Medium Voltage Cable

Cable Selection

It is essential that any design of a cable system selected for a particular project or a distribution system is suitable for its intended use. Choice needs to be based on a range of factors including installation specifications, local regulations and the required performance characteristics, some of which are shown below:

- Normal current load
- Maximum fault current and its duration under fault conditions
- Voltage grade
- Subsoil conditions for underground installations e.g., presence of water, soil temperature and thermal resistivity, possible attack of rodents, termites etc.
- Cable fire performance requirements
- Compatibility with an existing distribution system

In the tables in the next section, cable constructions and performance features correspond to AS/NZS 1429.1 Standard and Ducab's in-house quality norms.

Cable design and construction

Conductors

The Conductors of MV cables are stranded circular compacted class 2 as per AS/NZS 1125. Ducab offers both aluminium & copper conductor cables.

Conductor Screen

This is a layer of crosslinkable semi-conducting compound extruded directly over the conductor during the XLPE insulation extrusion.

Insulation

All Ducab's MV and HV cables feature DFI™ XLPE insulation which is virtually discharge free, ensuring a long and trouble-free service life.

The insulation is extruded and dry cured to meet the requirements of the standards and/or customer specification. A high degree of concentricity is assured through the use of x-ray monitoring device during extrusion. The XLPE insulation is capable of operating continuously at 90°C.

Insulation Screen

This is a layer of cross-linkable semi-conducting compound extruded directly over the insulation at the same time when the conductor screen and XLPE insulation are extruded. This semi-conducting screen is cold strippable but fully bonded screens may be provided, if specified.

Metallic Screen

The metallic screen can be a helically applied copper tape or a number of copper wires applied with a lay or a combination of tape and wires applied over the semi-conducting screen. The metallic screen provides the earth fault current path and it is of a cross section designed as per customer's specification.

In case of three core cables, phase identification tapes (red/white/blue) are generally longitudinally applied under the metallic screen.

Laying up

In the case of three core cables, the three cores identified as red, white and blue are laid up together with polypropylene string fillers at the interstices between the three cores. A binder e.g., polyester tape is wrapped round the assembly to form a compact circular cable during this process.

Lead Sheath

When required, lead alloy E as per AS/NZS 2893 is provided. The lead sheath perform the mechanical function of acting as a barrier to entry of hydrocarbons. In addition, it can also be engaged to perform the electrical function of sharing the earth fault current with the armour.

Bedding Sheath

As per client's requirement, Black polyvinyl chloride (PVC) or Polyethylene (PE) Compound is extruded over the laid up 3 core cable or on the screened single core cables.

Armouring

This process is not applicable if an unarmoured cable is specified. If armour is required, then following variations are possible:

- Single Core Cables: Aluminium armour wires applied all round the cable with a lay.
- Three Core Cables: Galvanised Steel Wires applied all round the cable with a lay.

Oversheath

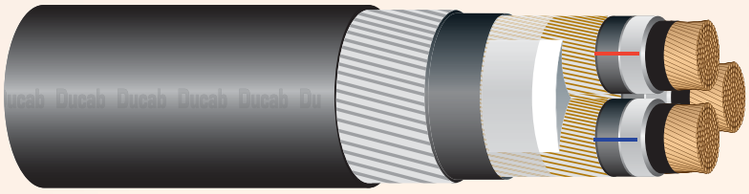
This is an extruded layer of black PVC (5V-90) or PE (LLDPE or MDPE or HDPE) as required by customer specification. The oversheath has an embossed legend in two or more lines appropriate for the cable.

