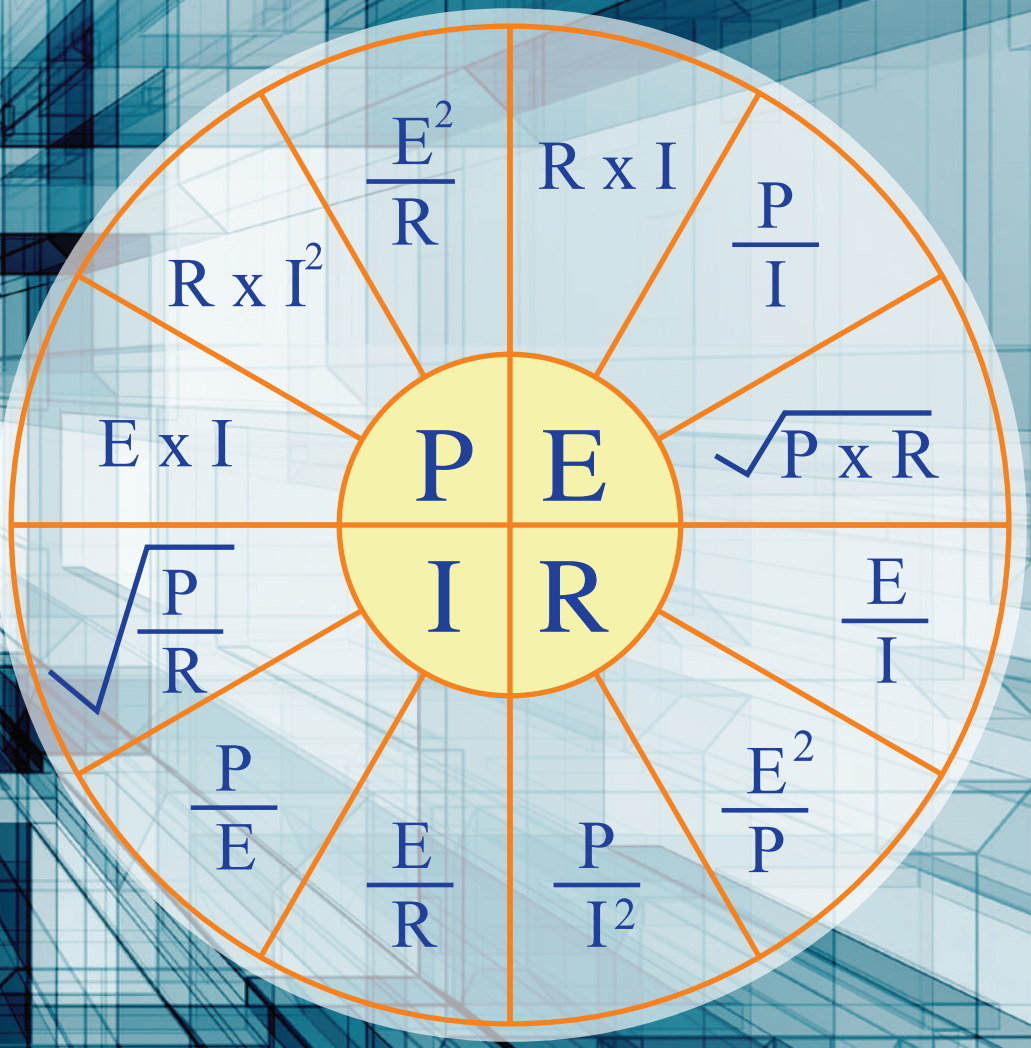
ÜNTEL

Quality Through Experience

INDUSTRIAL CABLES

TECHNICAL DATA



TECHNICAL DATA

MAJOR INTERNATIONAL INSTITUTES & ORGANIZATIONS

Abbreviation	Name of the Organisation	Main Region of Appliance
AENOR	Asociacion Espanola de Normalizacion y Certificacion	Spain
AFNOR - CEF	Association Française de Normalisation	France
ANSI	American National Standards Institute	USA
AS	Australian Standard Australia	Australia
ASTM	American Standard of Testing Materials	USA
BASEC	British Approvals Service for Cables	United Kingdom
BSI	British Standard Institution	United Kingdom
BV	Bureau Veritas	France
CEI	Comitato Elettrotecnico Italiano	Italy
CENELEC	Comité Européen de Normalisation Electrotechniques	Europe
CNOMO	Comité de NOrmalisationdes MOyens de Production	France
CSA	Canadian Standards Association	Canada
CSB TS (GB)	China State Bureau of Technical Supervision	China
DIN	Deutsches Institut für Normung	Germany
DKE	German Commission for Electrical, Electronic and Information Technologies of DIN and VDE	Germany
EAC	Eurassian Customs Union	Russi, Belarus, Kazakhstan, Armenia, Kyrgyzstan
EN	European Standards - Norms	Europe
GOST-R	Russian Standards	Russia
HD	Harmonization Documents	International
IEC	International Electrotechnical Commission	International
IEEE	Institute of Electrical and Electronics Engineers	USA
IMQ	Instituto Italiano de Marchio Qualita	Italy
ISO	International Organization for Standardization	International
JIS/JSA JIS/JSA	Japanese Standards (English Language)	Japan
KEMA	Keuring van Elektrotechnische Materalien	Netherlands
MIL	Military Specification	USA
NEC	National Electrical Code	USA
NEK	Norsk Elektroteknisk Komite	Norway
NEMA	National Electrical Manufacturers Association	USA
NEN	Nederlands Normalisatie-Instituut	Netherlands
NF	Normes Françaises	France
NZS	Standards of New Zealand	New Zealand
ÖVE	Österreichischer Verband für Elektrotechnik	Austria
SAE	Society of Automotive Engineers	USA
TSE	Turkish Standards Institution	Turkey
TUV	Technischer Überwachungs Verein	Germany
UL	Underwriters Laboratories Inc.	USA
UNE	Asociación Española de Normalización	Spain
UNI	Unificazione Nationale Italiana	Italy
VDE	Verein Deutscher Elektrotechniker e.V.	Germany
ZVEI	ZentralVerband der Elektrotechnik- und Elektronik- Industrie e.V.	Germany

CABLE DESIGNATION CODES

Harmonised Cables
(HD 361 S4 - DIN VDE 0281/0282/0292)

							-			X	
1	2	3	4	5	6	7		8	9	10	11

1) Relationship of cable to standards

H	Cable conforming with harmonized standards
–	Non-harmonized cable

2) Rated Voltage

01	100/100 V
03	300/300 V
05	300/500 V
07	450/750 V
1	1000/1000 V (*)

(*) At present, the rated voltage is limited to PV-cables acc. to EN 50618.

