

## 1. Applications

This specification covers high-voltage cables, for rating voltage of 36/66kV, 64/110kV, 76/132kV and respectively 93/161kV, having XLPE (cross-linked polyethylene) insulation.

The cables covered by this specification are designed to be used mainly in underground transmission lines which connect units of electricity distribution grid.

They may be used inside stations or sub-stations.

They may also be used in conjunction with overhead transmission lines.

## 2. Reference Standards and documents

The cables covered by this specification are manufactured and tested as per the following references:

2.1	IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) – Test methods and requirements
2.2	HD 632	Power cables with extruded insulation and their accessories for rated voltages above 36 kV (Um = 42 kV) up to 150 kV (Um = 170 kV)
2.3	IEC 60183	Guidance for the selection of high-voltage A.C. cable systems
2.4	IEC 60228	Conductors of insulated cables
2.5	IEC 60229	Electric Cables – Tests on extruded over-sheaths with a special protective function.
2.6	IEC 61443	Short-circuits temperature limits of electric cables with rated voltages above 30kV (Um=36kV)
2.7	IEC 60811 series	Common test methods for insulation and sheathing materials of electrical and optical cables

## 3. HV Cables Construction

### 3.1 Conductor

Conductors used in High Voltage Cables construction are stranded from aluminum or copper wires. Conductors having a cross-sectional area up to and including 1000 mm<sup>2</sup> are compact-round stranded. Conductors having a cross-sectional area from 1200 mm<sup>2</sup> up 2000 mm<sup>2</sup> are segmental (also known as **Milliken**). Segmental (Milliken) reduces the unfavorable skin-effect and proximity-effect, thus increasing the current rating.

### 3.2 Conductor screen

An extruded layer of semi-conductive, cross-linked polymer, firmly bonded to the insulation, is applied over the conductor.

### 3.3 Insulation

An extruded layer of super-clean XLPE (cross-linked polyethylene) is subsequently applied.

### 3.4 Insulation screen

An extruded layer of semi-conductive, cross-linked polymer firmly bonded to the insulation.  
**Note:** Conductor screen, insulation and insulation screen are extruded in a single operation.

### 3.5 Metal screen

A semi-conductive tape is helically applied around the completed insulated core, as bedding between insulation screen and metal screen components.

Metal screen is built from round copper wires and copper equalizing tape.

**3.6 Longitudinal water-blocking barrier**

A semi-conductive and swelling tape is helically applied around the screened core.  
Metal screen is built from round copper wires and copper equalizing tape.

**3.7 Radial water-blocking barrier**

An aluminum-foil/polymer laminate is longitudinal, with overlapping, applied over the longitudinal water-blocking barrier.

**3.8 Outer protective sheath**

A black HDPE sheath is extruded overall.

A thin conductive covering is applied on the HDPE sheath, in order to make possible the after-installation test.

**3.9 Constructive options**

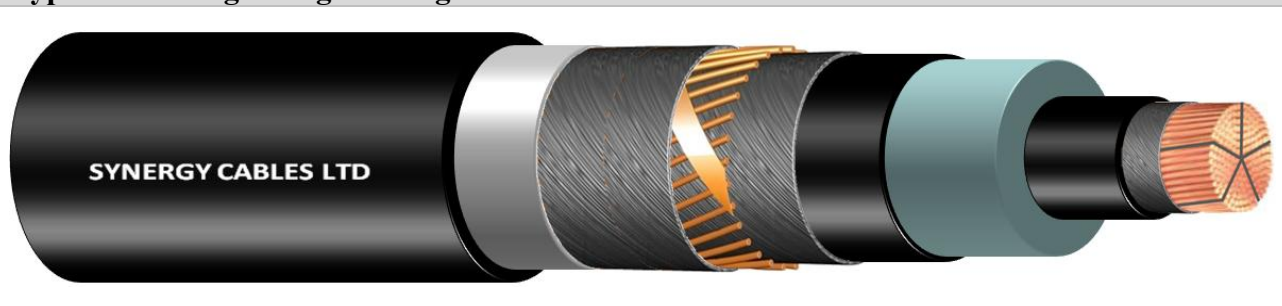
**Conductor:** water-blocked conductor, available as option