Special Features

The cable as a whole or its specific cores or other design elements can vary in a number of ways to meet specific customer needs. The following are some examples, and by no means an exhaustive list of special features possible:

- Longitudinal and radial water blocking of conductors, cores or complete cable.
- Extra water-tree retardant XLPE insulation
- PVC oversheath with:
  a) reduced flame propagation (RP) and low HCL (LHCL) emission properties
  b) anti-termite properties
- Ducab Smokemaster Low Smoke and Fume construction using zero-halogen bedding and oversheath
- Oversheath of red colour with sulphide-resistant and/or UV resistant properties
- Graphite coated oversheath
- Embossed legend as per customer specification
- Metre length marking

Three Core, armoured 3.8/6.6 kV to AS/NZS 1429.1



Three cores circular copper conductor, 3.8/6.6 kV, XLPE insulated, Cu wires screened, PVC bedded, steel wire armoured and PVC sheathed as per AS/NZS 1429.1

* **Conductor :** Stranded compacted copper as per AS/NZS 1125
* **Insulation:** XLPE as per AS/NZS 3808
* Cu wire screen for Heavy Duty application (10.1 kA /1 second)
* **Bedding:** PVC
* **Armour:** Galvanised steel wires
* **Outer sheath:** PVC (5V-90) as per AS/NZS 3808
* **Operating Temperature:** 90°C

Nominal Area of Conductor	mm^2	70	95	120	150	185	240	300	400
Conductor Diameter (Max)	mm	10	11.5	13	14.5	16.2	18.4	20.7	23.1
Weight of Conductor (Approx)	Kg/Km	1797	2490	3133	3847	4833	6350	7969	10176
Insulation Thickness (Nominal)	mm	2.5	2.5	2.5	2.5	2.5	2.6	2.8	3
Screen area	mm^2	26	26	26	26	26	26	26	26
Seperation Sheath Thickness	mm	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2
Armour Wire Diameter	mm	2.5	2.5	2.5	2.5	2.5	3.15	3.15	3.15
Outersheath Thickness (Nominal)	mm	2.7	2.8	2.9	3	3.2	3.4	3.6	3.9
Approximate Overall Diameter	mm	58	61.7	65.1	68.8	73	80.1	87.5	94.4
Approximate Cable Weight	Kg/Km	6640	7720	8725	9840	11295	14240	16830	20045
Maximum DC resistance of Conductor at 20°C	ohm/Km	0.268	0.193	0.153	0.124	0.0991	0.0754	0.0601	0.047
Approximate AC resistance of Conductor at 90°C	ohm/Km	0.342	0.247	0.196	0.159	0.128	0.099	0.08	0.064
Approxiamte Reactance at 50 Hertz	ohm/Km	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.08
Approxiamte Impedance at 50 Hertz	ohm/Km	0.36	0.26	0.22	0.18	0.15	0.13	0.12	0.10
Approxiamte Capacitance of Cable	µf/Km	0.43	0.49	0.53	0.58	0.63	0.69	0.71	0.74
Sustained Current Ratings:									
1. Laid Direct, Ground Temp. 30°C & g=1.2°C m/W depth of laying = 0.8m, laid in trefoil touching	A	227	267	303	338	383	436	481	534
2. Laid in Air trefoil touching, Ambient Temp. 35°C	A	248	304	345	396	451	524	598	681
One second Short Circuit Current Rating of Conductor	kA	10.01	13.6	17.2	21.5	26.5	34.3	42.9	57.2

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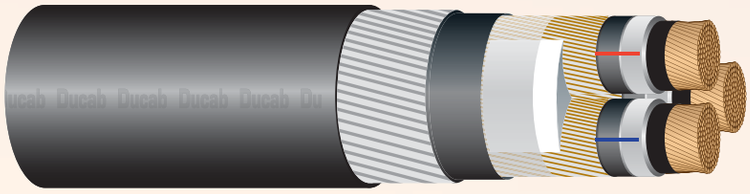
Three Core, armoured 6.35/11 kV to AS/NZS 1429.1

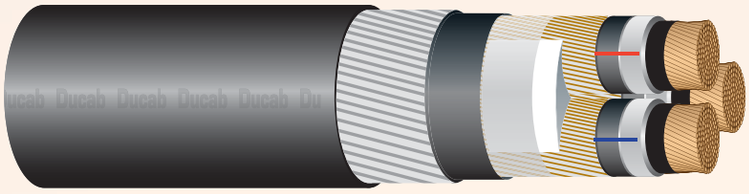


Three cores circular copper conductor, 6.35/11 kV, XLPE insulated, Cu wires screened, PVC bedded, steel wire armoured and PVC sheathed as per AS/NZS 1429.1

