KEC INTERNATIONAL LIMITED

EXTRA HIGH VOLTAGE
cables

RPG CABLES
(A Division of KEC International Limited)

RPG CABLES MANUFACTURES A RANGE OF HIGH VOLTAGE AND EXTRA HIGH VOLTAGE CABLES AT ITS FACILITY AT VADODARA

The newly commissioned state-of-the-art facility at Vadodara has the capacity to manufacture 3500 kms per annum of cables upto 220 kV and boasts of several 'Firsts' including:

1. Best in class plant and machinery from top manufacturers across the world.
2. Unique High Performance Teams that ensure highest level of productivity through a 'Learn and Earn' program
3. Platinum Certification from the Indian Green Buildings Council for its environmental commitment
4. World Class Quality and IT systems

We also offer total turnkey solution for EXTRA HIGH VOLTAGE (EHV) cables which includes manufacturing, testing, supply of cables, supply of cable accessories, installation of cables and accessories, testing and commissioning.

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CONTENTS

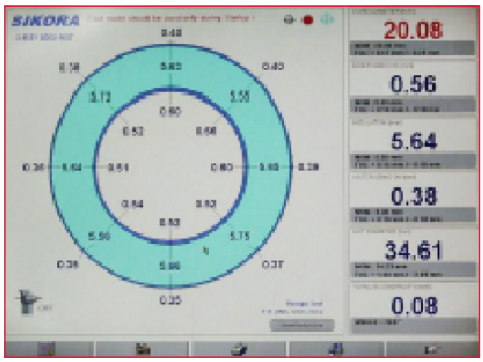
COMPONENTS OF EHV CABLES

ELEMENT	MATERIAL	STANDARD	CONSTRUCTION – CODING	
			DESCRIPTION	ABBREVIATION
Conductor	The conductor shall be formed from plain copper or aluminum, Basically of 2 types, compacted circular and segmental compacted circular. Conductor above 1000 mm2 cross section shall be segmental (Milliken) conductors.	IS: 8130 or IEC 60228	Aluminium	**A**
			Plain / Tinned Copper	Blank (No code)
Conductor Screening	Conductor screening of an extruded semiconducting XLPE compound shall be applied over the conductor. One or two layers of semiconducting tape(s) may be applied with suitable overlap between the conductor and the extruded semiconducting layer.	IS 7098 (P3) or IEC 60840 or IEC 62067	-	-
Insulation	The insulation shall be of dry – cured super clean XLPE compound with suitable thickness to meet dimensional, electrical and physical requirements. The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90^{0}C for normal condition, 130^{0}C for emergency overload conditions and 250^{0}C for short circuit conditions.	IS 7098 (P3) or IEC 60840 or IEC 62067	-	**2X**
Insulation Screening	The insulation screening shall be applied directly over the insulation and shall consist of a layer of extruded semiconducting compound. The extruded semiconducting compound shall be a thermoset type and firmly and totally bonded to the insulation.	IS 7098 (P3) or IEC 60840 or IEC 62067	-	-
Metal Wire Screen	When a layer of copper wire screen is required, it shall be applied over the insulation screening. One or more layers of suitable separator / binder tape may be applied helically over the screen as applicable.	IS 7098 (P3) or IEC 60840 or IEC 62067	-	**C**
Radial Water Barrier	Lead Alloy Sheath is very effective radial water barrier and is applied by a continuous screw extrusion, as a seamless sheath with smooth surface, free from pinholes and any other imperfections including one associated with oxide inclusions. The lead sheath offers very good chemical resistance. The lead sheath can act as metallic screen as well as radial moisture barrier. Additional cooper wire screen may be required some times to augment fault current carrying capacity.	**IS 7098 (P3) or** IEC 60840 or IEC 62067	Lead Alloy Sheath	**Ly**

ELEMENT	MATERIAL	STANDARD	CONSTRUCTION – CODING	
			DESCRIPTION	ABBREVIATION
	Corrugated Aluminum Sheath Corrugated aluminum sheath also acts as metallic screen and radial moisture barrier. The corrugated aluminium sheath offers good mechanical protection and avoids need of any additional armoring. Suitable corrosion protection is applied over the sheath for protection from corrosion.		Corrugated Aluminum Sheath	**A**
	Poly-Al Laminate Sheath Poly-Al Laminate sheath is yet another moisture barrier other than lead sheath and corrugated aluminum sheath. This is an aluminum tape with PE lamination on both sides. It is applied longitudinally with overlap and its PE laminations get bonded with overlying PE sheath and form a sheath of aluminum for radial moisture protection. Since the thickness of aluminum tape is very low in this sheath, additional copper wire screening is required for carrying earth fault current.		Poly-Al Laminate Sheath	**PolyAL**
Longitudinal Water Barrier	Water swellable tapes are used in cables to prevent longitudinal water penetration along the cable – between core and metallic sheath. Longitudinal water tightness can also offered along the conductor by use of water tight conductor as per requirement.	IS 7098 (P3) or IEC 60840 orIEC 62067	-	-
Outer Jacket	The outer jacket shall consist of thermoplastic compound (PVC, PE or similar materials) extruded continuously over the metallic layer or moisture barrier. A conductive layer is also applied over outer jacket to facilitate voltage testing of jacket to check its integrity.	IS 7098 (P3) or IEC 60840 or IEC 62067	PVC ST 2	**Y**
			PE	**2Y**

SPECIAL FEATURES OF EHV XLPE MANUFACTURING LINE :

- Highly sophisticated Dry Cure Dry Cool (DCDC) Triple Extrusion process
- Unique CCV Line equipped EHT system for perfect concentricity
- Computerized vulcanizing & cooling systems as well as extruder heating control system
- In – line metal detectors for Semicon & XLPE materials which ensure removal of ferrous & non – ferrous metallic Impurities from compound before extrusion
- In – line fine dust separator for XLPE insulation to have homogenous & extra clean insulation
- Separate pressurized rooms for Semicon screening & XLPE insulation compound to avoid contamination
- Automatic material handling by vacuum loaders
- On – line dimesional measurement