**Metal Screen:** Other cross-sectional areas than those listed in this specification, available as option.

**Optical fibers tubes:** (for DTS – Distributed temperature sensing), available as option.

**Outer protective sheath:** Extruded, thermoplastic HFFR, available as option

**Typical Drawing of High-Voltage Cable**





## 36/66(72.5) kV/ ALUMINUM CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
185	COMPACT	16.3	9.0	35	2.6	50.5	2,260	5.4	1,265	760
240	COMPACT	18.6	9.0	50	2.7	53.0	2,680	7.1	1,325	795
300	COMPACT	20.9	9.0	70	2.8	56.5	3,170	8.8	1,415	850
400	COMPACT	23.9	9.3	95	2.9	61.0	3,900	11.8	1,525	915
500	COMPACT	26.8	9.5	120	3.1	65.5	4,640	14.7	1,640	985
630	COMPACT	31.0	9.5	135	3.2	70.0	5,360	18.5	1,750	1,050
800	COMPACT	35.0	10.0	135	3.4	75.5	6,190	23.5	1,890	1,135
1000	COMPACT	40.4	10.0	135	3.6	81.0	7,140	29.4	2,025	1,215
1200	MILLIKEN	42.5	10.0	135	3.7	85.0	8,030	30.0	2,125	1,275

**Remarks:**

- (1) *Other cross-sectional sizes may be available, at the request of the client*
- (2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*
- (3) *While pulling over rolls or through duct*
- (4) *After installation, with cable former*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
185	304	319	304	456	440
240	352	370	351	538	509
300	397	418	408	619	569
400	455	480	467	725	644
500	521	550	533	846	723
630	594	631	609	993	814
800	670	717	708	1147	904
1000	748	808	796	1326	932
1200	849	907	888	1494	1074

**Remarks:**

- (1)– *Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (2)– *Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (3) – *In Free Air, protected against direct sun radiation, ambient air temperature = 40°C*
- (4)– *Touching-trefoil formation*
- (5) – *Flat-parallel formation, inter-axial spacing = 2 x D of cable*
- (6) – *Flat-parallel formation, inter-axial spacing = 2 x D of duct*
- (7) – *Metal screens cross-bonded or single-point bonded*
- (8) – *Metal screens bonded at two points*

## 36/66(72.5) kV/ ALUMINUM CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
185	0.200	0.211	0.130	0.516	0.056	0.209	0.188	0.516	0.115
240	0.219	0.161	0.125	0.396	0.056	0.160	0.183	0.396	0.114
300	0.240	0.129	0.122	0.305	0.055	0.128	0.180	0.305	0.114
400	0.259	0.101	0.118	0.235	0.055	0.100	0.176	0.235	0.113
500	0.276	0.079	0.115	0.186	0.054	0.078	0.173	0.186	0.112
630	0.308	0.063	0.110	0.161	0.054	0.061	0.169	0.161	0.112
800	0.325	0.050	0.108	0.150	0.053	0.049	0.166	0.150	0.111
1000	0.361	0.041	0.103	0.141	0.053	0.040	0.161	0.141	0.111
1200	0.385	0.032	0.103	0.134	0.053	0.032	0.161	0.134	0.111

*Remarks:*

- |          |  |
|----------|--|
| <i>1</i> | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| <i>2</i> | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |



## 36/66(72.5) kV/ COPPER CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
185	COMPACT	16.3	9.0	35	2.6	50.5	3,415	9.1	1,265	760
240	COMPACT	18.6	9.0	50	2.7	53.0	4,165	11.8	1,325	795
300	COMPACT	20.9	9.0	70	2.8	56.5	5,045	14.7	1,415	850
400	COMPACT	23.9	9.3	95	2.9	61.0	6,270	19.6	1,525	915
500	COMPACT	26.8	9.5	120	3.1	65.5	7,670	24.5	1,640	985
630	COMPACT	31.0	9.5	135	3.2	70.0	9,340	30.0	1,750	1,050
800	COMPACT	35.0	10.0	135	3.4	75.5	11,155	30.0	1,890	1,135
1000	COMPACT	40.4	10.0	135	3.6	81.0	13,420	30.0	2,025	1,215
1200	MILLIKEN	42.5	10.0	135	3.7	85.0	15,640	30.0	2,125	1,275

