps the cable in two, but the limit which guarantees that the fibers will not be damaged.

For checking purposes, upon installation, it is strongly recommended to place a mid-cable and a pull cable measuring pull for the continuous monitoring of the current cable pull. If necessary, also record a video of the course of installation, which then significantly aids in resolving consequent problems following installation. In order to decrease resistance when dragging, it is suitable to use a lubricant. Prior to use, verify that it is compatible with the material of the cable coating.

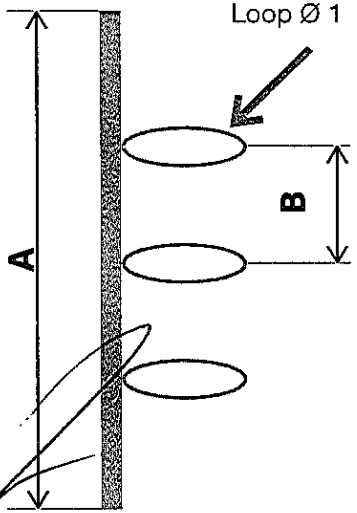
Vertical Installation

A gel, resistant to dripping up to 70 °C for a period of 24 hours, is used in optical KDP cables. This gel is also excludes oil and maintains its characteristics for the entire lifetime of the cable. Therefore, it is possible to install optical cables with independent secondary protection, a gel-filled tube, vertically, either as a construction with one central tube as well as multi-tube cables. This does not apply for multi-tubes, where the inner cable tube (the space between the individual tubes) is filled with gel. We do not recommend installing such cables vertically.

Conditions for the bend radius of the pull strength and other parameters are the same as for any common horizontal installation. The procedure applies for installation outdoors as well as indoors, sewage systems, etc.

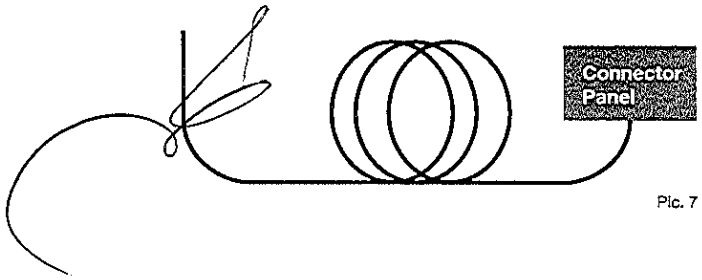
The vertical placement of cables has to be fastened by clamps, to prevent sliding. The maximum distance between individual clamps has to be such, where the weight of the cables between the clamps exceeds the pull strength and does not strain the fibers in the cable. Horizontal loops will form on vertically running cable as a relief element and protection against the possible movement of the cable in case of vibration of the load bearing construction against fixed mounting in the lower part of the cable. The distance of the loops depends on the inner diameter of the tubes in the cable. /Pic. 6

If the cable in the lower part directly enters into the connector panel, it should enter by 3 loops. The purpose of this is to compare the change in the lengths of cables given the change in temperatures. This is from the lower part of the panel. /Pic. 7



Tube Diameter		
A	500 m	300 m
B	20 m	20 m

Pic. 6



Pic. 7

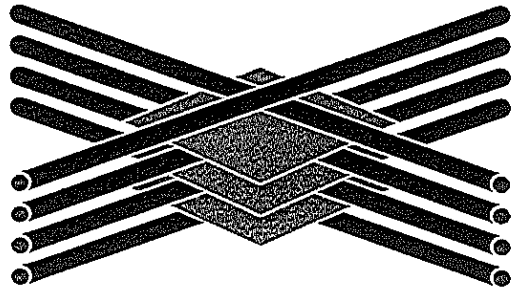
0003772

Twist of Cable

Avoid twisting the cable during installation because this can cause stress to the fiber. If you install a cable longer than 30 m and you are pulling it through a narrower section (for example, underground), unwind the cable beforehand. Place cables freely in a figure eight on the floor. /Pic. 8. Placing cables in a loop prevents twisting. The diameter of the loop should be 2–4 m, depending on the rigidity of the cable. The length of the figure eight is 8–10 m.

Pic. 8

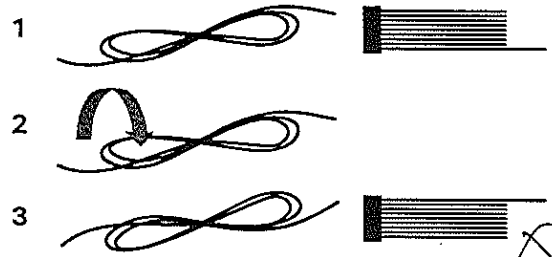
It is recommended to place for example, cardboard paper between individual rolls. Pic. 9



Pic. 9

Prior to taking the cable from the figure eight, tilt it by 180°, with the aid of other individuals, so that the beginning of the cable is facing upward. /Pic. 10

After pulling it through, do not wind it back up onto the drum, but place it back in a figure eight for further laying.



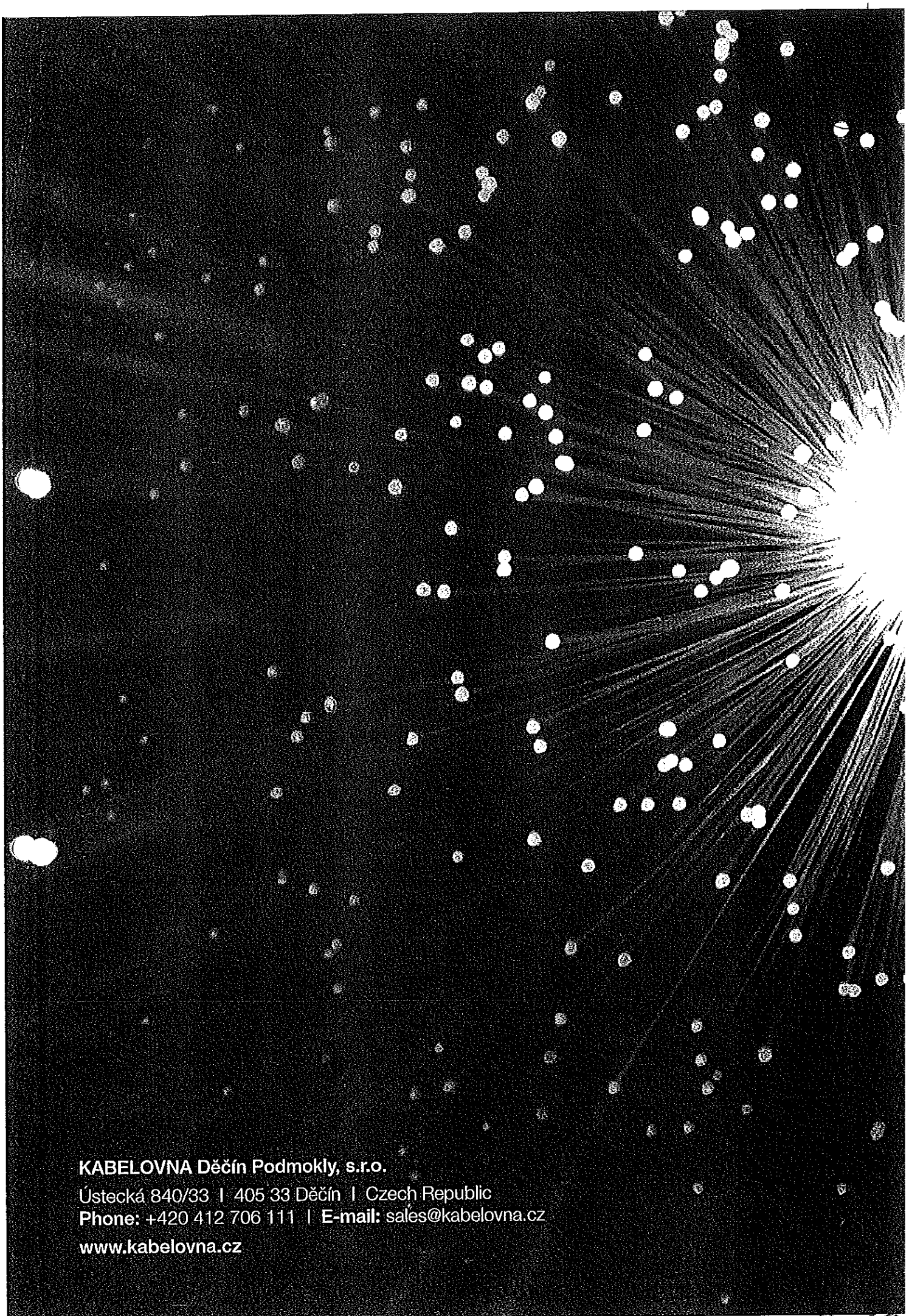
Pic. 10

Notes

000373

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД



KABELOVNA Děčín Podmokly, s.r.o.
Ústecká 840/33 I 405 33 Děčín I Czech Republic
Phone: +420 412 706 111 I **E-mail:** sales@kabelovna.cz
www.kabelovna.cz

Multi Loose Tube Cable

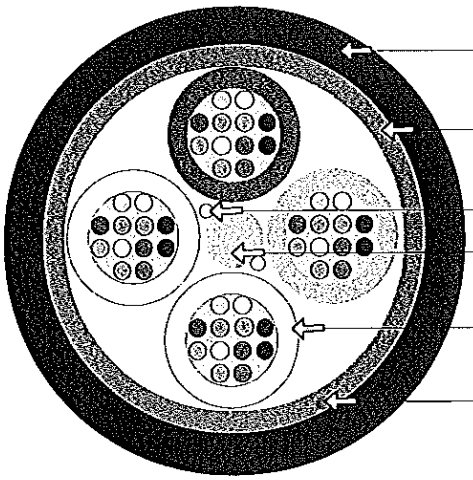
ID: LE02

KABELOVNA Děčín Podmokly s.r.o.
Ústecká 840/33, 405 33 Děčín 5
Czech Republic
DIČ CZ26759993
tel.: +420 412 706 222
www.kabelovna.cz

6.5.2016 ver.8

J/A-DQ(BN)H 4×2,3 max. 48F

This cable is is suitable for indoor or outdoor use. The cable has standard level of rodent protection.



Order example

2100 m J/A-DQ(BN)H 48E9/125 G.657.A1 jacket coulour BLK, cable specification LE02

Fibre colour coding

According to IEC 60304

1 Red	7 Brown
2 Green	8 Violet
3 Blue	9 Turquoise
4 Yellow	10 Black
5 White	11 Orange
6 Grey	12 Pink

Other fibre colour sequences available on request

Tube colour coding

1 Red
2 Green
3-4 White

In the case of lower number of fibres some tubes are replaced by uncoloured fillers
Other tubes colour sequences available on request

Fibre Type

Single mode fiber 9/125
Multi mode fiber 50/125
Multi mode fiber 62,5/125
See the Fibre Specification sheet

Sheat Marking

Print colour	White
Print method	INK-Jet
Print legend	manufacturer's name, job number, type of cable, length marking @ 1 m intervals

Other print legends available on request

Packaging	Standard put-up length	Drum size
Plywood	2100 m ±5 %, other lengths on request	1000×640×600
Plywood	4100 m ±5 %, other lengths on request	1200×640×600

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ВЯРНО С ОРИГИНАЛА

СМОЛЯН ООД

Multi Loose Tube Cable

ID: **LE02**

KABELOVNA Děčín Podmokly s.r.o.
Ústecká 840/33, 405 33 Děčín 5
Czech Republic
DIČ CZ26759993
tel.: +420 412 706 222
www.kabelovna.cz

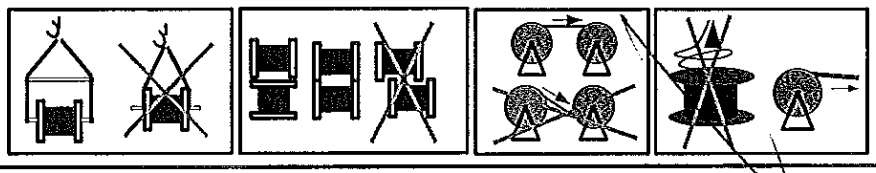
6.5.2016 ver.8

J/A-DQ(BN)H 4×2,3 max. 48F

Mechanical and Environmental properties

Test		Value	Unit	Method
Cable outer diameter		8,9 ±0,4	mm	EN 60811-1-1
Cable weight		86	kg/km	
Outer jacket thickness		1,5	mm	
Loose tube diameter		2,3	mm	
Max. tensile strength		1400	N	EN 60974-1-2-E1
Crush resistance test		2000	N	EN 60974-1-2-E3
Impact resistance test		3	Number of. impact	EN 60974-1-2-E4
Min. bend radius (no load) Min. bend radius (load)		15 20	×OD ×OD	EN 60974-1-2-E11a EN60974-1-2-E11b
Moisture resistance test		pass		EN 60794-1-22-F5
Temperature range	Installation Operation Storage	-15 to +50°C -40 to +70°C -40 to +70°C		EN 60794-1-22-F1
Fire properties – Flammability		pass		EN60332-3-22 (cat.A) ČSN EN 50266-2-2
Fire properties – Acid gases		pass		EN 50267 EN 50267-2-2 EN 50267-2-3
Fire properties – Smoke density		pass		EN 61034-1 EN 61034-2

Cable life time - minimum 30 years



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ВЯРНО С ОРИГИНАЛА

КРАСИМ СМОЛЯН ООД

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация

Приложение № 2 към Предложение за изпълнение на поръчката по т.15.2. от Техническото предложение – Заверени копия на документи за Оптичен кабел:

- Приложение № 2.2. към т.15.2.2. от Техническото предложение – Други по преценка на участника (декларации за съответствие, протоколи от типови изпитания и др.).

000377

Tel: +359878130074; 0878130076; office@netgroup.bg;

ДЕКЛАРАЦИЯ ЗА СЪОТВЕТСТВИЕ

Долуподписаната Златина Ангелова Ангелова, Управител на "Нет Груп Плюс" ООД, гр. Пловдив, Ж.К. Тракия, бл.61, вх.Г,

Декларирам на собствена отговорност, че продуктите:

K1FUE02048YEAA	J/A-DQ(ZN)H WBF 5x1,7 48(4x12) 9/125 G652 Draka YEL
K1FLE02048YEAA	J/A-DQ(ZN)H WBF 4x2,3 48(4x12) 9/125 G652 Draka YEL

За които се отнася тази Декларация, са нови, неупотребявани, са в производствената листа на производителите и са в съответствие със следните стандарти:

ISO 9001:2008 на Kabelovna Decin Podmokly s.r.o.

Декларирам, че ми е известна отговорността, която нося съгласно чл. 313 от НК.

на основание чл. 2 от ЗЗЛД

Пловдив, 17.01.2017

Златина Ангелова

/ Управител /

000378

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация
Приложение № 3 към Предложение за изпълнение на поръчката по т.15.3. от Техническото предложение – Заверени копия на документи за Сух силов кабел 110 kV - Al 1600 mm2: • Приложение/я № 3.1. към т.15.3.1. от Техническото предложение – Заверено/и копие/я на протокол/и от типови изпитвания, проведени от независима изпитвателна лаборатория, с приложен списък на отделните изпитвания на български език.

000379

KEMA

Report
Отчет

TIC 3181-13

Типови изпитания на 64/110 (123) kV кабелна система

Производител на кабела Estralin HVC LLC, Moscow, Russia

Производител на Аксесоарите ARKASIL SK LLC, Moscow, Russia

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Архем, 19 Декември 2013

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Отчет инспекционен TIC 3181-13

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1.2 Tan δ измерване тест

1.3 Частичен тест разряд при стайна температура

1.4 Частичен тест разряд при висока температура

1.5 Тест импулсно напрежение

1.6 Тест при напрежение с промишлена честота

1.7 Тест на кабел с дължина с прилагана метална лента или фолио свързани към обвивката

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2.2 Тестове за определяне на механичните свойства на изолацията преди и след стареене

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2.7 Измерване на сажди съдържанието на сажди във външната PE обвивка

2.8 Тест за водонепропускливост.

на основание чл. 2 от ЗЗЛД

KEMA Nederland

S.A.M. Verhoeven
Director Testing, I
Certification The Netherlands
Arnhem, 19 December 2013

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

KEMA

Report

TIC 3181-13

Type tests on a 64/110 (123) kV cable system

Manufacturer cable
Estralin HVC LLC,
Moscow, Russia

Manufacturer accessories
ARKASIL SK LLC,
Moscow, Russia

Arnhem, 19 December 2013

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S: EL

INSPECTION REPORT

TIC 3181-13

OBJECT	Power cable system consisting of 1-core power cable, 2 terminations, and 1 joint 64/110 (123) kV – 1x2000 mm^2 – Cu – XLPE	
CLIENT	OMACS LLC, Moscow, Russia	
MANUFACTURERS	Cable	Estralin HVC LLC, Moscow, Russia
	Accessory 1	ARKASIL SK LLC, Moscow, Russia
	Accessory 2	ARKASIL SK LLC, Moscow, Russia
	Accessories	See section 1.1.3 Characteristics of the accessories
REFERENCE	72130463	
INSPECTED BY	KEMA Nederland B.V., Arnhem, The Netherlands	
TEST LOCATION	OMACS LLC, Moscow, Russia	
DATE(S) OF TESTS	1 March untill 30 September 2013	
TEST SPECIFICATION	The tests have been carried out based on IEC 60840 (2011).	
SUMMARY AND CONCLUSION	The cable system passed the tests.	

PL ■ GC ■ MT ■

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the manufacturer.

This report consists of 61 pages in total.

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O: 72130463

KEMA Nederland B.V.

на основание чл. 2 от ЗЗЛД

Certification The Netherlands

Arnhem, 19 December 2013

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

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ВЯРНО С ОРИГИНАЛА

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1 IDENTIFICATION OF THE OBJECT TESTED

1.1 Ratings/characteristics of the object tested

1.1.1 Characteristics of the cable system

Rated voltage, U_0/U (U_m)	64/110 (123) kV
Rated maximum conductor temperature	90 °C
Rated conductor cross-section	2000 mm²
Composition of the cable system:	
– Cable	2XS(FL)2Y 1x2000RMS/185-64/110 kV
– Accessory 1	MKB 126
– Accessory 2	MCB 126 X

The test voltages and calculated nominal field stresses were based on U_0 test = 64 kV.

1.1.2 Characteristics of the cable

Standard	IEC 60840, Clause 6
Manufacturer	Estralin HVC LLC, Moscow, Russia
Type	U_0 = 64 kV 1x2000 mm² XLPE CABLE
Manufacturing date	2013
Sampling procedure	by the manufacturer
Rated voltage, U_0/U (U_m)	64/110 (123) kV
No. of cores (core identification)	1
Overall diameter (D)	100,7 mm
Calculated nominal electrical stress at conductor screen at U_0 = 64 kV (E_i)	7,09 kV/mm
Calculated nominal electrical stress at insulation screen at U_0 = 64 kV (E_o)	5,28 kV/mm
Nominal capacitance between conductor and metal screen	0,44 µF/km
Embossing on the oversheath	ЭСТРАЛИН ЗВК ПвП2г - 1×2000сгж/185-64/110кВ 2012г + length marking
Construction	see List of drawings

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160342**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0319

Length 530 m

Cable drum № 27Д5874

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,13	min 49,11
	nom 49,60	avg 49,30	avg 49,25
	max 50,10	max 49,46	max 49,38
Conductor screen			
thickness, mm	min 1,00	min 1,83	min 1,81
	nom 1,50	avg 2,02	avg 2,11
	max 2,50	max 2,20	max 2,41
max-min point difference, mm	≤ 1,0	0,37	0,60
Insulation			
thickness, mm	min 13,5	min 14,30	min 14,37
	nom 15,0	avg 15,03	avg 15,01
	max 18,0	max 15,75	max 15,65
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	9	8
diameter over Insulation, mm	min 83,2	min 83,20	min 83,23
	nom 84,2	avg 83,80	avg 83,81
	max 85,2	max 84,39	max 84,38
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,94
	nom 1,1	avg 1,25	avg 1,13
	max 1,7	max 1,58	max 1,31
max-min point difference, mm	≤ 1,0	0,66	0,37
diameter over Insulation screen, mm	min 85,2	min 85,37	min 85,40
	nom 86,4	avg 85,97	avg 86,00
	max 87,6	max 86,56	max 86,59
ratio Ø min/Ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3	min 4,08	min 4,11
	nom 4,0	avg 5,08	avg 4,69
		max 6,07	max 5,27
diameter over outer sheath, mm		min 100,29	min 100,14
		max 100,67	max 100,68

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160342**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0319 Cable drum № 27Д5874

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0183
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg Gross weight 7209 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

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FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160343**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0320 Cable drum № 27Д5875

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,23	min 49,11
	nom 49,60	avg 49,32	avg 49,23
	max 50,10	max 49,41	max 49,34
Conductor screen			
thickness, mm	min 1,00	min 1,76	min 1,72
	nom 1,50	avg 1,96	avg 2,09
	max 2,50	max 2,15	max 2,45
max-min point difference, mm	≤ 1,0	0,39	0,73
Insulation			
thickness, mm	min 13,5	min 14,63	min 14,60
	nom 15,0	avg 15,16	avg 15,03
	max 18,0	max 15,68	max 15,45
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	7	6
diameter over Insulation, mm	min 83,2	min 83,23	min 83,22
	nom 84,2	avg 83,69	avg 83,73
	max 85,2	max 84,15	max 84,23
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,98
	nom 1,1	avg 1,11	avg 1,16
	max 1,7	max 1,29	max 1,34
max-min point difference, mm	≤ 1,0	0,37	0,36
diameter over insulation screen, mm	min 85,2	min 85,51	min 85,43
	nom 86,4	avg 85,94	avg 85,93
	max 87,6	max 86,37	max 86,42
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,67	112,67
Outer sheath			
thickness, mm	min 3,3	min 3,62	min 3,74
	nom 4,0	avg 4,35	avg 4,54
		max 5,07	max 5,33
diameter over outer sheath, mm		min 100,36	min 100,42
		max 100,93	max 101,03

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160343**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0320 Cable drum № 27Д5875

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg Gross weight 7209 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

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FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160344**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0321 Cable drum № **27Д5876**

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,19	min 49,27
	nom 49,60	avg 49,29	avg 49,40
	max 50,10	max 49,39	max 49,53
Conductor screen			
thickness, mm	min 1,00	min 1,43	min 1,72
	nom 1,50	avg 1,79	avg 1,91
	max 2,50	max 2,14	max 2,09
max-min point difference, mm	≤ 1,0	0,71	0,37
Insulation			
thickness, mm	min 13,5	min 14,57	min 14,79
	nom 15,0	avg 15,02	avg 15,09
	max 18,0	max 15,47	max 15,38
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	4
diameter over Insulation, mm	min 83,2	min 83,21	min 83,33
	nom 84,2	avg 83,69	avg 83,86
	max 85,2	max 84,17	max 84,39
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,70
	nom 1,1	avg 1,26	avg 1,14
	max 1,7	max 1,58	max 1,58
max-min point difference, mm	≤ 1,0	0,64	0,88
diameter over Insulation screen, mm	min 85,2	min 85,35	min 85,20
	nom 86,4	avg 85,86	avg 85,85
	max 87,6	max 86,37	max 86,50
ratio Ø min/Ø max	≥ 0,95	0,99	0,98
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,20	min 5,02
	nom 4,0	avg 4,65	avg 5,41
		max 5,10	max 5,79
diameter over outer sheath, mm		min 102,30	min 101,80
		max 102,65	max 102,03

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

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ООО ЭСТРАЛИН ЗВК
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QD:

000393

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160344**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0321 Cable drum № 27Д5876

Length 530 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5809 kg Gross weight 7209 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of:

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ВЕРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160351**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0322 Cable drum № 27Д5877

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,10
	nom 49,60	avg 49,15	avg 49,17
	max 50,10	max 49,19	max 49,23
Conductor screen			
thickness, mm	min 1,00	min 1,69	min 1,81
	nom 1,50	avg 1,93	avg 1,96
	max 2,50	max 2,16	max 2,11
max-min point difference, mm	≤ 1,0	0,47	0,30
Insulation			
thickness, mm	min 13,5	min 14,77	min 14,83
	nom 15,0	avg 15,21	avg 15,16
	max 18,0	max 15,65	max 15,48
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	4
diameter over insulation, mm	min 83,2	min 83,23	min 83,45
	nom 84,2	avg 83,97	avg 83,85
	max 85,2	max 84,71	max 84,25
Insulation screen			
thickness, mm	min 0,5	min 0,95	min 0,98
	nom 1,1	avg 1,13	avg 1,14
	max 1,7	max 1,30	max 1,29
max-min point difference, mm	≤ 1,0	0,35	0,31
diameter over insulation screen, mm	min 85,2	min 85,73	min 85,67
	nom 86,4	avg 86,34	avg 86,08
	max 87,6	max 86,94	max 86,49
ratio Ø min/Ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,67	112,67
Outer sheath			
thickness, mm	min 3,3	min 3,99	min 3,98
	nom 4,0	avg 4,52	avg 4,54
		max 5,04	max 5,10
diameter over outer sheath, mm		min 100,52	min 100,24
		max 101,17	max 101,15

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜVNORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СМОЛЯН С.В.

000395

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160351**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0322 Cable drum № **27Д5877**

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	57
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg Gross weight 6332 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫПКО С.В.

000396

ВЗЯТО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООО

Ltd «Estralin HVC»
111024, Moscow, 2-nd Kabelnaya str, 2, bld. 24
www.estralin.com

ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160352**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0323 Cable drum № **27Д5878**

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,16	min 49,22
	nom 49,60	avg 49,47	avg 49,57
	max 50,10	max 49,78	max 49,92
Conductor screen			
thickness, mm	min 1,00	min 1,47	min 1,64
	nom 1,50	avg 1,82	avg 1,88
	max 2,50	max 2,17	max 2,11
max-min point difference, mm	≤ 1,0	0,70	0,47
Insulation			
thickness, mm	min 13,5	min 14,66	min 14,50
	nom 15,0	avg 15,16	avg 15,24
	max 18,0	max 15,66	max 15,97
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	9
diameter over insulation, mm	min 83,2	min 83,68	min 83,40
	nom 84,2	avg 84,09	avg 83,96
	max 85,2	max 84,49	max 84,51
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,93
	nom 1,1	avg 1,14	avg 1,12
	max 1,7	max 1,35	max 1,30
max-min point difference, mm	≤ 1,0	0,43	0,37
diameter over insulation screen, mm	min 85,2	min 85,95	min 85,50
	nom 86,4	avg 86,36	avg 86,05
	max 87,6	max 86,77	max 86,59
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3	min 4,12	min 4,35
	nom 4,0	avg 4,31	avg 4,68
		max 4,49	max 5,01
diameter over outer sheath, mm		min 100,65	min 100,84
		max 101,23	max 101,83

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЕВ С.В.

00039?

ЗАВЕРЯЕТСЯ ОРИГИНАЛ

«КРАСИН» СМОЛЯН ООО

Ltd «Estralin HVC»

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160352**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0323 Cable drum № 27Д5878

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	50
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,31
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg **Gross weight 6332 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сычев С.В.

000398

ВЗЯТО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООО

Ltd «Estralin HVC»
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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160353**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0324 Cable drum № 27Д5879

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,10
	nom 49,60	avg 49,39	avg 49,42
	max 50,10	max 49,67	max 49,74
Conductor screen			
thickness, mm	min 1,00	min 1,62	min 1,62
	nom 1,50	avg 1,88	avg 1,89
	max 2,50	max 2,14	max 2,16
max-min point difference, mm	≤ 1,0	0,52	0,54
Insulation			
thickness, mm	min 13,5	min 15,02	min 14,76
	nom 15,0	avg 15,32	avg 15,19
	max 18,0	max 15,61	max 15,62
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	6
diameter over insulation, mm	min 83,2	min 83,77	min 83,65
	nom 84,2	avg 84,21	avg 83,95
	max 85,2	max 84,65	max 84,25
Insulation screen			
thickness, mm	min 0,5	min 0,95	min 0,87
	nom 1,1	avg 1,13	avg 1,15
	max 1,7	max 1,31	max 1,43
max-min point difference, mm	≤ 1,0	0,36	0,56
diameter over insulation screen, mm	min 85,2	min 86,05	min 85,87
	nom 86,4	avg 86,46	avg 86,22
	max 87,6	max 86,87	max 86,56
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,95	min 3,90
	nom 4,0	avg 4,43	avg 4,46
		max 4,90	max 5,01
diameter over outer sheath, mm		min 100,82	min 100,38
		max 101,47	max 101,19

Notes: all tests were passed successfully, cable meets ТУ 3630-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD:

000399

ВЕРНО С ОРИГИНАЛОМ

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160353**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0324

Cable drum № 27Д5879

Length 450 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	50
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 4932 kg **Gross weight 6332 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЗВК
СЫЧИН С.В.

000400

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООО

Ltd «Estralin HVC»
111024, Moscow, 2-nd Kabelnaya str, 2, bld. 24
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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160345**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0325

Length 485 m

Cable drum № 27Д5880

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,19 avg 49,52 max 49,85	min 49,10 avg 49,45 max 49,79
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,55 avg 1,81 max 2,07	min 1,65 avg 2,03 max 2,41
max-min point difference, mm	≤ 1,0	0,52	0,76
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 15,05 avg 15,32 max 15,58	min 15,11 avg 15,54 max 15,97
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	3	5
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,64 avg 84,24 max 84,84	min 84,25 avg 84,50 max 84,75
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,95 avg 1,13 max 1,30	min 0,98 avg 1,12 max 1,26
max-min point difference, mm	≤ 1,0	0,35	0,28
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,88 avg 86,46 max 87,04	min 86,61 avg 86,79 max 86,96
ratio ø min/ø max	≥ 0,95	0,99	1,00
Copper screen			
cross-section, mm²	≥ 110	112,40	112,40
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 4,10 avg 4,40 max 4,70	min 4,20 avg 4,41 max 4,62
diameter over outer sheath, mm		min 100,84 max 101,51	min 99,45 max 100,36

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА
ООО ЭСТРАЛИН ЭВК
СЫЧЕВ С.В.

000401

ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160345**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0325 Cable drum № **27Д5880**

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	72
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg Gross weight 6716 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сынин С.В.

000402

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯНИ ООК

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160346**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0326 **Cable drum № 27Д5881**

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,11	min 49,22
	nom 49,60	avg 49,35	avg 49,27
	max 50,10	max 49,59	max 49,31
Conductor screen			
thickness, mm	min 1,00	min 1,52	min 1,66
	nom 1,50	avg 1,97	avg 1,94
	max 2,50	max 2,42	max 2,21
max-min point difference, mm	≤ 1,0	0,90	0,55
Insulation			
thickness, mm	min 13,5	min 14,88	min 14,61
	nom 15,0	avg 15,36	avg 15,08
	max 18,0	max 15,84	max 15,54
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	6
diameter over Insulation, mm	min 83,2	min 83,96	min 83,47
	nom 84,2	avg 84,35	avg 84,08
	max 85,2	max 84,73	max 84,68
Insulation screen			
thickness, mm	min 0,5	min 0,90	min 0,97
	nom 1,1	avg 1,10	avg 1,14
	max 1,7	max 1,30	max 1,31
max-min point difference, mm	≤ 1,0	0,40	0,34
diameter over Insulation screen, mm	min 85,2	min 86,08	min 85,72
	nom 86,4	avg 86,51	avg 86,31
	max 87,6	max 86,93	max 86,89
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,54	112,54
Outer sheath			
thickness, mm	min 3,3	min 3,72	min 4,10
	nom 4,0	avg 4,38	avg 4,45
		max 5,03	max 4,80
diameter over outer sheath, mm		min 100,32	min 100,49
		max 101,09	max 101,30

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫПИН С.В.

000403

ВЫПИСКА С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160346**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0326

Length 485 m

Cable drum № 27Д5881

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg Gross weight 6716 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified in accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сынин С.В.

000404

ВЯРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160347**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0327 Cable drum № **27Д5882**

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,11	min 49,11
	nom 49,60	avg 49,35	avg 49,23
	max 50,10	max 49,58	max 49,35
Conductor screen			
thickness, mm	min 1,00	min 1,84	min 1,79
	nom 1,50	avg 1,98	avg 1,93
	max 2,50	max 2,12	max 2,07
max-min point difference, mm	≤ 1,0	0,28	0,28
Insulation			
thickness, mm	min 13,5	min 14,80	min 14,79
	nom 15,0	avg 15,17	avg 15,26
	max 18,0	max 15,54	max 15,72
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	6
diameter over Insulation, mm	min 83,2	min 83,90	min 83,63
	nom 84,2	avg 84,25	avg 84,09
	max 85,2	max 84,60	max 84,54
Insulation screen			
thickness, mm	min 0,5	min 0,92	min 0,94
	nom 1,1	avg 1,11	avg 1,12
	max 1,7	max 1,29	max 1,29
max-min point difference, mm	≤ 1,0	0,37	0,35
diameter over Insulation screen, mm	min 85,2	min 86,14	min 86,26
	nom 86,4	avg 86,45	avg 86,48
	max 87,6	max 86,75	max 86,70
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm^2	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,60	min 4,45
	nom 4,0	avg 4,33	avg 4,78
		max 5,05	max 5,10
diameter over outer sheath, mm		min 101,98	min 100,66
		max 102,81	max 101,81

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TUV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сыпкин С.В.

QD:

000405

ВЗЯТО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160347**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0327 Cable drum № **27Д5882**

Length 485 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,29
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5316 kg Gross weight 6716 kg

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫРИН С.В.

000406

ВЕРНО С ОРИГИНАЛОМ

"КРАСИН" СМОЛЯН ООО

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160348**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0329 Cable drum № 27Д5884

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,11
	nom 49,60	avg 49,25	avg 49,33
	max 50,10	max 49,40	max 49,54
Conductor screen			
thickness, mm	min 1,00	min 1,63	min 1,49
	nom 1,50	avg 1,96	avg 1,83
	max 2,50	max 2,29	max 2,16
max-min point difference, mm	≤ 1,0	0,66	0,67
Insulation			
thickness, mm	min 13,5	min 14,88	min 14,65
	nom 15,0	avg 15,18	avg 15,17
	max 18,0	max 15,47	max 15,69
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	7
diameter over insulation, mm	min 83,2	min 83,70	min 83,45
	nom 84,2	avg 84,20	avg 84,03
	max 85,2	max 84,70	max 84,60
Insulation screen			
thickness, mm	min 0,5	min 0,97	min 0,95
	nom 1,1	avg 1,14	avg 1,15
	max 1,7	max 1,30	max 1,34
max-min point difference, mm	≤ 1,0	0,33	0,39
diameter over insulation screen, mm	min 85,2	min 86,04	min 85,78
	nom 86,4	avg 86,44	avg 86,30
	max 87,6	max 86,84	max 86,82
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,90	min 3,90
	nom 4,0	avg 4,45	avg 4,18
		max 5,00	max 4,46
diameter over outer sheath, mm		min 100,76	min 100,38
		max 101,80	max 101,09

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК СЫЧЕВ С.В.

QD:

000407

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООО

Ltd «Estralin HVC»
111024, Moscow, 2nd Kabelnaya str, 2, bld. 24
www.estralin.com

ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160348**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0329 Cable drum № 27Д5884

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	64
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg **Gross weight 6552 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of:

TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА ООО «СТРАЛИН ЭВК» Сынгин С.В.

000408

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООД

Ltd «Estralin HVC»
111024, Moscow, 2-nd Kabelnaya str, 2, bld. 24
www.estralin.com

ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160349**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0330 Cable drum № **27Д5885**

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10 nom 49,60 max 50,10	min 49,10 avg 49,34 max 49,58	min 49,17 avg 49,30 max 49,43
Conductor screen			
thickness, mm	min 1,00 nom 1,50 max 2,50	min 1,53 avg 1,84 max 2,15	min 1,86 avg 1,98 max 2,10
max-min point difference, mm	≤ 1,0	0,62	0,24
Insulation			
thickness, mm	min 13,5 nom 15,0 max 18,0	min 14,41 avg 15,08 max 15,75	min 14,79 avg 15,26 max 15,73
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	9	6
diameter over insulation, mm	min 83,2 nom 84,2 max 85,2	min 83,57 avg 83,92 max 84,27	min 83,51 avg 84,00 max 84,49
Insulation screen			
thickness, mm	min 0,5 nom 1,1 max 1,7	min 0,91 avg 1,27 max 1,62	min 0,63 avg 1,08 max 1,53
max-min point difference, mm	≤ 1,0	0,71	0,90
diameter over insulation screen, mm	min 85,2 nom 86,4 max 87,6	min 85,87 avg 86,34 max 86,80	min 85,60 avg 85,93 max 86,25
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3 nom 4,0	min 3,95 avg 4,11 max 4,27	min 4,02 avg 4,55 max 5,07
diameter over outer sheath, mm		min 100,36 max 102,20	min 100,40 max 101,15

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD:

ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сычин С.В.

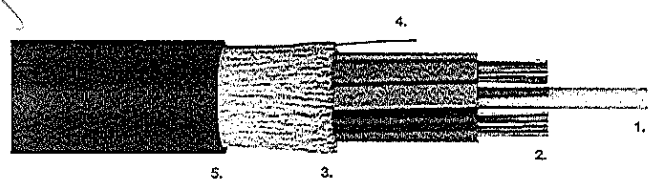
000409

ВЕРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

MLT STANDARD

Specification: YE0I, YE02



Description of materials:

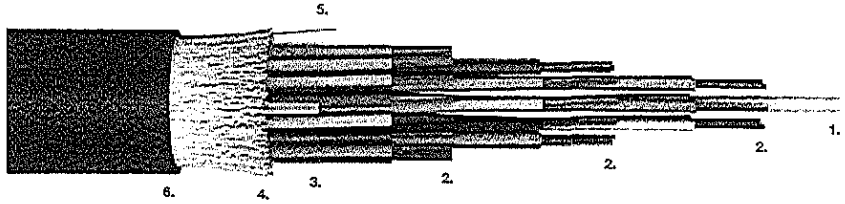
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
YE0I	288	2.8	17.2	240.0	6,400	3,000
☆ YE02	288	2.8	17.2	279.0	6,400	3,000

MLT STANDARD

Specification: DE0I, SE0I, KE0I, DE02, SE02, KE02



Description of materials:

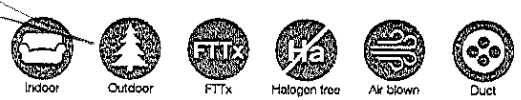
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking E-glass yarn. **5.** Rip-Cord. **6.** FR-LSZH or PE outer jacket, UV stable.

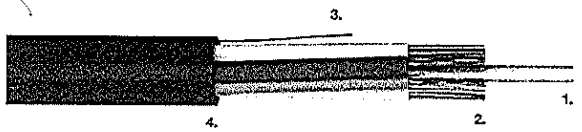
Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
DE0I	144	2.5	11.7	73.0	2,000	1,500
SE0I	288	2.5	16.2	157.0	5,200	1,500
KE0I	192	2.5	13.1	98.0	3,200	1,500
DE02	144	2.5	11.7	102.0	2,000	1,500
SE02	288	2.5	16.2	201.0	5,200	1,500
KE02	192	2.5	13.1	132.0	3,200	1,500

MICROCABLES

Specification: Z019, TM0I, TM02, QM0I, QM02, WM0I, WM02, Z202, Z108





Description of materials:

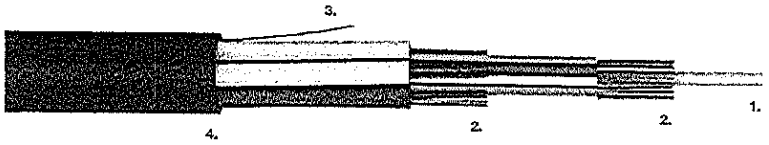
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Rip-Cord. **4.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z019	60	1.5	5.2	22.0	250	1,500
TM0I	72	1.5	5.8	29.0	700	1,500
TM02	72	1.5	6.8	48.0	700	1,500
QM0I	96	1.5	6.5	40.0	1,400	1,500
QM02	96	1.5	7.5	62.0	1,400	1,500
WM0I	144	1.5	8.6	82.0	1,500	1,500
WM02	144	1.5	9.6	91.0	1,500	1,500
Z202	144	1.5	7.1	43.0	450	1,500
Z108	192	1.5	8.0	53.0	700	1,500

MICROCABLES

Specification: Z049



Description of materials:

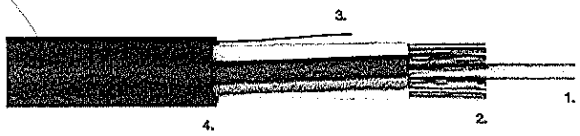
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Rip-Cord. **4.** PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z049	288	1.5	10.2	87	1,100	1,500

MICROCABLES

Specification: UM0I, UM02, CM0I, CM02, PM0I, PM02, RM0I, RM02, VM0I, VM02



Description of materials:

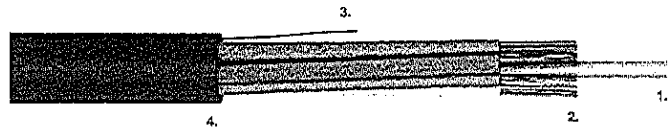
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Rip-Cord. **4.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
UM0I	60	1.7	9.7	27.0	320	1,500
UM02	60	1.7	6.7	53.0	320	1,500
CM0I	72	1.7	6.2	33.0	680	1,500
CM02	72	1.7	7.2	61.0	680	1,500
PM0I	96	1.7	7.4	50.0	2,400	1,500
PM02	96	1.7	8.4	84.0	2,400	1,500
RM0I	144	1.7	9.6	76.0	2,700	1,500
RM02	144	1.7	10.6	119.0	2,700	1,500
VM0I	216	1.7	9.5	72	700	1,500
VM02	216	1.7	10.5	105	700	1,500

MICROCABLES

Specification: DM0I, SM0I, KM0I, DM02, SM02, KM02



Description of materials:

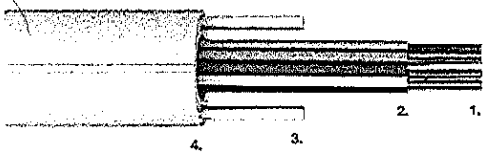
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Rip-Cord. **4.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
DM0I	144	2.5	8.7	58.0	200	1,000
SM0I	288	2.5	13.3	138.0	1,500	1,000
KM0I	192	2.5	10.2	83.0	1,000	1,000
DM02	144	2.5	9.7	87.0	200	1,000
SM02	288	2.5	14.3	182.0	1,500	1,000
KM02	192	2.5	11.2	117.0	1,000	1,000

RISER MICROCABLES

Specification: X009



Description of materials:

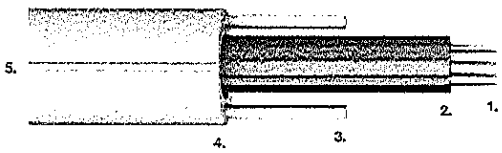
1. Optical fibers. **2.** Gell filled micro tubes. **3.** FRP rods. **4.** FR-LSZH outer jacket.
5. Lines show place for opening of the cable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

	Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/cm]
NEW	X009	96	10.5	84.5	400	80

TIGHT-BUFFERED RISER CABLE

Specification: X010



Description of materials:

1. Optical fibers. **2.** Tight buffer. **3.** FRP rods. **4.** FR-LSZH outer jacket.
5. Lines show place for opening of the cable.

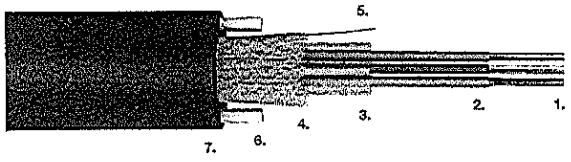
Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

	Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/cm]
NEW	X010	24	10.5	91.3	400	80

0003949

TIGHT-BUFFERED RISER CABLE

Specification: X007



Description of materials:

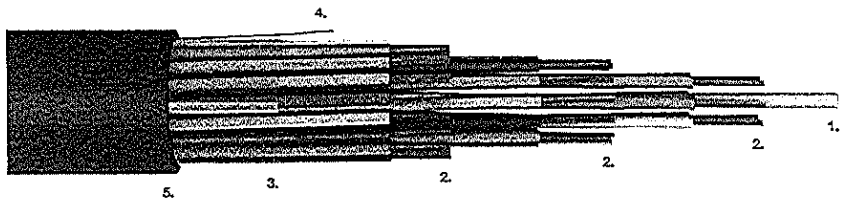
1. Optical fiber. **2.** Gell filled micro tubes. **3.** Water-swellable Tape. **4.** Waterblocking aramid yarn.
5. Rip-Cord. **6.** FRP rods. **7.** PE outer Jacket, UV stable.

Temperature range	
Installation	-30 to +60 °C
Operation	-10 to +50 °C
Storage	-50 to +50 °C

Design code	Max. fiber count	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/cm]
X007	12	7.1	38.9	600	250
X007	48	8.4	55.4	700	250
X007	72	9.2	65.9	900	250
X007	96	9.8	73.2	900	250
X007	144	10.9	90.1	1,200	250

MLT STANDARD

Specification: Z022, Z304



Description of materials:

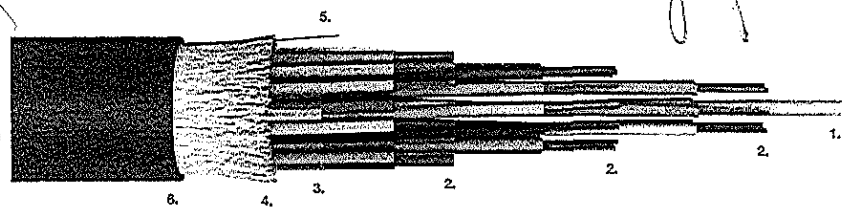
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibres.
3. Water-swellable tape. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z022	432	1.7	14.3	155.0	700	1,000
Z304	432	1.7	15.3	215.0	700	1,000

MLT STANDARD

Specification: Z017, Z018, Z349, Z350



Description of materials:

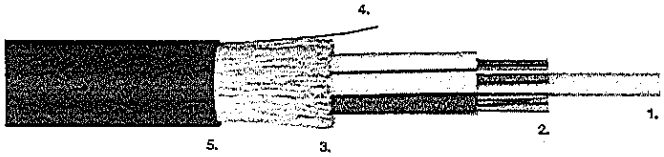
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking E-glass yarn. **5.** Rip-Cord. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-30 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z017	864	3.0	26.2	496.0	4,800	2,000
Z018	864	3.0	26.2	575.0	4,800	2,000
Z349	864	2.5	21.7	353.0	4,500	2,000
Z350	864	2.5	21.7	407.0	4,500	2,000

MLT STANDARD

Specification: UE0I, UE02, CE0I, CE02, PE0I, PE02, RE0I, RE02, VE0I, VE02



Description of materials:

1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

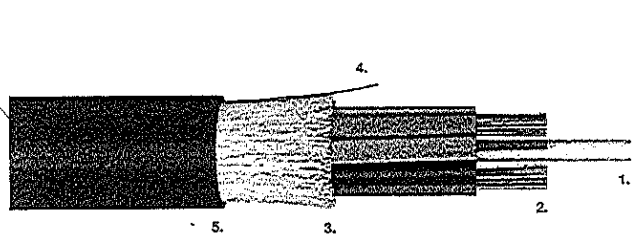
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
UE0I	60	1.7	7.9	56.0	1,300	3,000
UE02	60	1.7	7.9	72.0	1,300	3,000
CE0I	72	1.7	8.4	65.0	2,000	3,000
CE02	72	1.7	8.4	83.0	2,000	3,000
PE0I	96	1.7	9.5	87.0	4,300	3,000
PE02	96	1.7	9.5	107.0	4,300	3,000
RE0I	144	1.7	11.8	125.0	7,300	3,000
RE02	144	1.7	11.8	151.0	7,300	3,000
VE0I	216	1.7	11.9	116.0	2,200	2,000
VE02	216	1.7	11.9	145.0	2,200	2,000

MLT STANDARD

Specification: LE0I, LE02, FE0I, FE02, GE0I, GE02, HE0I, HE02

Indoor Outdoor Halogen free FTTx Duct



Description of materials:

1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Rip-Cord. **5.** FR-LSZH or PE outer jacket, UV stable.

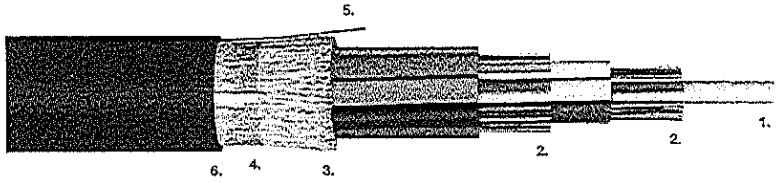
Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
LE0I	48	2.3	8.9	83.0	1,400	2,000
LE02	48	2.3	8.9	83.0	1,400	2,000
FE0I	72	2.3	10.6	89.0	2,400	2,000
FE02	72	2.3	10.6	113.0	2,400	2,000
GE0I	96	2.3	11.9	113.0	3,400	2,000
GE02	96	2.3	11.9	140.0	3,400	2,000
HE0I	144	2.3	14.8	170.0	5,500	2,000
HE02	144	2.3	14.8	206.0	5,500	2,000

MLT STANDARD

Specification: IE00, IE02

Indoor Outdoor Halogen free FTTx Duct



Description of materials:

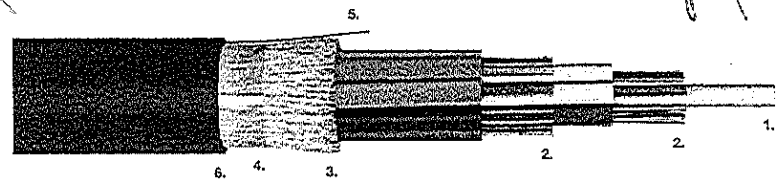
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Water-swellable tape. **5.** Rip-Cord. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
IE00	216	2.3	15.4	184.0	3,300	2,000
IE02	216	2.3	15.4	223.0	3,300	2,000

MLT STANDARD

Specification: Z090, Z182



Description of materials:

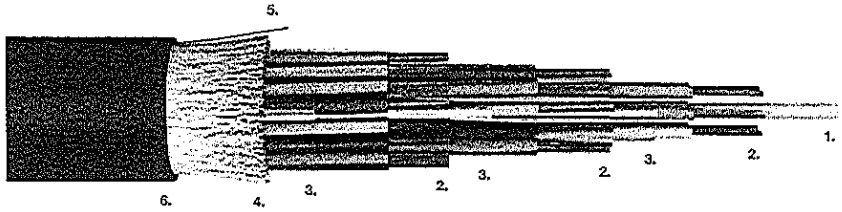
1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Waterblocking E-glass yarn. **4.** Water-swellable tape. **5.** Rip-Cord. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
Z090	288	2.3	17.7	234.0	5,500	2,000
Z182	288	2.3	17.7	276.0	5,500	2,000

MLT STANDARD

Specification: ME00, ME02



Description of materials:

1. FRP dielectric central strength member. **2.** Gel filled PBT loose tube with optical fibers.
3. Water-swellable tape. **4.** Waterblocking E-glass yarn. **5.** Rip-Cord. **6.** FR-LSZH or PE outer jacket, UV stable.

Temperature range	
Installation	-15 to +50 °C
Operation	-40 to +70 °C
Storage	-40 to +70 °C

Design code	Max. fiber count	Loose tube diameter [mm]	Cable size	Net weight [kg/km]	Max. load (installation) [N]	Crush resistance [N/10 cm]
ME00	432	2.5	22.6	348.0	2,400	2,000
ME02	432	2.5	22.6	408.0	2,400	2,000

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160349**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0330 Cable drum № **27Д5885**

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	64
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the Insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg **Gross weight 6552 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫПЕН С.В.

000410

ВЗЯТО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160354**

Date 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0328 Cable drum № **27Д5883**

Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,17	min 49,38
	nom 49,60	avg 49,35	avg 49,49
	max 50,10	max 49,52	max 49,60
Conductor screen			
thickness, mm	min 1,00	min 1,75	min 1,80
	nom 1,50	avg 2,10	avg 2,02
	max 2,50	max 2,44	max 2,24
max-min point difference, mm	≤ 1,0	0,69	0,44
Insulation			
thickness, mm	min 13,5	min 14,69	min 14,72
	nom 15,0	avg 15,17	avg 15,15
	max 18,0	max 15,65	max 15,58
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	6	6
diameter over insulation, mm	min 83,2	min 83,52	min 83,79
	nom 84,2	avg 83,97	avg 83,99
	max 85,2	max 84,41	max 84,19
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,65
	nom 1,1	avg 1,26	avg 1,08
	max 1,7	max 1,58	max 1,51
max-min point difference, mm	≤ 1,0	0,64	0,86
diameter over insulation screen, mm	min 85,2	min 85,79	min 85,85
	nom 86,4	avg 86,23	avg 86,27
	max 87,6	max 86,67	max 86,69
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm^2	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,25	min 4,44
	nom 4,0	avg 4,61	avg 4,73
		max 4,97	max 5,02
diameter over outer sheath, mm		min 100,65	min 101,70
		max 101,38	max 102,08

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜVNORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «СТРАЛИН ЭВК» С. [illegible] С.В.

000411

ЗАВЕРЕНО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160354**

DATE 26.07.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879
Factory length № 0328 Cable drum № 27Д5883
Length 470 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	71
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5152 kg Gross weight 6552 kg

Notes: all tests were passed successfully, cable meets ТУ 3630-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЗВК Сыпин С.В.

000412

ЗАВЕРЕНО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160355**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0331 Cable drum № **27ДТ5898**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,18	min 49,47
	nom 49,60	avg 49,39	avg 49,65
	max 50,10	max 49,60	max 49,83
Conductor screen			
thickness, mm	min 1,00	min 1,70	min 1,63
	nom 1,50	avg 2,07	avg 1,92
	max 2,50	max 2,44	max 2,20
max-min point difference, mm	≤ 1,0	0,74	0,57
Insulation			
thickness, mm	min 13,5	min 14,80	min 14,66
	nom 15,0	avg 15,07	avg 15,00
	max 18,0	max 15,34	max 15,34
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	4	4
diameter over Insulation, mm	min 83,2	min 83,35	min 83,20
	nom 84,2	avg 83,70	avg 83,67
	max 85,2	max 84,04	max 84,13
Insulation screen			
thickness, mm	min 0,5	min 0,93	min 0,94
	nom 1,1	avg 1,22	avg 1,21
	max 1,7	max 1,50	max 1,48
max-min point difference, mm	≤ 1,0	0,57	0,54
diameter over Insulation screen, mm	min 85,2	min 85,86	min 85,20
	nom 86,4	avg 86,22	avg 85,78
	max 87,6	max 86,57	max 86,35
ratio Ø min/Ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,26	min 4,12
	nom 4,0	avg 4,61	avg 4,46
		max 4,95	max 4,80
diameter over outer sheath, mm		min 101,18	min 100,67
		max 101,79	max 101,00

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО ЭСТРАЛИН ЭЧВ Сычев С.В.

000413

ЗАВЕРЯЮ С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Serial number **160355**

DATE 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0331 Cable drum № 27ДТ5898

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg **Gross weight 7264 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫЧЕВ С.А.

000414

ВЕРНО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160356**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0333 **Cable drum № 27ДТ5900**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,12	min 49,23
	nom 49,60	avg 49,32	avg 49,43
	max 50,10	max 49,52	max 49,62
Conductor screen			
thickness, mm	min 1,00	min 1,64	min 1,71
	nom 1,50	avg 1,91	avg 1,96
	max 2,50	max 2,18	max 2,21
max-min point difference, mm	≤ 1,0	0,54	0,50
Insulation			
thickness, mm	min 13,5	min 14,69	min 14,59
	nom 15,0	avg 15,21	avg 15,17
	max 18,0	max 15,72	max 15,75
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	7	7
diameter over insulation, mm	min 83,2	min 83,59	min 83,43
	nom 84,2	avg 83,87	avg 84,11
	max 85,2	max 84,15	max 84,79
Insulation screen			
thickness, mm	min 0,5	min 0,93	min 0,58
	nom 1,1	avg 1,22	avg 0,93
	max 1,7	max 1,50	max 1,28
max-min point difference, mm	≤ 1,0	0,57	0,70
diameter over insulation screen, mm	min 85,2	min 85,73	min 85,31
	nom 86,4	avg 86,06	avg 86,16
	max 87,6	max 86,39	max 87,00
ratio ø min/ø max	≥ 0,95	0,99	0,98
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,98	min 4,79
	nom 4,0	avg 5,22	avg 5,06
		max 5,45	max 5,32
diameter over outer sheath, mm		min 102,37	min 101,27
		max 102,62	max 101,66

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЭВК»

000415

ВЕРНО С ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160356**

DATE 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0333 **Cable drum № 27ДТ5900**

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg **Gross weight 7264 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of:

TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» Сытый С.В.

000416

ВЕРНО ОРИГИНАЛ

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Serial number **160364**

Date 03.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0332

Cable drum № 27ДТ5899

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,20
	nom 49,60	avg 49,17	avg 49,33
	max 50,10	max 49,24	max 49,45
Conductor screen			
thickness, mm	min 1,00	min 1,45	min 1,76
	nom 1,50	avg 1,94	avg 1,99
	max 2,50	max 2,42	max 2,22
max-min point difference, mm	≤ 1,0	0,97	0,46
Insulation			
thickness, mm	min 13,5	min 14,83	min 14,75
	nom 15,0	avg 15,24	avg 15,19
	max 18,0	max 15,65	max 15,62
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	6
diameter over insulation, mm	min 83,2	min 83,74	min 83,51
	nom 84,2	avg 84,16	avg 84,05
	max 85,2	max 84,58	max 84,58
Insulation screen			
thickness, mm	min 0,5	min 0,94	min 0,93
	nom 1,1	avg 1,14	avg 1,11
	max 1,7	max 1,34	max 1,29
max-min point difference, mm	≤ 1,0	0,40	0,36
diameter over insulation screen, mm	min 85,2	min 86,08	min 85,87
	nom 86,4	avg 86,40	avg 86,36
	max 87,6	max 86,72	max 86,84
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 4,24	min 3,63
	nom 4,0	avg 4,44	avg 4,35
		max 4,64	max 5,06
diameter over outer sheath, mm		min 100,25	min 100,55
		max 101,43	max 101,18

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЭВК» СЕЛИН С.В.

000417

ВЯРНО ОРИГИНАЛА

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FACTORY ACCEPTANCE TEST REPORT

Page 2

Serial number **160364**

DATE 03.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0332 Cable drum № 27ДТ5899

Length 535 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 5864 kg **Gross weight 7264 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified

In accordance with the requirements of: TUV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» С.В.

000418

ВЕРНО С ОРИГИНАЛА

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ESTRALIN HVC

FACTORY ACCEPTANCE TEST REPORT

Page 1

Serial number **160357**

Date 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ (A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0334

Cable drum № **25Д5901**

Length 300 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS	
		The outer end	The inner end
Conductor			
conductor diameter, mm	min 49,10	min 49,10	min 49,15
	nom 49,60	avg 49,17	avg 49,25
	max 50,10	max 49,24	max 49,35
Conductor screen			
thickness, mm	min 1,00	min 1,70	min 1,88
	nom 1,50	avg 1,95	avg 2,00
	max 2,50	max 2,20	max 2,11
max-min point difference, mm	≤ 1,0	0,50	0,23
Insulation			
thickness, mm	min 13,5	min 14,79	min 14,32
	nom 15,0	avg 15,17	avg 15,06
	max 18,0	max 15,54	max 15,80
eccentricity (Tmax-Tmin)/Tmax, %	≤ 15	5	9
diameter over insulation, mm	min 83,2	min 83,61	min 83,40
	nom 84,2	avg 84,08	avg 84,11
	max 85,2	max 84,55	max 84,81
Insulation screen			
thickness, mm	min 0,5	min 0,96	min 0,95
	nom 1,1	avg 1,17	avg 1,26
	max 1,7	max 1,37	max 1,56
max-min point difference, mm	≤ 1,0	0,41	0,61
diameter over insulation screen, mm	min 85,2	min 85,82	min 85,86
	nom 86,4	avg 86,28	avg 86,50
	max 87,6	max 86,74	max 87,13
ratio ø min/ø max	≥ 0,95	0,99	0,99
Copper screen			
cross-section, mm²	≥ 110	112,13	112,13
Outer sheath			
thickness, mm	min 3,3	min 3,95	min 4,05
	nom 4,0	avg 4,31	avg 4,38
		max 4,66	max 4,71
diameter over outer sheath, mm		min 101,85	min 100,93
		max 102,30	max 101,65

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of: TÜV NORD ISO 9001

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СЫЧЕВ С.С.

000419

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООД

Ltd «Estralin HVC»

111024, Moscow, 2-nd Kabelnaya str, 2, bld. 24

ESTRALIN HVC

www.estralin.com

FACTORY ACCEPTANCE TEST REPORT

Serial number **160357**

DATE 01.08.2016

Marking АПвП2г 1х1600(сгж)/110-64/110кВ
(A2XS(FL)2Y 1X1600RMS/110-64/110 kV)

Order № 879

Factory length № 0334 Cable drum № **25Д5901**

Length 300 m

PARAMETER, UNITS OF MEASUREMENT	REQUIREMENTS	RESULTS
Hot-set Test for Insulation		
elongation under load, %	≤ 175	68
permanent elongation, %	≤ 15	0
Check for inclusions or contaminants (metals, fibers, gas bubbles) in the insulation	No Contaminant	No Contaminant
Longitudinal sealing (metal foil)		
peel strength of overlapped foil, N/mm	≥ 1,0	1,3
adhesion strength of foil, N/mm	≥ 1,0	1,8
Al tape thickness, mm	≥ 0,1	0,15
overlaping, mm	≥ 15	16,1
Electrical tests		
electrical resistance of conductor, Ω/km	≤ 0,0186	0,0184
Voltage Test (160 kV, 30 min.)	No breakdown	No breakdown
Partial Discharge Test		
noise level at voltage of 160 kV, pC	≤ 10	≤ 10
noise level at voltage of 96 kV, pC	≤ 5	≤ 5
cable capacity, μF/km	≤ 0,32	0,30
Check of outer sheath marking	meets customer requirements	meets customer requirements
Check of packing	meets customer requirements	meets customer requirements

Net weight 3288 kg **Gross weight 4588 kg**

Notes: all tests were passed successfully, cable meets ТУ 3530-003-42747015-2007, IEC 60840.

Quality System certified
In accordance with the requirements of:

QD: ОТДЕЛ КАЧЕСТВА ООО «ЭСТРАЛИН ЗВК» СМОЛЯН С.С.

000420

ВЕРНО С ОРИГИНАЛА

«КРАСИН» СМОЛЯН ООО

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация

Приложение № 3 към Предложение за изпълнение на поръчката по т.15.3. от Техническото предложение – Заверени копия на документи за Сух силов кабел 110 kV - Al 1600 mm2:

- Приложение № 3.2. към т.15.3.2. от Техническото предложение – Заверено копие на Сертификат/акредитация на независимата изпитвателна лаборатория, провела типовите изпитвания.

RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
Inspection Services
Arnhem

The organisation has demonstrated to be able to perform inspections, as type **A** inspection body, in a competent, consistent and independent way.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17020:1998

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

I 049

is granted on 26 March 2014

This declaration is valid until

1 April 2018

The accreditation has been granted for the first time on

17 November 1994

The Chief Executive

Ir. J.C. van der Poel

The Dutch Accreditation Council (RvA) is a signatory of the European co-operation for Accreditation (EA) Multilateral Agreement for accreditation in this field.

000422

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018**

Replaces annex dated: **26-10-2012**

No.	Field of inspection	Type and Range of Inspection	Methods and Procedures[1]
	Rotating electrical machines, Transformers, Capacitors, Reactors		
1	Rotating electrical machines	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60034
2	Power transformers		IEC 60076 – 1,2,3,4,5,7,8,10,11,13, 15 NEMA 107 CISPR 16 EN 60076-11
3	Current transformers		IEC 60044 – 1,3,6,8
4	Voltage transformers		IEC 60044 – 2,3,7
5	Capacitors		IEC 60358 IEC 60831-1/-2 IEC 60871-1/-2
6	Reactors		IEC 60076-6

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Field of inspection	Type and Range of Inspection	Methods and Procedures[1]
		Switchgear	
7	Metal-enclosed AC switchgear 1-52 kV resp. ≥ 52 kV	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 62271-200 IEC 62271-1 IEC 60265 –1 IEC 62271-104 IEC 62271-105
8	Insulation-enclosed AC switchgear		IEC 62271-201
9	Gas insulated metal-enclosed AC switchgear (GIS)		IEC 62271-203 IEC 62271-1
10	High Voltage AC circuit breakers		IEC 62271-100
11	High-voltage AC disconnectors and earthing switches		IEC 62271-102
		Insulators, Arresters	
12	Insulators and insulated bushings	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60137 IEC 60168 IEC 60383 –1,2 IEC 60507 IEC 60660 IEC 61109 IEC 60815 ANSI C29 CAN/CSA C411.1-M89
13	Surge arresters		IEC 60099 –1,3,4,5,6,7 IEEE Std C62.11

Annex to ISO/IEC 17020:1998 declaration of accreditation for registration number: **I 049, type A**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
Inspection Services
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Field of inspection	Type and Range of Inspection	Methods and Procedures[1]
		Cables	
14	Cables	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60055 –1,2 IEC 60141-1 IEC 60502 –1,2,4 IEC 60840 NEN 3620 NEN 3172 BS 6622 HD 620 S2 NEN 3616 NEN 3619 NEN 3630 IEC 62067 CSA C49 NF C34-125 IEC 61089
15	Cable accessories		IEC 60055 –1,2 IEC 60502 –1,2,4 VDE 278 IEEE Std 404 IEEE Std 48 IEC 62271-209
		Electrical Energy Meters	
16	Electricity metering equipment (a.c.)	European directive 2004/22/EC: - Annex B: EC type examination - Annex F: Product verification Taking into account the requirements of EA-2/17	Directive 2004/22/EC: Annex I, B, F, MI-003

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
High-Power Laboratory
Arnhem

The organisation has demonstrated to be able to generate technical valid results in a competent way and work according to a management system.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17025:2005.

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

L 020

is granted on 26 March 2014

This declaration is valid until

1 April 2018

The accreditation has been granted for the first time on

30 October 1990

The Chief Executive

Ir. J.C. van der Poel

The Dutch Accreditation Council (RvA) is a signatory of the European co-operation for Accreditation (EA) Multilateral Agreement for accreditation in this field.

000426

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
		Transformers, Reactors, Line traps	
1	Power transformers	Short-circuit tests	IEC 60076-5 IEC 60076-11 STL Guide to IEC 60076 EN 60076-5 EN 50464-1 NEN-EN 50541-1 IEEE Std C57.12.90
2	Current transformers	Short-time current tests Transient Instantaneous error measurement	IEC 60044-1 IEC 60044 -6 STL Guide to IEC 60044-1 STL Guide to IEC 60044-6 IEEE Std C57.13
3	Reactors	Short-time current tests	IEC 60076-6 IEEE Std C57.21
4	Line traps for A.C. power systems	Short-time current tests	IEC 60353
		Switchgear	
5	Metal-enclosed A.C. switchgear 1 - 52 kV resp. > 1 kV and prefabricated substations	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-200 IEC 62271-202 STL Guide to IEC 62271-200 IEEE Std C37.20.2 IEEE C37.21 ANSI C37.54 ANSI C37.55
6	Metal-enclosed A.C. switchgear ≥ 72,5 kV resp. ≥ 52 kV	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-203 STL Guide to IEC 60517 IEEE Std C37.122

This annex has been approved by:

[redacted] на основание чл. 2 от ЗЗЛД

Ir. J.C. van der Poel, RA
Chief Executive

Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
7	Low-voltage A.C. switchgear and control gear assemblies	Short-time current tests	IEC 61439-1 IEC 61439-2 IEC 60439-2 EN 61439-1 EN 61439-2 EN 60439-2 ANSI C37.20.2
8	Insulation-enclosed A.C. switchgear 1 - 52 kV	Short-time current tests Verification of making and breaking capacities Mechanical operation test Arcing due to internal fault	IEC 62271-201
9	High-voltage AC circuit breakers	Short-time current tests Making and breaking tests Switching tests Mechanical and environmental tests	NEN-EN-IEC 62271-100 IEC 62271-110 IEC 62271-101 STL Guide to IEC 62271-100 STL Guide to IEC 62271-101 ANSI/IEEE C37.09 ANSI/IEEE C37.081 IEEE Std C37.013 NEN-EN 50152-1
10	High-voltage A.C. switches	Short-time current tests Making and breaking tests Mechanical endurance tests Operation under severe ice conditions	NEN-EN-IEC 62271-103 IEC 62271-104 STL Guide to IEC 60265-1 IEEE Std C37.74
11	High-voltage A.C. disconnectors and earthing switches	Short-time current tests Switching tests Short-circuit making performance Operating and mechanical endurance tests Operation under severe ice conditions Operation at the temperature limits Contact zone tests	IEC 62271-102 STL Guide to IEC 62271-102 IEEE Std C37.34 IEEE Std C37.41
12	High-voltage A.C. contactors and motor starters	Making and breaking capacities Coordination with short-circuit protective device	NEN-EN-IEC 62271-106
13	Automatic circuit reclosers and fault interrupters	Interruption tests Operating duty tests	IEC 62271-111 / IEEE Std C37.60

Annex to ISO/IEC 17025:2005 declaration of accreditation
for registration number: **L 020**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Power Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2012**

No.	Material or product	Type of activity	Internal reference number
		Arresters	
14	Surge arresters	Pressure-relief tests	IEC 60099-1 IEC 60099-4 IEEE Std C62.11
		Fuses	
15	High-voltage A.C. switch-fuse combinations	Making and breaking tests Tests on the mechanism	IEC 62271-105 IEEE Std C37.41 IEEE Std C37.74
16	High-voltage A.C. fuses	Breaking tests	NEN-EN-IEC 60282-1 IEC 60282-2 IEC 60549 NEN-EN-IEC 60644 STL Guide to IEC 60282-1 STL Guide to IEC 60282-2 IEEE Std C37.41 ANSI C37.44
		Cables/Networks	
17	Equipment for networks for transmission and distribution of electrical power	Test as mentioned above (1-16)	In accordance with or equivalent to the reference methods as mentioned above (1-16).

ВЯРНО С ОРИГИНАЛА

"РАСИН" СМОЛЯН ООД

RAAD VOOR ACCREDITATIE

Dutch Accreditation Council RvA
PO Box 2768 NL-3500 GT Utrecht

The Dutch Accreditation Council RvA, by law appointed as the national accreditation body for The Netherlands, hereby declares that accreditation has been granted to:

KEMA Nederland B.V.
High-Voltage Laboratory
Arnhem

The organisation has demonstrated to be able to generate technical valid results in a competent way and work according to a management system.

This accreditation is based on an assessment against the requirements as laid down in ISO/IEC 17025:2005.

The accreditation covers the activities as specified in the authorized annex bearing the registration number.

The accreditation is valid provided that the organisation continues to meet the requirements.

The accreditation with registration number:

L 218

is granted on 26 March 2014

This declaration is valid until
1 April 2018

The accreditation has been granted for the first time on
17 November 1994

The Chief Executive
на основание чл. 2 от ЗЗЛД

Ir. J.C. van der Poel

The Dutch Accreditation Council (RvA) is a signatory of the European co-operation for Accreditation (EA) Multilateral Agreement for accreditation in this field.