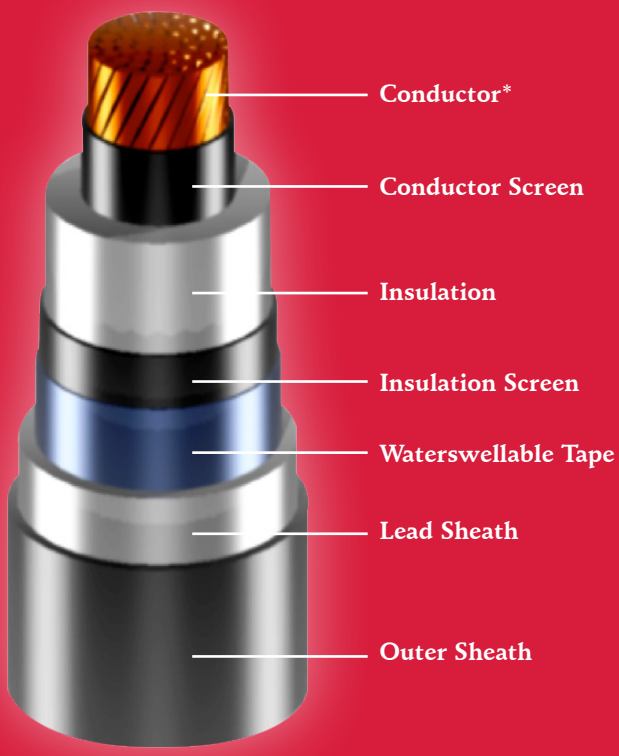


SIKORA online measurement

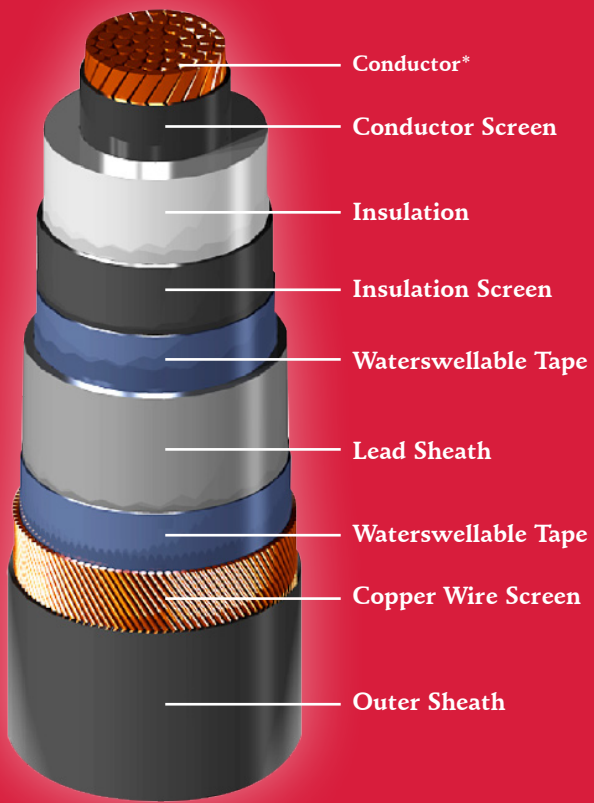
Class 1000 clean rooms for semicon shielding & XLPE insulation compound

TYPICAL CONSTRUCTION FOR EHV CABLES

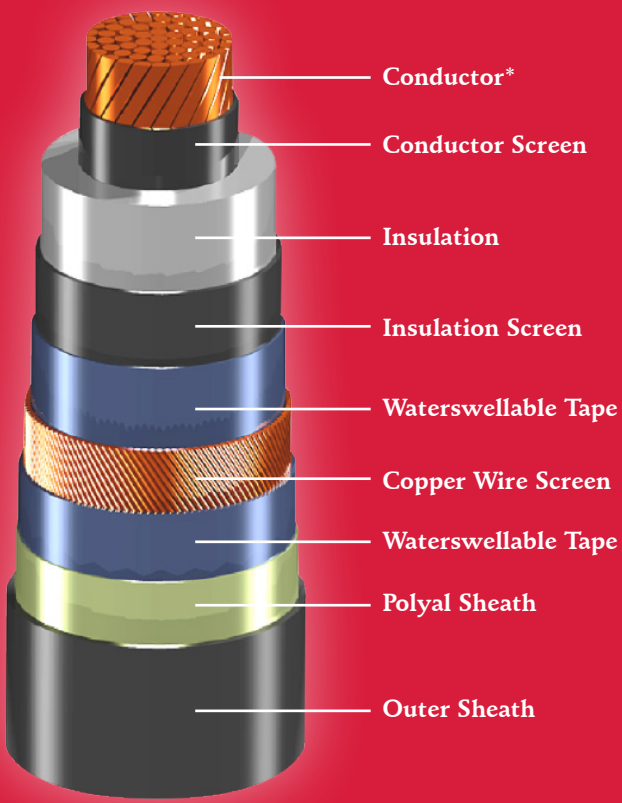
CORRUGATED ALUMINIUM SHEATHED CABLE



LEAD SHEATHED CABLE



LEAD SHEATHED COPPER WIRE SCREENED CABLE



COPPER WIRE SCEENED POLY-AL TAPE CABLE

*CONDUCTOR SHALL BE MILLIKEN (SEGMENTAL) FOR CROSS SECTION ABOVE 1000 SQ.MM.

CURRENT RATING AND DIMENSIONS

Current rating depends upon:

- Installation conditions (ground, air, ducts, depth of burial, etc.)
- Environmental effects – soil temp, soil thermal resistivity, depth of burial, spacing
- Mutual heating – derates cable
- Laying Method – Flat Formation, Close Touching Trefoil formation
- Type of Bonding – Both End Bonding, Single Point Bonding & Cross bonding

The Current ratings and physical dimensions for the following constructions are given here;

1. Corrugated Aluminum sheath

a. 38/66 kV
b. 64/110 kV
c. 76/132 kV
d. 127/220 kV

2. Lead alloy E sheath

a. 38/66 kV
b. 64/110 kV
c. 76/132 kV
d. 127/220 kV

3. Copper wire screen – Polyal Sheath

a. 38/66 kV
b. 64/110 kV
c. 76/132 kV
d. 127/220 kV

CONDUCTOR RESISTANCE AND SHORT CIRCUIT RATINGS

Nom. Cross sectional Area	Diameter (Nominal)	Max. DC Resistance at 20 deg.C		Short circuit current for 1 second	
		Aluminium	Copper	Aluminium	Copper
mm^2	Mm	Ohms/Kms	Ohms/Kms	KA	KA
95	11.25	0.3200	0.1930	8.93	13.58
120	13.10	0.2530	0.1530	11.28	17.16
150	13.90	0.2060	0.1240	14.10	21.45
185	15.60	0.1640	0.0991	17.39	26.46
240	17.60	0.1250	0.0754	22.56	34.32
300	19.70	0.1000	0.0601	28.20	42.90
400	22.60	0.0778	0.0470	37.60	57.20
500	25.60	0.0605	0.0366	47.00	71.50
630	29.00	0.0469	0.0283	59.22	90.09
800	33.00	0.0367	0.0221	75.22	114.40
1000	36.80	0.0291	0.0176	94.00	143.00
1200	42.50	0.0247	0.0151	112.80	171.60
1400	46.50	0.0212	0.0129	131.60	200.20
1600	49.50	0.0186	0.0113	150.40	228.80
2000	56.00	0.0149	0.0090	188.00	286.00

ASSUMED CONDITIONS FOR CURRENT RATING CALCULATIONS

- Ground Temperature: 30^0 C
- Depth of Laying: 1.0 m
- Soil Thermal Resistivity: 1.5Km/W
- Ambient Temperature: 40^0 C
- Max. Conductor Temperature: 90^0 C
- Cable Formation: Close Trefoil / Flat (S=2D)
- Frequency: 50Hz
- Load factor: 100%
- Fault current of Metal sheath/screen shall be as follows,
  - For 220 KV: 40 kA for 1 sec or same as that of conductor whichever is lower
  - For 66,110 and 132 KV: 31.5 kA for 1 sec or same as that of the conductor whichever is lower
  - Additional copper screen considered for lead sheathed cable to meet earth fault current.