**Remarks:**

(1)	<i>Other cross-sectional sizes may be available, at the request of the client</i>
(2)	<i>Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN/m</i>
(3)	<i>while pulling over rolls or through duct</i>
(4)	<i>After installation, with cable former</i>

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
185	391	410	391	587	554
240	452	475	452	691	632
300	510	537	525	796	700
400	580	613	597	925	774
500	658	699	678	1073	850
630	743	797	771	1255	941
800	827	896	888	1434	1027
1000	906	994	983	1632	1111
1200	1056	1138	1118	1877	1194

**Remarks:**

- (1)– Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (2)– Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (3) – In Free Air, protected against direct sun radiation, ambient air temperature = 40°C
- (4)– Touching-trefoil formation
- (5) – Flat-parallel formation, inter-axial spacing = 2 x D of cable
- (6) – Flat-parallel formation, inter-axial spacing = 2 x D of duct
- (7) – Metal screens cross-bonded or single-point bonded
- (8) – Metal screens bonded at two points

### 36/66(72.5) kV/ COPPER CONDUCTOR (...continued)

#### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation (1)				Flat-Parallel Formation (1), (2)			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
185	0.200	0.127	0.130	0.452	0.056	0.126	0.188	0.452	0.115
240	0.218	0.097	0.125	0.347	0.056	0.097	0.183	0.347	0.114
300	0.240	0.078	0.121	0.265	0.055	0.077	0.179	0.265	0.113
400	0.257	0.062	0.118	0.205	0.055	0.061	0.176	0.205	0.112
500	0.275	0.049	0.116	0.163	0.054	0.048	0.174	0.163	0.112
630	0.308	0.040	0.110	0.143	0.054	0.038	0.169	0.143	0.112
800	0.325	0.033	0.108	0.136	0.053	0.031	0.166	0.136	0.111
1000	0.361	0.028	0.103	0.131	0.053	0.026	0.161	0.131	0.111
1200	0.385	0.021	0.103	0.125	0.053	0.020	0.161	0.125	0.111

*Remarks:*

- 1 Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections
- 2 Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable

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## 64/110(123) kV/ ALUMINUM CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
240	COMPACT	18.6	15.0	50	3.1	66	3,735	7.1	1,650	990
300	COMPACT	20.9	14.0	70	3.1	67	4,075	8.8	1,675	1,005
400	COMPACT	23.9	13.5	95	3.2	70	4,705	11.8	1,750	1,050
500	COMPACT	26.8	13.0	120	3.3	73	5,335	14.7	1,825	1,095
630	COMPACT	31.0	13.5	135	3.5	79	6,235	18.5	1,975	1,185
800	COMPACT	35.0	13.5	135	3.6	83	7,000	23.5	2,075	1,245
1000	COMPACT	40.4	13.5	135	3.8	89	8,005	29.4	2,225	1,335
1200	MILLIKEN	42.5	13.5	135	4.0	93	8,970	30.0	2,325	1,395
1600	MILLIKEN	49.5	13.5	135	4.2	101	10,765	30.0	2,525	1,515

**Remarks:**

- (1) *Other cross-sectional sizes may be available, at the request of the client*
- (2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*
- (3) *While pulling over rolls or through duct*
- (4) *After installation, with cable former*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
240	352	369	358	524	499
300	397	418	404	604	562
400	455	480	463	709	639
500	520	550	529	829	720
630	594	631	621	969	812
800	671	717	703	1122	903
1000	750	808	790	1297	999
1200	849	906	903	1460	1076
1600	983	1058	1049	1747	1201

**Remarks:**

- (1)– *Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (2)– *Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (3) – *In Free Air, protected against direct sun radiation, ambient air temperature = 40°C*
- (4)– *Touching-trefoil formation*
- (5) – *Flat-parallel formation, inter-axial spacing = 2 x D of cable*
- (6) – *Flat-parallel formation, inter-axial spacing = 2 x D of duct*
- (7) – *Metal screens cross-bonded or single-point bonded*
- (8) – *Metal screens bonded at two points*