3) Insulating and non-metallic sheathing materials

B	Ethylene- propylene rubber for conductor temperature 90 °C
G	Ethylene-vinyl-acetate
J	Glass-fibre braid
M	Mineral
N	Polychloroprene-rubber (or equivalent material)
N2	Special-rubber compound of polychloroprene for sheathing of welding cable
N4	Chlorosulphonated polyethylene
N8	Special-rubber compound of polychloroprene, water resistant
Q	Polyurethane
Q4	Polyimide
R	Ethylene- propylene or equivalent synthetic rubber for conductor temperature 60 °C
S	Silicone-rubber
T	Textile braid, impregnated or not, on assembled cores
T6	Textile braid, impregnated or not, on individual cores of a multicore cable
V	Ordinary PVC
V2	PVC compound for conductor temperature of 90 °C
V3	Ordinary PVC, for low temperature operating
V4	Ordinary PVC, crosslinked
V5	Ordinary PVC, special oil resistant
Z	Crosslinked polyolefin-compound for cable with low smoke and non-corrosive gases in the case of fire
Z1	Thermoplastic polyolefin-compound for cable with low smoke and non-corrosive gases in the case of fire
Z2	Crosslinked polyolefin-compound for cable with low smoke and non-corrosive gases in the case of fire for photovoltaic cable
Z5	Thermoplastic compound EVM-1 for cable with non-corrosive gases in the case of fire for EV charging cable
Z6	Crosslinked compound EVM-2 for cable with non-corrosive gases in the case of fire for EV charging cable

4) Metallic coverings

C	Concentric copper conductor
C4	Copper braid over assembled cores

5) Special constructional components of a cable

D3	Strain-bearing element consisting of one or more components (textile or metallic), placed at the centre of a round cable or distributed inside a flat cable
D5	Central heart (non-strain-bearing)

6) Special construction of cable

No Symbol	Round cable construction
H	Flat construction of „divisible“ cables and cores, either sheathed or non-sheathed
H2	Flat construction of „non-divisible“ cables and cords
H6	Flat cable having 3 or more cores, according to EN 50214
H7	Cables with extruded double layer insulation
H8	Coiled cable

7) Conductor material

no symbol Copper
–A Aluminium

8) Conductor form

–D Flexible conductor of welding cables (flexibility departing from EN 60228 class 5)
–E Highly flexible conductor of welding cables (flexibility departing from EN 60228 class 6)
–F Flexible conductor of a flexible cable or cord (flexibility according to EN 60228 class 5)
–H Highly flexible conductor of a flexible cable or cord (flexibility according to EN 60228 class 6)
–K Flexible conductor of a cable for fixed installations (unless otherwise specified, flexibility according to EN 60228 class 5)
–R Rigid, round conductor, stranded
–U Rigid, round conductor, solid
–Y Tinsel conductor

9-10-11) Number and size of conductors

X(**) Times, where a green/yellow core is not included
G Times, where a green/yellow core is included
Number (*) Nominal cross-section, size of conductor in mm2
Y For a tinsel conductor where the cross-section is not specified

(*) Countries are free to assign the symbol „N“ (placed after the conductor cross-section) to indicate that the cores are identified by numbers.
(**) Only capital letter shall be used.

Summary of symbols and their sequence in cable designation

1	2	3	4	5	6	7	8	9	10	11
Part 1		Part 2						Part 3		
Related standard	Rated voltage	Insulation material	Metallic coverings	Non-metallic sheath	Constructional components and special constructions	Conductor material	Conductor form	Number of cores	Times	Conductor cross - section mm^2
Symbols according to table(s)										
2	3	4	5	4	4 and 7	8	9	10		
H	01	B	C	B	D3	No symbols: copper	– D	1	X	Y
					D5		– E	2		0,5
	03	G	C4	G			– F	3	G	
							– H	4		0,75
	05	J		J		– A	– K	5		
					No symbol: circular construction of cable		– R	...		1
	07	M					– U			
							– Y			1,5
	1	N, N4		N, N_2, N4, N8						
										2,5
				Q, Q4	H					
					H2					4
		R		R	H6					
					H7					6
		S		S	H8					
										10
				T, T6						
										16
		V, V2, V3, V4		V, V2, V3, V4, V5						25
		Z, Z1, Z2		Z, Z1, Z2, Z5, Z6						...

CABLE DESIGNATION CODES

Cables, wires and flexible cords for power installation (VDE 0250)

							X	
1	2	3	4	5	6	7		8

1) Relationship of cable to standards

N	according to VDE
(N)/X	with reference to VDE

2) Insulating materials

Y	PVC
2Y	Polyethylene
4Y	Polyamide
5Y	PTFE
6Y	FEP
9Y	Polypropylene
11Y	Polyurethane (PUR)
X	Cross-linked thermoplastics
2X	XLPE
G	Elastomer
2G	Silicon
3G	EPR-rubber
4G	EVA
5G	Poly-chloroprene
HX	Halogen free materials

3) Cable descriptions

A	Single-core non-sheathed cables
D	Solid wire
AF	Single-core, fine stranded
F	Flexible wire for fittings
L	Fluorescent tube cable
LH	Connecting cable for light mechanical load
MH	Connecting cable for middle mechanical Load
SH	Connecting cable for heavy mechanical load
SSH	Connecting cable for special mechanical load
SL	Control/welding cable
S	Control cable
LS	Light control cable
FL	Flat cable
Si	Silicon cable
Z	Twin cable
GL	Glass fibre
Li	Stranded wires as per VDE 812
LiF	Stranded fine wires as per VDE 812

4) Special constructions

T	Strength member – supporting element
ö	Oil resistant
u	Flame retardant
w	Heat resistant - weather resistant
FE	Insulation integrity - Fire resistant for a limited time
C	Screen braided
D	Screen spiral Cu wire
S	Steel wire armouring