MAXIMUM PERMISSIBLE CONDUCTOR TEMPERATURE

- Normal Operation: 90^0 C
- Emergency Operation: 130^0 C
- Short Circuit Condition: 250^0 C

CORRUGATED ALUMINUM SHEATH

38/66 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 11.0 MM (NOMINAL)

Nominal Area	Alu. sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	mm	kg/m	kg/m	µF/km
95	1.8	2.4	51.0	4.4	5.3	0.15
120	1.8	2.5	53.0	4.8	5.9	0.16
150	1.8	2.6	55.0	5.2	6.5	0.16
185	1.8	2.6	57.0	5.7	7.3	0.18
240	1.9	2.7	60.0	6.5	8.5	0.19
300	1.9	2.8	62.0	7.2	9.2	0.20
400	2.0	3.0	66.0	8.1	10.4	0.22
500	2.1	3.0	69.0	8.9	11.9	0.24
630	2.2	3.1	73.0	9.9	13.6	0.26
800	2.3	3.3	78.0	11	15.9	0.29
1000	2.4	3.4	81.0	12.2	18.2	0.31
1200	2.5	3.5	89.0	14	21.3	0.36
1400	2.6	3.6	93.0	15.3	23.6	0.38
1600	2.7	3.8	97.0	16.5	26	0.40
2000	2.9	3.9	103.0	19.1	31	0.44

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
95	260	340	270	380	205	265	205	295
120	295	395	305	440	230	305	235	340
150	330	445	340	495	255	345	265	385
185	375	510	385	570	290	395	300	440
240	430	595	445	670	335	460	345	520
300	480	675	500	765	375	525	390	595
400	545	780	570	890	430	610	445	695
500	610	895	650	1030	490	710	510	805
630	685	1020	735	1190	555	815	580	940
800	755	1155	825	1365	620	935	660	1085
1000	820	1270	910	1530	685	1055	740	1240
1200	925	1475	1035	1780	770	1215	835	1425
1400	980	1595	1115	1950	825	1325	905	1570
1600	1015	1680	1180	2090	865	1415	965	1700
2000	1080	1840	1295	2360	945	1585	1080	1945

CORRUGATED ALUMINUM SHEATH

64/110 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 16.0 MM (NOMINAL)

Nominal Area	Alu. sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm^2	mm	mm	mm	kg/m	kg/m	µF/km
150	1.5	2.8	74.0	3.9	4.8	0.13
185	1.6	2.9	76.0	4.2	5.3	0.14
240	1.8	3.0	79.0	4.7	6.1	0.15
300	1.7	3.0	81.0	5.0	6.7	0.16
400	1.7	3.1	84.0	5.5	7.7	0.17
500	1.7	3.2	88.0	6.0	8.9	0.18
630	1.8	3.3	92.0	6.8	10.5	0.20
800	1.8	3.5	97.0	7.6	12.4	0.22
1000	1.9	3.6	102.0	8.6	14.5	0.23
1200	2.0	3.7	110.0	10.0	17.3	0.26
1400	2.0	3.8	114.0	11.0	19.3	0.28
1600	2.1	4.0	118.0	12.0	21.4	0.29
2000	2.2	4.1	126.0	13.8	25.7	0.32

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm^2	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
150	330	440	340	485	255	340	265	375
185	375	505	385	555	290	390	300	430
240	430	590	445	655	335	460	345	505
300	480	670	500	745	375	520	390	580
400	545	770	570	865	430	605	445	675
500	610	885	650	1005	490	700	510	785
630	680	1010	735	1155	550	810	580	910
800	755	1140	825	1325	620	925	660	1055
1000	810	1255	905	1490	680	1040	740	1200
1200	910	1450	1030	1725	760	1190	830	1385
1400	965	1565	1110	1890	815	1300	900	1525
1600	1000	1650	1175	2025	855	1390	965	1645
2000	1065	1810	1290	2285	930	1555	1075	1885

CORRUGATED ALUMINUM SHEATH

76/132 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 18.0 MM (NOMINAL)

Nominal Area	Alu. sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	mm	kg/m	kg/m	µF/km
240	1.7	3.1	84.0	5.2	6.6	0.14
300	1.7	3.2	86.0	5.5	7.3	0.15
400	1.7	3.3	90.0	6.0	8.3	0.16
500	1.8	3.4	93.0	6.7	9.6	0.17
630	1.8	3.5	97.0	7.4	11.1	0.18
800	1.9	3.6	102.0	8.4	13.1	0.20
1000	2.0	3.8	107.0	9.4	15.3	0.22
1200	2.1	3.9	115.0	10.9	18.1	0.24
1400	2.1	4.0	119.0	11.8	20.1	0.26
1600	2.2	4.1	123.0	12.8	22.2	0.27
2000	2.3	4.3	131.0	14.7	26.6	0.29

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
240	430	585	445	650	335	455	345	500
300	480	665	500	740	375	520	390	575
400	545	765	570	855	430	605	445	670
500	610	880	645	995	485	695	510	775
630	680	1005	735	1145	550	805	580	900
800	750	1135	820	1315	615	920	660	1045
1000	810	1250	905	1470	680	1035	735	1190
1200	905	1440	1030	1705	755	1185	830	1365
1400	960	1550	1105	1870	810	1290	900	1505
1600	995	1640	1170	2005	855	1380	960	1625
2000	1060	1800	1285	2260	930	1545	1075	1865

CORRUGATED ALUMINUM SHEATH

127/220 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 25.0 MM (NOMINAL)

Nominal Area	Alu. sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm^2	mm	mm	mm	kg/m	kg/m	µF/km
400	2.0	3.8	108.0	8.5	10.8	0.13
500	2.1	3.9	112.0	9.3	12.2	0.14
630	2.1	4.0	116.0	10.1	13.8	0.15
800	2.2	4.1	121.0	11.2	16.0	0.16
1000	2.3	4.3	126.0	12.3	18.3	0.17
1200	2.3	4.4	132.0	13.7	20.9	0.19
1400	2.4	4.5	137.0	14.9	23.2	0.20
1600	2.5	4.6	141.0	16.1	25.5	0.21
2000	2.6	4.8	149.0	18.2	30.1	0.23

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm^2	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
400	535	755	565	830	425	590	445	645
500	600	865	645	960	480	685	505	750
630	670	985	730	1105	545	785	580	870
800	740	1110	815	1265	610	900	655	1005
1000	795	1225	895	1420	670	1010	730	1145
1200	890	1410	1020	1645	745	1155	825	1320
1400	940	1520	1095	1800	795	1260	890	1450
1600	980	1605	1160	1935	840	1345	955	1570
2000	1045	1765	1275	2180	915	1510	1065	1795

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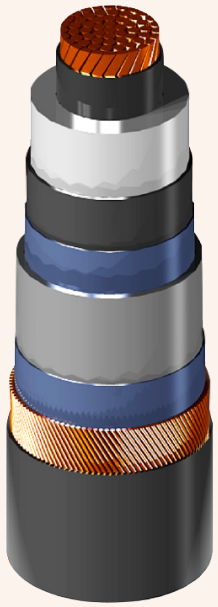
LEAD ALLOY E SHEATH

38/66 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 11.0 MM (NOMINAL)

Nominal Area	Lead sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	mm	kg/m	kg/m	µF/km
95	1.8	2.4	51.0	4.4	5.3	0.15
120	1.8	2.5	53.0	4.8	5.9	0.16
150	1.8	2.6	55.0	5.2	6.5	0.16
185	1.8	2.6	57.0	5.7	7.3	0.18
240	1.9	2.7	60.0	6.5	8.5	0.19
300	1.9	2.8	62.0	7.2	9.2	0.20
400	2.0	3.0	66.0	8.1	10.4	0.22
500	2.1	3.0	69.0	8.9	11.9	0.24
630	2.2	3.1	73.0	9.9	13.6	0.26
800	2.3	3.3	78.0	11	15.9	0.29
1000	2.4	3.4	81.0	12.2	18.2	0.31
1200	2.5	3.5	89	14	21.3	0.36
1400	2.6	3.6	93	15.3	23.6	0.38
1600	2.7	3.8	97	16.5	26	0.40
2000	2.9	3.9	103	19.1	31	0.44



Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
95	265	350	270	395	205	270	210	305
120	300	405	305	455	235	310	235	350
150	335	455	345	515	260	350	265	400
185	375	520	385	595	295	405	300	460
240	430	610	445	700	340	475	350	540
300	485	690	505	800	380	540	390	620
400	550	800	575	930	435	630	450	725
500	620	920	655	1085	495	730	515	845
630	690	1055	740	1255	560	845	585	990
800	765	1195	830	1445	630	970	665	1145
1000	830	1325	920	1625	695	1095	745	1310
1200	960	1560	1050	1900	790	1275	845	1520
1400	1025	1700	1140	2090	855	1405	920	1680
1600	1085	1815	1210	2250	910	1510	985	1825
2000	1180	2030	1345	2565	1010	1720	1110	2105

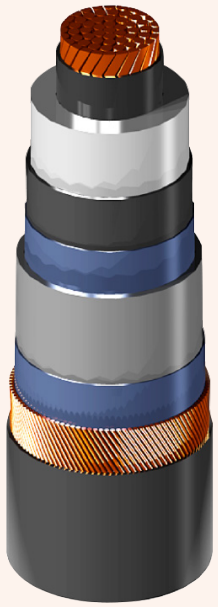
LEAD ALLOY E SHEATH

64/110 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 16.0 MM (NOMINAL)

Nominal Area	Lead sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm^2	mm	mm	mm	kg/m	kg/m	µF/km
150	2.1	2.9	66.0	7.1	8.4	0.13
185	2.1	3.0	68.0	7.6	9.3	0.14
240	1.9	2.7	60.0	6.5	8.5	0.19
300	1.9	2.8	62.0	7.2	9.2	0.20
400	2.0	3.0	66.0	8.1	10.4	0.22
500	2.1	3.0	69.0	8.9	11.9	0.24
630	2.2	3.1	73.0	9.9	13.6	0.26
800	2.3	3.3	78.0	11	15.9	0.29
1000	2.4	3.4	81.0	12.2	18.2	0.31
1200	2.5	3.5	89	14	21.3	0.36
1400	2.6	3.6	93	15.3	23.6	0.38
1600	2.7	3.8	97	16.5	26	0.40
2000	2.9	3.9	103	19.1	31	0.44



Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm^2	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
150	335	450	345	500	260	350	265	390
185	375	515	385	580	295	400	300	445
240	435	605	450	680	340	470	350	525
300	485	685	505	775	380	535	390	600
400	550	795	575	905	435	625	450	705
500	620	915	655	1050	495	720	515	820
630	695	1045	740	1215	560	835	585	955
800	775	1190	835	1395	630	960	665	1110
1000	845	1320	920	1570	700	1090	750	1265
1200	970	1550	1055	1835	795	1260	845	1465
1400	1040	1690	1140	2020	860	1385	920	1620
1600	1100	1810	1215	2175	915	1495	985	1760
2000	1200	2025	1350	2475	1025	1710	1115	2030

RPG CABLES
(A Division of KEC International Limited)

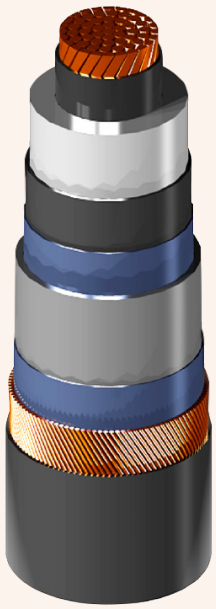
LEAD ALLOY E SHEATH

76/132 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 18.0 MM (NOMINAL)

Nominal Area	Lead sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	mm	kg/m	kg/m	µF/km
240	2.3	3.2	76	9.4	11.4	0.14
300	2.4	3.3	79	10.4	12.4	0.15
400	2.4	3.4	82	11.3	13.5	0.16
500	2.5	3.5	85	12.2	15.2	0.17
630	2.6	3.6	89	13.3	17.1	0.18
800	2.7	3.8	93	14.7	19.6	0.2
1000	2.8	3.9	97	16.1	22	0.22
1200	2.9	4	104	18.1	25.3	0.24
1400	3	4.1	108	19.6	27.8	0.26
1600	3.1	4.2	112	20.9	30.4	0.27
2000	3.3	4.4	119	23.8	35.7	0.29



Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
240	435	605	450	675	340	470	345	520
300	485	685	505	765	380	535	390	595
400	550	790	575	890	435	620	450	695
500	620	910	655	1040	495	720	515	810
630	700	1045	740	1200	560	835	585	945
800	775	1185	835	1380	635	955	665	1095
1000	845	1315	920	1550	705	1085	745	1250
1200	970	1545	1055	1810	795	1255	845	1445
1400	1040	1685	1140	1990	860	1380	920	1600
1600	1100	1805	1215	2150	920	1490	985	1735
2000	1210	2025	1350	2445	1025	1700	1115	2005

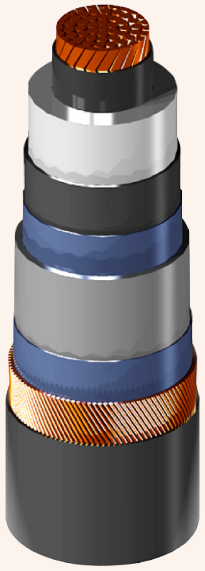
LEAD ALLOY E SHEATH

127/220 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 25.0 MM (NOMINAL)

Nominal Area	Lead sheath thickness (Minimum)	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm^2	mm	mm	mm	kg/m	kg/m	µF/km
400	2.9	4	99	15.9	18.3	0.13
500	2.9	4.1	103	16.9	19.9	0.14
630	3	4.2	106	18.2	22	0.15
800	3.1	4.3	110	19.7	24.6	0.16
1000	3.3	4.4	115	21.6	27.6	0.17
1200	3.4	4.6	121	23.7	31	0.19
1400	3.5	4.7	125	25.4	33.7	0.2
1600	3.5	4.8	128	26.5	36	0.21
2000	3.7	5	135	29.7	41.6	0.23



Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm^2	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
400	545	775	570	860	430	610	445	670
500	615	895	650	1000	490	705	510	780
630	690	1020	735	1150	555	815	585	905
800	770	1160	830	1325	625	935	660	1050
1000	840	1295	915	1490	700	1060	745	1200
1200	955	1505	1045	1740	785	1225	840	1385
1400	1025	1645	1130	1910	850	1345	910	1530
1600	1080	1755	1200	2055	905	1445	975	1660
2000	1180	1965	1335	2335	1005	1650	1100	1915

COPPER WIRE SCREEN – POLYAL SHEATH

38/66 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 11.0 MM (NOMINAL)

Nominal Area	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	kg/m	kg/m	µF/km
95	2.3	48.0	2.2	3.0	0.15
120	2.4	50.0	2.5	3.5	0.16
150	2.4	51.0	2.8	4.1	0.16
185	2.5	53.0	3.1	4.8	0.18
240	2.6	56.0	3.7	5.7	0.19
300	2.7	59.0	4.3	6.3	0.2
400	2.8	62.0	4.9	7.1	0.22
500	2.9	65.0	5.3	8.2	0.24
630	3	69.0	5.9	9.6	0.26
800	3.2	73.0	6.6	11.3	0.29
1000	3.3	77.0	7.3	13.2	0.31
1200	3.4	84.0	8.4	15.6	0.36
1400	3.5	89.0	9.2	17.4	0.38
1600	3.6	92.0	9.8	19.3	0.4
2000	3.8	99.0	11.3	23.2	0.44