## 64/110(123) kV/ ALUMINUM CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
240	0.153	0.161	0.139	0.378	0.054	0.160	0.196	0.378	0.112
300	0.174	0.129	0.132	0.295	0.054	0.128	0.191	0.295	0.112
400	0.196	0.101	0.127	0.231	0.054	0.100	0.185	0.231	0.112
500	0.218	0.079	0.122	0.184	0.053	0.078	0.180	0.184	0.112
630	0.234	0.062	0.118	0.159	0.053	0.061	0.176	0.159	0.111
800	0.256	0.050	0.113	0.148	0.053	0.049	0.172	0.148	0.111
1000	0.283	0.041	0.108	0.139	0.052	0.040	0.167	0.140	0.111
1200	0.301	0.032	0.108	0.133	0.052	0.032	0.166	0.133	0.110
1600	0.340	0.025	0.104	0.125	0.052	0.024	0.162	0.125	0.110

*Remarks:*

- |   |   |
|---|---|
| 1 | Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections |
| 2 | Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable  |



## 64/110(123) kV/ COPPER CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
240	COMPACT	18.6	15.0	50	3.1	66.0	5,195	11.8	1,650	990
300	COMPACT	20.9	14.0	70	3.1	67.0	5,925	14.7	1,675	1,005
400	COMPACT	23.9	13.5	95	3.2	70.0	7,060	19.6	1,750	1,050
500	COMPACT	26.8	13.0	120	3.3	73.0	8,345	24.5	1,825	1,095
630	COMPACT	31.0	13.5	135	3.5	79.0	10,190	30.0	1,975	1,185
800	COMPACT	35.0	13.5	135	3.6	83.0	11,940	30.0	2,075	1,245
1000	COMPACT	40.4	13.5	135	3.8	88.5	14,265	30.0	2,215	1,330
1200	MILLIKEN	42.5	13.5	135	4.0	93.0	16,560	30.0	2,325	1,395
1600	MILLIKEN	49.5	13.5	135	4.2	101.0	21,120	30.0	2,525	1,515

#### Remarks:

- (1) *Other cross-sectional sizes may be available, at the request of the client*
- (2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*
- (3) *While pulling over rolls or through duct*
- (4) *After installation, with cable former*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
240	452	475	460	674	625
300	510	537	520	777	694
400	580	613	592	905	772
500	658	698	674	1052	853
630	744	797	786	1225	946
800	829	896	882	1404	1033
1000	910	995	976	1598	1120
1200	1057	1137	1137	1835	1204
1600	1204	1313	1308	2172	1317

#### Remarks:

- (1) – Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (2) – Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (3) – In Free Air, protected against direct sun radiation, ambient air temperature = 40°C
- (4) – Touching-trefoil formation
- (5) – Flat-parallel formation, inter-axial spacing = 2 x D of cable
- (6) – Flat-parallel formation, inter-axial spacing = 2 x D of duct
- (7) – Metal screens cross-bonded or single-point bonded
- (8) – Metal screens bonded at two points

## 64/110(123) kV/ COPPER CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
240	0.153	0.097	0.139	0.329	0.054	0.096	0.196	0.329	0.112
300	0.174	0.078	0.132	0.255	0.054	0.077	0.191	0.255	0.112
400	0.195	0.062	0.127	0.200	0.054	0.061	0.185	0.200	0.112
500	0.216	0.049	0.122	0.161	0.053	0.048	0.180	0.161	0.111
630	0.234	0.039	0.118	0.141	0.053	0.038	0.176	0.141	0.111
800	0.256	0.032	0.113	0.134	0.053	0.031	0.172	0.134	0.111
1000	0.283	0.028	0.108	0.129	0.052	0.026	0.167	0.129	0.111
1200	0.301	0.021	0.108	0.123	0.052	0.020	0.166	0.123	0.110
1600	0.340	0.016	0.104	0.118	0.052	0.015	0.162	0.118	0.110