000430

ВЯРНО С ОРИГИНАЛА

"К.РАСИ... СМОЛЯН... ООД

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
1	Coils and/or windings of rotating electrical machines	AC voltage test Lightning impulse voltage test	IEC 60034
2	Power transformers	AC voltage test Lightning impulse voltage test Temperature-rise test Capacitance and tan δ measurement Power measurement DC resistance measurement Temperature measurement Sound level measurement R.I.V. measurement Partial discharge measurement SFRA measurement Verification of voltage ratio and phase displacement Low ambient test on dry-type transformer Thermal shock test on dry type transformer Condensation test on dry-type transformer Humidity penetration test on dry-type transformer Inspection of the active part	IEC 60076-1, -2, -3, -10, -11, -13, -15, -16, -18 CISPR 16 STL Guide to IEC 60076 NEN-EN 50464-1 NEN-EN 50541-1 IEEE Std. C57.12.00 IEEE Std. C57.12.90 IEEE Std. C57.12.91
3	AC Metal-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV and prefabricated substations	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-200 STL Guide to IEC 62271-200 IEC 62271-202 STL Guide to IEC 62271-202 IEEE C37.20.2 IEEE C37.21 ANSI C37.54 ANSI C37.55 IEC 60529

has been approved by:

на основание чл. 2 от ЗЗЛД

Ir. J.C. van der Poel
Chief Executive

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
4	AC Insulation-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-201 IEC 60529
5	Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement	IEC 62271-203 STL Guide to IEC 60517 IEEE Std C37.122
6	High-voltage AC circuit breakers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement Test under wet conditions	NEN-EN-IEC 62271-100 STL Guide to IEC 62271-100 IEEE Std C37.09 IEEE Std C37.013 NEN-EN 50152-1
7	High-voltage AC disconnectors and earthing switches	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Partial discharge measurement DC resistance measurement R.I.V. measurement Test under wet conditions Temperature measurement	IEC 62271-102 STL Guide to IEC 62271-102 IEEE Std C37.34 IEEE Std C37.41
8	High-voltage AC switches	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	NEN-EN-IEC 62271-103 STL Guide to IEC 60265-1 NEN-EN-IEC 62271-104 IEEE Std C37.74

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
9	High-voltage AC contactors	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	NEN-EN-IEC 62271-106
10	Automatic circuit reclosers and fault interrupters	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-111/ IEEE Std C37.60
11	Busducts	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEEE Std C37.23
12	High-voltage AC switch-fuse combinations and high-voltage AC fuses	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-105 IEEE Std C37.41 IEEE Std C37.74 NEN-EN-IEC 60282-1 IEC 60282-2 STL Guide to IEC 60282-1 STL Guide to IEC 60282-2

ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
13	Insulators and insulated bushings	AC voltage test Lightning impulse voltage test Partial discharge measurement Test under wet conditions Thermal-mechanical performance test Electro-mechanical failing load test R.I.V. measurement Pollution tests Temperature measurement Visible corona test Steep front wave flashover test Porosity test Visual and dimensional test Galvanizing test Thermal shock test Thermal cycle test Water absorption test Impact test Test of housing: tracking and erosion tests	IEC 60137 IEEE Std C57.19.00 IEEE Std C57.19.01 IEC 60168 IEC 60383 IEC 60507 IEC 60660 IEC 61109 IEC 62217 ANSI C29.1, -2, -6, -7, -12, -13 CAN/CSA C411.1
14	Cables	AC voltage test DC voltage test Lightning impulse test Heat cycle voltage test Capacitance and tan δ measurement Partial discharge measurement Insulation resistance measurement DC resistance measurement Temperature measurement Condition test of XLPE cable Water penetration test Bending test	IEC 60055 IEC 60141 IEC 60502 IEC 60840 IEC 62067 NEN-HD 620 NEN-HD 632 NEN 3619 BS 6622 BS 7835 BS 7870 BS 7912 BS 7970
15	Cable accessories	AC voltage test DC voltage test Lightning impulse voltage test Heat cycle voltage test Temperature measurement Partial discharge measurement Insulation resistance measurement Test under wet conditions Pollution tests R.I.V. measurement Water penetration test Impact test	IEC 60502-4 IEC 60055 IEC 60840 IEC 62067 HD 629-1 HD 629-2 NEN-HD 632 IEEE Std 48 IEEE Std 404

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
16	Current transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Accuracy test Test under wet conditions Temperature measurement Inspection of active part	NEN-EN-IEC 60044-1 NEN-EN-IEC 60044-6 IEC 60044-8
17	Voltage transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Temperature measurement Accuracy test Test under wet conditions Leakage test Inspection of active part	IEC 61869-1 IEC 61869-3 IEC 61869-5 IEC 60044-7
18	Capacitors	AC voltage test Lightning impulse voltage test Capacitance and tan δ measurement Temperature measurement Test under wet conditions Thermal stability test Short-circuit discharge test Endurance test Sealing test Self-healing test Destruction test Ageing test	IEC 60358 IEC 60831 IEC 60871
19	Surge arresters	AC voltage test Lightning impulse voltage test Switching impulse voltage test Current impulse test Pollution tests Partial discharge measurement Temperature measurement Ageing test R.I.V. measurement	IEC 60099 IEEE Std C62.11

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
20	Reactors	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Impedance measurement AC resistance measurement Power measurement DC resistance measurement Temperature measurement Acoustic sound level measurement Verification of voltage ratio and phase displacement check	IEC 60076-6 IEEE Std C57.21
21	Compression and mechanical connectors	Temperature-rise test Temperature measurement DC resistance measurement Mechanical tests	IEC 61238-1
22	Protection relays & substation automation equipment	Functional requirements	IEC 60255-1 IEC 60255-8 IEC 60255-12 IEC 60255-13 IEC 60255-16 IEC 60255-127 IEC 60255-151 IEEE C37.112
		Product safety requirements	IEC 60255-1 IEC 60255-27
		EMC requirements	IEC 60255-1 IEC 60255-26 IEC 60255-22 series IEC 60255-11 IEC 61000-4-2 IEC 61000-4-3 IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 IEC 61000-4-8 IEC 61000-4-9 IEC 61000-4-10 IEC 61000-4-11 IEC 61000-4-16 (only 50 Hz) IEC 61000-4-17 IEC 61000-4-18 IEC 61000-4-29 IEEE C37.90 IEEE C37.90.1 IEEE C37.90.2 IEEE C37.90.3

Annex to ISO/IEC 17025:2005 declaration of accreditation for registration number: **L 218**

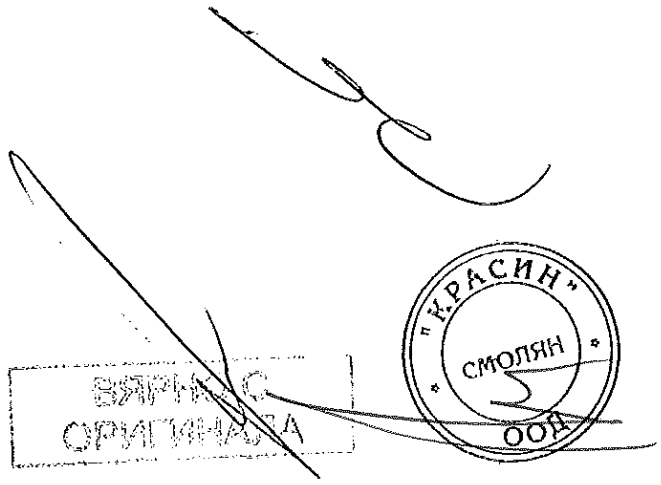
RAAD VOOR ACCREDITATIE

of **KEMA Nederland B.V.**
High-Voltage Laboratory
Arnhem

This annex is valid from: **26-03-2014** to **01-04-2018** Replaces annex dated: **26-10-2011**

No.	Material or product	Type of activity	Internal reference number
	Protection relays & substation automation equipment	Energizing quantities	IEC 60255-1
		Climatic environmental tests	IEC 60255-1 IEC 60068-2-2 tests Bd, Bb IEC 60068-2-1 tests Ad, Ab IEC 60068-2-14 test Nb IEC 60068-2-78 test Cab IEC 60068-2-30 test Db
		Mechanical environmental tests	IEC 60255-1 IEC 60255-21 series
23	Electrical Energy Meters	Tests of - insulation properties, - accuracy requirements, - disturbances of long duration, - electrical requirements, - electromagnetic compatibility, - the effect of climatic environments, - mechanical requirements.	IEC 62052-11 and IEC 62053-11/21/22/23 EN 50470-1/2/3 - Directive 2004/22/EC, annex I, B, F and MI-003

Remark
"in accordance with" is applicable for all standards.



Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 020**

of **DNV GL Netherlands B.V.**
High Power Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

Location(s) where activities are performed under accreditation

Head Office

Utrechtseweg 310
6812 AR
Arnhem
The Netherlands

Location	Abbreviation/ location code
Utrechtseweg 310 6812 AR Arnhem The Netherlands	ARN

No.	Material or product	Type of activity[1]	Internal reference number	Location
1	Power Transformers	Short-circuit tests	IEC 60076-5 IEC 60076-11 EN 50464-1 IEEE Std C57.12.90 IEEE Std. C57.12.00	ARN
2	Current Transformers	Short-time current tests Transient instantaneous error measurement	IEC 61869-2 IEEE Std C57.13 IEC 61869-1	ARN
3	Reactors	Short-time current tests	IEC 60076-6 IEEE Std C57.21	ARN
4	Line traps for A.C. power systems	Short-time current tests	IEC 60353	ARN

This annex has been approved by the Board of the Dutch Accreditation Council, on its behalf,

J.A.W.M. de Haas
Director of Operations

на основание чл. 2 от ЗЗЛД

[1] If there is a referral to a code starting with NAW, NAP, EA of IAF, this constitutes a scheme for which RvA-BR010 applies. The accepted version accreditation can be granted by the RvA.

ВЯРНО С ОРИГИНАЛА

ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 020**

of **DNV GL Netherlands B.V.**
High Power Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
5	Metal-enclosed A.C. switchgear 1 - 52 kV resp > 1 kV and prefabricated substations	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-200 IEC 62271-202 IEEE C37.74 IEEE Std C37.20.2 IEEE Std C37.20.7 ANSI C37.54 ANSI C37.55	ARN
6	Metal-enclosed A.C. switchgear >52kV	Short-time current tests Verification of making and breaking capacities Mechanical operation tests Arcing due to internal fault	IEC 62271-203 IEEE Std C37.122	ARN
7	Low-voltage A.C. switchgear and control gear assemblies	Short-time current tests	IEC 61439-1 IEC 61439-2	ARN
8	Insulation-enclosed A,C switchgear 1-52kV	Short time current tests Verification of making and breaking capacities Mechanical operation test Arcing due to internal fault	IEC 62271-201	ARN
9	High-voltage AC circuit breakers	Short-time current tests Making and breaking tests Switching tests Mechanical and environmental tests	IEC 62271-100 IEC 62271-110 IEC 62271-101 IEEE Std C37.09 IEEE Std C37.09a IEEE Std C37.09b IEEE Std C37.081	ARN
10	High-voltage generator Circuit breaker	Short circuit test	IEEE Std C37.013 IEEE Std C37.013a	ARN
11	AC circuit breakers for Railway applications	Making and Breaking test	EN 50152-1 IEC 60077-4	ARN
12	High-voltage A.C. switches for rated Voltages above 1 kV up to and including 52 kV	Short-time current tests Making and breaking tests Mechanical endurance tests	IEC 62271-103	ARN
13	Alternating current switches for rated voltages of 52 kV and above	Short-time current tests Making and breaking tests Mechanical endurance tests	IEC 62271-104 IEEE Std 1247	ARN

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 020**

of **DNV GL Netherlands B.V.**
High Power Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
14	High-voltage A.C. disconnectors and earthing switches	Short-time current tests Switching tests Short-circuit making performance Operating and mechanical endurance tests Operation under severe ice conditions Operation at the temperature limits Contact zone tests	IEC 62271-102 IEEE Std C37.34	ARN
15	Alternating current contactors and motor starters	Making and breaking capacities Coordination with short-circuit protective device	IEC 62271-106	ARN
16	Automatic circuit reclosers and fault interrupters	Interruption tests Operating duty tests	IEC 62271-111 / IEEE Std C37.60	ARN
17	Surge arresters	Pressure-relief tests	IEC 60099-1 IEC 60099-4 IEEE Std C62.11	ARN
18	High-voltage A.C. switchfuse combinations for rated Voltages above 1 kV Up to and including 52 kV	Making and breaking tests Tests on the mechanism	IEC 62271-105 IEEE Std C37.41	ARN
19	Current limiting fuses	Breaking tests	IEC 60282-1 IEC 60549 IEEE Std C37.41 ANSI C37.44	ARN
20	Expulsion fuses	Breaking tests	IEC 60282-2	ARN
21	High Voltage fuse-links for motor circuit applications	Breaking tests	IEC 60644	ARN
22	Equipment for networks for transmission and distribution of electrical power	Test as mentioned above (1-21)	In accordance with or equivalent to the reference methods as mentioned above (1-21).	ARN

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Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: L 218

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

Location(s) where activities are performed under accreditation

Head Office

Utrechtseweg 310, Building no. R11
6812 AR
Arnhem
The Netherlands

Location	Abbreviation/ location code
Utrechtseweg 310, Building no. R11 6812 AR Arnhem The Netherlands	ARN

No.	Material or product	Type of activity[1]	Internal reference number	Location
1	Coils and/or windings of rotating electrical machines	AC voltage test Lightning impulse voltage test	IEC 60034	ARN

This annex has been approved by the Board of the Dutch Accreditation Council, on its behalf,

I.A.W.M. de Haas

на основание чл. 2 от ЗЗЛД

[1] If there is a referral to a code starting with NAW, NAP, EA of IAF, this constitutes a scheme for which RvA-BR010 applies. The accepted version is m
accreditation can be granted by the RvA.

000441

ВЯРНО С ОРИГИНАЛА

СМОЛЯ... ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
2	Power transformers	AC voltage test Lightning impulse voltage test Temperature-rise test Capacitance and tan δ measurement Power measurement DC resistance measurement Temperature measurement Sound level measurement R.I.V. measurement Partial discharge measurement SFRA measurement Verification of voltage ratio and phase displacement Low ambient test on dry-type transformer Thermal shock test on dry type transformer Condensation test on dry-type transformer Humidity penetration test on dry-type transformer Inspection of the active part	IEC 60076-1, -2, -3, -10, -11, -13, -15, -16, -18 CISPR 18.2 EN 50464-1 EN 50541-1 IEEE Std. C57.12.00 IEEE Std. C57.12.90 IEEE Std. C57.12.91	ARN
3	AC Metal-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV and prefabricated substations	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-200 IEC 62271-202 IEEE C37.20.2 IEEE C37.21 ANSI C37.54 ANSI C37.55 IEC 60529	ARN
4	AC Solid Insulation-enclosed switchgear and controlgear above 1 kV and ≤ 52 kV	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection R.I.V. measurement	IEC 62271-201 IEC 60529	ARN

ВЯРНО С ОРИГИНАЛА
"КРАСКИН" СМОЛЯН ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
5	Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement	IEC 62271-203 IEEE Std C37.122	ARN
6	High-voltage AC circuit breakers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement R.I.V. measurement Test under wet conditions	IEC 62271-100 IEEE Std C37.09 IEEE Std C37.013 EN 50152-1	ARN
7	High-voltage AC disconnectors and earthing switches	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Partial discharge measurement DC resistance measurement R.I.V. measurement Test under wet conditions Temperature measurement	IEC 62271-102 IEEE Std C37.34 IEEE Std C37.41	ARN
8	High-voltage AC switches	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-103 IEC 62271-104 IEEE Std C37.74	ARN
9	High-voltage AC contactors	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-106	ARN

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
10	Automatic circuit reclosers and fault interrupters	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-111/ IEEE Std C37.60	ARN
11	Busducts	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEEE Std C37.23	ARN
12	High-voltage AC switch-fuse combinations and high-voltage AC fuses	AC voltage test Lightning impulse voltage test Partial discharge measurement Temperature-rise test Temperature measurement DC resistance measurement Verification of degree of protection	IEC 62271-105 IEEE Std C37.41 IEEE Std C37.74 IEC 60282-1 IEC 60282-2	ARN
13	Insulators and insulated bushings	AC voltage test Lightning impulse voltage test Partial discharge measurement Test under wet conditions Thermal-mechanical performance test Electro-mechanical failing load test R.I.V. measurement Pollution tests Temperature measurement Visible corona test Steep front wave flashover test Porosity test Visual and dimensional test Galvanizing test Thermal shock test Thermal cycle test Water absorption test Impact test Test of housing: tracking and erosion tests	IEC 60137 IEEE Std C57.19.00 IEEE Std C57.19.01 IEC 60168 IEC 60383 IEC 60507 IEC 60660 IEC 61109 IEC 62217 IEC 62730 ANSI C29.1, -6, -7, -12 ANSI/NEMA C29.2, -13 CAN/CSA C411.1	ARN

ВЯРНО С ОРИГИНАЛА
«КРАСИН» СМОЛЕНСК ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
14	Cables	AC voltage test DC voltage test Lightning impulse test Heat cycle voltage test Capacitance and tan δ measurement Partial discharge measurement Insulation resistance measurement DC resistance measurement Temperature measurement Condition test of XLPE cable Water penetration test Bending test	IEC 60055 IEC 60141 IEC 60502 IEC 60840 IEC 62067 HD 620 HD 632 NEN 3619 BS 6622 BS 7835 BS 7870 BS 7912 BS 7970	ARN
15	Cable accessories	AC voltage test DC voltage test Lightning impulse voltage test Heat cycle voltage test Temperature measurement Partial discharge measurement Insulation resistance measurement Test under wet conditions Pollution tests R.I.V. measurement Water penetration test Impact test	IEC 60502-4 IEC 60055 IEC 60840 IEC 62067 HD 629-1 HD 629-2 HD 632 IEEE Std 48 IEEE Std 404	ARN
16	Current transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Accuracy test Test under wet conditions Temperature measurement Inspection of active part	IEC 60044-8 IEC 61869-2 IEC 61869-1	ARN

ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

000445

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
17	Voltage transformers	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Capacitance and tan δ measurement Partial discharge measurement Temperature measurement Accuracy test Test under wet conditions Leakage test Inspection of active part	IEC 61869-1 IEC 61869-3 IEC 61869-5 IEC 60044-7	ARN
18	Capacitors	AC voltage test Lightning impulse voltage test Capacitance and tan δ measurement Temperature measurement Test under wet conditions Thermal stability test Short-circuit discharge test Endurance test Sealing test Self-healing test Destruction test Ageing test	IEC 60358 IEC 60831 IEC 60871	ARN
19	Surge arresters	AC voltage test Lightning impulse voltage test Switching impulse voltage test Current impulse test Pollution tests Partial discharge measurement Temperature measurement Ageing test R.I.V. measurement	IEC 60099 IEEE Std C62.11	ARN

ВЯРНО С ОРИГИНАЛА

000446

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
20	Reactors	AC voltage test Lightning impulse voltage test Switching impulse voltage test Temperature-rise test Impedance measurement AC resistance measurement Power measurement DC resistance measurement Temperature measurement Acoustic sound level measurement Verification of voltage ratio and phase displacement check	IEC 60076-6 IEEE Std C57.21	ARN
21	Compression and mechanical connectors	Temperature-rise test Temperature measurement DC resistance measurement Mechanical tests	IEC 61238-1	ARN
22	Protection relays & substation automation equipment	Functional requirements	IEC 60255-1 IEC 60255-149 IEC 60255-12 IEC 60255-13 IEC 60255-121 IEC 60255-127 IEC 60255-151 IEEE C37.112	ARN
		Product safety requirements	IEC 60255-1 IEC 60255-27	

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

000447

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17025:2005
Registration number: **L 218**

of **DNV GL Netherlands B.V.**
High-Voltage Laboratory

This annex is valid from: **20-03-2017** to **01-04-2018** Replaces annex dated: **03-10-2016**
Prolonged until 01-07-2018

No.	Material or product	Type of activity[1]	Internal reference number	Location
	Protection relays & substation automation equipment	EMC requirements	IEC 60255-1 IEC 60255-26 IEC 61000-4-2 IEC 61000-4-3 IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 IEC 61000-4-8 IEC 61000-4-9 IEC 61000-4-10 IEC 61000-4-11 IEC 61000-4-16 (only 50 Hz) IEC 61000-4-17 IEC 61000-4-18 IEC 61000-4-29 IEEE C37.90 IEEE C37.90.1 IEEE C37.90.2 IEEE C37.90.3	ARN
		Energizing quantities	IEC 60255-1	
		Climatic environmental tests	IEC 60255-1 IEC 60068-2-2 tests Bd, Bb IEC 60068-2-1 tests Ad, Ab IEC 60068-2-14 test Nb IEC 60068-2-78 test Cab IEC 60068-2-30 test Db	
		Mechanical environmental tests	IEC 60255-1 IEC 60255-21 series	
23	Electrical Energy Meters	Tests of insulation properties, accuracy requirements, disturbances of long duration, electrical requirements, electromagnetic compatibility, the effect of climatic environments, mechanical requirements.	IEC 62052-11 and IEC 62053-11/21/22/23 EN 50470-1/2/3	ARN

Remark
"in accordance with" is applicable for all standards.

ВЯРНО С ОРИГИНАЛА

000448

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17020:2012
Registration number: **I 049, type A**

of **DNV GL Netherlands B.V.**
Inspection Service

This annex is valid from: **03-10-2016** to **01-04-2018** Replaces annex dated: **21-04-2016**
Prolonged until 01-07-2018

Location(s) where activities are performed under accreditation

Head Office

Utrechtseweg 310, Building no. R11
6812 AR
Arnhem
The Netherlands

Location	Abbreviation/ location code
Utrechtseweg 310, Building no. R11 6812 AR Arnhem The Netherlands	ARN

No.	Field of inspection	Type and range of inspection	Methods & procedures[1]	Location
Rotating electrical machines, Transformers, Capacitors, Reactors				
1	Rotating electrical machines	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60034	ARN
2	Power transformers		IEC 60076 NEMA 107 CISPR 16 EN 60076-11	ARN
3	Current transformers		IEC 61869 – 2,4,9	ARN
4	Voltage transformers		IEC 61869 – 3,4,7	ARN

This annex has been approved by the Board of the
Dutch Accredita на основание чл. 2 от ЗЗЛД

Director of Operations

If there is no reference to a code and no date or version number is mentioned for a normative document, the accreditation concerns the most current version of the document.
[1] If there is a referral to a code starting with NAW, NAP, EA of IAF, this constitutes a scheme to which RvA-BR012 applies. The accepted version is mentioned on the list of schemes for which accreditation can be granted by the RvA, as meant in RvA-BR010.

000449

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17020:2012
Registration number: **I 049, type A**

of **DNV GL Netherlands B.V.**
Inspection Service

This annex is valid from: **03-10-2016** to **01-04-2018** Replaces annex dated: **21-04-2016**
Prolonged until 01-07-2018

No.	Field of inspection	Type and range of inspection	Methods & procedures[1]	Location
5	Capacitors	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60358 IEC 60831-1/-2 IEC 60871-1/-2	ARN
6	Reactors		IEC 60076-6	ARN
	Switchgear			
7	Metal-enclosed AC switchgear 1-52 kV resp. ≥ 52 kV	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 62271-200 IEC 62271-1 IEC 60265 –1 IEC 62271-104 IEC 62271-105	ARN
8	Insulation-enclosed AC switchgear		IEC 62271-201	ARN
9	Gas insulated metal-enclosed AC switchgear (GIS)		IEC 62271-203 IEC 62271-1	ARN
10	High Voltage AC circuit breakers		IEC 62271-100	ARN
11	High-voltage AC disconnectors and earthing switches		IEC 62271-102	ARN
	Insulators, Arresters			
12	Insulators and insulated bushings	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60137 IEC 60168 IEC 60383 –1,2 IEC 60507 IEC 60660 IEC 61109 IEC 60815 ANSI/NEMA C29 CAN/CSA C411.1-M89	ARN
13	Surge arresters		IEC 60099 – 3,4,5,6,7 IEEE Std C62.11	ARN

000450

ВЯРНО С ОРИГИНАЛА

"ЛАСИН" СОФИЯ ООД

Annex to declaration of accreditation (scope of accreditation)
Normative document: EN ISO/IEC 17020:2012
Registration number: **I 049, type A**

of **DNV GL Netherlands B.V.**
Inspection Service

This annex is valid from: **03-10-2016** to **01-04-2018** Replaces annex dated: **21-04-2016**
Prolonged until 01-07-2018

No.	Field of inspection	Type and range of inspection	Methods & procedures[1]	Location
		Cables		
14	Cables	- examine manufacturers' quality registrations - monitor factory inspections - evaluate the results obtained by these examinations	IEC 60055 –1,2 IEC 60141-1 IEC 60502 –1,2,4 IEC 60840 NEN-HD 620 NEN 3172 BS 6622 HD 620 S2 NEN 3616 NEN 3619 NEN-HD 632 IEC 62067 CSA C49 NF C34-125 IEC 61089	ARN
15	Cable accessories		IEC 60055 –1,2 IEC 60502 –1,2,4 VDE 278 IEEE Std 404 IEEE Std 48 IEC 62271-209	ARN
		Directive 2014/32/EU **Measuring instruments** *The accreditation for the specified activities is suitable for notification*		
16	Active electrical energy meters	EU-type examination (module B)	Annex II, module B Annex V, MI-003	ARN
17	Active electrical energy meters	Conformity to type based on product verification(module F)	Annex II, module F Annex V, MI-003	ARN

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН

000451

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация

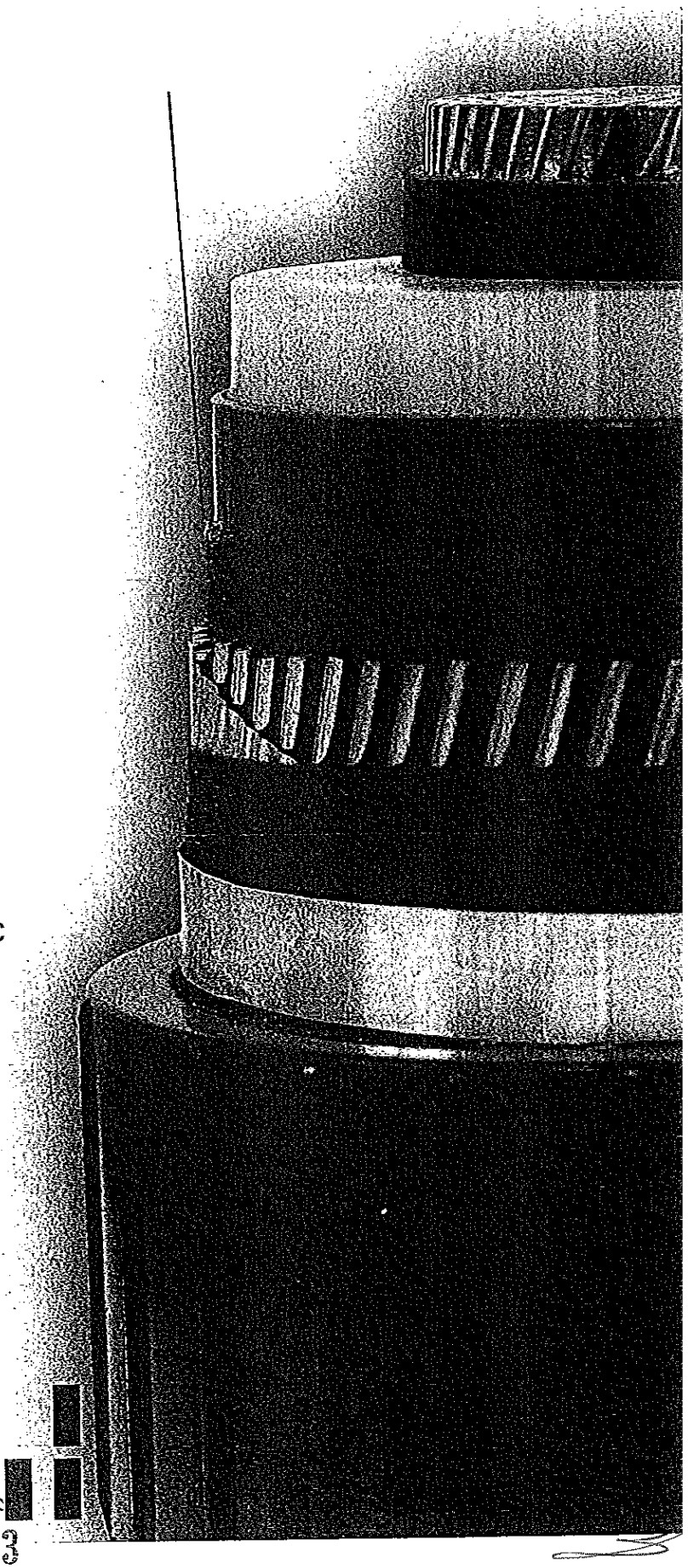
Приложение № 3 към Предложение за изпълнение на поръчката по т.15.3. от Техническото предложение – Заверени копия на документи за Сух силов кабел 110 kV - Al 1600 mm2:

- Приложение № 3.3. към т.15.3.3. от Техническото предложение – Последни издания на каталози на производителя.

000452

ESTRALIN HVC

XLPE CABLES
AND CABLE SYSTEMS
66-220 KV



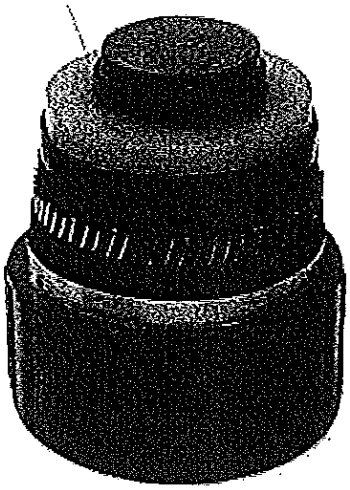
MODERN SOLUTIONS FOR
POWER CABLES/ESTRALIN HVC

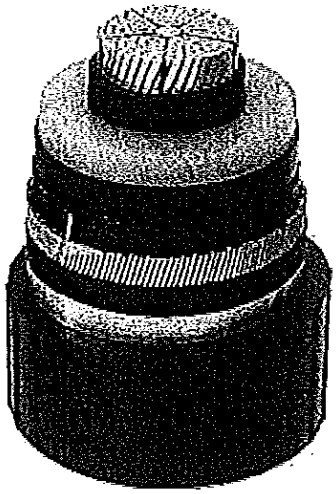
000453

ВЯРНО С ОРИГИНАЛА

"КРАСНИ" СМОЛЯН ООД

000454





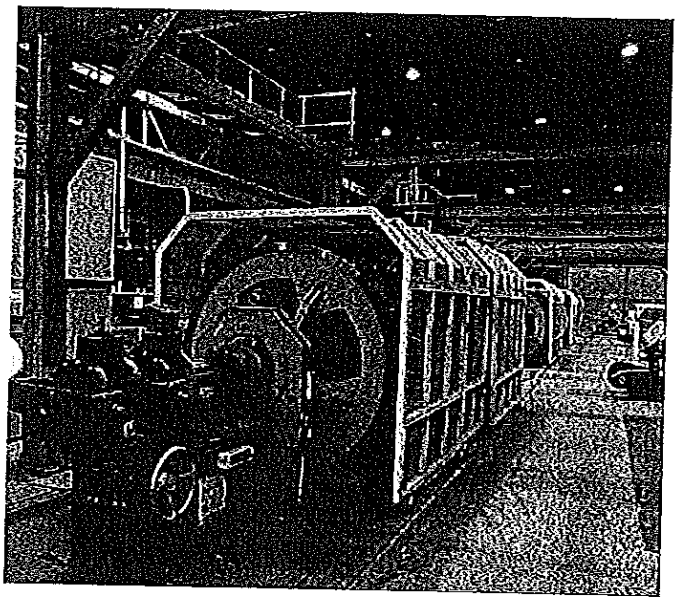
Cables 66-220 kV are widely used for electric energy transmission and distribution especially in large cities and at production plants, where electric energy consumption and load density levels are particularly high. Although basic requirements of cables (i.e. reliability, functionality, low maintenance costs) are obvious, failing in one of these requirements can cause remarkable financial losses as well as interruption of the service being provided.

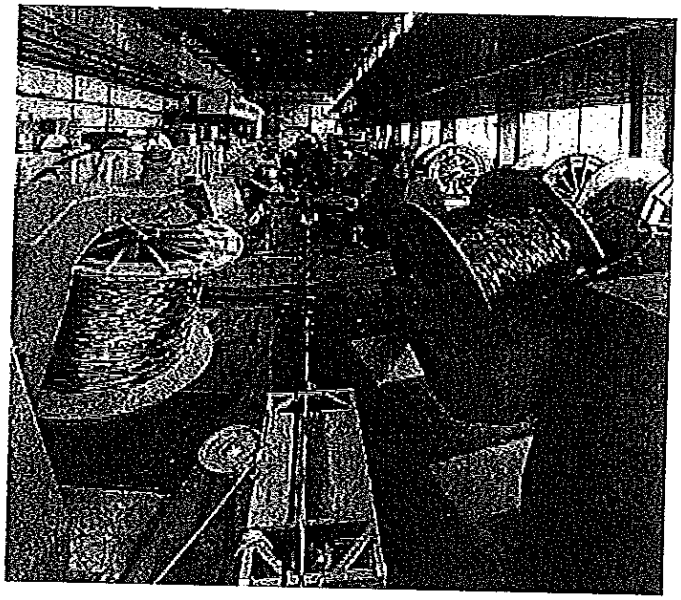
Unlike cables with paper or oil-filled insulation which have reliability issues as well as high maintenance needs, medium and high voltage XLPE power cables provides very long service life and provide continuous electric power to consumer during their service life without any maintenance needs.

Design, modern production technologies and perfect materials with better electric and mechanical properties makes XLPE cables service life longest among other types of cables.

XLPE cables transfer capability is substantially higher than paper or oil-filled insulated cables. According to international standards, XLPE cables are designed for continuous service with conductor temperature of 90°C and it is still active under emergency conditions even at higher temperatures while oil-filled or paper insulated cables can withstand conductor temperature only up to 70°C which significantly decreases their transfer capability.

ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД
000455





XLPE cables are environmentally safe. Absence of liquid inclusions ensures maintaining clean environment, which permits usage at any environmentally demanding projects and service-free maintenance of cable lines.

Due to its single core design, cable laying and installation of accessories, even in the most extreme conditions, are easier. XLPE cables with polyethylene sheath can be laid even temperatures as low as -20°C.

XLPE cable production technology was first introduced in the 1970s. The cross-links are a space lattice constructed using formation of longitudinal and transversal ties between macromolecules of polymer. With its physical and electrical properties, cross-linked polymer suits ideally for insulation of medium, high and extra-high voltage cables.

During production of XLPE cables, as any inclusions to the insulation will reduce life expectancy of the cable, special attention has to be paid regarding the purity and quality of insulation materials. In order to reach the ultimate target of producing reliable cable with a long trouble free operation time, special measures has to be taken by providing high quality raw material from a reliable supplier and treating them in special "clean rooms" in order to avoid contamination of insulating material.

High adhesion between semiconducive screens and insulation is a critical point. Applying insulation and semiconductive screens with triple extrusion technology followed by simultaneous cross linking of all three layers ensures high adhesion.

Based on obvious advantages of enhanced design and modern production technology, XLPE cables proved their universal application in developed countries and cause remarkable, continuous decrease of usage of oil and paper filled insulated cables day by day.

ВЕРНО С ОРИГИНАЛА
КРАСИН, СМОЛЯН, ООД

000456

Estralin HVC – High Voltage cable production pioneer in Russia

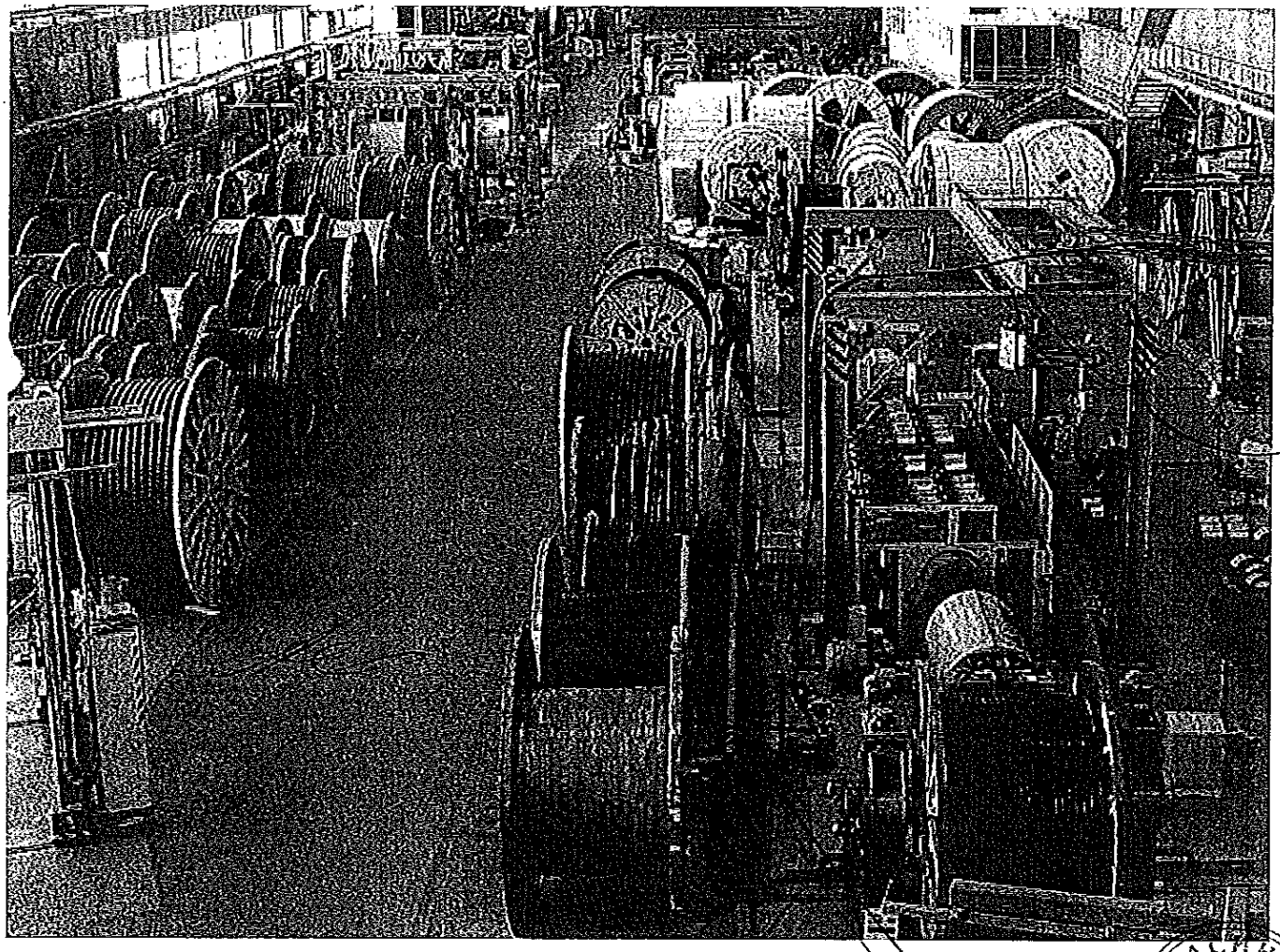
The ultimate target of the «Estralin High Voltage Cables» (Estralin HVC) plant is introduction of innovative technologies in the field of power cable production. Providing high quality production and services, we help our customers to increase their competitiveness as well as reduce the adverse impact upon environment.

Estralin HVC gives utmost importance to Research & Development of new technologies in order to provide high quality, competitive final product. Using best materials from leading global manufacturers for insulation (peroxide-cross-linked polyethylenes, triingostable (TSPE) and copolymer (CCPE) polyethylenes), high skilled personnel are key for us to perfect production which complies International and Russian Standards which put us on par with Western European Manufacturers.

Starting from choosing the right cables and accessories according to project and customer requirements until commissioning of complete cable line, Estralin has continuous control over the project in order to guarantee full satisfaction of final client.

In order to maintain complying to international quality standards, systematic approach has been introduced at the factory. Environmental aspects are very important for Estralin HVC and all necessary measures are being taken accordingly.

Estralin HVC's successes in development, introduction of quality assurance and environmental management systems have been recognized by the largest independent European certification Company, TUV CERT: the Plant was awarded certificates of conformity with regulatory requirements of ISO 9001 : 2008, ISO 14001 : 2004.



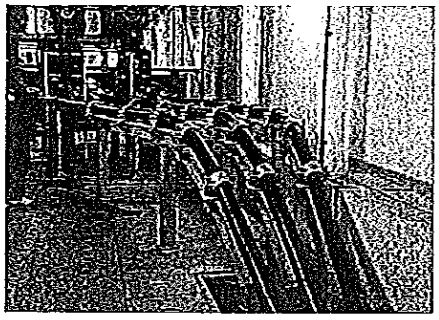
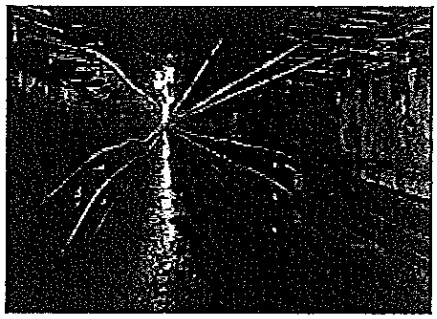
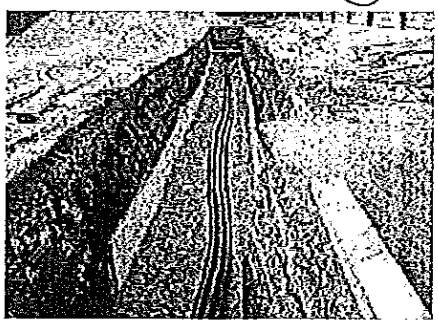
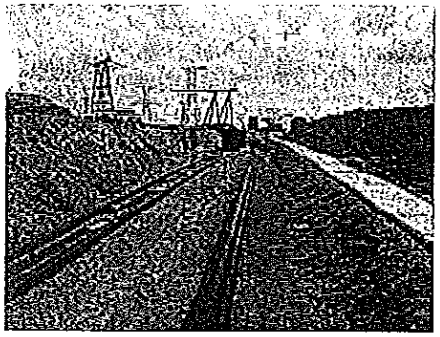
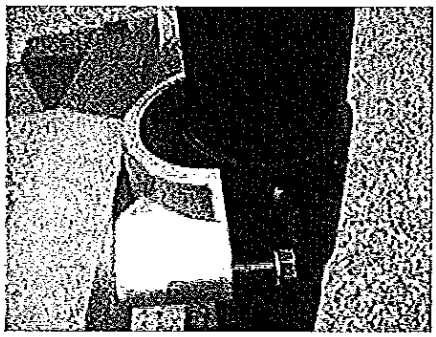
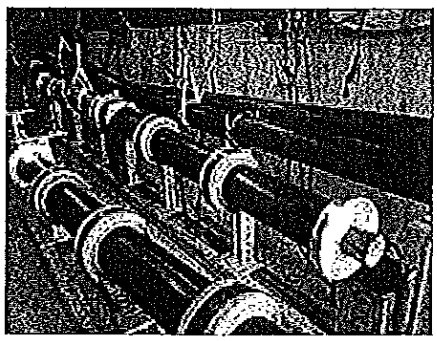
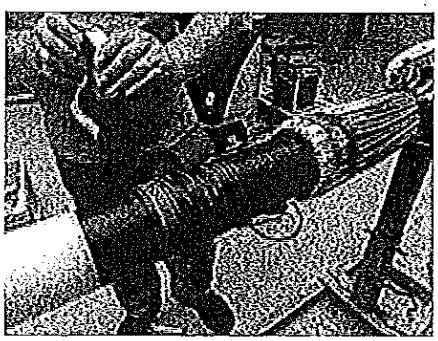
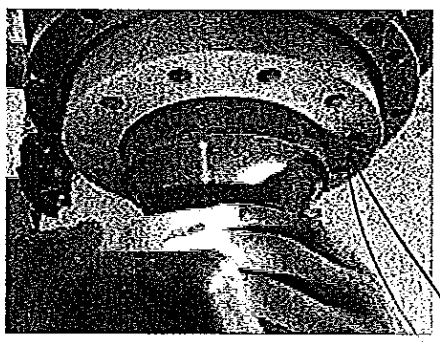
000457

Core production of Estralin HVC is 66-220 kV XLPE cables.

According to their design, all cables technological data and service characteristics comply the international standard requirements:IEC 60840 (66-150 kV cables), and IEC 62067 (220 kV cables), as well as with the GOST R certification, including those with regard to fire safety.

Our company offers:

- medium and high voltage cables
- technical support at all stages of cooperation.


000458

Markings

Conductor material	Without designation	Copper conductor
	A	Aluminum conductor
	RM	Round conductor
	RMS	Segmented conductor
Insulation material	2X	XLPE insulation
Screen	S	Copper wire and copper tape screen
	SA	Aluminium wire and aluminium tape screen
	(F)	Watertight screen from swelling tape which provides longitudinal water sealing
	(FL)	Watertight screen from swelling tape which provides radial water sealing and laminated polymer
Armouring	AWA	Wires armouring from galvanized steel
Sheath	K	Lead sheath
	Y	PVC sheath
	2Y	XLPE sheath
	H	Halogen free flame retardant sheath
	LWL (following screen designation)	Optic fibers in steel tubing inserted into copper

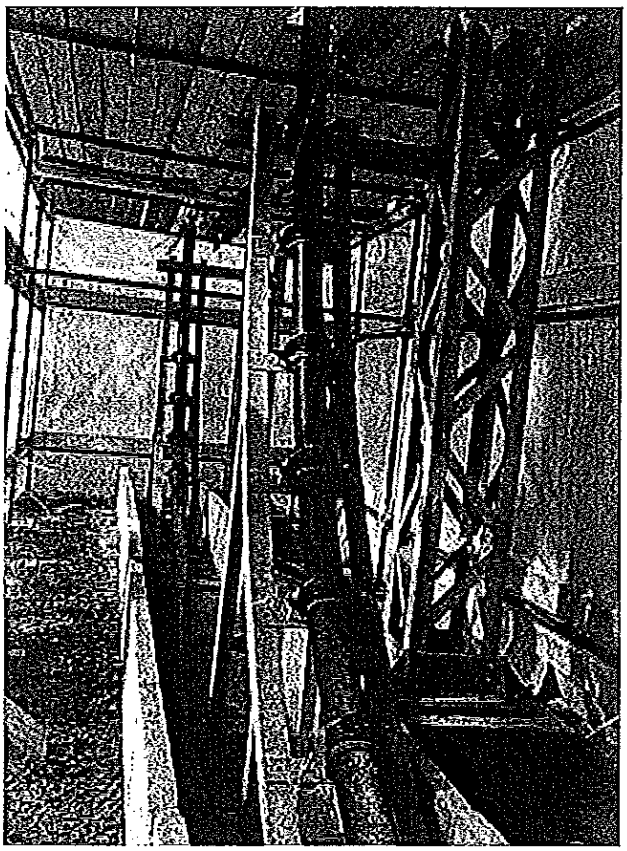
Example[1]:

A2XS(FL)Y-A-LWL 1x1600RMS/185 64/110 kV

- A2X — Aluminum conductor
- S(FL) — XLPE insulation
- Y — Dual water sealed, flame retardant PVC outer sheath of category «A»
- A — Integrated optical fiber
- LWL — Conductor quantity
- 1x1600RMS — Longitudinal segmented conductor
- 185 — Screen cross-section
- 64/110 kV — Nominal voltage

[1] Cable design and markings can be changed when new decisions are implemented.

000459



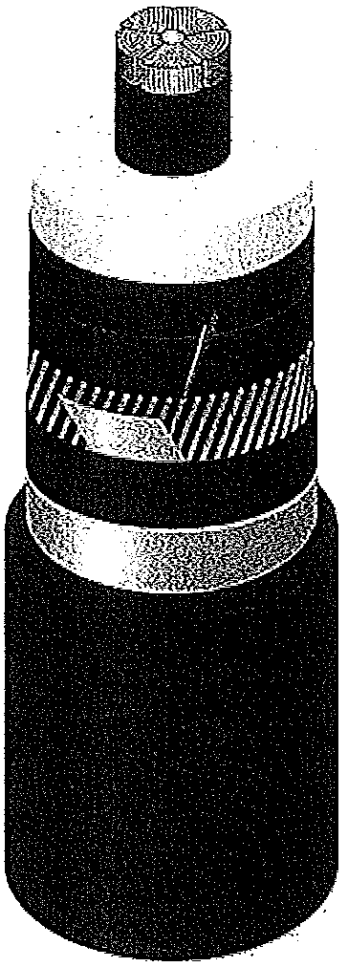
Comparative characteristics	XLPE cable	High pressure oil-filled cable
Continuous permissible temperature, °C	90	85
Permissible heating in emergency, °C	105	90
Ultimate permissible temperature under short-circuit current flow, °C	250	200
Density of 1-sec. short-circuit current, A/mm² — copper conductor — aluminum conductor	 144 93	 101 67
Relative permittivity ε at 20°C	2,5	3,3
Dielectric loss ratio, tg δ at 20°C	0,001	0,004

Main advantages of XLPE cables are the following:

- high cable transmission capacity due to increased conductor permissible temperature;
- high current of thermal resistance during short-circuit that is of a special importance when a cross-section has been chosen on the basis of short-circuit nominal current only;
- low weight, smaller diameter and bending radius, which facilitates laying in both cable structures and underground along complicated routes;
- strong insulation provides enormous advantages at the laying over a sloping, hilly or rough territory, i.e. along the routes with considerable level difference due to absence of mass dulling effect;
- absence of liquids (oils) under pressure, and consequently, no need for costly refilling equipment, that means the considerable saving in operational costs, simplification of installation equipment, reducing time and cost of cable laying, as well as installation;
- the possibility of fast repair in emergency situation;
- absence of leakages and, therefore, no risks of environmental pollution in case of damage.

ВЯРНО С ОРИГИНАЛА
"КРАСИН" СТОЛИЯН ООД
000460

Design



XLPE insulated 66-220 kV cables consist of a round or segment copper or aluminum conductor, semiconductive core layer, XLPE insulation, semiconductive insulation layer, semiconductive tape, copper wire screen and copper tape screen, semiconductive tape, outer XLPE-sheath or PVC-compound.

Extruded screen made of semiconductive material, insulation and semiconductive insulation screen is laid over the conductor. Insulation thickness depends on conductor diameter.

The metal screen consists of copper wires and a copper tape laid above them. The screen cross-section is selected from short-circuit (SC) currents flow condition.

To ensure longitudinal sealing with "F"-index, a layer of waterproofing material should be used. Upon contact with water, the layer swells and makes a lateral barrier, thus preventing spreading of moisture in case of outer sheath failure.

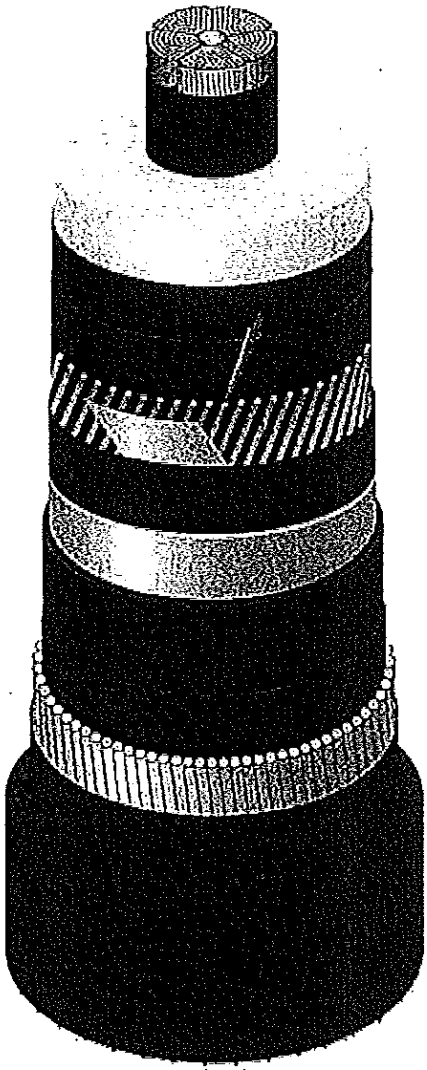
"FL"-index has a sheath made of aluminum polyethylene tape welded together with XLPE- or PVC-sheath. This design allows to have an effective diffusion barrier, which prevents penetration of water vapor, whereas the outer sheath made of black PE serves as the mechanical protection.

Cables with reinforced XLPE-sheath and longitudinal ribs designed for sheath damage control, are used during cable laying.

On the Customer request, a 66-220 kV cable may be manufactured with optical fiber which is used for temperature measurement through the full length of the cable and for signals transmission.

ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД
000461

Design



In addition, to ensure the sealing, lead sheath may be used. When this occurs, the cable will have the "K"-index. The lead sheath do not only ensure the sealing but also can replace, partially or in full, the screen transmitting short-circuit currents.

To ensure the additional mechanical protection the aluminum-alloy wire armor with "AWA"-index can be used.

Cables with reinforced XLPE-sheath and longitudinal ribs designed for sheath damage control, are used during cable laying.

On the Customer request, a 66-220 kV cable may be manufactured with optical fiber which is used for temperature measurement through the full length of the cable and for signals transmission.

ВЕРНО С ОРИГИНАЛА

г. КРАСНИЙ СМОЛЯН ООД

000462

XLPE 66 kV cable specification

Conductor cross-section (S)	mm²	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	11,5	11,0	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	63,6	64,9	66,2	67,8	69,4	72,4	75,6	79,5	83,7	89,3	93,2	96,4	102,4
Weight approx. Al conductor Cu conductor	kg/m	 4,4 5,5	 4,6 6,1	 4,8 6,6	 5,0 7,2	 5,2 7,7	 5,7 8,8	 6,2 10,2	 6,9 11,9	 7,7 14,0	 8,7 16,1	 9,5 18,2	 10,2 20,2	 11,6 24,1
Min. bending radius (15D)	m	0,954	0,974	0,993	1,017	1,041	1,086	1,134	1,193	1,256	1,340	1,398	1,446	1,536
Maximum pulling force Al (30 S) Cu (50 S)	kN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Cu conductor Al conductor	Ω/km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,4627	0,4439	0,4289	0,4209	0,4057	0,39	0,3781	0,363	0,351	0,339	0,334	0,330	0,317
Inductance between conductor and screen	mH/km	0,228	0,206	0,187	0,178	0,170	0,183	0,181	0,132	0,121	0,114	0,106	0,101	0,092
Capacitance (per phase)	uF/km	0,167	0,188	0,210	0,221	0,232	0,252	0,274	0,300	0,328	0,366	0,392	0,413	0,453

ВЕРНО С ОРИГИНАЛА

КРАСНЫЙ СМОЛЯНИН ООО

000463

XLPE 66 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	11,5	11,0	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	67,6	68,9	70,2	71,8	73,4	76,4	80,0	83,9	88,5	94,1	98,2	101,4	107,6
Weight approx. Al conductor Cu conductor	kg/m	 8,6 9,7	 8,9 10,4	 9,2 11,1	 9,5 11,7	 9,9 12,4	 10,6 13,7	 11,9 15,8	 12,9 17,9	 14,6 20,8	 16,1 23,5	 17,5 26,2	 18,5 28,5	 20,9 33,4
Min. bending radius (20D)	m	1,352	1,378	1,404	1,436	1,468	1,528	1,600	1,678	1,770	1,882	1,964	2,028	2,152
Maximum pulling force Al (30 S) Cu (50 S)	kN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Cu conductor Al conductor	Ω/km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,479	0,456	0,436	0,425	0,416	0,400	0,386	0,371	0,358	0,348	0,339	0,332	0,321
Inductance between conductor and screen	mH/km	0,232	0,210	0,191	0,182	0,173	0,160	0,148	0,135	0,124	0,117	0,109	0,104	0,095
Capacitance (per phase)	uF/km	0,167	0,188	0,210	0,221	0,232	0,252	0,274	0,300	0,328	0,366	0,392	0,413	0,453

ЗАВЕРЕНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД
000464

Permissible continuous current-capacity during cable laying for XLPE cables 66 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.1. Continious current-carrying capacity during cable laying in ground

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF=0,8	489	568	642	682	734	834	945	1058	1164	1365	1474	1558	1664
	Cu LF=1,0	438	506	571	605	650	737	832	927	1016	1186	1276	1345	1430
	Al LF=0,8	380	442	500	534	576	659	754	856	959	1093	1187	1268	1395
	Al LF=1,0	340	394	445	474	510	582	664	750	837	950	1028	1095	1199
Continuous current-capacity, A														
	Cu LF=0,8	511	595	674	716	771	880	1001	1128	1251	1337	1423	1496	1620
	Cu LF=1,0	456	528	597	634	682	776	883	990	1095	1168	1242	1303	1408
	Al LF=0,8	397	462	524	560	603	692	793	903	1017	1103	1186	1259	1383
	Al LF=1,0	354	411	464	496	533	610	698	793	891	964	1035	1097	1202

Table 1.2. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF =0,8	460	524	582	613	651	722	794	865	927	1024	1075	1113	1162
	Cu LF =1,0	410	466	516	541	574	634	695	752	803	881	922	952	989
	Al LF =0,8	366	420	470	499	533	599	671	743	813	892	947	991	1058
	Al LF =1,0	327	374	417	442	471	527	588	648	706	770	814	849	902
Continuous current-capacity, A														
	Cu LF =0,8	448	501	547	570	599	649	706	752	791	840	868	891	916
	Cu LF =1,0	396	441	479	499	523	564	612	649	681	721	743	762	781
	Al LF =0,8	365	414	457	481	509	561	614	666	713	758	790	815	853
	Al LF =1,0	324	365	402	423	446	490	534	577	615	652	679	699	729

000465

Permissible continuous current-capacity during cable laying in air for XLPE cables 66 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.3. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	563	661	756	809	876	1009	1156	1312	1464	1741	1901	2027	2200
	Al	438	514	589	633	687	797	922	1061	1205	1391	1528	1646	1840
Continuous current-capacity, A	Cu	626	737	849	909	987	1142	1319	1511	1703	1994	2191	2350	2576
	Al	486	573	659	711	772	898	1043	1208	1382	1580	1742	1883	2120

Table 1.4. Both ends earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	536	620	698	741	795	895	1001	1109	1209	1362	1450	1518	1612
	Al	425	494	560	599	645	737	837	944	1050	1173	1262	1335	1453
Continuous current-capacity, A	Cu	550	625	689	724	765	839	913	984	1049	1132	1182	1220	1276
	Al	448	515	575	611	650	726	805	884	959	1037	1092	1137	1207

ВЕРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

000466

XLPE 110 kV cable specification

Conductor cross-section (S)	mm²	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150	150
Thickness of insulation	mm	16,0	16,0	16,0	16,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	71,7	74,0	76,5	77,9	77,5	80,5	83,7	88,6	92,8	97,8	102,6	104,9	112,9
Weight approx. Al conductor Cu conductor	kg/m	 5,5 6,6	 5,8 7,3	 6,2 8,1	 6,4 8,6	 6,5 8,9	 7,0 10,1	 7,6 11,6	 8,4 13,5	 9,3 15,7	 10,6 18,0	 11,5 20,2	 12,2 22,1	 13,8 26,2
Minimal bending radius (15·D)	m	1,071	1,110	1,148	1,169	1,163	1,208	1,256	1,329	1,392	1,469	1,539	1,574	1,694
Maximum pulling force Al (30·S) Cu (50·S)	kN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Al Cu	Om/ km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/ km	0,494	0,473	0,455	0,444	0,429	0,412	0,397	0,382	0,368	0,356	0,347	0,339	0,328
Inductance between conductors and screen	mH/ km	0,261	0,242	0,225	0,215	0,206	0,185	0,172	0,158	0,145	0,136	0,128	0,122	0,111
Capacitance (per phase)	uF/ km	0,135	0,146	0,157	0,164	0,179	0,194	0,209	0,228	0,248	0,274	0,293	0,308	0,336

000467

XLPE 110 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150	150
Thickness of insulation	mm	16,0	16,0	16,0	16,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0	15,0
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	76,6	78,9	81,2	82,8	82,4	85,4	89,0	92,9	97,5	103,1	107,2	110,4	116,6
Weight approx. Al conductor Cu conductor	kg/m	 10,1 11,2	 10,6 12,1	 11,1 13,0	 11,5 13,7	 11,5 14,0	 12,2 15,3	 13,6 17,5	 14,7 19,7	 16,5 22,7	 18,0 25,5	 19,6 28,3	 20,7 30,6	 23,1 25,6
Minimal bending radius (20·D)	m	1,532	1,578	1,624	1,656	1,648	1,708	1,780	1,858	1,950	2,062	2,144	2,208	2,332
Maximum pulling force Al (30·S) Cu (50·S)	kN	 5,55 9,25	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Al Cu	Om/ km	 0,1640 0,0991	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/ km	0,504	0,483	0,465	0,454	0,439	0,422	0,407	0,391	0,378	0,366	0,356	0,349	0,337
Inductance between conductors and screen	mH/ km	0,265	0,245	0,228	0,218	0,203	0,188	0,175	0,161	0,148	0,139	0,131	0,124	0,114
Capacitance (per phase)	uF/ km	0,135	0,146	0,157	0,164	0,179	0,194	0,209	0,228	0,248	0,274	0,293	0,308	0,336

000468

XLPE 132 kV cable specification

Conductor cross-section (S)	mm²	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	17,5	17,5	16,5	16,0	16,0	16,0	16,0	16,0	16,0	16,0	16,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	79,0	79,3	80,9	80,5	82,5	85,7	89,6	93,8	99,4	103,3	106,5	112,5
Weight approx. Al conductor Cu conductor	kg/m	 6,0 7,5	 6,1 8,0	 6,4 8,6	 6,4 8,9	 6,8 9,9	 7,4 11,4	 8,2 13,2	 9,0 15,3	 10,1 17,6	 10,9 19,6	 11,7 21,7	 13,3 25,7
Min. bending radius (15D)	m	1,185	1,190	1,214	1,208	1,238	1,286	1,344	1,407	1,491	1,550	1,598	1,688
Maximum pulling force Al (30 S) Cu (50 S)	kN	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Cu conductor Al conductor	Ω/km	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,483	0,460	0,449	0,434	0,415	0,400	0,384	0,370	0,359	0,349	0,341	0,330
Inductance between conductor and screen	mH/km	0,255	0,232	0,222	0,207	0,189	0,175	0,161	0,149	0,139	0,131	0,124	0,114
Capacitance (per phase)	uF/km	0,133	0,148	0,154	0,168	0,185	0,199	0,217	0,236	0,261	0,278	0,292	0,319

000469

XLPE 132 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	17,5	17,5	16,5	16,0	16,0	16,0	16,0	16,0	16,0	16,0	16,0
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	83,9	84,2	85,8	85,4	87,4	91,0	94,9	99,5	105,1	109,2	112,4	118,6
Weight approx. Al conductor Cu conductor	kg/m	 11,5 13,0	 11,7 13,5	 12,0 14,2	 12,1 14,5	 12,6 15,7	 14,0 17,9	 15,1 20,1	 16,9 23,2	 18,5 26,0	 20,0 28,8	 21,1 31,1	 23,6 36,1
Min. bending radius (20D)	m	1,678	1,684	1,716	1,708	1,748	1,820	1,898	1,990	2,102	2,184	2,248	2,378
Maximum pulling force Al (30 S) Cu (50 S)	kN	 7,20 12,00	 9,00 15,00	 10,5 17,5	 12,0 20,00	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0
DC resistance Cu conductor Al conductor	Ω/km	 0,1250 0,0754	 0,1000 0,0601	 0,0890 0,0543	 0,0778 0,0470	 0,0605 0,0366	 0,0460 0,0280	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,0090
Inductance between conductors	mH/km	0,495	0,472	0,461	0,446	0,427	0,412	0,396	0,382	0,370	0,360	0,352	0,340
Inductance between conductor and screen	mH/km	0,261	0,238	0,227	0,212	0,194	0,180	0,166	0,153	0,144	0,135	0,129	0,118
Capacitance (per phase)	uF/km	0,133	0,148	0,154	0,168	0,185	0,199	0,217	0,236	0,261	0,278	0,292	0,319

ВЕРНО С ОРИГИНАЛА
"КРАСНИ" смолян ООД
000470

XLPE 150 kV cable specification

Conductor cross-section (S)	mm²	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	18,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	81,3	82,9	82,5	85,5	88,7	92,6	96,8	102,4	106,3	109,5	115,5
Weight approx. Al conductor Cu conductor	kg/m	6,4 8,2	6,6 8,8	6,7 9,2	7,2 10,3	7,8 11,7	8,6 13,5	9,4 15,7	10,5 18,0	11,4 20,1	12,2 22,1	13,7 26,2
Min. bending radius (15D)	m	1,220	1,244	1,238	1,283	1,331	1,389	1,452	1,536	1,595	1,643	1,733
Maximum pulling force Al (30 S) Cu (50 S)	kN	9,00 15,00	10,5 17,5	12,0 20,0	15,0 25,0	18,9 31,5	24,0 40,0	30,0 50,0	36,0 60,0	42,0 70,0	48,0 80,0	60,0 100
DC resistance Al conductor Cu conductor	Ω/km	0,1000 0,0601	0,0890 0,0543	0,0778 0,047	0,0605 0,0366	0,464 0,028	0,0367 0,0221	0,0291 0,0176	0,0247 0,0151	0,0212 0,0129	0,0186 0,0113	0,0149 0,009
Inductance between conductors	mH/km	0,465	0,454	0,439	0,422	0,407	0,391	0,376	0,365	0,354	0,347	0,335
Inductance between conductor and screen	mH/km	0,238	0,228	0,213	0,197	0,184	0,169	0,156	0,146	0,137	0,131	0,120
Capacitance (per phase)	uF/km	0,142	0,149	0,161	0,174	0,187	0,203	0,221	0,243	0,259	0,272	0,297

ВЕРНО С ОРИГИНАЛА

"КРАСНИ" СМОЛЯН ООД

000471

XLPE 150 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	300	350	400	500	630	800	1000	1200	1400	1600	2000
Screen cross-section	mm²	150	150	150	150	150	150	150	150	150	150	150
Insulation thickness	mm	18,5	18,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5
Thickness of lead sheah	mm	2,2	2,2	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	86,2	87,7	87,4	90,4	94,0	97,9	102,5	108,1	112,2	115,4	121,6
Weight approx.	kg/m											
Al conductor		12,0	12,4	12,4	13,2	14,6	15,7	17,6	19,2	20,8	21,9	24,4
Cu conductor		13,9	14,6	14,9	16,3	18,6	20,7	23,8	26,7	29,5	31,8	36,9
Min. bending radius (20D)	m	1,724	1,754	1,748	1,808	1,880	1,958	2,050	2,162	2,244	2,308	2,432
Maximum pulling force	kN											
Al (30 S)		9,00	10,5	12,0	15,0	18,9	24,0	30,0	36,0	42,0	48,0	60,0
Cu (50 S)		15,00	17,5	20,0	25,0	31,5	40,0	50,0	60,0	70,0	80,0	100
DC resistance	Ω/km											
Al conductor		0,1000	0,0890	0,0778	0,0605	0,464	0,0367	0,0291	0,0247	0,0212	0,0186	0,0149
Cu conductor		0,0601	0,0543	0,047	0,0366	0,028	0,0221	0,0176	0,0151	0,0129	0,0113	0,009
Inductance between conductors	mH/km	0,477	0,465	0,450	0,433	0,418	0,402	0,388	0,375	0,365	0,358	0,345
Inductance between conductor and screen	mH/km	0,243	0,233	0,218	0,202	0,188	0,174	0,161	0,151	0,142	0,135	0,124
Capacitance (per phase)	uF/km	0,142	0,149	0,161	0,174	0,187	0,203	0,221	0,243	0,259	0,272	0,297

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

000472

Permissible continuous current-capacity during cable laying for XLPE cables 110-150 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.5. Continious current-carrying capacity during cable laying in ground

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF =0,8	490	569	644	684	736	837	949	1064	1173	1369	1479	1565	1669
	Cu LF =1,0	438	507	572	606	652	739	835	932	1023	1189	1280	1350	1437
	Al LF =0,8	380	442	501	535	577	661	756	859	964	1095	1189	1271	1396
	Al LF =1,0	341	395	445	475	511	584	665	753	841	951	1030	1097	1202
Continuous current-capacity, A														
	Cu LF =0,8	510	592	671	714	769	878	1000	1128	1253	1444	1567	1661	1794
	Cu LF =1,0	456	529	598	634	683	777	883	994	1100	1266	1371	1450	1562
	Al LF =0,8	396	460	522	558	601	690	792	902	1017	1146	1247	1332	1478
	Al LF =1,0	354	411	465	496	534	611	699	794	893	1004	1091	1164	1287

Table 1.6. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A														
	Cu LF =0,8	463	529	589	621	660	732	807	879	944	1038	1091	1130	1181
	Cu LF =1,0	413	470	521	548	581	641	704	763	816	892	933	964	1001
	Al LF =0,8	368	423	474	504	538	605	678	752	824	902	957	1003	1071
	Al LF =1,0	328	376	420	445	475	532	593	655	714	777	822	858	911
Continuous current-capacity, A														
	Cu LF =0,8	451	505	552	576	605	656	706	752	791	840	868	891	916
	Cu LF =1,0	398	445	485	505	529	571	612	649	681	721	743	762	781
	Al LF =0,8	366	415	460	484	513	565	620	672	720	767	800	827	864
	Al LF =1,0	325	368	405	426	450	494	539	583	622	660	687	710	739

000473

Permissible continuous current-capacity during cable laying in air for XLPE cables 110-150 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases–cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.7. Single point earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	563	660	754	806	874	1006	1153	1310	1462	1729	1888	2013	2185
	Al	437	513	587	631	684	794	918	1056	1200	1380	1515	1632	1824
Continuous current-capacity, A	Cu	618	727	833	892	968	1123	1296	1483	1671	1953	2145	2300	2519
	Al	480	565	647	697	756	882	1025	1185	1356	1548	1705	1842	2072

Table 1.8. Both ends earthing currents

Conductor cross-section (S), mm²		185	240	300	350	400	500	630	800	1000	1200	1400	1600	2000
Continuous current-capacity, A	Cu	540	625	706	749	804	905	1015	1125	1229	1383	1474	1543	1639
	Al	426	497	563	603	649	741	843	952	1060	1183	1274	1348	1468
Continuous current-capacity, A	Cu	552	628	696	732	776	852	929	1004	1072	1158	1210	1249	1306
	Al	447	514	576	612	653	731	812	894	972	1053	1110	1157	1229

000474

XLPE 220 kV cable specification

Conductor cross-section (S)	mm²	400	500	630	800	1000	1200	1400	1600	2000	2500
Screen cross-section	mm²	265	265	265	265	265	265	265	265	265	265
Insulation thickness	mm	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	94,3	97,3	100,5	105,4	109,6	114,5	119,3	121,6	127,6	134,5
Weight approx. Al conductor Cu conductor	kg/m	 9,6 12,1	 10,2 13,3	 10,9 14,9	 11,9 17,0	 12,8 19,2	 14,1 21,5	 15,1 23,8	 15,9 25,8	 17,6 30,0	 19,7 35,2
Min. bending radius (20D)	m	1,884	1,946	2,010	2,108	2,192	2,290	2,386	2,432	2,552	2,690
Maximum pulling force Al (30 S) Cu (50 S)	kN	 12,0 20,0	 15,0 25,0	 18,9 31,5	 24,0 40,0	 30,0 50,0	 36,0 60,0	 42,0 70,0	 48,0 80,0	 60,0 100,0	 75,0 125,0
DC resistance Al conductor Cu conductor	Ω/km	 0,0778 0,047	 0,0605 0,0366	 0,464 0,028	 0,0367 0,0221	 0,0291 0,0176	 0,0247 0,0151	 0,0212 0,0129	 0,0186 0,0113	 0,0149 0,009	 0,0119 0,0072
Inductance between conductors	mH/ km	0,468	0,450	0,434	0,416	0,401	0,386	0,375	0,367	0,354	0,341
Inductance between conductor and screen	mH/ km	0,246	0,230	0,214	0,199	0,184	0,171	0,161	0,154	0,142	0,130
Capacitance (per phase)	uF/km	0,138	0,148	0,158	0,171	0,184	0,199	0,211	0,221	0,240	0,261

000475

XLPE 220 kV cable specification with lead sheath

Conductor cross-section (S)	mm²	400	500	630	800	1000	1200	1400	1600	2000	2500
Screen cross-section	mm²	265	265	265	265	265	265	265	265	265	265
Insulation thickness	mm	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0	23,0
Thickness of lead sheah	mm	2,2	2,2	2,4	2,4	2,6	2,6	2,7	2,7	2,8	3,0
Thickness of outer cover	mm	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
Cable diameter (D)	mm	98,4	101,4	105,0	108,9	113,5	119,1	123,2	126,4	132,6	139,9
Weight approx. Al conductor Cu conductor	kg/m	15,7 18,2	16,5 19,6	18,0 22,0	19,2 24,2	21,2 27,5	22,9 30,4	24,6 33,3	25,8 35,7	28,4 40,9	32,1 47,6
Min. bending radius (20D)	m	1,968	2,028	2,100	2,178	2,270	2,382	2,464	2,528	2,652	2,798
Maximum pulling force Al (30 S) Cu (50 S)	kN	12,0 20,0	15,0 25,0	18,9 31,5	24,0 40,0	30,0 50,0	36,0 60,0	42,0 70,0	48,0 80,0	60,0 100,0	75,0 125,0
DC resistance Al conductor Cu conductor	Ω/km	0,0778 0,047	0,0605 0,0366	0,464 0,028	0,0367 0,0221	0,0291 0,0176	0,0247 0,0151	0,0212 0,0129	0,0186 0,0113	0,0149 0,009	0,0119 0,0072
Inductance between conductors	mH/km	0,474	0,456	0,441	0,423	0,408	0,395	0,384	0,376	0,362	0,350
Inductance between conductor and screen	mH/km	0,247	0,230	0,215	0,199	0,185	0,174	0,164	0,156	0,144	0,133
Capacitance (per phase)	uF/km	0,138	0,148	0,158	0,171	0,184	0,199	0,211	0,221	0,240	0,261

ЗАВЕРЕНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

000476

Permissible continuous current-capacity during cable laying for XLPE cables 220 kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in ground;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases --cable diameter;
- cable laying depth – 1,5 m;
- soil maximum temperature +15°C;
- soil thermal resistance– 1,2 K·m/W;
- conductor temperature - +90°C;
- circuits quantity– 1;
- load factor (LF) – 0,1 и 0,8.

Table 1.9. Continious current -carrying capacity during cable laying in ground

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A Cu	LF =0,8	731	832	944	1060	1169	1356	1465	1550	1658	1718
	LF =1,0	645	732	827	924	1015	1172	1261	1330	1415	1457
 Al	LF =0,8	573	657	751	853	958	1084	1177	1258	1384	1488
	LF =1,0	506	577	658	744	832	937	1014	1079	1182	1263
Continuous current-capacity, A Cu	LF =0,8	759	866	986	1112	1235	1421	1542	1638	1764	1837
	LF =1,0	675	768	873	982	1087	1247	1350	1431	1536	1595
 Al	LF =0,8	593	680	780	889	1002	1128	1227	1313	1453	1570
	LF =1,0	528	604	690	784	882	990	1074	1148	1266	1363

Table 1.10. Single point earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A Cu	LF =0,8	647	716	787	855	914	995	1042	1077	1121	1151
	LF =1,0	566	623	681	735	782	846	882	908	940	959
 Al	LF =0,8	530	595	664	735	802	871	922	963	1024	1073
	LF =1,0	464	519	577	634	689	743	783	814	861	897
Continuous current-capacity, A Cu	LF =0,8	615	670	723	772	814	866	896	918	947	967
	LF =1,0	538	583	627	666	700	741	765	782	804	819
 Al	LF =0,8	517	572	629	685	736	785	820	848	889	921
	LF =1,0	454	501	548	594	635	675	703	724	757	782

000477

Permissible continuous current-capacity during cable laying in air for XLPE cables kV

The load-carrying capacity of high-voltage cables can be calculated under the following laying conditions:

- cable laying in the air;
- cable laying in triangle formation;
- cable laying in flat formation, the distance between phases –cable diameter;
- conductor temperature - +90°C;
- ambient temperature - +25°C;
- protection from solar radiation.

Table 1.11. Single point earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A	Cu	863	992	1138	1292	1443	1695	1850	1973	2141	2250
	Al	676	782	904	1039	1181	1352	1483	1596	1782	1944
Continuous current-capacity, A	Cu	942	1087	1253	1433	1613	1883	2066	2214	2423	2565
	Al	736	854	990	1144	1307	1492	1641	1773	1992	2187

Table 1.12. Both ends earthing currents

Conductor cross-section (S), mm²		400	500	630	800	1000	1200	1400	1600	2000	2500
Continuous current-capacity, A	Cu	791	891	997	1104	1203	1343	1428	1493	1581	1646
	Al	640	730	828	933	1037	1151	1236	1307	1418	1513
Continuous current-capacity, A	Cu	798	886	975	1061	1140	1237	1298	1344	1408	1460
	Al	661	746	835	927	1015	1104	1171	1224	1307	1379

ВЕРНО С ОРИГИНАЛА
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Correction factors for XLPE cables 66 – 220 kV

Correction factors for different temperatures												
Temperature °C	- 5	0	5	10	15	20	25	30	35	40	45	50
in the ground	1,13	1,1	1,06	1,03	1,0	0,97	0,93	0,89	0,86	0,82	0,77	0,73
in the air	1,21	1,18	1,14	1,11	1,07	1,04	1,0	0,96	0,92	0,88	0,83	0,78

Correction factors for different thermal resistivities of soil						
Thermal resistivity of soil, K·m/W	0,8	1,0	1,2	1,5	2,0	2,5
Correction factor	1,13	1,05	1,0	0,93	0,85	0,8

Correction factors for different instalation dephts										
Cable laying depth, m	1	1,5	1,8	2,0	2,2	2,5	3,0	4,0	5,0	10,0
Correction factor	1,05	1,0	0,98	0,96	0,95	0,93	0,91	0,88	0,86	0,8

Correction factors of cable laying in pipes			
Laying conditions	Cable laid in pipes partially	Cable laid in separate pipes	Cable laid in one pipe
Correction factor	0,94	0,9	0,9

Correction factors for numbers of cables						
Distance between CL, mm	Number of parallel CL					
	2	3	4	5	6	7
500	0,86	0,76	0,72	0,68	0,65	0,63
700	0,87	0,79	0,75	0,72	0,7	0,68
900	0,89	0,81	0,78	0,75	0,73	0,72
1000	0,9	0,82	0,79	0,76	0,75	0,74
1500	0,92	0,86	0,84	0,82	0,81	0,8
2000	0,94	0,9	0,88	0,87	0,86	0,85
2500	0,95	0,92	0,9	0,89	0,89	0,88
3000	0,96	0,93	0,92	0,91	0,91	0,91
3500	0,97	0,94	0,94	0,93	0,93	0,93
4000	0,97	0,95	0,95	0,94	0,94	0,94
4500	0,98	0,96	0,96	0,95	0,95	0,95
5000	0,98	0,97	0,96	0,96	0,96	0,95
5500	0,98	0,97	0,97	0,96	0,96	0,96
6000	0,98	0,97	0,97	0,96	0,96	0,96

000479
ОРИГИНАЛ
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Example of calculating of current capacity for 66 – 220 kV cables

Cable line 110 kV

- conductor material - copper;
- conductor cross-section - 800 mm^2;
- installation type – in ground;
- type of installation – close trefoil;
- laying depth – 3 m;
- number of circuits - 2;
- distance between parallel circuits -1.5 m;
- cable screens earthing –both ends;
- ambient temperature +30°C;
- load factor-1;
- thermal resistivity of native soil – 2.0 K•m/W.