5) Sheathing materials

Y	PVC
X	Cross-linked thermoplastics
G	Elastomer
5G	Poly-chloroprene
HX	Halogen free materials
11Y/ P	PUR - Polyurethane

6) Protective conductor

-J	with green/yellow core
-O	without green/yellow core

7) Number of cores

…	Number of cores

8) Conductor cross-section

…	Figures in mm^2

CABLE DESIGNATION CODES

Power Cables
(VDE 0271 / 276)

											X	
1	2	3	4	5	6	7	8	9	10	11		12

1) Relationship of cable to standards

N	According to VDE
(N)/X	With reference to VDE

2) Conductor

…	Copper
A	Aluminium

3) Insulating materials

Y	PVC
2Y	Polyethylene
2X	XLPE
H	Halogen free materials
HX	Cross-linked halogen-free polymer blend

4) Concentric conductor

C	Concentric Cu conductor in longitudinal lay
CW	Concentric Cu conductor in wave form- r eversing lay
CE	Concentric Cu conductor for individual core

5) Screen, shielding

S	Common Copper shielding
SE	Copper screening per individual core in multicore cables
SL	Control/welding cable
H	Conductive layer
(F)	Longitudinally watertight screening

6) Metal sheath

A	Protective cover consisting of fibrous materials
K	Lead sheath
KL	Aluminium sheath

7) Inner sheath or bedding

See item 3 – insulating materials

8) Armouring

B	Steel tape
F	Galvanized flat steel wires
R	Galvanized round steel wires
G	Counter helix of galvanized steel tape

9) Outer sheath materials

Y	PVC
2Y	Polyethylene
2X	XLPE
H	Halogen free materials
HX	Cross-linked halogen-free polymer blend

10) Protective conductor

- J	With green-yellow core
– O	Without green-yellow core

11) Number of cores

12) Conductor cross section and type in mm²

Nominal cross-section, size of conductor in mm²

R	Circular conductor
S	Sector conductor
O	Oval conductor
E	Circular Solid conductor
M	Stranded conductor
RE	Circular solid conductor
RM	Circular stranded conductor
SE	Sector shaped solid conductor
SM	Sector shaped stranded conductor
OM	Oval shaped stranded conductor
V	Compacted conductor

CABLE DESIGNATION CODES

Italian System
(CEI 35011:2000-08)

							X	
1	2	3	4	5	6	7		8

1) Type and Flexibility of conductor

-	Copper conductor
A	Aluminium conductor
F	Stranded flexible round conductor
EF	Stranded extra flexible round stranded or special construction
FF	Stranded very flexible round conductor
R	Stranded rigid conductor
S	Sector stranded conductor
SU	Sector single conductor
U	Solid round conductor

2) Insulating materials

E	Polyethylene
E4	Cross-linked polyethylene (XLPE)
G	Synthetic rubber compound at 60°C
G4	Silicone rubber compound at 180°C
G7	High module ethylene propylene rubber (HEPR)
G8	EPR compound at 85°C also for cables without protecting covering
G9	Cross-linked elastomeric compound with low emission of smoke and toxic and corrosive gases at 90°C, also for cables without protecting covering
G10	Cross-linked elastomeric compound with low emission of smoke and toxic and corrosive gases at 90°C
G16	High modulus EPR based compound with low emission of smoke and toxic and corrosive gases and acidity at 90°C for CPR cables
G17	Cross-linked elastomeric compound with low emission of smoke, toxic & corrosive gases and acidity at 90°C, also for cables without protecting covering for CPR
G19	Cross-linked elastomeric compound with low emission of smoke, toxic & corrosive gases at 90°C
G20	Cross-linked elastomeric compound with low emission of smoke and toxic and corrosive gases at 90°C
M	Mineral insulation
M9	Thermoplastic compound with low emission of smoke, toxic and corrosive gases at 70°C
R	TI1 and TI2 type PVC compound at 70°C**,**
R2	R2 type PVC compound at 70°C**,**
R4	Polyamide resin compound
R7	TI3 type PVC compound at 90°C,
T	Mica tape

3) Cable shape

-	Single core cable
O	Assembled cores to form a round shape cable
D	Flat cable
X	Cores twisted in pair, triad or quad

4) Screen and concentric conductors

AC	Concentric aluminium conductor
C	Concentric Copper conductor
H	Metallised paper or aluminium tape
H1	Copper tape, copper flat strip or copper wire shield
H2	Copper braid screen
H3	Double copper braid screen
H4	Longitudinal corrugated steel tape
H5	Longitudinal laminated aluminium tape

5) Armour – Metallic Covering

A	Smooth aluminium sheath or metallic wire braiding
A1	Corrugated aluminium sheath
F	Steel wire armour
H4	Longitudinal corrugated steel tape
H5	Longitudinal laminated aluminium tape
L	Lead alloy sheath
N	Steel tape
P	Lead sheath
Q	Copper sheath
Z	Steel flat wires

6) Outer Sheath

E	Thermoplastic compound, Ez type
E4	Cross-linked polyethylene, E4M type
G	Natural and/or synthetic rubber compound, Gy type
K	Poly-Chloroprene or similar compound, Ky, Kn, Kz type
M1	LSOH Thermoplastic compound
M2	LSOH Elastomeric compound, M2 type
M3	LSOH Elastomeric compound, M3 type
M4	LSOH Elastomeric compound, M4 type
M16	Thermoplastic compound with low development of fumes and acidity (CPR)
M21	Cross-linked compound with low smoke, toxic and corrosive gas emission
R	PVC compound, TM1, TM2, RZ type
R4	Polyamide resin compound
R16	PVC-based thermoplastic compound (CPR)
T	Textile braid (impregnated if necessary)
T2	Special textile braid (impregnated if necessary)

7) Number of cores

8) Conductor cross section and type in mm^2

CORE COLOUR CODES ACCORDING TO HD 308 S2 / DIN VDE 0293-308

The cores of cables and cords shall be identified by the colours given in below tables. Below tables indicate the colours of the cores, according to the number of cores and the order of rotation of those colours in clockwise.