* **Conductor :** Stranded compacted copper as per AS/NZS 1125
* **Insulation:** XLPE as per AS/NZS 3808
* Cu wire screen for Heavy Duty application (10.1 kA /1 second)
* **Bedding:** PVC
* **Armour:** Galvanised steel wires
* **Outer sheath:** PVC (5V-90) as per AS/NZS 3808
* **Operating Temperature:** 90˚C

Nominal Area of Conductor	mm^2	70	95	120	150	185	240	300	400
Conductor Diameter (Max)	mm	10	11.5	13	14.5	16.2	18.4	20.7	23.1
Weight of Conductor (Approx)	Kg/Km	1797	2490	3133	3847	4833	6350	7969	10176
Insulation Thickness (Nominal)	mm	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Screen area	mm^2	26	26	26	26	26	26	26	26
Seperation Sheath Thickness	mm	1.5	1.6	1.6	1.7	1.7	1.8	1.9	2.1
Armour Wire Diameter	mm	2.5	2.5	2.5	2.5	3.15	3.15	3.15	3.15
Outersheath Thickness (Nominal)	mm	2.8	3	3.1	3.2	3.3	3.5	3.7	3.9
Approximate Overall Diameter	mm	62.3	66.2	69.6	73.3	78.4	83.8	90.3	96.3
Approximate Cable Weight	Kg/Km	7185	8315	9300	10440	12625	14820	17355	20415
Maximum DC resistance of Conductor at 20˚C	ohm/Km	0.268	0.193	0.153	0.124	0.0991	0.0754	0.0601	0.047
Approximate AC resistance of Conductor at 90˚C	ohm/Km	0.342	0.247	0.196	0.159	0.128	0.099	0.08	0.064
Approxiamte Reactance at 50 Hertz	ohm/Km	0.11	0.10	0.10	0.09	0.09	0.09	0.09	0.08
Approxiamte Impedance at 50 Hertz	ohm/Km	0.36	0.27	0.22	0.18	0.16	0.13	0.12	0.10
Approxiamte Capacitance of Cable	µf/Km	0.29	0.35	0.38	0.41	0.47	0.51	0.54	0.58
Sustained Current Ratings:									
1. Laid Direct, Ground Temp. 30˚C & g=1.2˚C m/W depth of laying = 0.8m, laid in trefoil touching	A	227	267	303	338	383	436	481	534
2. Laid in Air trefoil touching, Ambient Temp. 35˚C	A	248	304	345	396	451	524	598	681
One second Short Circuit Current Rating of Conductor	kA	10.01	13.6	17.2	21.5	26.5	34.3	42.9	57.2

Three Core, armoured 12.7/22 kV to AS/NZS 1429.1



Three cores circular copper conductor, 12.7/22 kV, XLPE insulated, Cu wires screened, PVC bedded, steel wire armoured and PVC sheathed as per AS/NZS 1429.1

* **Conductor :** Stranded compacted copper as per AS/NZS 1125
* **Insulation:** XLPE as per AS/NZS 3808
* Cu wire screen for Heavy Duty application (10.1 kA /1 second)
* **Bedding:** PVC
* **Armour:** Galvanised steel wires
* **Outer sheath:** PVC (5V-90) as per AS/NZS 3808
* **Operating Temperature:** 90°C