According to tables, current capacity for standard cable laying conditions (cable with a copper conductor with cross-section 800 mm^2 with both-ends earthing and a load factor 1.0) is 816 A.

Correction factor:

Correction factor for different instalation dephts K1=0,91;
Correction factor for numbers of cables K2= 0,92;
Correction factor for different temperatures K3=0,86;
Correction factor for different thermal resistivities of soil K4=0,85.

Permissible continuous current (ACC) for the above conditions can be calculated by:

Iper.=Ist·K1·K2·K3·K4 =816·0,91·0,92·0,86·0,85≈499 A.*

* The exact value of the permissible continuous current is determined after calculation of IEC 60287 method.

ВЯРНО С ОРИГИНАЛА

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Formulas for auxiliary calculations

1. Dynamic forces in case of short-circuit

$$F = \frac{0.2}{s} \cdot I_{max}^2 \ [N/m]$$

where I_{max} – 2.5·I_{sc} [кА];
I_{sc} – short-circuit current [кА];
s – distance between cable axes [m];
F – maximum force [N/m].

2. Electrical stresses

$$E_{max} = \frac{U_0}{r_1 \cdot \ln(\frac{r_e}{r_i})} \ [kV/mm] \qquad E_{min} = \frac{U_0}{r_e \cdot \ln(\frac{r_e}{r_i})} \ [kV/mm]$$

where: r_e – outer insulation radius [mm];
r_i – inner insulation radius [mm];
U_0 – nominal voltage[kV];
E_{max} – electrical stress at conductor screen [kV/mm];
E_{min} – electrical stress at insulation screen [kV/mm].

3. Dielectric losses

$$W = 2 \cdot \pi \cdot f \cdot U_0^2 \cdot C \cdot tan(\delta) \ [W/km]$$

where: f – frequency [Hz];
U_0 – nominal voltage [kV];
C – capacity [mkF/km];
$tan(\delta)$ – tan of dielectric losses.

4. Induction and inductive resistance

$$L = 2 \cdot \ln(\frac{k \cdot b}{r_0}) \cdot 10^{-1} \ [mGn/kg]$$

where: k=1 trefoil formation, k=1.26 flat formation;
b – distance between axes [mm];
r_0 – average radius of the conductor [mm].

$$X = \frac{2 \cdot \pi \cdot f \cdot L}{1000} \ [Ohm/km]$$

where: f – frequency [Hz];
L – inductance [mGn/km];
X – inductance resistance [Ohm/km].

5. Maximum one-second short-circuit current

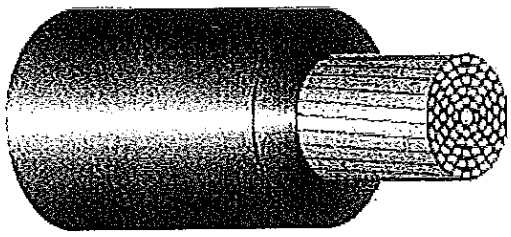
$$I_s = \frac{I_{sc}}{\sqrt{t_{sc}}} \ [кА]$$

where: I_s – maximum one-second SC current [кА];
I_{sc} – short-circuit current [кА];
t_{sc} – duration of the short-circuit current [s].

000481 ОРИГИНАЛ

Earthing/cross-bonding cable

Earthing/cross-bonding cables are designed for transposition and screen earthing of XLPE cables. They can also be used as an additional earthing cable which is used as the connecting earthing points of cable screens when the cable line is earthed single-sided. The additional earthing cable can be used when it comes to single-sided erthing to keep down induced voltage occur in short-circuit fault.



Technical specification of earthing/cross-bonding cable

Conductor cross-section (S)	mm²	240	400
Cable sheath thickness	mm	3,5	3,5
Cable diameter (D)	mm	25,1	30,6
Weight	kg/km	2414	3911
Min banding radius(10·D)	m	0,251	0,306
Conductor resistance against DC, at 20 °C, Cu	Om/km	0,754	0,0470

Permissible short-circuit currents for earthing/cross-bonding cables

Conductor heating temperature:

-before short-circuit 40°C
-after short-circuit 80°C

Permissible one-second SC current		
Cable cross-section, mm²	240	400
Short circuit current, кА	35,3	58,7

ВЯРНО С ОРИГИНАЛА

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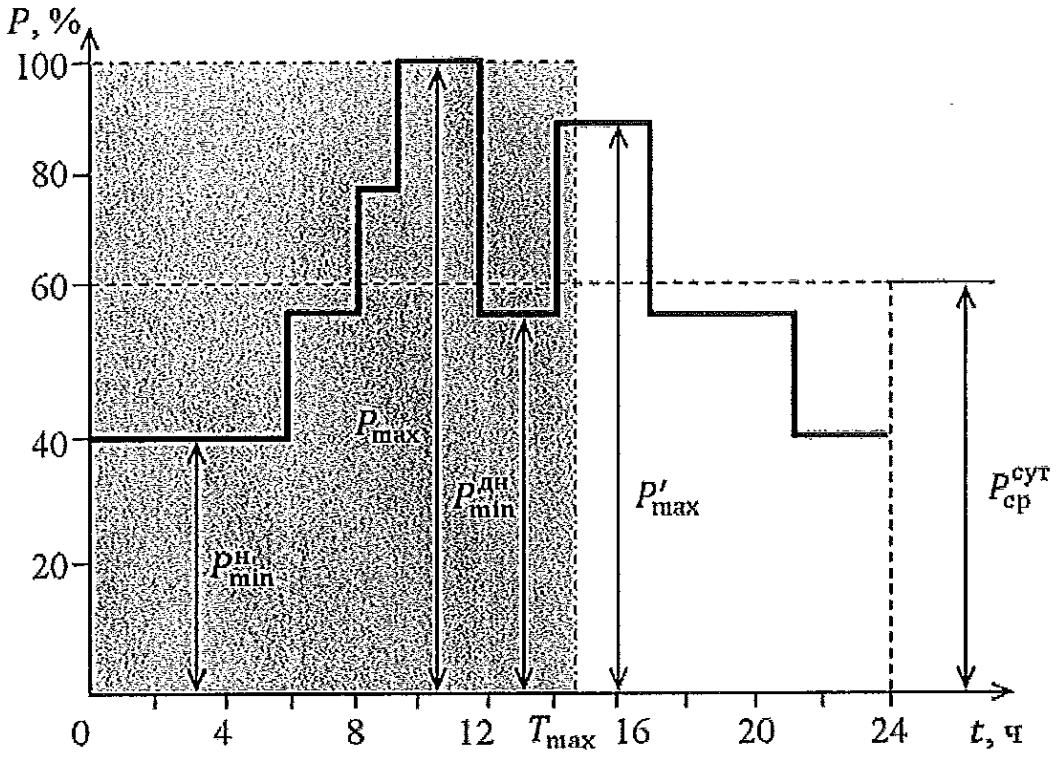
Load factor

Load factor % - average energy load to the maximum peak load during a period. Most clearly, the load factor can be determined from the schedule of CL load.

Example of the CL load schedule



From the CL load schedule you can see that the load factor is equal to 0.6. The exact value of the load factor may be determined in the Regional Dispatching Office of the power system. The load factor can be calculated from the daily load schedule :

$$K_н = \frac{\sum_{i=1}^{n}(P_i \cdot t_i)}{24}$$

where: t_i – the period of i-time duration

P_i (%) – the ratio of power in the i-th time interval to the maximum power.

ОРИГИНАЛ
000483

Short-circuit currents

Short-circuit current for all types of cables is calculated on the basis of the following conditions:

conductor temperature:

-before short-circuit 90°C
-after short-circuit 250°C

copper and alloy screen temperature:

-before short-circuit 70°C
-after short-circuit 350°C

Lead sheath temperature:

--before short-circuit 70°C
--after short-circuit 180°C

XLPE cable can be overloaded with temperatures up to 105°C. Emergency overloads do not considerably affect cable service life. The total duration of the overload mode should be no more than 100 hours per year and not more than 1000 hours for the service life. One-second long permissible short-circuit currents along the conductor and through the screen should not exceed the figures presented in the Tables.

Permissible one-cecond short-circuit current in the conductor												
Conductor cross-section, mm²	185	240	300	350	400	500	630	800	1000	1200	1600	2000
Cu conductor	26,5	34,3	42,9	50,1	57,2	71,5	90,1	114,4	14	172,8	230	288
Al conductor	17,5	22,7	28,2	33,1	37,6	47	59,2	75,2	93,1	114,3	152	190

Permissible one-cecond short-circuit current in the screen														
Copper screen cross-section, mm²	35	50	70	95	120	150	185	210	240	265	280	290	300	310
Lead sheath cross-section, mm²	249	383	551	769	968	1199	1493	1732	1963	2197	2288	2385	2458	2562
Short-circuit current, кА	6,8	9,8	13,6	17,7	22,9	28,2	34,7	40,0	45,2	50,4	52,4	54,7	56,3	58,6

Permissible one-cecond short-circuit current in the screen														
Alloy screen cross-section, mm²	35	50	70	95	120	150	185	210	240	265	280	290	300	310
Short-circuit current, кА	4,4	6,4	9,2	12,2	15,6	19,0	23,4	26,9	30,4	34,0	35,02	36,8	37,8	39,4

In the case of short-circuit, apart from the heating, the dynamic forces between cable phases have to be taken into consideration; their values can be significant. These values are important for cable clamps.

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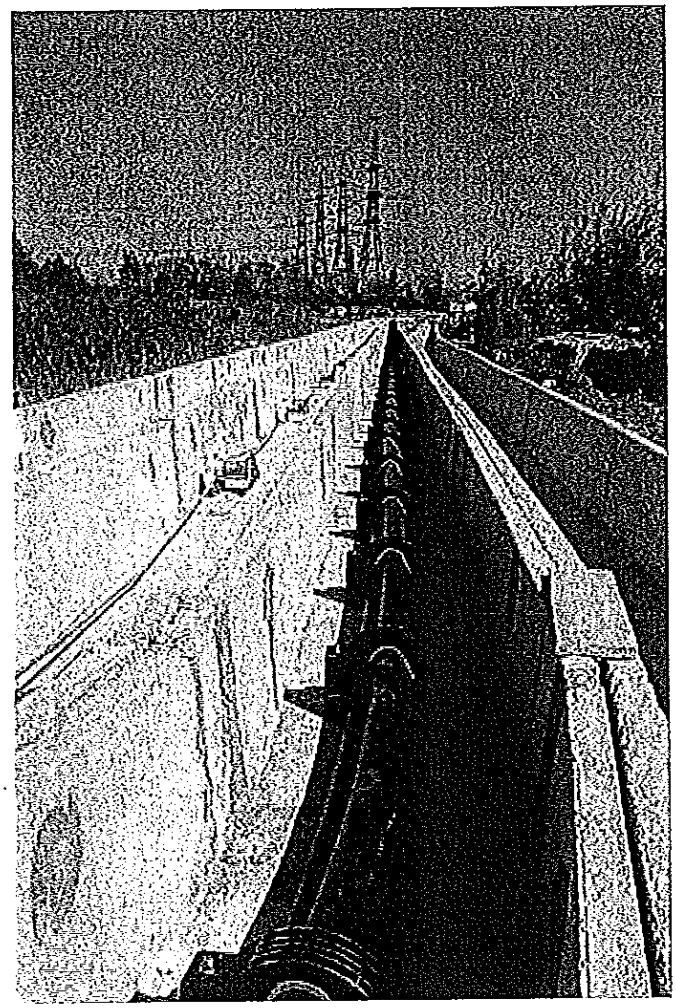
Cable laying conditions and testing after high voltage cable laying



During XLPE 66-220 kV cable laying the bending radius should be not less than 20xD, where D — outside cable diameter. When cables accessories installation is carried out with the use of a special template the preheating, minimal bending radius should be at least 15xD.

During cable laying use a cable sleeve or pulling eye, pulling force should not exceed the following figures:

F=Sx50 N/ mm^2 — for copper conductor,
F=Sx30 N/ mm^2 — for aluminum conductor

where S — conductor area of the cross-section, mm^2.

Ambient temperature during cable laying should not be lower than -5°C. If cable is preheated the cable laying can be carried out at the following temperatures:

-15°C – for cables with PVC-plasticate sheath;
-20°C – for cables with polyethylene sheath.

After cable line installation and commissioning, each phase of the cable and its accessories should be tested by increased AC voltage of 128 kV during one hour with frequency of 20 to 300 Hz. As agreed between manufacturing company and customer, it is permitted to conduct testing by nominal working AC voltage of 64 kV during 24 hours without load, instead of the test by increased AC voltage. The test by increased DC is feasible, but not recommended, and only as agreed between manufacturing company and customer.

Cable sheath has to be tested by DC of 10 kV, applied between a metallic screen and earthing for one minute.

During cable laying of Estralin HVC production the requirements of «Maintenance of XLPE cable laying 110-500 kV, №TD-16-01P» should be met.

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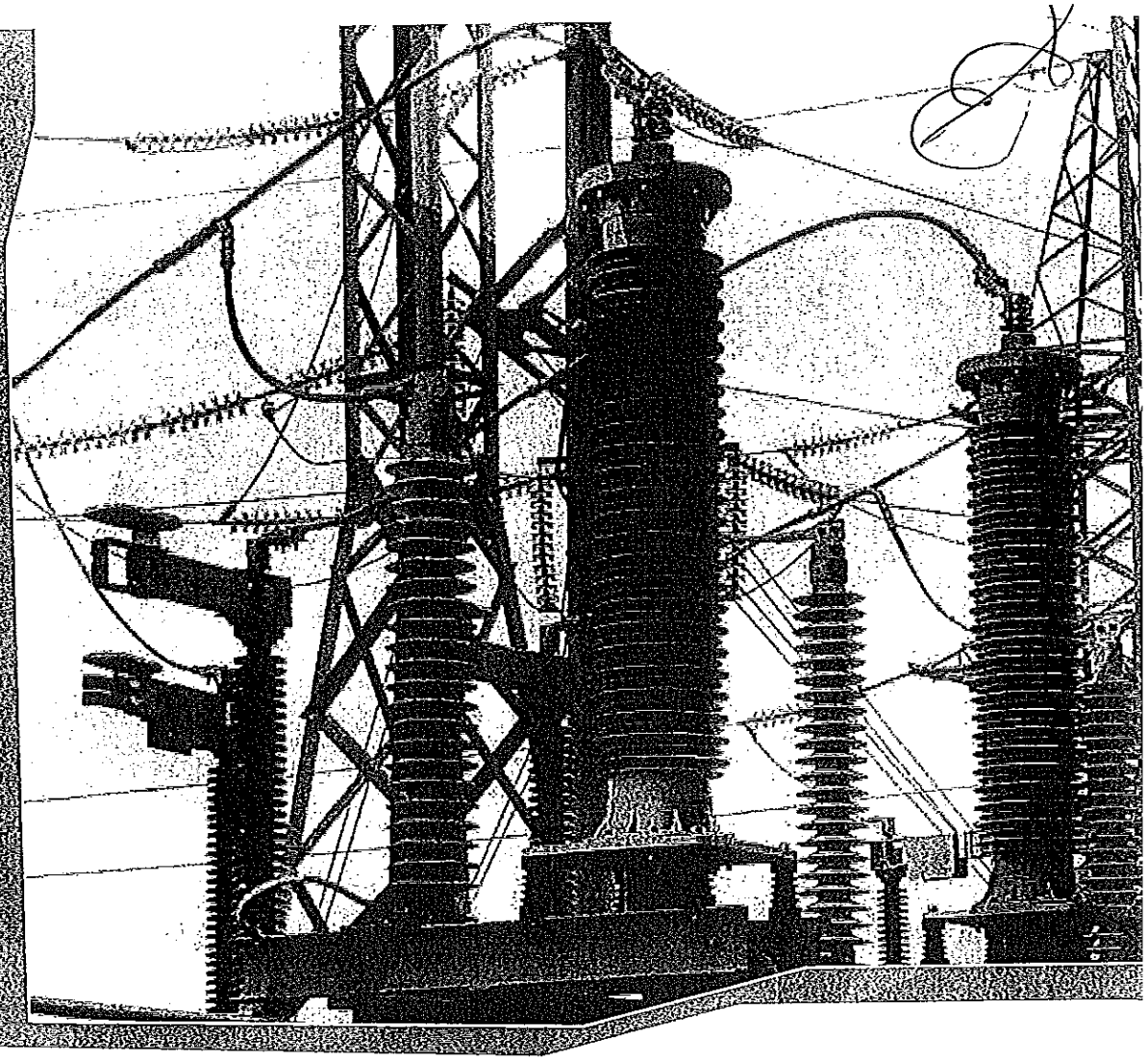

CABLE ACCESSORIES

110-220 kV

www.arkasil.com

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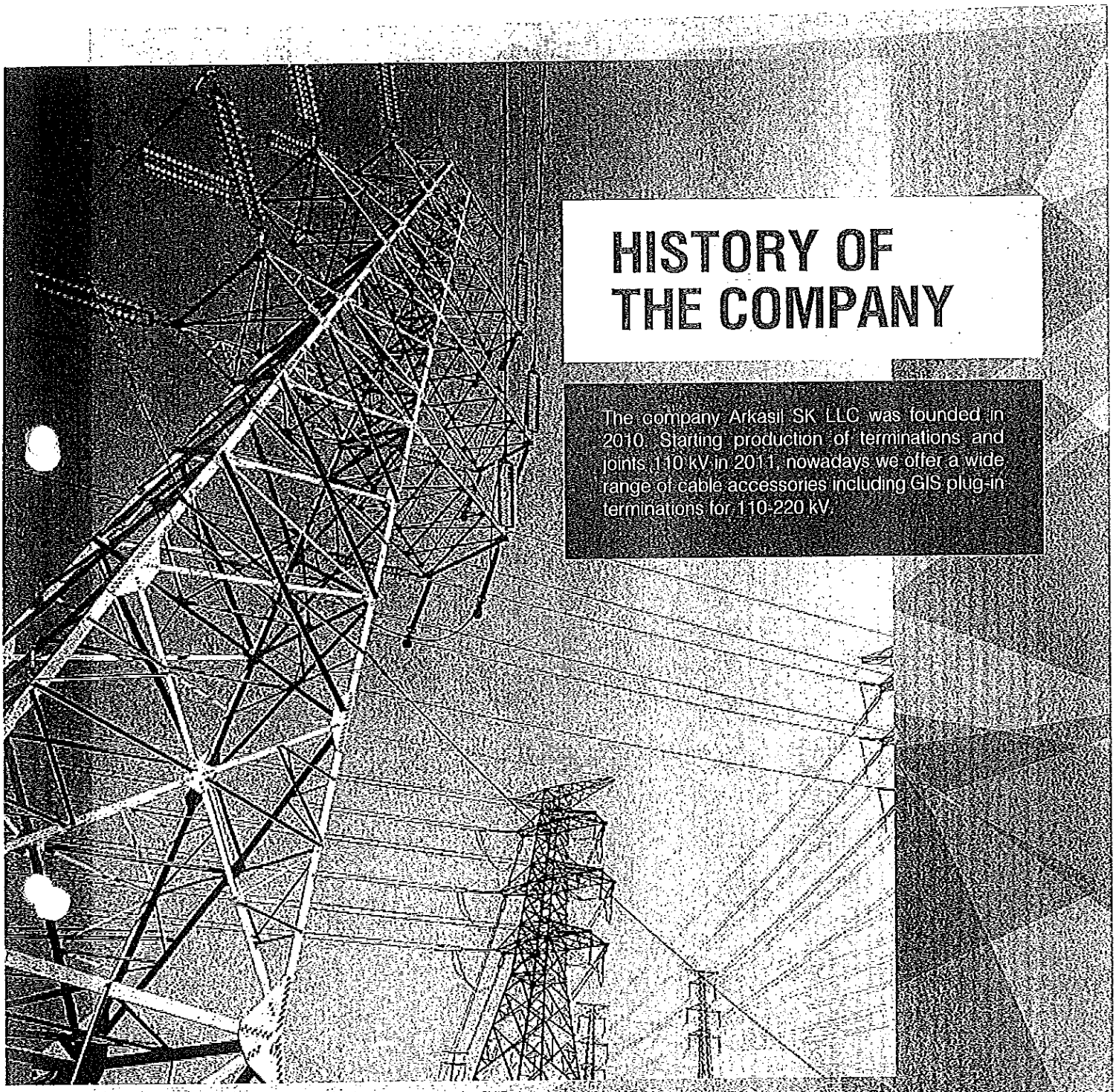

HISTORY OF THE COMPANY

The company Arkasil SK LLC was founded in 2010. Starting production of terminations and joints 110 kV in 2011, nowadays we offer a wide range of cable accessories including GIS plug-in terminations for 110-220 kV.

MAIN INFORMATION

Arkasil is the first and the only Russian company offering owned-produced accessories for 110-220 kV XLPE cables. Applicable innovation design methods and more than 10-years experience of our employees in delivery, mounting and tests of HV and EHV cables and cable accessories make Arkasil the leader in the domestic market. Dynamic development of the company, optimization of technological processes and flexible pricing policy allow us to set ambitious objectives and be a serious competitor to international producers of cable accessories world-wide.

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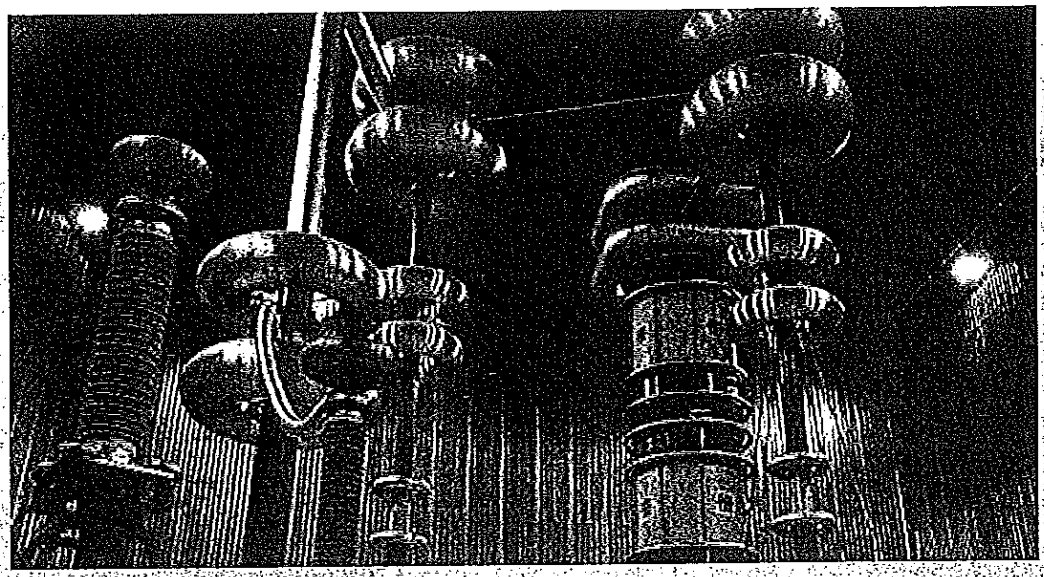
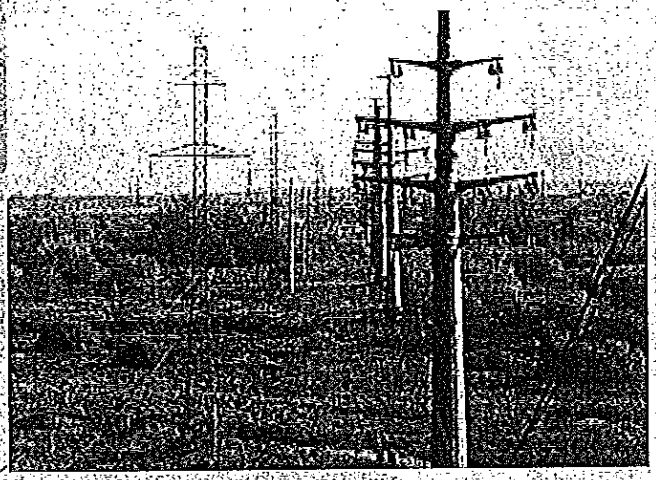
Arkasil



Aspiring to leading positions on the market of the cable accessories producers, our company pays much attention to development of new products. As a result of innovation Arkasil has launched different types of accessories for different voltage classes within 5 years.The company continuously carries out different tests of new products for approval of engineering decisions, quality of materials and production processes.

Manufacturing of high-quality products that meet modern standards, satisfying customer needs is our priority. That's why we co-operate only with the leading international and domestic producers of isolation materials and components. Quality management system is developed and implemented in the company in accordance with ISO 9001 requirements. Continuous control of material quality, production processes and complete production control during routine tests ensure our customers the compliance of the output products with the stated specification and requirements of international and local standards.



The key factor of company innovative development is the involvement of all employees. The implemented system of continuous improvements ensures the increase of the quality of output products and optimization of production processes.

Due to individual approach to the assigned tasks, flexibility in communication with the customers, strict fulfillment of contractual obligations managed to take an essential part of the Russian market. On customers' demands Arkasil develops and implements individual solution for construction of cable lines. Own design department enables us to implement the most sophisticated projects in the shortest possible time taking into account their unique features.

Together with assurance of our products quality we pay much attention to environment and energy efficiency issues. Environment management system is implemented and applied at the company in accordance with ISO 14001:2004.

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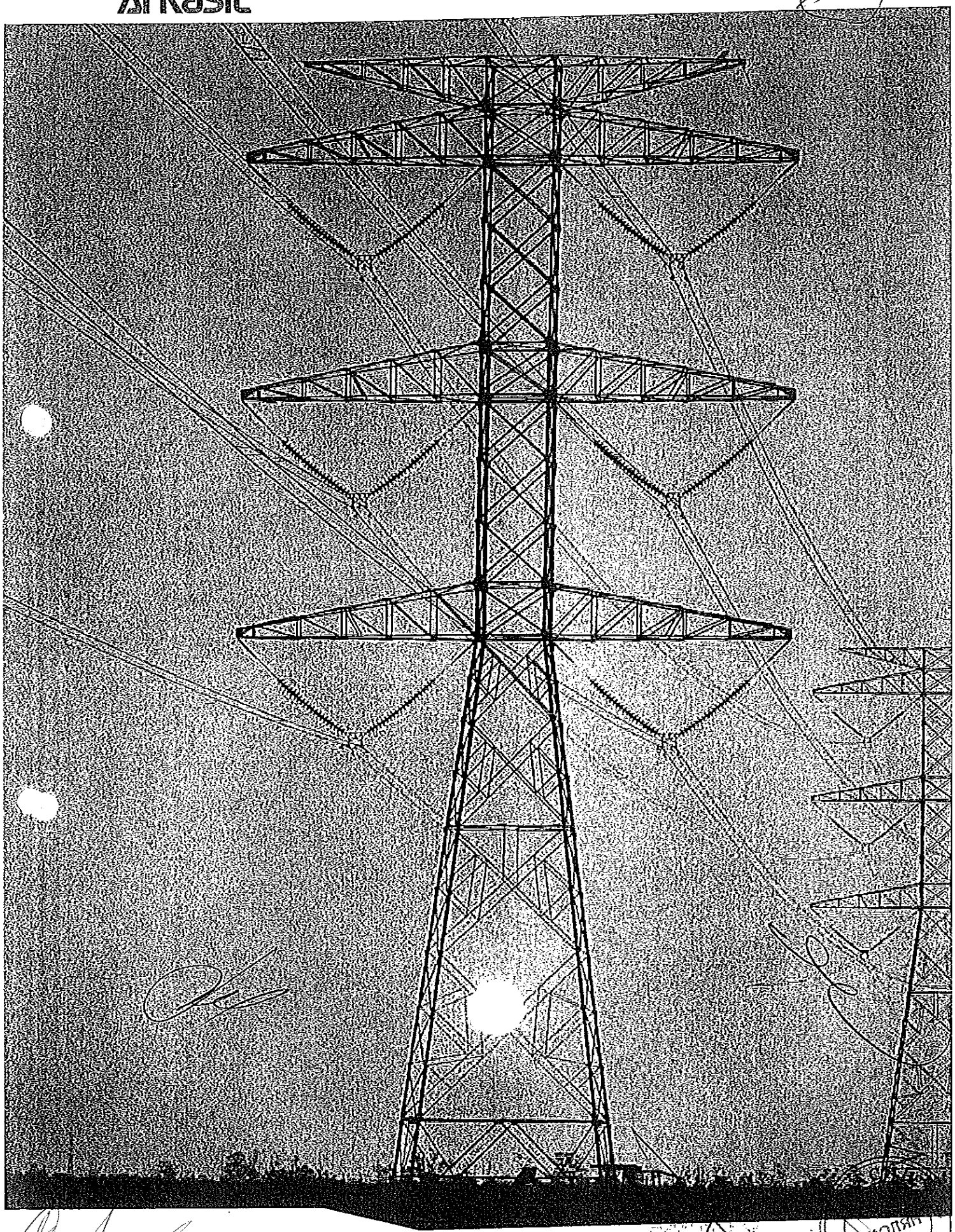

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Terminations MKB 126, MKB 145, MKB 170, MKB 252

Arkasil terminations 110-220 kV with composite type insulator are used for cable lines connection with power-supply systems. Terminations are used for outdoor and indoor installation for XLPE cables 64/110, 76/132, 150/170 kV,127/220 kV (conductor cross-section 185-2500 mm²).Terminations could be produced for XLPE cable with optical fibers (OF) screen which are used for temperature monitoring.

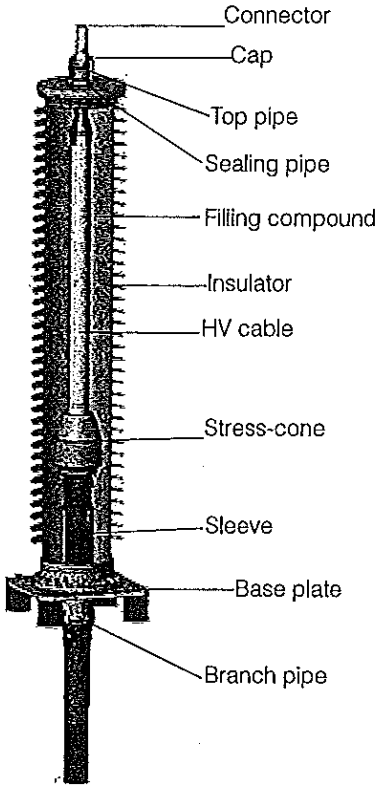
Main parts

Insulator:

- composite type porcelain insulator with glass fiber, reinforced epoxy resin tube and silicone rubber, the color of sheds - light gray;
- top and bottom flanges glued and sealed to the composite insulator.

Cable end:

- pre-molded and factory-tested silicone stress cone;
- cable end;
- base plate;
- branch pipe with flange;
- support insulators;
- seals and fixing materials;
- unpressurised synthetic oil as an insulating compound;
- optical fiber.



ВЫПИСКА
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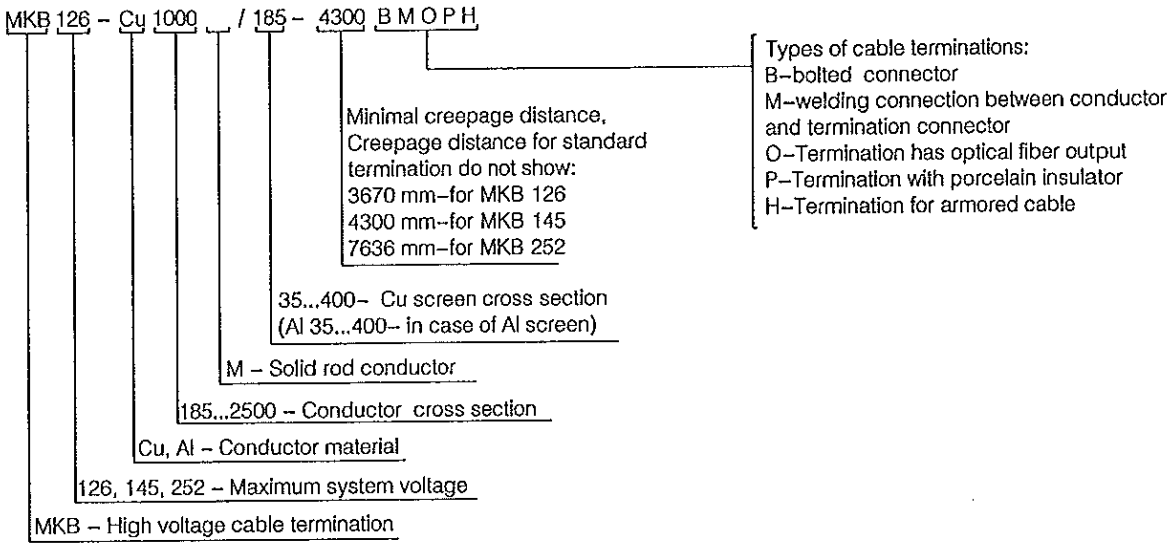
ООО

Labeling of high-voltage cable termination



Area of application

Type		МКВ 126	МКВ 145	МКВ 170	МКВ 252
Phase voltage	kV	64	76	87	127
Line voltage	kV	110	132	150	220
Maximum system voltage	kV	126	145	170	252
Cable conductor cross-section range	mm²	185 ÷ 2000	185÷ 2000	185÷ 2000	400÷2500
Maximum cable sheath diameter	mm	115	115	115	126
Maximum cable insulation diameter	mm	91	91	95	108

Installation options	МКВ 126	МКВ 145	МКВ 170	МКВ 252
On support	+	+	+	+
On high-voltage power transmission line	+	+	+	+
High voltage	+	+	+	+

Installation can be simplified by assembling the termination horizontally on the ground before lifting it into place.

000494
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ОРИГИНАЛА
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Technical data

Electrical parameters	MKB 126	MKB 145	MKB 170	MKB 252
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Partial discharges	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV	<5 pC at 190 kV
Impulse voltage (10+/10- impulses)	550 kV	650 kV	750 kV	1050 kV

Climatic characteristics	MKB 126	MKB 145	MKB 170	MKB 252
Environmental condition class	U1,2	U1,2	U1,2	U1,2

Nominal operating current
Limited by cable specification

Stress cone routine tests	MKB 126	MKB 145	MKB 170	MKB 252
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Partial discharges	<5pC at 96 kV	<5pC at 114 kV	<5 pC at 131 kV	<5pC at 190 kV

Technical parametrs		MKB 126				MKB 145			MKB 170		MKB 252			
Hollow insulator type		composit		porcelain		composit		porc.	comp.	porc.	composit		porcelain	
Termination length (L)	mm	1300	1443	1622	1622	1443	1588	1622	1923	2500	2500	2624	2500	2500
Creepage distance length	mm	3670	4300	3200	4600	4300	4820	4600	6050	7820	7636	8058	7812	10000
Pollution level in accordance with IEC 60137		III	IV	III	IV	III	IV	IV	IV	IV	III	IV	III	IV
Volume of compound	l	28	32	39	39	32	38	39	42	170	200	215	170	170
Weight	kg	104	108	332	362	108	113	362	153	690	400	430	690	770
Maximum allowed force on top connector	kN	3,5	3,15	2,8	2,8	3,15	2,86	2,8	2200	5000	5	4,76	5	5

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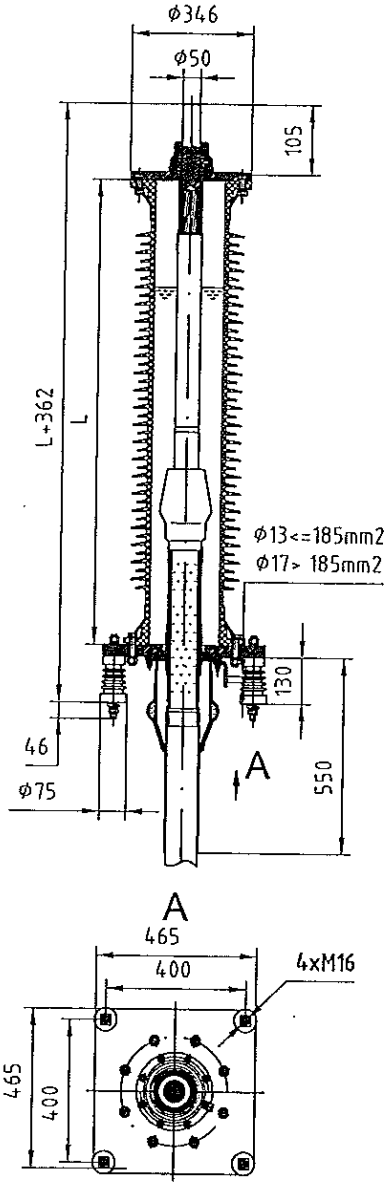
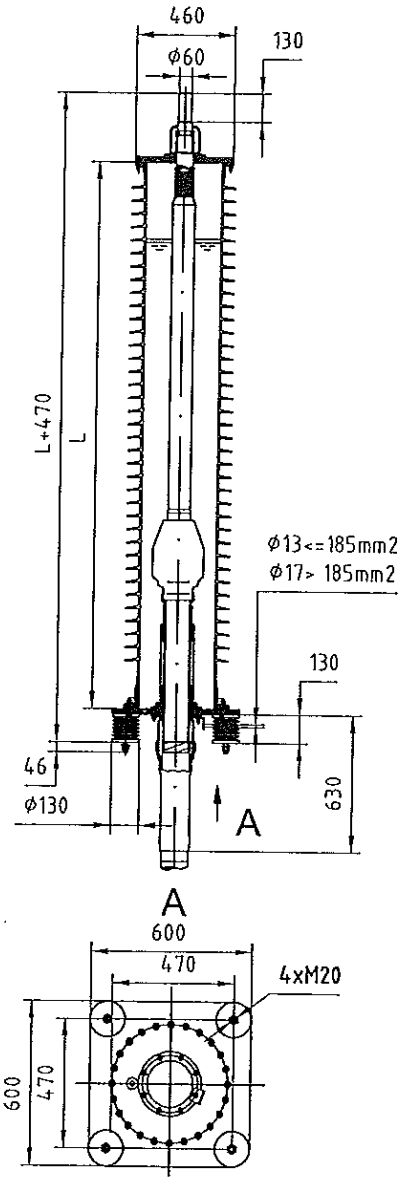
ВЕРНО С ОРИГИНАЛА

MKB 126 / 145 / 170



MKB 252



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ВЗРЕЗ С ОРИГИНАЛА
"КАСИН" СМОЛЯН ООД

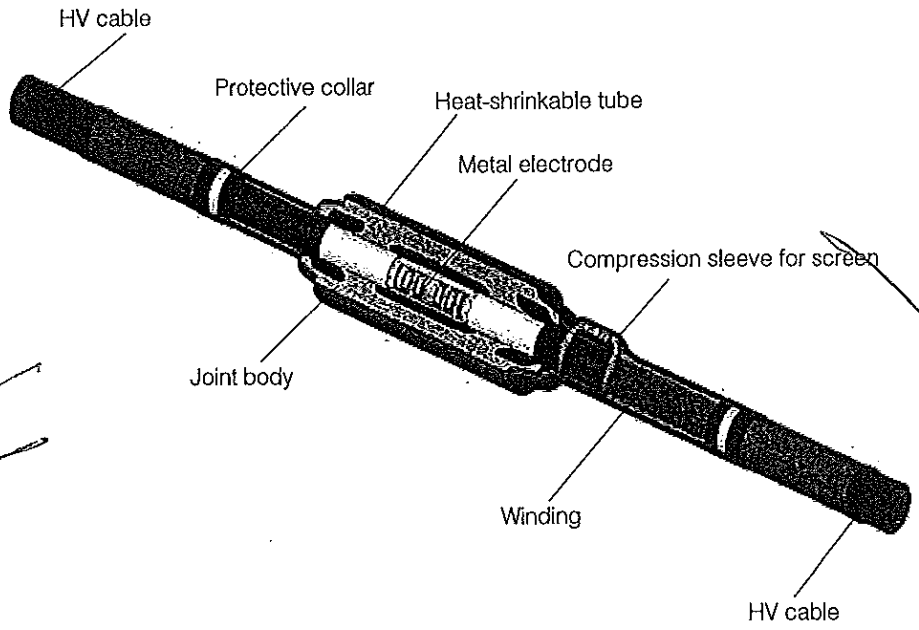
Straight joints MCB 126, MCB 145, MCB 170, MCB 252

Arkasil straight joints 110-220 kV are prefabricated silicone joint, designed to connect high-voltage cables 110/132/150/220 kV with XLPE insulation (conductor cross-section 185-2500 mm²) with direct connection wire screens. Factory produced and tested silicone joint-body is the main element of joint. Joint body is made of high quality silicone rubber (LSR) and contains conductive deflectors and middle electrode for electrical stress control. Straight joints could be produced for a different connection schemes of cable screens and with different outer covering.

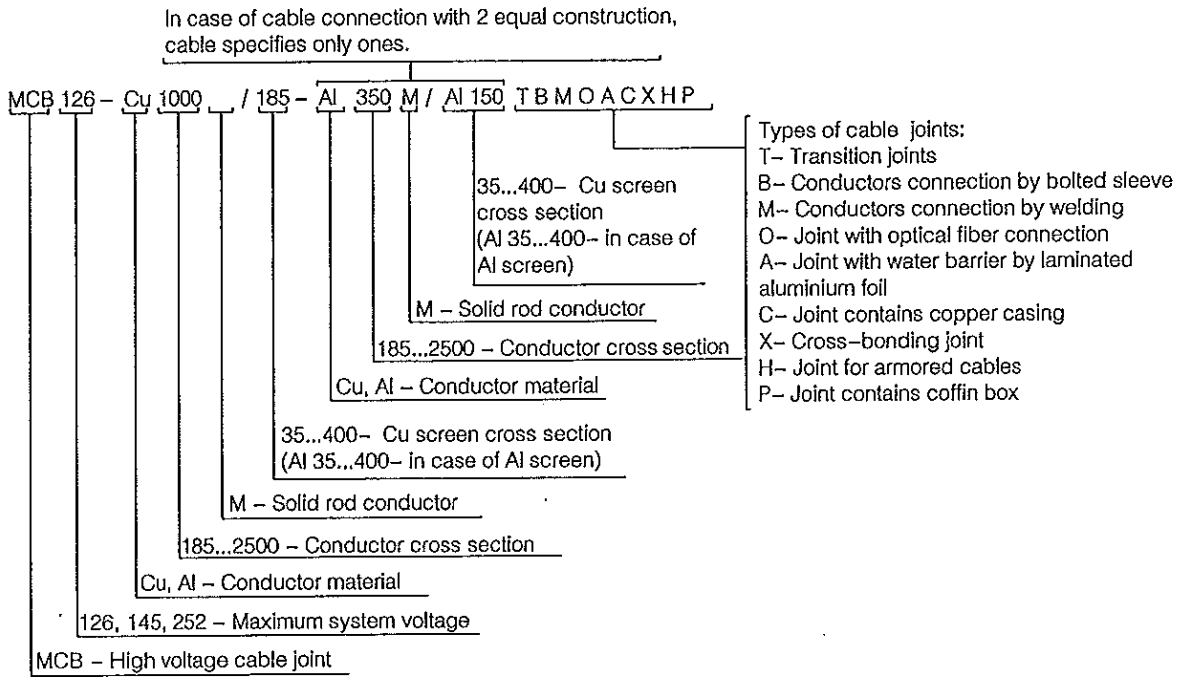
Main parts

- copper or components wire connector (screw connector or compression sleeve);
- pre-molded silicone insulator - joint body (with premolded field smoothing elements);
- sealing materials;
- tapes (semiconductive, conductive etc.);
- heat-shrinkable protective tubes and collars;
- coffin box;
- copper casing;
- filled coffin box or copper casing.

MCB 126 / 145 /170 /252



Labeling of high-voltage cable joint



Area of application

Type		MCB 126	MCB 145	MCB 170	MCB 252
Phase voltage	kV	64	76	87	127
Line voltage	kV	110	132	150	220
Maximum system voltage	kV	126	145	170	252
Cable conductor cross-section range	mm²	185 ÷ 2000	185 ÷ 2000	185 ÷ 2000	400 ÷ 2500
Maximum cable sheath diameter	mm	115	115	126	126
Maximum cable insulation diameter	mm	91	91	108	108
Rated minimal insulation thickness	mm	10,5	14	14	20

Installation options	MCB 126	MCB 145	MCB 170	MCB 252
On support	+	+	+	+
On high-voltage power transmission line	+	+	+	+
High voltage	+	+	+	+

000498
ОРИГИНАЛ
"ХРАСИН" СМОЛЯН ООД

Technical data

Electrical parameters	MCB 126	MCB 145	MCB 170	MCB 252
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Partial discharges	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV	<5 pC at 190 kV
Impulse voltage (10+/10- impulses)	550 kV	650 kV	750 kV	1050 kV

Current load rating	MCB 126	MCB 145	MCB 170	MCB 252
Rated operational current	limited by cable specification	limited by cable specification	limited by cable specification	limited by cable specification
Short circuit current	limited by cable specification	limited by cable specification	limited by cable specification	limited by cable specification

Stress cone routine tests	MCB 126	MCB 145	MCB 170	MCB 252
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Partial discharges	<5pC at 96 kV	<5pC at 114 kV	<5 pC at 131 kV	<5pC at 190 kV

Climatic characteristics	MCB 126	MCB 145	MCB 170	MCB 252
Temperature	U1,2	U1,2	U1,2	U1,2

000499
ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

Cable sheath test voltage	MCB 126	MCB 145	MCB 170	MCB 252
AC voltage	10 kV within 1 min	10 kV within 1 min	10 kV within 1 min	10 kV within 1 min
DC voltage	20 kV within 1 min	20 kV within 1 min	20 kV within 1 min	20 kV within 1 min

Test voltages of the cross-bonding joints	MCB 126 X	MCB 145 X	MCB 170 X	MCB 252 X
Impulse voltage (10+/10- impulses)	37,5 kV	37,5 kV	47,5 kV	47,5 kV
DC voltage	25 kV within 1 min	25 kV within 1 min	25 kV within 1 min	25 kV within 1 min

Test voltages between transposition wires	MCB 126 X	MCB 145 X	MCB 170 X	MCB 252 X
DC voltage	25 kV within 1 min	25 kV within 1 min	25 kV within 1 min	25 kV within 1 min
Impulse voltage (10+/10- impulses)	75 kV	75 kV	95 kV	95 kV

Mechanical characteristics	MCB 126 MCB 126 X	MCB 145 MCB 145X	MCB 170 MCB 170 X	MCB 252 MCB 252 X
Approximate weight, kg	35	35	80	80

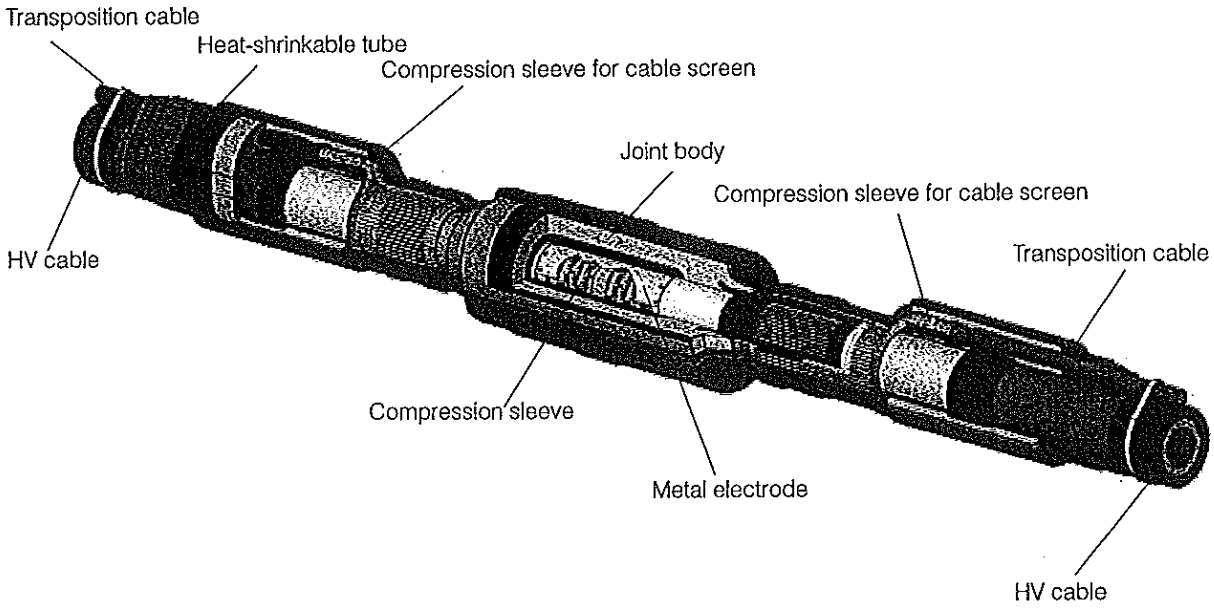
000500

ВЕРНО
ОРИГИНАЛА

"КРАСИН" СМОЛЕНСК ООО

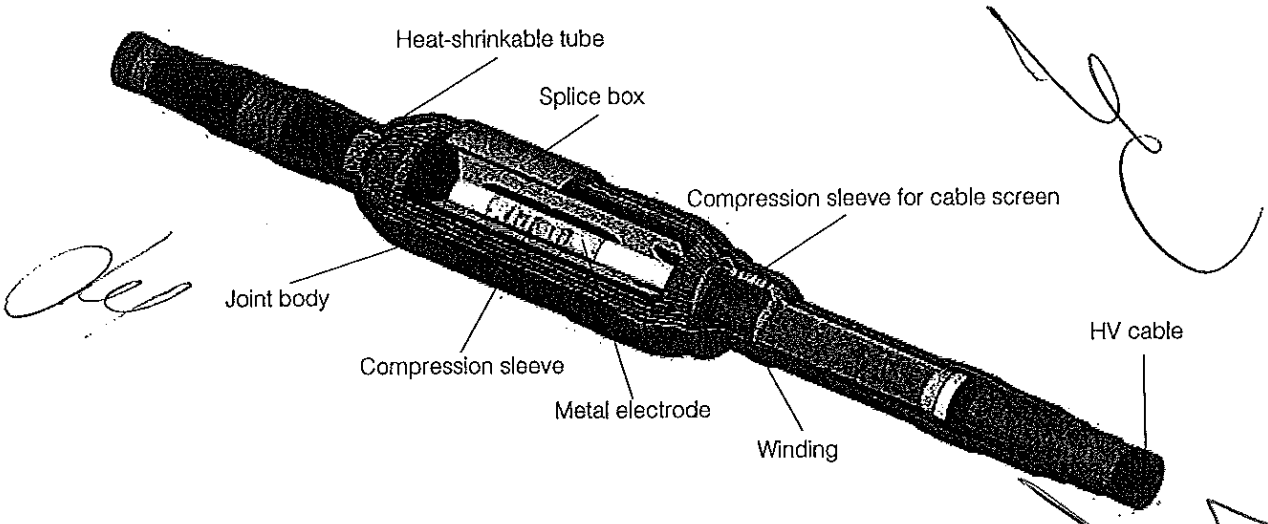
Cross-bonding joints MCB 126 X / 145 X / 170 X / 252 X

Arkasil cross-bonding joints 110-220 kV are a prefabricated silicone joint, designed to connect high-voltage cables 110/132/150/220 kV with XLPE insulation (conductor cross-section 185-2500 mm²) with integrated screen interruption. Joint body has the dielectric gap. Cable screen interruption is organized by 2 single-wire bonding cables.



Joints with splice-box for optical fiber connection MCB 126 O / 145 O / 170 O / 252 O

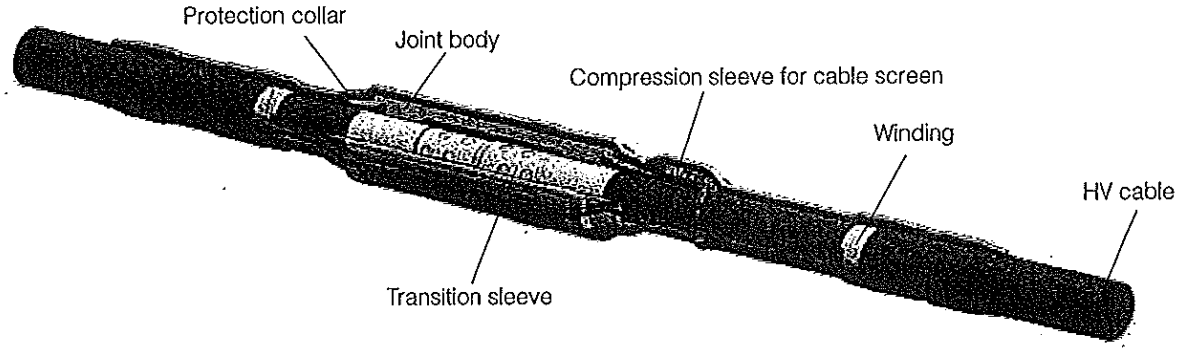
Arkasil joints 110-220 kV with connector (splice-box) of optical fiber integrated in screen are a prefabricated silicone joint, designed to connect high-voltage cables 110/132/150/220 kV with XLPE insulation (conductor cross-section 185-2500 mm²). Splice-box includes all necessary components for splicing and mechanical protection.



000501
КРАСИН
СМОЛЯ
ООО

Transition joints MCB 126 T / 145 T / 170 T / 252 T

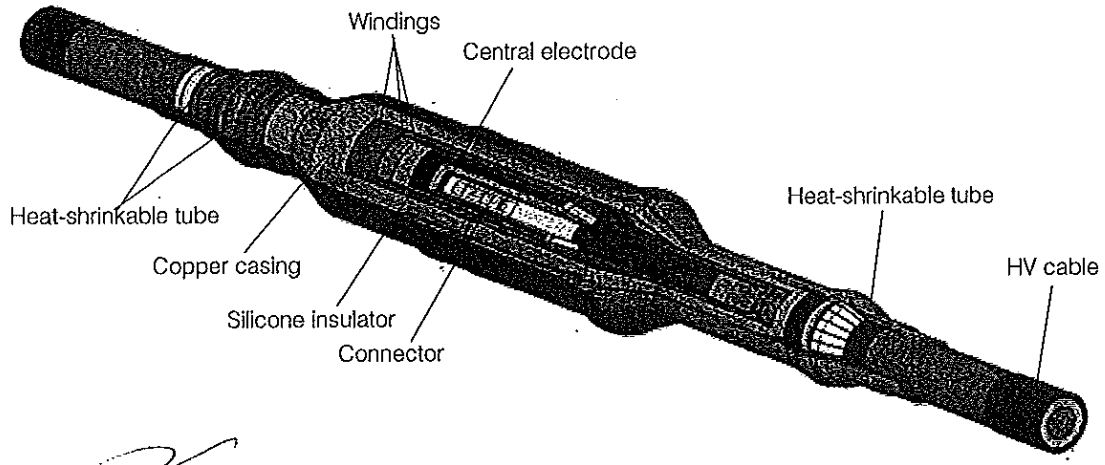
Arkasil transition joints 110-220 kV are a prefabricated silicone joints, designed to connect high-voltage cables with XLPE insulation voltage 110/132/150/220 kV (conductor cross-section 185-2500 mm²) with different constructions, different cross section of the core and screen, insulation thickneses, core material etc. Transition joint dimensions depends on cables constructions.



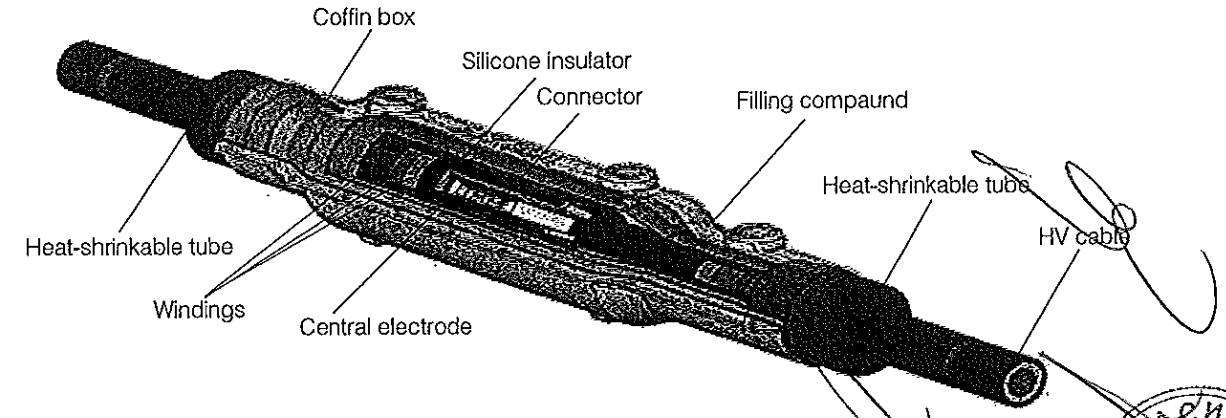
Joints with copper cases (index C) and coffin-boxes (index P) MCB 126 C,P(CP) / 145 C,P(CP) / 170 C,P(CP) / 252 C,P(CP)

Arkasil joints MCB 126/145/170/252 with copper cases (index C and coffin-boxes index P) are premolded silicone joints which are used for XLPE cables connection having different screen connection. Cases are served for joints mechanical protection.

MCB 126 C / 145 C /170 C / 252 C

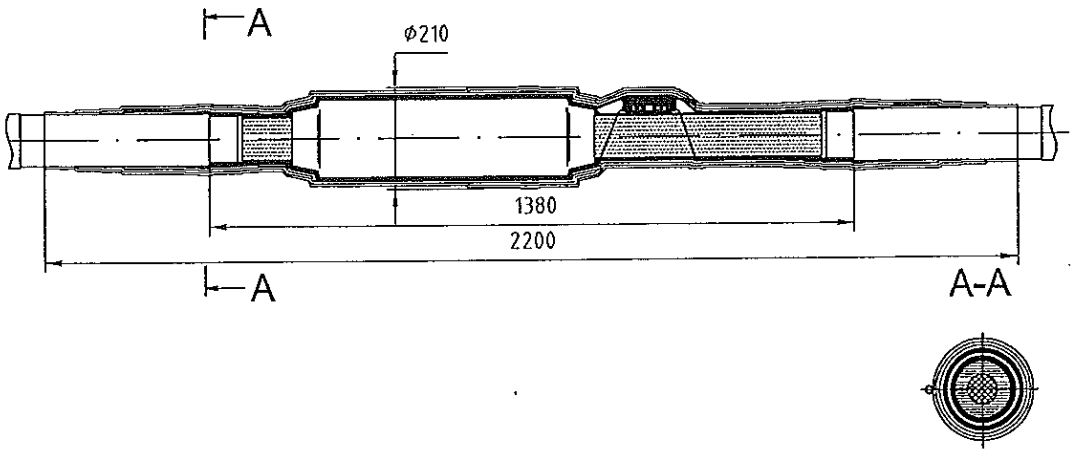


MCB 126 P / 145 P / 170 P / 252 P

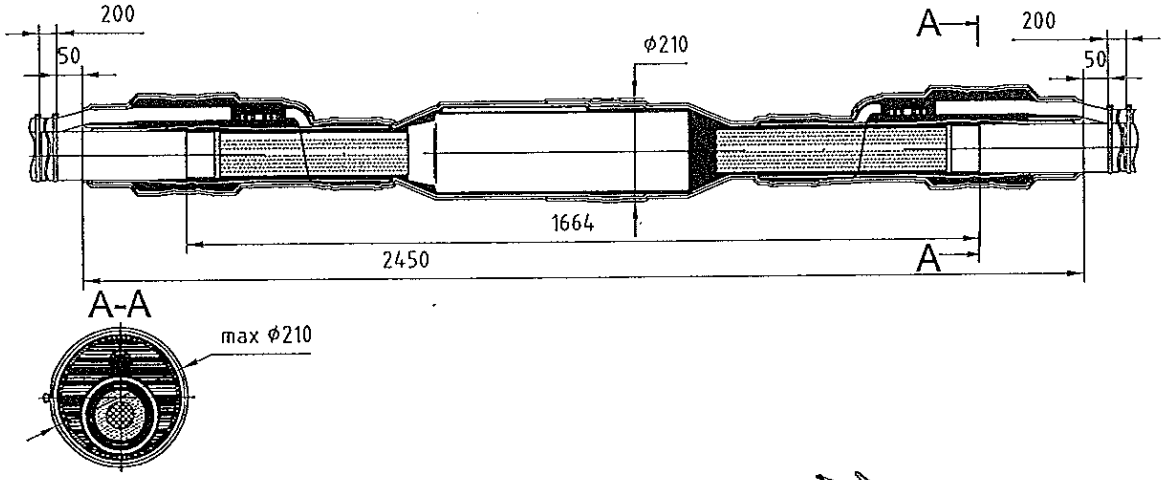


Drawings

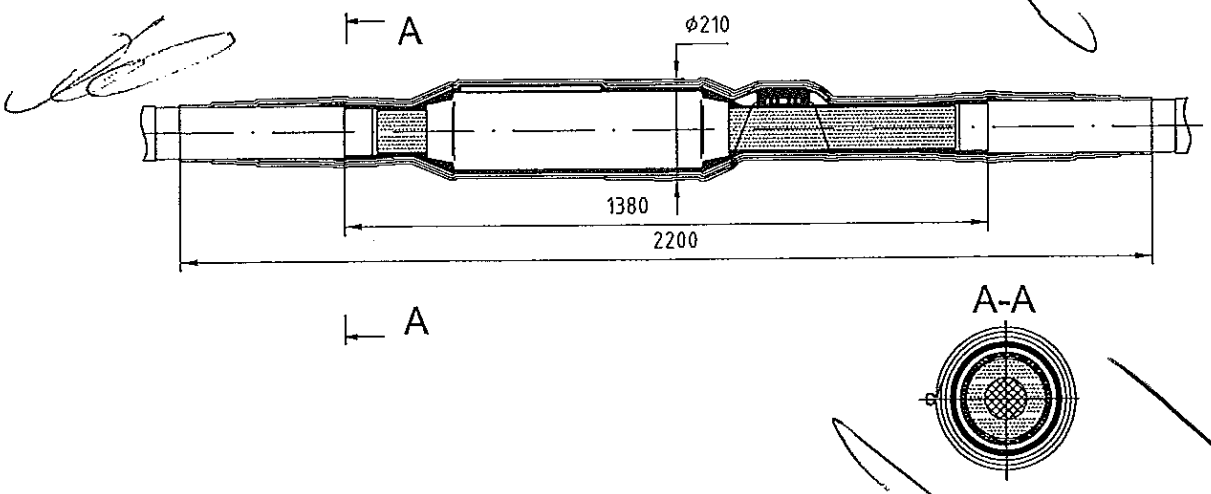
MCB 126 / 145 / 170



MCB 126 X /145 X /170 X

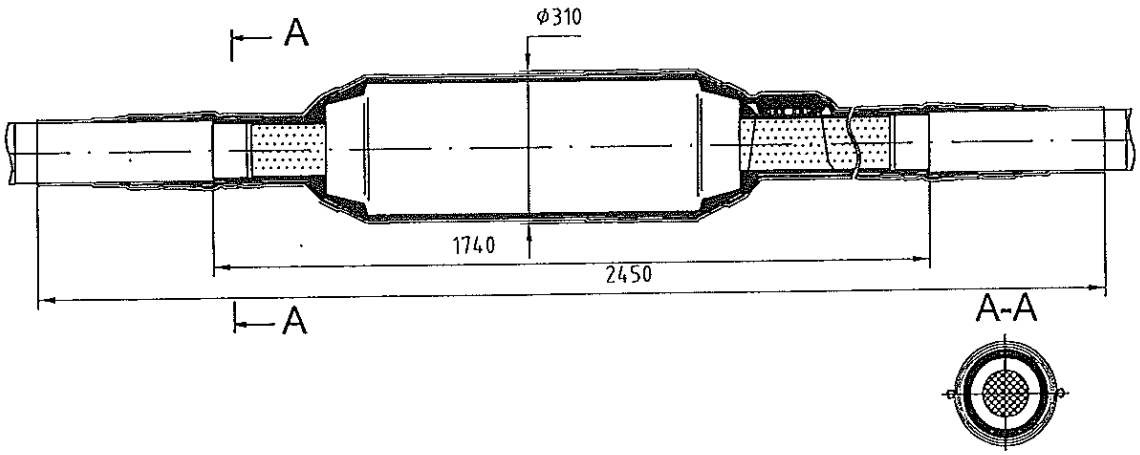


MCB 126 O / 145 O / 170 O

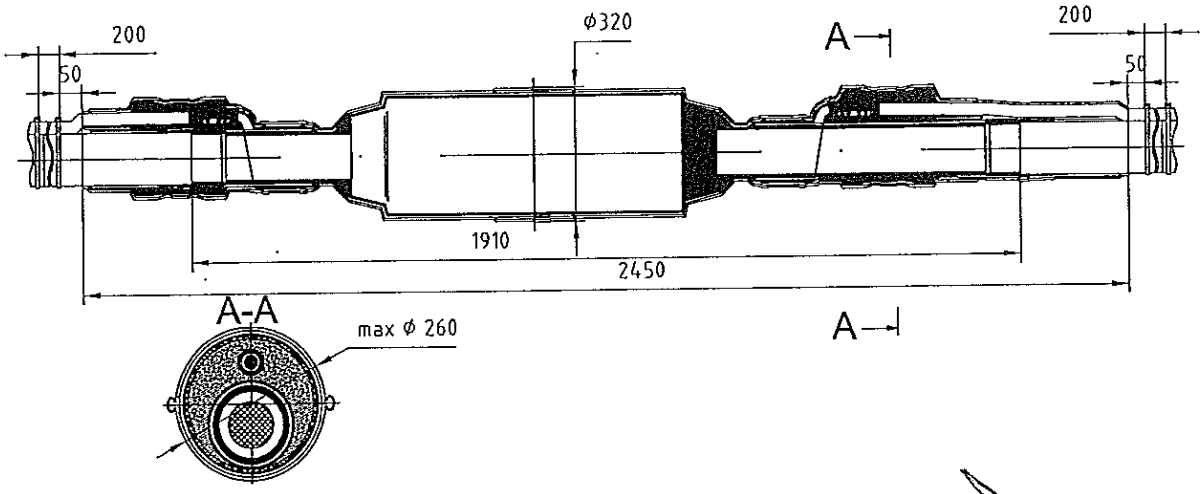


000503
ВЕРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

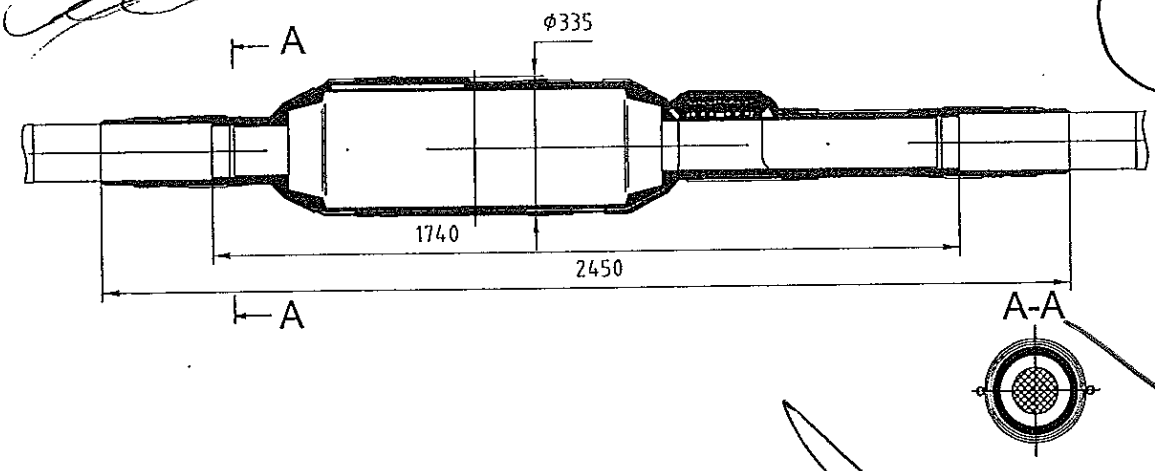
МСВ 252



МСВ 252 Х



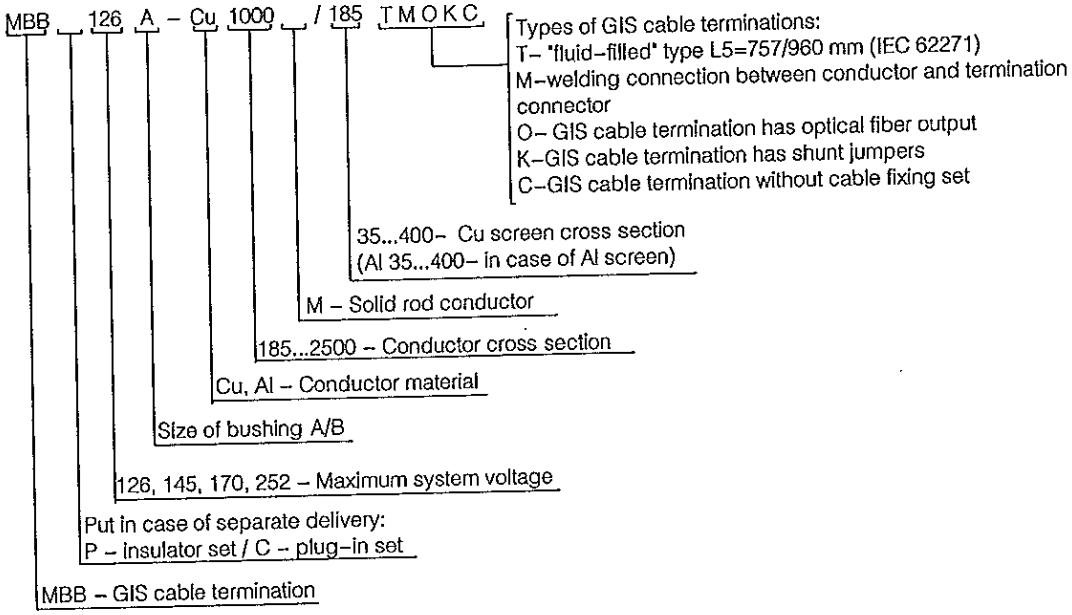
МСВ 252 О



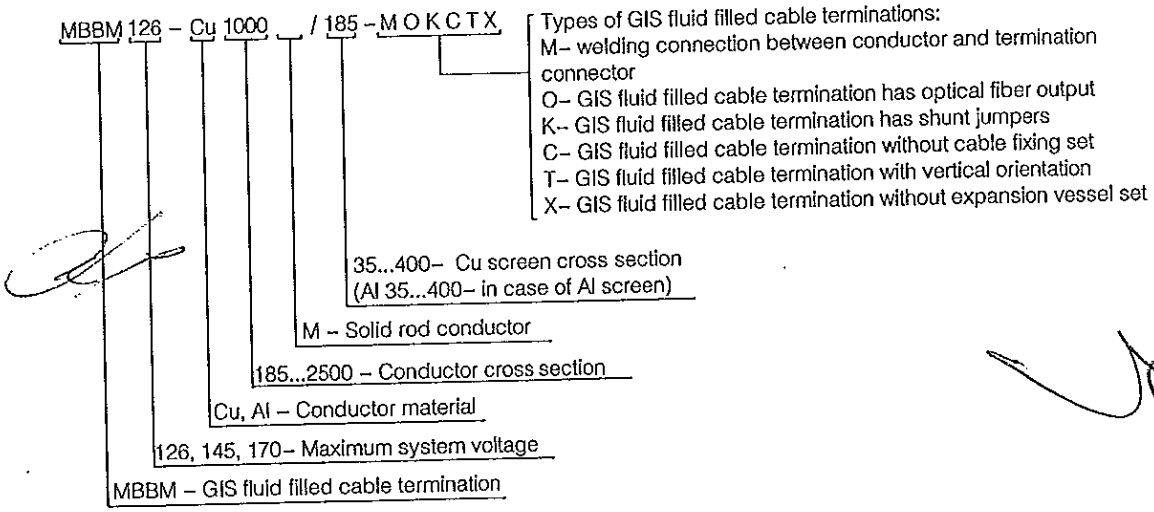
000504
ВЫПИСКА
СЕРТИФИКАТА
"КРАСИН"
СМОЛЯН
ООД

GIS termination labeling

Labeling of GIS termination MBB



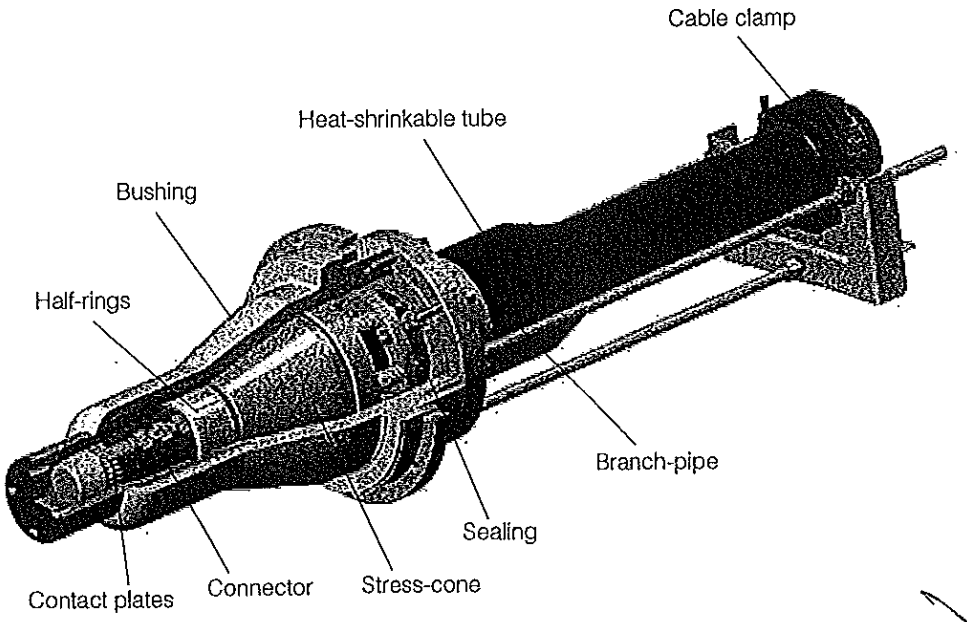
Labeling of fluid filled GIS termination MBBM



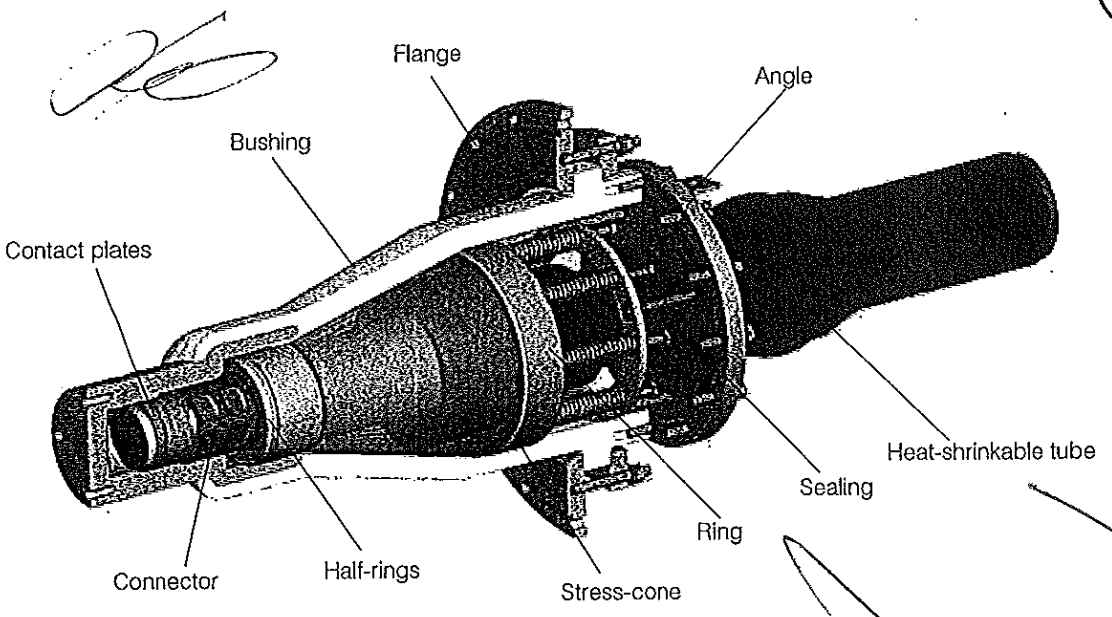
GIS terminations
MBB 126 / 145 / 170 / 252

Arkasil GIS terminations are used for cable lines connection to gas-insulated switchgear and transformers. MBB 126/145/170/252 are used for indoor installation for XLPE cables 64/110, 76/132, 87/150, 127/220 kV (conductor cross-section 185-2500 mm²). GIS terminations could be produced for XLPE cable with optical fibers in screen which are used for temperature monitoring. All types of GIS terminations made in accordance with IEC 62271-209 and could be used with switchgears for the dry type and oil filled GIS terminations. GIS termination consist of epoxy insulator and plug-in part. Due to such design cable can be disconnected from the GIS and connected again without SF6 or oil evacuation. The epoxy insulator could be delivered with GIS or with plug-in part only (epoxy insulator installed in switchgear by the manufacturer).