Cables and cords with a protective core

Number of cores	Colours of cores [b]				
	Protective	Live			
3	Green-and-yellow	Blue	Brown		
4	Green-and-yellow	-	Brown	Black	Grey
4[a]	Green-and-yellow	Blue	Brown	Black	
5	Green-and-yellow	Blue	Brown	Black	Grey
6 & Up	Green - Yellow / Black Cores with White Numbers				

[a] For certain applications only.
[b] In this table an uninsulated concentric conductor, such as a metallic sheath, armour or screen wires, Is not regarded as a core. A concentric conductor is identified by its position and, therefore, need not be identified by colour.

Cables and cords without a protective core

Number of cores	Colours of cores [b]				
2	Blue	Brown			
3	-	Brown	Black	Grey	
3[a]	Blue	Brown	Black		
4	Blue	Brown	Black	Grey	
5	Blue	Brown	Black	Grey	Black
6 & Up	Black Cores with White Numbers				

[a] For certain applications only.
[b] In this table an uninsulated concentric conductor, such as a metallic sheath, armour or screen wires, Is not regarded as a core. A concentric conductor is identified by its position and, therefore, need not be identified by colour.

ÜNTEL KABLO CORE COLOUR CODES
(based on GERMAN SYSTEM)

For CONTROL / SIGNAL CABLES

JZ Black cores with white numbers with green-yellow ground core

OZ Black cores with white numbers without green-yellow ground core

JB Coloured cores with green-yellow ground core

OB Coloured cores without green-yellow ground core

For POWER CABLES

J Coloured cores with green-yellow ground core

O Coloured cores without green-yellow ground core

OUTER DIAMETER TOLERANCE OF THE CABLES (*)

Nominal Outer Diameter (mm)	Tolerance (+/- mm)
1 - 10	0.5
10.1 - 20	1.0
20.1 - 30	1.5
30.1 - 40	2.0
40.1 - 50	2.5
50.1 - 60	3.0
60.1 - 70	3.5
70.1 - 80	4.0

(*) Not applicable to MV cables and sector shaped cables. For OD tolerances of these cables, refer to their own catalogue page

AD PRESENCE OF WATER

According to IEC 60364-5-51 / NF C15-100

AD1	Negligible	Probability of presence of water is negligible Location in which the walls do not generally show traces of water but may do so for short periods, for example in the form of vapour which good ventilation dries rapidly IPX0	IEC 60721-3-4, class 4Z6 IEC 60529
AD2	Free-falling drops	Possibility of vertically falling drops Location in which water vapour occasionally condenses as drops or where steam may occasionally be present IPX1 or IPX2	IEC 60721-3-3, class 3Z7 IEC 60529
AD3	Sprays	Possibility of water falling as a spray at an angle up to 60° from the vertical Locations in which sprayed water forms a continuous film on floors and/or walls IPX3	IEC 60721-3-3, class 3Z8 IEC 60721-3-4, class 4Z7 IEC 60529
AD4	Splashes	Possibility of splashes from any direction Locations where equipment may be subjected to splashed water; this applies, for example, to certain external luminaires, construction site equipment IPX4	IEC 60721-3-3, class 3Z9 IEC 60721-3-4, class 4Z7 IEC 60529
AD5	Jets	Possibility of jets of water from any direction Locations where hot water is used regularly (yards, car-washing bays) IPX5	IEC 60721-3-3, class 3Z10 IEC 60721-3-4, class 4Z8 IEC 60529
AD6	Waves	Possibility of water waves Seashore locations such as piers, beaches, quays, etc. IPX6	IEC 60721-3-4, class 4Z9 IEC 60529
AD7	Immersion	Possibility of intermittent partial or total covering by water Locations which may be flooded and/or where the equipment is immersed as follows: • Equipment with a height of less than 850 mm is located in such a way that its lowest point is not more than 1 000 mm below the surface of the water • Equipment with a height equal to or greater than 850 mm is located in such a way that its highest point is not more than 150 mm below the surface of the water IPX7	 IEC 60529
AD8	Submersion	Possibility of permanent and total covering by water Locations such as swimming pools where electrical equipment is permanently and totally covered with water under a pressure greater than 10 kPa. IPX8	 IEC 60529

WATER RESISTANCE TEST FOR AD8 CATEGORY

According to EN 50525-2-21 Annex E

Water resistance test for H07RN8-F flexible cables – Mechanical properties of sheath after water immersion

General

This test shall be carried out on samples taken from:
a) the sheath when applied as a single layer; or
b) the inner and outer layers of sheath when applied in two layers.

Procedure

Four sets of three dumb bell samples shall be taken from each layer of the sheath of the cable as manufactured as described in EN 60811-1-1, 9.2.3, and conditioned for seven days at a temperature of (20 ± 5) °C and a relative humidity of (50 ± 5) %. At the end of the conditioning period the sets shall be used as follows:

a) One set shall be weighed to 0,1 mg. The samples shall then be immersed in potable tap water at (50 ± 2) °C for 100 days.
After removal from the potable tap water, surface water shall be removed by wiping lightly with a filter paper and the samples conditioned for 16 h at a temperature of (20 ± 5) °C and a relative humidity of (50 ± 5) %.
The samples shall then be re-weighed and the weights determined to 0,1 mg as soon as possible after removal from the conditioning chamber.

b) Three sets shall be used for determination of tensile strength and elongation at break as follows:

1) Without immersion;

2) After immersion in potable tap water at (50 ± 2) °C for 28 days;

3) After immersion in potable tap water at (50 ± 2) °C for 100 days.

Requirements

a) Increase in mass
The increase of mass after immersion for 100 days shall not be greater than 40 % of the mass before immersion.

b) Tensile strength and elongation at break
The tensile strength and elongation at break, as described in EN 60811-1-1, 9.2.7, after immersion for 100 days shall be greater than or equal to the values given in below table.