*Remarks:*

- |   |  |
|---|--|
| 1 | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| 2 | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |



## 76/132(145) kV/ ALUMINUM CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
300	COMPACT	20.9	18.5	70.0	3.4	77.0	5,040	8.8	1,675	1,005
400	COMPACT	23.9	17.0	95.0	3.4	77.5	5,465	11.8	1,750	1,050
500	COMPACT	26.8	16.5	120.0	3.5	80.5	6,115	14.7	1,825	1,095
630	COMPACT	31.0	15.5	135.0	3.6	83.0	6,700	18.5	1,975	1,185
800	COMPACT	35.0	15.0	135.0	3.7	86.5	7,375	23.5	2,075	1,245
1000	COMPACT	40.4	15.0	135.0	3.9	92.0	8,405	29.4	2,215	1,330
1200	MILLIKEN	42.5	15.0	135.0	4.0	96.0	9,360	30.0	2,325	1,395
1600	MILLIKEN	49.5	15.5	135.0	4.3	104.5	11,355	30.0	2,525	1,515
2000	MILLIKEN	57.0	15.5	135.0	4.5	112.5	13,120	30.0	2,815	1,690

**Remarks:**

- (1) *Other cross-sectional sizes may be available, at the request of the client*
- (2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*
- (3) *While pulling over rolls or through duct*
- (4) *After installation, with cable former*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
300	397	417	411	592	556
400	455	480	472	697	634
500	520	549	539	814	716
630	594	630	618	959	810
800	671	716	701	1113	903
1000	751	808	788	1285	999
1200	849	906	901	1448	1078
1600	985	1060	1048	1730	1205
2000	1103	1199	1230	2005	1313

**Remarks:**

- (1)– *Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (2)– *Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (3) – *In Free Air, protected against direct sun radiation, ambient air temperature = 40°C*
- (4)– *Touching-trefoil formation*
- (5) – *Flat-parallel formation, inter-axial spacing = 2 x D of cable*
- (6) – *Flat-parallel formation, inter-axial spacing = 2 x D of duct*
- (7) – *Metal screens cross-bonded or single-point bonded*
- (8) – *Metal screens bonded at two points*

## 76/132(145) kV/ ALUMINUM CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
300	0.145	0.129	0.141	0.287	0.053	0.128	0.199	0.287	0.111
400	0.167	0.101	0.133	0.227	0.053	0.100	0.191	0.227	0.111
500	0.183	0.079	0.128	0.182	0.053	0.078	0.186	0.182	0.111
630	0.211	0.062	0.121	0.158	0.053	0.061	0.179	0.158	0.111
800	0.236	0.050	0.116	0.147	0.052	0.049	0.174	0.147	0.110
1000	0.261	0.041	0.111	0.139	0.052	0.040	0.169	0.139	0.110
1200	0.277	0.032	0.110	0.132	0.052	0.032	0.168	0.132	0.110
1600	0.304	0.024	0.106	0.124	0.052	0.024	0.164	0.124	0.110
2000	0.338	0.020	0.102	0.119	0.051	0.019	0.160	0.119	0.109

*Remarks:*

- |   |  |
|---|--|
| 1 | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| 2 | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |



## 76/132(145) kV/ COPPER CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
300	COMPACT	20.9	18.5	70.0	3.4	76.5	6,910	14.7	1,675	1,005
400	COMPACT	23.9	17.0	95.0	3.4	77.5	7,835	19.6	1,750	1,050
500	COMPACT	26.8	16.5	120.0	3.5	80.5	9,145	24.5	1,825	1,095
630	COMPACT	31.0	15.5	135.0	3.6	83.0	10,680	30.0	1,975	1,185
800	COMPACT	35.0	15.0	135.0	3.7	86.5	12,335	30.0	2,075	1,245
1000	COMPACT	40.4	15.0	135.0	3.9	92.0	14,690	30.0	2,215	1,330
1200	MILLIKEN	42.5	15.0	135.0	4.0	95.5	16,975	30.0	2,325	1,395
1600	MILLIKEN	49.5	15.5	135.0	4.3	104.5	21,740	30.0	2,525	1,515
2000	MILLIKEN	57.0	15.5	135.0	4.5	112.5	25,620	30.0	2,815	1,690