MBB 126 / 145 / 170



MBB 252



000506
ВЗЯТО С ОРИГИНАЛА
КРАСНИН
СМОЛЯН
ООД

Area of application

Type		MBB 126	MBB 145	MBB 170
Phase voltage	kV	126	145	170
		MBB 126 A	**MBB 145 A**	**MBB 170 A**
Maximum cable sheath diameter	mm	42÷86	42÷86	42÷86
Cable conductor cross-section range	mm²	185÷2500	185÷1600	185÷1600
Maximum cable insulation diameter	mm	115	115	115
		MBB 126 B	**MBB 145 B**	**MBB 170 B**
Maximum cable sheath	mm	55÷103	55÷103	55÷103
Diameter	mm²	400÷2500	400÷2500	400÷2500
Maximum cable insulation diameter	mm	130	130	130

Type		MBB 252
Phase voltage	kV	252
Maximum cable sheath	mm	65÷112
Diameter	mm²	400÷2500
Maximum cable insulation diameter	mm	130

Technical data

Electrical parameters	MBB 126	MBB 145	MBB 170	MBB 252
Phase voltage	126 kV	145 kV	170 kV	252 kV
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Impulse voltage (10+/10- impulses)	550 kV	650 kV	750 kV	1050 kV
Partial discharges	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV	<5 pC at 190 kV
Climatic characteristics				
Temperature	У1,2	У1,2	У1,2	У1,2

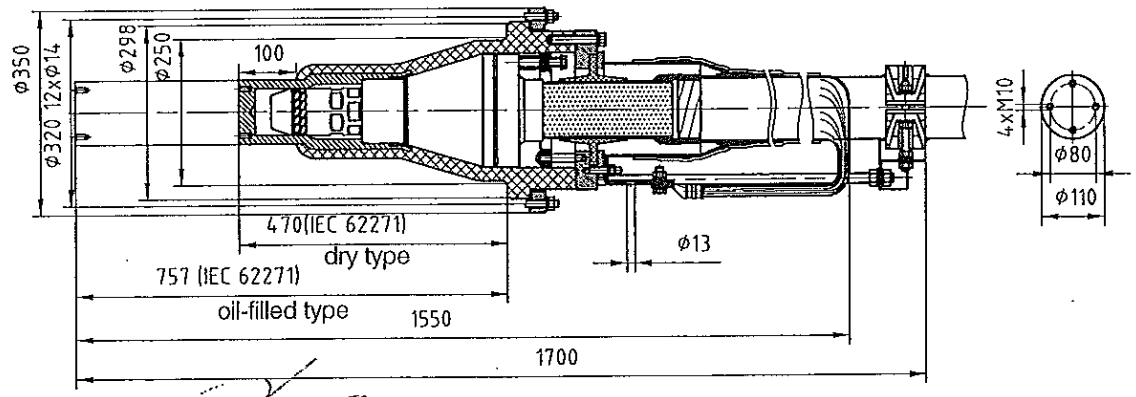
000507
ВЗЯТО С ОРИГИНАЛА
КРАСНИН СМОЛЯН

Current load rating	
Rated operational current	limited by cable specification
Short circuit current	limited by cable specification

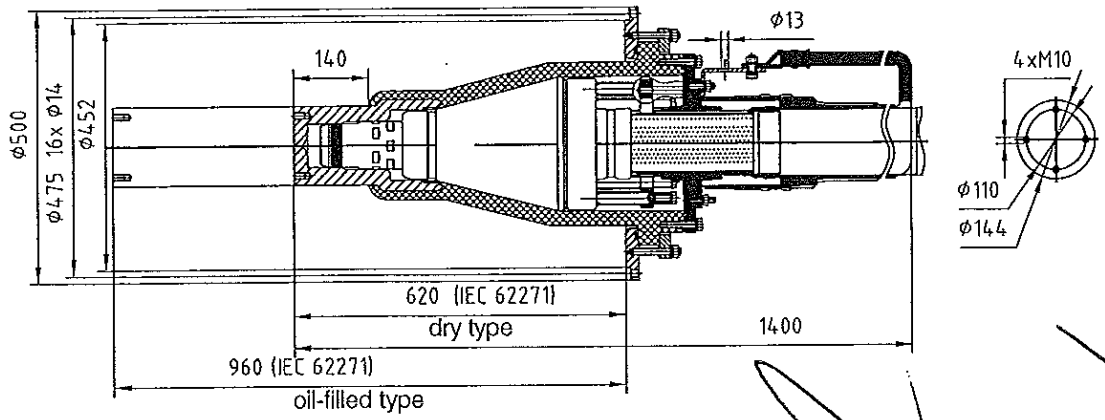
Stress cone routine tests	MBB 126	MBB 145	MBB 170	MBB 252
Stress cone	126 kV	145 kV	170 kV	252 kV
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min	318 kV for 30 min
Partial discharges	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV	<5 pC at 190 kV

Mechanical characteristics		MBB 126/145/170 A	MBB 126/145/170 B	MBB 252
Approximate weight	kg	50	54	80
Length	mm	1400	1400	1400

MBB 126 / 145 / 170



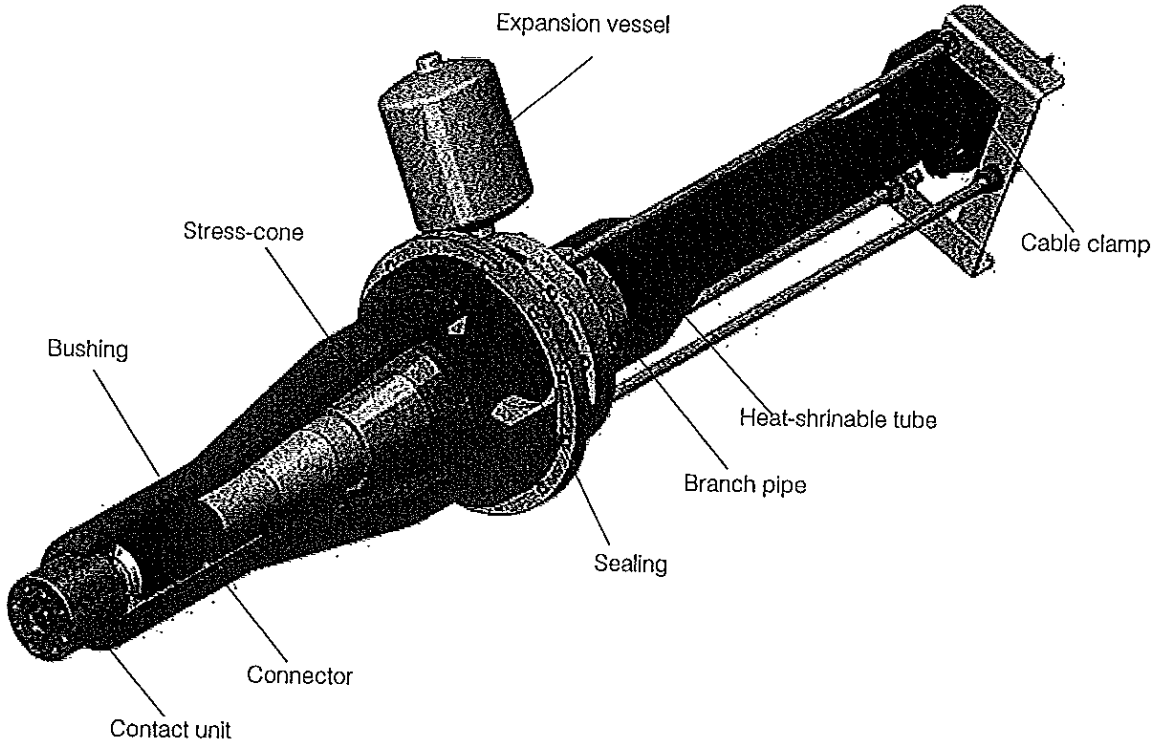
MBB 252

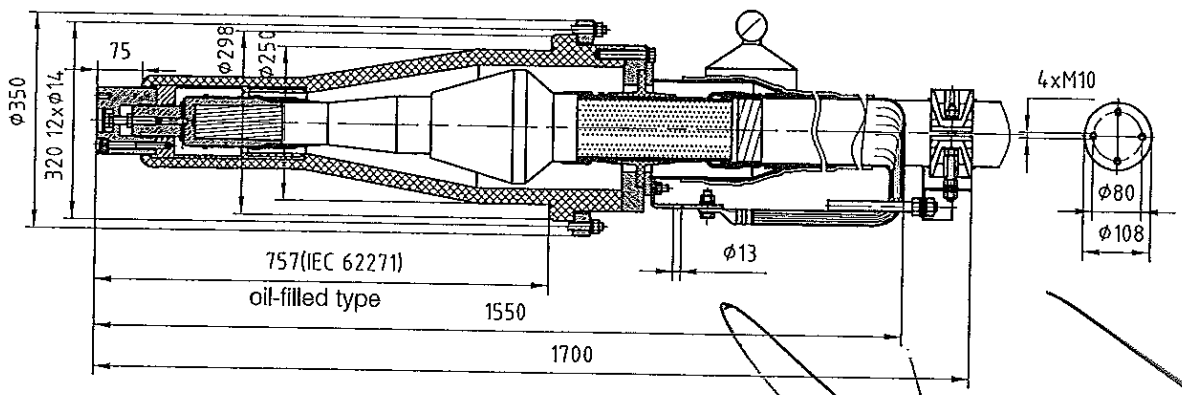


000508
КРАСИН
СМОЛЯН
ООД

GIS terminations
MBBM 126 / 145 / 170

Arkasil oil-filled GIS terminations are used for cable lines connection to gas-insulated switchgear, oil-filled switchgear and transformers. GIS oil-filled terminations are used for indoor installation for XLPE cables 64/110, 76/132, 87/150, 127/220 kV (conductor cross-section 185-2500 mm²). GIS oil-filled terminations could be produced for XLPE cable with optical fibers in screen which are used for temperature monitoring. All types of GIS oil-filled terminations made in accordance with IEC 62271-209. GIS oil-filled termination consists of epoxy insulator and plug-in part.





000509
ВЗЯТО С ОРИГИНАЛА
"КРАСКИН" СМОЛЯН ООД

Area of application

Type		MBBM 126	MBBM 145	MBBM 170
Phase voltage	kV	126	145	170
Maximum cable sheath diameter	mm	42-95	42-95	42-95
Cable conductor cross-section range	mm²	185÷2500	185÷2500	185÷2000
Maximum cable insulation diameter	mm	130	130	130

Technical data

Electrical parameters		MBBM 126	MBBM 145	MBBM 170
Phase voltage	kV	126	145	170
AC voltage withstand test	kV	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min
Impulse voltage (10+/10- impulses)	kV	550	650	750
Partial discharges	kV	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV

Climatic characteristics	MBBM 126	MBBM 145	MBBM 170
Environmental condition class	U1,2	U1,2	U1,2

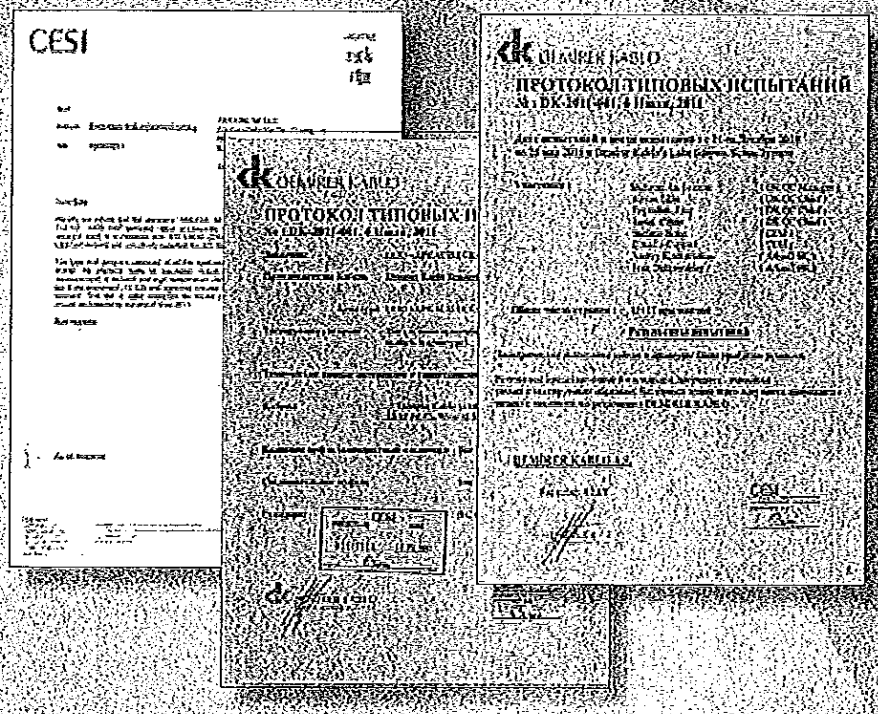
Current load rating	
Rated operational current	limited by cable specification
Short circuit current	limited by cable specification

Stress cone routine tests	MBBM 126	MBBM 145	MBBM 170
Phase voltage	126 kV	145 kV	170 kV
AC voltage withstand test	160 kV for 30 min	190 kV for 30 min	218 kV for 30 min
Partial discharges	<5 pC at 96 kV	<5 pC at 114 kV	<5 pC at 131 kV

Mechanical characteristics		MBBM 126	MBBM 145	MBBM 170
Approximate weight	kg	80	80	80
Length	mm	1550	1550	1550

000510 ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

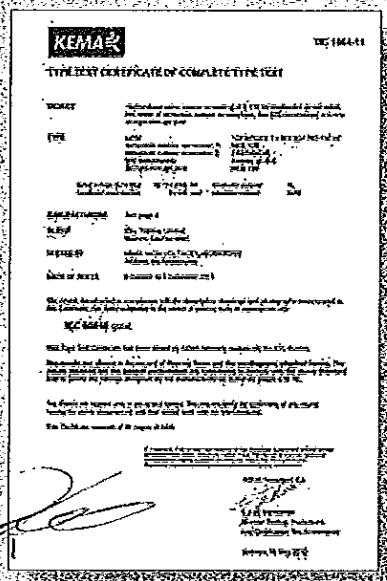
TYPE TESTS OF CABLE SYSTEM 110 kV



CESI, Italy

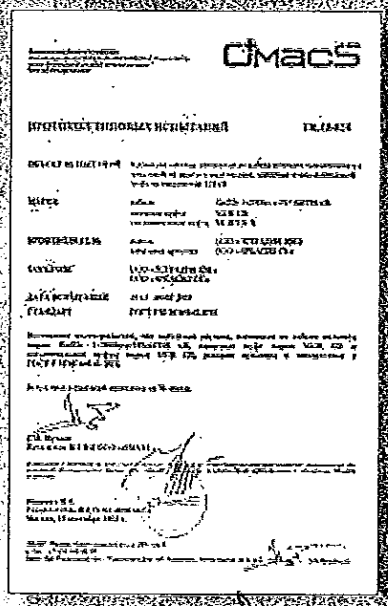
- heating cycle voltage test;
- partial discharge test at ambient temperature;
- partial discharge test at high temperature;
- tan measurement;
- lightning impulse voltage test followed by power frequency voltage test;
- examination of the cable system;
- test of outer protection of joint.

KEMA, The Neatherlands



Tests were made according to the program of the harmonized European standard HD 632 S2, part 1, analogue of IEC 60840 edition 3 (2004), in the test laboratory of KEMA (Netherlands).

OMACS, Russia

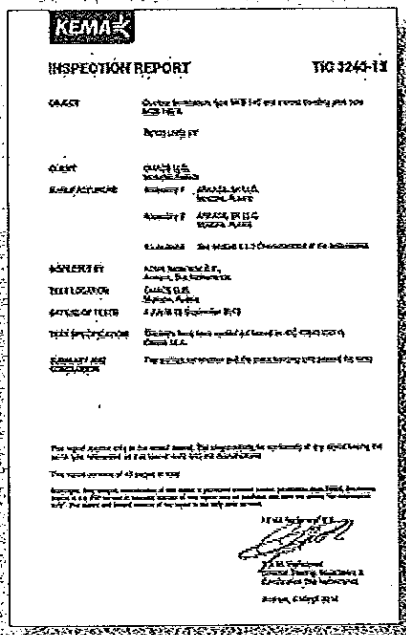


Type tests according to IEC 60840.

000511

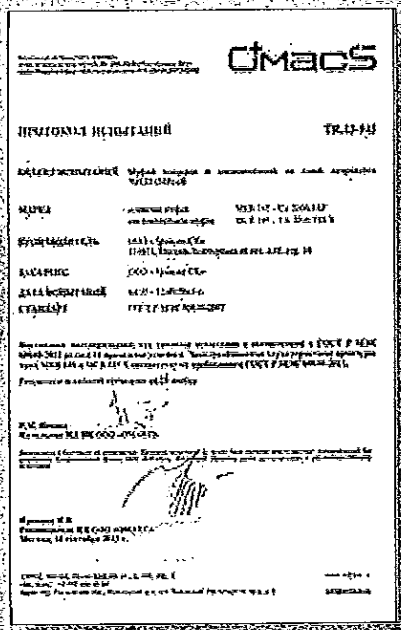
Arkasil

TYPE TESTS OF CABLE SYSTEM 132 kV


KEMA

INSPECTION REPORT TIC 3245-13

KEMA,
The Netherlands


OMACS

OMACS,
Russia

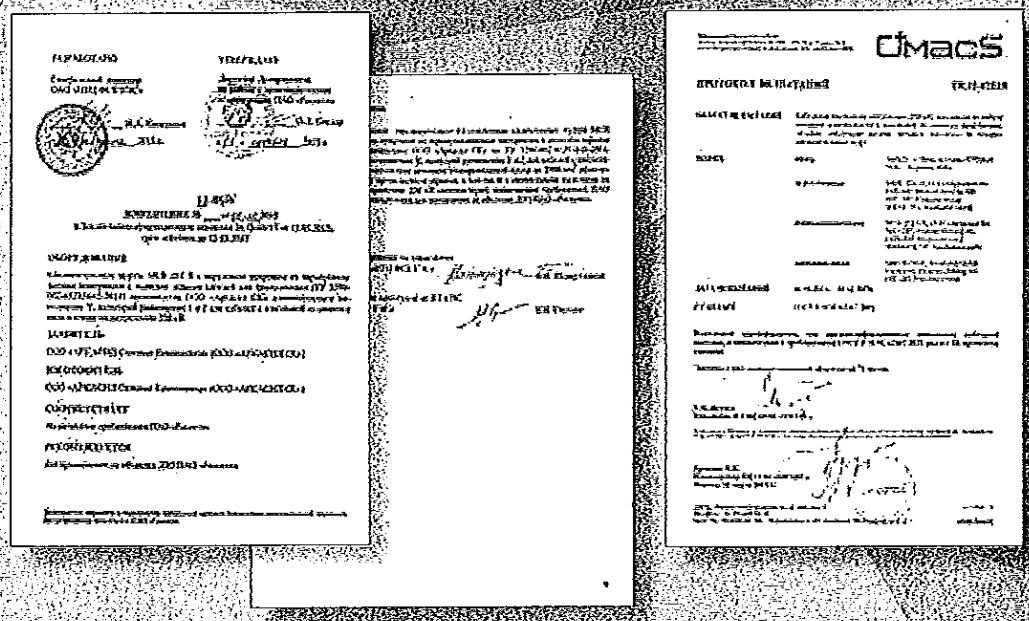
Tests were made on cable with 14 mm insulation thickness.

000512

КРАСНИЯ СМОЛЯН 23 ООД

Arkasil

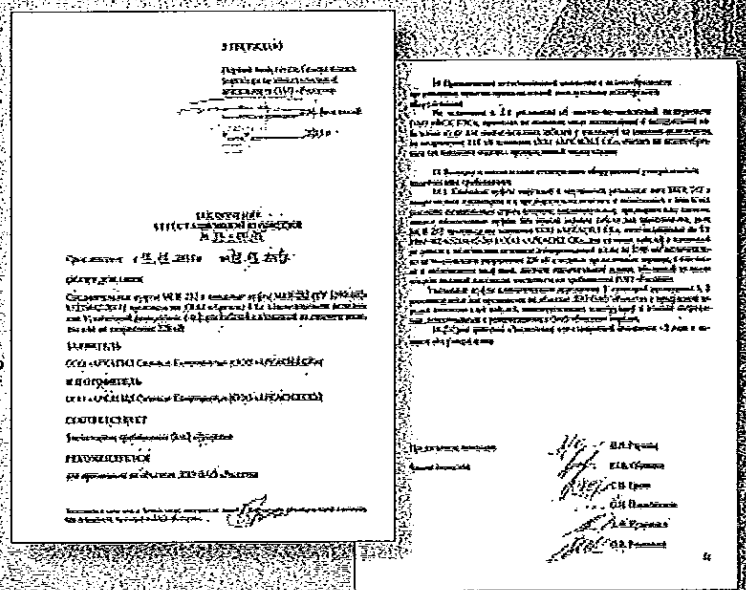
TYPE TESTS OF CABLE SYSTEM 220 kV



"OMACS", Russia

Tests were made under CESI supervision.

PREQUALIFICATION TESTS OF CABLE SYSTEM 220 kV

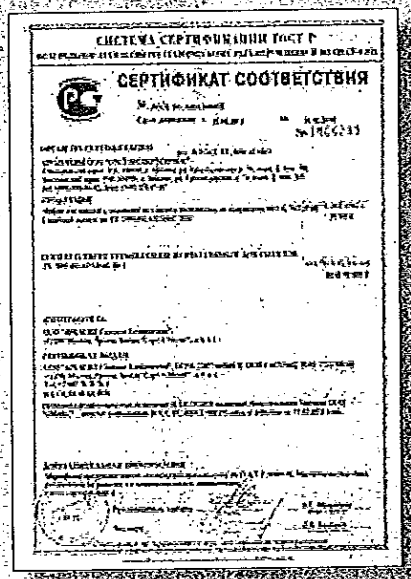


The electrical test of High-voltage cable system consisting of a 220 kV single-core power cable, four outdoor terminations, four cross-bonding joints and four GIS terminations is in process.

000513

ЗАВЕРЕНО С ОРИГИНАЛА

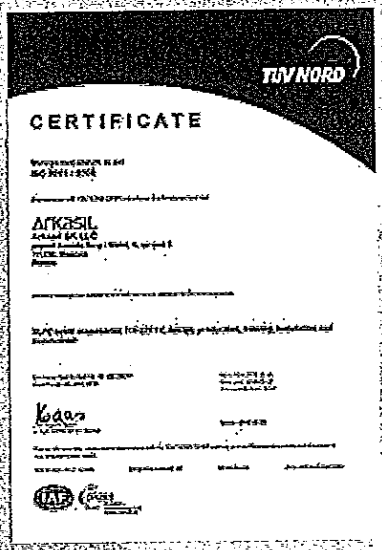
"КРАСИН" СМОЛЯН ООД


СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р

СЕРТИФИКАТ СООТВЕТСТВИЯ

ТУ 3599-001-65235642-2011

ARKASIL-SK LLC production complies with the requirements of regulatory documents.


TÜVNORD

CERTIFICATE

ARKASIL

000514

HEAT-SHRINKABLE COMPONENTS

Heat shrinkable cable end caps

Heat Shrinkable cable End Caps are used to seal the ends of all types of Cables protect from ingress of water/ moisture. The caps are manufactured from high quality cross linked polyolefin material. Compatible with most commonly used Cable Jackets i.e. XLPE, PVC, PILC or Rubber Sheathed Cable. Hot Melt adhesive lining provides seal from irregular cable sheaths. Excellent resistance to weathering, moisture, contamination and adverse environmental conditions.

Area of application

- valved end caps available for pressurized application for telecom cables;
- special relief valved end caps available for degassing application in High Voltage Power cables;
- high voltage (non tracking) end caps available for sealing live parts;
- conductive end caps are available with;
- conductive mastic.

Technical specification

Type		Standard
Physical		
Tensile Strength	12 H/mm² (Mpa)	ASTM D638
Ultimate Elongation	350%	ASTM D638
Density	1,05 ± 0,2 g/cm³	ASTM D792
Hardness	45 ± 10 Shore D	ASTM D2240
Water Absorption	0,2 % (max)	ASTM D570

Type		Standard
Low Temperature Flexibility		
(-40°C for 4 hrs.)	No Cracking	ASTM D2671
Heat Shock (250°C for 30 min.)	No cracking or flowing	ESI 09-11
Shrink Temperature	125°C	IEC 216
Temperature range	-40°C to +110°C	IEC 216

Thermal		
Accelerated Ageing	(120°C for 500 h)	ASTM D2671
Tensile Strength	11 H/mm² (Mpa)	ASTM D638
Ultimate Elongation	300 %	ASTM D638

Electrical		
Dielectric Strength	12 кВ/mm	ASTM D149
Volume Resistivity	$1 \cdot 10^{14}$ Ohm·cm	ASTM D257
Dielectric Constant (E)	5 (max)	ASTM D150

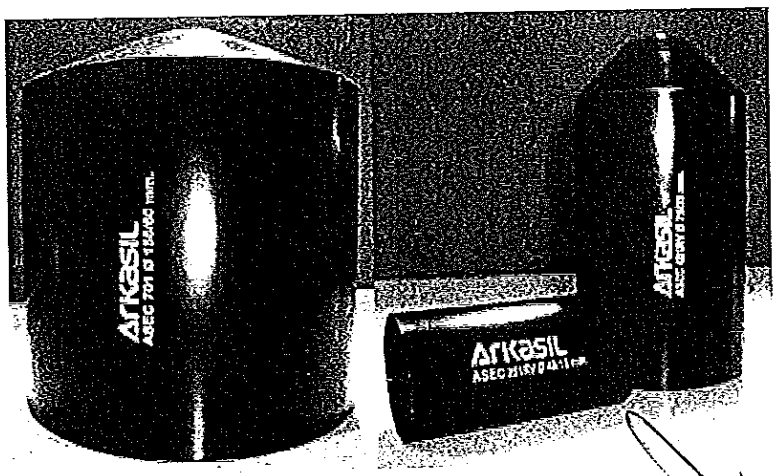
000515

ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Code	D min (mm)	D max (mm)	T±10 (mm)	Length (min)	Cable diameter
ASEC 001S	6	2.0	2.0	25	2-4
ASEC 001	12	4.0	2.3	38	4-8
ASEC 001L	12	4.0	2.3	58	4-8
ASEC 001A	14	4.0	2.3	58	4-11
ASEC 101	20	7.5	2.3	55	8-16
ASEC 101 L	20	7.5	2.5	75	8-16
ASEC 101 A*	25	8.0	2.3	75	8-20
ASEC 102	30	11	2.5	75	12-26
ASEC 102 A	35	11	2.5	75	12-30
ASEC 201*	40	15	3.3	90	16-35
ASEC 201 L	40	15	3.3	120	16-35
ASEC 201 AL	45	15	3.3	120	16-40
ASEC 301*	55	25	3.8	122	25-47
ASEC 301 L	55	25	3.8	170	25-47
ASEC 301 AL	63	25	3.8	170	25-55
ASEC 401*	75	35	3.8	140	35-68
ASEC 401 L	75	35	4.0	180	35-68
ASEC 501 S	85	45	4.0	160	45-80
ASEC 501*	100	45	4.0	160	45-90
ASEC 501 L	100	45	4.0	200	45-90
ASEC 501 AL	120	45	4.0	200	45-110
ASEC 601*	130	60	4.6	160	64-120
ASEC 701*	154	60	4.6	165	70-145
ASEC 801	230	120	5.5	220	140-200
ASEC 901	310	120	5.5	220	140-280
ASEC 1001	400	200	6.0	220	230-380

* Widely applied



000516

HEAT-SHRINKABLE TUBES

Heat-shrinkable tubes ASMW and ASHW are medium wall and heavy wall black tubes. ASMW tubes are used for environmental protection of cable termination and insulating the connectors for straight through joints/ splice. ASHW tubes are used for mechanical protection and outer sealing of underground straight through cable joints/splice.

Technical specification

- these tubes are manufactured from high quality cross inked polyolefin material;
- optional hot melt adhesive lining for complete environmental protection and insulation;
- excellent resistance to weathering, UV rays, chemical and solvents;
- maximum cut length available up to 1500 mm;
- custom dimensions, thickness, length & colors available on request;
- conform to IEC standard.

Heat-shrinkable tubes	45/13 (250 mm)
Heat-shrinkable tubes	52/13 (1000 mm)
Heat-shrinkable tubes	130/35 (1000 mm)
Heat-shrinkable tubes	160/50 (900 mm)
Heat-shrinkable tubes	180/50 (1000 mm)
Heat-shrinkable tubes	200/55 (1300 mm)
Heat-shrinkable tubes	227/77 (1300 mm)
Heat-shrinkable tubes	300/90 (1200 mm)
Heat-shrinkable tubes	350/110 (1500 mm)

Type		Standard
Physical		
Tensile Strength	12 H/mm² (Mpa)	ASTM D638
Ultimate Elongation	350%	ASTM D638
Longitudinal Change	-10% (max)	ASTM D2671
Density	1,15 ± 0,2 g/cm³	ASTM D792
Hardness	45 ± 10 Shore D	ASTM D2240
Water Absorption	0,5 % (max)	ASTM D570
Thermal		
Accelerated Ageing	(120°C for 500 h)	ASTM D2671
Tensile Strength	11 H/mm² (Mpa)	ASTM D 638
Ultimate Elongation	300 %	ASTM D 638
Low temperature Flexibility (-40oC for 4 h.)	No Cracking	ASTM D2671
Heat Shock (250oC for 30 min.)	No Cracking or flowing	ESI 09-91
Shrink Temperature	125°C	IEC 216
Temperature range	-40°C to + 110°C	IEC 216
Electrical		
Dielectric Strength	12 kB/mm	ASTM D 149
Volume Resistivity	$1 \cdot 10^{14}$ Ohm·cm	ASTM D257
Dielectric Constant (E)	5 (max)	ASTM D150

ВЕРНО С ОРИГИНАЛА
000517
"КАБЕЛЬ-СИН" СМОЛЯН ООД

HEAT-SHRINKABLE COLLAR

Heat-shrinkable collar is a polyolefin tube with metal zipper that can be mounted on installed cable without cutting.

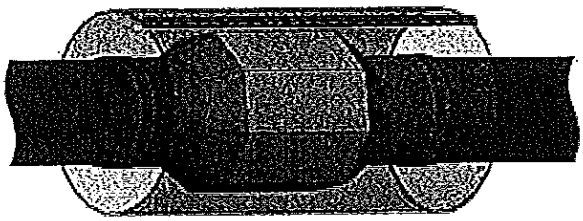
Technical specification

- hot melt adhesive provides complete environmental sealing and insulation;
- high resistance to UV rays, chemicals, corrosion, fungus, etc.;
- temperature sensitive paint changes color when heat shrinking process is complete;
- maximum length available up to 1500 mm.

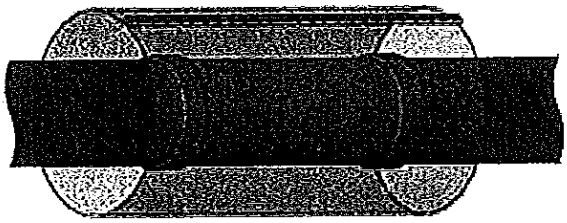
Heat-shrinkable collar	198/55 (2200 mm)
Heat-shrinkable collar	198/55 (2450 mm)

Type		Standard
Physical characteristics		
Tensile Strength	17 H/mm² (Mpa)	ASTM D638
Ultimate Elongation	300%	ASTM D638
Longitudinal Change	-10% (max)	ASTM D2671
Water Absorption	0,2 % (max)	ASTM D570

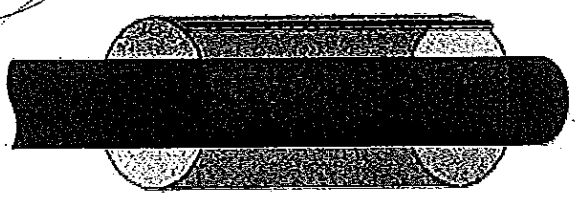
For the protection of Cable joint



For Cable Repairs



For corrosion protection of Oil, Water & Gas pipeline



Thermal characteristics		
Accelerated Ageing	(120°C for 500 h)	ASTM D2671
Tensile Strength	15 H/mm² (Mpa)	ASTM D 638
Ultimate Elongation	220 % (min.)	ASTM D 638

Thermomarker color change		
150°C for 30 min.	No change	Visual
250°C for 5 min.	Color change	Visual

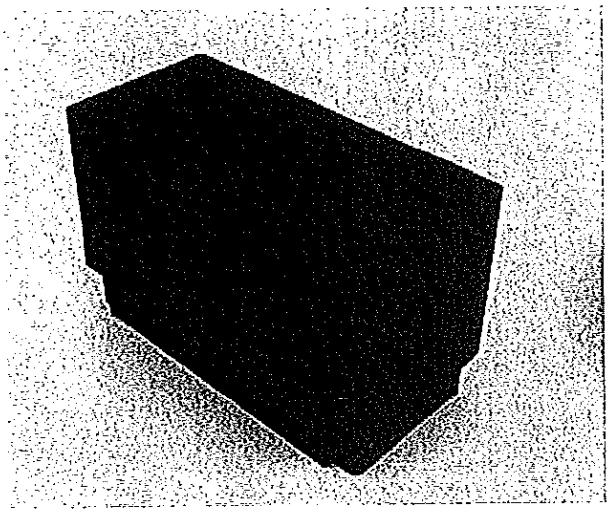
Electrical		
Dielectric Strength	12 kB/mm (min.)	ASTM D149

000518
ВЫПИСКА ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

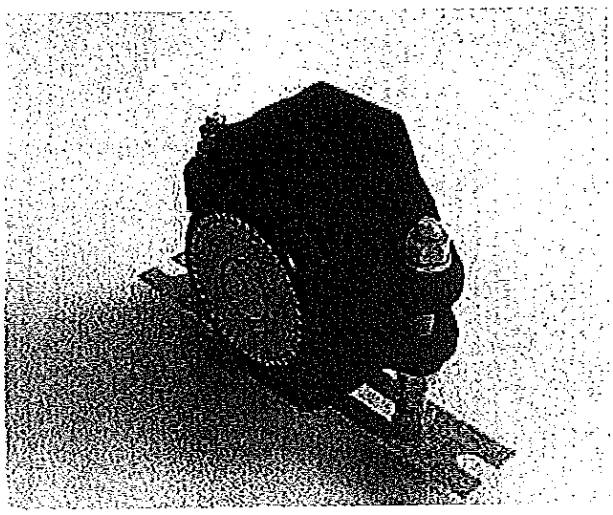
FIXING FOR HIGH-VOLTAGE CABLES

BKK3 and BKK cable clamps provide reliable fixing of high voltage cables and even at high short-circuit currents.

Cable clamps BKK3



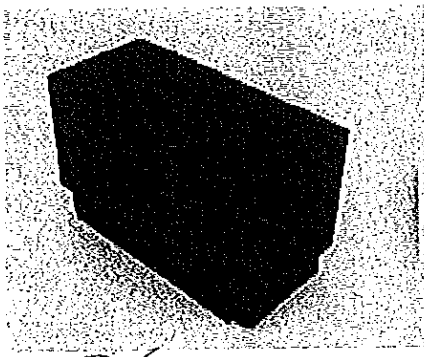
Cable clamps BKK



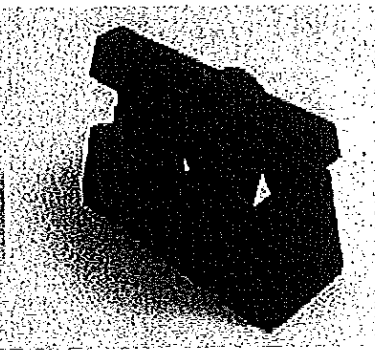
FIXING FOR MIDDLE VOLTAGE CABLES

YKK3 and YKK-60 universal cable clamps as well as PKK cable clamps are designed for fixing of all types of middle voltage cables.

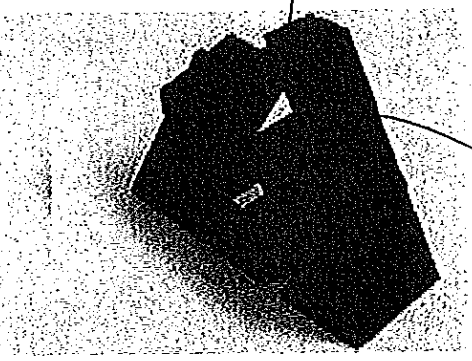
Cable clamps RKK



Cable clamps YKK3



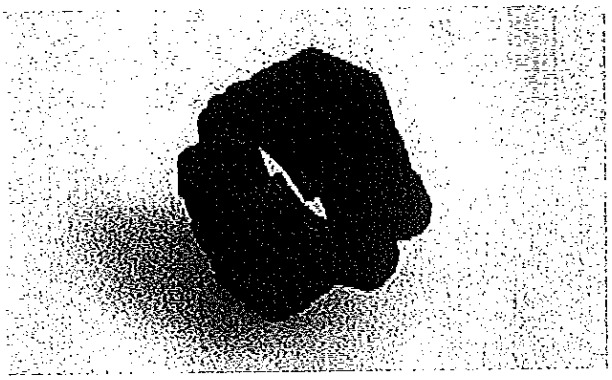
Cable clamps УКК-60 and УКК2-60

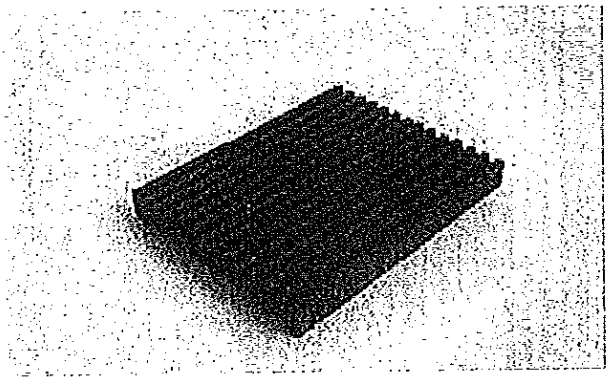


000519
ВЕРНО С ОРИГИНАЛА
"КРАСНЫЙ" СМОЛЯН ООД

SILICONE GASKET HEAT RESISTANT PST-80

Laying PST-80 is used when laying the cable in the vertical sections to increase coefficient of friction and prevent Gasket of the cable. Gaskets are made of organosilicone cal rubber (silicone). Gasket design is made for careful gasket and cable fixing.

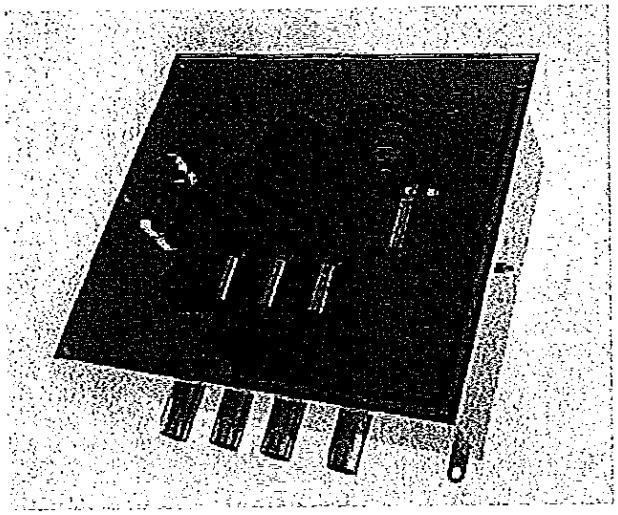




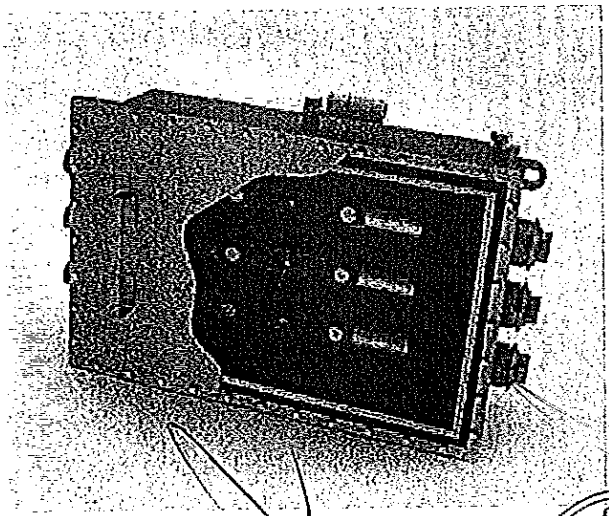
EARTHING AND CROSS-BONDING BOXES

Earthing and cross-bonding boxes are used for cross-connection of six single - core wires and for grounding of 150-500 kV cable screens.

Earthing boxes



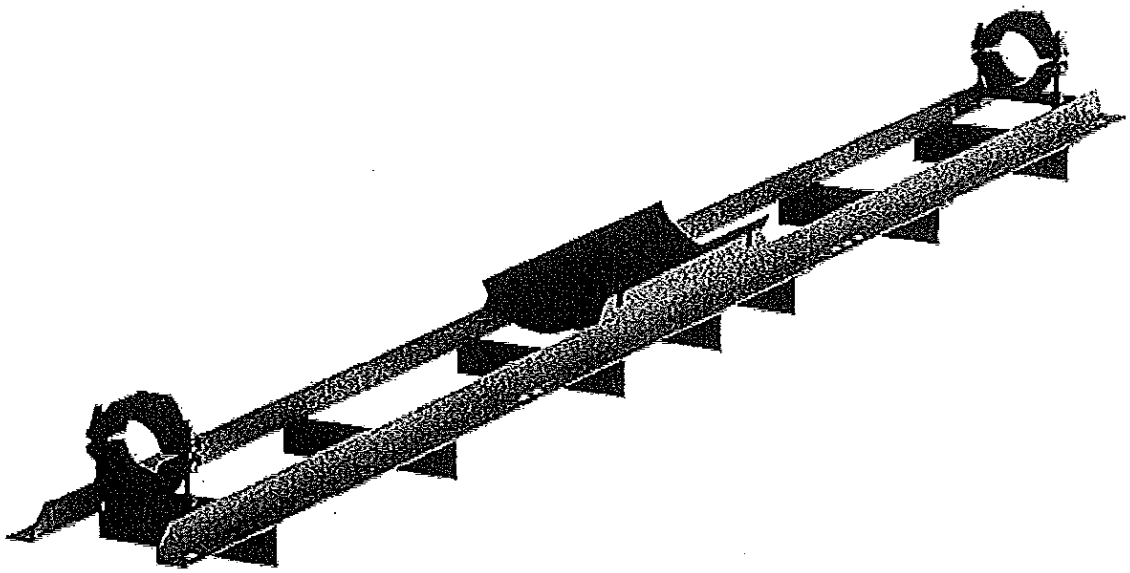
Cross-bonding boxes



000520
КРАСИН
СМОЛЯН
ООД

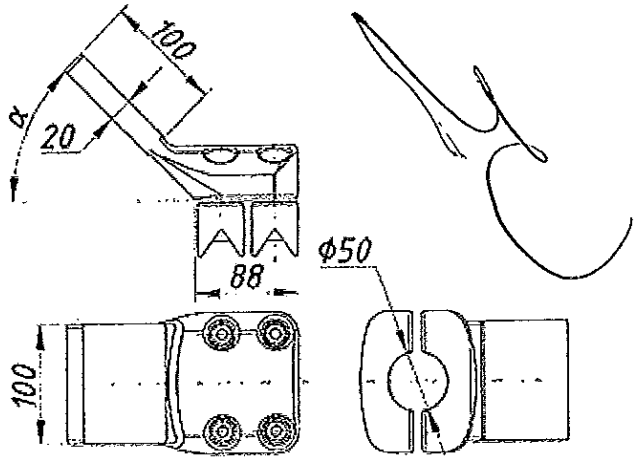
SUPPORT ASSEMBLY

Support assembly is designed for installation of joints.
Support assembly consists of steel corners with supporting stand for installation of joints.



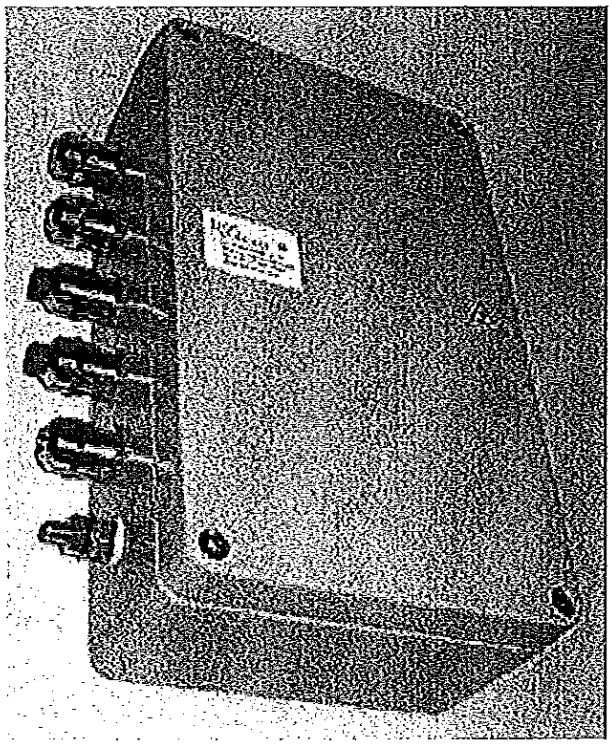
CABLE CONNECTOR

For connection of termination to cable lines it is necessary to use cable connectors. Arkasil SK delivers aluminum, bronze and bimetallic cable connectors.



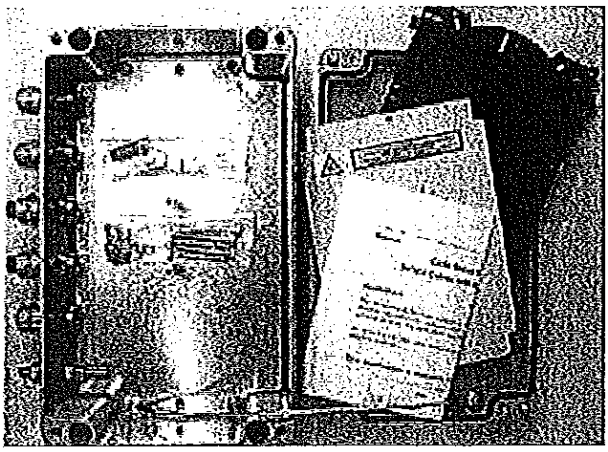
000521
ОРИГИНАЛА
«КРАСНИ»
СМОЛЯН
ООД

TERMINATIONS SPLICE BOX

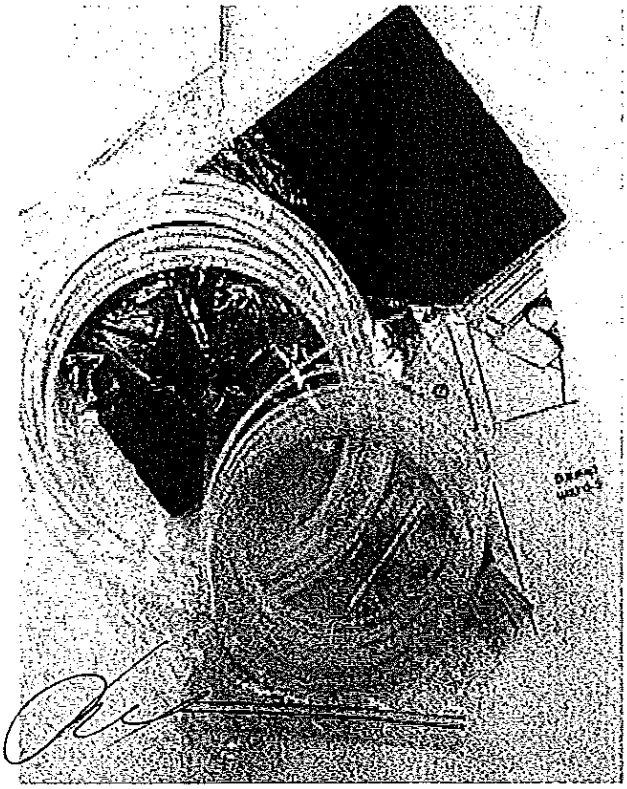


It is applied for connection of fiber-optical modules installed in the high-voltage optical fiber.

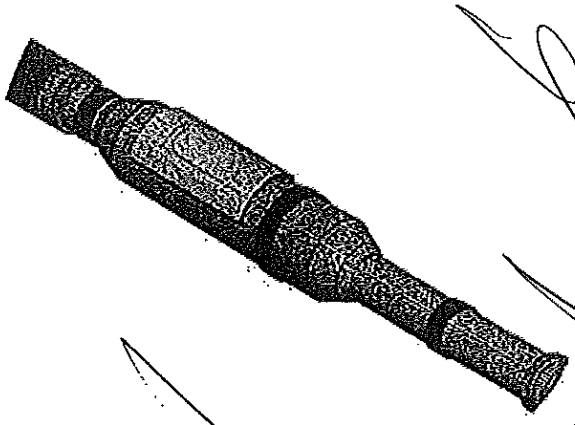
Splice box is a high voltage metal tray, safety class IP66, with 4 inputs for optical fiber modules, 2,5 - 5,5 mm² in diameter. It protects the connection point and is applied to store the fiber stock necessary for repair or preventive works.



JOINTS SPLICE BOX

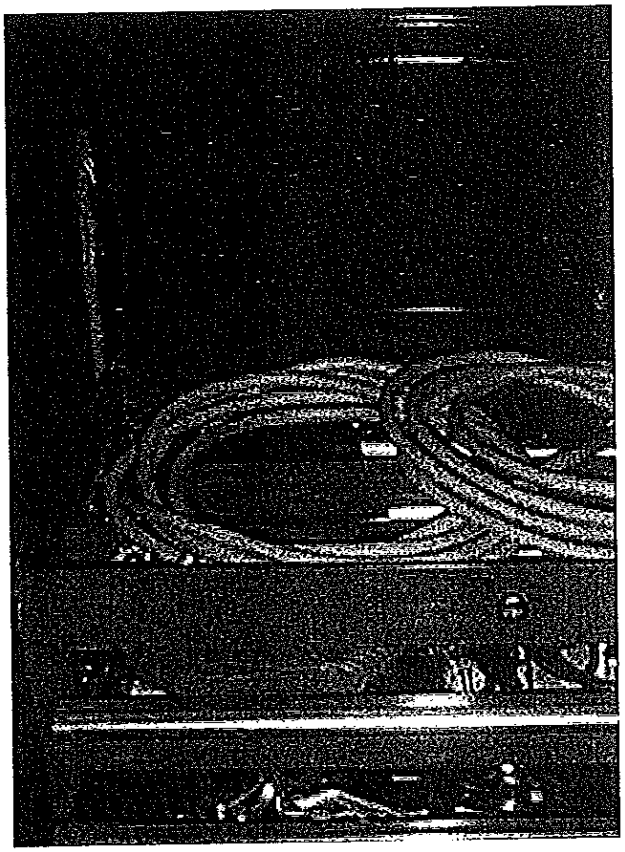


It is applied for connection of fiber-optical modules installed in the high-voltage optical fiber. A joint splice box is a high voltage rubber base with slots and channels for the optical fibers, it provides connection of the modules, protects the connection point. It is fixed during the joint installation. The supply complete set includes all necessary accessories for the optical modules welding.



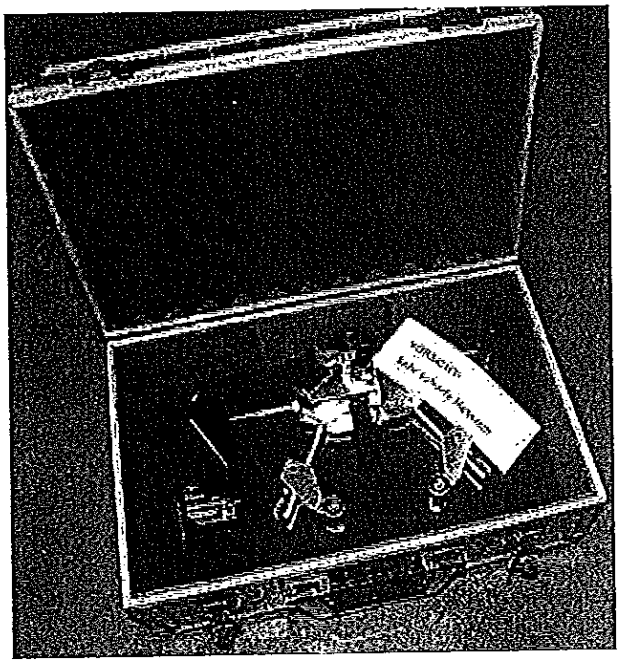
000522
ВЯРНО С ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

TOOLS FOR ARKASIL SK CABLE ACCESSORIES INSTALLATION



Installation Tool Kits 1010 Kit

The installation tools including all necessary items for the high-voltage cable and cable accessories high voltage and installation.

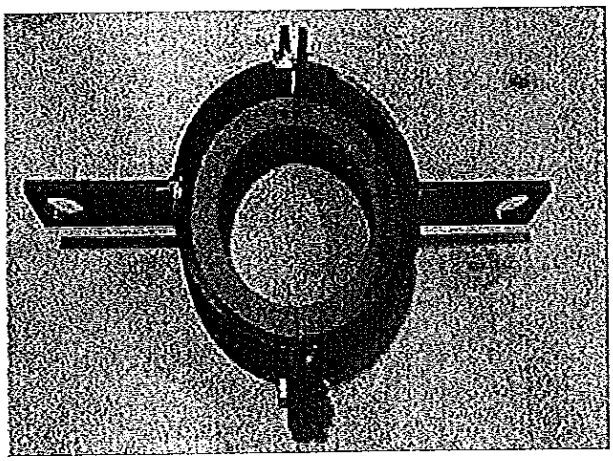


Tools for cutting and preparation cable MAS 130

MAS 130 is a cable knife Combined mechanical device for the removal of conductive and insulating layer cables with XLPE insulated polyethylene. Diameter range 18-130 insulation mm. A feature of the tool is the MAS 130 no need for silicone howling lubrication during operation.

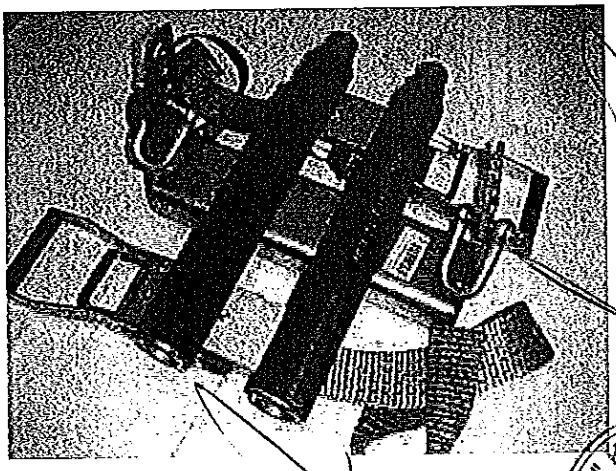
000523
ОРИГИНАЛА
"КРАСИН" СМОЛЯН ООД

1000 kg Belt Winch
For pulling the silicone insulator on the cable.



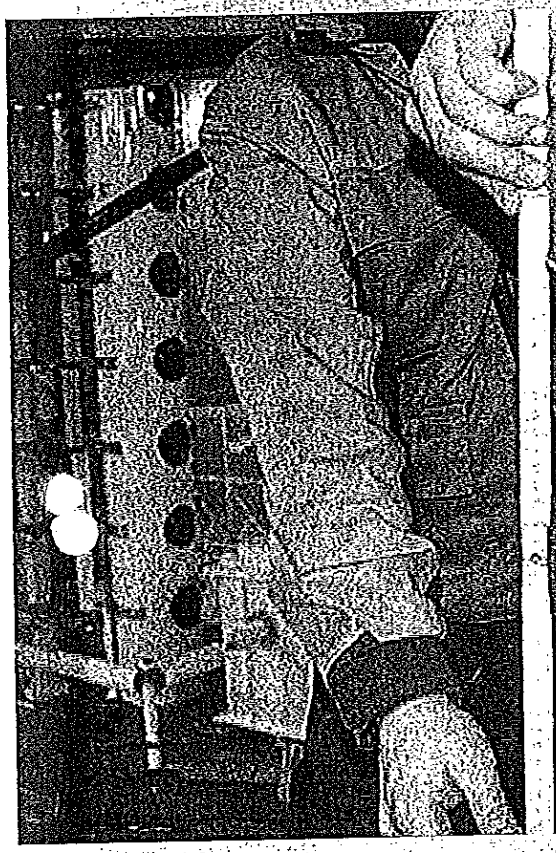
Cable heating kit 1080 kit
This instrument is used for cable heating.

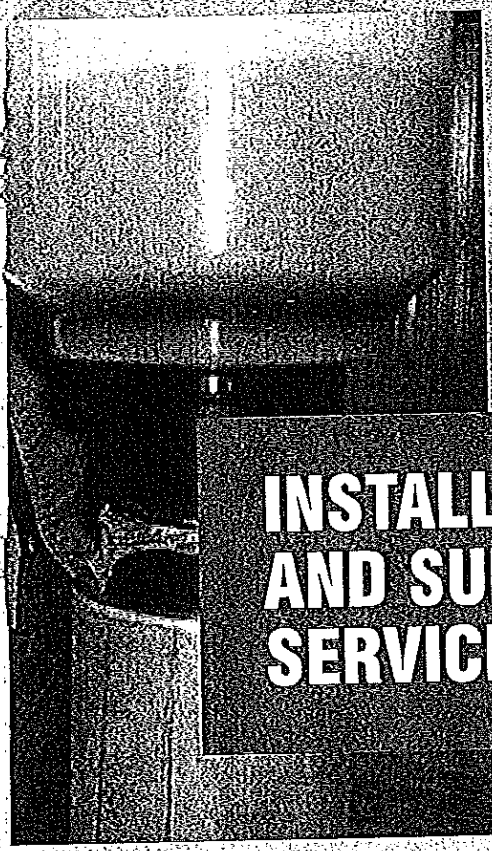
Winch-to-cable fixing device
The device is fixed on the cable, and has terminals for fixing the winches.



000524
ВЕРНО С ОРИГИНАЛА
г. КРАСНИ
СМОЛЯН
ООП

SUPERVISION SERVICE





INSTALLATION AND SUPERVISION SERVICE

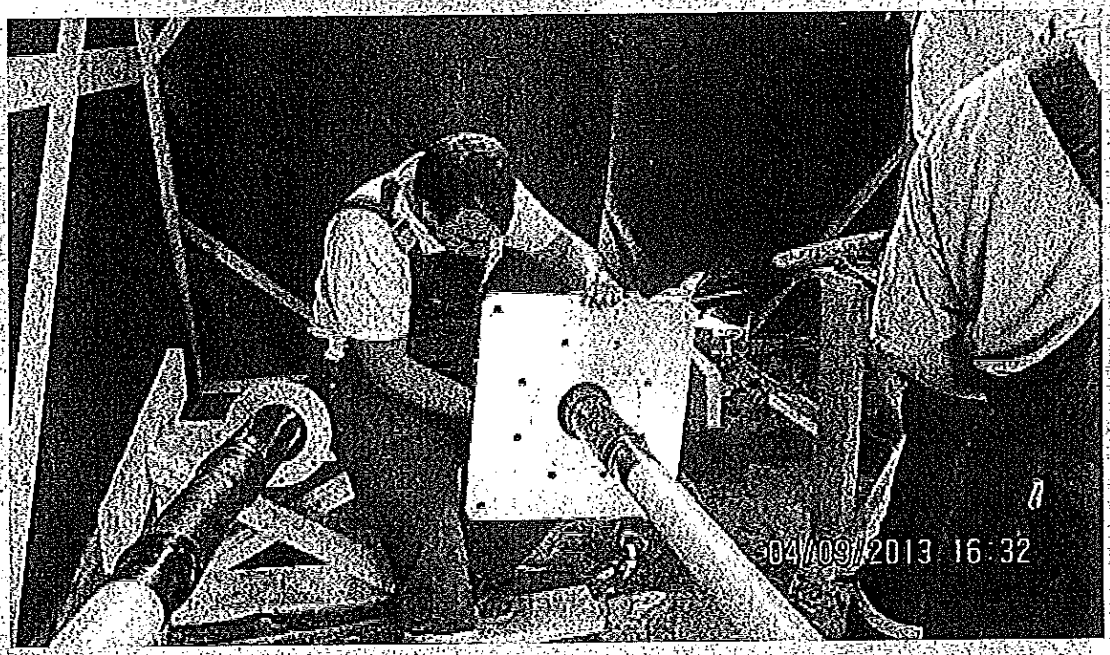
- technical and technological global supervision;
- installation quality control by specialists having ARKASIL SK certificates;
- providing documentation on the installed Arkasil SK cable accessories;
- the Arkasil SK cable accessories related consultations;
- "Installation Supervision" in the construction standards is not defined yet. Therefore, when making an agreement, it is necessary to be governed by the normative documents, including "The Regulations For Installation/ Supervision", governing the basis for granting consulting services and the contractual relations, in general.

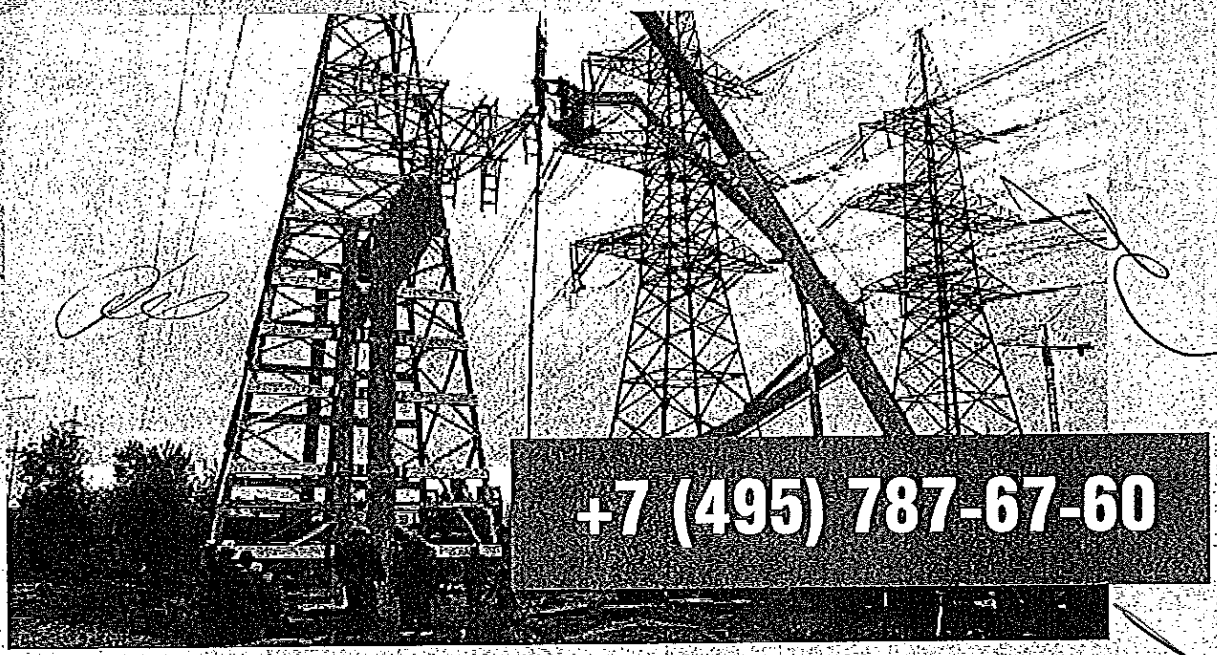
000525

Arkasil

INSTALLATION SERVICE

- installation of the Arkasil SK cable accessories by the specialists certified by Arkasil SK for these works;
- guarantee documentation on the installed Arkasil SK cable accessories;
- the Arkasil SK cable accessories related consultations.





+7 (495) 787-67-60

FOR MORE INFORMATION

000526

"КРАСИН" СМОЛЯН ООД

SPECIALISTS TRAINING OF ASSEMBLY COMPANIES

Training takes place at the training center, located in the industrial base of Arkasil SK. Also, in order to optimize the training company Arkasil SK provides it on the jointers site service for the training of production facilities and training installers.

THE TRAINING SHALL INCLUDE

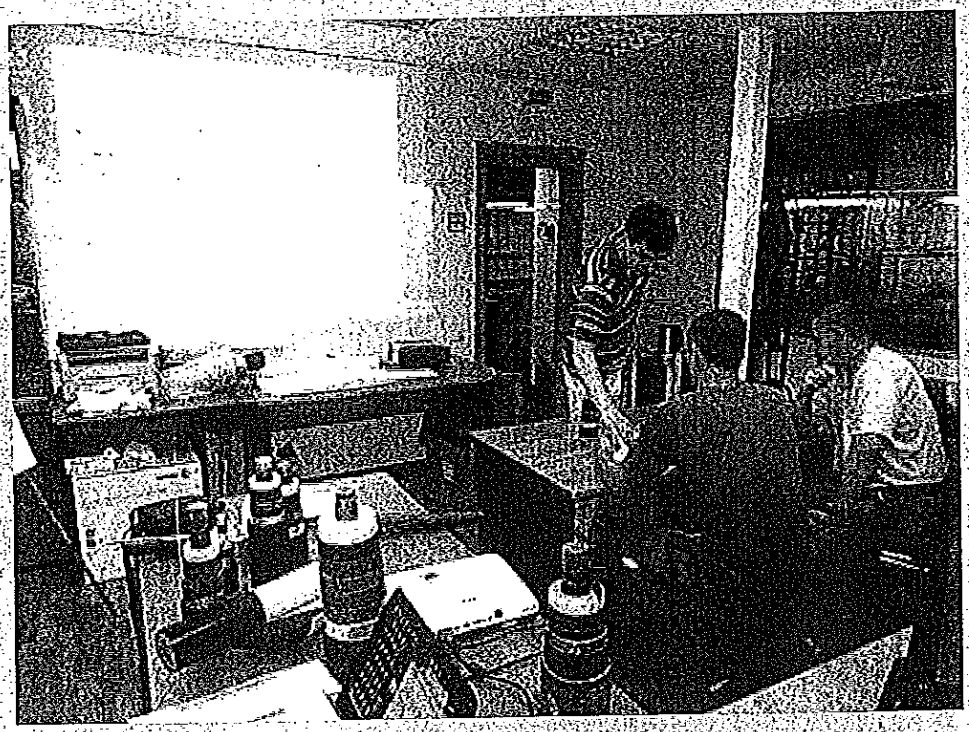
- theory training;
- practical training;
- tests;
- sample preparation for certification;
- granting certificates.

During the theoretical part of the training specialists communicate general information about cables.

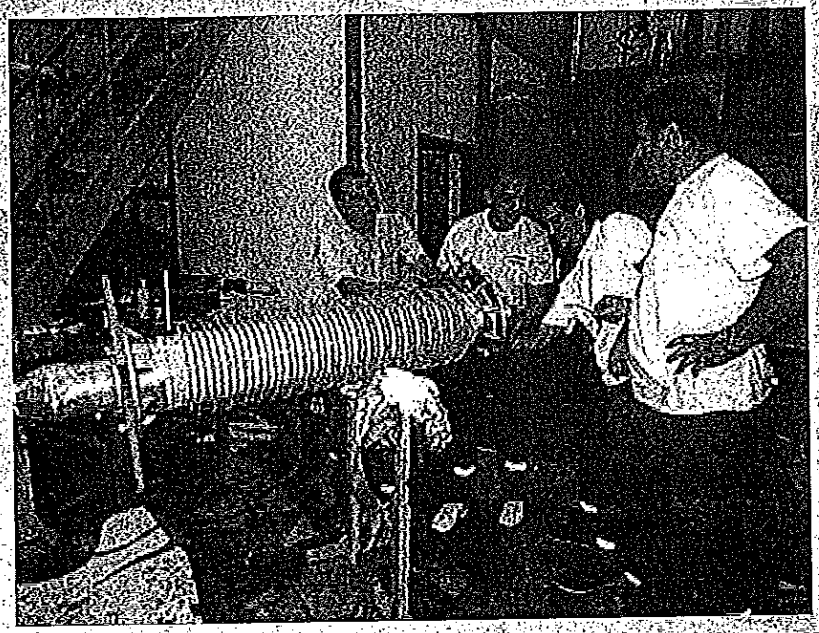
The theoretical part includes information about XLPE-cables, cable accessories 110-220 kV of different types, technological processes of terminations and joints installation, workplace preparation, safety measures, technical documentation preparation. The practical part includes the technological process using cable samples and installation tools, practicing terminations and joints installation work. The quality of technological operations on the cable sample is estimated in the accompanying of an experienced jointer attestat-training-insulating sheet.

000527

"КРАСИН" СМОЛЯН ООД



On the exam checked the quality of theoretical material and process of terminations and joints installation on the stand. Affter the interview and the practical experience the staff get the certificate in accordance with Regulation of qualified Arkasil SK cable accessories 110-220 kV installation training.



As the result of the examination the jointers from other companies get the permission to carry out the installation of Arkasil SK cable accessories.

000528

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН 39 ООД

Arkasil-SK LLC

Contacts:

111250, Russia, Moscow, Proezd Zavoda Serp i Molot 6, bld.1
Tel./Fax: +7 495 787-67-60
E-mail: info@arkasil.com
web-site: www.arkasil.com

000529

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация

Приложение № 3 към Предложение за изпълнение на поръчката по т.15.3. от Техническото предложение – Заверени копия на документи за Сух силов кабел 110 kV - Al 1600 mm2:

- Приложение № 3.4. към т.15.3.4 от Техническото предложение – Други по преценка на участника (декларации за съответствие и др.) – технически данни, инструкции за транспорт и съхранение от производителя.

000530

ESTRALIN PS

APPROVED BY

General Director

на основание чл. 2 от ЗЗЛД

Estralin PS" LLC

P.S. Velkhov

"06" 10 2015

ETI-15-06

Transport and Storage of 110-500 kV XLPE cables and cable accessories

Approved on 06.10.2015

		Full name	Signature	Date
DEVELOPED BY	Leading Constructor			
	Engineer	Grip A.V.	на основание чл. 2 от ЗЗЛД	
	Technical Director	Mirkin A.S.		
	Deputy of General Engineer			
	Head of Projects	Murzin A.V.		
AGREED BY				

000531

КРАСИН СМОЛЕНСК ООО

1 Scope

1.1 This manual is intended for transportation, loading, unloading and storage of drums with 110 - 500 kV power cables with XLPE insulation (hereinafter - cable) and cable accessories for these cables supplied by "Estralin PS" LLC.

1.2 Cable accessories include: joints, outdoor terminations, GIS compact sealing end, transformers compact sealing end, cross-bonding link boxes, earthing link boxes, and other equipment which are installed on cables and accessories and their components.

1.3 The requirements of this manual should be taken into account at work performance planning and also should be used by carriers and customers during transportation and storage of drums with cables and cable accessories.

2 References

During the loading/unloading works and cables transportation one should observe the safety regulations according to local regulatory documents:

Safety regulations in construction;

Safety regulations in work with power-driven tools and accessories;

Fire protection regulations in power plants;

Safety regulations at construction and installation works;

Regulations on labor protection during loading and unloading and positioning of loads;

Regulations on labor protection during operation of industrial vehicles.

3 General

3.1 Main structural elements and the weight of drums for cables are given in Appendices A and B. The size and weight of wooden drums are given in Appendix A. The size and weight of metal drums are given in Appendix B and may also have other parameters. Packaging dimensions are determined by the supplier after obtaining data on the construction lengths from the customer.

3.2 Transportation and storage of drums with power cable should be performed according to local standards.

3.3 Conditions of transportation and storage of cable drums in terms of the climatic factors of the environment impact should meet the following requirements: the open areas in the macroclimatic areas with temperate and cold climate on the atmosphere of any type, at temperatures from -50°C to +50°C, except for cables with polymer materials that do not contain halogens. Provider determines the storage conditions for such cables based on the official data from the manufacturer.

3.4 Conditions of storage of cable drums in terms of the climatic factors of the environment impact should also meet the following requirements: sheds and premises, where air temperature and humidity fluctuations differ insignificantly from outdoor fluctuations (for example, tents, metal storages without thermal insulation) located in macroclimatic areas with temperate and cold climates, at the air temperature from -50°C to +50°C.

For cable drums stored in conditions which set out in cl. 3.3 the storage period comprises 2 years.

For cable drums stored in conditions which set out in cl. 3.4 the storage period comprises 5 years.

Upon the parties agreement, the storage period can be extended after inspection of the cable drums by the supplier's representative and his/her conclusion on the condition of the drums and the cable on it.

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3.5 Conditions of transportation of cable accessories in terms of the climatic factors of the environment impact should meet the requirements as per cl. 3.4.

3.6 Conditions of storage of cable accessories in terms of the climatic factors of the environment impact should meet the following requirements: heated and ventilated warehouses, storages located in any microclimatic areas.

Air temperature at storage - from +5°C to + 40°C.

Relative air humidity at storage:

- average annual value of 60% at + 20°C;
- upper value of 80% at + 25°C.