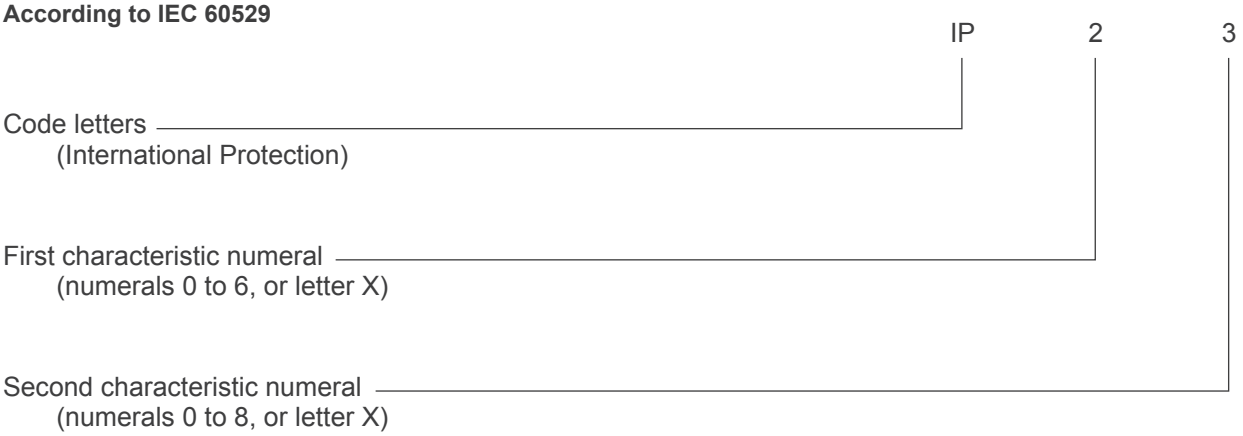
Parameter	Units	Inner layer	Single layer / outer layer
Tensile strength	N/mm^2	5	7
Elongation at break	%	175	200

Variation between 28 days immersion and 100 days immersion:

$$-0,15 \leq \frac{TS_{28} - TS_{100}}{TS_{28}} \leq +0,15 \qquad -0,2 \leq \frac{EB_{28} - EB_{100}}{EB_{28}} \leq +0,2$$

ARRANGEMENT OF THE IP CODES

According to IEC 60529



Element	Numerals or letters	Meaning for the protection of equipment	Meaning for the protection of persons
Code letters	IP	-	-
First characteristic numeral	0 1 2 3 4 5 6	Against ingress of solid foreign objects (non-protected) ≥ 50 mm diameter ≥ 12,5 mm diameter ≥ 2,5 mm diameter ≥ 1,0 mm diameter dust-protected dust-tight	Against access to hazardous parts with (non-protected) back of hand finger tool wire wire wire
Second characteristic numeral	0 1 2 3 4 5 6 7 8	Against ingress of water with harmful effects (non-protected) vertically dripping dripping (15° tilted) spraying splashing jetting powerful jetting temporary immersion continuous immersion	-

MAXIMUM PULLING TENSION OF CABLES

The tension applied to a cable shall not exceed the following values of tensile stress per conductor, subject to a total maximum tensile force of 1.000 N unless otherwise agreed by the cable manufacturer.

For non-flexible cables during installation:

The maximum pulling force (P) in the main conductors shall be calculated as follows:

P = 50 x S (Copper conductors)

P = 30 x S (Aluminium conductors)

Where

P is in Newton

S is total cross-sectional area in mm² of the main conductors (ignoring screens, concentric conductors and auxiliary conductors).

Pulling grip around the cable over sheath

$P = 5 \times D^2$

where

P is in Newton

D is the outer diameter of the cable in mm.

For flexible cables under static tensile stress and for non-flexible cables in service in fixed circuits:

The maximum pulling force P in the main conductors shall be calculated as follows:

P = 15 x S (Copper conductors)

Where

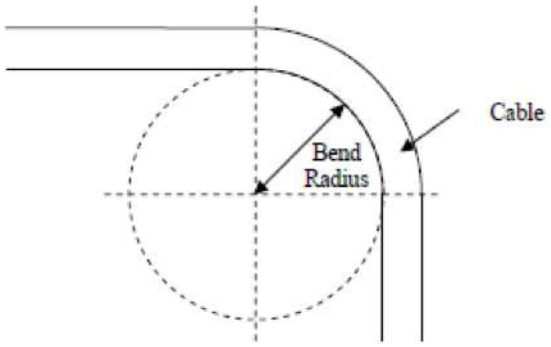
P is in Newton

S is total cross-sectional area in mm² of the main conductors (ignoring screens, concentric conductors and auxiliary conductors).

NOTE: A mass of 1 kg is approximately equal to 10 N.

MINIMUM PERMISSIBLE BENDING RADIUS

The cable bending radius is the minimum radius a cable can be bent without damaging it.



The bending radii recommended are for ambient temperatures of (20 ± 10) ºC.
For temperatures outside these limits, please ask for recommendations.

During the installation and/or flexing applications, the permissible bending radius of the cable shall not be smaller than the values given in this catalogue and tables

Minimum Bending Radius as per DIN VDE 0276-603, DIN VDE 0276-604

During installation

- Single core cables 15 x D (cable diameter)
- Multi core cables 12 x D (cable diameter)

Minimum Bending Radius as per HD 603-S1 Part 4 Section B

During installation

- Multi core cables 10 x D (cable diameter)

Minimum Bending Radius as per HD 603-S1 Part 3

Cable type	Bending radius	
	Class 2 conductors	Class 5 conductors
Cables without metallic screen	12 D	8 D
Cables with metallic screen	16 D	12 D

MINIMUM RECOMENDED BENDING RADIUS AT CABLE TEMPERATURES OF (20± 10) ^{0}C

According to EN 50565-1 Table.3

Cable type	Minimum bending radius R (mm)			
	Cable diameter D ≥ 8	Cable diameter 8 > D ≥ 12	Cable diameter 12 > D ≥ 20	Cable diameter D > 20
Cable for fixed installation				
Normal use	4D	5D	6D	6D
Carefull bending at termination (with a former)	2D	3D	4D	4D
Flexible cables (thermoplastic)				
Fixed installation	3D	3D	4D	4D
Free movement	5D	5D	6D	6D
At inlet of portable appliance or mobile equipment [a]	5D	5D	6D	6D
Under mechanicl load [b]	9D	9D	9D	10D
Festooned [c]	10D	10D	11D	12D
Repeated reeling [b]	7D	7D	8D	8D
Deflected by pulleys [b]	10D	10D	10D	10D
Flexible cables (cross-linked)				
Fixed installation	3D	3D	4D	4D
Free movement	4D	4D	5D	6D
At inlet of portable appliance or mobile equipment [a]	4D	4D	5D	6D
Under mechanicl load [b]	6D	6D	6D	8D
Festooned [c]	6D	6D	6D	8D
Repeated reeling [b]	6D	6D	6D	8D
Deflected by pulleys [b]	6D	8D	8D	8D

D = the overall diameter of round cables or the smaller dimensions of flat cables.
[a] No mechanical load on the cable
[b] See 5.6.2 with regard to dynamic stress of EN 50565-1
[c] As in gantry cranes.