Nominal Area of Conductor	mm^2	70	95	120	150	185	240	300	400
Conductor Diameter (Max)	mm	10	11.5	13	14.5	16.2	18.4	20.7	23.1
Weight of Conductor (Approx)	Kg/Km	1797	2490	3133	3847	4833	6350	7969	10176
Insulation Thickness (Nominal)	mm	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Screen area	mm^2	26	26	26	26	26	26	26	26
Seperation Sheath Thickness	mm	1.7	1.7	1.8	1.9	1.9	2	2.1	2.2
Armour Wire Diameter	mm	2.5	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Outersheath Thickness (Nominal)	mm	3.2	3.3	3.4	3.6	3.7	3.8	4	4.2
Approximate Overall Diameter	mm	72.6	77.3	81	84.7	88.6	93.7	100.4	106.2
Approximate Cable Weight	Kg/Km	8525	10390	11540	12800	14305	16595	19160	22265
Maximum DC resistance of Conductor at 20°C	ohm/Km	0.268	0.193	0.153	0.124	0.0991	0.0754	0.0601	0.047
Approximate AC resistance of Conductor at 90°C	ohm/Km	0.342	0.247	0.196	0.159	0.128	0.099	0.08	0.064
Approxiamte Reactance at 50 Hertz	ohm/Km	0.12	0.11	0.11	0.10	0.10	0.10	0.09	0.09
Approxiamte Impedance at 50 Hertz	ohm/Km	0.36	0.27	0.22	0.19	0.16	0.14	0.12	0.11
Approxiamte Capacitance of Cable	µf/Km	0.21	0.23	0.25	0.27	0.29	0.32	0.35	0.39
Sustained Current Ratings:									
1. Laid Direct, Ground Temp. 30°C & g=1.2°C m/W depth of laying = 0.8m, laid in trefoil touching	A	227	263	298	334	374	427	472	525
2. Laid in Air trefoil touching, Ambient Temp. 35°C	A	253	304	350	396	451	524	598	681
One second Short Circuit Current Rating of Conductor	kA	10.01	13.6	17.2	21.5	26.5	34.3	42.9	57.2

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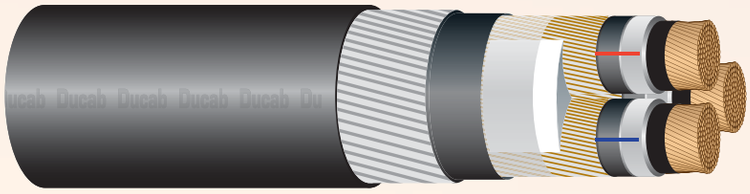
Three Core, armoured 19/33 kV to AS/NZS 1429.1



Three cores circular copper conductor, 19/33 kV, XLPE insulated, Cu wires screened, PVC bedded, steel wire armoured and PVC sheathed as per AS/NZS 1429.1

* **Conductor :** Stranded compacted copper as per AS/NZS 1125
* **Insulation:** XLPE as per AS/NZS 3808
* Cu wire screen for Heavy Duty application (10.1 kA /1 second)
* **Bedding:** PVC
* **Armour:** Galvanised steel wires
* **Outer sheath:** PVC (5V-90) as per AS/NZS 3808
* **Operating Temperature:** 90°C

Nominal Area of Conductor	mm^2	70	95	120	150	185	240	300	400
Conductor Diameter (Max)	mm	10	11.5	13	14.5	16.2	18.4	20.7	23.1
Weight of Conductor (Approx)	Kg/Km	1797	2490	3133	3847	4833	6350	7969	10176
Insulation Thickness (Nominal)	mm	8	8	8	8	8	8	8	8
Screen area	mm^2	26	26	26	26	26	26	26	26
Seperation Sheath Thickness	mm	1.9	2	2	2.1	2.1	2.2	2.3	2.5
Armour Wire Diameter	mm	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Outersheath Thickness (Nominal)	mm	3.6	3.7	3.8	4	4.1	4.2	4.4	4.6
Approximate Overall Diameter	mm	85.8	89.4	92.9	96.7	100.6	105.7	112.4	118.3
Approximate Cable Weight	Kg/Km	11165	12410	13580	14910	16480	18790	21535	24790
Maximum DC resistance of Conductor at 20°C	ohm/Km	0.268	0.193	0.153	0.124	0.0991	0.0754	0.0601	0.047
Approximate AC resistance of Conductor at 90°C	ohm/Km	0.343	0.247	0.196	0.159	0.128	0.099	0.08	0.064
Approxiamte Reactance at 50 Hertz	ohm/Km	0.13	0.12	0.12	0.11	0.11	0.11	0.10	0.10
Approxiamte Impedance at 50 Hertz	ohm/Km	0.37	0.28	0.23	0.2	0.17	0.14	0.13	0.12
Approxiamte Capacitance of Cable	µf/Km	0.16	0.18	0.19	0.2	0.22	0.24	0.26	0.29
Sustained Current Ratings:									
1. Laid Direct, Ground Temp. 30°C & g=1.2°C m/W depth of laying = 0.8m, laid in trefoil touching	A	227	267	303	338	383	436	481	534
2. Laid in Air trefoil touching, Ambient Temp. 35°C	A	248	304	345	396	451	524	598	681
One second Short Circuit Current Rating of Conductor	kA	10.01	13.6	17.2	21.5	26.5	34.3	42.9	57.2