The above upper value of the relative humidity is also normative at lower temperatures; at higher temperatures the relative humidity is lower. Values of 90% at + 20°C or 50-60% at +40°C correspond to the set upper value of 80% at + 25°C.

3.7 The storage period of cable accessories, their components and materials should meet the requirements set by the manufacturer of cable accessories.

3.8 There can be other conditions of storage and transportation of cables and cable accessories set out in the manufacturers' regulatory technical documentation, on which the Customer shall be notified. The Supplier shall request for an official confirmation of conditions of storage of cable and cable accessories from the manufacturer. These conditions of storage and transportation of cables and cable accessories set by the manufacturer shall be obligatorily met, otherwise, the manufacturer's warranty obligations can be withdrawn.

3.9 At transportation and storage cable drums and accessories shall not be exposed to the impact of vapors of acids, alkalis and other aggressive media, which affect drums, cable and accessories. The list of substances affecting PE cable sheath is set out in Appendix C.

3.10 At transportation, unloading, loading and storage of drums and cable accessories on the territories of substations and functioning power plants it is necessary to comply with the regulations on labor protection (safety precautions) in operation of power plants.

3.11 Works with application of hoisting machines and mechanisms shall be performed in accordance with the requirements and regulations on labor protection at handling operations and positioning of loads and inter-industry regulations on labor protection at operation of industrial vehicles.

3.12 At transportation and storage cable ends shall be sealed.

3.13 At transportation, handling operations and storage it is necessary to ensure integrity of labeling of cable drums and boxes with cable accessories, as well as integrity of labeling of drums, boxes and accompanying documentation attached to the drum or the box.

3.14 It is prohibited to load, unload, transport and store cable drums with defective labeling and cable accessories with damaged package.

3.15 Before and after transportation cable drums and boxes with cable accessories shall be inspected with the participation of the carrier's representative to determine integrity of the drum, cable sheath, as well as integrity of the cable accessories package. The operating procedure of detection of damages is set out in section 5 hereof.

4 Loading, Unloading and Transportation of Cable Drums and Accessories

4.1 Cable drums and accessories can be transported by all modes of transport in accordance with current carriage regulations and cargo loading and fastening regulations applicable for each mode of transport.

4.2 At transportation cable drums must not be on the flange.

4.3 At transportation cable drums must be fastened. At fastening of drums it is prohibited to pierce sidings of drum flanges and lagging with nails and clamps.

An example of cable drum fastening on a low-frame platform is shown in Appendix D.

Picture D1 in Appendix D shows that for drum fastening on the platform chains fastened by hooks to clamps with apertures on the metal platform pass through the aperture in the drum axis and pull the drum to the platform. For tensioning chains are fitted with stretchers.

Picture D2 in Appendix D shows that to prevent rolling down of the drum wooden bars with knees for leaning of the drum flanges are fastened across the wooden floor of the platform.

4.4 For transportation of cable drums it is permitted to use special cages in the vehicle's cargo compartment (in the carbody, trailer, railway platform, barge, etc.).

4.5 For transportation of heavy cable drums it is permitted to use special metal supporting structures for fastening of cable drums. It is permitted to unload cable drums from the vehicle together with the supporting structures. An example of transportation and unloading of the cable drum fastened on the metal supporting structure is shown in Appendix E, pictures D1 and D2.

4.6 At fastening of drums by any of the above means the cable drum shall not touch the floor (platform) to prevent cable damage.

4.7 At transportation cable drums shall be arranged in one layer.

4.8 At placement of two or more drums on a vehicle each drum shall be fastened separately from each other to prevent damage of drums at dynamic loads occurred during transportation (for example, during speedup, braking or dusting).

4.9 The speed of transportation of cable drums shall ensure preservation of drums in case of hard braking.

4.10 Heavy and off-size cable drums shall be transported in accordance with local regulations on highway carriage of heavy and off-size cargos by motor vehicles.

At transportation of drums with large external diameters traffic limitations shall be considered. Depending on local regulations and conditions permits issued by traffic regulation authorities and special trailers with a low draft can be required.

4.11 At loading-unloading of cable drums it is necessary to apply handling accessories (cross-arms) with straps excluding damage of drum flanges and lagging, as well as spindles, insert bushings and cable jaws with hooks inserted in the aperture on the drum axis (see pictures C2 and C3 in Appendix C).

4.12 It is prohibited to unload cable drums by throwing off from cars and other vehicles.

4.13 It is prohibited to unload cable drums by rolling down from cars and other vehicles as well as to load them by rolling up, except for cases when the bottom of the carbody (or the bottom of the railway platform, etc.) is at one level with the floor of the site, on which cable drums are unloaded (or from which cable drums are loaded).

4.14 At roll-over of cable drums it is necessary to observe the direction of rotation marked by an arrow on the drum flange. Rolling of drums with protruding cable ends is prohibited. Cable ends shall be fastened on the interior of the drum, for mean stress cables it is allowed to bring out the cable end to the drum flange.

4.15 Cable drums shall be rolled over such rolling site without objects, which can damage the cable, fastening and the cable.

4.16 When unloading outdoors on soil it is necessary to consider potential damage of the drum lagging and the cable due to soil settlement under the drum load. Large drums can be unloaded and further stored on reinforced concrete slabs placed on the soil, on asphalted or metal platforms.

4.17 In all cases of unloading/loading and storage it is necessary to provide for measures on prevention of self-existing rolling of drums.

4.18 At loading and unloading of drums by means of a forklift loader, the fork shall be aligned with the drum, wherein all the drum flanges shall be placed on the fork (see Appendix F, which contains warning signs on loading and unloading of cable drums).

4.19 Cable accessories shall be transported in covered vehicles.

If necessary, the vehicle type can be set in the manufacturer's regulatory technical documentation.

4.20 Before transportation cable accessories shall be safely fastened in the vehicle.

4.21 It is prohibited to unload cable accessories by throwing off from the vehicle.

4.22 Cable accessories shall be stored in the manufacturer's original package.

4.23 At storage packed cable accessories can be arranged in several layers. The number of permitted layers shall comply with the specification marked on the cable accessories package; otherwise, it is determined by the supplier of cable accessories.

4.24 Cable accessories shall be stored in covered premises beyond the reach of unauthorized persons.

4.25 During storage cable accessories shall be protected from mechanical impact, vapors of acids, alkalis and other aggressive media, which affect package and cable accessories themselves, as well as from sun rays, precipitations and dust.

4.26 During storage it is necessary to observe completeness of cable accessories. It is prohibited to seize components from cable accessories without re-registration of cable accessories in the accounting storage documentation.

5 Operating Procedure at Detection of Defects in the Cable on the Drum, Cable Accessories, Damage of Drum Lagging or Cable Accessories Package

5.1 All detected damages of cable drum, drum lagging, defects in cable accessories and damage of cable accessories package shall be immediately notified to "Estralin PS" LLC.

5.2 Damages shall be inspected by a commission in the presence of an authorized representative of "Estralin PS" LLC.

5.3 In case of a cable drum damage, the damage report shall contain: order number, name of the cable line, for which the cable is meant, cable grade, factory number of the cable drum, date of manufacture, factory length, cable length on the drum, location and nature of damage, date and place of drawing up the protocol, last names and positions of signatories with specification of represented organizations or enterprises.

5.4 Upon detection of defects in cable accessories or damage of cable accessories package the report shall contain: order number, name of the cable line or substation, for which the cable accessories are meant, grade of the cable, for which the cable accessories are meant, manufacturer of the cable accessories, brief description of the detected defects or damage of package, date and place of drawing up the protocol, last names and positions of signatories with specification of represented organizations or enterprises.

5.5 Photos of the defects shall be also attached to the report.

5.6 One copy of the report shall be submitted to "Estralin PS" LLC.

5.7 In case of considerable cable damages it is necessary to inspect not only cable sheath but also structural elements under the sheath with obligatory participation of "Estralin PS" LLC's representative. The necessity and procedure of such inspection shall be determined by the commission on inspection of the damage site with the participation of "Estralin PS" LLC's representative.

5.8 In particular cases, in case of doubts about the quality of parts and units of cable accessories, these parts and units can be returned to "Estralin PS" LLC for quality expertise with attraction of specialists from the manufacturer of cable accessories. A conclusion on causes of the defects and suitability for mounting shall be drawn up based on the examination results.

6 Appendices

Appendix A. Dimensions and Weight of Wooden Cable Drums.
Appendix B. Dimensions and Weight of Metal Cable Drums.
Appendix C. List of Substances Affecting PE Cable Sheath.
Appendix D. Fastening of a Cable Drum on a Low-Frame Platform.
Appendix E. Transportation, Loading and Unloading of Cable Drums
Appendix F. Warning Signs with Requirements to Loading and Unloading of Cable Drums.

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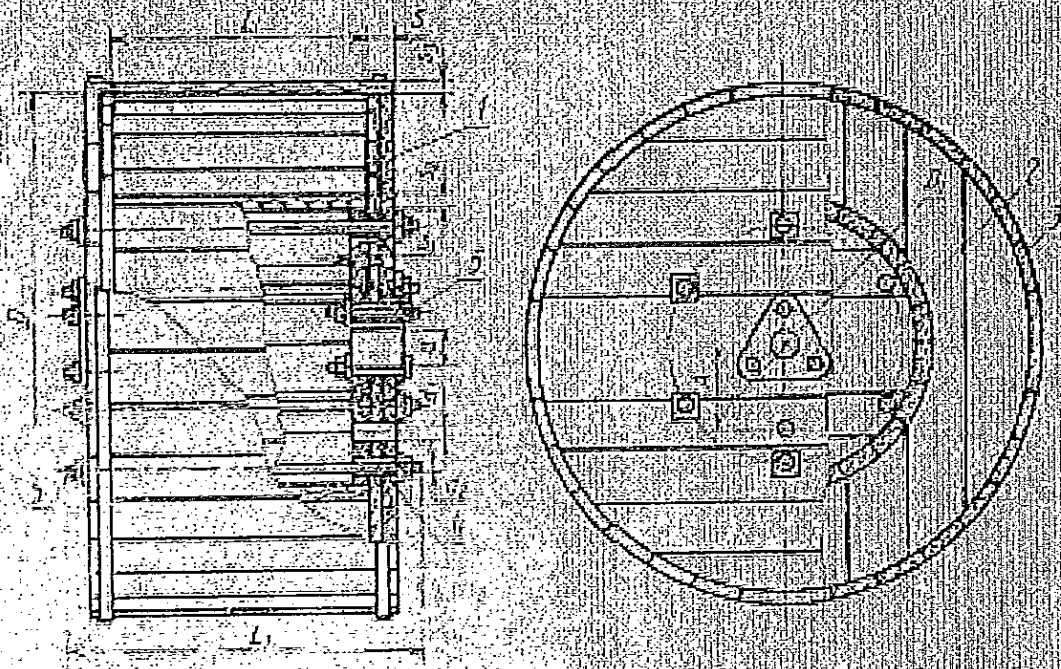
Appendix A

Dimensions and Weight of Wooden Cable Drums



flange; 2-barrel; 3-lagging; 4- barrel ring; 5-central bore; 6-pin

able A1. Dimensions of Sidings and Tapes for Wooden Drum Lagging

Drum number	Siding, mm		Thickness and width of the steel tape, mm
	Thickness of siding S_1, mm	Width of siding, no more than, mm	
5-8(5	16	150	0.5-0.5 x 20-55
10-14g	19	200	0.5-0.5 x 20-55
16-18)	25	250	0.5-0.5 x 25-55
20(-22)	32	250	0.5-0.5 x 35-45
25-30g	40	250	0.5-0.5 x 35-55

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Appendix A (continued)

Table A2. Dimensions of Wooden Drums (all dimensions in mm)

Drum number	Diameter flange D	Diameter barrel D1	Barrel length L	Thickness flange S	Thickness barrel S2	Inside diameter axial d	Inside diameter driving d1	Dimension A	Lagging length	Pin length L1
5	500	200	230	38	16	35	35	60	306	350
6	600	200	230	38	19	35	35	60	326	370
8	800	450	230	38	19	50	50	130	306	350
8а	800	450	400	38	19	50	50	150	476	520
8б	800	450	500	38	19	50	50	150	576	620
10	1000	545	500	50	22	50	50	150	600	646
10а	1000	500	710	50	22	50	50	150	810	864
12	1220	650	500	50	22	70	50	250	600	650
12а	1220	650	710	50	22	70	50	250	810	864
12б	1220	600	600	50	25	70	50	250	700	750
14	1400	750	710	38	28	70	50	250	824	875
14а	1400	900	500	58	22	70	50	250	616	665
14б	1400	1000	600	58	28	70	50	250	716	770
14в	1400	750	710	70	28	70	50	250	830	904
14г	1400	750	900	58	28	70	50	250	1016	1065
16	1600	1200	600	58	30	70	50	300	716	770
16а	1600	800	800	58	30	80	50	300	916	970
17	1700	900	750	70	28	80	50	400	890	944
17а	1700	900	900	70	28	80	50	300	1040	1094
18	1800	1120	900	80	30	80	50	300	1060	1120
18а	1800	900	900	80	36	80	50	300	1060	1122
18б	1800	750	1000	80	36	80	50	300	1160	1222
18в	1800	900	730	80	30	80	50	300	890	950
20	2000	1220	1000	90	36	80	50	300	1180	1250
20а	2000	1000	1060	90	36	80	50	400	1240	1302
20б	2000	1500	1000	90	36	80	50	400	1180	1242
22	2200	1320	1000	118	46	100	50	400	1236	[illegible]
22а	2200	1400	[illegible]	118	46	100	50	400	1336	1348
22б	2200	1400	1100	118	46	100	50	400	[illegible]	[illegible]
22в	2200	1520	1300	118	46	100	50	400	[illegible]	[illegible]
25	2500	1500	1300	130	56	120	50	400	1560	[illegible]
26	2600	1500	1500	140	56	120	50	400	1780	1850
30	3000	1800	1800	180	56	150	50	400	[illegible]	[illegible]
30а	3000	2500	1700	[illegible]	46	150	50	400	[illegible]	[illegible]

Note: There are other customized dimensions of wooden drums. [illegible]

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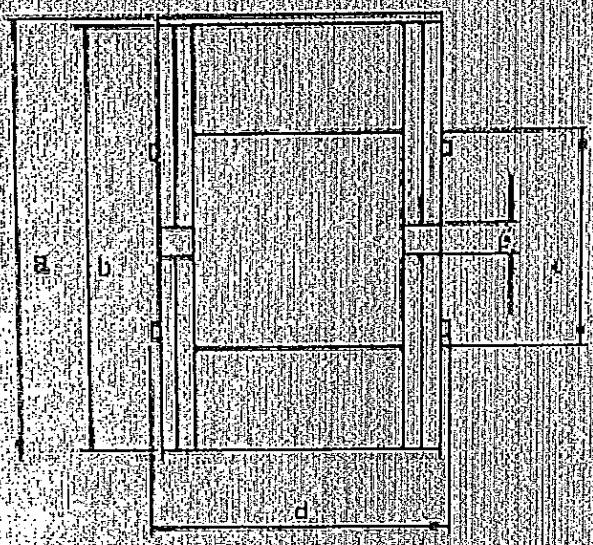
Appendix 18

Dimensions and Weight of Metal Cable Drums



a) diameter, including lagging;
b) flange diameter;
c) barrel diameter;
d) total width;
e) central bore diameter.

Table B1: Dimensions and Weight of Metal Drums

Drum type	Volume, m³	Weight, including weight of lagging, kg	Diameter, including lagging, mm	Flange diameter, mm	Barrel diameter, mm	Total width, mm	Central bore diameter, mm
SI-28	20.6	1500	2930	2800	2000	2400	150
SI-30	23.5	1700	3170	3000	2000	2510	150
SI-32	26.6	2200	3430	3200	2000	2700	180
SI-34	28.7	2600	3570	3400	2000	2900	180
SI-35	30.6	2700	3630	3500	2000	2900	180
SI-36	33.4	2800	3730	3600	2000	2900	180
SI-37	35.2	3000	3830	3700	2000	2900	180
SI-38	37	3100	3930	3800	2000	2900	180
SI-39	38.9	3300	4030	3900	2000	2900	180
SI-40	40.8	3500	4130	4000	2000	2900	180
SI-42	45.1	4000	4430	4300	2000	3200	180

Appendix C

List of Substances Affecting PE Cable Sheath

The list contains data on stability (satisfactory, limited or unsatisfactory) of the material of cable sheath (high density PE) to the impact of different substances in the absence of internal pressure and external mechanic tension and at the temperatures of 20°C and 60°C.

1. The material of cable sheath has an **unsatisfactory stability at the temperatures of 20°C and 60°C** to the impact of the following substances:

- brome (liquid or gas), iodine in alcoholic solution and potassium salt, fluorine (gas);
- halogen derivatives: methyl bromide, bromoform, Dutch liquid, dichlorobenzene, dichloropropylene, methylcyclohexane, propylene dichloride, tetrachloroethylene, trichlorobenzene, trichloroethylene, tetrabromoethane, benzene chloride, chloroform, chlorosulfonic acid, thionyl chloride, ethyl chloride, ethylene chloride, methyl chloride, methylene chloride;
- aromatic hydrocarbons;
- depentene, tetradecane, tetrahydrofuran, sulfur trioxide, diethyl ether, depentene, iso-pentane, isopropylamine, isopropanol amine, ethyl mercaptamine, nitrobenzene, nitrotoluene, N-pentane, oleum, pentane-2, furfurol, cyclohexane, O-Zylene, P-Zylene, ethyl benzene;
- nitric acid (95% and higher), nitrohydrochloric acid (HCl : HNO_3 = 3:1), sulfuric acid (fuming);
- kerosene, turpentine (gum).

2. The material of cable sheath has a limited stability at the temperature of 20°C and unsatisfactory stability at the temperature of 60°C to the impact of the following substances: ethyl acrylate, decane, dibutyl amine, carbon disulfide, carbon tetrachloride, xylene, ligroin, lysol, methylcyclohexane, N-heptane, ozone, styrene, titanium tetrachloride, tetrachloromethane, boron trifluoride, toluene, brake fluid, chlorine (saturated water solution or gas), allyl chloride.

3. The material of cable sheath has a satisfactory stability at the temperature of 20°C and unsatisfactory stability at the temperature of 60°C to the impact of the following substances: isopropyl ether, nitroethane, octyl alcohol, olive oil, hydrogen dioxide (90%), sulfuric acid (from 90% to 98%), perchloric acid (70%), ethyl acetate.

4. The material of cable sheath has a limited stability at the temperatures of 20°C and 60°C to the impact of the following substances: acetone, banana oil, benzol, benzene, diacetone alcohol, diethyl ketone, hexachlorophene, camphor oil, calcium sulfide.

5. The material of cable sheath has a satisfactory stability at the temperature of 20°C and a limited stability at the temperature of 60°C to the impact of the following substances: diesel fuel, oil products, carriage grease, solid oil, aniline, hexane, benzaldehyde, benzolchloride, isooctane, sulfuric acid (70%), acetic acid (over 96%), butyric acid, chromic acid, perchloric acid (50%), furfural alcohol, [illegible] alcohol, hydrogen dioxide and some other substances.

Note: The material of cable sheath has a **satisfactory stability at the temperatures 20°C and 60°C** at the impact of [illegible] lubricating oils [illegible] engine oil, etc.), bitumen, castor oil, sunflower, corn and coconut oil, linseed, butter, silicone grease.

The data is [illegible] based on the data provided by Borealis company, source of information: ISO/TR [illegible] [illegible] Kirschner, Borealis, [illegible] [illegible].

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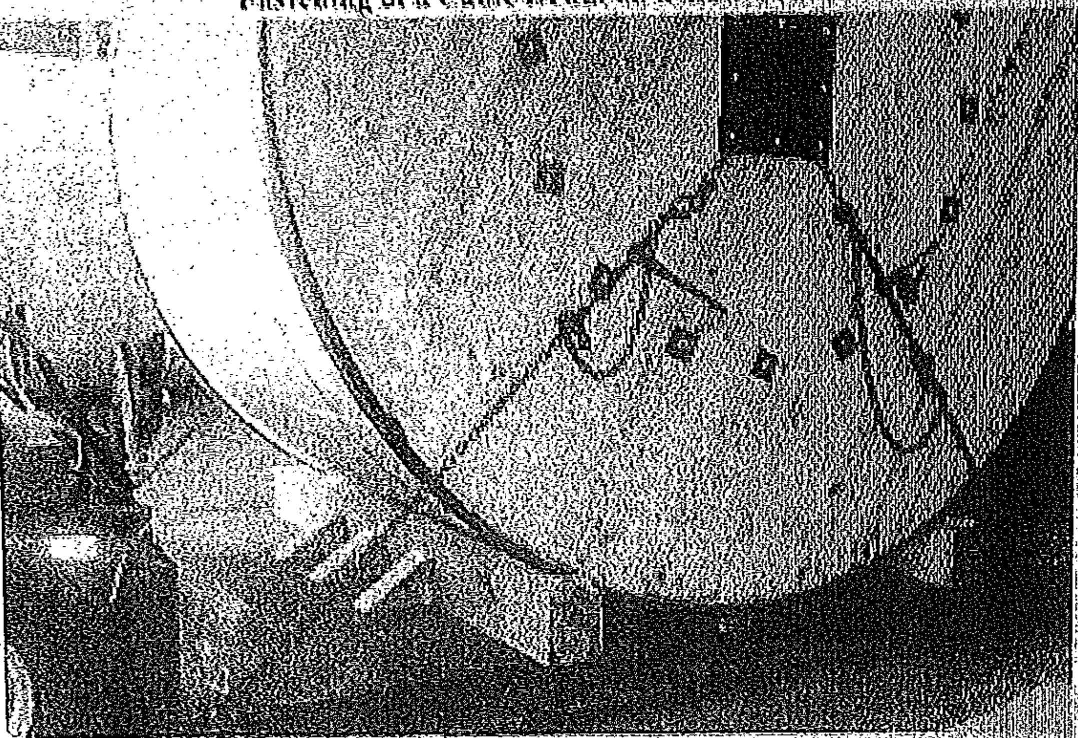
ВЯРНО С ОРИГИНАЛА

КРАСИН СМОЛЯН ООД

Appendix D

Fastening of a Cable Drum on a Low-Frame Platform

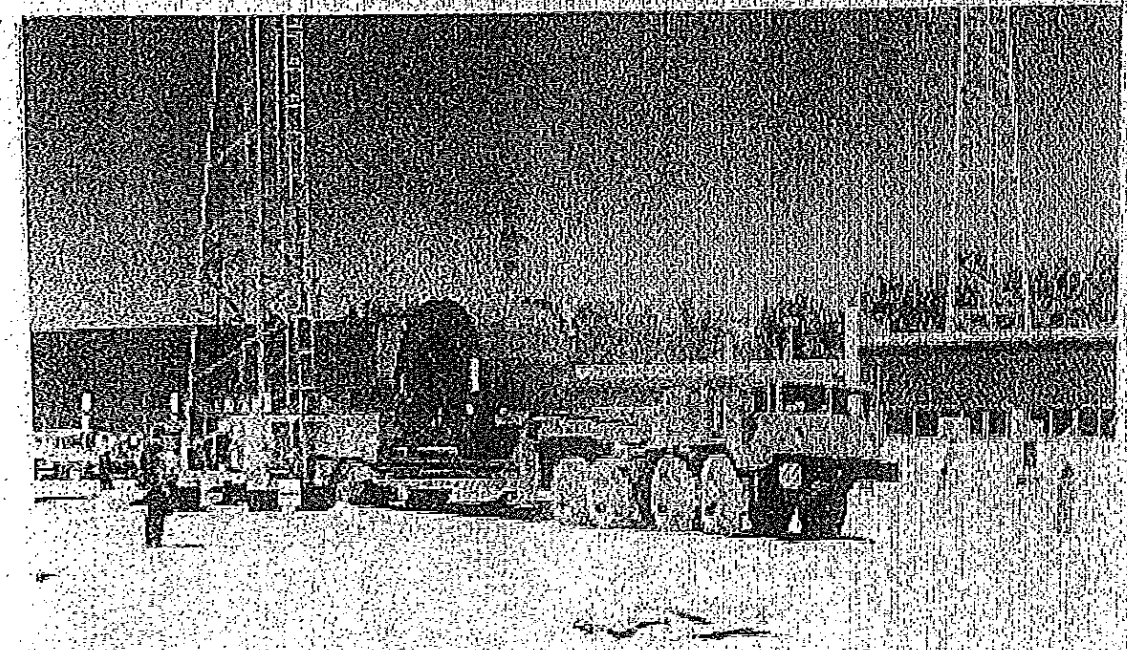


Pic. D1. Fastening of a cable drum to the platform with chains passing through the axis

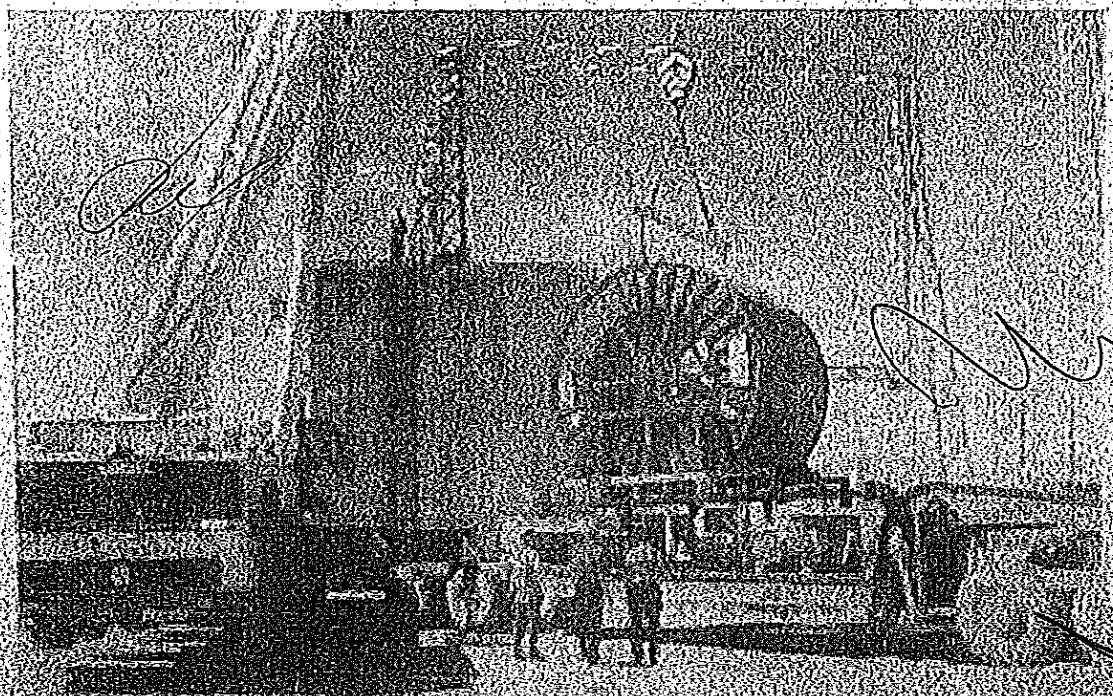
Pic. D2. Fastening of cable on the platform with wooden bars and supports to prevent rolling down

Appendix E

Transportation, Loading and Unloading of Cable Drums



Pic. E1 Transportation of a cable drum fastened on a metal support structure



Pic. E2 Unloading of a cable drum fastened on a metal support structure

Appendix E (continued)

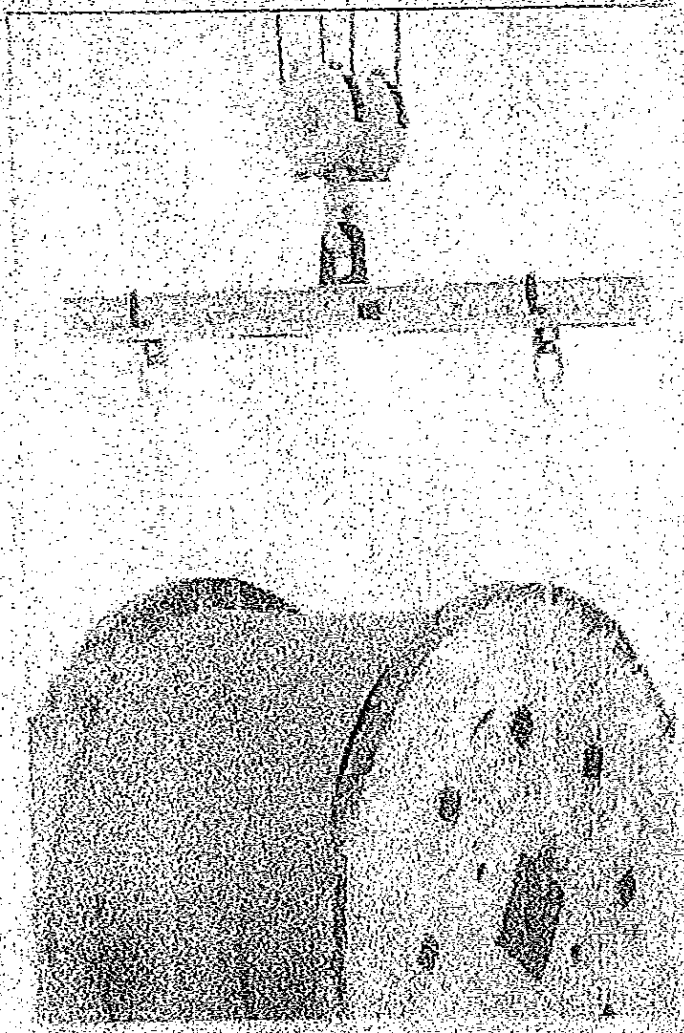
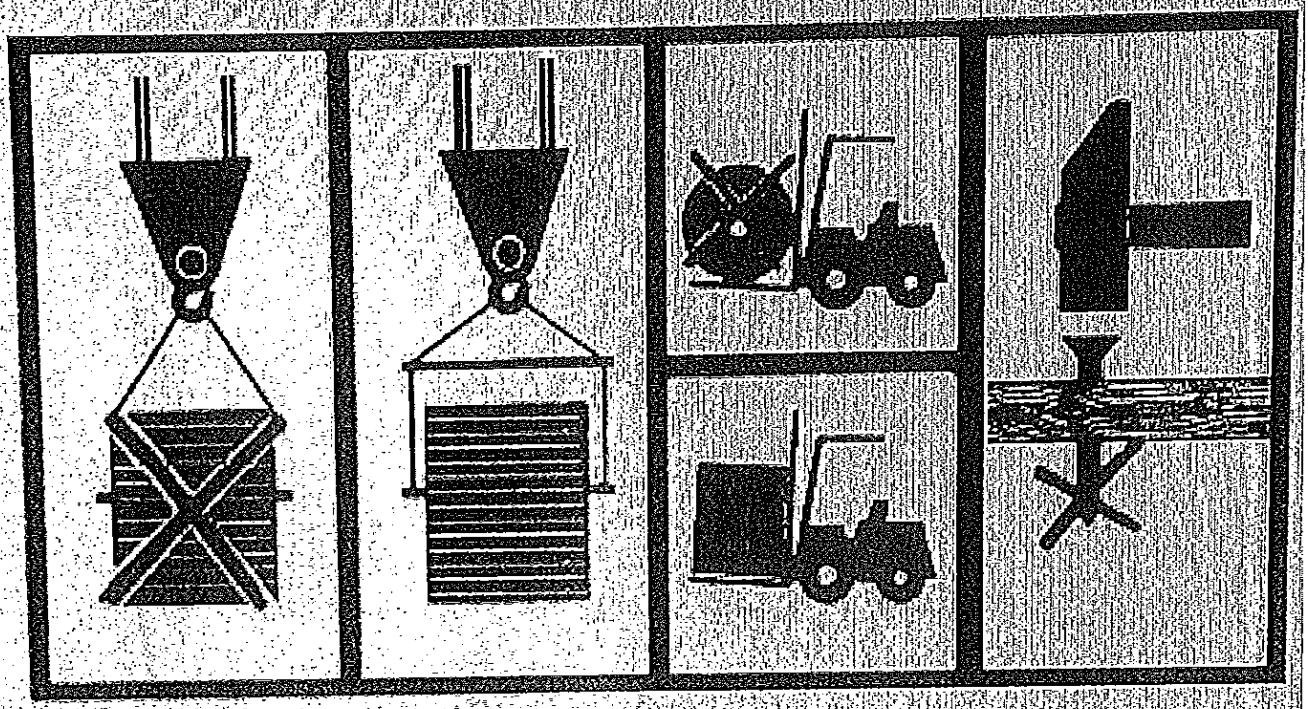


Fig. E.1 Loading and unloading of a cable drum by means of a cross arm with straps and cable jaws

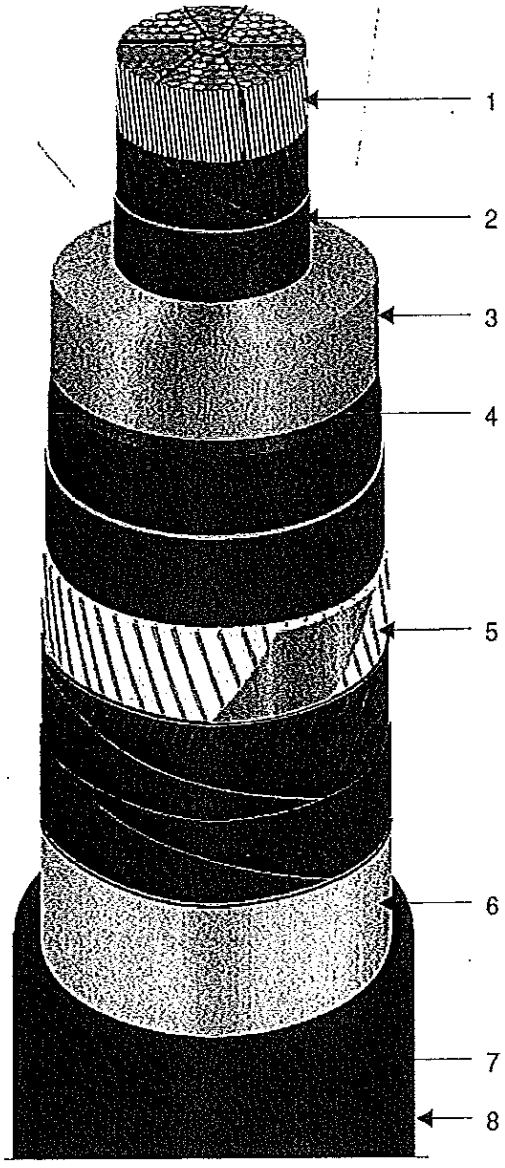
Appendix F

Warning Signs with Requirements to Loading and Unloading of Cable Drums



Design of a cable

A2XS(FL)2Y 1x1600RMS/110 – 64/110 kV



1.Conductor

Material:	Aluminum
Cross section:	1600 mm²
Diameter of conductor:	49,6 mm
Type of conductor:	circular, stranded, segmented
Longitudinal water-tight:	water swelling tape

2.Conductor screen

Material:	semi-conductive PE
Wall thickness:approx.	1,5 mm *
Type:	extruded PE

3.Insulation

Material:	XLPE
Nominal Wall Thickness:	15,0 mm
Voltage level $U_o/U_n/U_m$:	64 / 110 / 123 kV

4.Insulation screen

Material:	semi-conductive PE
Type:	extruded PE

5.Screen/metallic sheath

Material:	Copper wire and copper tape
Cross section:	110 mm²
Longitudinal water-tight :	semi-conductive water blocking tape

6.Radial water barrier

Material:	Aluminium
Wall thickness:	0,2 mm

7.Outer sheath

Material:	HDPE
Nominal thickness:	3,8 mm
Overall diameter:	approx.101,6 mm

8.Special components

Conductive layer:	no
Weight:	approx. 11,0 kg/m;
Min bending radius:	1,524 m.
Max pulling force:	48 kN.

* All data's are computed values. The exact value will be submitted at the beginning of manufacturing.

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

Mechanical characteristics	
Cable weight, approximately, kg/m	11,0
Outer diameter, mm	101,6
Maximum pulling force, kN	48,0
Minimal bending radius, m	1,524
Electrical parameters	
DC resistance of the conductor at 20°C, Ω/km	0,0186
AC resistance of the conductor. at 90°C, Ω/km	0,0247
Capacitance per phase, uF/km	0,31
Inductance between the conductor and screen, mH/km	0,12
Capacitive charging current, per phase, A/km	6,16
One second short circuit current on the conductor, kA	152,3
One second short circuit current on the screen, kA	20,6

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ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация

Приложение № 4 към Предложение за изпълнение на поръчката по т.15.4. от Техническото предложение – Заверени копия на документи за Цифрови защити за въводно поле „ЗЕНИТ" 110 kV:

- Приложение/я № 4.1. към т.15.4.1. от Техническото предложение – Последно издание на каталога/части от каталога на производителя/ите.

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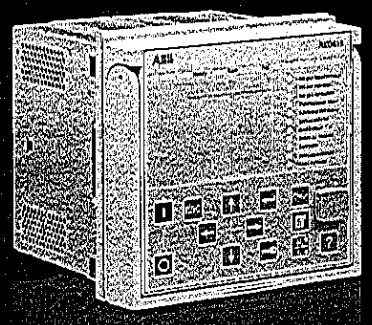

Relion® 615 series

Line Differential Protection and Control RED615 Product Guide

Line Differential Protection and Control	1MRS756500 L
RED615	
Product version: 5.0 FP1	

Contents

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Power and productivity for a better world™

ABB

1. Description

RED615 is a phase-segregated two-end line differential protection and control relay designed for utility and industrial power systems, including radial, looped and meshed distribution networks with or without distributed power generation. RED615 is also designed for the protection of line differential applications with a transformer within the protection zone. RED615 relays communicate between substations over a fiber optic link or a galvanic pilot wire connection. RED615 is a member of ABB's Relion® product family and part of its 615 protection and control product series. The 615 series relays are characterized by their compactness and withdrawable-unit design. Re-engineered from the ground up, the 615 series has been guided by the IEC 61850 standard for communication and interoperability of substation automation equipment.

The relay provides unit type main protection for overhead lines and cable feeders in distribution networks. The relay also features current-based protection functions for remote back-up for down-stream protection relays and local back-up for the line differential main protection. Further, standard configurations B and C also include earth-fault protection. Standard configurations D and E include directional overcurrent and voltage based protection functions.

The relay is adapted for the protection of overhead line and cable feeders in isolated neutral, resistance earthed, compensated (impedance earthed) and solidly earthed networks. Once the relay has been given the application-specific settings, it can directly be put into service.

The 615 series relays support a range of communication protocols including IEC 61850 with Edition 2 support, process bus according to IEC 61850-9-2 LE, IEC 60870-5-103, Modbus® and DNP3. Profibus DPV1 communication protocol is supported by using the protocol converter SPA-ZC 302.

2. Standard configurations

RED615 is available in five alternative standard configurations. The standard signal configuration can be altered by means of the signal matrix or the graphical application functionality of the Protection and Control IED Manager PCM600. Further, the application configuration functionality of PCM600 supports the creation of multi-layer logic functions utilizing various logical elements including timers and flip-flops. By combining protection functions with logic function blocks the relay configuration can be adapted to user specific application requirements.

The relay is delivered from the factory with default connections described in the functional diagrams for binary inputs, binary outputs, function-to-function connections and alarm LEDs. Some of the supported functions in RED615 must be added with the Application Configuration tool to be available in the Signal Matrix tool and in the relay. The positive measuring direction of directional protection functions is towards the outgoing feeder.

Line Differential Protection and Control | 1MRS756500 L
RED615
Product version: 5.0 FP1

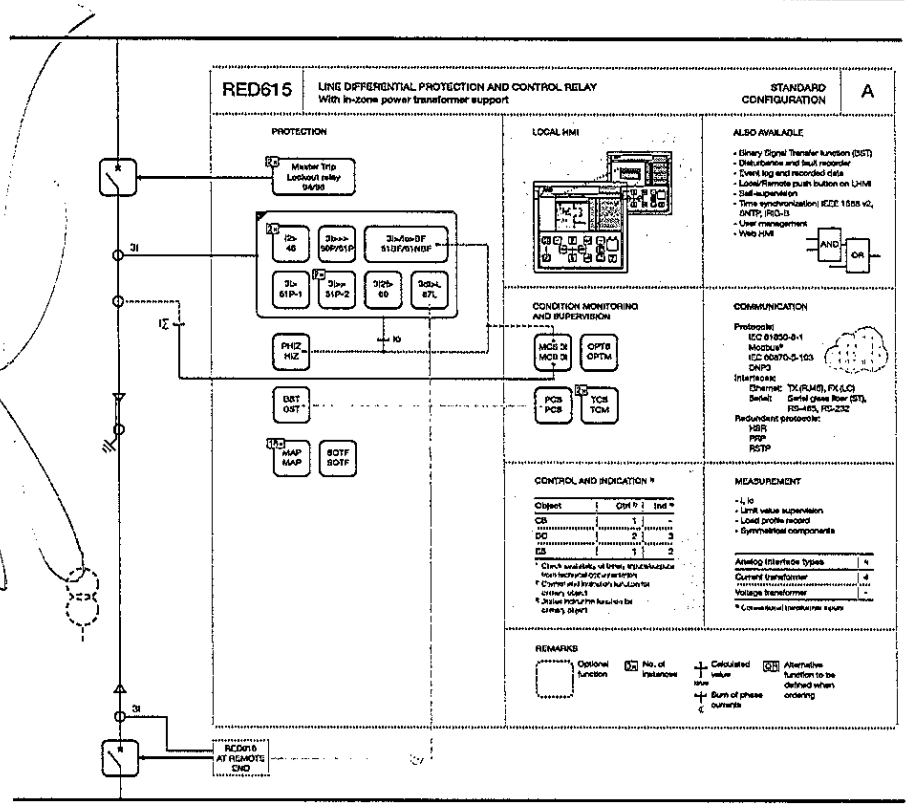

Figure 1. Functionality overview for standard configuration A

ABB

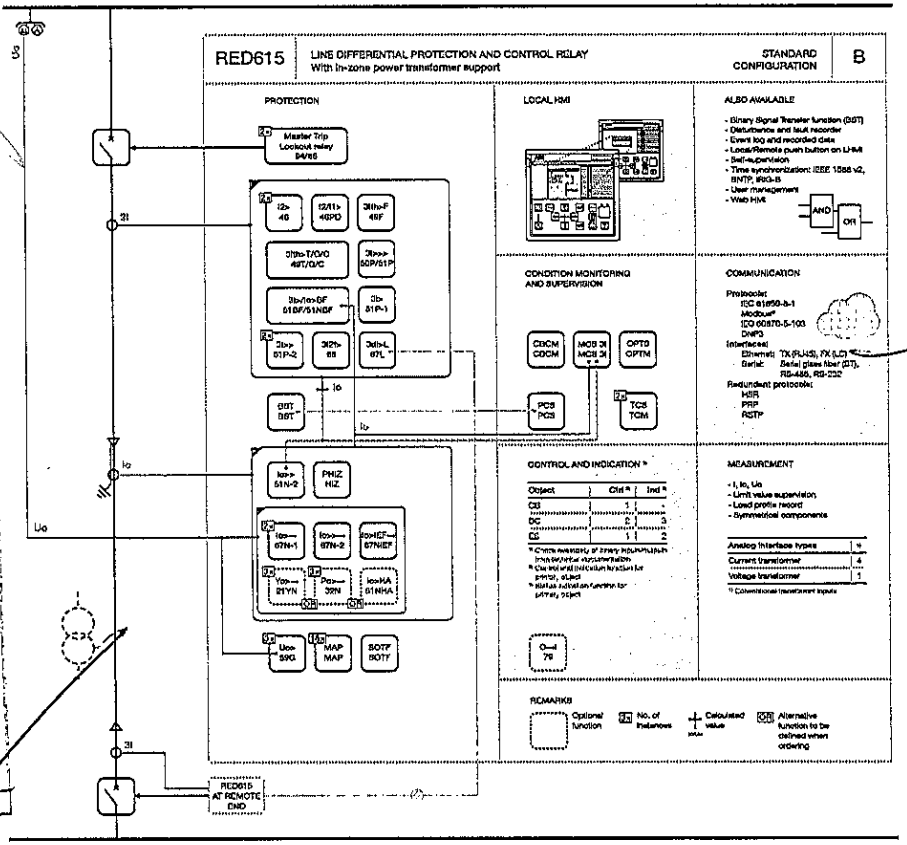

Figure 2. Functionality overview for standard configuration B

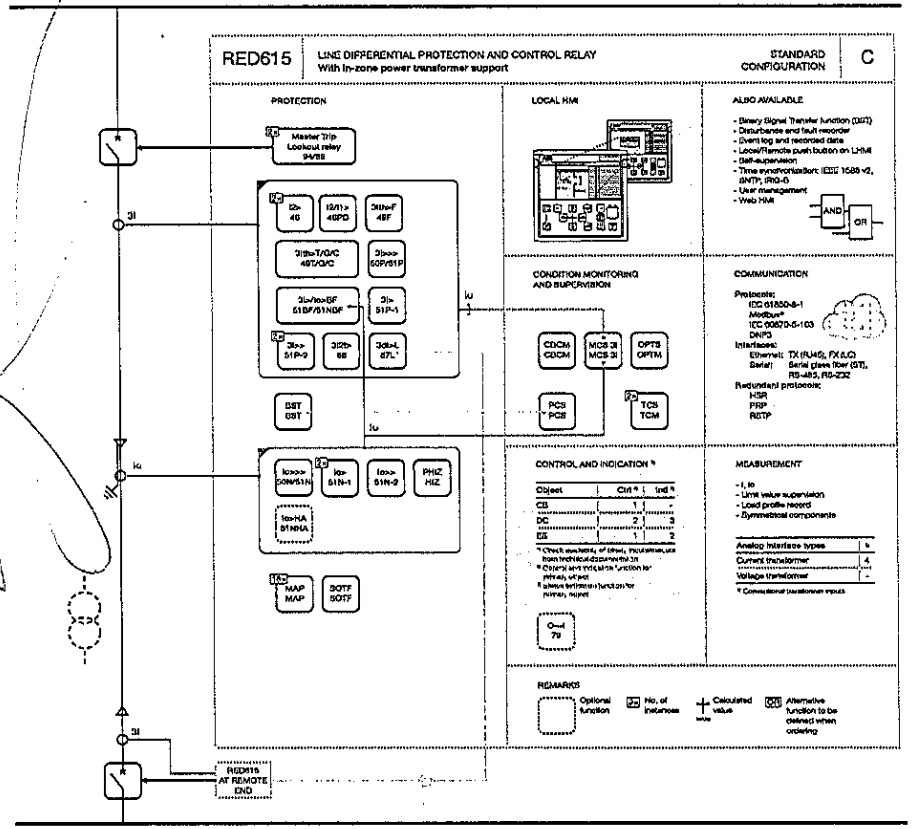

Figure 3. Functionality overview for standard configuration C

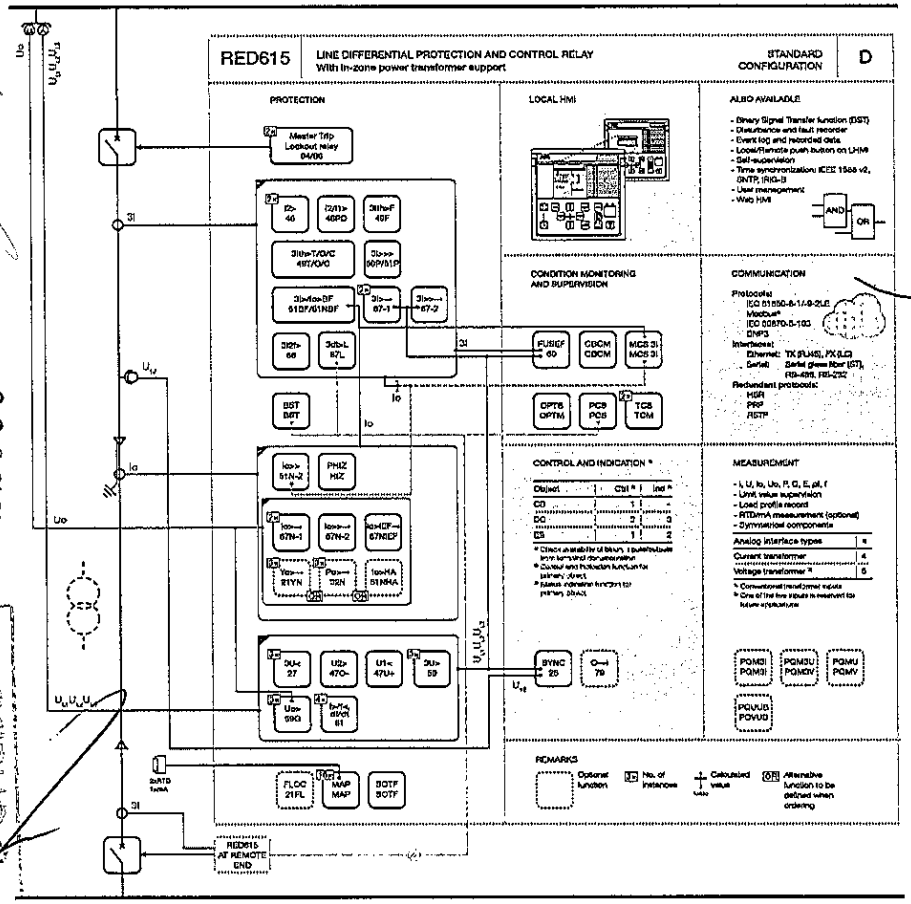

Figure 4. Functionality overview for standard configuration D

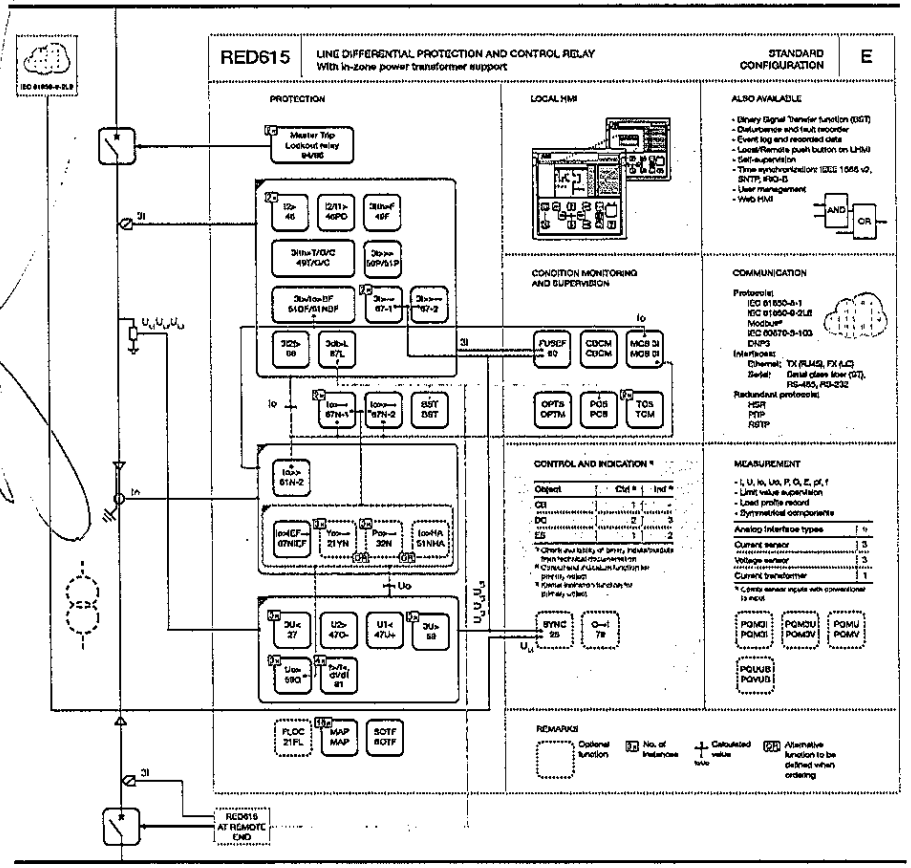

Figure 5. Functionality overview for standard configuration E

Table 1. Standard configurations

Description	Std. conf.
Line differential protection	A
Line differential protection with directional earth-fault protection and circuit-breaker condition monitoring	B
Line differential protection with non-directional earth-fault protection and circuit-breaker condition monitoring	C
Line differential protection with directional overcurrent and earth-fault protection, voltage and frequency based protection and measurements, synchro-check and circuit-breaker condition monitoring (RTD option, optional power quality and fault locator)	D
Line differential protection with directional overcurrent and earth-fault protection, voltage and frequency based protection and measurements, and circuit-breaker condition monitoring (sensor inputs, optional power quality, fault locator and synchro-check with IEC 61850-9-2 LE)	E

Table 2. Supported functions

Function	IEC 61850	A	B	C	D	E
Protection						
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	1	1	1		
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	2	2	2		
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	1	1	1	1	1
Three-phase directional overcurrent protection, low stage	DPHLPDOC				2	2
Three-phase directional overcurrent protection, high stage	DPHHPDOC				1	1
Non-directional earth-fault protection, low stage	EFLPTOC			2		
Non-directional earth-fault protection, high stage	EFHPTOC			1		
Non-directional earth-fault protection, instantaneous stage	EFIPTOC			1		
Directional earth-fault protection, low stage	DEFLPDEF		2 [1]		2	2 [2]
Directional earth-fault protection, high stage	DEFHPDEF		1 [1]		1	1 [2]
Admittance-based earth-fault protection [3]	EFPADM		(3) [1][3]		(3) [3]	(3) [2][3]
Wattmetric-based earth-fault protection [3]	WPWDE		(3) [1][3]		(3) [3]	(3) [2][3]
Transient/intermittent earth-fault protection	INTRPTEF		1 [1][4]		1 [4]	1 [2][4]
Harmonics-based earth-fault protection [3]	HAEFPTOC		(1) [3][4]	(1) [3][4]	(1) [3][4]	(1) [3][4]
Non-directional (cross-country) earth-fault protection, using calculated Io	EFHPTOC		1		1	1
Negative-sequence overcurrent protection	NSPTOC	2	2	2	2	2
Phase discontinuity protection	PDNSPTOC		1	1	1	1
Residual overvoltage protection	ROVPTOV		3 [1]		3	3 [2]
Three-phase undervoltage protection	PHPTUV				3	3
Three-phase overvoltage protection	PHPTOV				3	3
Positive-sequence undervoltage protection	PSPTUV				1	1
Negative-sequence overvoltage protection	NSPTOV				1	1
Frequency protection	FRPFRQ				4	4
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR		1	1	1	1
Three-phase thermal overload protection, two time constants	T2PTTR		1	1	1	1
Binary signal transfer	BSTGGIO	1	1	1	1	1
Circuit breaker failure protection	CCBRBRF	1 [6]	1	1	1	1
Three-phase inrush detector	INRPHAR	1	1	1	1	1
Switch onto fault	CBPSOF	1	1	1	1	1
Master trip	TRPPTRC	2	2	2	2	2
Multipurpose protection	MAPGAPC	18	18	18	18	18
Fault locator	SCEFRFLO				(1)	(1)
Line differential protection with in-zone power transformer	LNPLDF	1	1	1	1	1
High-impedance fault detection	PHIZ	1	1	1	1	
Power quality						
Current total demand distortion	CMHAI				(1) [5]	(1) [5]
Voltage total harmonic distortion	VMHAI				(1) [5]	(1) [5]
Voltage variation	PHQVVR				(1) [5]	(1) [5]
Voltage unbalance	VSQVUB				(1) [5]	(1) [5]
Control						
Circuit-breaker control	CBXCBR	1	1	1	1	1
Disconnector control	DCXSWI	2	2	2	2	2
Earthing switch control	ESXSWI	1	1	1	1	1
Disconnector position indication	DCSXSWI	3	3	3	3	3
Earthing switch indication	ESSXSWI	2	2	2	2	2
Autoreclosing	DARREC		(1)	(1)	(1)	(1)
Synchronism and energizing check	SECRSYN				1	(1) [7]
Condition monitoring and supervision						
Circuit-breaker condition monitoring	SSCBR		1	1	1	1
Trip circuit supervision	TCSSCBR	2	2	2	2	2
Current circuit supervision	CCSPVC	1	1	1	1	1

Table 2. Supported functions, continued

Function	IEC 61850	A	B	C	D	E
Fuse failure supervision	SEQSPVC				1	1
Protection communication supervision	PCSITPC	1	1	1	1	1
Runtime counter for machines and devices	MDSOPT	1	1	1	1	1
Measurement						
Disturbance recorder	RDRE	1	1	1	1	1
Load profile record	LDPRLRC	1	1	1	1	1
Fault record	FLTRFRC	1	1	1	1	1
Three-phase current measurement	CMMXU	1	1	1	1	1
Sequence current measurement	CSMSQI	1	1	1	1	1
Residual current measurement	RESCMMXU		1	1	1	1
Three-phase voltage measurement	VMMXU				2	1 (1) [7]
Residual voltage measurement	RESVMMXU		1		1	
Sequence voltage measurement	VSMSQI				1	1
Three-phase power and energy measurement	PEMMXU				1	1
RTD/mA measurement	XRGGIO130				(2)	
Frequency measurement	FMMXU				1	1
IEC 61850-9-2 LE sampled value sending [7][9]	SMVSENDER				(1)	(1)
IEC 61850-9-2 LE sampled value receiving (voltage sharing) [7][9]	SMVRCV				(1)	(1)
Other						
Minimum pulse timer (2 pcs)	TPGAPC	4	4	4	4	4
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC	1	1	1	1	1
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC	1	1	1	1	1
Pulse timer (8 pcs)	PTGAPC	2	2	2	2	2
Time delay off (8 pcs)	TOFGAPC	4	4	4	4	4
Time delay on (8 pcs)	TONGAPC	4	4	4	4	4
Set-reset (8 pcs)	SRGAPC	4	4	4	4	4
Move (8 pcs)	MVGAPC	2	2	2	2	2
Generic control point (16 pcs)	SPCGAPC	2	2	2	2	2
Analog value scaling (4 pcs)	SCA4GAPC	4	4	4	4	4
Integer value move (4 pcs)	MVI4GAPC	1	1	1	1	1

1, 2, ... = Number of included instances. The instances of a protection function represent the number of identical protection function blocks available in the standard configuration.
(1) = optional

1) "Uo measured" is always used.
2) "Uo calculated" is always used.
3) One of the following can be ordered as an option: admittance-based E/F, wattmetric-based E/F or harmonics-based E/F.
4) "Io measured" is always used.
5) "Io calculated" is always used.
6) Power quality option includes current total demand distortion, voltage total harmonic distortion, voltage variation and voltage unbalance.
7) Available only with IEC 61850-9-2
8) Available only with COM0031...0037

3. Protection functions

The relay offers two-stage phase-segregated line differential protection, phase overcurrent protection, negative-sequence overcurrent protection and circuit breaker failure protection. Depending on the chosen standard configuration, the basic functionality can be extended by thermal overload protection, non-directional or directional overcurrent protection, directional or non-directional earth-fault protection, sensitive earth-fault protection, phase discontinuity protection, transient/intermittent earth-fault protection, residual overvoltage protection, phase-voltage and frequency based protection and three-pole multishot autoreclosing functions for overhead line feeders. For standard configurations B, D and E, admittance-based, wattmetric-based or harmonics-based earth-fault protection is offered as an option in addition to the directional earth-fault protection.

The line differential protection function includes a stabilized low stage and an instantaneous high stage. The stabilized low stage provides sensitive differential protection and remains stable during, for example, current transformer saturation conditions. The low-stage operation can be restrained using second harmonic detection if an out-of-zone power transformer is to be energized. The instantaneous high stage offers less sensitive differential protection but enables fast operation during high fault currents. If there is an in-zone transformer in the protection zone, the vector group is automatically compensated based on the winding types and clock number setting values.

The operating time characteristic for the low stage can be set to definite time or inverse definite time mode. The direct intertrip function ensures that both ends are always simultaneously tripped, independent of the fault current contribution.

4. Application

RED615 can be used in a variety of applications requiring an absolutely selective unit type protection system. The zone-of-protection of a line differential protection system is the feeder section defined by the location of the current transformers in the local and the remote substation. RED615 can also be used for line differential protection if there is an in-zone transformer in the protected feeder section.

Combining horizontal GOOSE communication over a station bus and binary signal transfer over the protection communication link offers new application possibilities beyond traditional line differential protection. One interesting application based on inter-substation signal transfer is loss-of-mains (LOM) protection in networks with distributed generation. The performance of the combination of binary signal transfer and horizontal GOOSE communication performance as to speed, selectivity and reliability are hard to match with conventional loss-of-mains protection.

RED615 is the ideal relay for the protection of feeders in network configurations containing closed loops. Under normal operating conditions the feeder loop is closed. The aim of the closed loop is to secure the availability of power for the end users. As a result of the closed loop configuration, any fault spot in the system will be fed with fault current from two directions. Using plain overcurrent protection, either directional or non-directional, it is difficult to obtain fast and selective short circuit protection. With RED615 line differential protection relays the faulty part of the network can be selectively isolated, thus securing power distribution to the healthy part of the network.

The standard configuration E includes one conventional residual current (Io) input and three combi-sensor inputs for phase currents and phase voltages. The connection of the three combi-sensors is made with RJ-45 type of connectors.

Sensors offer certain benefits compared to conventional current and voltage instrument transformers. For example, current sensors do not saturate at high currents, they consume less energy and they weigh less. In voltage sensors the risk of ferro-resonance is eliminated. The sensor inputs also enable the use of the relay in compact medium voltage switchgears, such as ABB's UniGear Digital, SafeRing and SafePlus, with limited space for conventional measuring transformers, thus requiring the use of sensor technology. Further, the adapters also enable the use of sensors with Twin-BNC connectors.

Under certain operational circumstances, such as maintenance of primary equipment or substation extension projects there will be a need to interconnect network parts, which normally are separated. To avoid major re-parameterization of the protection devices of the network when the network topology is changed, line differential protection relays can be used to obtain absolutely selective feeder protection in looped networks.

ABB

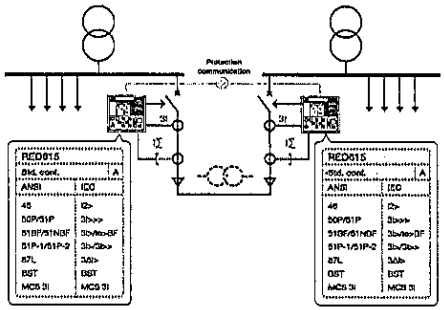

Figure 6. Line differential protection for an interconnecting feeder between two primary distribution substations using standard configuration A

Figure 6 illustrates line differential protection for an interconnecting feeder between two primary distribution substations using standard configuration A. Additionally, protection is offered for a in-zone power transformer, when available and located in the protection zone.

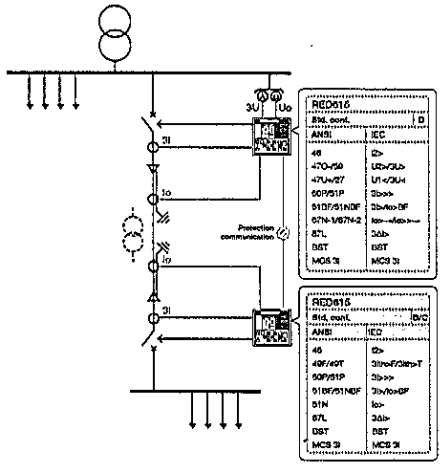

Figure 7. Line differential protection of a feeder using the standard configurations D and B or C

Line differential protection of a feeder using the standard configurations D and B or C is shown in Figure 7. Additionally, protection is offered for an in-zone power transformer, when available and located in the protection zone.

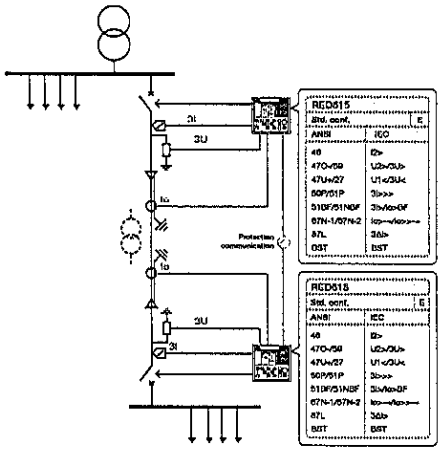

Figure 8. Line differential protection of a feeder using the standard configuration E

Figure 8 illustrates line differential protection of a feeder using the standard configuration E, in which current sensors (Rogowski coil) and voltage sensors (voltage divider) are used for the measurements. Additionally, protection is offered for an in-zone power transformer, when available and located in the protection zone. The standard configuration E has been pre-configured especially for ABB switchgears, for example, UniGear Digital. However, the use of this configuration is not restricted for this purpose only.

Standard configurations D and E are not designed for using all the available functionality content in one relay at the same time. Frequency protection functions and third instances of voltage protection functions must be added with the Application Configuration tool. To ensure the performance of the relay, the user-specific configuration load is verified with the Application Configuration tool in PCM600.

5. Supported ABB solutions

The 615 series protection relays together with the Substation Management Unit COM600S constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate the system engineering, ABB's relays are supplied with connectivity packages. The connectivity packages include a compilation of software and relay-specific information, including single-line diagram templates and a full relay data model. The data model includes event and parameter lists. With the connectivity packages, the relays can be readily configured using PCM600 and integrated with COM600S or the network control and management system MicroSCADA Pro.

The 615 series relays offer native support for IEC 61850 Edition 2 also including binary and analog horizontal GOOSE messaging. In addition, process bus with the sending of sampled values of analog currents and voltages and the receiving of sampled values of voltages is supported. Compared to traditional hard-wired, inter-device signaling, peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for power system protection. Among the distinctive features of the protection system approach, enabled by the full implementation of the IEC 61850 substation automation standard, are fast communication capability, continuous supervision of the protection and communication system's integrity, and an inherent flexibility regarding reconfiguration and upgrades.This protection relay series is able to optimally utilize interoperability provided by the IEC 61850 Edition 2 features.

At substation level, COM600S uses the data content of the bay-level devices to enhance substation level functionality. COM600S features a Web browser-based HMI, which provides a customizable graphical display for visualizing single-line mimic diagrams for switchgear bay solutions. The SLD feature

is especially useful when 615 series relays without the optional single-line diagram feature are used. The Web HMI of COM600S also provides an overview of the whole substation, including relay-specific single-line diagrams, which makes information easily accessible. Substation devices and processes can also be remotely accessed through the Web HMI, which improves personnel safety.

In addition, COM600S can be used as a local data warehouse for the substation's technical documentation and for the network data collected by the devices. The collected network data facilitates extensive reporting and analyzing of network fault situations by using the data historian and event handling features of COM600S. The historical data can be used for accurate monitoring of process and equipment performance, using calculations based on both real-time and historical values. A better understanding of the process dynamics is achieved by combining time-based process measurements with production and maintenance events.

COM600S can also function as a gateway and provide seamless connectivity between the substation devices and network-level control and management systems, such as MicroSCADA Pro and System 800xA.

GOOSE Analyzer interface in COM600S enables the following and analyzing the horizontal IEC 61850 application during commissioning and operation at station level. It logs all GOOSE events during substation operation to enable improved system supervision.

Table 3. Supported ABB solutions

Product	Version
Substation Management Unit COM600S	4.0 SP1 or later
	4.1 or later (Edition 2)
MicroSCADA Pro SYS 600	9.3 FP2 or later
	9.4 or later (Edition 2)
System 800xA	5.1 or later

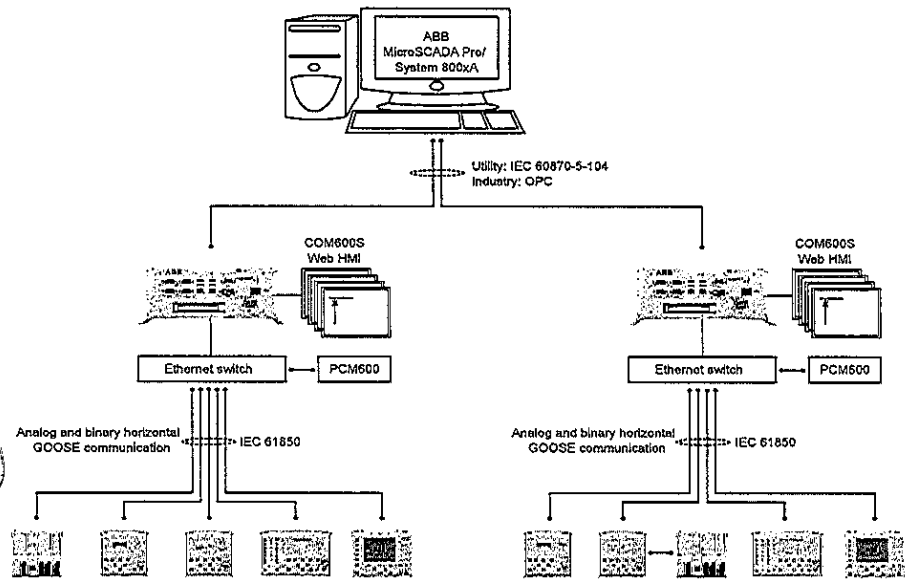

Figure 9. ABB power system example using Relion relays, COM600S and MicroSCADA Pro/System 800xA

6. Control

RED615 integrates functionality for the control of a circuit breaker via the front panel HMI or by means of remote controls. In addition to the circuit-breaker control the relay features two control blocks which are intended for motor-operated control of disconnectors or circuit breaker truck and for their position indications. Further, the relay offers one control block which is intended for motor-operated control of one earthing switch control and its position indication.

Two physical binary inputs and two physical binary outputs are needed in the relay for each controllable primary device taken into use. The number of unused binary inputs and binary outputs varies depending on the chosen standard configuration. Further, some standard configurations also offer optional hardware modules that increase the number of available binary inputs and outputs.

If the amount of available binary inputs or outputs of the chosen standard configuration is not sufficient, the standard configuration can be modified to release some binary inputs or outputs which have originally been configured for other purposes, when applicable, or an external input or output module such as RIO600 can be integrated to the relay. The binary inputs and outputs of the external I/O module can be used for the less time critical binary signals of the application. The integration enables the releasing of some initially reserved binary inputs and outputs of the relay in the standard configuration.

The suitability of the relay's binary outputs which have been selected for controlling of primary devices should be carefully verified, for example, the make and carry as well as the breaking capacity should be considered. In case the requirements for the control-circuit of the primary device are not met, the use of external auxiliary relays should be considered.

The optional large graphical LCD of the relay's HMI includes a single-line diagram (SLD) with position indication for the relevant primary devices. Interlocking schemes required by the application are configured using the signal matrix or the application configuration functionality of PCM600.

ABB

7. Measurements

The relay continuously measures the phase currents, the symmetrical components of the currents and the residual current. If the relay includes voltage measurements, it also measures the residual voltage. The relay also calculates the demand value of the current over a user-selectable, pre-set time frame, the thermal overload of the protected object, and the phase unbalance based on the ratio between the negative-sequence and positive-sequence current.

Furthermore, the relay monitors the phase differential, bias and remote-end phase currents.

The measured values can be accessed via the local HMI or remotely via the communication interface of the relay. The values can also be accessed locally or remotely using the Web HMI.

The relay is provided with a load profile recorder. The load profile feature stores the historical load data captured at a periodical time interval (demand interval). The records are in COMTRADE format.

8. Power quality

In the EN standards, power quality is defined through the characteristics of the supply voltage. Transients, short-duration and long-duration voltage variations and unbalance and waveform distortions are the key characteristics describing power quality. The distortion monitoring functions are used for monitoring the current total demand distortion and the voltage total harmonic distortion.

Power quality monitoring is an essential service that utilities can provide for their industrial and key customers. A monitoring system can provide information about system disturbances and their possible causes. It can also detect problem conditions throughout the system before they cause customer complaints, equipment malfunctions and even equipment damage or failure. Power quality problems are not limited to the utility side of the system. In fact, the majority of power quality problems are localized within customer facilities. Thus, power quality monitoring is not only an effective customer service strategy but also a way to protect a utility's reputation for quality power and service.

The protection relay has the following power quality monitoring functions.

- Voltage variation
- Voltage unbalance
- Current harmonics
- Voltage harmonics

The voltage unbalance and voltage variation functions are used for measuring short-duration voltage variations and monitoring voltage unbalance conditions in power transmission and distribution networks.

The voltage and current harmonics functions provide a method for monitoring the power quality by means of the current waveform distortion and voltage waveform distortion. The functions provides a short-term three-second average and a long-term demand for total demand distortion TDD and total harmonic distortion THD.

9. Fault location

RED615 features an optional impedance-measuring fault location function suitable for locating short-circuits in radial distribution systems. Earth faults can be located in effectively and low-resistance earthed networks. Under circumstances where the fault current magnitude is at least of the same order of magnitude or higher than the load current, earth faults can also be located in isolated neutral distribution networks. The fault location function identifies the type of the fault and then calculates the distance to the fault point. An estimate of the fault resistance value is also calculated. The estimate provides information about the possible fault cause and the accuracy of the estimated distance to the fault point.

10. Disturbance recorder

The relay is provided with a disturbance recorder featuring up to 12 analog and 64 binary signal channels. The analog channels can be set to record either the waveform or the trend of the currents and voltages measured.

The analog channels can be set to trigger the recording function when the measured value falls below or exceeds the set values. The binary signal channels can be set to start a recording either on the rising or the falling edge of the binary signal or on both.

By default, the binary channels are set to record external or internal relay signals, for example, the start or trip signals of the relay stages, or external blocking or control signals. Binary relay signals, such as protection start and trip signals, or an external relay control signal via a binary input, can be set to trigger the recording. Recorded information is stored in a non-volatile memory and can be uploaded for subsequent fault analysis.

11. Event log

To collect sequence-of-events information, the relay has a non-volatile memory capable of storing 1024 events with the associated time stamps. The non-volatile memory retains its data even if the relay temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances. The considerable capacity to process and store data and events in the relay facilitates meeting the growing information demand of future network configurations.

The sequence-of-events information can be accessed either via local HMI or remotely via the communication interface of the relay. The information can also be accessed locally or remotely using the Web HMI.

12. Recorded data

The relay has the capacity to store the records of the 128 latest fault events. The records can be used to analyze the power system events. Each record includes, for example, phase, differential and bias current values and a time stamp. The fault recording can be triggered by the start or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. Fault records store relay measurement values at the moment when any protection function starts. In addition, the maximum demand current with time stamp is separately recorded. The records are stored in the non-volatile memory.

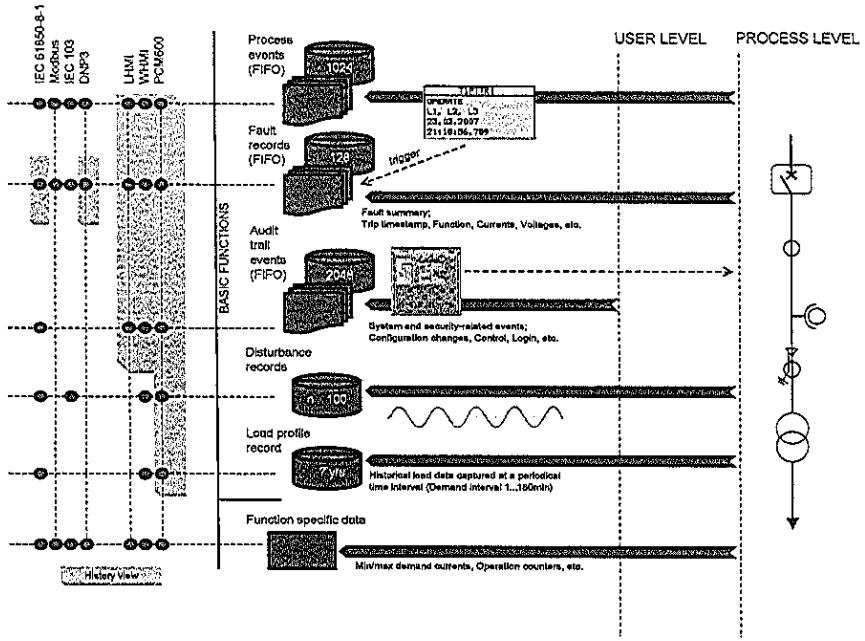

Figure 10. Recording and event capabilities overview

13. Condition monitoring

The condition monitoring functions of the relay constantly monitor the performance and the condition of the circuit breaker. The monitoring comprises the spring charging time, SF6 gas pressure, the travel time and the inactivity time of the circuit breaker.