MINIMUM PERMISSIBLE BENDING RADIUS ACC. TO DIN VDE 0298 PART3

Rated voltage	up to 0,6/1kV				above 0,6/1kV
Outher diameter of the cable or thicness of flat cable (mm)	up to 8	above 8 up to 12	above12 up to 20	above 20	
Fixed installation	3 x d	3 x d	4 x d	4 x d	6 x d
Freely movable	3 x d	4 x d	5 x d	5 x d	10 x d
Cable entry/gland	3 x d	4 x d	5 x d	5 x d	10 x d
As for cable-drum mode	5 x d	5 x d	5 x d	6 x d	12 x d
Festoon mode	3 x d	4 x d	5 x d	5 x d	10 x d
Drag-chain mode	4 x d	4 x d	5 x d	5 x d	10 x d
Roller reversing	7.5 x d	7.5 x d	7.5 x d	10 x d	15 x d
Cable tenders	7.5 x d	7.5 x d	7.5 x d	7.5 x d	15 x d
Minimum distance with double or S-type directional changes	20 x d	20 x d	20 x d	20 x d	20 x d

AWG - METRIC CONVERSION CHART

AWG Number	Cross section mm^2	Cross section mm^2 (nearest metric size)	Conductor diameter mm
1000 MCM	507	500	29,3
900	456	-	27,8
750	380	400	25,4
600	304	300	22,7
550	279	-	21,7
500	253	240	20,7
450	228	-	19,6
400	203	-	18,5
350	177	185	17,3
300	152	150	16,0
250	127	-	14,6
4/0	107,2	120	11,68
3/0	85	95	10,4
2/0	67,4	70	9,27
0	53,4	-	8,25
1	42,4	50	7,35
2	33,6	35	6,54
3	26,7	-	5,83
4	21,2	25	5,19
5	16,8	-	4,62
6	13,3	16	4,11
7	10,6	-	3,67
8	8,34	10	3,26
9	6,62	-	2,91
10	5,26	6	2,59
11	4,15	-	2,30
12	3,31	4	2,05
13	2,63	-	1,83
14	2,08	2,5	1,63
15	1,65	-	1,45
16	1,31	1,5	1,29
17	1,04	-	1,15
18	0,823	1	1,024
19	0,653	0,75	0,912
20	0,519	0,5	0,812
21	0,412	-	0,723
22	0,324	0,34	0,644
23	0,259	-	0,573
24	0,205	0,25	0,511
25	0,163	-	0,455
26	0,128	0,14	0,405

1 mil = inch = 0.0254 mm 1 CM = 1 Circ. mil = 0.0005067 mm^2 1 MCM = 1000 Circ. mils = 0.5067 mm^2

GENERAL CONDUCTOR STRANDING

According to DIN VDE 0295 / IEC 60228

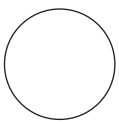
	Ordinary Stranding	multi wire strands	fine strands	super fine strands
Class	**2**		**5**	**6**
cross-section mm^2	number of single wires x wire ø mm			
0,50	7 x 0,30	7 x 0,30	16 x 0,20	28 x 0,15
0,75	7 x 0,37	7 x 0,37	24 x 0,20	42 x 0,15
1,0	7 x 0,43	7 x 0,43	32 x 0,20	56 x 0,15
1,5	7 x 0,52	7 x 0,52	30 x 0,25	84 x 0,15
2,5	7 x 0,67	19 x 0,41	50 x 0,25	140 x 0,15
4	7 x 0,85	19 x 0,52	56 x 0,30	224 x 0,15
6	7 x 1,05	19 x 0,64	84 x 0,30	192 x 0,20
10	7 x 1,35	49 x 0,51	80 x 0,40	320 x 0,20
16	7 x 1,70	49 x 0,65	128 x 0,40	512 x 0,20
25	7 x 2,13	200 x 0,40	128 x 0,40	800 x 0,20
35	7 x 2,52	133 x 0,58	280 x 0,40	1.120 x 0,20
50	19 x 1,83	133 x 0,69	400 x 0,40	705 x 0,30
70	19 x 2,17	189 x 0,69	356 x 0,50	990 x 0,30
95	19 x 2,52	259 x 0,69	485 x 0,50	1.340 x 0,30
120	37 x 2,03	336 x 0,67	614 x 0,50	1.690 x 0,30
150	37 x 2,27	392 x 0,69	765 x 0,50	2.123 x 0,30
185	37 x 2.52	494 x 0,69	944 x 0,50	1.470 x 0.40
240	61 x 2,24	627 x 0,70	1.225 x 0,50	1,905 x 0,40
300	61 x 2,50	790 x 0,70	1,530 x 0,50	2,385 x 0,40
400	61 x 2,89		2.035 x 0,50	
500	61 x 3,23		1.768 x 0,60	

NOTE:

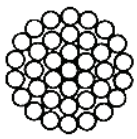
- The number of wires indicated in the column 3-7 is non binding and they are just general informations.
- The VDE 0295 only stipulates the max. diameter of the individual wires and the max. resistance allocated to the cross-section.
- From cross-section 0,5mm2 onwards the listed conductor stranding is also in line with IEC 60228

Additional information is also available in IEC 60228 & DIN VDE 0295

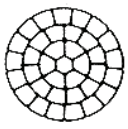
Conductor Construction



circular
solid
RE

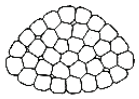


circular
stranded
RM



circular
stranded
compacted
RMV

sector-shaped
solid
SE



sector-shaped
stranded
SM

TECHNICAL DATA

Conductor Resistance at 20 ^{0}C
(IEC 60228, DIN VDE 0295)