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
95	260	345	270	390	205	265	205	300
120	295	395	305	450	230	305	235	350
150	330	445	340	510	260	345	265	395
185	375	510	385	585	290	395	300	455
240	430	600	445	690	335	465	345	535
300	480	680	500	790	375	530	390	610
400	545	785	570	920	430	620	445	715
500	610	905	645	1070	490	720	510	835
630	680	1030	735	1235	555	830	580	975
800	755	1170	825	1425	620	950	660	1130
1000	815	1290	910	1600	685	1075	740	1295
1200	935	1520	1040	1870	775	1250	835	1500
1400	995	1645	1120	2055	835	1365	910	1655
1600	1045	1750	1190	2215	885	1470	970	1795
2000	1130	1940	1315	2510	975	1665	1090	2070

COPPER WIRE SCREEN – POLYAL SHEATH

64/110 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 16.0 MM (NOMINAL)

Nominal Area	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	kg/m	kg/m	µF/km
150	2.8	63.0	3.6	4.9	0.13
185	2.9	64.0	4.0	5.6	0.14
240	2.9	67.0	4.6	6.6	0.15
300	3.1	70.0	5.3	7.2	0.16
400	3.2	73.0	5.9	8.1	0.17
500	3.3	76.0	6.4	9.3	0.18
630	3.4	80.0	7.0	10.7	0.2
800	3.5	84.0	7.7	12.5	0.22
1000	3.6	88.0	8.5	14.4	0.23
1200	3.8	95.0	9.7	17.0	0.26
1400	3.9	100.0	10.5	18.8	0.28
1600	4	103.0	11.3	20.8	0.29
2000	4.2	110.0	12.9	24.8	0.32

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
150	330	445	340	500	260	345	265	385
185	375	510	385	570	290	395	300	440
240	430	595	445	675	335	465	345	520
300	480	675	500	770	380	530	390	595
400	545	780	570	895	430	615	445	695
500	615	900	650	1040	490	710	510	810
630	685	1025	735	1200	555	825	580	945
800	760	1165	825	1380	620	945	660	1095
1000	820	1290	910	1555	690	1065	740	1255
1200	940	1510	1040	1810	780	1235	835	1450
1400	1000	1635	1120	1990	835	1350	905	1600
1600	1050	1740	1190	2140	890	1455	970	1735
2000	1135	1930	1315	2430	980	1645	1090	2000

COPPER WIRE SCREEN – POLYAL SHEATH

76/132 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 18.0 MM (NOMINAL)

Nominal Area	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm²	mm	mm	kg/m	kg/m	µF/km
240	3.1	72.0	5.0	7.0	0.14
300	3.2	74.0	5.7	7.6	0.15
400	3.3	78.0	6.3	8.6	0.16
500	3.4	81.0	6.8	9.7	0.17
630	3.5	85.0	7.5	11.2	0.18
800	3.7	89.0	8.3	13.0	0.2
1000	3.8	93.0	9.1	15.0	0.22
1200	3.9	100.0	10.3	17.5	0.24
1400	4	104.0	11.1	19.4	0.26
1600	4.1	107.0	11.9	21.4	0.27
2000	4.3	114.0	13.5	25.4	0.29

Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm²	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
240	430	595	445	665	335	460	345	515
300	480	675	500	760	380	525	390	590
400	545	780	570	885	430	615	445	690
500	615	900	650	1030	490	710	510	805
630	685	1025	735	1185	555	820	580	935
800	760	1160	825	1365	625	940	660	1085
1000	825	1285	910	1535	690	1060	740	1235
1200	940	1505	1040	1790	780	1230	835	1430
1400	1000	1630	1120	1965	835	1345	905	1580
1600	1050	1735	1190	2115	890	1445	970	1715
2000	1135	1925	1315	2400	980	1640	1090	1975

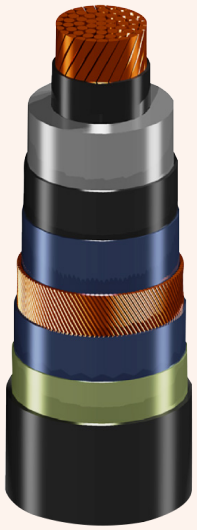
COPPER WIRE SCREEN – POLYAL SHEATH

127/220 kV

CONSTRUCTIONAL FEATURES:

INSULATION THICKNESS: 25.0 MM (NOMINAL)

Nominal Area	Outer sheath thickness (Nominal)	Overall Diameter (Approx.)	App. Weight (Aluminium)	App. Weight (Copper)	Approx. Capacitance
mm^2	mm	mm	kg/m	kg/m	µF/km
400	3.9	94.0	8.7	11.0	0.13
500	3.9	97.0	9.3	12.2	0.14
630	4.1	101.0	10.0	13.8	0.15
800	4.2	105.0	10.9	15.7	0.16
1000	4.3	109.0	11.8	17.7	0.17
1200	4.4	115.0	13.0	20.3	0.19
1400	4.5	120.0	13.9	22.2	0.2
1600	4.6	123.0	14.8	24.2	0.21
2000	4.8	130.0	16.5	28.4	0.23



Nominal Area	Trefoil SPB/CB		Flat SPB/CB		Trefoil SPB/CB		Flat SPB/CB	
	Copper Ground	Copper Air	Copper Ground	Copper Air	Aluminium Ground	Aluminium Air	Aluminium Ground	Aluminium Air
mm^2	Amp	Amp	Amp	Amp	Amp	Amp	Amp	Amp
400	540	765	565	855	425	605	445	665
500	605	880	645	990	485	695	505	775
630	680	1005	730	1145	550	805	580	900
800	750	1140	820	1315	615	920	655	1040
1000	815	1260	900	1475	680	1040	735	1190
1200	920	1465	1025	1720	765	1200	825	1375
1400	980	1590	1105	1885	820	1310	895	1515
1600	1025	1690	1175	2025	870	1410	960	1640
2000	1105	1875	1295	2295	955	1590	1075	1890

DERATING FACTORS:

To determine current capacity for the various laying conditions than those indicated on the every table, multiply table values by the correction factors shown below.

AMBIENT AIR TEMPERATURE

Temp. (Deg.C)	25	30	35	40	45	50	55
Rating Factor	1.14	1.10	1.05	1.00	0.95	0.89	0.84

GROUND TEMPERATURE

Temp. (Deg.C)	15	20	25	30	35	40	45
Rating Factor	1.12	1.08	1.04	1.00	0.96	0.91	0.87

DEPTH OF LYING

Depth (mm)	700	900	1000	1300	1500	2000
Rating Factor	1.05	1.02	1.00	0.98	0.97	0.92

SOIL THERMAL RESISTIVITY

STR (Km/W)	1.0	1.2	1.5	2.0	2.5	3.0
Rating Factor	1.17	1.09	1.00	0.89	0.81	0.74

GROUP RATING FACTORS:

RATING FACTORS FOR GROUPING OF SINGLE CORE CABLE LAID DIRECT IN GROUND IN HORIZONTAL FORMATION						
Distance between circuits	Number of circuits in group					
	1	2	3	4	5	6
100	1	0.76	0.67	0.59	0.55	0.51
200	1	0.81	0.71	0.65	0.61	0.58
400	1	0.85	0.77	0.72	0.69	0.66
600	1	0.88	0.81	0.77	0.74	0.72
800	1	0.90	0.84	0.81	0.79	0.77
2000	1	0.96	0.93	0.92	0.91	0.91

PERMISSIBLE SHORT CIRCUIT CURRENTS

The permissible short circuit current of a cable is determined by the maximum permissible conductor temperature and by the duration of the short circuit current. At high peak currents, the dynamic forces between the conductors must be taken into account.