#### Remarks:

- (1) *Other cross-sectional sizes may be available, at the request of the client*
- (2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*
- (3) *While pulling over rolls or through duct*
- (4) *After installation, with cable former*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
300	510	537	529	762	689
400	581	613	604	892	771
500	658	699	687	1036	854
630	745	796	783	1212	948
800	831	896	879	1393	1036
1000	912	995	973	1584	1123
1200	1057	1137	1134	1819	1210
1600	1204	1311	1302	2144	1323
2000	1323	1461	1509	2450	1417

#### Remarks:

- (1)– *Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (2)– *Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C*
- (3) – *In Free Air, protected against direct sun radiation, ambient air temperature = 40°C*
- (4)– *Touching-trefoil formation*
- (5) – *Flat-parallel formation, inter-axial spacing = 2 x D of cable*
- (6) – *Flat-parallel formation, inter-axial spacing = 2 x D of duct*
- (7) – *Metal screens cross-bonded or single-point bonded*
- (8) – *Metal screens bonded at two points*

## 76/132(145) kV/ COPPER CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
300	0.145	0.129	0.141	0.287	0.053	0.128	0.199	0.287	0.111
400	0.167	0.101	0.133	0.227	0.053	0.100	0.191	0.227	0.111
500	0.183	0.079	0.128	0.182	0.053	0.078	0.186	0.182	0.111
630	0.211	0.062	0.121	0.158	0.053	0.061	0.179	0.158	0.111
800	0.236	0.050	0.116	0.147	0.052	0.049	0.174	0.147	0.110
1000	0.261	0.041	0.111	0.139	0.052	0.040	0.169	0.139	0.110
1200	0.277	0.032	0.110	0.132	0.052	0.032	0.168	0.132	0.110
1600	0.304	0.024	0.106	0.124	0.052	0.024	0.164	0.124	0.110
2000	0.338	0.020	0.102	0.119	0.051	0.019	0.160	0.119	0.109

*Remarks:*

- |          |  |
|----------|--|
| <i>1</i> | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| <i>2</i> | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |



## 93/161(170) kV/ ALUMINUM CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
400	COMPACT	23.9	23.0	95.0	6.0	95.0	7,550	11.8	2,375	1,425
500	COMPACT	26.8	22.0	120.0	6.0	96.5	8,105	14.7	2,415	1,450
630	COMPACT	31.0	20.5	135.0	6.0	98.0	8,580	18.5	2,450	1,470
800	COMPACT	35.0	19.5	135.0	6.0	100.0	9,160	23.5	2,500	1,500
1000	COMPACT	40.4	18.5	135.0	6.0	103.5	9,950	29.4	2,590	1,555
1200	MILLIKEN	42.5	18.0	135.0	6.0	105.5	10,780	30.0	2,640	1,585
1600	MILLIKEN	49.5	18.5	135.0	6.0	114.0	12,825	30.0	2,850	1,710
2000	MILLIKEN	57.0	17.0	135.0	6.0	118.5	14,130	30.0	2,965	1,780

*Remarks:*

(1) *Other cross-sectional sizes may be available, at the request of the client*

(2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*

(3) *While pulling over rolls or through duct*

(4) *After installation, with cable former*

## 93/161(170) kV/ ALUMINUM CONDUCTOR

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
400	455	479	467	679	626
500	520	549	547	794	709
630	594	630	626	935	805
800	672	716	713	1087	901
1000	751	808	802	1263	1001
1200	848	905	896	1422	1078
1600	982	1056	1081	1695	1206
2000	1099	1193	1220	1977	1310

*Remarks:*

- (1)– Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (2)– Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (3) – In Free Air, protected against direct sun radiation, ambient air temperature = 40°C
- (4)– Touching-trefoil formation
- (5) – Flat-parallel formation, inter-axial spacing = 2 x D of cable
- (6) – Flat-parallel formation, inter-axial spacing = 2 x D of duct
- (7) – Metal screens cross-bonded or single-point bonded
- (8) – Metal screens bonded at two points