Technical Data

Current Ratings and Rating Factors for MV cables

The current ratings of copper conductor cables stated in the tables in this catalogue are based on the IEC 60287 Publication, assuming continuous conductor operating temperature of 90°C, for cables laid underground or in air.

These ratings are applicable for conditions defined in the tables and derating factors need to be applied in case of variations in:

- Ambient temperature
- Ground temperature
- Depth of buried cable
- Thermal resistivity of soil
- Multiple circuits and their configuration

Appropriate tables for derating factors are provided in the latter part of this catalogue.

Short Circuit Ratings

The short circuit rating graph given in this catalogue assume final conductor temperature of 250°C rising from 90°C i.e., in a fully loaded condition. It is therefore necessary that accessories used with the cables are also capable of operation at these values of fault current and temperature.

The tables also indicate the specific short circuit fault current rating for a duration of one second for each cable size and type. When the fault duration (t) is different, then the appropriate rating may be obtained by multiplying the 1 second rating by the factor $1/\sqrt{t}$.

Short circuit forces should be taken into account when single core cables are installed touching each other. Cleating and strapping should be such that repulsive forces that occur under short circuit conditions are contained.

Installation

Cables described in this publication are suitable for laying direct in ground, in air or drawn through ducts. Special construction features are needed when sustained wet conditions prevail in the ground.

Cable pulling forces have to be limited according to the total conductor cross section area (A) in mm^2 and the maximum may be limited to A x 50 Newtons for copper and A x 30 Newtons for aluminium.

Cable bending radii shall be as per table D1 of AS/NZS 1429.1.

As intended in all international specifications; whenever possible larger installation radii should be used. Minimum values hold for areas of constraints such as close to joints or terminations etc.

Voltage Tests After Installation

The test after installation shall be as per appendix F of AS/NZS 1429.1

Rating Factors

Cables laid direct in ground

Variation in Ground Temperature

Ground temperature° C	15	20	25	30	35	40	45
	Rating factor						
Cable Type All Cables	1.11	1.08	1.04	1.00	0.96	0.91	0.87

RATING FACTORS FOR DEPTH OF LAYING

(TO CENTRE OF CABLE OR TREFOIL GROUP OF CABLES)

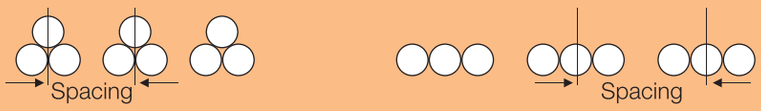
3.8/6.6 kV to 19/33 kV cables		
Depth of laying m	Above 300mm²	Up to 300mm²
0.80	1.00	1.00
1.00	0.98	0.97
1.25	0.96	0.95
1.50	0.95	0.94
1.75	0.94	0.92
2.00	0.92	0.90
2.50	0.91	0.89
3.00	0.90	0.88
or more		

RATING FACTORS FOR VARIATION IN THERMAL RESISTIVITY OF SOIL (AVERAGE VALUES)