The monitoring functions provide operational circuit breaker history data, which can be used for scheduling preventive circuit breaker maintenance.

In addition, the relay includes a runtime counter for monitoring of how many hours a protected device has been in operation thus enabling scheduling of time-based preventive maintenance of the device.

14. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed and in its open position. It also detects loss of circuit-breaker control voltage.

15. Self-supervision

The relay's built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected is used for alerting the operator.

A permanent relay fault blocks the protection functions to prevent incorrect operation.

16. Current circuit supervision

The relay includes current circuit supervision. Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED and blocks the line differential protection and negative-sequence overcurrent protection functions to avoid unintended operation. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer or from separate cores in the phase current transformers

17. Protection communication and supervision

The communication between the relays is enabled by means of a dedicated fiber optic communication channel. 1310 nm multi-mode or single-mode fibers with LC connectors are used for line differential communication. The channel is used for transferring the phase segregated current value data between the relays. The current phasors from the two relays, geographically located apart from each other, must be time coordinated so that the current differential algorithm can be executed correctly. The so called echo method is used for time synchronization. No external devices such as GPS clocks are thereby needed for the line differential protection communication.

As an option to the fiber optic communication link a galvanic connection over a pilot wire link composed of a twisted pair cable and RPW600 link-end communication modems can be established. The optional pilot wire communication link is also an ideal and cost efficient retrofit solution for electromechanical line differential protection installations. Compared to conventional combined sequence line differential protection solutions with analog pilot wire communication, RED615 relays in combination with RPW600 communication modems offer a modern phase-segregated line differential protection solution over existing pilot wire cables.

The pilot wire link supports the same protection and communication functionality as the fiber optic link. The quality of service (QoS) is indicated by the modems and the communication link is continuously supervised by the relay. The RPW600 modem offers a 5 kV (RMS) level of isolation between the pilot wire terminals and ground. The RPW600 modems (master and follower) are galvanically connected to either end of the pilot wire and optically connected to the relays using short optical single-mode cables. Using 0.8 mm^2 twisted pair cables pilot wire link distances up to 8 km are typically supported. However, twisted pair pilot wire cables in good conditions may support even longer distances to be covered. The length of the supported pilot wire link also depends on the noise environment in the installation. Should the need arise to replace the pilot wire cables with fiber optic cables, the single mode fiber optic LC connectors of the relays can be utilized for direct connection of the fiber optic communication link.

Apart from the continued protection communication, the communication channel can also be used for binary signal transfer (BST) that is, transferring of user configurable binary information between the relays. There are a total of eight BST signals available for user definable purposes. The BST signals can originate from the relay's binary inputs or internal logics, and be assigned to the remote relay's binary outputs or internal logics.

The protection communication supervision continuously monitors the protection communication link. The relay immediately blocks the line differential protection function in case that severe interference in the communication link, risking the correct operation of the function, is detected. An alarm signal will eventually be issued if the interference, indicating permanent failure in the protection communication, persists. The two high-set stages of the overcurrent protection are further by default released.

Figure 11. Fiber optic protection communication link

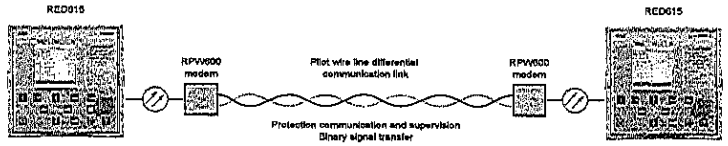

Figure 12. Pilot wire protection communication link

18. Access control

To protect the relay from unauthorized access and to maintain information integrity, the relay is provided with a four-level, role-based authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator levels. The access control applies to the local HMI, the Web HMI and PCM600.

19. Inputs and outputs

Depending on the standard configuration selected, the relay is equipped with three phase-current inputs and one residual-current input for non-directional earth-fault protection and current circuit supervision, or three phase-current inputs, one residual-current input and one residual voltage input for directional earth-fault protection and current circuit supervision.

The standard configuration E includes one conventional residual current (Io 0.2/1 A) input and three sensor inputs for the direct connection of three combi-sensors with RJ-45 connectors. As an alternative to combi-sensors, separate current and voltage sensors can be utilized using adapters. Furthermore, the adapters also enable the use of sensors with Twin-BNC connectors.

The phase-current inputs are rated 1/5 A. Two optional residual-current inputs are available, that is, 1/5 A or 0.2/1 A. The 0.2/1 A input is normally used in applications requiring sensitive earth-fault protection and featuring core-balance current transformers. The residual-voltage input covers the rated voltages 60...210 V.

The phase-current input 1 A or 5 A, the residual-current input 1 A or 5 A, alternatively 0.2 A or 1 A, and the rated voltage of the residual voltage input are selected in the relay software. In addition, the binary input thresholds 16...176 V DC are selected by adjusting the relay's parameter settings.

All binary inputs and outputs contacts are freely configurable with the signal matrix or application configuration functionality of PCM600.

See the input/output overview table and the terminal diagrams for more information about the inputs and outputs.

Table 4. Input/output overview

Std. conf.	Order code digit		Analog channels			Binary channels			
	5-6	7-8	CT	VT	Combi sensor	BI	BO	RTD	mA
A	AC	AD	4	-	-	12	4 PO + 6 SO	-	-
		AF	4	-	-	18	4 PO + 9 SO	-	-
B	AA / AB	AC	4	1	-	11	4 PO + 6 SO	-	-
		AE	4	1	-	17	4 PO + 9 SO	-	-
C	AC	AD	4	-	-	12	4 PO + 6 SO	-	-
		AF	4	-	-	18	4 PO + 9 SO	-	-
D	FE / FF	AD	4	5	-	12	4 PO + 6 SO	2	1
	AE / AF	AG	4	5	-	16	4 PO + 6 SO	-	-
E	DA	AH	1	-	3	8	4 PO + 6 SO	-	-

20. Station communication

The relay supports a range of communication protocols including IEC 61850 Edition 2, IEC 61850-9-2 LE, IEC 60870-5-103, Modbus® and DNP3. Profibus DPV1 communication protocol is supported with using the protocol converter SPA-ZC 302. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the relays, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 protocol is a core part of the relay as the protection and control application is fully based on standard modelling. The relay supports Edition 2 and Edition 1 versions of the standard. With Edition 2 support, the relay has the latest functionality modelling for substation applications and the best interoperability for modern substations. It incorporates also the full support of standard device mode functionality supporting different test applications. Control applications can utilize the new safe and advanced station control authority feature.

The IEC 61850 communication implementation supports monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the standard COMTRADE file format. The relay supports simultaneous event reporting to five different clients on the station bus. The relay can exchange data with other devices using the IEC 61850 protocol.

The relay can send binary and analog signals to other devices using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, for example, be employed for protection and interlocking-based protection schemes. The relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard (<10 ms data exchange between the devices). The relay also supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables easy transfer of analog measurement values over the station bus, thus facilitating for example the sending of measurement values between the relays when controlling parallel running transformers.

The relay also supports IEC 61850 process bus by sending sampled values of analog currents and voltages and by receiving sampled values of voltages. With this functionality the galvanic interpanel wiring can be replaced with Ethernet communication. The measured values are transferred as sampled values using IEC 61850-9-2 LE protocol. The intended application for sampled values shares the voltages to other 615 series relays, having voltage based functions and 9-2 support. 615 relays with process bus based applications use IEEE 1588 for high accuracy time synchronization.

For redundant Ethernet communication, the relay offers two optical Ethernet network interfaces. Ethernet network redundancy can be achieved using the high-availability seamless redundancy (HSR) protocol or the parallel redundancy protocol (PRP) or a with self-healing ring using RSTP in managed switches. Ethernet redundancy can be applied to Ethernet-based IEC 61850, Modbus and DNP3 protocols.

All communication card variants support self-healing ring based Ethernet redundancy. Communication card variants with two optical interfaces for station bus communication have support for HSR and PRP redundancy protocols. These variants include also support for IEEE 1588 based time synchronization.

The IEC 61850 standard specifies network redundancy which improves the system availability for the substation communication. The network redundancy is based on two complementary protocols defined in the IEC 62439-3 standard: PRP and HSR protocols. Both the protocols are able to overcome a failure of a link or switch with a zero switch-over time. In both the protocols, each network node has two identical Ethernet ports dedicated for one network connection. The protocols rely on the duplication of all transmitted information and provide a zero switch-over time if the links or switches fail, thus fulfilling all the stringent real-time requirements of substation automation.

In PRP, each network node is attached to two independent networks operated in parallel. The networks are completely separated to ensure failure independence and can have different topologies. The networks operate in parallel, thus providing zero-time recovery and continuous checking of redundancy to avoid failures.

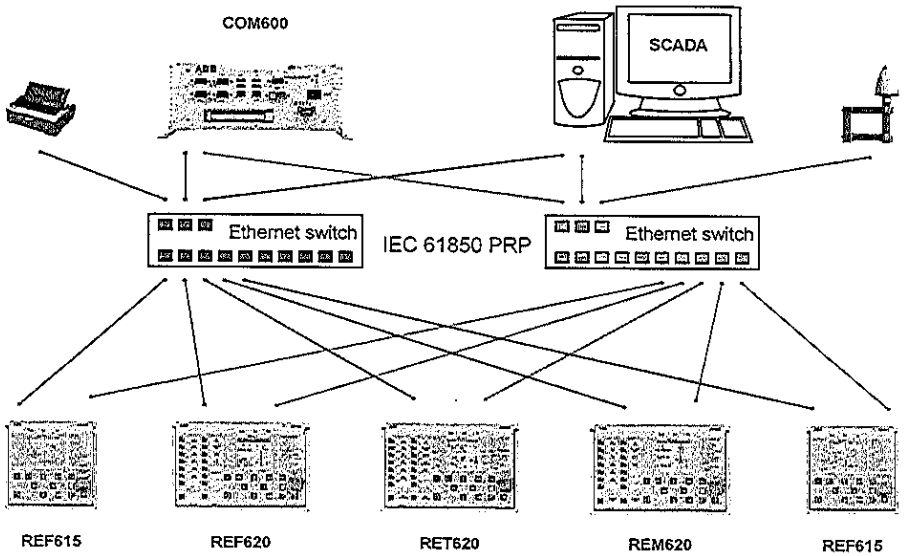

Figure 13. Parallel redundancy protocol (PRP) solution

HSR applies the PRP principle of parallel operation to a single ring. For each message sent, the node sends two frames, one through each port. Both the frames circulate in opposite directions over the ring. Every node forwards the frames it receives from one port to another to reach the next node. When the originating sender node receives the frame it sent, the sender node discards the frame to avoid loops. The HSR ring with 615 series relays supports the connection of up to 30 relays. If more than 30 relays are to be connected, it is recommended to split the network into several rings to guarantee the performance for real-time applications.

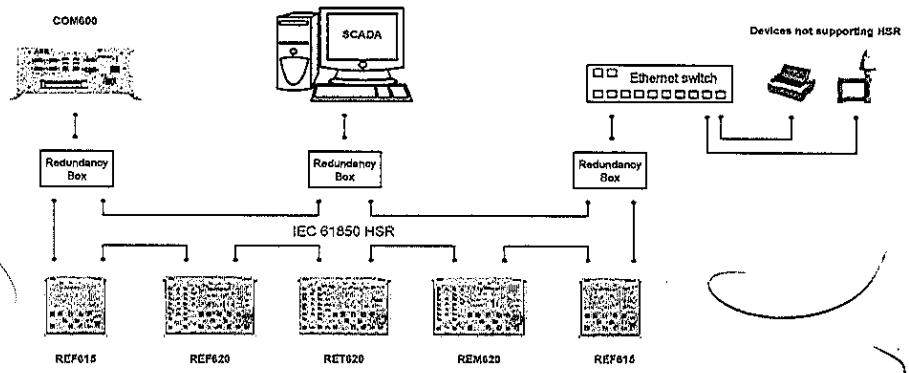

Figure 14. High availability seamless redundancy (HSR) solution

The choice between the HSR and PRP redundancy protocols depends on the required functionality, cost and complexity.

The self-healing Ethernet ring solution enables a cost-efficient communication ring controlled by a managed switch with standard Rapid Spanning Tree Protocol (RSTP) support. The managed switch controls the consistency of the loop, routes the data and corrects the data flow in case of a communication switch-over. The relays in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to 30 615 series relays. If more than 30 relays are to be connected, it is recommended to split the network into several rings. The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication.

The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication. The solution can be applied for the Ethernet-based IEC 61850, Modbus and DNP3 protocols.

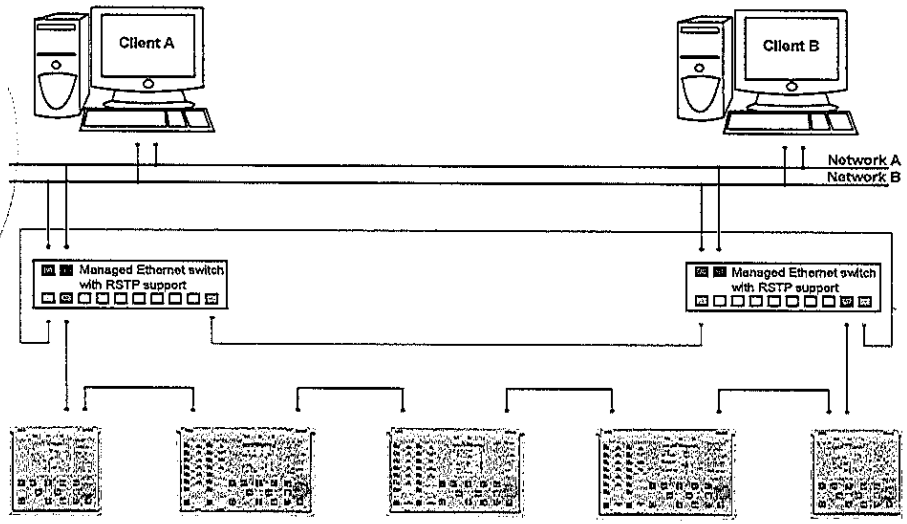

Figure 15. Self-healing Ethernet ring solution

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The relay can be connected to Ethernet-based communication systems via the RJ-45 connector (100Base-TX) or the fiber optic LC connector (100Base-FX).

Modbus implementation supports RTU, ASCII and TCP modes. Besides standard Modbus functionality, the relay supports retrieval of time-stamped events, changing the active setting group and uploading of the latest fault records. If a Modbus TCP connection is used, five clients can be connected to the relay simultaneously. Further, Modbus serial and Modbus TCP can be used in parallel, and if required both IEC 61850 and Modbus protocols can be run simultaneously.

The IEC 60870-5-103 implementation supports two parallel serial bus connections to two different masters. Besides basic standard functionality, the relay supports changing of the active setting group and uploading of disturbance recordings in IEC 60870-5-103 format. Further, IEC 60870-5-103 can be used at the same time with the IEC 61850 protocol.

DNP3 supports both serial and TCP modes for connection up to five masters. Changing of the active setting and reading fault records are supported. DNP serial and DNP TCP can be used in parallel. If required, both IEC 61850 and DNP protocols can be run simultaneously.

615 series supports Profibus DPV1 with support of SPA-ZC 302 Profibus adapter. If Profibus is required the relay must be ordered with Modbus serial options. Modbus implementation includes SPA-protocol emulation functionality. This functionality enables connection to SPA-ZC 302.

When the relay uses the RS-485 bus for the serial communication, both two- and four wire connections are supported. Termination and pull-up/down resistors can be configured with jumpers on the communication card so external resistors are not needed.

The relay supports the following time synchronization methods with a time-stamping resolution of 1 ms.

Ethernet-based
- SNTP (Simple Network Time Protocol)

With special time synchronization wiring
- IRIG-B (Inter-Range Instrumentation Group - Time Code Format B)

Remote-end station time reference
- Line differential

The relay supports the following high accuracy time synchronization method with a time-stamping resolution of 4 µs required especially in process bus applications.
- PTP (IEEE 1588) v2 with Power Profile

The IEEE 1588 support is included in all variants having a redundant Ethernet communication module.

IEEE 1588 v2 features
- Ordinary Clock with Best Master Clock algorithm
- One-step Transparent Clock for Ethernet ring topology
- 1588 v2 Power Profile
- Receive (slave): 1-step/2-step
- Transmit (master): 1-step
- Layer 2 mapping
- Peer to peer delay calculation
- Multicast operation

Required accuracy of grandmaster clock is +/-1 µs. The relay can work as a master clock per BMC algorithm if the external grandmaster clock is not available for short term.

The IEEE 1588 support is included in all variants having a redundant Ethernet communication module.

In addition, the relay supports time synchronization via Modbus, DNP3 and IEC 60870-5-103 serial communication protocols.

Table 5. Supported station communication interfaces and protocols

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX RJ-45	100BASE-FX LC	RS-485	Fiber optic ST
IEC 61850-8-1	•	•	-	-
IEC 61850-9-2 LE	-	•		
MODBUS RTU/ASCII	-	-	•	•
MODBUS TCP/IP	•	•	-	-
DNP3 (serial)	-	-	•	•
DNP3 TCP/IP	•	•	-	-
IEC 60870-5-103	-	-	•	•

• = Supported

21. Technical data

Table 6. Dimensions

Description	Value	
Width	Frame	177 mm
	Case	164 mm
Height	Frame	177 mm (4U)
	Case	160 mm
Depth		201 mm (153 + 48 mm)
Weight	Complete protection relay	4.1 kg
	Plug-in unit only	2.1 kg

Table 7. Power supply

Description	Type 1	Type 2
Nominal auxiliary voltage U_n	100, 110, 120, 220, 240 V AC, 50 and 60 Hz	24, 30, 48, 60 V DC
	48, 60, 110, 125, 220, 250 V DC	
Maximum interruption time in the auxiliary DC voltage without resetting the relay	50 ms at U_n	
Auxiliary voltage variation	38...110% of U_n (38...264 V AC)	50...120% of U_n (12...72 V DC)
	80...120% of U_n (38.4...300 V DC)	
Start-up threshold		19.2 V DC (24 V DC × 80%)
Burden of auxiliary voltage supply under quiescent (P_q)/operating condition	DC <13.0 W (nominal)/<18.0 W (max.) AC <16.0 W (nominal)/<21.0 W (max.)	DC <13.0 W (nominal)/<18.0 W (max.)
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)	
Fuse type	T4A/250 V	

Table 8. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz	
Current inputs	Rated current, I_n	0.2/1 A	1/5 A[1]
	Thermal withstand capability:		
	• Continuously	4 A	20 A
	• For 1 s	100 A	500 A
	Dynamic current withstand:		
	• Half-wave value	250 A	1250 A
	Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage	60...210 V AC	
	Voltage withstand:		
	• Continuous	240 V AC	
	• For 10 s	360 V AC	
	Burden at rated voltage	<0.05 VA	

1) Residual current and/or phase current

ABB

Table 9. Energizing inputs (sensors)

Description		Value
Current sensor input	Rated current voltage (in secondary side)	75 mV...9000 mV[1]
	Continuous voltage withstand	125 V
	Input impedance at 50/60 Hz	2...3 MΩ[2]
Voltage sensor input	Rated voltage	6 kV...30 kV[3]
	Continuous voltage withstand	50 V
	Input impedance at 50/60 Hz	3 MΩ

1) Equals the current range of 40...4000 A with a 80 A, 3 mV/Hz Rogowski
2) Depending on the used nominal current (hardware gain)
3) This range is covered (up to 2*rated) with sensor division ratio of 10 000:1

Table 10. Binary inputs

Description	Value
Operating range	±20% of the rated voltage
Rated voltage	24...250 V DC
Current drain	1.6...1.9 mA
Power consumption	31.0...570.0 mW
Threshold voltage	16...176 V DC
Reaction time	<3 ms

Table 11. RTD/mA measurement (XRGGIO130)

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum 250 Ω platinum 100 Ω nickel 120 Ω nickel 250 Ω nickel 10 Ω copper	TCR 0.00385 (DIN 43760) TCR 0.00385 TCR 0.00618 (DIN 43760) TCR 0.00618 TCR 0.00618 TCR 0.00427
	Supported resistance range	0...2 kΩ	
	Maximum lead resistance (three-wire measurement)	25 Ω per lead	
	Isolation	2 kV (inputs to protective earth)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		± 2.0% or ±1 Ω	±1°C 10 Ω copper: ±2°C
mA inputs	Supported current range	0...20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	±0.5% or ±0.01 mA	

Table 12. Signal output X100: SO1

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

Table 13. Signal outputs and IRF output

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	10 mA at 5 V AC/DC

Table 14. Double-pole power output relays with TCS function

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC (two contacts connected in series)	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC
Trip-circuit supervision (TCS):	
• Control voltage range	20...250 V AC/DC
• Current drain through the supervision circuit	~1.5 mA
• Minimum voltage over the TCS contact	20 V AC/DC (15...20 V)

Table 15. Single-pole power output relays

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC

Table 16. High-speed output HSO with BIO0007

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	6 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Operate time	<1 ms
Reset	<20 ms, resistive load

Table 17. Front port Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
Front	TCP/IP protocol	Standard Ethernet CAT 5 cable with RJ-45 connector	10 MBits/s

Table 18. Protection communication link

Connector	Fibre type	Wave length	Typical max. length[1]	Permitted path attenuation[2]
LC	MM 62.5/125 or 50/125 µm	1300 nm	2 km	<8 dB
LC	SM 9/125 µm[3]	1300 nm	20 km	<8 dB

1) Maximum length depends on the cable attenuation and quality, the amount of splices and connectors in the path.
2) Maximum allowed attenuation caused by connectors and cable altogether
3) Use single-mode fiber with recommended minimum length of 3 m to connect RED615 to the pilot wire modem RPW600.

Table 19. IRIG-B

Description	Value
IRIG time code format	B004, B005[1]
Isolation	500V 1 min
Modulation	Unmodulated
Logic level	5 V TTL
Current consumption	<4 mA
Power consumption	<20 mW

1) According to the 200-04 IRIG standard

Table 20. Degree of protection of flush-mounted protection relay

Description	Value
Front side	IP 54
Rear side, connection terminals	IP 20

Table 21. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C (continuous)
Short-time service temperature range	-40...+70°C (<16h)[1][2]
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	Up to 2000 m
Transport and storage temperature range	-40...+85°C

1) Degradation in MTBF and HMI performance outside the temperature range of -25...+55 °C
2) For relays with an LC communication interface the maximum operating temperature is +70 °C

Table 22. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz/100 kHz burst disturbance test		IEC 61000-4-18 IEC 60255-26, class III IEEE C37.90.1-2002
• Common mode	2.5 kV	
• Differential mode	2.5 kV	
3 MHz, 10 MHz and 30 MHz burst disturbance test		IEC 61000-4-18 IEC 60255-26, class III
• Common mode	2.5 kV	
Electrostatic discharge test		IEC 61000-4-2 IEC 60255-26 IEEE C37.90.3-2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference test		
	10 V (rms) f = 150 kHz...80 MHz	IEC 61000-4-6 IEC 60255-26, class III
	10 V/m (rms) f = 80...2700 MHz	IEC 61000-4-3 IEC 60255-26, class III
	10 V/m f = 900 MHz	ENV 50204 IEC 60255-26, class III
	20 V/m (rms) f = 80...1000 MHz	IEEE C37.90.2-2004
Fast transient disturbance test		IEC 61000-4-4 IEC 60255-26 IEEE C37.90.1-2002
• All ports	4 kV	
Surge immunity test		IEC 61000-4-5 IEC 60255-26
• Communication	1 kV, line-to-earth	
• Other ports	4 kV, line-to-earth 2 kV, line-to-line	
Power frequency (50 Hz) magnetic field immunity test		IEC 61000-4-8
• Continuous	300 A/m	
• 1...3 s	1000 A/m	
Pulse magnetic field immunity test	1000 A/m 6.4/16 µs	IEC 61000-4-9
Damped oscillatory magnetic field immunity test		IEC 61000-4-10
• 2 s	100 A/m	
• 1 MHz	400 transients/s	
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11

Table 22. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
Power frequency immunity test	Binary inputs only	IEC 61000-4-16 IEC 60255-26, class A
• Common mode	300 V rms	
• Differential mode	150 V rms	
Conducted common mode disturbances	15 Hz...150 kHz Test level 3 (10/1/10 V rms)	IEC 61000-4-16
Emission tests		EN 55011, class A IEC 60255-26 CISPR 11 CISPR 12
• Conducted		
0.15...0.50 MHz	<79 dB (µV) quasi peak <66 dB (µV) average	
0.5...30 MHz	<73 dB (µV) quasi peak <60 dB (µV) average	
• Radiated		
30...230 MHz	<40 dB (µV/m) quasi peak, measured at 10 m distance	
230...1000 MHz	<47 dB (µV/m) quasi peak, measured at 10 m distance	
1...3 GHz	<76 dB (µV/m) peak <56 dB (µV/m) average, measured at 3 m distance	
3...6 GHz	<80 dB (µV/m) peak <60 dB (µV/m) average, measured at 3 m distance	

Table 23. Insulation tests

Description	Type test value	Reference
Dielectric tests	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min, communication	IEC 60255-27
Impulse voltage test	5 kV, 1.2/50 µs, 0.5 J 1 kV, 1.2/50 µs, 0.5 J, communication	IEC 60255-27
Insulation resistance measurements	>100 MΩ, 500 V DC	IEC 60255-27
Protective bonding resistance	<0.1 Ω, 4 A, 60 s	IEC 60255-27

Table 24. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 2
Shock and bump test	IEC 60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 2
Seismic test	IEC 60255-21-3	Class 2

Table 25. Environmental tests

Description	Type test value	Reference
Dry heat test	• 96 h at +55°C • 16 h at +70°C[1]	IEC 60068-2-2
Dry cold test	• 96 h at -25°C • 16 h at -40°C	IEC 60068-2-1
Damp heat test	• 6 cycles (12 h + 12 h) at +25°C...+55°C, humidity >93%	IEC 60068-2-30
Change of temperature test	• 5 cycles (3 h + 3 h) at -25°C...+55°C	IEC60068-2-14
Storage test	• 96 h at -40°C • 96 h at +85°C	IEC 60068-2-1 IEC 60068-2-2

1) For relays with an LC communication interface the maximum operating temperature is +70°C

Table 26. Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2013) EN 60255-1 (2009)

Table 27. EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 60255-26 (2013)

Table 28. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Protection functions

Table 29. Three-phase non-directional overcurrent protection (PHxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	PHLPTOC	±1.5% of the set value or ±0.002 × I_n		
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n)		
Start time [1][2]		Minimum	Typical	Maximum
	PHIPTOC: I_{Fault} = 2 × set *Start value* I_{Fault} = 10 × set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	PHHPTOC and PHLPTOC: I_{Fault} = 2 × set *Start value*	23 ms	26 ms	29 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression P-to-P+backup: No suppression		

1) Set *Operate delay time* = 0.02 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact

Table 30. Three-phase non-directional overcurrent protection (PHxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PHLPTOC	0.05...5.00 × I_n	0.01
	PHHPTOC	0.10...40.00 × I_n	0.01
	PHIPTOC	1.00...40.00 × I_n	0.01
Time multiplier	PHLPTOC and PHHPTOC	0.05...15.00	0.01
Operate delay time	PHLPTOC and PHHPTOC	40...200000 ms	10
	PHIPTOC	20...200000 ms	10
Operating curve type[1]	PHLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	PHHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	PHIPTOC	Definite time	

1) For further reference, see the Operation characteristics table

Table 31. Three-phase directional overcurrent protection (DPHxPDOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current/voltage measured: f_n ±2 Hz		
	DPHLPDOC	Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
	DPHHPDOC	Current: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n) Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
Start time[1)2)]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 × set *Start value*	39 ms	43 ms	47 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3)]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) *Measurement mode* and *Pol quantity* = default, current before fault = 0.0 × I_n, voltage before fault = 1.0 × U_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 1.5...20

Table 32. Three-phase directional overcurrent protection (DPHxPDOC) main settings

Parameter	Function	Value (Range)	Step
Start value	DPHLPDOC	0.05...5.00 × I_n	0.01
	DPHHPDOC	0.10...40.00 × I_n	0.01
Time multiplier	DPHxPDOC	0.05...15.00	0.01
Operate delay time	DPHxPDOC	40...200000 ms	10
Directional mode	DPHxPDOC	1 = Non-directional 2 = Forward 3 = Reverse	-
Characteristic angle	DPHxPDOC	-179...180°	1
Operating curve type[1)]	DPHLPDOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DPHHPDOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	

1) For further reference, see the Operating characteristics table

Table 33. Non-directional earth-fault protection (EFxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	EFLPTOC	±1.5% of the set value or ±0.002 × I_n		
	EFHPTOC and EFIPTOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n)		
Start time[1)2)]		Minimum	Typical	Maximum
	EFIPTOC: I_{Fault} = 2 × set *Start value* I_{Fault} = 10 × set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	EFHPTOC and EFLPTOC: I_{Fault} = 2 × set *Start value*	23 ms	26 ms	29 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3)]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression		

1) *Measurement mode* = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 1.5...20

Table 34. Non-directional earth-fault protection (EFxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	EFLPTOC	0.010...5.000 × I_n	0.005
	EFHPTOC	0.10...40.00 × I_n	0.01
	EFIPTOC	1.00...40.00 × I_n	0.01
Time multiplier	EFLPTOC and EFHPTOC	0.05...15.00	0.01
Operate delay time	EFLPTOC and EFHPTOC	40...200000 ms	10
	EFIPTOC	20...200000 ms	10
Operating curve type[1)]	EFLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	EFHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	EFIPTOC	Definite time	

1) For further reference, see the Operation characteristics table

Table 35. Directional earth-fault protection (DEFxPDEF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	DEFLPDEF	Current: ±1.5% of the set value or ±0.002 × I_n Voltage ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
	DEFHPDEF	Current: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n) Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
Start time [1)2)]		Minimum	Typical	Maximum
	DEFHPDEF I_{Fault} = 2 × set *Start value*	42 ms	46 ms	49 ms
	DEFLPDEF I_{Fault} = 2 × set *Start value*	58 ms	62 ms	66 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression		

1) Set *Operate delay time* = 0.06 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 1.5...20

Table 36. Directional earth-fault protection (DEFxPDEF) main settings

Parameter	Function	Value (Range)	Step
Start value	DEFLPDEF	0.010...5.000 × I_n	0.005
	DEFHPDEF	0.10...40.00 × I_n	0.01
Directional mode	DEFLPDEF and DEFHPDEF	1 = Non-directional 2 = Forward 3 = Reverse	-
Time multiplier	DEFLPDEF	0.05...15.00	0.01
	DEFHPDEF	0.05...15.00	0.01
Operate delay time	DEFLPDEF	50...200000 ms	10
	DEFHPDEF	40...200000 ms	10
Operating curve type[1)]	DEFLPDEF	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DEFHPDEF	Definite or inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	DEFxPDEF	1 = Phase angle 2 = IoSin 3 = IoCos 4 = Phase angle 80 5 = Phase angle 88	-

1) For further reference, see the Operating characteristics table

Table 37. Admittance-based earth-fault protection (EFPADM)

Characteristic	Value		
Operation accuracy[1)]	At the frequency f = f_n		
	±1.0% or ±0.01 mS (In range of 0.5...100 mS)		
Start time[2)]	Minimum	Typical	Maximum
	56 ms	60 ms	64 ms
Reset time	40 ms		
Operate time accuracy	±1.0% of the set value of ±20 ms		
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Uo = 1.0 × Un
2) Includes the delay of the signal output contact, results based on statistical distribution of 1000 measurements

Table 38. Admittance-based earth-fault protection (EFPADM) main settings

Parameter	Function	Value (Range)	Step
Voltage start value	EFPADM	0.01...2.00 × U_n	0.01
Directional mode	EFPADM	1 = Non-directional 2 = Forward 3 = Reverse	-
Operation mode	EFPADM	1 = Yo 2 = Go 3 = Bo 4 = Yo, Go 5 = Yo, Bo 6 = Go, Bo 7 = Yo, Go, Bo	-
Operate delay time	EFPADM	60...200000 ms	10
Circle radius	EFPADM	0.05...500.00 mS	0.01
Circle conductance	EFPADM	-500.00...500.00 mS	0.01
Circle susceptance	EFPADM	-500.00...500.00 mS	0.01
Conductance forward	EFPADM	-500.00...500.00 mS	0.01
Conductance reverse	EFPADM	-500.00...500.00 mS	0.01
Susceptance forward	EFPADM	-500.00...500.00 mS	0.01
Susceptance reverse	EFPADM	-500.00...500.00 mS	0.01
Conductance tilt Ang	EFPADM	-30...30°	1
Susceptance tilt Ang	EFPADM	-30...30°	1

Table 39. Wattmetric-based earth-fault protection (WPWDE)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	Current and voltage: ±1.5% of the set value or ±0.002 × I_n Power: ±3% of the set value or ±0.002 × P_n
Start time [1][2]	Typically 63 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Operate time accuracy in IDMT mode	±5.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2,3,4,5,...

1) Io varied during the test, Uo = 1.0 × U_n, = phase to earth voltage during earth fault in compensated or un-earthed network, the residual power value before fault = 0.0 pu, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 40. Wattmetric-based earth-fault protection (WPWDE) main settings

Parameter	Function	Value (Range)	Step
Directional mode	WPWDE	2 = Forward 3 = Reverse	-
Current start value	WPWDE	0.010...5.000 × I_n	0.001
Voltage start value	WPWDE	0.010...1.000 × U_n	0.001
Power start value	WPWDE	0.003...1.000 × P_n	0.001
Reference power	WPWDE	0.050...1.000 × P_n	0.001
Characteristic angle	WPWDE	-179...180°	1
Time multiplier	WPWDE	0.05...2.00	0.01
Operating curve type[1]	WPWDE	Definite or inverse time Curve type: 5, 15, 20	
Operate delay time	WPWDE	60...200000 ms	10
Min operate current	WPWDE	0.010...1.000 × I_n	0.001
Min operate voltage	WPWDE	0.01...1.00 × U_n	0.01

1) For further reference, refer to the Operating characteristics table

Table 41. Transient/intermittent earth-fault protection (INTRPTEF)

Characteristic	Value
Operation accuracy (Uo criteria with transient protection)	Depending on the frequency of the measured current: f_n ±2 Hz ±1.5% of the set value or ±0.002 × Uo
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5

Table 42. Transient/intermittent earth-fault protection (INTRPTEF) main settings

Parameter	Function	Value (Range)	Step
Directional mode	INTRPTEF	1 = Non-directional 2 = Forward 3 = Reverse	-
Operate delay time	INTRPTEF	40...1200000 ms	10
Voltage start value	INTRPTEF	0.05...0.50 × U_n	0.01
Operation mode	INTRPTEF	1 = Intermittent EF 2 = Transient EF	-
Peak counter limit	INTRPTEF	2...20	1
Min operate current	INTRPTEF	0.01...1.00 × I_n	0.01

Table 43. Harmonics-based earth-fault protection (HAEFPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	±5% of the set value or ±0.004 × I_n
Start time [1)2)]	Typically 77 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Operate time accuracy in IDMT mode [3)]	±5.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at f = f_n
	-3 dB at f = 13 × f_n

1) Fundamental frequency current = 1.0 × I_n, harmonics current before fault = 0.0 × I_n, harmonics fault current 2.0 × *Start value*, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 2...20

Table 44. Harmonics-based earth-fault protection (HAEFPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	HAEFPTOC	0.05...5.00 × I_n	0.01
Time multiplier	HAEFPTOC	0.05...15.00	0.01
Operate delay time	HAEFPTOC	100...200000 ms	10
Operating curve type[1)]	HAEFPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
Minimum operate time	HAEFPTOC	100...200000 ms	10

1) For further reference, see Operation characteristics table

Table 45. Negative-sequence overcurrent protection (NSPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n		
		±1.5% of the set value or ±0.002 × I_n		
Start time [1)2)]		Minimum	Typical	Maximum
	I_{Fault} = 2 × set *Start value*	23 ms	26 ms	28 ms
	I_{Fault} = 10 × set *Start value*	15 ms	18 ms	20 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Negative sequence current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 1.5...20

Table 46. Negative-sequence overcurrent protection (NSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOC	0.01...5.00 × I_n	0.01
Time multiplier	NSPTOC	0.05...15.00	0.01
Operate delay time	NSPTOC	40...200000 ms	10
Operating curve type[1)]	NSPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	

1) For further reference, see the Operation characteristics table

Table 47. Phase discontinuity protection (PDNSPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	±2% of the set value
Start time	<70 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Retardation time	<35 ms
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 48. Phase discontinuity protection (PDNSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PDNSPTOC	10...100%	1
Operate delay time	PDNSPTOC	100...30000 ms	1
Min phase current	PDNSPTOC	0.05...0.30 × I_n	0.01

Table 49. Residual overvoltage protection (ROVPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 × U_n		
Start time[1)2)]		Minimum	Typical	Maximum
	U_{Fault} = 2 × set *Start value*	48 ms	51 ms	54 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Residual voltage before fault = 0.0 × U_n, f_n = 50 Hz, residual voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 50. Residual overvoltage protection (ROVPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	ROVPTOV	0.010...1.000 × U_n	0.001
Operate delay time	ROVPTOV	40...300000 ms	1

Table 51. Three-phase undervoltage protection (PHPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 × U_n		
Start time[1][2]		Minimum	Typical	Maximum
	U_{Fault} = 0.9 × set *Start value*	62 ms	66 ms	70 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, Voltage before fault = 1.1 × U_n, f_n = 50 Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 0.50, *Start value* multiples in range of 0.90...0.20

Table 52. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	0.05...1.20 × U_n	0.01
Time multiplier	PHPTUV	0.05...15.00	0.01
Operate delay time	PHPTUV	60...300000 ms	10
Operating curve type[1]	PHPTUV	Definite or inverse time Curve type: 5, 15, 21, 22, 23	

1) For further reference, see the Operation characteristics table

Table 53. Three-phase overvoltage protection (PHPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 × U_n		
Start time[1][2]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value*	23 ms	27 ms	31 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, Voltage before fault = 0.9 × U_n, f_n = 50 Hz, overvoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 1.20 × U_n, *Start value* multiples in range of 1.10...2.00

Table 54. Three-phase overvoltage protection (PHPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTOV	0.05...1.60 × U_n	0.01
Time multiplier	PHPTOV	0.05...15.00	0.01
Operate delay time	PHPTOV	40...300000 ms	10
Operating curve type[1]	PHPTOV	Definite or inverse time Curve type: 5, 15, 17, 18, 19, 20	

1) For further reference, see the Operation characteristics table

Table 55. Positive-sequence undervoltage protection (PSPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 × U_n		
Start time[1][2]		Minimum	Typical	Maximum
	U_{Fault} = 0.99 × set *Start value*	52 ms	55 ms	58 ms
	U_{Fault} = 0.9 × set *Start value*	44 ms	47 ms	50 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, positive-sequence voltage before fault = 1.1 × U_n, f_n = 50 Hz, positive sequence undervoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 56. Positive-sequence undervoltage protection (PSPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTUV	0.010...1.200 × U_n	0.001
Operate delay time	PSPTUV	40...120000 ms	10
Voltage block value	PSPTUV	0.01...1.00 × U_n	0.01

Table 57. Negative-sequence overvoltage protection (NSPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n		
		±1.5% of the set value or ±0.002 × U_n		
Start time[1][2]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value*	33 ms	35 ms	37 ms
	U_{Fault} = 2.0 × set *Start value*	24 ms	26 ms	28 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Negative-sequence voltage before fault = 0.0 × U_n, f_n = 50 Hz, negative-sequence overvoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 58. Negative-sequence overvoltage protection (NSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOV	0.010...1.000 × U_n	0.001
Operate delay time	NSPTOV	40...120000 ms	1

Table 59. Frequency protection (FRPFRQ)

Characteristic		Value
Operation accuracy	f>/f<	±5 mHz
	df/dt	±50 mHz/s (in range |df/dt| <5 Hz/s) ±2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	f>/f<	<80 ms
	df/dt	<120 ms
Reset time		<150 ms
Operate time accuracy		±1.0% of the set value or ±30 ms

Table 60. Frequency protection (FRPFRQ) main settings

Parameter	Function	Value (Range)	Step
Operation mode	FRPFRQ	1 = Freq< 2 = Freq> 3 = df/dt 4 = Freq< + df/dt 5 = Freq> + df/dt 6 = Freq< OR df/dt 7 = Freq> OR df/dt	-
Start value Freq>	FRPFRQ	0.9000...1.2000 × f_n	0.0001
Start value Freq<	FRPFRQ	0.8000...1.1000 × f_n	0.0001
Start value df/dt	FRPFRQ	-0.2000...0.2000 × f_n/s	0.005
Operate Tm Freq	FRPFRQ	80...200000 ms	10
Operate Tm df/dt	FRPFRQ	120...200000 ms	10

Table 61. Three-phase thermal protection for feeders, cables and distribution transformers (T1PTTR)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	Current measurement: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Operate time accuracy[1]	±2.0% of the theoretical value or ±0.50 s

1) Overload current > 1.2 × Operate level temperature

Table 62. Three-phase thermal protection for feeders, cables and distribution transformers (T1PTTR) main settings

Parameter	Function	Value (Range)	Step
Env temperature Set	T1PTTR	-50...100°C	1
Current reference	T1PTTR	0.05...4.00 × I_n	0.01
Temperature rise	T1PTTR	0.0...200.0°C	0.1
Time constant	T1PTTR	60...60000 s	1
Maximum temperature	T1PTTR	20.0...200.0°C	0.1
Alarm value	T1PTTR	20.0...150.0°C	0.1
Reclose temperature	T1PTTR	20.0...150.0°C	0.1
Current multiplier	T1PTTR	1...5	1
Initial temperature	T1PTTR	-50.0...100.0°C	0.1

Table 63. Three-phase thermal overload protection, two time constants (T2PTTR)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	Current measurement: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Operate time accuracy[1]	±2.0% of the theoretical value or ±0.50 s

1) Overload current > 1.2 × Operate level temperature

Table 64. Three-phase thermal overload protection, two time constants (T2PTTR) main settings

Parameter	Function	Value (Range)	Step
Temperature rise	T2PTTR	0.0...200.0°C	0.1
Max temperature	T2PTTR	0.0...200.0°C	0.1
Operate temperature	T2PTTR	80.0...120.0%	0.1
Short time constant	T2PTTR	6...60000 s	1
Weighting factor p	T2PTTR	0.00...1.00	0.01
Current reference	T2PTTR	0.05...4.00 × I_n	0.01
Operation	T2PTTR	1 = on 5 = off	-

Table 65. Binary signal transfer (BSTGGIO)

Characteristic		Value
Signalling delay	Fiber optic link	<5 ms
	Galvanic pilot wire link	<10 ms

Table 66. Circuit breaker failure protection (CCBRBRF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz
	±1.5% of the set value or ±0.002 × I_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Reset time	Typically 40 ms
Retardation time	<20 ms

Table 67. Circuit breaker failure protection (CCBRBRF) main settings

Parameter	Function	Value (Range)	Step
Current value	CCBRBRF	0.05...2.00 × I_n	0.05
Current value Res	CCBRBRF	0.05...2.00 × I_n	0.05
CB failure mode	CCBRBRF	1 = Current 2 = Breaker status 3 = Both	-
CB fail trip mode	CCBRBRF	1 = Off 2 = Without check 3 = Current check	-
Retrip time	CCBRBRF	0...60000 ms	10
CB failure delay	CCBRBRF	0...60000 ms	10
CB fault delay	CCBRBRF	0...60000 ms	10

Table 68. Three-phase inrush detector (INRPHAR)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	Current measurement: ±1.5% of the set value or ±0.002 × I_n Ratio I2f/I1f measurement: ±5.0% of the set value
Reset time	+35 ms / -0 ms
Reset ratio	Typically 0.96
Operate time accuracy	+35 ms / -0 ms

Table 69. Three-phase inrush detector (INRPHAR) main settings

Parameter	Function	Value (Range)	Step
Start value	INRPHAR	5...100%	1
Operate delay time	INRPHAR	20...60000 ms	1

Table 70. Switch onto fault (CBPSOF)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 71. Switch onto fault (CBPSOF) main settings

Parameter	Function	Value (Range)	Step
SOTF reset time	CBPSOF	0...60000 ms	1

Table 72. Multipurpose protection (MAPGAPC)

Characteristic	Value
Operation accuracy	±1.0% of the set value or ±20 ms

Table 73. Multipurpose protection (MAPGAPC) main settings

Parameter	Function	Value (Range)	Step
Start value	MAPGAPC	-10000.0...10000.0	0.1
Operate delay time	MAPGAPC	0...200000 ms	100
Operation mode	MAPGAPC	1 = Over 2 = Under	-

Table 74. Fault locator (SCEFRFLO)

Characteristic	Value
Measurement accuracy	At the frequency $f = f_n$ Impedance: ±2.5% or ±0.25 Ω Distance: ±2.5% or ±0.16 km/0.1 mile XC0F_CALC: ±2.5% or ±50 Ω IFLT_PER_ILD: ±5% or ±0.05

Table 75. Fault locator (SCEFRFLO) main settings

Parameter	Function	Value (Range)	Step
Z Max phase load	SCEFRFLO	1.0...10000.00 Ω	0.1
Ph leakage Ris	SCEFRFLO	20...1000000 Ω	1
Ph capacitive React	SCEFRFLO	10...1000000 Ω	1
R1 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
X1 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
R0 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
X0 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
Line Len section A	SCEFRFLO	0.000...1000.000 pu	0.001

Table 76. Line differential protection with in-zone power transformer (LNPLDF)

Characteristics	Value		
Operation accuracy [1]	Depending on the frequency of the measured current: f_n ±2 Hz		
	Low stage	±2.5% of the set value	
	High stage	±2.5% of the set value	
	Minimum	Typical	Maximum
High stage, operate time [2][3]	22 ms	25 ms	29 ms
Reset time	Typically 40 ms		
Reset ratio	Typically 0.96		
Retardation time (Low stage)	<40 ms		
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode	±5.0% of the set value or ±20 ms [4]		

1) With the symmetrical communication channel (as when using dedicated fiber optic).
2) Without additional delay in the communication channel (as when using dedicated fiber optic).
3) Including the delay of the output contact. When differential current = 2 × *High operate value* and f_n = 50 Hz with galvanic pilot wire link + 5 ms.
4) *Low operate value* multiples in range of 1.5...20.

Table 77. Line differential protection with in-zone power transformer (LNPLDF) main settings

Parameter	Function	Value (Range)	Step
Low operate value	LNPLDF	10...200 % I_n	1
High operate value	LNPLDF	200...4000 % I_n	1
Start value 2.H	LNPLDF	10...50 %	1
Time multiplier	LNPLDF	0.05...15.00	0.01
Operate curve type	LNPLDF	1=ANSI Ext. inv. 3=ANSI Norm. inv. 5=ANSI Def. Time 9=IEC Norm. inv. 10=IEC Very inv. 12=IEC Ext. inv. 15=IEC Def. Time	-
Operate delay time	LNPLDF	45...200000 ms	1
CT ratio correction	LNPLDF	0.200...5.000	0.001

Table 78. High-impedance fault detection (PHIZ) main settings

Parameter	Function	Value (Range)	Step
Security Level	PHIZ	1...10	1
System type	PHIZ	1 = Grounded 2 = Ungrounded	-

Table 79. Operation characteristics

Parameter	Value (Range)
Operating curve type	1 = ANSI Ext. inv. 2 = ANSI Very. Inv. 3 = ANSI Norm. inv. 4 = ANSI Mod inv. 5 = ANSI Def. Time 6 = L.T.E. inv. 7 = L.T.V. inv. 8 = L.T. inv. 9 = IEC Norm. inv. 10 = IEC Very inv. 11 = IEC inv. 12 = IEC Ext. inv. 13 = IEC S.T. inv. 14 = IEC L.T. inv 15 = IEC Def. Time 17 = Programmable 18 = RI type 19 = RD type
Operating curve type (voltage protection)	5 = ANSI Def. Time 15 = IEC Def. Time 17 = Inv. Curve A 18 = Inv. Curve B 19 = Inv. Curve C 20 = Programmable 21 = Inv. Curve A 22 = Inv. Curve B 23 = Programmable

Power quality functions

Table 80. Voltage variation (PHQVVR)

Characteristic	Value
Operation accuracy	±1.5% of the set value or ±0.2% of reference voltage
Reset ratio	Typically 0.96 (Swell), 1.04 (Dip, Interruption)

Table 81. Voltage variation (PHQVVR) main settings

Parameter	Function	Value (Range)	Step
Voltage dip set 1	PHQVVR	10.0...100.0%	0.1
Voltage dip set 2	PHQVVR	10.0...100.0%	0.1
Voltage dip set 3	PHQVVR	10.0...100.0%	0.1
Voltage swell set 1	PHQVVR	100.0...140.0%	0.1
Voltage swell set 2	PHQVVR	100.0...140.0%	0.1
Voltage swell set 3	PHQVVR	100.0...140.0%	0.1
Voltage Int set	PHQVVR	0.0...100.0%	0.1
VVa Dur Max	PHQVVR	100...3600000 ms	100

Table 82. Voltage unbalance (VSQVUB)

Characteristic	Value
Operation accuracy	±1.5% of the set value or ±0.002 × U_n
Reset ratio	Typically 0.96

Table 83. Voltage unbalance (VSQVUB) main settings

Parameter	Function	Value (Range)	Step
Operation	VSQVUB	1 = on 5 = off	-
Unb detection method	VSQVUB	1 = Neg Seq 2 = Zero Seq 3 = Neg to Pos Seq 4 = Zero to Pos Seq 5 = Ph vectors Comp	-

Control functions

Table 84. Autoreclosing (DARREC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 85. Synchronism and energizing check (SECRSYN)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±1 Hz Voltage: ±3.0% of the set value or ±0.01 × U_n Frequency: ±10 mHz Phase angle: ±3°
Reset time	<50 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms

Table 86. Synchronism and energizing check (SECRSYN) main settings

Parameter	Function	Value (Range)	Step
Live dead mode	SECRSYN	-1 = Off 1 = Both Dead 2 = Live L, Dead B 3 = Dead L, Live B 4 = Dead Bus, L Any 5 = Dead L, Bus Any 6 = One Live, Dead 7 = Not Both Live	-
Difference voltage	SECRSYN	0.01...0.50 × U_n	0.01
Difference frequency	SECRSYN	0.001...0.100 × f_n	0.001
Difference angle	SECRSYN	5...90°	1
Synchrocheck mode	SECRSYN	1 = Off 2 = Synchronous 3 = Asynchronous	-
Dead line value	SECRSYN	0.1...0.8 × U_n	0.1
Live line value	SECRSYN	0.2...1.0 × U_n	0.1
Max energizing V	SECRSYN	0.50...1.15 × U_n	0.01
Control mode	SECRSYN	1 = Continuous 2 = Command	-
Close pulse	SECRSYN	200...60000 ms	10
Phase shift	SECRSYN	-180...180°	1
Minimum Syn time	SECRSYN	0...60000 ms	10
Maximum Syn time	SECRSYN	100...6000000 ms	10
Energizing time	SECRSYN	100...60000 ms	10
Closing time of CB	SECRSYN	40...250 ms	10

Condition monitoring and supervision functions

Table 87. Circuit-breaker condition monitoring (SSCBR)

Characteristic	Value
Current measuring accuracy	±1.5% or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% (at currents in the range of 10...40 × I_n)
Operate time accuracy	±1.0% of the set value or ±20 ms
Travelling time measurement	+10 ms / -0 ms

Table 88. Current circuit supervision (CCSPVC)

Characteristic	Value
Operate time [1]	<30 ms

1) Including the delay of the output contact

Table 89. Current circuit supervision (CCSPVC) main settings

Parameter	Function	Value (Range)	Step
Start value	CCSPVC	0.05...0.20 × I_n	0.01
Max operate current	CCSPVC	1.00...5.00 × I_n	0.01

Table 90. Fuse failure supervision (SEQSPVC)

Characteristic		Value	
Operate time[1]	NPS function	U_{Fault} = 1.1 × set *Neg Seq voltage Lev*	<33 ms
		U_{Fault} = 5.0 × set *Neg Seq voltage Lev*	<18 ms
	Delta function	ΔU = 1.1 × set *Voltage change rate*	<30 ms
		ΔU = 2.0 × set *Voltage change rate*	<24 ms

1) Includes the delay of the signal output contact, f_n = 50 Hz, fault voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

Table 91. Runtime counter for machines and devices (MDSOPT)

Description	Value
Motor runtime measurement accuracy[1]	±0.5%

1) Of the reading, for a stand-alone relay, without time synchronization

Measurement functions

Table 92. Three-phase current measurement (CMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±0.5% or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 93. Sequence current measurement (CSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f/f_n = ±2 Hz ±1.0% or ±0.002 × I_n at currents in the range of 0.01...4.00 × I_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 94. Residual current measurement (RESCMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f/f_n = ±2 Hz ±0.5% or ±0.002 × I_n at currents in the range of 0.01...4.00 × I_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 95. Three-phase voltage measurement (VMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2 Hz At voltages in range 0.01...1.15 × U_n ±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 96. Residual voltage measurement (RESVMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f/f_n = ±2 Hz ±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 97. Sequence voltage measurement (VSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2 Hz At voltages in range 0.01...1.15 × U_n
	±1.0% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 98. Three-phase power and energy measurement (PEMMXU)

Characteristic	Value
Operation accuracy	At all three currents in range 0.10...1.20 × I_n At all three voltages in range 0.50...1.15 × U_n At the frequency f_n ±1 Hz
	±1.5% for apparent power S ±1.5% for active power P and active energy[1] ±1.5% for reactive power Q and reactive energy[2] ±0.015 for power factor
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) |PF| >0.8 which equals |cose| >0.5
2) |PF| <0.86 which equals |sine| >0.5

Table 99. RTD/mA measurement (XRGGIO130)

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum 250 Ω platinum 100 Ω nickel 120 Ω nickel 250 Ω nickel 10 Ω copper	TCR 0.00385 (DIN 43760) TCR 0.00385 TCR 0.00618 (DIN 43760) TCR 0.00618 TCR 0.00618 TCR 0.00427
	Supported resistance range	0...2 kΩ	
	Maximum lead resistance (three-wire measurement)	25 Ω per lead	
	Isolation	2 kV (inputs to protective earth)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		± 2.0% or ±1 Ω	±1°C 10 Ω copper: ±2°C
mA inputs	Supported current range	0...20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	±0.1% or ±0.01 mA	

Table 100. Frequency measurement (FMMXU)

Characteristic	Value
Operation accuracy	±5 mHz (in measurement range 35...75 Hz)

Other functions

Table 101. Pulse timer (PTGAPC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 102. Time delay off (8 pcs) (TOFPAGC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 103. Time delay on (8 pcs) (TONGAPC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

22. Local HMI

The relay is available with two optional displays, a large one and a small one. The large display is suited for relay installations where the front panel user interface is frequently used and a single line diagram is required. The small display is suited for remotely controlled substations where the relay is only occasionally accessed locally via the front panel user interface.

Both LCD displays offer front-panel user interface functionality with menu navigation and menu views. However, the large display offers increased front-panel usability with less menu scrolling and improved information overview. In addition, the large display includes a user-configurable single line diagram (SLD) with position indication for the associated primary equipment. Depending on the chosen standard configuration, the relay displays the related measuring values, apart from the default single line diagram. The SLD view can also be accessed using the Web browser-based user interface. The default SLD can be modified according to user requirements by using the Graphical Display Editor in PCM600. The user can create up to 10 SLD pages.

The local HMI includes a push button (L/R) for local/remote operation of the relay. When the relay is in the local mode, it can be operated only by using the local front panel user interface. When the relay is in the remote mode, it can execute commands sent from a remote location. The relay supports the remote selection of local/remote mode via a binary input. This feature facilitates, for example, the use of an external switch at the substation to ensure that all relays are in the local mode during maintenance work and that the circuit breakers cannot be operated remotely from the network control center.

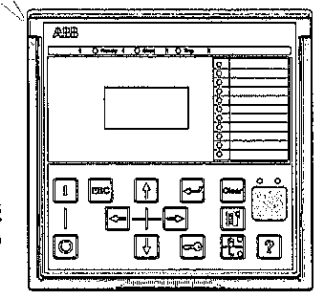

Figure 18. Small display

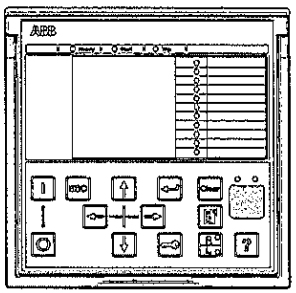

Figure 17. Large display

Table 104. Small display

Character size[1]	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	5	20
Large, variable width (13 × 14 pixels)	3	8 or more

1) Depending on the selected language

Table 105. Large display

Character size[1]	Rows in the view	Characters per row
Small, mono-spaced (6 × 12 pixels)	10	20
Large, variable width (13 × 14 pixels)	7	8 or more

1) Depending on the selected language

23. Mounting methods

By means of appropriate mounting accessories, the standard relay case can be flush mounted, semi-flush mounted or wall mounted. The flush mounted and wall mounted relay cases can also be mounted in a tilted position (25°) using special accessories.

Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two relays. Alternatively, the relays can be mounted in 19" instrument cabinets by means of 4U Combiflex equipment frames.

For routine testing purposes, the relay cases can be equipped with test switches, type RTXP 18, which can be mounted side by side with the relay cases.

Mounting methods
- Flush mounting
- Semi-flush mounting
- Semi-flush mounting in a 25° tilt
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame
- Mounting with an RTXP 18 test switch to a 19" rack

Panel cut-out for flush mounting
- Height: 161.5 ±1 mm
- Width: 165.5 ±1 mm

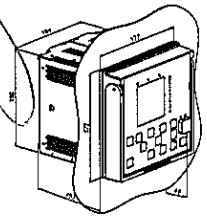

Figure 18. Flush mounting

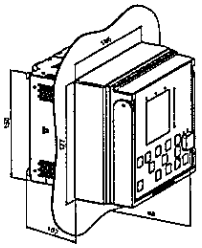

Figure 19. Semi-flush mounting

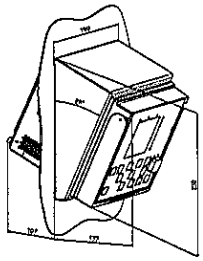

Figure 20. Semi-flush mounting in a 25° tilt

24. Relay case and plug-in unit

The relay cases are assigned to a certain type of plug-in unit. For safety reasons, the relay cases for current measuring relays are provided with automatically operating contacts for short-circuiting the CT secondary circuits when a relay unit is withdrawn from its case. The relay case is further provided with a mechanical coding system preventing the current measuring relay units from being inserted into relay cases intended for voltage measuring relay units.

25. Selection and ordering data

Use ABB Library to access the selection and ordering information and to generate the order number.

Product Selection Tool (PST), a Next-Generation Order Number Tool, supports order code creation for ABB Distribution Automation IEC products with emphasis on but not exclusively for the Relion product family. PST is an easy to use, online tool always containing the latest product information. The complete order code can be created with detailed specification and the result can be printed and mailed. Registration is required.

26. Accessories and ordering data

Table 106. Pilot wire communication

Item	Order number
Pilot Wire communication package including two Pilot Wire modems: RPW600AM (master) and RPW600AF (follower)	RPW600AMF
Diagnostics kit including the RPW-diagnostic tool, a diagnostic cable and a CD with necessary drivers and information	RPW600ADP
3.0 meter LC-LC single-mode fiber-optic patch cable for connecting one Pilot Wire modem to the RED615 relay[1)]	1MRS120547-3

1) Two patch cables are required for connecting the Pilot Wire communication package (RPW600AMF).

Table 107. Mounting accessories

Item	Order number
Semi-flush mounting kit	1MRS050696
Wall mounting kit	1MRS050697
Inclined semi-flush mounting kit	1MRS050831
19" rack mounting kit with cut-out for one relay	1MRS050694
19" rack mounting kit with cut-out for two relays	1MRS050695
Mounting bracket for one relay with test switch RTXP in 4U Combiflex (RHGT 19" variant C)	2RCA022642P0001
Mounting bracket for one relay in 4U Combiflex (RHGT 19" variant C)	2RCA022643P0001
19" rack mounting kit for one relay and one RTXP18 test switch (the test switch is not included in the delivery)	2RCA021952A0003
19" rack mounting kit for one relay and one RTXP24 test switch (the test switch is not included in the delivery)	2RCA022561A0003
Functional earthing flange for RTD modules[1)]	2RCA036978A0001
Replacement kit for a Strömberg SP_J40 series relay (cut-out in the center of the installation plate)	2RCA027871A0001
Replacement kit for a Strömberg SP_J40 series relay (cut-out on the left or the right of the installation plate)	2RCA027874A0001
Replacement kit for two Strömberg SP_J3 series relays	2RCA027880A0001
19" rack replacement kit for Strömberg SP_J3/J6 series relays (one cut-out)	2RCA027894A0001
19" rack replacement kit for Strömberg SP_J3/J6 series relays (two cut-outs)	2RCA027897A0001
Replacement kit for a Strömberg SP_J6 series relay	2RCA027881A0001
Replacement kit for three BBC S_ series relays	2RCA027882A0001
Replacement kit for a SPA 300 series relay	2RCA027885A0001

1) Cannot be used when the protection relay is mounted with the Combiflex 19" equipment frame (2RCA032826A0001)

27. Tools

The protection relay is delivered as a preconfigured unit. The default parameter setting values can be changed from the front-panel user interface (local HMI), the Web browser-based user interface (Web HMI) or Protection and Control IED Manager PCM600 in combination with the relay-specific connectivity package.

PCM600 offers extensive relay configuration functions. For example, depending on the protection relay, the relay signals, application, graphical display and single-line diagram, and IEC 61850 communication, including horizontal GOOSE communication, can be modified with PCM600.

When the Web HMI is used, the protection relay can be accessed either locally or remotely using a Web browser (Internet Explorer). For security reasons, the Web HMI is disabled by default but it can be enabled via the local HMI. The Web HMI functionality can be limited to read-only access.

The relay connectivity package is a collection of software and specific relay information, which enables system products and tools to connect and interact with the protection relay. The

connectivity packages reduce the risk of errors in system integration, minimizing device configuration and setup times. Further, the connectivity packages for protection relays of this product series include a flexible update tool for adding one additional local HMI language to the protection relay. The update tool is activated using PCM600, and it enables multiple updates of the additional HMI language, thus offering flexible means for possible future language updates.

Table 108. Tools

Description	Version
PCM600	2.6 (Rollup 20150626) or later
Web browser	IE 8.0, IE 9.0, IE 10.0 or IE 11.0
RED615 Connectivity Package	5.1 or later

Table 109. Supported functions

Function	Web HMI	PCM600
Relay parameter setting	•	•
Saving of relay parameter settings in the relay	•	•
Signal monitoring	•	•
Disturbance recorder handling	•	•
Alarm LED viewing	•	•
Access control management	•	•
Relay signal configuration (Signal Matrix)	-	•
Modbus® communication configuration (communication management)	-	•
DNP3 communication configuration (communication management)	-	•
IEC 60870-5-103 communication configuration (communication management)	-	•
Saving of relay parameter settings in the tool	-	•
Disturbance record analysis	-	•
XRIO parameter export/import	•	•
Graphical display configuration	-	•
Application configuration	-	•
IEC 61850 communication configuration, GOOSE (communication configuration)	-	•
Phasor diagram viewing	•	-
Event viewing	•	•
Saving of event data on the user's PC	•	•
Online monitoring	-	•

• = Supported

28. Cyber security

The relay supports role based user authentication and authorization. It can store 2048 audit trail events to a non-volatile memory. The non-volatile memory is based on a memory type which does not need battery backup or regular component exchange to maintain the memory storage. FTP and Web HMI use TLS encryption with a minimum of 128 bit key length protecting the data in transit. In this case the used communication protocols are FTPS and HTTPS. All rear communication ports and optional protocol services can be deactivated according to the required system setup.

29. Terminal diagrams

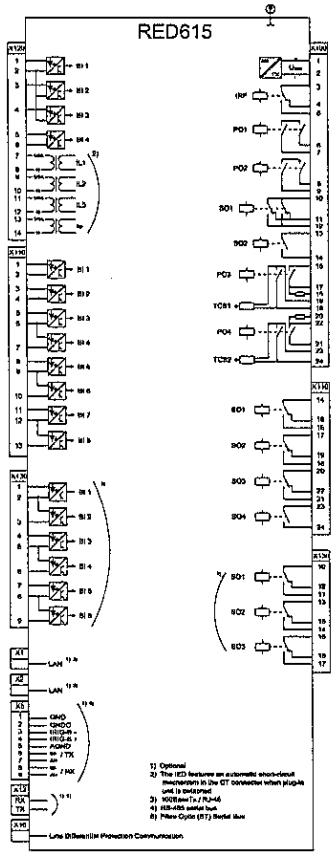

Figure 21. Terminal diagram for configuration A and C

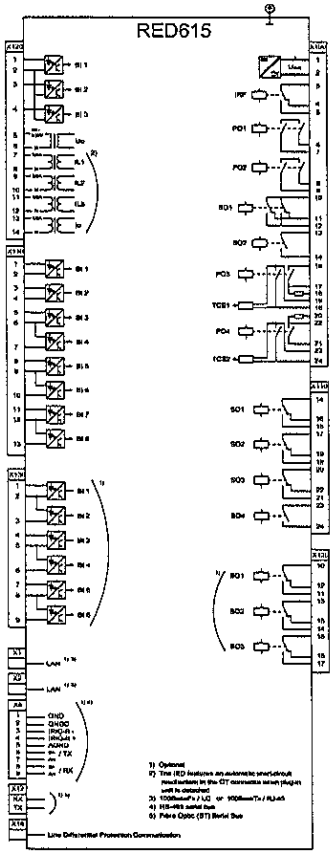

Figure 22. Terminal diagram for configuration B

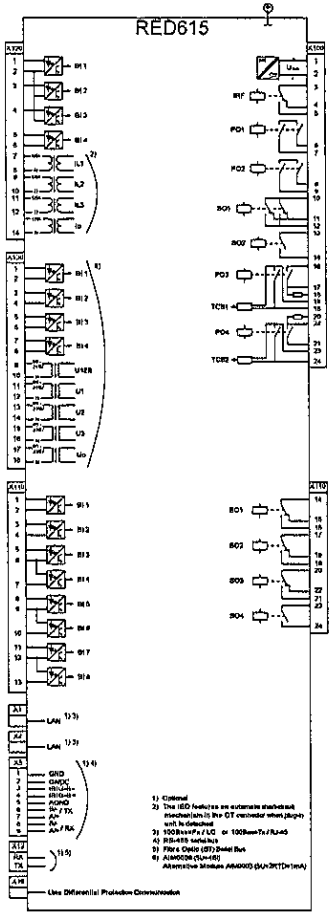

Figure 23. Terminal diagram for configuration D

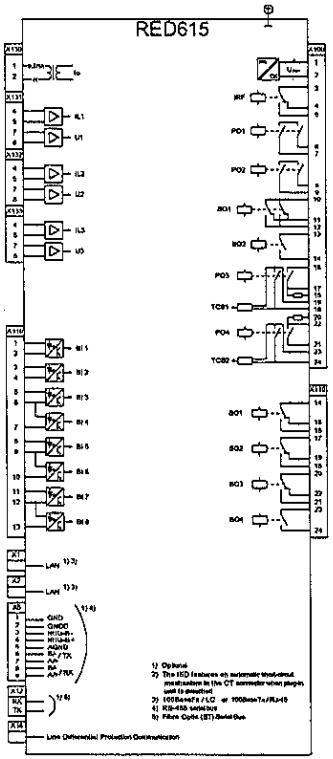

Figure 24. Terminal diagram for configuration E

30. Certificates

DNV GL has issued an IEC 61850 Edition 2 Certificate Level A1 for Relion® 615 series. Certificate number: 74105701-OPE/INC 15-1135.

DNV GL has issued an IEC 61850 Edition 1 Certificate Level A1 for Relion® 615 series. Certificate number: 74105701-OPE/INC 15-1145.

Additional certificates can be found on the product page.

31. References

The www.abb.com/substationautomation portal provides information on the entire range of distribution automation products and services.

The latest relevant information on the RED615 protection and control relay is found on the product page. Scroll down the page to find and download the related documentation.

For information regarding the RPW600 modems please refer to the RPW600 User's Guide, document id 6621-2260. The document is available for download on the RED615 product page. Scroll down the page to find and download the related documentation.

32. Functions, codes and symbols

Table 110. Functions included in the relay

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
Three-phase directional overcurrent protection, low stage	DPHLPDOC1	3I> -> (1)	67-1 (1)
	DPHLPDOC2	3I> -> (2)	67-1 (2)
Three-phase directional overcurrent protection, high stage	DPHHPDOC1	3I>> -> (1)	67-2 (1)
Non-directional earth-fault protection, low stage	EFLPTOC1	Io> (1)	51N-1 (1)
	EFLPTOC2	Io> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	Io>> (1)	51N-2 (1)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	Io>>> (1)	50N/51N (1)
Directional earth-fault protection, low stage	DEFLPDEF1	Io> -> (1)	67N-1 (1)
	DEFLPDEF2	Io> -> (2)	67N-1 (2)
Directional earth-fault protection, high stage	DEFHPDEF1	Io>> -> (1)	67N-2 (1)
Admittance-based earth-fault protection	EFPADM1	Yo> -> (1)	21YN (1)
	EFPADM2	Yo> -> (2)	21YN (2)
	EFPADM3	Yo> -> (3)	21YN (3)
Wattmetric-based earth-fault protection	WPWDE1	Po> -> (1)	32N (1)
	WPWDE2	Po> -> (2)	32N (2)
	WPWDE3	Po> -> (3)	32N (3)
Transient/intermittent earth-fault protection	INTRPTEF1	Io> -> IEF (1)	67NIEF (1)
Harmonics-based earth-fault protection	HAEFPTOC1	Io>HA (1)	51NHA (1)
Non-directional (cross-country) earth-fault protection, using calculated Io	EFHPTOC1	Io>> (1)	51N-2 (1)
Negative-sequence overcurrent protection	NSPTOC1	I2> (1)	46 (1)
	NSPTOC2	I2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I2/I1> (1)	46PD (1)
Residual overvoltage protection	ROVPTOV1	Uo> (1)	59G (1)
	ROVPTOV2	Uo> (2)	59G (2)
	ROVPTOV3	Uo> (3)	59G (3)
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
	PHPTUV3	3U< (3)	27 (3)

Table 110. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
	PHPTOV3	3U> (3)	59 (3)
Positive-sequence undervoltage protection	PSPTUV1	U1< (1)	47U+ (1)
Negative-sequence overvoltage protection	NSPTOV1	U2> (1)	47O- (1)
Frequency protection	FRPFRQ1	f>/f<,df/dt (1)	81 (1)
	FRPFRQ2	f>/f<,df/dt (2)	81 (2)
	FRPFRQ3	f>/f<,df/dt (3)	81 (3)
	FRPFRQ4	f>/f<,df/dt (4)	81 (4)
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F (1)	49F (1)
Three-phase thermal overload protection, two time constants	T2PTTR1	3Ith>T/G/C (1)	49T/G/C (1)
Binary signal transfer	BSTGGIO1	BST (1)	BST (1)
Circuit breaker failure protection	CCBRBRF1	3I>/Io>BF (1)	51BF/51NBF (1)
Three-phase inrush detector	INRPHAR1	3I2I> (1)	68 (1)
Switch onto fault	CBPSOF1	SOTF (1)	SOTF (1)
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
Multipurpose protection	MAPGAPC1	MAP (1)	MAP (1)
	MAPGAPC2	MAP (2)	MAP (2)
	MAPGAPC3	MAP (3)	MAP (3)
	MAPGAPC4	MAP (4)	MAP (4)
	MAPGAPC5	MAP (5)	MAP (5)
	MAPGAPC6	MAP (6)	MAP (6)
	MAPGAPC7	MAP (7)	MAP (7)
	MAPGAPC8	MAP (8)	MAP (8)
	MAPGAPC9	MAP (9)	MAP (9)
	MAPGAPC10	MAP (10)	MAP (10)
	MAPGAPC11	MAP (11)	MAP (11)
	MAPGAPC12	MAP (12)	MAP (12)
	MAPGAPC13	MAP (13)	MAP (13)
	MAPGAPC14	MAP (14)	MAP (14)
	MAPGAPC15	MAP (15)	MAP (15)
	MAPGAPC16	MAP (16)	MAP (16)
	MAPGAPC17	MAP (17)	MAP (17)
	MAPGAPC18	MAP (18)	MAP (18)
Fault locator	SCEFRFLO1	FLOC (1)	21FL (1)
Line differential protection with in-zone power transformer	LNPLDF1	3Id/I> (1)	87L (1)

Table 110. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
High-impedance fault detection	PHIZ1	HIF (1)	HIZ (1)
Power quality			
Current total demand distortion	CMHAI1	PQM3I (1)	PQM3I (1)
Voltage total harmonic distortion	VMHAI1	PQM3U (1)	PQM3V (1)
Voltage variation	PHQVVR1	PQMU (1)	PQMV (1)
Voltage unbalance	VSQVUB1	PQUUB (1)	PQVUB (1)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB (1)	I <-> O CB (1)
Disconnector control	DCXSWI1	I <-> O DCC (1)	I <-> O DCC (1)
	DCXSWI2	I <-> O DCC (2)	I <-> O DCC (2)
Earthing switch control	ESXSWI1	I <-> O ESC (1)	I <-> O ESC (1)
Disconnector position indication	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
	DCSXSWI3	I <-> O DC (3)	I <-> O DC (3)
Earthing switch indication	ESSXSWI1	I <-> O ES (1)	I <-> O ES (1)
	ESSXSWI2	I <-> O ES (2)	I <-> O ES (2)
Autoreclosing	DARREC1	O -> I (1)	79 (1)
Synchronism and energizing check	SECRSYN1	SYNC (1)	25 (1)
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR1	CBCM (1)	CBCM (1)
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCSPVC1	MCS 3I (1)	MCS 3I (1)
Fuse failure supervision	SEQSPVC1	FUSEF (1)	60 (1)
Protection communication supervision	PCSITPC1	PCS (1)	PCS (1)
Runtime counter for machines and devices	MDSOPT1	OPTS (1)	OPTM (1)
Measurement			
Disturbance recorder	RDRE1	DR (1)	DFR (1)
Load profile record	LDPRLRC1	LOADPROF (1)	LOADPROF (1)
Fault record	FLTRFRC1	FAULTREC (1)	FAULTREC (1)
Three-phase current measurement	CMMXU1	3I (1)	3I (1)
Sequence current measurement	CSMSQI1	I1, I2, I0 (1)	I1, I2, I0 (1)
Residual current measurement	RESCMMXU1	Io (1)	In (1)
Three-phase voltage measurement	VMMXU1	3U (1)	3V (1)
	VMMXU2	3U (2)	3V (2)
Residual voltage measurement	RESVMMXU1	Uo (1)	Vn (1)
Sequence voltage measurement	VSMSQI1	U1, U2, U0 (1)	V1, V2, V0 (1)
Three-phase power and energy measurement	PEMMXU1	P, E (1)	P, E (1)

Table 110. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
RTD/mA measurement	XRGGIO130	X130 (RTD) (1)	X130 (RTD) (1)
Frequency measurement	FMMXU1	f (1)	f (1)
IEC 61850-9-2 LE sampled value sending	SMVSENDER	SMVSENDER	SMVSENDER
IEC 61850-9-2 LE sampled value receiving (voltage sharing)	SMVRCV	SMVRCV	SMVRCV
Other			
Minimum pulse timer (2 pcs)	TPGAPC1	TP (1)	TP (1)
	TPGAPC2	TP (2)	TP (2)
	TPGAPC3	TP (3)	TP (3)
	TPGAPC4	TP (4)	TP (4)
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC1	TPS (1)	TPS (1)
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC1	TPM (1)	TPM (1)
Pulse timer (8 pcs)	PTGAPC1	PT (1)	PT (1)
	PTGAPC2	PT (2)	PT (2)
Time delay off (8 pcs)	TOFGAPC1	TOF (1)	TOF (1)
	TOFGAPC2	TOF (2)	TOF (2)
	TOFGAPC3	TOF (3)	TOF (3)
	TOFGAPC4	TOF (4)	TOF (4)
Time delay on (8 pcs)	TONGAPC1	TON (1)	TON (1)
	TONGAPC2	TON (2)	TON (2)
	TONGAPC3	TON (3)	TON (3)
	TONGAPC4	TON (4)	TON (4)
Set-reset (8 pcs)	SRGAPC1	SR (1)	SR (1)
	SRGAPC2	SR (2)	SR (2)
	SRGAPC3	SR (3)	SR (3)
	SRGAPC4	SR (4)	SR (4)
Move (8 pcs)	MVGAPC1	MV (1)	MV (1)
	MVGAPC2	MV (2)	MV (2)
Generic control point (16 pcs)	SPCGAPC1	SPC (1)	SPC (1)
	SPCGAPC2	SPC (2)	SPC (2)
Analog value scaling	SCA4GAPC1	SCA4 (1)	SCA4 (1)
	SCA4GAPC2	SCA4 (2)	SCA4 (2)
	SCA4GAPC3	SCA4 (3)	SCA4 (3)
	SCA4GAPC4	SCA4 (4)	SCA4 (4)
Integer value move	MVI4GAPC1	MVI4 (1)	MVI4 (1)

33. Document revision history

Document revision/date	Product version	History
A/2008-10-03	1.1	First release
B/2009-07-03	2.0	Content updated to correspond to the product version
C/2010-06-11	3.0	Content updated to correspond to the product version
D/2010-06-29	3.0	Terminology updated
E/2010-09-07	3.0	Content updated
F/2012-05-11	4.0	Content updated to correspond to the product version
G/2013-02-21	4.0 FP1	Content updated to correspond to the product version
H/2014-01-24	5.0	Content updated to correspond to the product version
K/2015-10-30	5.0 FP1	Content updated to correspond to the product version
L/2016-05-20	5.0 FP1	Content updated

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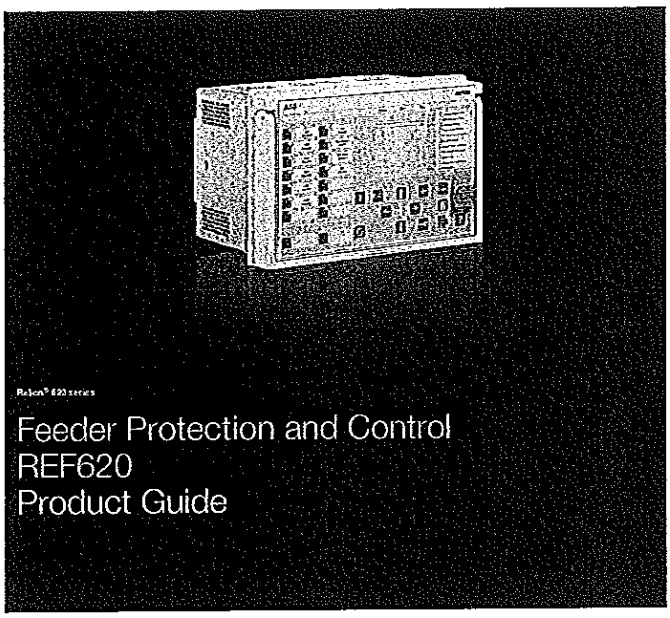

Relion® 620 series

Feeder Protection and Control
REF620
Product Guide

Power and productivity for a better world™

ABB

Contents

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Feeder Protection and Control	1MRS757844 E
REF620	
Product version: 2.0 FP1	Issued: 2015-12-11
	Revision: E

1. Description

REF620 is a dedicated feeder management relay perfectly aligned for the protection, control, measurement and supervision of utility and industrial power distribution systems, including radial, looped and meshed networks, with or without distributed power generation. REF620 can also be used to protect feeders including motors or capacitor banks. Additionally REF620 offers functionality for interconnection protection used with distributed generation like wind or solar power connection to utility grid. Furthermore REF620 includes functionality for high-impedance based busbar protection. REF620 is a member of ABB's Relion® protection and control product family and its 620 series. The 620 series relays are characterized by their functional scalability and withdrawable-unit design. The 620 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability of substation automation devices.