## 93/161(170) kV/ ALUMINUM CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
400	0.137	0.101	0.143	0.221	0.052	0.100	0.201	0.221	0.111
500	0.151	0.079	0.137	0.178	0.052	0.078	0.195	0.178	0.110
630	0.173	0.062	0.129	0.155	0.052	0.061	0.187	0.155	0.110
800	0.195	0.050	0.122	0.145	0.052	0.049	0.180	0.145	0.110
1000	0.222	0.041	0.115	0.137	0.052	0.039	0.174	0.137	0.110
1200	0.241	0.032	0.114	0.131	0.052	0.032	0.172	0.131	0.110
1600	0.264	0.024	0.110	0.123	0.051	0.024	0.168	0.123	0.109
2000	0.314	0.020	0.104	0.119	0.051	0.019	0.162	0.119	0.109

*Remarks:*

- |          |  |
|----------|--|
| <i>1</i> | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| <i>2</i> | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |



## 93/161(170) kV/ COPPER CONDUCTOR

### Construction and Dimensional Data

Conductor Cross-Sectional Area	Conductor Strand Type	Conductor Diameter (approx.)	Insulation Thickness (Nom.)	Metal Screen Cross-Sectional Area (1)	Outer Protective Sheath Thickness (Nom.)	Overall Diameter (approx.)	Completed Cable Weight (approx.)	Max. pulling tension (2)	Minimum bending radius (pulling) (3)	Minimum bending radius (permanent training) (4)
mm <sup>2</sup>	-	mm	mm	mm <sup>2</sup>	mm	mm	kg/km	kN	mm	mm
400	COMPACT	23.7	23.0	240(*)	6.0	96.0	11,440	19.6	2,400	1,440
500	COMPACT	26.6	22.0	120	6.0	96.5	11,130	24.5	2,415	1,450
630	COMPACT	31.0	20.5	135	6.0	97.5	12,560	30.0	2,440	1,465
800	COMPACT	35.0	19.5	135	6.0	100.0	14,125	30.0	2,500	1,500
1000	COMPACT	40.4	18.5	135	6.0	103.0	16,235	30.0	2,575	1,545
1200	MILLIKEN	42.5	18.0	240(*)	6.0	106.0	19,525	30.0	2,650	1,590
1600	MILLIKEN	49.5	18.5	135	6.0	114.0	23,210	30.0	2,850	1,710
2000	MILLIKEN	57.0	17.0	240(*)	6.0	119.5	27,750	30.0	2,990	1,795

*Remarks:*

(1) *Other cross-sectional sizes may be available, at the request of the client*

(2) *Pulling tension applied to the conductor by means of pulling head or pulling eye. Maximum pulling tension for straight sections, while pulling over rolls or in pulling in straight duct. For bent sections, the sidewall pressure shall be kept below 1000 daN /m*

(3) *While pulling over rolls or through duct*

(4) *After installation, with cable former*

(\*) *Metal screen cross-sectional area conforming to I. E. Corp. requirements*

### Continuous current ratings

Conductor Cross-Sectional Area	Direct Buried, Touching-Trefoil (1), (4), (7)	Direct Buried, Spaced Flat-Parallel (1), (5), (7)	Buried in Ducts, Spaced Flat-Parallel (2), (6), (7)	In Free Air (Cross-bonded Screens) (3), (5), (7)	In Free Air (Two-points bonded Screens) (3), (5), (8)
mm <sup>2</sup>	A	A	A	A	A
400	580	612	597	868	764
500	658	698	695	1008	851
630	747	796	793	1183	949
800	833	896	893	1361	1040
1000	915	995	991	1554	1128
1200	1057	1136	1127	1787	1216
1600	1205	1311	1349	2108	1333
2000	1322	1461	1504	2427	1421

*Remarks:*

- (1)– Direct Buried, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (2)– Buried in single way ducts, burial depth = 1.5 m, native soil thermal resistivity = 1.2 K\*m/w, soil ambient temperature = 30°C
- (3) – In Free Air, protected against direct sun radiation, ambient air temperature = 40°C
- (4)– Touching-trefoil formation
- (5) – Flat-parallel formation, inter-axial spacing = 2 x D of cable
- (6) – Flat-parallel formation, inter-axial spacing = 2 x D of duct
- (7) – Metal screens cross-bonded or single-point bonded
- (8) – Metal screens bonded at a single point