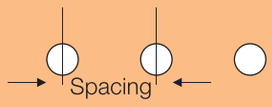
Size of cables mm^2	Soil thermal resistivity in K.m./W						
	0.8	0.9	1.0	1.5	2.0	2.5	3.0
Single core							
50	1.15	1.11	1.07	0.91	0.81	0.73	0.68
70	1.16	1.12	1.07	0.91	0.81	0.73	0.68
95	1.16	1.12	1.07	0.91	0.81	0.73	0.68
120	1.16	1.12	1.07	0.91	0.81	0.73	0.68
150	1.17	1.12	1.07	0.91	0.81	0.73	0.68
185	1.17	1.12	1.07	0.91	0.81	0.73	0.68
240	1.17	1.12	1.07	0.91	0.80	0.73	0.68
300	1.18	1.12	1.07	0.91	0.80	0.73	0.68
400	1.18	1.12	1.07	0.91	0.80	0.73	0.67
500	1.18	1.12	1.07	0.91	0.80	0.73	0.67
630	1.18	1.12	1.07	0.91	0.80	0.73	0.67
800	1.18	1.12	1.07	0.91	0.80	0.72	0.66
1000	1.18	1.12	1.07	0.91	0.80	0.72	0.66
Multi core							
50	1.13	1.09	1.06	0.92	0.83	0.76	0.71
70	1.14	1.09	1.06	0.92	0.83	0.75	0.70
95	1.14	1.09	1.06	0.92	0.83	0.75	0.70
120	1.14	1.10	1.06	0.92	0.82	0.75	0.69
150	1.14	1.10	1.06	0.92	0.82	0.75	0.69
185	1.14	1.10	1.06	0.92	0.82	0.74	0.69
240	1.15	1.10	1.07	0.92	0.81	0.74	0.69
300	1.15	1.10	1.07	0.92	0.81	0.74	0.69
400	1.15	1.10	1.07	0.92	0.81	0.74	0.69

Group Rating Factors

GROUP RATING FACTORS FOR CIRCUITS OF THREE SINGLE CORE CABLES IN TREFOIL AND LAID FLAT TOUCHING, HORIZONTAL FORMATION (AVERAGE VALUES)

						
	Number of Circuits	Spacing of Circuits				
		Touching +				
		Trefoil	Laid flat	0.15 m	0.30 m	0.45 m	0.60 m
3.8/6.6 to 12.7/22 kV cables	2	0.78	0.81	0.81	0.85	0.88	0.90
	3	0.66	0.68	0.71	0.76	0.80	0.83
	4	0.59	0.62	0.65	0.72	0.76	0.80
	5	0.55	0.58	0.61	0.68	0.73	0.77
	6	0.52	0.55	0.58	0.66	0.72	0.76
19/33kV cables	2	0.79	0.81	0.81	0.85	0.88	0.90
	3	0.67	0.70	0.71	0.76	0.80	0.83
	4	0.62	0.65	0.65	0.72	0.76	0.80
	5	0.57	0.60	0.60	0.68	0.73	0.77
	6	0.54	0.57	0.57	0.66	0.72	0.76

GROUP RATING FACTORS FOR MULTICORE CABLES IN HORIZONTAL FORMATION

					
	Number of Cables in Group	Spacing				
		Touching	0.15 m	0.30 m	0.45 m	0.60 m
3.8/6.6 to 12.7/22kV cables	2	0.80	0.85	0.89	0.90	0.92
	3	0.68	0.75	0.80	0.84	0.86
	4	0.62	0.70	0.77	0.80	0.84
	5	0.57	0.66	0.73	0.78	0.81
	6	0.55	0.63	0.71	0.76	0.80
19/33kV cables	2	0.80	0.83	0.87	0.89	0.91
	3	0.70	0.73	0.78	0.82	0.85
	4	0.64	0.68	0.74	0.78	0.82
	5	0.59	0.63	0.70	0.75	0.79
	6	0.56	0.60	0.68	0.74	0.78

Cables installed in free air:

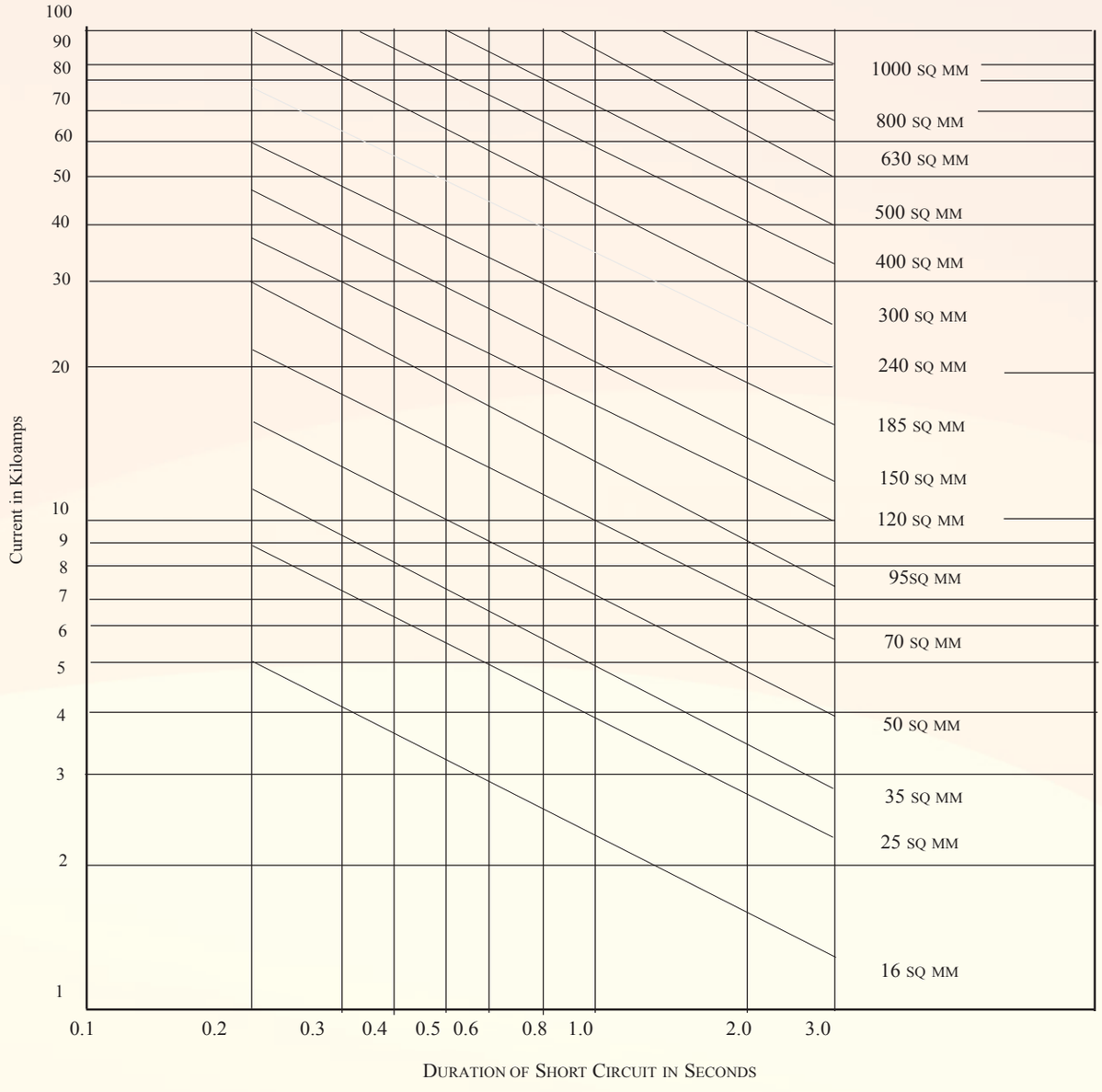
All the ratings for cables run in air are based upon the assumption that they are shielded from direct sunlight and without restriction of ventilation.

Ambient temperature° C	25	30	35	40	45	50	55
Cable Type	Rating factor						
All Types	1.09	1.04	1.00	0.95	0.90	0.85	0.80

Effect of grouping cables: No reduction in rating is necessary where there is free circulation of air around the circuits provided that:

1. The horizontal clearance between circuits is not less than twice the overall diameter of an individual cable.
2. The vertical clearance between circuits is not less than four times the diameter of an individual cable.
3. If the number of circuits exceeds three, they are installed in a horizontal plane.

Short Circuit Rating Copper Conductor



Basis

1. Cable fully loaded at start of short circuit. (Conductor temperature: 90˚C)
2. Conductor temperature at end of short circuit: 250˚C

Note:

It should be ensured that the accessories associated with the cable are also capable of operation at these values of fault current and temperature.