The 620 series relays support a range of communication protocols including IEC 61850 with Edition 2 support, process bus according to IEC 61850-9-2 LE, IEC 60870-5-103, Modbus® and DNP3. Profibus DPV1 communication protocol is supported by using the protocol converter SPA-ZC 302.

2. Default configurations

The 620 series relays are configured with default configurations, which can be used as examples of the 620 series engineering with different function blocks. The default configurations are not aimed to be used as real end-user applications. The end-users always need to create their own application configuration with the configuration tool. However, the default configuration can be used as a starting point by modifying it according to the requirements.

REF620 is available in two alternative default configurations: configuration A with traditional current and voltage measurement transducers and configuration B with current and voltage sensors. Default configuration A with measurement transducers has more voltage measurements and I/Os than default configuration B. This gives more possibilities in applications supported by default configuration A. The default configuration can be altered by means of the graphical signal matrix or the graphical application functionality of the Protection and Control IED Manager PCM600. Furthermore, the application configuration functionality of PCM600 supports the creation of multi-layer logic functions using various logical elements, including timers and flip-flops. By combining protection functions with logic function blocks, the relay configuration can be adapted to user-specific application requirements.

Feeder Protection and Control	1MRS757844 E
REF620	
Product version: 2.0 FP1	

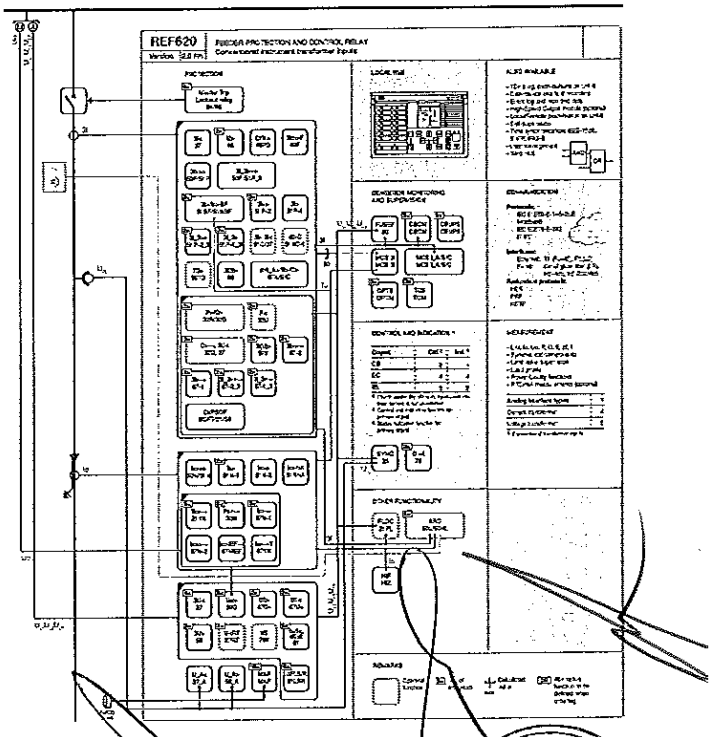

Figure 1. Functionality overview of default configurations with conventional instrument transformer inputs

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ВЕРНО С ОРИГИНАЛА

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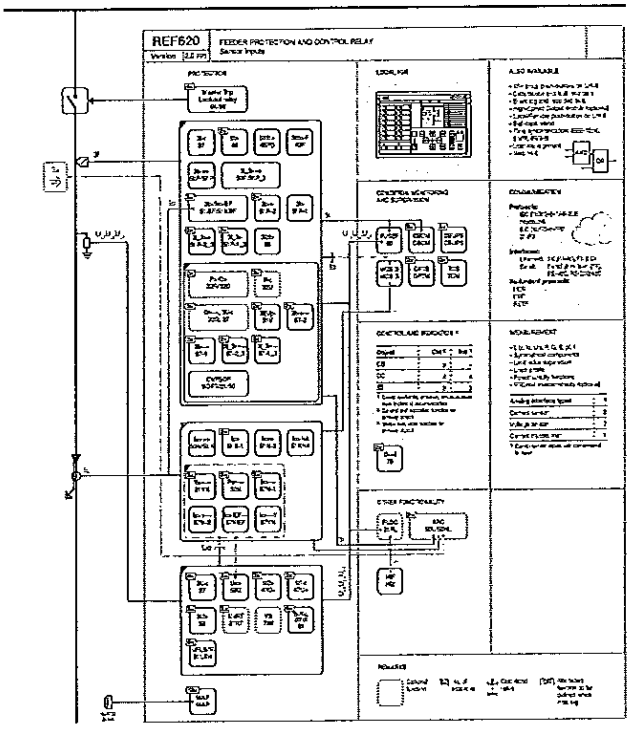

Figure 2. Functionality overview of default configuration with sensor inputs

Table 1. Supported functions

Function	IEC 61850	A (CTs/VTs)	B (Sensors)
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	1	1
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	2	2
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	1	1
Three-phase directional overcurrent protection, low stage	DPHLPDOC	2	2
Three-phase directional overcurrent protection, high stage	DPHHPDOC	2	2
Three-phase voltage-dependent overcurrent protection	PHPVOC	2	2
Non-directional earth-fault protection, low stage	EFLPTOC	2	2
Non-directional earth-fault protection, high stage	EFHPTOC	1	1
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	1	1
Directional earth-fault protection, low stage	DEFLPDEF	3	3[1]
Directional earth-fault protection, high stage	DEFHPDEF	1	1[1]
Admittance-based earth-fault protection	EFPADM	3	3[1]
Wattmetric-based earth-fault protection	WPWDE	3	3[1]
Multifrequency admittance-based earth-fault protection	MFADPSDE	1	1[1]
Transient/intermittent earth-fault protection	INTRPTEF	1	1[1]
Harmonics-based earth-fault protection	HAEFPTOC	1	1
Negative-sequence overcurrent protection	NSPTOC	2	2
Phase discontinuity protection	PDNSPTOC	1	1
Residual overvoltage protection	ROVPTOV	3	3[1]
Three-phase undervoltage protection	PHPTUV	4	4
Single-phase undervoltage protection, secondary side	PHAPTUV	1	
Three-phase overvoltage protection	PHPTOV	3	3
Single-phase overvoltage protection, secondary side	PHAPTOV	1	
Positive-sequence undervoltage protection	PSPTUV	2	2
Negative-sequence overvoltage protection	NSPTOV	2	2
Frequency protection	FRPFRQ	6	6
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	1	1
Loss of phase (undercurrent)	PHPTUC	1	1
Circuit breaker failure protection	CCBRBRF	3	3
Three-phase inrush detector	INRPHAR	1	1
Master trip	TRPPTRC	4	4
Arc protection	ARCSARC	(3)	(3)
High-impedance fault detection	PHIZ	1	1
Load-shedding and restoration	LSHDPFRQ	6	6
Multipurpose protection	MAPGAPC	18	18

Table 1. Supported functions, continued

Function	IEC 61850	A (CTs/VTs)	B (Sensors)
Automatic switch-onto-fault logic (SOF)	CVPSOF	1	1
Voltage vector shift protection	VVSPPAM	(1)	(1)
Directional reactive power undervoltage protection	DQPTUV	(2)	(2)
Underpower protection	DUPPDPR	(2)	(2)
Reverse power/directional overpower protection	DOPPDPR	(2)	(2)
Low-voltage ride-through protection	LVRTPTUV	(3)	(3)
High-impedance differential protection for phase A	HIAPDIF	1	
High-impedance differential protection for phase B	HIBPDIF	1	
High-impedance differential protection for phase C	HICPDIF	1	
Circuit breaker uncorresponding position start-up	CUPCALH	3	3
Three-independent-phase non-directional overcurrent protection, low stage	PH3LPTOC	2	2
Three-independent-phase non-directional overcurrent protection, high stage	PH3HPTOC	2	2
Three-independent-phase non-directional overcurrent protection, instantaneous stage	PH3IPTOC	1	1
Directional three-independent-phase directional overcurrent protection, low stage	DPH3LPDOC	2	2
Directional three-independent-phase directional overcurrent protection, high stage	DPH3HPDOC	2	2
Three-phase overload protection for shunt capacitor banks	COLPTOC	(1)	
Current unbalance protection for shunt capacitor banks	CUBPTOC	(1)	
Shunt capacitor bank switching resonance protection, current based	SRCPTOC	(1)	
Control			
Circuit-breaker control	CBXCSR	3	3
Disconnector control	DCXSWI	4	4
Earthing switch control	ESXSWI	3	3
Disconnector position indication	DCSXSWI	4	4
Earthing switch indication	ESSXSWI	3	3
Autoreclosing	DARREC	2	2
Synchronism and energizing check	SECRSYN	1	(1)[2]
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR	3	3
Trip circuit supervision	TCSSCBR	2	2
Current circuit supervision	CCSPVC	1	1
Current transformer supervision for high-impedance protection scheme for phase A	HZCCASPVC	1	
Current transformer supervision for high-impedance protection scheme for phase B	HZCCBSPVC	1	

Table 1. Supported functions, continued

Function	IEC 61850	A (CTs/VTs)	B (Sensors)
Current transformer supervision for high-impedance protection scheme for phase C	HZCCCSPVC	1	
Fuse failure supervision	SEQSPVC	1	1
Runtime counter for machines and devices	MDSOPT	2	2
Measurement			
Three-phase current measurement	CMMXU	1	1
Sequence current measurement	CSMSQI	1	1
Residual current measurement	RESCMMXU	1	1
Three-phase voltage measurement	VMMXU	1	1
Single-phase voltage measurement	VAMMXU	1	(1)[3]
Residual voltage measurement	RESVMMXU	1	
Sequence voltage measurement	VSMSQI	1	1
Three-phase power and energy measurement	PEMMXU	1	1
Load profile record	LDPRLRC	1	1
Frequency measurement	FMMXU	1	1
Fault location			
Fault locator	SCEFRFLO	(1)	(1)
Power quality			
Current total demand distortion	CMHAI	1	1
Voltage total harmonic distortion	VMHAI	1	1
Voltage variation	PHQVVR	1	1
Voltage unbalance	VSQVUB	1	1
Other			
Minimum pulse timer (2 pcs)	TPGAPC	4	4
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC	2	2
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC	2	2
Pulse timer (8 pcs)	PTGAPC	2	2
Time delay off (8 pcs)	TOFGAPC	4	4
Time delay on (8 pcs)	TONGAPC	4	4
Set-reset (8 pcs)	SRGAPC	4	4
Move (8 pcs)	MVGAPC	4	4
Integer value move	MVIGAPC	4	4
Analog value scaling	SCAMGAPC	4	4
Generic control point (16 pcs)	SPCGAPC	1	1
Remote generic control points	SPCRGAPC		
Local generic control points	SPCLGAPC	1	
Generic up-down counters	UDFCNT	12	

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ВЯРНО С ОРИГИНАЛА

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Table 1. Supported functions, continued

Function	IEC 61850	A (CTA/VTs)	B (Sensors)
Programmable buttons (16 buttons)	FKEYGGIO	1	1
Logging functions			
Disturbance recorder	RDRE	1	1
Fault recorder	FLTRFRC	1	1
Sequence event recorder	SER	1	1

1, 2, ... = Number of included instances. The instances of a protection function represent the number of identical protection function blocks available in the standard configuration.
0 = optional

1) Up is calculated from the measured phase voltages
2) Available only with IEC 61850-9-2 LE

3. Protection functions

The basic configurations available in REF620 consist of a wide range of protection functions making the protection relay suitable for various basic feeder applications. The relay offers directional and non-directional overcurrent and thermal overload protection as well as directional and non-directional earth-fault protection. Admittance-based, harmonics-based or wattmetric-based earth-fault protection can be used in addition to directional earth-fault protection. Furthermore, the relay features sensitive earth-fault protection, phase discontinuity protection, transient/intermittent earth-fault protection, overvoltage and undervoltage protection, residual overvoltage protection, positive-sequence undervoltage protection and negative-sequence overvoltage protection. In addition, the relay offers frequency protection including overfrequency, underfrequency and frequency rate-of-change protection. The relay also incorporates three-pole multi-shot autoreclosing functions for overhead line feeders.

The standard content additionally includes multifrequency admittance-based earth-fault protection providing selective directional earth-fault protection for high-impedance earthed networks. The operation is based on multifrequency neutral admittance measurement utilizing fundamental frequency and harmonic components in Uo and Io.

ABB's continuous investments in research and a close cooperation with customers have resulted in the best earth-fault protection portfolio on the market. These functions are vital with different physical neutral groundings. In REF620, a special filtering algorithm enables dependable and secure fault direction also during intermittent/restriking earth faults. It provides a good combination of reliability and sensitivity of protection with a single function for low ohmic and higher ohmic earth faults and for transient and intermittent or restriking earth faults.

REF620 is also capable of protecting other applications than basic incoming or outgoing feeders. The relay includes high-impedance based busbar protection and measurement circuit supervision functions which enable the feeder relay to be used also for busbar protection. The relay includes an optional function package offering directional active and reactive power protection that enable the protected feeder to include also motors. Additionally, the optional package for capacitor bank protection includes functions for capacitor bank overload, unbalance and resonance protection enabling the protection of single star (wye) connected capacitor banks or double star (wye) connected capacitor banks with isolated or compensated neutral. Furthermore, the relay offers an optional protection package for interconnection protection providing function for low-voltage-ride-through, directional reactive power undervoltage protection (QU) and the voltage vector shift protection. This optional application package together with the relay's basic functionality can be used with distributed power generation like wind power or solar power generation to determine when to stay connected and when to disconnect distributed generation from the utility grid following different utility Grid Codes.

Enhanced with optional hardware and software, the relay also features three light detection point-to-point lens sensors for arc fault protection of the circuit breaker, busbar and cable compartment of metal-enclosed indoor switchgear.

The arc-fault protection sensor interface is available on the optional communication module. Fast tripping increases staff safety and security and limits material damage in an arc fault situation. A binary input and output module can be selected as an option - having three high speed binary outputs (HSO) it further decreases the total operate time with typically 4...6 ms compared to the normal power outputs.

4. Application

REF620 provides feeder overcurrent and earth-fault protection for utility and industry distribution networks. The relay fits both isolated neutral networks and networks with resistance- or impedance-earthed neutrals. Furthermore, based on its advanced interstation communication facilities, the relay can also be applied for protecting ring type and meshed distribution networks as well as radial networks.

REF620 can be used with either single- or double-busbar configurations with one or two breakers, and with numerous switching device configurations. It supports a substantial number of both manually and motor-operated disconnectors and earthing switches, and it is capable of running large configurations. The number of controllable devices depends on the number of inputs and outputs left free from other application needs. The number of available I/Os can be increased with the RIO600 Remote I/O device.

The relay offers extensive possibilities to tailor the configurations to application requirements. The tool suite for all Relion relays is Protection and Control IED Manager PCM600, which contains all the necessary tools for configuring the device, including functionality, parameterization, the HMI and communication.

REF620 is an ideal protection and control relay for more advanced feeder schemes. To further improve the arc protection and to minimize the effects of an arc fault, the 620 series relays ordered with the arc protection option can be equipped with an I/O card featuring high-speed outputs operating in one millisecond.

The following figures demonstrate different application examples using relay's basic configuration. The configurations are modified by engineering functionality according to different application needs.

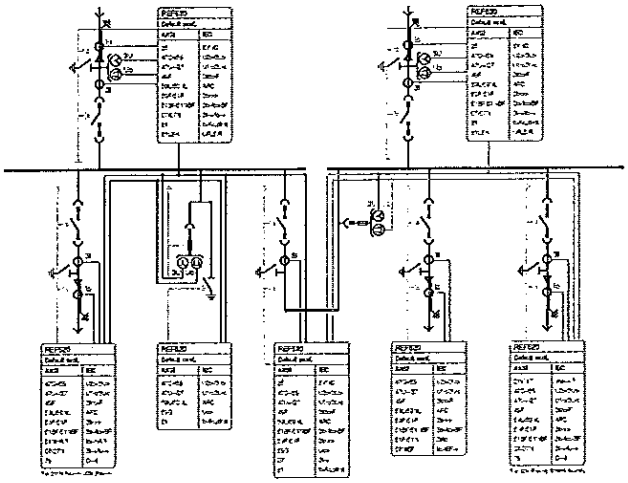

Figure 3. Single busbar AIS 2 section switchgear with conventional instrument transformers

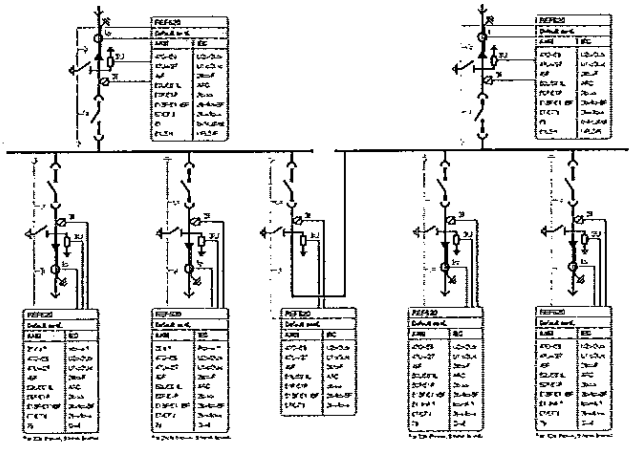

Figure 4. Single busbar AIS switchgear 2 section with sensors

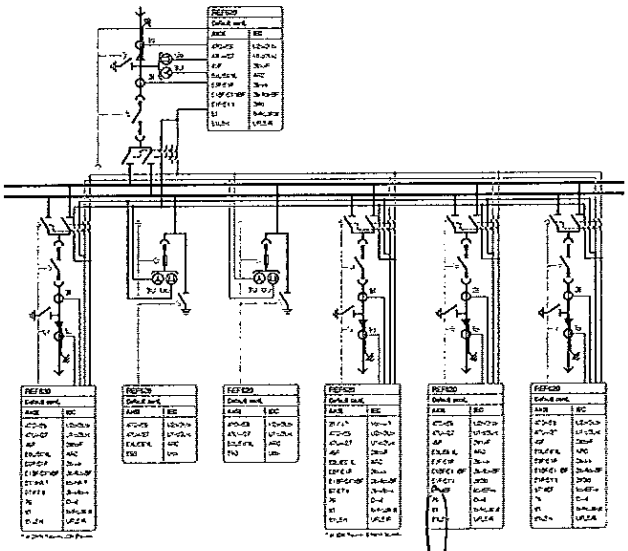

Figure 5. DSB AIS system with one busbar only (with some arrangements simplified)

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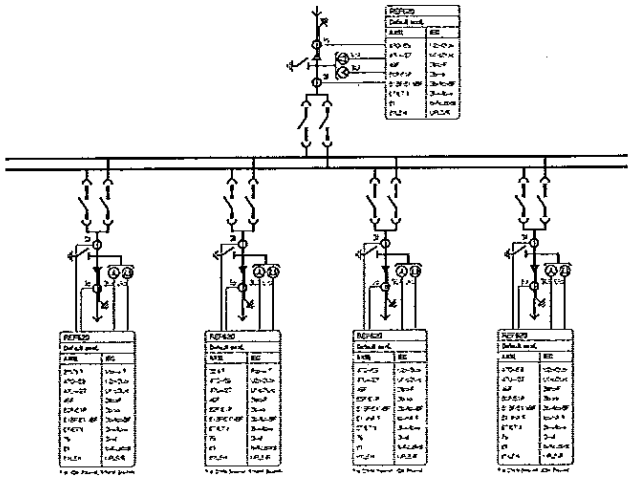

Figure 6. Back-to-back arrangement of AIS switchgear (two single-busbar panels with back walls facing each other), with two circuit breakers and a higher number of disconnectors available; A type of DSB system

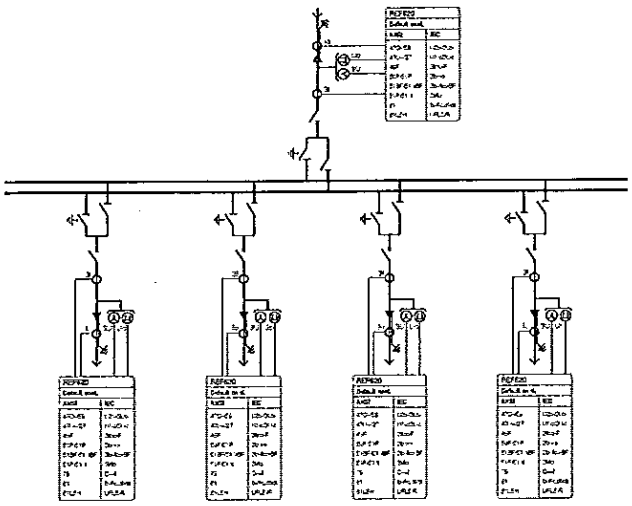

Figure 8. DSB GIS switchgear with the possibility to control the three-position disconnector switch

The following figures demonstrate the application function packages included in the relay. These packages offer new possibilities for several additional applications. The relay's basic functionality includes high-impedance based busbar differential protection functions. Thus, the relay can be engineered for busbar differential protection and by utilizing several relays, multizone differential protection schemes can also be created. The relay includes an optional protection package for capacitor bank protection and an optional protection package for interconnection protection for distributed power generation, for example, wind power. Furthermore, the relay includes an option for power protection. This package enhances the feeder relay capabilities to protect feeders including motors and includes also basic functionality to protect solar power generation connection to utility grid.

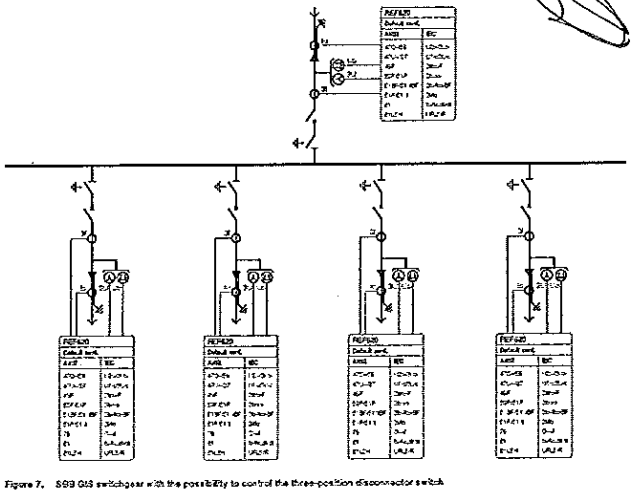

Figure 7. SSB GIS switchgear with the possibility to control the three-position disconnector switch

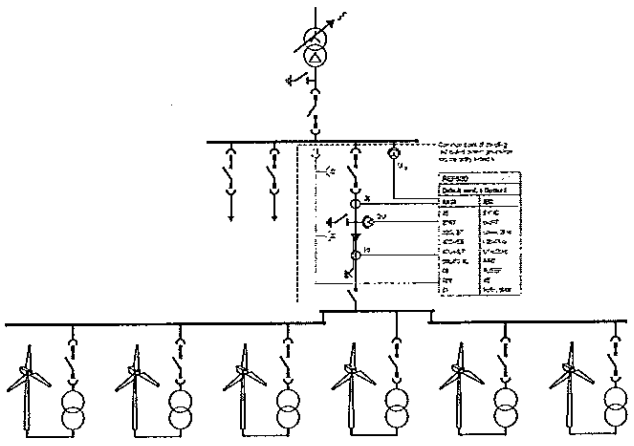

Figure 9. Application example of wind power plant as distributed power generation coupled into the utility network

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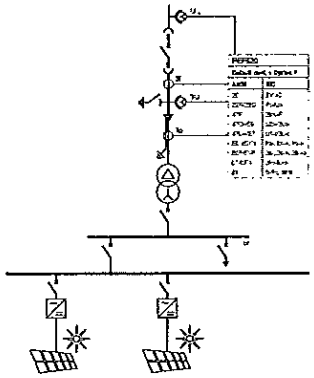

Figure 10. Application example of solar power plant as distributed power generation coupled into the utility network

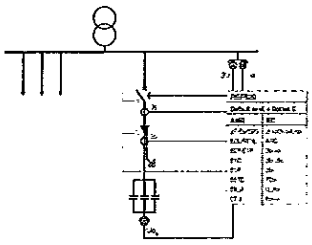

Figure 11. Protection of a single star connected capacitor bank

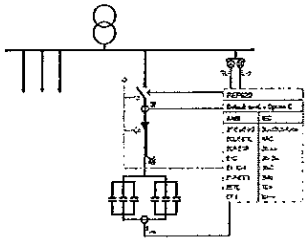

Figure 12. Protection of a double star connected capacitor bank in a distribution network with a compensated or isolated neutral

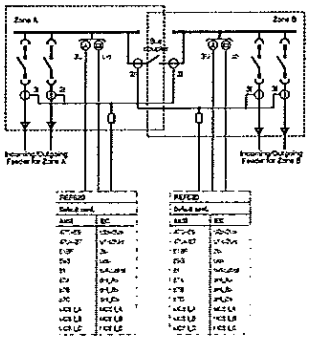

Figure 13. Application example of busbar differential protection covering two zones

6. Supported ABB solutions

ABB's 620 series protection and control relays together with the Substation Management Unit COM600 constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate and streamline the system engineering, ABB's relays are supplied with connectivity packages. The connectivity packages include a compilation of software and relay-specific information, including single-line diagram templates and a full relay data model. The data model also includes event and parameter lists. With the connectivity packages, the relays can be readily configured using PCM600 and integrated with the Substation Management Unit COM600 or the network control and management system MicroSCADA Pro.

The 620 series relays offer native support for IEC 61850 Edition 2 also including binary and analog horizontal GOOSE messaging. In addition, process bus with the sending of sampled values of analog currents and voltages and the receiving of sampled values of voltages is supported. Compared to traditional hard-wired, inter-device signaling, peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for power system protection. Among the distinctive features of the protection system approach, enabled by the full implementation of the IEC 61850 substation automation standard, are fast communication capability, continuous supervision of the integrity of the protection and communication system, and an inherent flexibility regarding reconfiguration and upgrades. This protection relay series is able to optimally utilize interoperability provided by the IEC 61850 Edition 2 features.

At substation level, COM600 uses the data content of the bay-level devices to enhance substation level functionality. COM600 features a Web browser-based HMI, which provides a customizable graphical display for visualizing single-line mimic diagrams for switchgear bay solutions. The Web HMI of COM600 also provides an overview of the whole substation, including relay-specific single-line diagrams, which makes information easily accessible. Substation devices and processes can also be remotely accessed through the Web HMI, which improves personnel safety.

In addition, COM600 can be used as a local data warehouse for the substation's technical documentation and for the network data collected by the devices. The collected network data facilitates extensive reporting and analyzing of network fault situations, by using the data historian and event handling features of COM600. The history data can be used for accurate monitoring of process and equipment performance, using calculations based on both real-time and history values. A better understanding of the process dynamics is achieved by combining time-based process measurements with production and maintenance events.

COM600 can also function as a gateway and provide seamless connectivity between the substation devices and network-level control and management systems, such as MicroSCADA Pro and System 800xA.

Table 2. Supported ABB solutions

Product	Version
Substation Management Unit COM600	4.0 SP1 or later
	4.1 or later (Edition 2)
MicroSCADA Pro SYS 600	9.3 FP2 or later
	9.4 or later (Edition 2)
System 800xA	5.1 or later

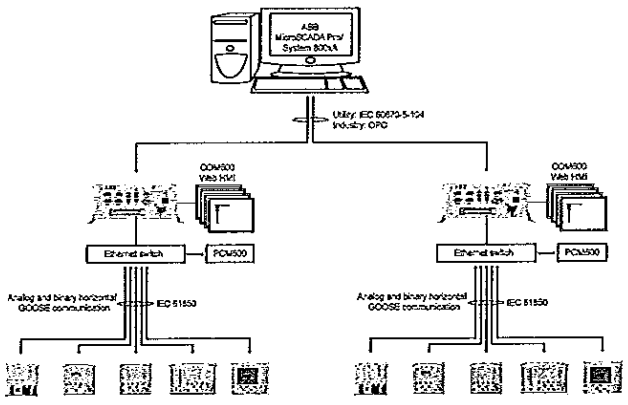

Figure 14. ABB power system example using Relion relays, Substation Management Unit COM600 and MicroSCADA Pro/System 800xA

8. Control

REF620 integrates functionality for the control of circuit breakers, disconnectors and earthing switches via the front panel HMI or by means of remote controls. The relay includes three circuit breaker control blocks. In addition to the circuit breaker control, the relay features four disconnector control blocks intended for the motor-operated control of disconnectors or circuit breaker truck. Furthermore, the relay offers three control blocks intended for the motor-operated control of earthing switch. On top of that, the relay includes additional four disconnector position indication blocks and three earthing switch position indication blocks usable with manually-only controlled disconnectors and earthing switches.

Two physical binary inputs and two physical binary outputs are needed in the relay for each controllable primary device taken into use. Depending on the chosen hardware configuration of the relay, the number of binary inputs and binary outputs varies. In case the amount of available binary inputs or outputs of the chosen hardware configuration is not sufficient, connecting an external input or output module, for example RIO600, to the relay can extend binary inputs and outputs utilizable in the relay configuration. The binary inputs and outputs of the external I/O module can be used for the less time-critical binary signals of the application. The integration enables releasing the one initially reserved binary inputs and outputs of the relay.

The suitability of the binary outputs of the relay which have been selected for the controlling of primary devices should be carefully verified, for example, the make and carry as well as the breaking capacity. In case the requirements for the control circuit of the primary device are not met, the use of external auxiliary relays should be considered.

The graphical LCD of the relay's HMI includes a single-line diagram (SLD) with position indication for the relevant primary devices. Interlocking schemes required by the application are configured using the Signal Matrix or the Application Configuration tools in PCM600.

Default configuration A incorporates a synchrocheck function to ensure that the voltage, phase angle and frequency on either side of an open circuit breaker satisfy the conditions for a safe interconnection of two networks. Synchrocheck function can also be used with default configuration B when 9-2 process bus

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is used. Compared to default configuration A, there are less physical voltage measurements available and thus the voltage measurements from the other side of the breaker have to be read through the 9-2 process bus. An autoreclosing function attempts to restore the power by reclosing the breaker with one to five programmable autoreclosing shots of desired type and duration. The function can be used with every circuit breaker that has the ability for a reclosing sequence. A load-shedding function is capable of performing load shedding based on underfrequency and the rate of change of the frequency.

7. Measurement

The relay continuously measures the phase currents and the neutral current. Furthermore, the relay measures the phase voltages and the residual voltage. In addition, the relay calculates the symmetrical components of the currents and voltages, the system frequency, the active and reactive power, the power factor, the active and reactive energy values as well as the demand value of current and power over a user-selectable preset time frame. Calculated values are also obtained from the protections and condition monitoring functions of the relay.

The values measured can be accessed locally via the user interface on the relay's front panel or remotely via the communication interface of the relay. The values can also be accessed locally or remotely using the Web browser-based user interface.

The relay is provided with a load profile recorder. The load profile feature stores the historical load data captured at a periodical time interval (demand interval). The records are in COMTRADE format.

8. Power quality

In the EN standards, power quality is defined through the characteristics of the supply voltage. Transients, short-duration and long-duration voltage variations and unbalance and waveform distortions are the key characteristics describing power quality. The distortion monitoring functions are used for monitoring the current total demand distortion and the voltage total harmonic distortion.

Power quality monitoring is an essential service that utilities can provide for their industrial and key customers. A monitoring system can provide information about system disturbances and their possible causes. It can also detect problem conditions throughout the system before they cause customer complaints, equipment malfunctions and even equipment damage or failure. Power quality problems are not limited to the utility side of the system. In fact, the majority of power quality problems are localized within customer facilities. Thus, power quality monitoring is not only an effective customer service strategy but also a way to protect a utility's reputation for quality power and service.

The protection relay has the following power quality monitoring functions.

- Voltage variation
- Voltage unbalance
- Current harmonics
- Voltage harmonics

The voltage variation and voltage variation functions are used for measuring short-duration voltage variations and monitoring voltage unbalance conditions in power transmission and distribution networks.

The voltage and current harmonics functions provide a method for monitoring the power quality by means of the current waveform distortion and voltage waveform distortion. The functions provides a short-term three-second average and a long-term demand for total demand distortion TDD and total harmonic distortion THD.

9. Fault location

The relay features an optional impedance-measuring fault location function suitable for locating short-circuits in radial distribution systems. Earth faults can be located in effectively and low-resistance earthed networks. Under circumstances where the fault current magnitude is at least of the same order of magnitude or higher than the load current, earth faults can also be located in isolated neutral distribution networks. The fault location function identifies the type of the fault and then calculates the distance to the fault point. An estimate of the fault resistance value is also calculated. The estimate provides information about the possible fault cause and the accuracy of the estimated distance to the fault point.

10. Disturbance recorder

The relay is provided with a disturbance recorder with up to 12 analog and 64 binary signal channels. The analog channels can be set to record either the waveform or the trend of the currents and voltages measured.

The analog channels can be set to trigger the recording function when the measured value falls below or exceeds the set values. The binary signal channels can be set to start a recording either on the rising or the falling edge of the binary signal or on both.

By default, the binary channels are set to record external or internal relay signals, for example, the start or trip signals of the relay stages, or external blocking or control signals. Binary relay signals, such as protection start and trip signals, or an external relay control signal via a binary input, can be set to trigger the recording. Recorded information is stored in a non-volatile memory and can be uploaded for subsequent fault analysis.

11. Event log

To collect sequence-of-events information, the relay has a non-volatile memory with a capacity of storing 1024 events with associated time stamps. The non-volatile memory retains its data also in case the relay temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances. The increased capacity to process and store data and events in the relay offers prerequisites to support the growing information demand of future network configurations.

The sequence-of-events information can be accessed either locally via the user interface on the relay's front panel, or remotely via the communication interface of the relay. The information can also be accessed using the Web browser-based user interface, either locally or remotely.

12. Recorded data

The relay has the capacity to store the records of the 128 latest fault events. The records enable the user to analyze the power system events. Each record includes current, voltage and angle values, time stamp and so on. The fault recording can be triggered by the start signal or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. Fault records store relay measurement values at the moment when any protection function starts. In addition, the maximum demand current with time stamp is separately recorded. The records are stored in the non-volatile memory.

13. Condition monitoring

The condition monitoring functions of the relay constantly monitor the performance and the condition of the circuit breaker. The monitoring comprises the spring charging time, SF6 gas pressure, the travel time and the inactivity time of the circuit breaker.

The monitoring functions provide operational circuit breaker history data, which can be used for scheduling preventive circuit breaker maintenance.

In addition, the relay includes a runtime counter for monitoring of how many hours a protected device has been in operation thus enabling scheduling of time-based preventive maintenance of the device.

14. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed and in its open position. It also detects loss of circuit-breaker control voltage.

15. Self-supervision

The relay's built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected is used for alerting the operator.

A permanent relay fault blocks the protection functions to prevent incorrect operation.

16. Fuse failure supervision

The fuse failure supervision detects failures between the voltage measurement circuit and the relay. The failures are detected either by the negative sequence-based algorithm or by the delta voltage and delta current algorithm. Upon the detection of a failure, the fuse failure supervision function activates an alarm and blocks voltage-dependent protection functions from unintended operation.

17. Current circuit supervision

Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED and blocks certain protection functions to avoid unintended operation. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer or from separate cores in the phase current transformers.

18. Access control

To protect the relay from unauthorized access and to maintain information integrity, the relay is provided with a four-level, role-based authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator level. The access control applies to the front-panel user interface, the Web browser-based user interface and PCM600.

19. Inputs and outputs

REF620 can be selected to measure currents and voltages either with conventional current transducers and voltage transducers or with current sensors and voltage sensors. The relay variant with conventional transducers is equipped with three phase current inputs, one residual-current input, three phase voltage inputs, one residual-voltage input and one phase-to-phase voltage for synorocheck input. In addition to current and voltage measurements, the relay's basic configuration includes 24 binary inputs and 14 binary outputs. The phase current inputs and the residual-current inputs are rated 1/5 A, that is, the inputs allow the connection of either 1 A or 5 A secondary current transformers. The optional sensitive residual-current input 0.2/1 A is normally used in applications requiring sensitive earth-fault protection and featuring core balance current transformers. The three phase voltage inputs and the residual-voltage input covers the rated voltages 60...

210 V. Both phase-to-phase voltages and phase-to-earth voltages can be connected.

The relay variant equipped with current and voltage sensors has three sensor inputs for the direct connection of three combisensors with RJ-45 connectors. As an alternative to the combisensors, separate current and voltage sensors can be utilized using adapters. Furthermore, the adapters also enable the use of sensors with Twin-BNC connectors. Additionally, the relay includes one conventional residual-current input 0.2/1 A normally used in applications requiring sensitive earth-fault protection and featuring core balance current transformers. In addition to current and voltage measurements, the relay's basic configuration includes 16 binary inputs and 14 binary outputs.

As an optional addition, the relay's basic configuration includes one empty slot which can be equipped with one of the following optional modules. The first option, additional binary inputs and outputs module, adds eight binary inputs and four binary outputs to the relay. This option is especially needed when connecting the relay to several controllable objects, still leaving room for additional inputs and outputs for other signals needed in configuration. The second option, an additional RTD/mA input module, increases the relay with six RTD inputs and two mA inputs when additional sensor measurements for example for temperatures, pressures, levels and so on are of interest. The third option is a high-speed output board including eight binary inputs and three high-speed outputs. The high-speed outputs have a shorter activation time compared to the conventional mechanical output relays, shortening the overall relay operation time by 4...6 ms with very time-critical applications like arc protection. The high-speed outputs are freely configurable in the relay application and not limited to arc protection only.

The rated values of the current and voltage inputs are settable parameters of the relay. In addition, the binary input thresholds are selectable within the range of 16...176 V DC by adjusting the relay's parameter settings.

All binary inputs and outputs contacts are freely configurable with the signal matrix or application configuration functionality of PCM600.

See the Input/output overview table and the terminal diagrams for more detailed information about the inputs and outputs.

If the number of the relay's own inputs and outputs does not cover all the intended purposes, connecting to an external input or output module, for example RIO600, increases the number of binary inputs and outputs utilizable in the relay configuration. In this case, the external inputs and outputs are connected to the relay via IEC 61850 GOOSE to reach fast reaction times between the relay and RIO600 information. The needed binary input and output connections between the relay and RIO600 units can be configured in a PCM600 tool and then utilized in the relay configuration.

Table 3. Input/output overview

Default conf.	Order code digit		Analog channels			Binary channels			
	5-6	7-8	CT	VT	Combi sensor	BI	BO	RTD	mA
A	AA/AB	AA	4	5	-	32	4 PO + 14 SO	-	-
		AB				24	4 PO + 10 SO	6	2
		AC				32	4 PO + 10 SO + 3 HSO	-	-
		NN				24	4 PO + 10 SO	-	-
B	AC	AA	1	-	3	24	4 PO + 14 SO	-	-
		AB				16	4 PO + 10 SO	6	2
		AC				24	4 PO + 10 SO + 3 HSO	-	-
		NN				16	4 PO + 10 SO	-	-

20. Station communication

The relay supports a range of communication protocols including IEC 61850 Edition 1 and Edition 2, IEC 61850-9-2 LE, IEC 60870-5-103, Modbus® and DNP3, Profibus DPV1 communication protocol is supported with using the protocol converter SPA-ZC 302. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the relays, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 protocol is a core part of the relay as the protection and control application is fully based on standard modelling. The relay supports Edition 2 and Edition 1 versions of the standard. With Edition 2 support, the relay has the latest functionality modelling for substation applications and the best interoperability for modern substations. It incorporates also the full support of standard device mode functionality supporting different test applications. Control applications can utilize the new safe and advanced station control authority feature.

The IEC 61850 communication implementation supports monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the standard COMTRADE file format. The relay supports simultaneous event reporting to five different clients on the station bus. The relay can exchange data with other devices using the IEC 61850 protocol.

The relay can send binary and analog signals to other devices using the IEC 61850-9-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, for example, be employed for protection and interlocking-based protection schemes. The relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard (<10 ms data exchange between the devices). The relay also supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables easy transfer of analog measurement values over the station bus, thus facilitating for example the sending of measurement values between the relays when controlling parallel running transformers.

The relay also supports IEC 61850 process bus by sending sampled values of analog currents and voltages and by receiving sampled values of voltages. With this functionality the galvanic interpanel wiring can be replaced with Ethernet communication. The measured values are transferred as sampled values using IEC 61850-9-2 LE protocol. The intended application for sampled values shares the voltages to other 620 series relays, having voltage based functions and 9-2 support. 620 relays with process bus based applications use IEEE 1588 for high accuracy time synchronization.

For redundant Ethernet communication, the relay offers either two optical or two galvanic Ethernet network interfaces. A third port with galvanic Ethernet network interface is also available. The third Ethernet interface provides connectivity for any other Ethernet device to an IEC 61850 station bus inside a switchgear bay, for example connection of a Remote I/O, Ethernet network redundancy can be achieved using the high-availability seamless redundancy (HSR) protocol or the parallel redundancy protocol (PRP) or a with self-healing ring using RSTP in managed switches. Ethernet redundancy can be applied to Ethernet-based IEC 61850, Modbus and DNP3 protocols.

The IEC 61850 standard specifies network redundancy which improves the system availability for the substation communication. The network redundancy is based on two complementary protocols defined in the IEC 62439-3 standard: PRP and HSR protocols. Both protocols are able to overcome a failure of a link or switch with a zero switch-over time. In both protocols, each network node has two identical Ethernet ports dedicated for one network connection. The protocols rely on the duplication of all transmitted information and provide a zero switch-over time if the links or switches fail, thus fulfilling all the stringent real-time requirements of substation automation.

In PRP, each network node is attached to two independent networks operated in parallel. The networks are completely separated to ensure failure independence and can have different topologies. The networks operate in parallel, thus providing zero-time recovery and continuous checking of redundancy to avoid failures.

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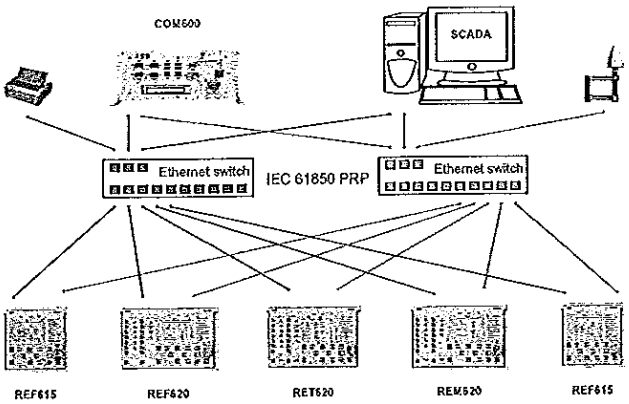

Figure 15. Parallel redundancy protocol (PRP) solution

HSR applies the PRP principle of parallel operation to a single ring. For each message sent, the node sends two frames, one through each port. Both frames circulate in opposite directions over the ring. Every node forwards the frames it receives from one port to another to reach the next node. When the originating sender node receives the frame it sent, the sender node discards the frame to avoid loops. The HSR ring with 620 series relays supports the connection of up to 30 relays. If more than 30 relays are connected, it is recommended to split the network into several rings to guarantee the performance for real-time applications.

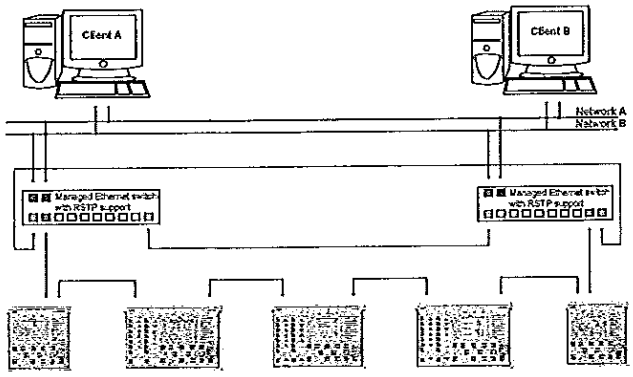

Figure 17. Self-healing Ethernet ring solution

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The relay can be connected to Ethernet-based communication systems via the RJ-45 connector (100Base-TX) or the fiber-optic LC connector (100Base-FX). If a connection to the serial bus is required, the 9-pin RS-485 screw-terminal can be used. An optional serial interface is available for RS-232 communication.

Modbus implementation supports RTU, ASCII and TCP modes. Besides standard Modbus functionality, the relay supports retrieval of time-stamped events, changing the active setting group and uploading of the latest fault records. If a Modbus TCP connection is used, five clients can be connected to the relay simultaneously. Further, Modbus serial and Modbus TCP can be used in parallel, and if required both IEC 61850 and Modbus protocols can be run simultaneously.

The IEC 60870-5-103 implementation supports two parallel serial bus connections to two different masters. Besides basic standard functionality, the relay supports changing of the active setting group and uploading of disturbance recordings in IEC 60870-5-103 format. Further, IEC 60870-5-103 can be used at the same time with the IEC 61850 protocol.

DNP3 supports both serial and TCP modes for connection up to five masters. Changing of the active setting and reading fault records are supported. DNP serial and DNP TCP can be used in parallel. If required, both IEC 61850 and DNP protocols can be run simultaneously.

620 series supports Profibus DPV1 with support of SPA-ZC 302 Profibus adapter. If Profibus is required the relay must be ordered with Modbus serial options. Modbus implementation includes SPA-protocol emulation functionality. This functionality enables connection to SPA-ZC 302.

When the relay uses the RS-485 bus for the serial communication, both two- and four wire connections are supported. Termination and pull-up/down resistors can be configured with jumpers on the communication card so external resistors are not needed.

The relay supports the following time synchronization methods with a time-stamping resolution of 1 ms.

Ethernet-based
- SNTP (Simple Network Time Protocol)

With special time synchronization wiring
- IRIG-B (Inter-Range Instrumentation Group - Time Code Format B)

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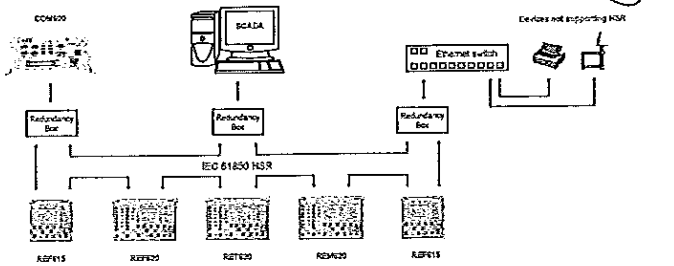

Figure 16. High availability seamless redundancy (HSR) solution

The choice between the HSR and PRP redundancy protocols depends on the required functionality, cost and complexity.

The self-healing Ethernet ring solution enables a cost-efficient communication ring controlled by a managed switch with standard Rapid Spanning Tree Protocol (RSTP) support. The managed switch controls the consistency of the loop, routes the data and corrects the data flow in case of a communication switch-over. The relays in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to thirty 620 series relays. If more than 30 relays are connected, it is recommended to split the network into several rings. The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication.

The relay supports the following high accuracy time synchronization method with a time-stamping resolution of 4 µs required especially in process bus applications.
- PTP (IEEE 1588) v2 with Power Profile

The IEEE 1588 support is included in all variants having a redundant Ethernet communication module.

IEEE 1588 v2 features
- Ordinary Clock with Best Master Clock algorithm
- One-step Transparent Clock for Ethernet ring topology
- 1588 v2 Power Profile
- Receive (slave): 1-step/2-step
- Transmit (master): 1-step
- Layer 2 mapping
- Peer to peer delay calculation
- Multicast operation

Required accuracy of grandmaster clock is +/-1 µs. The relay can work as a master clock per BMC algorithm if the external grandmaster clock is not available for short term.

The IEEE 1588 support is included in all variants having a redundant Ethernet communication module.

In addition, the relay supports time synchronization via Modbus, DNP3 and IEC 60870-5-103 serial communication protocols.

Table 4. Supported station communication interfaces and protocols

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX RJ-45	100BASE-FX LC	RS-232/RS-485	Fiber-optic ST
IEC 61850-8-1	•	•	-	-
IEC 61850-9-2 LE	•	•	-	-
MODBUS RTU/ASCII	-	-	•	•
MODBUS TCP/IP	•	•	•	•
DNP3 (serial)	-	-	•	•
DNP3 TCP/IP	•	•	•	-
IEC 60870-5-103	-	-	•	•

• = Supported

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21. Technical data

Table 5. Dimensions

Description	Value	
Width	Frame	262.2 mm
	Case	245 mm
Height	Frame	177 mm, 4U
	Case	160 mm
Depth		201 mm
Weight	Complete protection relay	max. 5.0 kg
	Plug-in unit only	max. 2.9 kg

Table 6. Power supply

Description	Type 1	Type 2
U_{aux} nominal	100, 110, 120, 220, 240 V AC, 50 and 60 Hz	24, 30, 48, 60 V DC
	48, 60, 110, 125, 220, 250 V DC	
Maximum interruption time in the auxiliary DC voltage without resetting the relay	50 ms at U_n rated	
U_{aux} variation	38...110% of U_n (38...264 V AC)	50...120% of U_n (12...72 V DC)
	80...120% of U_n (38.4...300 V DC)	
Start-up threshold		19.2 V DC (24 V DC × 80%)
Burden of auxiliary voltage supply under quiescent (P_q)/operating condition	DC <18.0 W (nominal[1])/<22.5 W (max[2]) AC <19.0 W (nominal[1])/<23.0 W (max[2])	DC <18.5 W (nominal[1])/<22.5 W (max[2])
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)	
Fuse type	T4A/250 V	

1) During the power consumption measurement, the relay is powered at rated auxiliary energizing voltage and the energizing quantities are energized without any binary output being active
2) During the power consumption measurement, the relay is powered at rated auxiliary energizing voltage and the energizing quantities are energized to activate at least half of the binary outputs

Table 7. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz	
Current inputs	Rated current, I_n	0.2/1 A[1]	1/5 A[2]
	Thermal withstand capability:		
	• Continuously	4 A	20 A
	• For 1 s	100 A	500 A
	Dynamic current withstand:		
	• Half-wave value	250 A	1250 A
	Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage	60...210 V AC	
	Voltage withstand:		
	• Continuous	240 V AC	
	• For 10 s	360 V AC	
	Burden at rated voltage	<0.05 VA	

1) Ordering option for residual current input
2) Residual current and/or phase current

Table 8. Energizing inputs (sensors)

Description		Value
Current sensor input	Rated current voltage (in secondary side)	75...9000 mV[1]
	Continuous voltage withstand	125 V
	Input impedance at 50/60 Hz	2...3 MΩ[2]
Voltage sensor input	Rated voltage	6...30 kV[3]
	Continuous voltage withstand	50 V
	Input impedance at 50/60 Hz	3 MΩ

1) Equals the current range of 40...4000 A with a 80 A, 3 mV/Hz Rogowski
2) Depending on the used nominal current (hardware gain)
3) This range is covered (up to 2 x rated) with sensor division ratio of 10 000:1

Table 9. Binary inputs

Description	Value
Operating range	±20% of the rated voltage
Rated voltage	24...250 V DC
Current drain	1.6...1.9 mA
Power consumption	31.0...570.0 mW
Threshold voltage	15...176 V DC
Reaction time	<3 ms

Table 10. RTD/mA measurement

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum 250 Ω platinum 100 Ω nickel 120 Ω nickel 250 Ω nickel 10 Ω copper	TCR 0.00385 (DIN 43760) TCR 0.00385 TCR 0.00618 (DIN 43760) TCR 0.00618 TCR 0.00618 TCR 0.00427
	Supported resistance range	0...2 kΩ	
	Maximum lead resistance (three-wire measurement)	25 Ω per lead	
	Isolation	2 kV (inputs to protective earth)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		± 2.0% or ±1 Ω	±1°C 10 Ω copper: ±2°C
mA inputs	Supported current range	0...20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	±0.5% or ±0.01 mA	

Table 11. Signal output with high make and carry

Description	Value [1]
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

1) X100: SO1
X105: SO1, SO2, when any of the protection relays is equipped with BIO0005
X110: SO1, SO2 when REF620 or RET620 is equipped with BIO0005
X115: SO1, SO2 when REF620 or REM620 is equipped with BIO0005

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Table 12. Signal outputs and IRF output

Description	Value [1]
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	10 mA at 5 V AC/DC

1) X100: IRF,SO2
X105: SO3, SO4, when any of the protection relays is equipped with BIO0005
X110: SO3, SO4, when REF620 or RET620 is equipped with BIO0005
X115: SO3, SO4, when REF620 or REM620 is equipped with BIO0005

Table 13. Double-pole power outputs with TCS function X100: PO3 and PO4

Description	Value [1]
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC (two contacts connected in a series)	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC
Trip-circuit monitoring (TCS)	
• Control voltage range	20...250 V AC/DC
• Current drain through the monitoring circuit	~1.5 mA
• Minimum voltage over the TCS contact	20 V AC/DC (15...20 V)

1) PSM0003: PO3, PSM0004: PO3, PSM0003: PO4 and PSM0004: PO4

Table 14. Single-pole power output relays X100: PO1 and PO2

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC

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Table 15. High-speed output HSO

Description	Value [1]
Rated voltage	250 V AC/DC
Continuous contact carry	6 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Operate time	<1 ms
Reset	<20 ms, resistive load

1) HSO1, HSO2, HSO3, when any of the protection relay is powered with 24 V DC

Table 16. Front port Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
Front	TCP/IP protocol	Standard Ethernet CAT 5 cable with RJ-45 connector	10 MBit/s

Table 17. Station communication link, fiber optic

Connector	Fiber type [1]	Wave length	Typical max. length [2]	Permitted path attenuation [3]
LC	MM 62.5/125 or 50/125 µm glass fiber core	1300 nm	2 km	<8 dB
ST	MM 62.5/125 or 50/125 µm glass fiber core	820...900 nm	1 km	<11 dB

1) MM: multimode fiber, SM: single-mode fiber
2) Maximum length depends on the cable attenuation and quality, the amount of splices and connections in the path
3) Maximum allowed attenuation caused by connectors and cable together

Table 18. IRIG-B

Description	Value
IRIG time code format	B004, B005 [1]
Isolation	500V 1 min
Modulation	Unmodulated
Logic level	5 V TTL
Current consumption	<4 mA
Power consumption	<20 mW

1) According to the 200-04 IRIG standard

Table 19. Lens sensor and optical fiber for arc protection

Description	Value
Fiber optic cable including lens	1.5 m, 3.0 m or 5.0 m
Normal service temperature range of the lens	-40...+100°C
Maximum service temperature range of the lens, max 1 h	+140°C
Minimum permissible bending radius of the connection fiber	100 mm

Table 20. Degree of protection of flush-mounted protection relay

Description	Value
Front side	IP 54
Rear side, connection terminals	IP 20

Table 21. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C (continuous)
Short-time service temperature range	-40...+85°C (<16h) [1] [2]
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	Up to 2000 m
Transport and storage temperature range	-40...+85°C

1) Degradation in MTBF and HMI performance outside the temperature range of -25...+55°C
2) For relays with an LCD communication interface the maximum operating temperature is +70°C

Table 22. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz/100 kHz burst disturbance test		IEC 61000-4-18 IEC 60255-26, class III IEEE C37.90.1-2002
• Common mode	2.5 kV	
• Differential mode	2.5 kV	
3 MHz, 10 MHz and 30 MHz burst disturbance test		IEC 61000-4-18 IEC 60255-26, class III
• Common mode	2.5 kV	
Electrostatic discharge test		IEC 61000-4-2 IEC 60255-26 IEEE C37.90.3-2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference test		
	10 V (rms) f = 150 kHz...80 MHz	IEC 61000-4-6 IEC 60255-26, class III
	10 V/m (rms) f = 80...2700 MHz	IEC 61000-4-3 IEC 60255-26, class III
	10 V/m f = 900 MHz	ENV 50204 IEC 60255-26, class III
Fast transient disturbance test		IEC 61000-4-4 IEC 60255-26 IEEE C37.90.1-2002
• All ports	4 kV	
Surge immunity test		IEC 61000-4-5 IEC 60255-26
• Communication	1 kV, line-to-earth	
• Other ports	4 kV, line-to-earth 2 kV, line-to-line	
Power frequency (50 Hz) magnetic field immunity test		IEC 61000-4-8
• Continuous	300 A/m	
• 1...3 s	1000 A/m	
Pulse magnetic field immunity test	1000 A/m 6.4/16 µs	IEC 61000-4-9
Damped oscillatory magnetic field immunity test		IEC 61000-4-10
• 2 s	100 A/m	
• 1 MHz	400 transients/s	
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Power frequency immunity test	Binary inputs only	IEC 61000-4-16 IEC 60255-26, class A
• Common mode	300 V rms	

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Table 22. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
• Differential mode	150 V rms	
Conducted common mode disturbances	15 Hz...150 kHz Test level 3 (10/1/10 V rms)	IEC 61000-4-16
Emission tests		EN 55011, class A IEC 60255-25 CISPR 11 CISPR 12
• Conducted		
0.15...0.50 MHz	<79 dB (µV) quasi peak <66 dB (µV) average	
0.5...30 MHz	<73 dB (µV) quasi peak <60 dB (µV) average	
• Radiated		
30...230 MHz	<40 dB (µV/m) quasi peak, measured at 10 m distance	
230...1000 MHz	<47 dB (µV/m) quasi peak, measured at 10 m distance	
1...3 GHz	<76 dB (µV/m) peak <56 dB (µV/m) average, measured at 3 m distance	
3...6 GHz	<80 dB (µV/m) peak <60 dB (µV/m) average, measured at 3 m distance	

Table 23. Insulation tests

Description	Type test value	Reference
Dielectric tests	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min, communication	IEC 60255-27
Impulse voltage test	5 kV, 1.2/50 µs, 0.5 J 1 kV, 1.2/50 µs, 0.5 J, communication	IEC 60255-27
Insulation resistance measurements	>100 MΩ, 500 V DC	IEC 60255-27
Protective bonding resistance	<0.1 Ω, 4 A, 60 s	IEC 60255-27

Table 24. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 2
Shock and bump test	IEC 60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 2
Seismic test	IEC 60255-21-3	Class 2

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Table 25. Environmental tests

Description	Type test value	Reference
Dry heat test	• 96 h at +55°C • 16 h at +85°C[1]	IEC 60068-2-2
Dry cold test	• 96 h at -25°C • 16 h at -40°C	IEC 60068-2-1
Damp heat test	• 6 cycles (12 h + 12 h) at +25°C…+55°C, humidity >93%	IEC 60068-2-30
Change of temperature test	• 5 cycles (3 h + 3 h) at -25°C…+55°C	IEC60068-2-14
Storage test	• 96 h at -40°C • 96 h at +85°C	IEC 60068-2-1 IEC 60068-2-2

1) For relays with an LC communication interface the maximum operating temperature is +70°C

Table 26. Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2013) EN 60255-1 (2009)

Table 27. EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 60255-26 (2013)

Table 28. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Protection functions

Table 29. Three-phase non-directional overcurrent protection (PHxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	PHLPTOC	±1.5% of the set value or ±0.002 × I_n		
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1…10 × I_n) ±5.0% of the set value (at currents in the range of 10…40 × I_n)		
Start time [1,2]		Minimum	Typical	Maximum
	PHIPTOC: I_{Fault} = 2 × set *Start value* I_{Fault} = 10 × set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	PHHPTOC and PHLPTOC: I_{Fault} = 2 × set *Start value*	23 ms	26 ms	29 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression		

1) [illegible]
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact

Table 30. Three-phase non-directional overcurrent protection (PHxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PHLPTOC	0.05…5.00 × I_n	0.01
	PHHPTOC	0.10…40.00 × I_n	0.01
	PHIPTOC	1.00…40.00 × I_n	0.01
Time multiplier	PHLPTOC	0.05…15.00	0.01
	PHHPTOC	0.05…15.00	0.01
Operate delay time	PHLPTOC	40…200000 ms	10
	PHHPTOC	40…200000 ms	10
	PHIPTOC	20…200000 ms	10
Operating curve type [1]	PHLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	PHHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	PHIPTOC	Definite time	

1) For further reference, see Operation characteristics table

Table 31. Three-phase directional overcurrent protection (DPHxPDOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current/voltage measured: f_n ±2 Hz		
	DPHLPDOC	Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
	DPHHPDOC	Current: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.1…10 × I_n) ±5.0% of the set value (at currents in the range of 10…40 × I_n) Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
Start time [1,2]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 × set *Start value*	39 ms	43 ms	47 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,…		

1) [illegible]
2) Includes the delay of the signal output contact
3) [illegible]

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Table 32. Three-phase directional overcurrent protection (DPHxPDOC) main settings

Parameter	Function	Value (Range)	Step
Start value	DPHLPDOC	0.05…5.00 × I_n	0.01
	DPHHPDOC	0.10…40.00 × I_n	0.01
Time multiplier	DPHxPDOC	0.05…15.00	0.01
Operate delay time	DPHxPDOC	40…200000 ms	10
Operating curve type [1]	DPHLPDOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DPHHPDOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
Directional mode	DPHxPDOC	1 = Non-directional 2 = Forward 3 = Reverse	-
Characteristic angle	DPHxPDOC	-179…180°	1

1) For further reference, refer to the Operating characteristics table

Table 33. Three-phase voltage-dependent overcurrent protection (PHPVOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current and voltage: f_n ±2 Hz
	Current: ±1.5% of the set value or ± 0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n
Start time [1,2]	Typically 26 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode	±5.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2, 3, 4, 5,…

1) [illegible]
2) Includes the delay of the signal output contact

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Table 34. Three-phase voltage-dependent overcurrent protection (PHPVOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPVOC	0.05...5.00 × I_n	0.01
Start value low	PHPVOC	0.05...1.00 × I_n	0.01
Voltage high limit	PHPVOC	0.01...1.00 × U_n	0.01
Voltage low limit	PHPVOC	0.0 (...1.00 × U_n	0.01
Start value M,A	PHPVOC	0.8...10.0	0.1
Time multiplier	PHPVOC	0.05...15.00	0.01
Operating curve type[1]	PHPVOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
Operate delay time	PHPVOC	40...200000 ms	10

1) For further reference, see Operation characteristics table

Table 35. Non-directional earth-fault protection (EFxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	EFLPTOC	±1.5% of the set value or ±0.002 × I_n		
	EFHPTOC and EFIPTOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n)		
Start time[1][2]		Minimum	Typical	Maximum
	EFIPTOC: I_{Fault} = 2 × set *Start value* I_{Fault} = 10 × set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	EFHPTOC and EFLPTOC: I_{Fault} = 2 × set *Start value*	23 ms	26 ms	29 ms
Reset time		Typically 43 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression		

1) Measurement mode = default (depends on stage), current before fault = 0.9 × I_n, I_n = 50 A, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 0.8 × I_n, *Start value* multiples in range of 1.5...20

Table 36. Non-directional earth-fault protection (EFxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	EFLPTOC	0.010...5.000 × I_n	0.005
	EFHPTOC	0.10...40.00 × I_n	0.01
	EFIPTOC	1.00...40.00 × I_n	0.01
Time multiplier	EFLPTOC	0.05...15.00	0.01
	EFHPTOC	0.05...15.00	0.01
Operate delay time	EFLPTOC	40...200000 ms	10
	EFHPTOC	40...200000 ms	10
	EFIPTOC	20...200000 ms	10
Operating curve type[1]	EFLPTOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	EFHPTOC	Definite or Inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	EFIPTOC	Definite time	

1) For further reference, see Operation characteristics table

Table 37. Directional earth-fault protection (DEFxPDEF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz		
	DEFLPDEF	Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
	DEFHPDEF	Current: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n) Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
Start time[1][2]		Minimum	Typical	Maximum
	DEFHPDEF I_{Fault} = 2 × set *Start value*	42 ms	46 ms	49 ms
	DEFLPDEF I_{Fault} = 2 × set *Start value*	58 ms	62 ms	66 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression		

1) Set *Operate delay time* = 0.06 s, *Operating curve type* = ANSI definite time, measurement mode = default (depends on stage), current before fault = 0.9 × I_n, I_n = 50 A, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 0.8 × I_n, *Start value* multiples in range of 1.5...20

Table 38. Directional earth-fault protection (DEFxPDEF) main settings

Parameter	Function	Value (Range)	Step
Start value	DEFLPDEF	0.010...5.000 × I_n	0.005
	DEFHPDEF	0.10...40.00 × I_n	0.01
Directional mode	DEFxPDEF	1 = Non-directional 2 = Forward 3 = Reverse	-
Time multiplier	DEFLPDEF	0.05...15.00	0.01
	DEFHPDEF	0.05...15.00	0.01
Operate delay time	DEFLPDEF	60...200000 ms	10
	DEFHPDEF	40...200000 ms	10
Operating curve type[1]	DEFLPDEF	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DEFHPDEF	Definite or Inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	DEFxPDEF	1 = Phase angle 2 = IoSin 3 = IoCos 4 = Phase angle 80 5 = Phase angle 88	-

1) For further reference, refer to the Operating characteristics table

Table 39. Admittance-based earth-fault protection (EFPADM)

Characteristic	Value		
Operation accuracy[1]	At the frequency f = f_n ±1.0% or ±0.01 mS (in range of 0.5...100 mS)		
Start time[2]	Minimum	Typical	Maximum
	56 ms	60 ms	64 ms
Reset time	60 ms		
Operate time accuracy	±1.0% of the set value of ±20 ms		
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) U_n = 1.0 × U_{in}
2) Includes the delay of the signal output contact, results based on statistical distribution of 1000 measurements

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Table 40. Admittance-based earth-fault protection (EFPADM) main settings

Parameter	Function	Value (Range)	Step
Voltage start value	EFPADM	0.01...2.00 × U_n	0.01
Directional mode	EFPADM	1 = Non-directional 2 = Forward 3 = Reverse	-
Operation mode	EFPADM	1 = Yo 2 = Go 3 = Bo 4 = Yo, Go 5 = Yo, Bo 6 = Go, Bo 7 = Yo, Go, Bo	-
Operate delay time	EFPADM	60...200000 ms	10
Circle radius	EFPADM	0.05...500.00 mS	0.01
Circle conductance	EFPADM	-500.00...500.00 mS	0.01
Circle susceptance	EFPADM	-500.00...500.00 mS	0.01
Conductance forward	EFPADM	-500.00...500.00 mS	0.01
Conductance reverse	EFPADM	-500.00...500.00 mS	0.01
Susceptance forward	EFPADM	-500.00...500.00 mS	0.01
Susceptance reverse	EFPADM	-500.00...500.00 mS	0.01
Conductance tilt Ang	EFPADM	-30...30°	1
Susceptance tilt Ang	EFPADM	-30...30°	1

Table 41. Wattmetric-based earth-fault protection (WPWDE)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz Current and voltage: ±1.5% of the set value or ±0.002 × I_n Power: ±3% of the set value or ±0.002 × P_n
Start time [1,2]	Typically 63 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Operate time accuracy in IDMT mode	±5.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2,3,4,5,...