## 93/161(170) kV/ COPPER CONDUCTOR (...continued)

### Electrical parameters (Capacitance and Sequence Impedances)

Conductor Cross-Sectional Area	Electrostatic Capacitance (Nom.)	Touching Trefoil Formation <i>(1)</i>				Flat-Parallel Formation <i>(1), (2)</i>			
		R1	X1	R0	X0	R1	X1	R0	X0
mm <sup>2</sup>	μF/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km	Ω/km
400(/240)	0.136	0.062	0.147	0.145	0.094	0.061	0.205	0.143	0.094
500	0.150	0.049	0.137	0.155	0.052	0.048	0.195	0.155	0.110
630	0.173	0.039	0.129	0.138	0.052	0.038	0.187	0.138	0.110
800	0.195	0.032	0.122	0.131	0.052	0.031	0.180	0.131	0.110
1000	0.222	0.027	0.116	0.126	0.052	0.026	0.174	0.126	0.110
1200(/240)	0.241	0.022	0.116	0.105	0.065	0.020	0.172	0.122	0.110
1600	0.264	0.016	0.110	0.116	0.051	0.015	0.168	0.116	0.109
2000(/240)	0.314	0.013	0.104	0.113	0.051	0.015	0.164	0.098	0.056

*Remarks:*

- |   |  |
|---|--|
| 1 | <i>Calculated for conductor continuous temperature = 90°C, system frequency = 50Hz, cross-bonded metal screens, equal minor sections</i> |
| 2 | <i>Flat-parallel formation, inter-axial spacing = 2 x D (overall diameter) of the cable</i>  |

## SHORT-CIRCUIT LIMITS

During the short-circuit working, the current-carrying components of the cable may reach a higher temperature which could endanger the polymeric materials used for insulation.

In order to prevent this, the fault-current and/or fault-duration shall be limited to the values specified in the following tables:

### SHORT-CIRCUIT CURRENT IN CONDUCTOR

Conductor Cross-Sectional Area	COPPER CONDUCTORS				ALUMINUM CONDUCTORS			
	Fault duration (s)				Fault duration (s)			
	0.5	1	1.5	2	0.5	1	1.5	2
	Fault-Current (max.)				Fault-Current (max.)			
mm <sup>2</sup>	kA	kA	kA	kA	kA	kA	kA	kA
185	37.4	26.4	21.6	18.7	24.7	17.5	14.3	12.4
240	49	34.3	28.0	24.3	32.1	22.7	18.5	16.1
300	61	43	35.0	30.3	40	28.4	23.2	20.1
400	81	57	47	40	54	37.8	30.9	26.8
500	101	71	58	51	67	47	38.6	33.4
630	127	90	74	64	84	60	49	42
800	162	114	93	81	107	76	62	54
1000	202	143	117	101	134	95	77	67
1200	243	171	140	121	161	113	93	80
1600	323	229	187	162	214	151	124	107
2000	404	286	233	202	268	189	154	134

*Remark:*

- *Maximum fault-current calculated considering adiabatic heating of the conductor from 90°C up to 250°C.*

### SHORT-CIRCUIT CURRENT IN METAL SCREEN

Metal Screen Cross- Sectional Area	Fault duration (s)			
	0.5	1	1.5	2
	Fault-Current			
mm <sup>2</sup>	kA	kA	kA	kA
35	7.5	5	4	3.5
50	10.5	7.5	6	5
70	14.5	10.5	8.5	7.5
95	20	14	11.5	10.0
120	25	18	14.5	12.5
135	28	20	16.5	14
150	31.5	22.5	18	15.5
185	39	27.5	22.5	19.5
240	50.5	35.5	29	25
300	63	44.5	36.5	31.5

*Remark:*

- *Maximum fault-current calculated considering adiabatic heating of the metal screen from 80°C up to 250°C.*