Conductor Resistance (mm^2)	Plain Copper Conductor (Ω/km)		Tinned Copper Conductor (Ω/km)	
	Class 1&2	Class 5&6	Class 1&2	Class 5&6
0,5	36,0	39,0	36,7	40,1
0,75	24,5	26,0	24,8	26,7
1	18,1	19,5	18,2	20,0
1,5	12,1	13,3	12,2	13,7
2,5	7,41	7,98	7,56	8,21
4	4,61	4,95	4,70	5,09
6	3,08	3,30	3,11	3,39
10	1,83	1,91	1,84	1,95
16	1,15	1,21	1,16	1,24
25	0,727	0,780	0,734	0,795
35	0,524	0,554	0,529	0,565
50	0,387	0,386	0,391	0,393
70	0,268	0,272	0,270	0,277
95	0,193	0,206	0,195	0,210
120	0,153	0,161	0,154	0,164
150	0,124	0,129	0,126	0,132
185	0,0991 (*)	0,106	0,100	0,108
240	0,0754 (*)	0,0801	0,0762	0,0817
300	0,0601 (*)	0,0641	0,0607	0,0654
400	0,0470 (*)	0,0486	0,0475	0,0495
500	0,0366 (*)	0,0384	0,0369	0,0391
630	0,0283 (*)	0,0287	0,0286	0,0292

Class 1: Single core conductor
Class 2: Stranded conductor
Class 5: Fine wire conductors
Class 6: Extra fine wire conductors

(*) Values are for Class 2 conductors

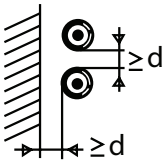
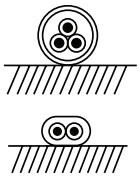
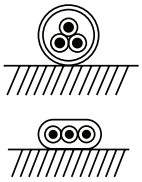
Formula for temperature correction factors to correct measured values to R 20^{0}C

$$k_{t,Cu} = \frac{254,5}{234,5 + t} = \frac{1}{1+0,00393(t-20)}$$

where t is the temperature of measurement

CURRENT CARRYING CAPACITIES

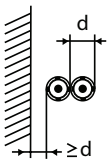
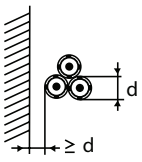
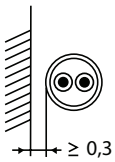
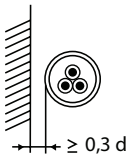
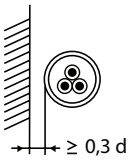
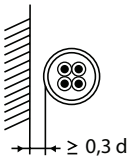
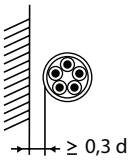
Recommended values according to DIN VDE 0298-4 / Table.11

Installation	Free in air	on or around surface		
	Single core - rubber insulated - PVC insulated - heat resistant 	Multi core cables for household or handheld devices - rubber insulated - PVC insulated 		Multi core cables (not for household or handheld devices) - rubber insulated - PVC insulated - heat resistant 
Number of loaded cores	1	2	3	2 or 3
Cross section (mm^2)	Current carrying capacity (A)			
0,5	-	3	3	-
0,75	15	6	6	12
1	19	10	10	15
1,5	24	16	16	18
2,5	32	25	20	26
4	42	32	25	34
6	54	40	-	44
10	73	63	-	61
16	98	-	-	82
25	129	-	-	108
35	158	-	-	135
50	198	-	-	168
70	245	-	-	207
95	292	-	-	250
120	344	-	-	292
150	391	-	-	335
185	448	-	-	382
240	528	-	-	453
300	608	-	-	523
400	726	-	-	-
500	830	-	-	-
Correction factors for				
Deviating ambient temparatures	Table 10, 17(*)	-		Table 10, 17 (*)
Accumulation / Grouping	Table 10 (*)	-		Table 21 (*)
Laying under the ceiling	-			Table 21 (*)
Multi core cables	-			Table 26 (*)

(*) Tables in VDE 0298 Part 4

CURRENT CARRYING CAPACITIES

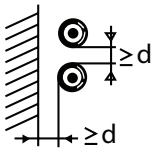
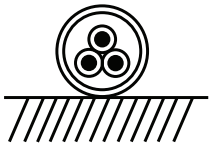
Recommended values according to DIN VDE 0298-4 / Table.13

Permissible operating temperature at the conductor	60 ^{0}C						
Ambient temperature	30 ^{0}C						
Installation Free in air							
Number of loaded cores	2	3	2	2	3	3	3
Cross section (mm^2)	Current carrying capacity (A)						
1	-	-	15,0	15,5	12,5	13,0	13,5
1,5	19,0	16,5	18,5	19,5	15,5	16,0	16,5
2,5	26	22	25	26	21	22	23
4	34	30	34	35	29	30	30
6	43	38	43	44	36	37	38
10	60	53	60	62	51	52	54
16	79	71	79	82	67	69	71
25	104	94	105	109	89	92	94
35	129	117	129	135	110	114	117
50	162	148	162	169	138	143	148
70	202	185	202	211	172	178	185
95	240	222	240	250	204	210	222
120	280	260	-	292	238	246	-
150	321	300	-	335	273	282	-
185	363	341	-	378	309	319	-
240	433	407	-	447	365	377	-
300	497	468	-	509	415	430	-
400	586	553	-	-	-	-	-
500	670	634	-	-	-	-	-
630	784	742	-	-	-	-	-
Correction factors for							
Deviating ambient temparatures	Table 17(*)						
Accumulation / Grouping	-	Table 23 (*)	Table 22 (*)				
Spooled - coiled wound cables	-		Table 22 (*)				
Multi core cables	-				Table 26 (*)	-	

(*) Tables in VDE 0298 Part 4

CURRENT CARRYING CAPACITIES

Recommended values according to VDE 0298-4 / Table.15

Rated temperature at the conductor	90 ^{0}C		-	
Recommended operating temperature	-		80 ^{0}C	
Ambient temperature	30 ^{0}C			
Installation type	free in air		on or around surface	
	Special rubber insulated single core cables 		Multi core rubber cables and trailing cables 	
Nominal Voltage	0,6/1 kV and 1,8/3 kV	3,6/6 kV and	6/1 kV up to	6/10 kV above
Number of loaded cores	1	1	3	3
Cross section (mm^2)	Current carrying capacity (A)			
1,5	30	32	-	-
2,5	41	43	30	-
4	55	56	41	-
6	70	71	53	-
10	98	99	74	-
16	132	133	99	105
35	218	215	162	172
50	276	270	202	216
70	347	338	250	265
95	416	403	301	319
120	488	473	352	371
150	566	546	404	428
185	644	622	461	488
240	775	-	-	-
300	898	-	-	-
Correction factors for				
Deviating ambient temparatures	Table 17(*), column 7		Table 17 (*), column 5	
Accumulation / Grouping	Table 14 (*)		Table 21 (*)	
For reeling applications	-		Table 27 (*)	
Multi core cables	-		Table 26 (*)	-

(*) Tables in VDE 0298 Part 4

PS: For reeling applications details use the current rating tables in our Crane Catalogue at our wep page.