1) Measured during the test, the 1.0 × U_n is given to earth voltage during earth-fault in compensated or unearthed network, the residual power value before fault = 0.0 pu, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 42. Wattmetric-based earth-fault protection (WPWDE) main settings

Parameter	Function	Value (Range)	Step
Directional mode	WPWDE	2 = Forward 3 = Reverse	-
Current start value	WPWDE	0.010...5.000 × I_n	0.001
Voltage start value	WPWDE	0.010...1.000 × U_n	0.001
Power start value	WPWDE	0.003...1.000 × P_n	0.001
Reference power	WPWDE	0.050...1.000 × P_n	0.001
Characteristic angle	WPWDE	-179...180°	1
Time multiplier	WPWDE	0.05...2.00	0.01
Operating curve type [1]	WPWDE	Definite or Inverse time Curve type: 5, 15, 20	
Operate delay time	WPWDE	60...200000 ms	10
Min operate current	WPWDE	0.010...1.000 × I_n	0.001
Min operate voltage	WPWDE	0.01...1.00 × U_n	0.01

1) For further reference, refer to the Operating characteristics table

Table 43. Multifrequency admittance-based earth-fault protection (MFADPSDE)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured voltage: f_n ±2 Hz ±1.5% of the set value or ±0.002 × U_n
Start time [1]	Typically 35 ms
Reset time	Typically 40 ms
Operate time accuracy	±1.0% of the set value or ±20 ms

1) Includes the delay of the signal output contact, results based on statistical distribution of 1000 measurements

Table 44. Multifrequency admittance-based earth-fault protection (MFADPSDE) main settings

Parameter	Function	Value (Range)	Step
Directional mode	MFADPSDE	2 = Forward 3 = Reverse	-
Voltage start value	MFADPSDE	0.01...1.00 × U_n	0.01
Operate delay time	MFADPSDE	60...1200000	10
Operating quantity	MFADPSDE	1 = Adaptive 2 = Amplitude	-
Min operate current	MFADPSDE	0.005...5.000 × I_n	0.001
Operation mode	MFADPSDE	1 = Intermittent EF 3 = General EF 4 = Alarming EF	-
Peak counter limit	MFADPSDE	2...20	1

Table 45. Transient/intermittent earth-fault protection (INTRPTEF)

Characteristic	Value
Operation accuracy (Uo criteria with transient protection)	Depending on the frequency of the measured current: f_n ±2 Hz ±1.5% of the set value or ±0.002 × Uo
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5

Table 46. Transient/intermittent earth-fault protection (INTRPTEF) main settings

Parameter	Function	Value (Range)	Step
Directional mode	INTRPTEF	1 = Non-directional 2 = Forward 3 = Reverse	-
Operate delay time	INTRPTEF	40...1200000 ms	10
Voltage start value	INTRPTEF	0.05...0.50 × U_n	0.01
Operation mode	INTRPTEF	1 = Intermittent EF 2 = Transient EF	-
Peak counter limit	INTRPTEF	2...20	-
Min operate current	INTRPTEF	0.01...1.00 × I_n	0.01

Table 47. Harmonics-based earth-fault protection (HAEFPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±5% of the set value or ±0.004 × I_n
Start time [1,2]	Typically 77 ms
Reset time	Typically 43 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Operate time accuracy in IDMT mode [3]	±5.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at f = f_n -3 dB at f = 13 × f_n

1) Fundamental frequency current = 1.0 × I_n, harmonic current before fault = 0.0 × I_n, harmonic fault current 2.0 × *Start value*, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start* value multiples in range of 1.5...20

Table 48. Harmonics-based earth-fault protection (HAEFPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	HAEFPTOC	0.05...5.00 × I_n	0.01
Time multiplier	HAEFPTOC	0.05...15.00	0.01
Operate delay time	HAEFPTOC	100...200000 ms	10
Operating curve type [1]	HAEFPTOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
Minimum operate time	HAEFPTOC	100...200000 ms	10

1) For further reference, see Operation characteristics table

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Table 49. Negative-sequence overcurrent protection (NSPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured current: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n		
Start time [1,2]		Minimum	Typical	Maximum
	I_{Fault} = 2 × set *Start value*	23 ms	26 ms	28 ms
	I_{Fault} = 10 × set *Start value*	15 ms	18 ms	20 ms
Reset time		Typically 43 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3]		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Negative sequence current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start* value multiples in range of 1.5...20

Table 50. Negative-sequence overcurrent protection (NSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOC	0.01...5.00 × I_n	0.01
Time multiplier	NSPTOC	0.05...15.00	0.01
Operate delay time	NSPTOC	40...200000 ms	10
Operating curve type [1]	NSPTOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	

1) For further reference, see Operation characteristics table

Table 51. Phase discontinuity protection (PDNSPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±2% of the set value
Start time	<73 ms
Reset time	Typically 40 ms
Reset ratio	Typically 0.96
Retardation time	<35 ms
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 52. Phase discontinuity protection (PDNSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PDNSPTOC	10...100%	1
Operate delay time	PDNSPTOC	100...30000 ms	1
Min phase current	PDNSPTOC	0.05...0.30 × I_n	0.01

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Table 53. Residual overvoltage protection (ROVPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 2 × set *Start value*	45 ms	51 ms	54 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) Residual voltage before fault = 0.0 × U_n, f_n = 50 Hz, residual voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 54. Residual overvoltage protection (ROVPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	ROVPTOV	0.010...1.000 × U_n	0.001
Operate delay time	ROVPTOV	40...300000 ms	1

Table 55. Three-phase undervoltage protection (PHPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 0.9 × set *Start value*	62 ms	66 ms	70 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, voltage before fault = 1.1 × U_n, f_n = 50 Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 0.50, *Start value* multiples in range of 0.50...0.70

Table 56. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	0.05...1.20 × U_n	0.01
Time multiplier	PHPTUV	0.05...15.00	0.01
Operate delay time	PHPTUV	60...300000 ms	10
Operating curve type[1]	PHPTUV	Definite or Inverse time Curve type: 5, 15, 21, 22, 23	

1) For further reference, see Operation characteristics table

Table 57. Single-phase undervoltage protection (PHAPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 0.9 × set *Start value*	64 ms	68 ms	71 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, voltage before fault = 1.1 × U_n, f_n = 50 Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 0.50 × U_n, *Start value* multiples in range of 0.50...0.70

Table 58. Single-phase undervoltage protection (PHAPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHAPTUV	0.05...1.20 × U_n	0.01
Time multiplier	PHAPTUV	0.05...15.00	0.01
Operate delay time	PHAPTUV	60...300000 ms	10
Operating curve type[1]	PHAPTUV	Definite or Inverse time Curve type: 5, 15, 21, 22, 23	

1) For further reference, see Operation characteristics table

Table 59. Three-phase overvoltage protection (PHPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value*	23 ms	27 ms	31 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, voltage before fault = 0.9 × U_n, f_n = 50 Hz, overvoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 1.30 × U_n, *Start value* multiples in range of 1.10...2.00

Table 60. Three-phase overvoltage protection (PHPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTOV	0.05...1.60 × U_n	0.01
Time multiplier	PHPTOV	0.05...15.00	0.01
Operate delay time	PHPTOV	40...300000 ms	10
Operating curve type[1]	PHPTOV	Definite or Inverse time Curve type: 5, 15, 17, 18, 19, 20	

1) For further reference, see Operation characteristics table

Table 61. Single-phase overvoltage protection (PHAPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value*	25 ms	28 ms	32 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, voltage before fault = 0.9 × U_n, f_n = 50 Hz, overvoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum *Start value* = 1.30 × U_n, *Start value* multiples in range of 1.10...2.00

Table 62. Single-phase overvoltage protection (PHAPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHAPTOV	0.05...1.60 × U_n	0.01
Time multiplier	PHAPTOV	0.05...15.00	0.01
Operate delay time	PHAPTOV	40...300000 ms	10
Operating curve type[1]	PHAPTOV	Definite or Inverse time Curve type: 5, 15, 17, 18, 19, 20	

1) For further reference, see Operation characteristics table

Table 63. Positive-sequence undervoltage protection (PSPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the measured voltage: $f_n \pm 2$ Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1,2]		Minimum	Typical	Maximum
	U_{Fault} = 0.99 × set *Start value*	52 ms	55 ms	58 ms
	U_{Fault} = 0.9 × set *Start value*	44 ms	47 ms	50 ms
Reset time		Typically 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,...		

1) *Start value* = 1.0 × U_n, positive-sequence voltage before fault = 1.1 × U_n, f_n = 50 Hz, positive sequence undervoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 64. Positive-sequence undervoltage protection (PSPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTUV	0.010...1.200 × U_n	0.001
Operate delay time	PSPTUV	40...120000 ms	10
Voltage block value	PSPTUV	0.01...1.00 × U_n	0.01

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Table 65. Negative-sequence overvoltage protection (NSPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz ±1.5% of the set value or ±0.002 × U_n		
Start time[1][2]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value* U_{Fault} = 2.0 × set *Start value*	33 ms 24 ms	35 ms 26 ms	37 ms 28 ms
Reset time		Typically 40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...		

1) Negative-sequence voltage before fault = 0.0 × U_n, f_n = 50 Hz, negative-sequence overvoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 66. Negative-sequence overvoltage protection (NSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOV	0.010...1.000 × U_n	0.001
Operate delay time	NSPTOV	40...120000 ms	1

Table 67. Frequency protection (FRPFRQ)

Characteristic		Value
Operation accuracy	f>/f<	±5 mHz
	df/dt	±50 mHz/s (in range |df/dt| <5 Hz/s) ±2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	f>/f<	<80 ms
	df/dt	<120 ms
Reset time		<150 ms
Operate time accuracy		±1.0% of the set value or ±30 ms

Table 68. Frequency protection (FRPFRQ) main settings

Parameter	Function	Value (Range)	Step
Operation mode	FRPFRQ	1 = Freq< 2 = Freq> 3 = df/dt 4 = Freq< + df/dt 5 = Freq> + df/dt 6 = Freq< OR df/dt 7 = Freq> OR df/dt	-
Start value Freq>	FRPFRQ	0.9000...1.2000 × f_n	0.0001
Start value Freq<	FRPFRQ	0.8000...1.1000 × f_n	0.0001
Start value df/dt	FRPFRQ	-0.2000...0.2000 × f_n/s	0.0025
Operate Tm Freq	FRPFRQ	80...200000 ms	10
Operate Tm df/dt	FRPFRQ	120...200000 ms	10

Table 69. Three-phase thermal protection for feeders, cables and distribution transformers (T1PTTR)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz Current measurement: ±1.5% of the set value or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Operate time accuracy[1]	±2.0% of the theoretical value or ±0.50 s

1) Overload current > 1.2 × Operate level temperature

Table 70. Three-phase thermal protection for feeders, cables and distribution transformers (T1PTTR) main settings

Parameter	Function	Value (Range)	Step
Env temperature Set	T1PTTR	-50...100°C	1
Current reference	T1PTTR	0.05...4.00 × I_n	0.01
Temperature rise	T1PTTR	0.0...200.0°C	0.1
Time constant	T1PTTR	60...60000 s	1
Maximum temperature	T1PTTR	20.0...200.0°C	0.1
Alarm value	T1PTTR	20.0...150.0°C	0.1
Reclose temperature	T1PTTR	20.0...150.0°C	0.1
Current multiplier	T1PTTR	1...5	1
Initial temperature	T1PTTR	-50.0...100.0°C	0.1

Table 71. Loss of phase, undercurrent (PHPTUC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n
Start time	Typically <55 ms
Reset time	<40 ms
Reset ratio	Typically 1.04
Retardation time	<35 ms
Operate time accuracy in definite time mode	Mode ±1.0% of the set value or ±20 ms

Table 72. Phase undercurrent protection (PHPTUC) main settings

Parameter	Function	Value (Range)	Step
Current block value	PHPTUC	0.00...0.50 × I_n	0.01
Start value	PHPTUC	0.01...1.00 × I_n	0.01
Operate delay time	PHPTUC	50...200000 ms	10

Table 73. Circuit breaker failure protection (CCBRBRF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Reset time[1]	Typically 40 ms
Retardation time	<20 ms

1) The pulse time defines the minimum pulse length

Table 74. Circuit breaker failure protection (CCBRBRF) main settings

Parameter	Function	Value (Range)	Step
Current value	CCBRBRF	0.05...2.00 × I_n	0.01
Current value Res	CCBRBRF	0.05...2.00 × I_n	0.01
CB failure mode	CCBRBRF	1 = Current 2 = Breaker status 3 = Both	-
CB fail retrip mode	CCBRBRF	1 = Off 2 = Without check 3 = Current check	-
Retrip time	CCBRBRF	0...60000 ms	10
CB failure delay	CCBRBRF	0...60000 ms	10
CB fault delay	CCBRBRF	0...60000 ms	10

Table 75. Three-phase inrush detector (INRPHAR)

Characteristic	Value
Operation accuracy	At the frequency f = f_n Current measurement: ±1.5% of the set value or ±0.002 × I_n Ratio I2/I1 measurement: ±5.0% of the set value
Reset time	+35 ms / -0 ms
Reset ratio	Typically 0.96
Operate time accuracy	+35 ms / -0 ms

Table 76. Three-phase inrush detector (INRPHAR) main settings

Parameter	Function	Value (Range)	Step
Start value	INRPHAR	5...100%	1
Operate delay time	INRPHAR	20...60000 ms	1

Table 77. Arc protection (ARCSARC)

Characteristic		Value		
Operation accuracy		±3% of the set value or ±0.01 × I_n		
Operate time		Minimum	Typical	Maximum
	Operation mode = "Light+current"[1][2]	9 ms[3] 4 ms[4]	12 ms[3] 6 ms[4]	15 ms[3] 9 ms[4]
	Operation mode = "Light only"[2]	9 ms[3] 4 ms[4]	12 ms[3] 6 ms[4]	12 ms[3] 7 ms[4]
Reset time		Typically 40 ms[3] <55 ms[4]		
Reset ratio		Typically 0.96		

1) Fixed light limit = 1.0 × I_n, current before fault = 0.0 × set *Phase start value*, f_n = 50 Hz, fault with nominal frequency, results based on statistical distribution of 200 measurements
2) Includes the delay of the heavy-duty output contact
3) Normal power output
4) High-speed output

Table 78. Arc protection (ARCSARC) main settings

Parameter	Function	Value (Range)	Step
Phase start value	ARCSARC	0.50...40.00 × I_n	0.01
Ground start value	ARCSARC	0.05...8.00 × I_n	0.01
Operation mode	ARCSARC	1 = Light+current 2 = Light only 3 = BI controlled	-

Table 79. High-impedance fault detection (PHIZ) main settings

Parameter	Function	Value (Range)	Step
Security Level	PHIZ	1...10	1
System type	PHIZ	1 = Grounded 2 = Ungrounded	-

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Table 80. Load-shedding and restoration (LSHDPFRQ)

Characteristic		Value
Operation accuracy	f<	±10 mHz
	df/dt	±100 mHz/s (in range |df/dt| < 5 Hz/s) ±2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	f<	<80 ms
	df/dt	<120 ms
Reset time		<150 ms
Operate time accuracy		±1.0% of the set value or ±30 ms

Table 81. Load-shedding and restoration (LSHDPFRQ) main settings

Parameter	Function	Value (Range)	Step
Load shed mode	LSHDPFRQ	1 = Freq< 6 = Freq< OR df/dt 8 = Freq< AND df/dt	-
Restore mode	LSHDPFRQ	1 = Disabled 2 = Auto 3 = Manual	-
Start value Freq	LSHDPFRQ	0.800...1.200 × f_n	0.001
Start value df/dt	LSHDPFRQ	-0.200...-0.005 × f_n	0.005
Operate Tm Freq	LSHDPFRQ	80...200000 ms	10
Operate Tm df/dt	LSHDPFRQ	120...200000 ms	10
Restore start Val	LSHDPFRQ	0.800...1.200 × f_n	0.001
Restore delay time	LSHDPFRQ	80...200000 ms	10

Table 82. Multipurpose protection (MAPGAPC)

Characteristic	Value
Operation accuracy	±1.0% of the set value or ±20 ms

Table 83. Multipurpose protection (MAPGAPC) main settings

Parameter	Function	Value (Range)	Step
Start value	MAPGAPC	-10000.0...10000.0	0.1
Operate delay time	MAPGAPC	0...200000 ms	100
Operation mode	MAPGAPC	1 = Over 2 = Under	-

Table 84. Automatic switch-onto-fault (CVPSOF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2Hz Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 85. Automatic switch-onto-fault logic (CVPSOF) main settings

Parameter	Function	Value (Range)	Step
SOTF reset time	CVPSOF	0...60000 ms	10

Table 86. Voltage vector shift protection (VVSPPAM)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured voltage: f_n ±1 Hz ±1°
Operate time[1][2]	Typically 53 ms

1) f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 87. Voltage vector shift protection (VVSPPAM) main settings

Parameter	Function	Value (Range)	Step
Start value	VVSPPAM	2.0...30.0°	0.1
Over Volt Blk value	VVSPPAM	0.40...1.50 × Un	0.01
Under Volt Blk value	VVSPPAM	0.15...1.00 × Un	0.01
Phase supervision	VVSPPAM	7 = Ph A + B + C 8 = Pos sequence	-

Table 88. Directional reactive power undervoltage protection (DQPTUV)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current and voltage: f_n ±2 Hz Reactive power range |PF| <0.71 Power: ±3.0% or ±0.002 × Q_n Voltage: ±1.5% of the set value or ±0.002 × U_n
Start time[1][2]	Typically 46 ms
Reset time	<50 ms
Reset ratio	Typically 0.96
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) Start value = 0.05 × I_n, reactive power before fault = 0.8 × start value, reactive power overshoot 2 times, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 89. Directional reactive power undervoltage protection (DQPTUV) main settings

Parameter	Function	Value (Range)	Step
Voltage start value	DQPTUV	0.20...1.20 × U_n	0.01
Operate delay time	DQPTUV	100...300000 ms	10
Min reactive power	DQPTUV	0.01...0.50 × S_n	0.01
Min Ps Seq current	DQPTUV	0.02...0.20 × I_n	0.01
Pwr sector reduction	DQPTUV	0...10°	1

Table 90. Underpower protection (DUPPDPR)

Characteristic	Value
Operation accuracy [1]	Depending on the frequency of the measured current and voltage: f_n ±2 Hz Power measurement accuracy ±3% of the set value or ±0.002 × S_n Phase angle: ±2°
Start time[2][3]	Typically 45 ms
Reset time	Typically 30 ms
Reset ratio	Typically 1.04
Operate time accuracy	±1.0% of the set value of ±20 ms
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) Measurement mode = "Pos Seq" (default)
2) U = U_n, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
3) Includes the delay of the signal output contact

Table 91. Underpower protection (DUPPDPR) main settings

Parameter	Function	Value (Range)	Step
Start value	DUPPDPR	0.01...2.00 × S_n	0.01
Operate delay time	DUPPDPR	40...300000 ms	10
Pol reversal	DUPPDPR	0 = False 1 = True	-
Disable time	DUPPDPR	0...60000 ms	1000

Table 92. Reverse power/directional overpower protection (DOPPDPR)

Characteristic	Value
Operation accuracy [1]	Depending on the frequency of the measured current and voltage: f = f_n ±2 Hz Power measurement accuracy ±3% of the set value or ±0.002 × S_n Phase angle: ±2°
Start time[2][3]	Typically 45 ms
Reset time	Typically 30 ms
Reset ratio	Typically 0.94
Operate time accuracy	±1.0% of the set value of ±20 ms
Suppression of harmonics	-50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) Measurement mode = "Pos Seq" (default)
2) U = U_n, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
3) Includes the delay of the signal output contact

Table 93. Reverse power/directional overpower protection (DOPPDPR) main settings

Parameter	Function	Value (Range)	Step
Start value	DOPPDPR	0.01...2.00 × S_n	0.01
Operate delay time	DOPPDPR	40...300000	10
Directional mode	DOPPDPR	2 = Forward 3 = Reverse	-
Power angle	DOPPDPR	-90...90°	1

Table 94. Low-voltage ride-through protection (LVRTPTUV)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured voltage: f_n ±2 Hz ±1.5% of the set value or ±0.002 × U_n
Start time[1][2]	Typically 40 ms
Reset time	Based on maximum value of Recovery time setting
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) Tested for Number of Start phases = 1 out of 3, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

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Table 95. Low-voltage ride-through protection (LVRTPTUV) main settings

Parameter	Function	Value (Range)	Step
Voltage start value	LVRTPTUV	0.05...1.20 × U_n	0.01
Num of start phases	LVRTPTUV	4 = Exactly 1 of 3 5 = Exactly 2 of 3 6 = Exactly 3 of 3	-
Voltage selection	LVRTPTUV	1 = Highest Ph-to-E 2 = Lowest Ph-to-E 3 = Highest Ph-to-Ph 4 = Lowest Ph-to-Ph 5 = Positive Seq	-
Active coordinates	LVRTPTUV	1...10	1
Voltage level 1	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 2	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 3	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 4	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 5	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 6	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 7	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 8	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 9	LVRTPTUV	0.00...1.20 pu	0.01
Voltage level 10	LVRTPTUV	0.00...1.20 pu	0.01
Recovery time 1	LVRTPTUV	0...300000 ms	1
Recovery time 2	LVRTPTUV	0...300000 ms	1
Recovery time 3	LVRTPTUV	0...300000 ms	1
Recovery time 4	LVRTPTUV	0...300000 ms	1
Recovery time 5	LVRTPTUV	0...300000 ms	1
Recovery time 6	LVRTPTUV	0...300000 ms	1
Recovery time 7	LVRTPTUV	0...300000 ms	1
Recovery time 8	LVRTPTUV	0...300000 ms	1
Recovery time 9	LVRTPTUV	0...300000 ms	1
Recovery time 10	LVRTPTUV	0...300000 ms	1

Table 96. High-impedance differential protection (HIxPDIF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n		
Start time[1,2]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 × set *Start value*	12 ms	15 ms	24 ms
	I_{Fault} = 10 × set *Start value*	10 ms	12 ms	14 ms
Reset time		<40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		

1) Measurement mode = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 97. High-impedance differential protection (HIxPDIF) main settings

Parameter	Function	Value (Range)	Step
Operate value	HIxPDIF	1.0...200.0 % N_n	1
Minimum operate time	HIxPDIF	20...300000 ms	10

Table 98. Circuit breaker uncorresponding position start-up (UPCALH)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 99. Three-independent-phase non-directional overcurrent protection (PHIxPTOC)

Characteristic		Value		
Operation accuracy	PHLPTOC	Depending on the frequency of the current measured: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n		
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n)		
Start time[1,2]		Minimum	Typical	Maximum
	PHIPTOC: I_{Fault} = 2 × set *Start value*	15 ms	16 ms	17 ms
	I_{Fault} = 10 × set *Start value*	11 ms	14 ms	17 ms
	PHHPTOC and PHLPTOC: I_{Fault} = 2 × set *Start value*	23 ms	25 ms	28 ms
Reset time		<40 ms		
Reset ratio		Typically 0.96		
Retardation time		<30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression Peak-to-Peak + backup: No suppression		

1) Measurement mode = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum start value = 2.5 × I_n, Start value multiples in range of 1.5...20

Table 100. Three-independent-phase non-directional overcurrent protection (PHIxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PHLPTOC	0.05...5.00 × I_n	0.01
	PHHPTOC	0.10...40.00 × I_n	0.01
	PHIPTOC	1.00...40.00 × I_n	0.01
Time multiplier	PHLPTOC	0.05...15.00	0.01
	PHHPTOC	0.05...15.00	0.01
Operate delay time	PHLPTOC	40...200000 ms	10
	PHHPTOC	40...200000 ms	10
	PHIPTOC	20...200000 ms	10
Operating curve type[1]	PHLPTOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	PHHPTOC	Definite or Inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	PHIPTOC	Definite time	

1) For further reference, see Operation characteristics table

Table 101. Directional three-independent-phase directional overcurrent protection (DPHIxPDOC)

Characteristic		Value		
Operation accuracy	DPHILPDOC	Depending on the frequency of the current measured: f_n ±2 Hz Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
	DPHIHPDOC	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of the set value (at currents in the range of 10...40 × I_n) Voltage: ±1.5% of the set value or ±0.002 × U_n Phase angle: ±2°		
Start time[1,2]		Minimum	Typical	Maximum
	I_{Fault} = 2 × set *Start value*	38 ms	40 ms	43 ms
Reset time		<40 ms		
Reset ratio		Typically 0.96		
Retardation time		<35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3]		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression Peak-to-Peak + backup: No suppression		

1) Measurement mode = default (depends on stage), current before fault = 0.0 × I_n, voltage before fault = 1.0 × U_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum Start value = 2.5 × I_n, Start value multiples in range of 1.5...20

Table 102. Directional three-independent-phase directional overcurrent protection (DPHIxPDOC) main settings

Parameter	Function	Value (Range)	Step
Start value	DPHILPDOC	0.05...5.00 × I_n	0.01
	DPHIHPDOC	0.10...40.00 × I_n	0.01
Time multiplier	DPHIxPDOC	0.05...15.00	0.01
Operate delay time	DPHIxPDOC	40...200000 ms	10
Operating curve type[1]	DPHILPDOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DPHIHPDOC	Definite or Inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
Directional mode	DPHIxPDOC	1 = Non-directional 2 = Forward 3 = Reverse	
Characteristic angle	DPHIxPDOC	-179...180	1

1) For further reference, see the Operating characteristics table

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Table 103. Three-phase overload protection for shunt capacitor banks (COLPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz, and no harmonics 5% of the set value or 0.002 × I_n
Start time for overload stage [1,2]	Typically 75 ms
Start time for under current stage [2,3]	Typically 28 ms
Reset time for overload and alarm stage	Typically 80 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	1% of the set value or ±20 ms
Operate time accuracy in inverse time mode	10% of the theoretical value or ±20 ms
Suppression of harmonics for under current stage	DFT: -50 dB at $f = n \times f_n$, where n = 2,3,4,5,...

1) Harmonic current before fault = 0.5 × I_n, harmonic fault current 1.5 × start value, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Harmonic current before fault = 1.2 × I_n, harmonic fault current 0.9 × start value, results based on statistical distribution of 1000 measurements

Table 104. Three-phase overload protection for shunt capacitor banks (COLPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value overload	COLPTOC	0.30...1.50 × I_n	0.01
Alarm start value	COLPTOC	50...120%	1
Start value Un Cur	COLPTOC	0.10...0.70 × I_n	0.01
Time multiplier	COLPTOC	0.05...2.00	0.01
Alarm delay time	COLPTOC	500...6000000	100
Un Cur delay time	COLPTOC	100...120000	100

Table 105. Current unbalance protection for shunt capacitor banks (CUSPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz 1.5% of the set value or 0.002 × I_n
Start time [1,2]	Typically 28 ms
Reset time	Typically 43 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	1% of the theoretical value or ±20 ms
Operate time accuracy in inverse definite minimum time mode	5% of the theoretical value or ±20 ms
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where n = 2,3,4,5,...

1) Fundamental frequency current = 1.0 × I_n, current before fault = 0.0 × I_n, fault current = 2.0 × start value, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 106. Current unbalance protection for shunt capacitor banks (CUSPTOC) main settings

Parameter	Function	Value (Range)	Step
Alarm mode	CUSPTOC	1 = Nominal 2 = Elapsed counter	-
Start value	CUSPTOC	0.01...1.00 × I_n	0.01
Alarm start value	CUSPTOC	0.01...1.00 × I_n	0.01
Time multiplier	CUSPTOC	0.05...15.00	0.01
Operating curve type [1]	CUSPTOC	Definite or Inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
Operate delay time	CUSPTOC	50...200000 ms	10
Alarm delay time	CUSPTOC	50...200000 ms	10

1) For further information, refer to the Operating characteristics table

Table 107. Shunt capacitor bank switching resonance protection, current based (SRCPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz Operate value accuracy: ±3% of the set value or ±0.002 × I_n (for 2nd order Harmonics) ±1.5% of the set value or ±0.002 × I_n (for 3rd order < Harmonics < 10th order) ±6% of the set value or ±0.004 × I_n (for Harmonics >= 10th order)
Reset time	Typically 45 ms or maximum 50 ms
Retardation time	Typically 0.96
Retardation time	<35 ms
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	-50 dB at $I = f_n$

Table 108. Shunt capacitor bank switching resonance protection, current based (SRCPTOC) main settings

Parameter	Function	Value (Range)	Step
Alarm start value	SRCPTOC	0.03...0.50 × I_n	0.01
Start value	SRCPTOC	0.03...0.50 × I_n	0.01
Tuning harmonic Num	SRCPTOC	1...11	1
Operate delay time	SRCPTOC	120...360000 ms	1
Alarm delay time	SRCPTOC	120...360000 ms	1

Table 109. Operation characteristics

Parameter	Value (Range)
Operating curve type	1 = ANSI Ext. Inv. 2 = ANSI Very. Inv. 3 = ANSI Norm. Inv. 4 = ANSI Mod Inv. 5 = ANSI Def. Time 6 = L.T.E. Inv. 7 = L.T.V. Inv. 8 = L.T. Inv. 9 = IEC Norm. Inv. 10 = IEC Very Inv. 11 = IEC Inv. 12 = IEC Ext. Inv. 13 = IEC S.T. Inv. 14 = IEC L.T. Inv 15 = IEC Def. Time 17 = Programmable 18 = RI type 19 = RD type
Operating curve type (voltage protection)	5 = ANSI Def. Time 15 = IEC Def. Time 17 = Inv. Curve A 18 = Inv. Curve B 19 = Inv. Curve C 20 = Programmable 21 = Inv. Curve A 22 = Inv. Curve B 23 = Programmable

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Table 110. Autoreclosing (DARREC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 111. Synchronism and energizing check (SECRSYN)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±1 Hz Voltage: ±3.0% of the set value or ±0.01 × U_n Frequency: ±10 mHz Phase angle: ±3°
Reset time	<50 ms
Reset ratio	Typically 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms

Table 112. Synchronism and energizing check (SECRSYN) main settings

Parameter	Function	Value (Range)	Step
Live dead mode	SECRSYN	-1 = Off 1 = Both Dead 2 = Live L, Dead B 3 = Dead L, Live B 4 = Dead Bus, L Any 5 = Dead L, Bus Any 6 = One Live, Dead 7 = Not Both Live	-
Difference voltage	SECRSYN	0.01...0.50 × U_n	0.01
Difference frequency	SECRSYN	0.001...0.100 × f_n	0.001
Difference angle	SECRSYN	5...90°	1
Synchrocheck mode	SECRSYN	1 = Off 2 = Synchronous 3 = Asynchronous	
Dead line value	SECRSYN	0.1...0.8 × U_n	0.1
Live line value	SECRSYN	0.2...1.0 × U_n	0.1
Close pulse	SECRSYN	200...60000 ms	10
Max energizing V	SECRSYN	0.50...1.15 × U_n	0.01
Control mode	SECRSYN	1 = Continuous 2 = Command	-
Phase shift	SECRSYN	-180...180°	1
Minimum Syn time	SECRSYN	0...60000 ms	10
Maximum Syn time	SECRSYN	100...6000000 ms	10
Energizing time	SECRSYN	100...60000 ms	10
Closing time of CB	SECRSYN	40...250 ms	10

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Condition monitoring and supervision functions

Table 113. Circuit-breaker condition monitoring (SSCBR)

Characteristic	Value
Current measuring accuracy	±1.5% or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% (at currents in the range of 10...40 × I_n)
Operate time accuracy	±1.0% of the set value or ±20 ms
Travelling time measurement	+10 ms / -0 ms

Table 114. Current circuit supervision (CCSPVC)

Characteristic	Value
Operate time [1]	<30 ms

1) Including the delay of the output contact

Table 115. Current circuit supervision (CCSPVC) main settings

Parameter	Function	Value (Range)	Step
Start value	CCSPVC	0.05...0.20 × I_n	0.01
Max operate current	CCSPVC	1.00...5.00 × I_n	0.01

Table 116. Current transformer supervision for high-impedance protection scheme (HZCCSPVC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ±2 Hz ±1.5% of the set value or ±0.002 × I_n
Reset time	<40 ms
Reset ratio	Typically 0.96
Retardation time	<35 ms
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms

Table 117. Fuse failure supervision (SEQSPVC)

Characteristic		Value	
Operate time [1]	NPS function	U_{Fault} = 1.1 × set *Neg Seq voltage Lev*	<33 ms
		U_{Fault} = 5.0 × set *Neg Seq voltage Lev*	<18 ms
	Delta function	ΔU = 1.1 × set *Voltage change rate*	<30 ms
		ΔU = 2.0 × set *Voltage change rate*	<24 ms

1) Includes the delay of the signal output contact, f_n = 50 Hz, fault voltage with nominal frequency, injected in random phase angle, results based on statistical distribution of 1000 measurements

Table 118. Runtime counter for machines and devices (MDSOPT)

Description	Value
Motor runtime measurement accuracy [1]	±0.5%

1) Of the reading, for a stand-alone relay, without time synchronization

Measurement functions

Table 119. Three-phase current measurement (CMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±0.5% or ±0.002 × I_n (at currents in the range of 0.01...4.00 × I_n)
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 120. Sequence current measurement (CSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±1.0% or ±0.002 × I_n at currents in the range of 0.01...4.00 × I_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 121. Residual current measurement (RESCMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ±2 Hz ±0.5% or ±0.002 × I_n at currents in the range of 0.01...4.00 × I_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 122. Three-phase voltage measurement (VMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2 Hz At voltages in range 0.01...1.15 × U_n ±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 123. Single-phase voltage measurement (VAMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2 Hz At voltages in range 0.01...1.15 × U_n ±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 124. Residual voltage measurement (RESVMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the measured current: f_n ±2 Hz ±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 125. Sequence voltage measurement (VSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±2 Hz At voltages in range 0.01...1.15 × U_n ±1.0% or ±0.002 × U_n
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 126. Three-phase power and energy measurement (PEMMXU)

Characteristic	Value
Operation accuracy	At all three currents in range 0.10...1.20 × I_n At all three voltages in range 0.50...1.15 × U_n At the frequency f_n ±1 Hz ±1.5% for apparent power S ±1.5% for active power P and active energy [1] ±1.5% for reactive power Q and reactive energy [2] ±0.015 for power factor
Suppression of harmonics	DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5,...

1) |PF| >0.5 which equals |cos φ| >0.5
2) |PF| <0.86 which equals |sin φ| >0.5

Table 127. Frequency measurement (FMMXU)

Characteristic	Value
Operation accuracy	±10 mHz (in measurement range 35...75 Hz)

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Fault location functions

Table 128. Fault locator (SCEFRFLO)

Characteristic	Value
Measurement accuracy	At the frequency f = f_n Impedance: ±2.5% or ±0.25 Ω Distance: ±2.5% or ±0.16 km/0.1 mile XCOF_CALC: ±2.5% or ±50 Ω IFLT_PER_3LD: ±5% or ±0.05

Table 129. Fault locator (SCEFRFLO) main settings

Parameter	Function	Value (Range)	Step
Z Max phase load	SCEFRFLO	1.0...10000.00 Ω	0.1
Ph leakage Rs	SCEFRFLO	20...1000000 Ω	1
Ph capacitive React	SCEFRFLO	10...1000000 Ω	1
R1 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
X1 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
R0 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
X0 line section A	SCEFRFLO	0.000...1000.000 Ω/pu	0.001
Line Len section A	SCEFRFLO	0.000...1000.000 pu	0.001

Power quality functions

Table 130. Voltage variation (PHQVVR)

Characteristic	Value
Operation accuracy	±1.5% of the set value or ±0.2% of reference voltage
Reset ratio	Typically 0.96 (Swell), 1.04 (Dip, Interruption)

Table 131. Voltage variation (PHQVVR) main settings

Parameter	Function	Value (Range)	Step
Voltage dip set 1	PHQVVR	10.0...100.0%	0.1
Voltage dip set 2	PHQVVR	10.0...100.0%	0.1
Voltage dip set 3	PHQVVR	10.0...100.0%	0.1
Voltage swell set 1	PHQVVR	100.0...140.0%	0.1
Voltage swell set 2	PHQVVR	100.0...140.0%	0.1
Voltage swell set 3	PHQVVR	100.0...140.0%	0.1
Voltage Int set	PHQVVR	0.0...100.0%	0.1
VVa Dur Max	PHQVVR	100...3600000 ms	100

Table 132. Voltage unbalance (VSQVUB)

Characteristic	Value
Operation accuracy	±1.5% of the set value or ±0.002 × U_n
Reset ratio	Typically 0.96

Table 133. Voltage unbalance (VSQVUB) main settings

Parameter	Function	Value (Range)	Step
Operation	VSQVUB	1 = on 5 = off	-
Unb detection method	VSQVUB	1 = Neg Seq 2 = Zero Seq 3 = Neg to Pos Seq 4 = Zero to Pos Seq 5 = Ph vectors Comp	-

Other functions

Table 134. Pulse timer (PTGAPC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 135. Time delay off (8 pcs) (TOFPADC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 136. Time delay on (8 pcs) (TONGAPC)

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

22. Local HMI

The relay supports process information and status monitoring from the relay's local HMI via its display and indication/alarm LEDs. The local HMI also enables control operations for the equipment connected and controlled by the relay, either via display or via manual push buttons available on the local HMI.

LCD display offers front-panel user interface functionality with menu navigation and menu views. In addition, the display includes a user-configurable two-page single-line diagram (SLD) with a position indication for the associated primary equipment and primary measurements from the process. The SLD can be modified according to user requirements by using Graphical Display Editor in PCM600.

The local HMI also includes 11 programmable LEDs. These LEDs can be configured to show alarms and indications as needed by PCM600 graphical configuration tool. The LEDs include two separately controllable colors, red and green, making one LED able to indicate better the different states of the monitored object.

The relay also includes 16 configurable manual push buttons, which can freely be configured by the PCM600 graphical configuration tool. These buttons can be configured to control the relay's internal feature, for example changing setting group, trigger disturbance recordings and changing operation modes for functions or to control relay's external equipment, for example opening or closing the equipment, via relay's binary outputs. These buttons also include a small indication LED for each button. This LED is freely configurable, making it possible to use push button LEDs to indicate button activities or as additional indication/alarm LEDs in addition to the 11 programmable LEDs.

The local HMI includes a push button (L/R) for the local/remote operation of the relay. When the relay is in the local mode, the relay can be operated only by using the local front-panel user interface. When the relay is in the remote mode, the relay can execute commands sent remotely. The relay supports the remote selection of local/remote mode via a binary input. This feature facilitates, for example, the use of an external switch at the substation to ensure that all the relays are in the local mode during maintenance work and that the circuit breakers cannot be operated remotely from the network control center.

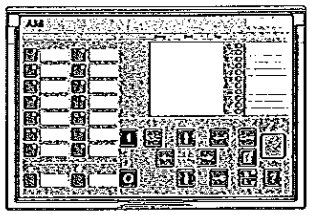

Figure 18. Example of the LHMI

23. Mounting methods

By means of appropriate mounting accessories the standard relay case can be flush mounted, semi-flush mounted or wall mounted.

Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one relay. Alternatively, the relay can be mounted in 19" instrument cabinets by means of 4U Combiflex equipment frames.

For the routine testing purposes, the relay cases can be equipped with test switches, type RTXP 24, which can be mounted side by side with the relay cases.

Mounting methods

- Flush mounting
- Semi-flush mounting
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame
- Mounting with a RTXP 24 test switch to a 19" rack

Panel cut-out for flush mounting

- Height: 162 ±1 mm
- Width: 248 ±1 mm

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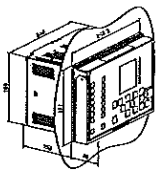

Figure 19. Flush mounting

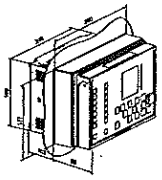

Figure 20. Semi-flush mounting

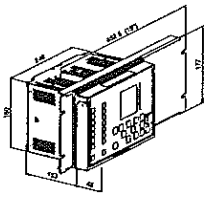

Figure 21. Rack mounting

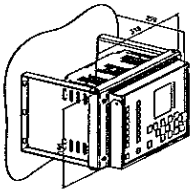

Figure 22. Wall mounting

24. Relay case and plug-in unit

For safety reasons, the relay cases for current measuring relays are provided with automatically operating contacts for short-circuiting the CT secondary circuits when a relay unit is withdrawn from its case. The relay case is further provided with a mechanical coding system preventing current measuring relay units from being inserted into a relay case for a voltage measuring relay unit and vice versa, that is, the relay cases are assigned to a certain type of plug-in unit.

25. Selection and ordering data

The relay type and serial number label identifies the protection and control relay. The label is placed above the HMI on the upper part of the plug-in-unit. An order code label is placed on the side of the plug-in unit as well as inside the case. The order code consists of a string of letters and digits generated from the relay's hardware and software modules.

Use ABB Library to access the selection and ordering information and to generate the order number.

Product Selection Tool (PST), a Next-Generation Order Number Tool, supports order code creation for ABB Distribution Automation IEC products with emphasis on but not exclusively for the Relion product family. PST is an easy to use, online tool always containing the latest product information. The complete order code can be created with detailed specification and the result can be printed and mailed. Registration is required.

N B F N A A N N A B C 1 B N N 1 1 G

#	Description	
1	HMI	
	620 series IED (including case)	N
	Complete Relay with conformal coating	S
2	Standard	
	IEC	B
	ON	O
3	Main application	
	Feeder protection and control	F
4	Functional application	
	Example configuration	N
5-6	Analog inputs and outputs	
	4 (1 A) + 5U + 24BI + 14BO	AA
	4 (0.2/1 A) + 5U + 24BI + 14BO	AB
	Sensors (6I + 5U) + 10I + 13BI + 14BO	AC
7-8	Optional board	
	Optional IOs 8BI + 4BO	AA
	Optional RTDs 6RTD in + 2mA in	AB
	Optional Fast IOs 8BI + 3HSO	AC
	No optional board	NN

N B F N A A N N A B C 1 B N N 1 1 G

#	Description	
9	Communication (Serial/Ethernet)	
10	Serial RS 485, incl. an input for RIO-B + Ethernet 100Base FX (1xLC)	AA
	Serial RS 485, incl. an input for RIO-B + Ethernet 100Base TX (1xRJ45)	AB
	Serial RS 485, incl. an input for RIO-B	AN
	Serial glass fibre (ST) + Ethernet 100Base TX (1xRJ45) + Serial RS 485 connector, RS 232/485 D-Sub 9 connector + Input for RIO-B (cannot be combined with arc protection)	BA
	Serial glass fibre (ST) + Ethernet 100Base TX and FX (1xLC, 2xRJ45) with HSR/PRP	BC
	Serial glass fibre (ST) + Ethernet 100Base TX (2xRJ45) with HSR/PRP	BD
	Serial glass fibre (ST) + Ethernet 100Base TX and FX (2xLC, 1xRJ45) with HSR/PRP	BE
	Serial glass fibre (ST) + Ethernet 100Base TX and FX (1xLC, 2xRJ45) with HSR/PRP and IEC61850-9-2LE	BF
	Serial glass fibre (ST) + Ethernet 100Base TX (2xRJ45) with HSR/PRP and IEC61850-9-2LE	BG
	Serial glass fibre (ST) + Ethernet 100Base TX and FX (2xLC, 1xRJ45) with HSR/PRP and IEC61850-9-2LE	BH
	Serial glass fibre (ST) + Serial RS 485 connector, RS 232/485 D-Sub 9 connector + Input for RIO-B (cannot be combined with arc protection)	BN
	RS 232/485 (including RIO-B) + Ethernet 100Base TX (1xRJ45) (cannot be combined with arc protection)	CB
	RS 232/485 + RS 485/Fiber/Fiber ST (including RIO-B) (cannot be combined with arc protection)	CN
	Ethernet 100Base FX (1xLC)	NA
	Ethernet 100Base TX (1xRJ45)	NC
	Ethernet 100Base TX and FX (1xLC, 2xRJ45) with HSR/PRP	NE
	Ethernet 100Base TX (2xRJ45) with HSR/PRP	NG
	Ethernet 100Base TX and FX (2xLC, 1xRJ45) with HSR/PRP	NJ
	Ethernet 100Base TX and FX (1xLC, 2xRJ45) with HSR/PRP and IEC61850-9-2LE	NF
	Ethernet 100Base TX (2xRJ45) with HSR/PRP and IEC61850-9-2LE	NH
	Ethernet 100Base TX and FX (2xLC, 1xRJ45) with HSR/PRP and IEC61850-9-2LE	NJ
	No communication module	NN

If serial communication is chosen, please choose a serial communication module including Ethernet (for example "BC") if a service bus for PCM600 or the Web-UI is required.

N B F N A A N N A B C 1 B N N 1 1 G

#	Description	
11	Communication protocols	
	IEC 61850 (for Ethernet communication modules and IEDs without a communication module)	A
	Modbus (for Ethernet/Serial or Ethernet + serial communication modules)	B
	IEC 61850 + Modbus (for Ethernet or serial + Ethernet communication modules)	C
	IEC 60870-5-103 (for serial or Ethernet + serial communication modules)	D
	DNP3 (for Ethernet/serial or Ethernet + serial communication modules)	F
	IEC 61850 + IEC 60870-5-103 (for serial + Ethernet communication modules)	G
	IEC 61850 + DNP3 (for Ethernet or serial + Ethernet communication modules)	H
12	Language	
	English	1
	English and Chinese	2
13	Front panel	
	Large LCD with Single Line Diagram - IEC	B
	Large LCD with single Line Diagram - GN	D
14	Option 1	
	Arc protection (requires a communication module, cannot be combined with com. module options DN, DD, CD and CN)	B
	None	N
15	Option 2	
	Fault locator	F
	Capacitor bank protection package	G
	Interconnection/Distributed generation protection package	D
	Power protection package	P
	All options (Fault locator + Capacitor bank protection + Interconnection/Distributed generation protection + Power protection)	L
	None	N
16	Power supply	
	Power supply 48-250 VDC, 100-240 VAC	1
	Power supply 24-60 VDC	2
17	Reserved	
18	Product version 2.0 FP1	13

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Example code: NBFNAANNABC1BNN11G

Your ordering code:

Digit (#)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Code																		

Figure 23. Ordering key for complete protection relays

26. Accessories and ordering data

Table 137. Cables

Item	Order number
Cable for optical sensors for arc protection 1.5 m	1MRS120534-1.5
Cable for optical sensors for arc protection 3.0 m	1MRS120534-3.0
Cable for optical sensors for arc protection 5.0 m	1MRS120534-5.0

Table 138. Mounting accessories

Item	Order number
Semi-flush mounting kit	2RCA035673A0001
Wall mounting kit	2RCA030894A0001
19" rack mounting kit with cut-out for one relay	2RCA031135A0001
19" rack mounting kit for one relay and one RTXP24 test switch (the test switch and wire harness are not included in the delivery)	2RCA032818A0001
Mounting bracket for one relay with test switch RTXP in 4U Combiflex (RHGT 19" variant C) (the test switch, wire harness and Combiflex RGHT 19" variant C are not included in the delivery)	2RCA032823A0001
Functional earthing flange for RTD modules	2RCA038973A0001[1]

1) Cannot be used when the IED is mounted with the Combiflex 19" equipment frame 2RCA032823A0001.

27. Tools

The protection relay is delivered as a pre-configured unit including the example configuration. The default parameter setting values can be changed from the front-panel user interface, the Web browser-based user interface (Web HMI) or the PCM600 tool in combination with the relay-specific connectivity package.

The Protection and Control IED Manager PCM600 offers extensive relay configuration functions such as relay signal configuration, application configuration, graphical display configuration including single line diagram configuration, and IEC 61850 communication configuration including horizontal GOOSE communication.

When the Web browser-based user interface is used, the protection relay can be accessed either locally or remotely using a Web browser (Internet Explorer). For security reasons, the Web browser-based user interface is disabled by default but it can be enabled via the front-panel user interface. The Web HMI functionality can be limited to read-only access.

The relay connectivity package is a collection of software and specific relay information, which enables system products and tools to connect and interact with the protection relay. The connectivity packages reduce the risk of errors in system integration, minimizing device configuration and setup times. Further, the connectivity packages for protection relays of this product series include a flexible update tool for adding one additional local HMI language to the protection relay. The update tool is activated using PCM600, and it enables multiple updates of the additional HMI language, thus offering flexible means for possible future language updates.

Table 139. Tools

Configuration and setting tools	Version
PCM600	2.6 (Rollup 20150626) or later
Web browser-based user interface	IE 8.0, IE 9.0, IE 10.0 or IE 11.0
REF620 Connectivity Package	2.1 or later

Table 140. Supported functions

Function	Web HMI	PCM600
Relay parameter setting	•	•
Saving of relay parameter settings in the relay	•	•
Signal monitoring	•	•
Disturbance recorder handling	•	•
Alarm LED viewing	•	•
Access control management	•	•
Relay signal configuration (Signal Matrix)	-	•
Modbus® communication configuration (communication management)	-	•
DNP3 communication configuration (communication management)	-	•
IEC 60870-5-103 communication configuration (communication management)	-	•
Saving of relay parameter settings in the tool	-	•
Disturbance record analysis	-	•
XRIO parameter export/import	-	•
Graphical display configuration	-	•
Application configuration	-	•
IEC 61850 communication configuration, GOOSE (communication configuration)	-	•
Phasor diagram viewing	•	•
Event viewing	•	•
Saving of event data on the user's PC	•	•
Online monitoring	•	•

• = Supported

28. Cyber security

The relay supports role based user authentication and authorization. It can store 2048 audit trail events to a non-volatile memory. The non-volatile memory is based on a memory type which does not need battery backup or regular component exchange to maintain the memory storage. FTP and Web HMI use TLS encryption with a minimum of 128 bit key length protecting the data in transit. In this case the used communication protocols are FTPS and HTTPS. All rear communication ports and optional protocol services can be deactivated according to the required system setup.

29. Connection diagrams

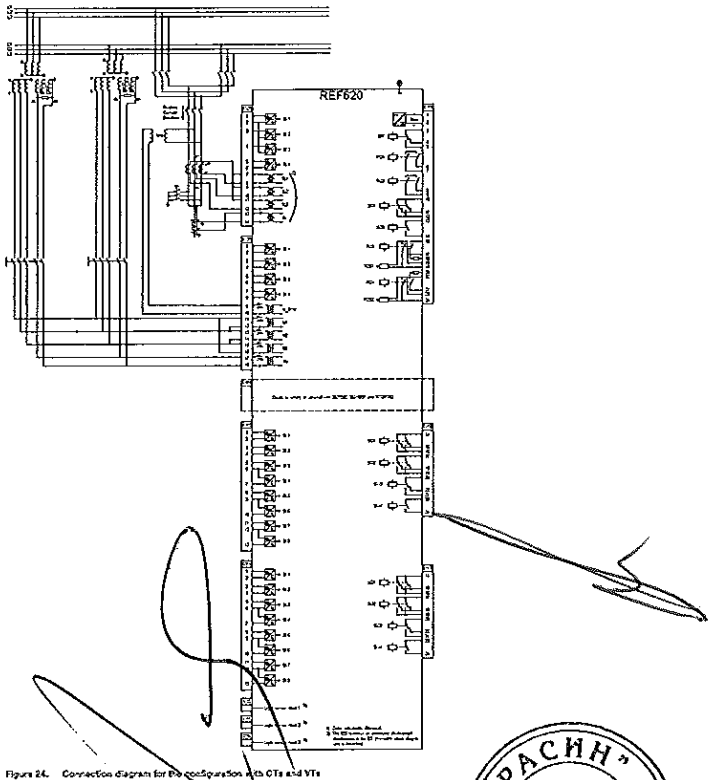

Figure 24. Connection diagram for the configuration with CTs and VTs

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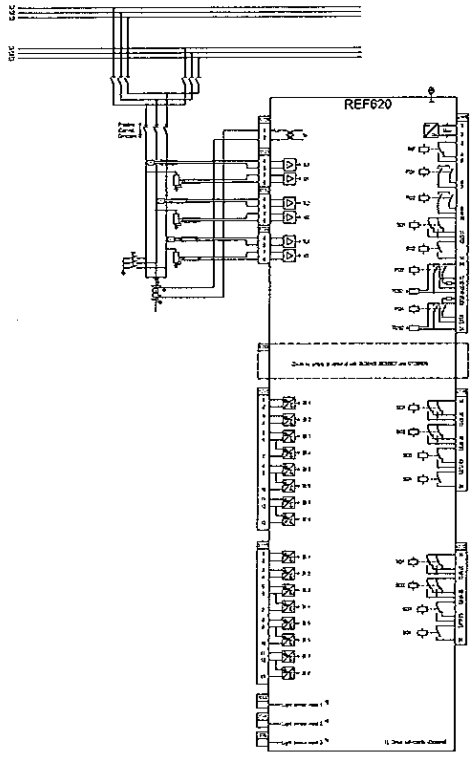

Figure 25. Connection diagram for the configuration with sections

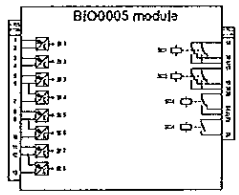

Figure 26. Optional BIO0005 module (slot X105)

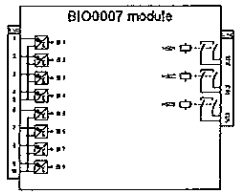

Figure 27. Optional BIO0007 module for fast outputs (slot X105)

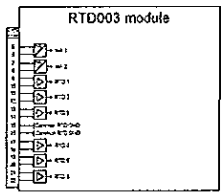

Figure 28. Optional RTD0003 module (slot X105)

30. Certificates

DNV GL has issued an IEC 61850 Edition 2 Certificate Level A1 for Relion® 620 series. Certificate number: 74108008-OPE/INC 15-2319.

DNV GL has issued an IEC 61850 Edition 1 Certificate Level A1 for Relion® 620 series. Certificate number: 74108008-OPE/INC 15-2323.

Additional certificates can be found on the product page.

31. References

The www.abb.com/substationautomation portal provides information on the entire range of distribution automation products and services.

The latest relevant information on the REF620 protection and control relay is found on the product page. Scroll down the page to find and download the related documentation.

32. Functions, codes and symbols

Table 141. Functions included in the relay

Function	IEC 61850	IEC 60617	ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
Three-phase directional overcurrent protection, low stage	DPHLPDOC1	3I> -> (1)	67-1 (1)
	DPHLPDOC2	3I> -> (2)	67-1 (2)
Three-phase directional overcurrent protection, high stage	DPHHPDOC1	3I>> -> (1)	67-2 (1)
	DPHHPDOC2	3I>> -> (2)	67-2 (2)
Three-phase voltage-dependent overcurrent protection	PHPVOC1	3I(U)> (1)	51V (1)
	PHPVOC2	3I(U)> (2)	51V (2)
Non-directional earth-fault protection, low stage	EFLPTOC1	Io> (1)	51N-1 (1)
	EFLPTOC2	Io> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	Io>> (1)	51N-2 (1)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	Io>>> (1)	50N/51N (1)
Directional earth-fault protection, low stage	DEFLPDEF1	Io> -> (1)	67N-1 (1)
	DEFLPDEF2	Io> -> (2)	67N-1 (2)
	DEFLPDEF3	Io> -> (3)	67N-1 (3)
Directional earth-fault protection, high stage	DEFHPDEF1	Io>> -> (1)	67N-2 (1)
Admittance-based earth-fault protection	EFPADM1	Yo> -> (1)	21YN (1)
	EFPADM2	Yo> -> (2)	21YN (2)
	EFPADM3	Yo> -> (3)	21YN (3)
Wattmetric-based earth-fault protection	WPWDE1	Po> -> (1)	32N (1)
	WPWDE2	Po> -> (2)	32N (2)
	WPWDE3	Po> -> (3)	32N (3)
Multifrequency admittance-based earth-fault protection	MFADPSDE1	Io> -> Y (1)	67YN (1)
Transient/intermittent earth-fault protection	INTRPTEF1	Io> -> IEF (1)	67NIEF (1)
Harmonics-based earth-fault protection	HAEFPTOC1	Io>HA (1)	51NHA (1)
Negative-sequence overcurrent protection	NSPTOC1	I2> (1)	46 (1)
	NSPTOC2	I2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I2/I1> (1)	46PD (1)
Residual overvoltage protection	ROVPTOV1	Uo> (1)	59G (1)
	ROVPTOV2	Uo> (2)	59G (2)
	ROVPTOV3	Uo> (3)	59G (3)

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Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
	PHPTUV3	3U< (3)	27 (3)
	PHPTUV4	3U< (4)	27 (4)
Single-phase undervoltage protection, secondary side	PHAPTUV1	U_A< (1)	27_A (1)
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
	PHPTOV3	3U> (3)	59 (3)
Single-phase overvoltage protection, secondary side	PHAPTOV1	U_A> (1)	59_A (1)
Positive-sequence undervoltage protection	PSPTUV1	U1< (1)	47U+ (1)
	PSPTUV2	U1< (2)	47U+ (2)
Negative-sequence overvoltage protection	NSPTOV1	U2> (1)	47O- (1)
	NSPTOV2	U2> (2)	47O- (2)
Frequency protection	FRPFRQ1	f>/f<,df/dt (1)	81 (1)
	FRPFRQ2	f>/f<,df/dt (2)	81 (2)
	FRPFRQ3	f>/f<,df/dt (3)	81 (3)
	FRPFRQ4	f>/f<,df/dt (4)	81 (4)
	FRPFRQ5	f>/f<,df/dt (5)	81 (5)
	FRPFRQ6	f>/f<,df/dt (6)	81 (6)
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F (1)	49F (1)
Loss of phase (undercurrent)	PHPTUC1	3I< (1)	37 (1)
Circuit breaker failure protection	CCBRBRF1	3I>/Io>BF (1)	51BF/51NBF (1)
	CCBRBRF2	3I>/Io>BF (2)	51BF/51NBF (2)
	CCBRBRF3	3I>/Io>BF (3)	51BF/51NBF (3)
Three-phase inrush detector	INRPHAR1	3I2f> (1)	68 (1)
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
	TRPPTRC3	Master Trip (3)	94/86 (3)
	TRPPTRC4	Master Trip (4)	94/86 (4)
Arc protection	ARCSARC1	ARC (1)	50L/50NL (1)
	ARCSARC2	ARC (2)	50L/50NL (2)
	ARCSARC3	ARC (3)	50L/50NL (3)
High-impedance fault detection	PHIZ1	HIF (1)	HIZ (1)

Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Load-shedding and restoration	LSHDPFR01	UFLS/R (1)	81LSH (1)
	LSHDPFR02	UFLS/R (2)	81LSH (2)
	LSHDPFR03	UFLS/R (3)	81LSH (3)
	LSHDPFR04	UFLS/R (4)	81LSH (4)
	LSHDPFR05	UFLS/R (5)	81LSH (5)
	LSHDPFR06	UFLS/R (6)	81LSH (6)
Multipurpose protection	MAPGAPC1	MAP (1)	MAP (1)
	MAPGAPC2	MAP (2)	MAP (2)
	MAPGAPC3	MAP (3)	MAP (3)
	MAPGAPC4	MAP (4)	MAP (4)
	MAPGAPC5	MAP (5)	MAP (5)
	MAPGAPC6	MAP (6)	MAP (6)
	MAPGAPC7	MAP (7)	MAP (7)
	MAPGAPC8	MAP (8)	MAP (8)
	MAPGAPC9	MAP (9)	MAP (9)
	MAPGAPC10	MAP (10)	MAP (10)
	MAPGAPC11	MAP (11)	MAP (11)
	MAPGAPC12	MAP (12)	MAP (12)
	MAPGAPC13	MAP (13)	MAP (13)
	MAPGAPC14	MAP (14)	MAP (14)
	MAPGAPC15	MAP (15)	MAP (15)
	MAPGAPC16	MAP (16)	MAP (16)
	MAPGAPC17	MAP (17)	MAP (17)
	MAPGAPC18	MAP (18)	MAP (18)
Automatic switch-onto-fault logic (SOF)	CVPSOF1	CVPSOF (1)	SOFT/21/50 (1)
Voltage vector shift protection	VVSPPAM1	VS (1)	78V (1)
Directional reactive power undervoltage protection	DQPTUV1	Q> -> ,3U< (1)	32Q,27 (1)
	DQPTUV2	Q> -> ,3U< (2)	32Q,27 (2)
Underpower protection	DUPPDPR1	P< (1)	32U (1)
	DUPPDPR2	P< (2)	32U (2)
Reverse power/directional overpower protection	DOPPDPR1	P>/Q> (1)	32R/32O (1)
	DOPPDPR2	P>/Q> (2)	32R/32O (2)
Low-voltage ride-through protection	LVRTPTUV1	U<RT (1)	27RT (1)
	LVRTPTUV2	U<RT (2)	27RT (2)
	LVRTPTUV3	U<RT (3)	27RT (3)
High-impedance differential protection for phase A	HIAPDIF1	dHi_A> (1)	87A (1)
High-impedance differential protection for phase B	HISPDIF1	dHi_B> (1)	87B (1)
High-impedance differential protection for phase C	HICPDIF1	dHi_C> (1)	87C (1)

Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Circuit breaker uncorresponding position start-up	UPCALH1	CBUPS (1)	CBUPS (1)
	UPCALH2	CBUPS (2)	CBUPS (2)
	UPCALH3	CBUPS (3)	CBUPS (3)
Three-independent-phase non-directional overcurrent protection, low stage	PHDLPTOC1	3I_3> (1)	51P-1_3 (1)
	PHDLPTOC2	3I_3> (2)	51P-1_3 (2)
Three-independent-phase non-directional overcurrent protection, high stage	PHDHPTOC1	3I_3>> (1)	51P-2_3 (1)
	PHDHPTOC2	3I_3>> (2)	51P-2_3 (2)
Three-independent-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I_3>>> (1)	50P/51P_3 (1)
Directional three-independent-phase directional overcurrent protection, low stage	DPHDLPDOC1	3I_3> -> (1)	67-1_3 (1)
	DPHDLPDOC2	3I_3> -> (2)	67-1_3 (2)
Directional three-independent-phase directional overcurrent protection, high stage	DPHHPDOC1	3I_3>> -> (1)	67-2_3 (1)
	DPHHPDOC2	3I_3>> -> (2)	67-2_3 (2)
Three-phase overload protection for shunt capacitor banks	COLPTOC1	3I> 3I< (1)	51C/37 (1)
Current unbalance protection for shunt capacitor banks	CUBPTOC1	dI>C (1)	51NC-1 (1)
Shunt capacitor bank switching resonance protection, current based	SRCPTOC1	TD> (1)	55TD (1)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB (1)	I <-> O CB (1)
	CBXCBR2	I <-> O CB (2)	I <-> O CB (2)
	CBXCBR3	I <-> O CB (3)	I <-> O CB (3)
Disconnector control	DCXSWI1	I <-> O DCC (1)	I <-> O DCC (1)
	DCXSWI2	I <-> O DCC (2)	I <-> O DCC (2)
	DCXSWI3	I <-> O DCC (3)	I <-> O DCC (3)
	DCXSWI4	I <-> O DCC (4)	I <-> O DCC (4)
Earthing switch control	ESXSWI1	I <-> O ESC (1)	I <-> O ESC (1)
	ESXSWI2	I <-> O ESC (2)	I <-> O ESC (2)
	ESXSWI3	I <-> O ESC (3)	I <-> O ESC (3)
Disconnector position indication	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
	DCSXSWI3	I <-> O DC (3)	I <-> O DC (3)
	DCSXSWI4	I <-> O DC (4)	I <-> O DC (4)
Earthing switch indication	ESSXSWI1	I <-> O ES (1)	I <-> O ES (1)
	ESSXSWI2	I <-> O ES (2)	I <-> O ES (2)
	ESSXSWI3	I <-> O ES (3)	I <-> O ES (3)
Autoreclosing	DARREC1	O -> I (1)	79 (1)
	DARREC2	O -> I (2)	79 (2)
Synchronism and energizing check	SECRSYN1	SYNC (1)	25 (1)

Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR1	CBCM (1)	CBCM (1)
	SSCBR2	CBCM (2)	CBCM (2)
	SSCBR3	CBCM (3)	CBCM (3)
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCSPVC1	MCS 3I (1)	MCS 3I (1)
Current transformer supervision for high-impedance protection scheme for phase A	HZCCASPVC1	MCS I_A (1)	MCS I_A (1)
Current transformer supervision for high-impedance protection scheme for phase B	HZCCBSPVC1	MCS I_B (1)	MCS I_B (1)
Current transformer supervision for high-impedance protection scheme for phase C	HZCCCSPVC1	MCS I_C (1)	MCS I_C (1)
Fuse failure supervision	SEQSPVC1	FUSEF (1)	60 (1)
Runtime counter for machines and devices	MDSOPT1	OPTS (1)	OPTM (1)
	MDSOPT2	OPTS (2)	OPTM (2)
Measurement			
Three-phase current measurement	CMMXU1	3I (1)	3I (1)
Sequence current measurement	CSMSQI1	I1, I2, I0 (1)	I1, I2, I0 (1)
Residual current measurement	RESCMMXU1	Io (1)	In (1)
Three-phase voltage measurement	VMMXU1	3U (1)	3V (1)
Single-phase voltage measurement	VAMMXU2	U_A (2)	V_A (2)
Residual voltage measurement	RESVMMXU1	Uo (1)	Vn (1)
Sequence voltage measurement	VSMSQI1	U1, U2, U3 (1)	V1, V2, V3 (1)
Three-phase power and energy measurement	PEMMXU1	P, E (1)	P, E (1)
Load profile record	LDPRLRC1	LOADPROF (1)	LOADPROF (1)
Frequency measurement	FMMXU1	f (1)	f (1)
Fault location			
Fault locator	SCEFRFLO1	FLOC (1)	21FL (1)
Power quality			
Current total demand distortion	CMHAI1	PQM3I (1)	PQM3I (1)
Voltage total harmonic distortion	VMHAI1	PQM3U (1)	PQM3V (1)
Voltage variation	PHQVVR1	PQMV (1)	PQMV (1)
Voltage unbalance	VSQVUB1	PQUUB (1)	PQVUB (1)
Other			
Minimum pulse timer (2 pcs)	TPGAPC1	TP (1)	TP (1)
	TPGAPC2	TP (2)	TP (2)
	TPGAPC3	TP (3)	TP (3)
	TPGAPC4	TP (4)	TP (4)

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Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC1	TPS (1)	TPS (1)
	TPSGAPC2	TPS (2)	TPS (2)
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC1	TPM (1)	TPM (1)
	TPMGAPC2	TPM (2)	TPM (2)
Pulse timer (8 pcs)	PTGAPC1	PT (1)	PT (1)
	PTGAPC2	PT (2)	PT (2)
Time delay off (8 pcs)	TOFGAPC1	TOF (1)	TOF (1)
	TOFGAPC2	TOF (2)	TOF (2)
	TOFGAPC3	TOF (3)	TOF (3)
	TOFGAPC4	TOF (4)	TOF (4)
Time delay on (8 pcs)	TONGAPC1	TON (1)	TON (1)
	TONGAPC2	TON (2)	TON (2)
	TONGAPC3	TON (3)	TON (3)
	TONGAPC4	TON (4)	TON (4)
Set-reset (8 pcs)	SRGAPC1	SR (1)	SR (1)
	SRGAPC2	SR (2)	SR (2)
	SRGAPC3	SR (3)	SR (3)
	SRGAPC4	SR (4)	SR (4)
Move (8 pcs)	MVGAPC1	MV (1)	MV (1)
	MVGAPC2	MV (2)	MV (2)
	MVGAPC3	MV (3)	MV (3)
	MVGAPC4	MV (4)	MV (4)
Integer value move	MVI4GAPC1	MVI4 (1)	MVI4 (1)
	MVI4GAPC2	MVI4 (2)	MVI4 (2)
	MVI4GAPC3	MVI4 (3)	MVI4 (3)
	MVI4GAPC4	MVI4 (4)	MVI4 (4)
Analog value scaling	SCA4GAPC1	SCA4 (1)	SCA4 (1)
	SCA4GAPC2	SCA4 (2)	SCA4 (2)
	SCA4GAPC3	SCA4 (3)	SCA4 (3)
	SCA4GAPC4	SCA4 (4)	SCA4 (4)
Generic control point (16 pcs)	SPCGAPC1	SPC (1)	SPC (1)
	SPCGAPC2	SPC (2)	SPC (2)
	SPCGAPC3	SPC (3)	SPC (3)
Remote generic control points	SPCRGAPC1	SPCR (1)	SPCR (1)
Local generic control points	SPCLGAPC1	SPCL (1)	SPCL (1)

Table 141. Functions included in the relay, continued

Function	IEC 61850	IEC 60617	ANSI
Generic up-down counters	UDFCNT1	UDCNT (1)	UDCNT (1)
	UDFCNT2	UDCNT (2)	UDCNT (2)
	UDFCNT3	UDCNT (3)	UDCNT (3)
	UDFCNT4	UDCNT (4)	UDCNT (4)
	UDFCNT5	UDCNT (5)	UDCNT (5)
	UDFCNT6	UDCNT (6)	UDCNT (6)
	UDFCNT7	UDCNT (7)	UDCNT (7)
	UDFCNT8	UDCNT (8)	UDCNT (8)
	UDFCNT9	UDCNT (9)	UDCNT (9)
	UDFCNT10	UDCNT (10)	UDCNT (10)
	UDFCNT11	UDCNT (11)	UDCNT (11)
	UDFCNT12	UDCNT (12)	UDCNT (12)
Programmable buttons (16 buttons)	FKEYGGIO1	FKEY (1)	FKEY (1)
Logging functions			
Disturbance recorder	RDRE1	DR (1)	DFR (1)
Fault recorder	FLTRFRC1	FAULTREC (1)	FAULTREC (1)
Sequence event recorder	SER1	SER (1)	SER (1)

33. Document revision history

Document revision/date	Product version	History
A/2013-05-07	2.0	First release
B/2013-07-01	2.0	Content updated
C/2014-07-01	2.0	Content updated
D/2014-09-11	2.0	Content updated
E/2015-12-11	2.0 FP1	Content updated to correspond to the product version

000607
ВЯРНО С ОРИГИНАЛА
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ВЯРНО С ОРИГИНАЛА

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Power and productivity for a better world™

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

Техническо предложение

Техническа документация
Приложение № 4 към Предложение за изпълнение на поръчката по т.15.4. от Техническото предложение – Заверени копия на документи за Цифрови защити за въводно поле „ЗЕНИТ" 110 kV: • Приложение № 4.2. към т.15.4.2. от Техническото предложение – Други по преценка на участника (декларации за съответствие, протоколи от типови изпитания и др.).

000609

1MRS756482

EU Declaration of Conformity

Issued	29.09.2008
Version	F/20.05.2016
Technical ref.	Mika Kortesniemi
Checked by	Asko Koiranen

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Application of this document

This document is intended for use as an approval for CE-marking of below mentioned products:

Family of	615 series

Declaration

We ABB Oy Medium Voltage Products, Distribution Automation
P.O. Box 699 FI-65101 Vaasa, FINLAND,
declare under our sole responsibility that the family:

Line Differential Protection Relay	RED615
Feeder Protection Relay	REF615
Generator and Interconnection Protection Relay	REG615
Motor Protection Relay	REM615
Transformer Protection Relay	RET615
Voltage Protection Relay	REU615
Capacitor Bank Protection Relay	REV615

to which this declaration relates is in conformity with the following directives:

Directives	EMC Directive 2014/30/EU Low Voltage Directive 2014/35/EU RoHS Directive 2011/65/EU
CE - marked	2007

Application of the objects

The family is intended for use in the industrial environment and to protect high voltage or high power apparatus, and thus normally used in a harsh electromagnetic environment near high voltage apparatus.

References

Standards	EN 60255-26:	2013
	EN 61000-6-2:	2005
	EN 61000-6-4:	2007
	EN 60255-1:	2010
	EN 60255-27:	2013

Vaasa

на основание чл. 2 от ЗЗЛД

Signed by:

Antti Hakala-Ranta, SVP Medium Voltage Products

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000610

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

1MRS757890

EU Declaration of Conformity

Issued	26.04.2013
Version	B/20.04.2016
Technical ref.	Mika Kortesniemi
Checked by	Asko Koiranen

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Application of this document

This document is intended for use as an approval for CE-marking of below mentioned products:

Family of	620 series

Declaration

We ABB Oy, Medium Voltage Products, Distribution Automation
P.O. Box 699 FI-65101 Vaasa, FINLAND,
declare under our sole responsibility that the family:

Feeder Protection and Control	REF620
Motor Protection and Control	REM620
Transformer Protection and Control	RET620

to which this declaration relates is in conformity with the following directives:

Directives	EMC Directive 2014/30/EU Low Voltage Directive 2014/35/EU RoHS Directive 2011/65/EU

CE - marked	2013

Application of the objects

The family is intended for use in the industrial environment and to protect high voltage or high power apparatus, and thus normally used in a harsh electromagnetic environment near high voltage apparatus.

References

Standards	EN 60255-26:	2013
	EN 61000-6-2:	2005
	EN 61000-6-4:	2007
	EN 60255-1:	2010
	EN 60255-27:	2013

Vaasa

на основание чл. 2 от ЗЗЛД

Signed by:

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ЗЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД

за участие в открита процедура за възлагане на обществена поръчка с предмет:

„Подмяна на маслонапълнена кабелна електропроводна линия 110 kV „Зенит" от линеен ножов разединител 110 kV на ПС „Хаджи Димитър" до линеен ножов разединител 110 kV в ПС „Подуяне", реф. № РРС 17 – 169

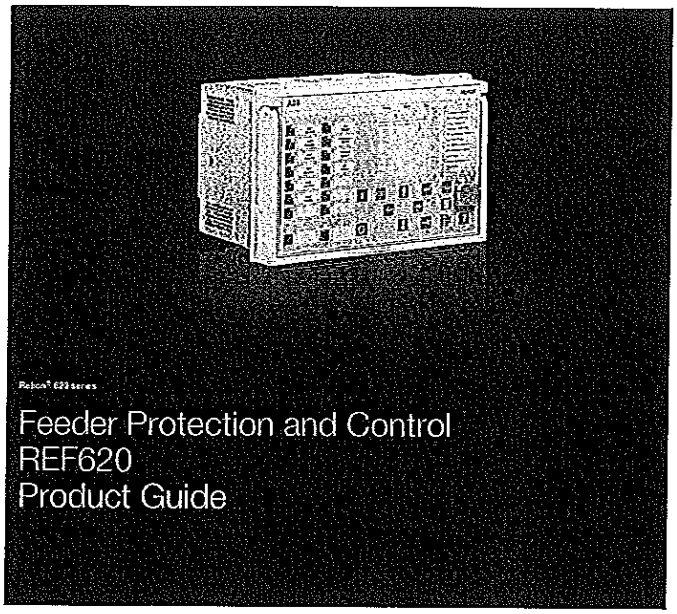
Техническо предложение

Техническа документация

Приложение № 5 към Предложение за изпълнение на поръчката по т.15.5. от Техническото предложение – Заверени копия на документи за Цифров локален контролер за въводно поле 110 kV:

- Приложение № 5.1. към т.15.5.1. от Техническото предложение – Последно издание на каталога на производителя

000612



Relion® 620 series

Feeder Protection and Control
REF620
Product Guide

Power and productivity for a better world™

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Contents

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1. Description

REF620 is a dedicated feeder management relay perfectly aligned for the protection, control, measurement and supervision of utility and industrial power distribution systems, including radial, looped and meshed networks, with or without distributed power generation. REF620 can also be used to protect feeders including motors or capacitor banks. Additionally REF620 offers functionality for interconnection protection used with distributed generation like wind or solar power connection to utility grid. Furthermore REF620 includes functionality for high-impedance based busbar protection. REF620 is a member of ABB's Relion® protection and control product family and its 620 series. The 620 series relays are characterized by their functional scalability and withdrawable-unit design. The 620 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability of substation automation devices.

The 620 series relays support a range of communication protocols including IEC 61850 with Edition 2 support, process bus according to IEC 61850-9-2 LE, IEC 60870-5-103, Modbus® and DNP3. Profibus DPV1 communication protocol is supported by using the protocol converter SPA-ZC 302.

2. Default configurations

The 620 series relays are configured with default configurations, which can be used as examples of the 620 series engineering with different function blocks. The default configurations are not aimed to be used as real end-user applications. The end-users always need to create their own application configuration with the configuration tool. However, the default configuration can be used as a starting point by modifying it according to the requirements.

REF620 is available in two alternative default configurations: configuration A with traditional current and voltage measurement transducers and configuration B with current and voltage sensors. Default configuration A with measurement transducers has more voltage measurements and I/Os than default configuration B. This gives more possibilities in applications supported by default configuration A. The default configuration can be altered by means of the graphical signal matrix or the graphical application functionality of the Protection and Control IED Manager PCM600. Furthermore, the application configuration functionality of PCM600 supports the creation of multi-layer logic functions using various logical elements, including timers and flip-flops. By combining protection functions with logic function blocks, the relay configuration can be adapted to user-specific application requirements.

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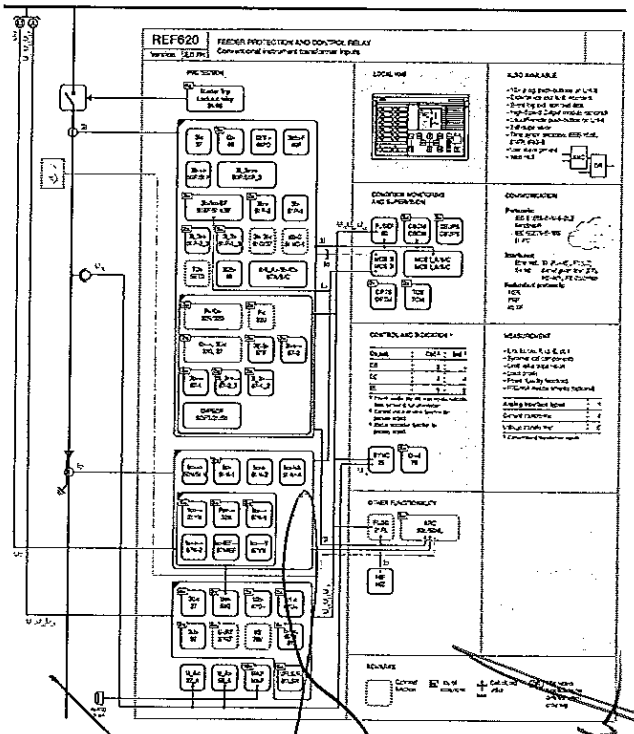

Figure 1. Functionality overview of default configuration with conventional instrument transformer inputs

ВЯРНО С ОРИГИНАЛА

"КРАСИН" СМОЛЯН ООД