The short circuit capacity of the conductor and metallic screen of a cable are related principally to their heat capacities and are limited by the maximum temperature permitted under short circuit XLPE power are 90 deg.C at normal operation and 250 deg.C at short circuit operation.
According to IEC 60949 based formula

$$I^2_{AD}\, t = K^2 S^2 \ln\left(\frac{\theta_f + \beta}{\theta_i + \beta}\right)$$

Where:

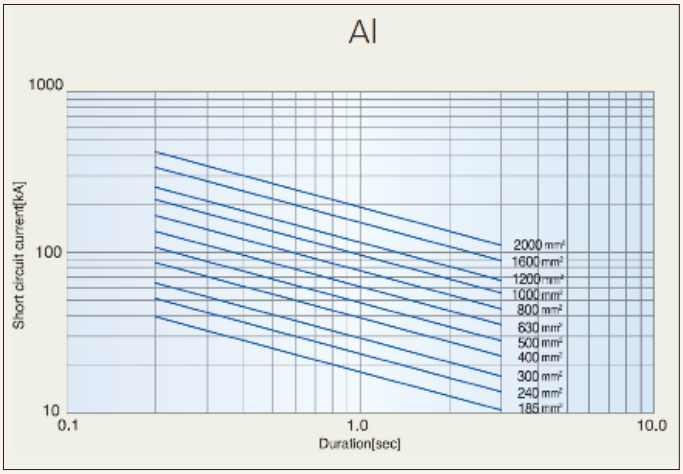
I_{AD} = Short circuit current on an adiabatic basis (in Amps)
t = Duration of short circuit (in seconds)
K = Constant depending on the material of the conductor

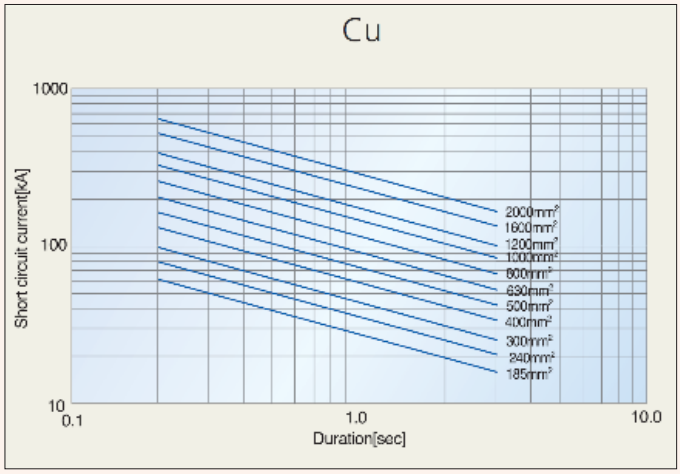
Values for constant are as below

K	Aluminium: 148	
	Copper: 226	
β	Aluminium: 228	
	Copper: 234.5	

S = Cross- sectional area of the current- carrying component (mm^2)
θ_i = Final temperature (^0C)
θ_f = Initial temperature (^0C)
β = reciprocal of temperature coefficient of resistance of the conductor at 0^0C

SHORT CIRCUIT CURRENT RATING GRAPH

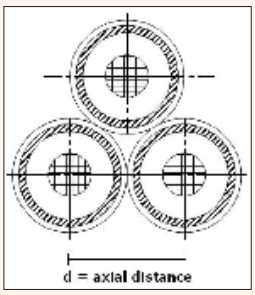




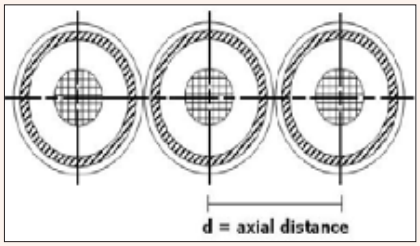
RPG CABLES
(A Division of KEC International Limited)

TREFOIL AND FLAT FORMATION

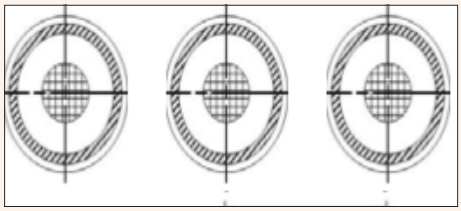
The three cables in a 3-phase circuit can be placed in different formations. Typical formations include trefoil (triangular) and flat formations. The choice depends on several factors like screen bonding method, conductor area and available space for installation.



TREFOIL FORMATION

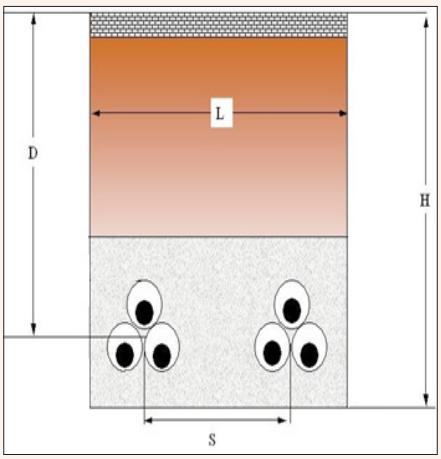


FLAT TOUCHING FORMATION

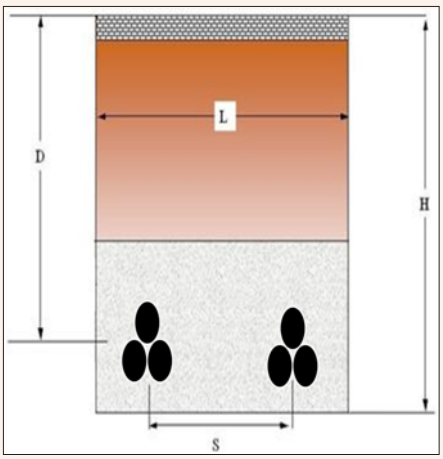


FLAT FORMATION WITH SPACING

Cables laid in ducts



Cables laid directly in ground



Cross sectional view of a typical trench having 2 circuits of cables laid in trefoil formation in ducts.

Where,

S = Distance between 2 circuits
D = Depth of laying
L = Width of trench
H = Height of trench

BONDING OF THE METALLIC SHEATH/SCREEN

Nowadays, in urban areas "Extra high voltage underground cables" are commonly used for the transmission of electricity. During earth faults applied to directly earthed systems, the metallic paths are expected to carry a substantial proportion of the total fault current, which would otherwise flow through the general mass of earth, while returning to system neutrals. These alternative return paths must be considered when determining the extent of the grid potential rise at an electrical plant due to earth faults. For safety and reliable operation, the metallic sheaths must be grounded. Without grounding, screens would operate at a potential considerably above ground. Thus, they would be hazardous to touch and would cause rapid degradation of the outer sheath. This is caused by the capacitive charging current of the cable insulation. This current normally flows, at power frequency, between the conductor and the earth electrode of the cable, normally the screen. In addition, the screen or metallic sheath provides a fault return path in the event of insulation failure, permitting rapid operation of the protection devices.

In order to reduce circulating current and electric potential difference between the sheathings the sheathing is grounded and bonded at one or both ends of the cables.

There are normally 3 types of Bonding for EHV Cables.

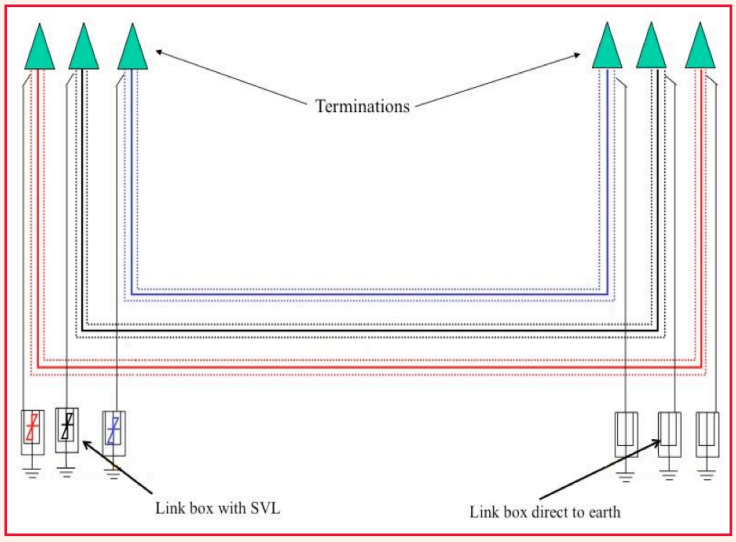
(1) Single Point Bonded System
(2) Both End Bonded System
(3) Cross Bonded System

SINGLE POINT BONDED SYSTEM

A system is single point bonded if the arrangements are such that the cable sheaths provide no path for the flow of circulating currents or external fault currents. In this connection system, the screens are connected to earth at one end, and the other end is isolated from earth by SVLs voltage limiters. In these cases there may be a need to install a bonding earthing cable to earth continuity for fault currents that normally would return through the screens.

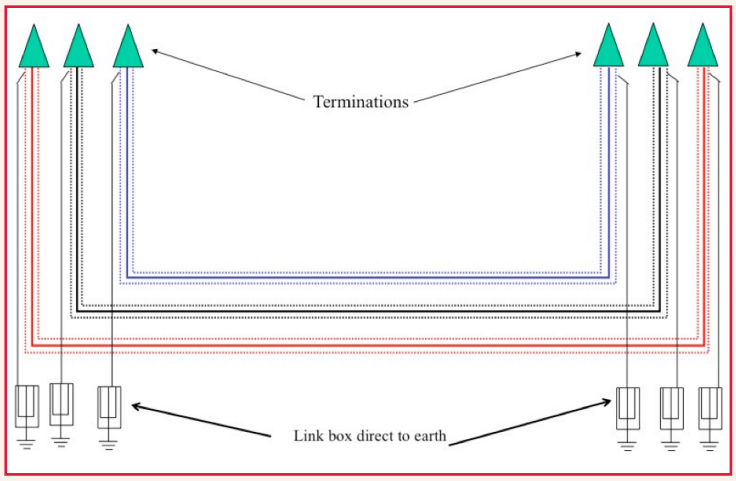
The induced voltage is proportional to the length of cable and hence the voltage limitation of this imposes a limitation on the maximum cable length which can be connected in this way.

This is the simplest form of special bonding. The sheaths of the three cable sections are connected and grounded at one point only along their length.



BOTH END BONDED SYSTEM

A system is both ends bonded if the arrangements are such that the cable sheaths provide path for circulating currents at normal conditions. This will cause losses in the screen, which reduce the cable current carrying capacity. These losses are smaller for cables in trefoil formation than in flat formation with separation.



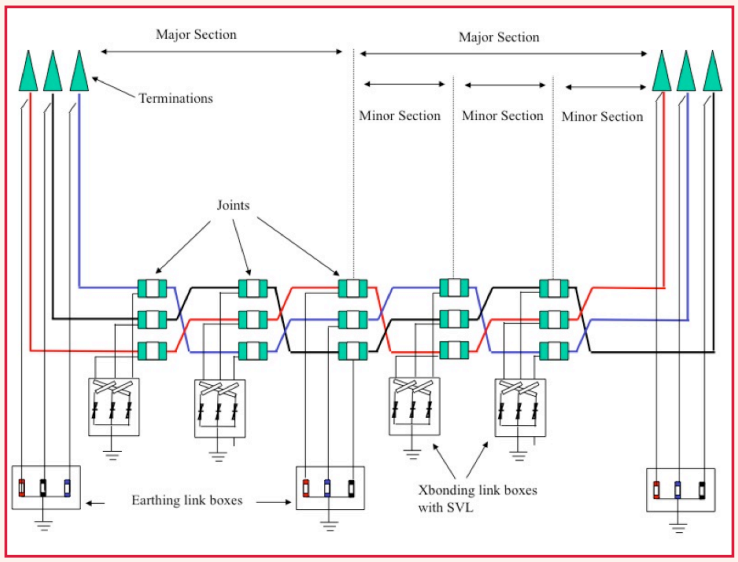
CROSS BONDED SYSTEM

In this connection system, the route is divided into major sections, each of which is divided into three subsections or minor sections.

Every three joints, the screens have to be connected directly to earth, and in the two intermediate joints, the screens have to be crossed according to figure above and will be isolated from earth via SVLs.

The three screens connected in series are associated with conductors of different phases, and when the cables are installed in a trefoil formation, their currents, and consequently the voltages of the screens have the same magnitude but with a phase shift of 120 °. The overall effect is that the resultant voltage and the current in the three screens are zero.

This connection system does not need a earthing connecting cable as the screens are continuously connected and it is only necessary to connect them to the ends of each major section.



FORMULAE

FORMULA FOR CAPACITANCE:

$$C = \frac{r_r}{18 \cdot \ln\left(\frac{r_o}{r_i}\right)} \text{ [mF/km]}$$

Where,
εr = relative permittivity of the insulation
ro = external radius of the insulation (mm)
ri = radius of conductor, including screen (mm)
εr = 2.5 (Value from IEC 60287)

FORMULA FOR INDUCTANCE:

$$L = 0.05 + 0.2 \cdot \ln\left(\frac{K \cdot s}{r_c}\right) \text{ [mH/km]}$$

Where,
Trefoil formation: K = 1
Flat formation: K = 1.26
s = distance between conductor axes (mm)
rc = conductor radius (mm)

FORMULA FOR ELECTRIC STRESS:

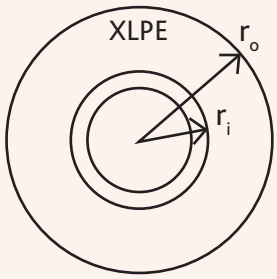
DIELECTRIC STRESS AT CONDUCTOR SCREEN

$$E_{max} = \frac{U_o}{r_i \ln\left(\frac{r_o}{r_i}\right)} \text{ [kV/mm]}$$

DIELECTRIC STRESS AT INSULATION SCREEN

$$E_{min} = \frac{U_o}{r_o \ln\left(\frac{r_o}{r_i}\right)} \text{ [kV/mm]}$$

Where,
ri = radius of conductor screen
ro = radius of XLPE insulation
Uo = voltage across insulation



CABLE HANDLING

RECOMMENDED MINIMUM BENDING RADIUS

Laying in air	20 times the Overall diameter
Laying in ground	20 times the Overall diameter
Laying in ducts	25 times the Overall diameter

MAXIMUM PULLING FORCES

The following pulling forces should not be exceeded when pulled through pulling eye:

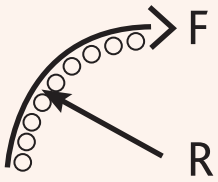
Aluminium conductors: 30 N/mm^2
Copper conductors: 50 N/mm^2

MAXIMUM SIDE WALL PRESSURE (SWP)

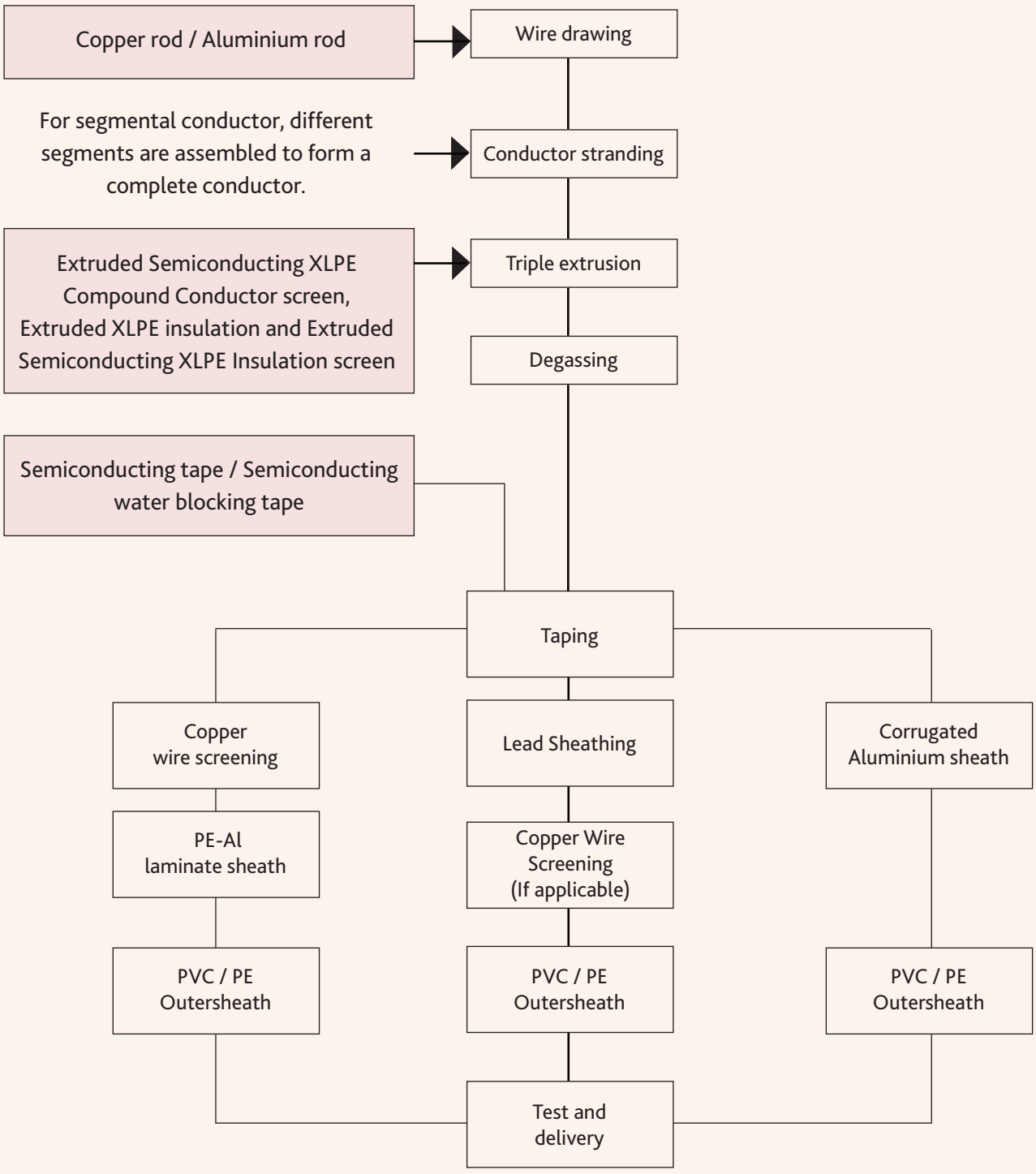
The maximum side wall pressure shall be calculated from the below:

$$SWP = \frac{F}{R} \text{ [kg/m]}$$

Where, F = Max. Pulling force
R = Bending radius



MANUFACTURING PROCESS FLOW CHART



CERTIFICATE

This is to certify that

KEC International Ltd.
Village: Godampura (Samlaya)
Ta. Savli, Vadodara – 391 520
Gujarat
INDIA

has implemented and maintains a **Quality Management System**.

Scope:
Design & Manufacture of Power Cables.

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2008

Certificate registration no.	20006674 QM08
Date of certification	2014-02-13
Valid until	2017-02-12

UL DQS Inc.

Ganesh Rao
Managing Director

Accredited Body: UL DQS Inc., 1130 West Lake Cook Road, Suite 340, Buffalo Grove, IL 60089 USA
Administrative Office: UL Management Systems Solutions India Pvt. Ltd., 5th Floor, Anjaneya Techno Park, 147, HAL Airport Road, Kodihalli, Bangalore - 560 017 - India

CERTIFICATE

This is to certify that

KEC International Ltd.
Village: Godampura (Samlaya)
Ta. Savli, Vadodara – 391 520
Gujarat
INDIA

has implemented and maintains an **Environmental Management System**.

Scope:
Environment activities and supporting processes associated with Design & Manufacture of Power Cables.

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 14001 : 2004

Certificate registration no.	20006674 UM
Date of certification	2014-02-13
Valid until	2017-02-12

UL DQS Inc.

Ganesh Rao
Managing Director

Accredited Body: UL DQS Inc., 1130 West Lake Cook Road, Suite 340, Buffalo Grove, IL 60089 USA
Administrative Office: UL Management Systems Solutions India Pvt. Ltd., 5th Floor, Anjaneya Techno Park, 147, HAL Airport Road, Kodihalli, Bangalore - 560 017 - India

Confederation of Indian Industry

Indian Green Building Council

Indian Green Building Council (IGBC)

hereby certifies that

KEC - RPG Cables Greenfield Facility
Vadodara

has successfully achieved the Green Building Standards required for the following level of certification under the IGBC Green Factory Building Rating System

IGBC Green Factory Building Platinum
April 2013

Pradeep Bhargava	**Dr Prem C Jain**	**S Raghupathy**
Chairman, IGBC Green Factory Building Rating System	Chairman, IGBC	Executive Director, CII-Godrej GBC

KEMA

Type test Certificate of complete type tests

KEC International Limited

Vadodara, Gujarat, India

have successfully passed the type test sequence on a

cable system (220 kV)

Cable:	1 x 2000 mm² – Cu – XLPE insulated
Manufacturer:	KEC International Limited (Cable Division)
Outdoor termination:	OHVT-245P, OHVT-245C
Manufacturer:	Raychem RPG (P) Ltd.
Cable connection:	PHVS-245
Manufacturer:	Raychem RPG (P) Ltd.
Joint:	EHVS-245
Manufacturer:	Raychem RPG (P) Ltd.

The test object passed the required clauses of

IEC 62067

The test results are recorded in Certificate No.

TIC 1013-15

This Certificate is issued on 2 March 2015

KEMA Nederland B.V.

S.M. Verhoeven
Director Testing, Inspections & Certification The Netherlands

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Experience you can trust.

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RPG CABLES
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