CURRENT CARRYING CAPACITIES

The correction factor for deviating ambient temperatures of 30 ^{0}C according to DIN VDE 0298 Part 4 Table 17

Insulation material	Rubber	PVC	XLPE / HEPR
Max. permissible operating temperature at conductor	60 ^{0}C	70 ^{0}C	90 ^{0}C
Ambient temperature ^{0}C	Correction factor		
10	1,29	1,22	1,15
15	1,22	1,17	1,12
20	1,15	1,12	1,08
25	1,08	1,06	1,04
30	1,00	1,00	1,00
35	0,91	0,94	0,96
40	0,82	0,87	0,91
45	0,71	0,79	0,87
50	0,58	0,71	0,82
55	0,41	0,61	0,76
60	-	0,5	0,71
65	-	0,35	0,65
70	-	-	0,58
75	-	-	0,50
80	-	-	0,41
85	-	-	0,29
90	-	-	-

De-rating factor for multi core cables in acc. with DIN VDE 0298, Part 4 Table 26

No. of wires carrying current	5	7	10	14	19	24	40	61
Correction factor (*)	0,75	0,65	0,55	0,50	0,45	0,40	0,35	0,30

(*) Installed as free air

De-rating factor for the dependency of ampacity on the number of layers on reel in acc. with DIN VDE 0298 Part 4 Table 27 for cable reeling applications

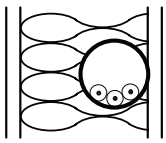
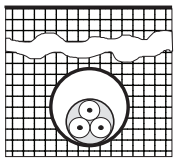
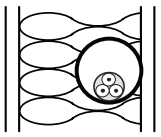
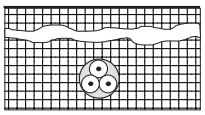
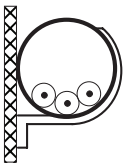
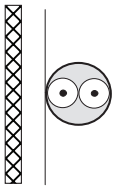
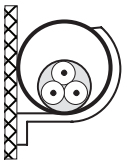
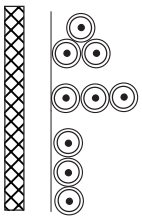
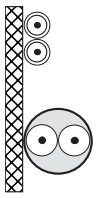
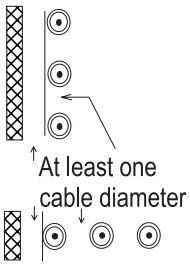
No. of wires full layers on reel	1 (*)	2	3	4	5
Conversion factor (*)	0,50	0,45	0,40	0,35	0,30

(*) Also applies for spiral winding

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

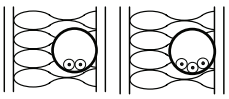
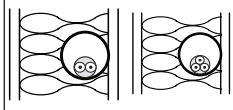
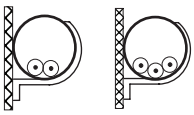
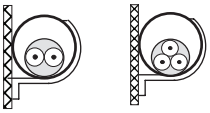
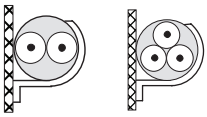
Installation reference methods forming basis of tabulated current-carrying capacities according to IEC 60364-5-52 Table B.52.1

Reference method of installation

A1		Insulated conductors (singlecore cables) in conduit in a thermally insulated wall	D1		Multi-core cable in ducts in the ground
A2		Multi-core cable in conduit in a thermally insulated wall	D2		Sheathed singlecore or multi-core cables direct in the ground.
B1		Insulated conductors (singlecore cables) in conduit on a wooden wall	E		Multi-core cable in free air. Clearance to wall not less than 0,3 times cable diameter
B2		Multi-core cable in conduit on a wooden wall	F		Single-core cables, touching in free air. Clearance to wall not less than one cable diameter
C		Single-core or multi-core cable on a wooden wall	G		Single-core cables, spaced in free air

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Recommended values according to table IEC 60364-5-52 table B.52.2 and B52.4
Operating temperature at conductor 70°C (PVC insulation) ; Ambient temperature 30°C in air, 20 °C in ground

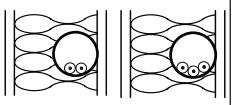
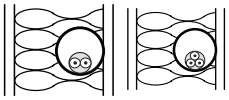
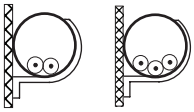
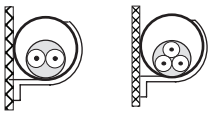
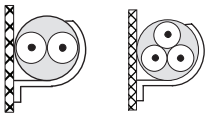
Installation methods as per Table B.52.1	A1		A2		B1		B2		C	
										
Number of loaded cores	2	3	2	3	2	3	2	3	2	3
Nominal cross-sectional area of conductor (mm^2)	Current Carrying Capacity (A)									
1,5	14,5	13,5	14	13	17,5	15,5	16,5	15	19,5	17,5
2,5	19,5	18	18,5	17,5	24	21	23	20	27	24
4	26	24	25	23	32	28	30	27	36	32
6	34	31	32	29	41	36	38	34	46	41
10	46	42	43	39	57	50	52	46	63	57
16	61	56	57	52	76	68	69	62	85	76
25	80	73	75	68	101	89	90	80	112	96
35	99	89	92	83	125	110	111	99	138	119
50	119	108	110	99	151	134	133	118	168	144
70	151	136	139	125	192	171	168	149	213	184
95	182	164	167	150	232	207	201	179	258	223
120	210	188	192	172	269	239	232	206	299	259
150	240	216	219	196	300	262	258	225	344	299
185	273	245	248	223	341	296	294	255	392	341
240	321	286	291	261	400	346	344	297	461	403
300	367	328	334	298	458	394	394	339	530	464

NOTE: In columns of A2, B2 and C installation method circular conductors are assumed for sizes up to and including 16 mm2. Values for larger sizes relate to shaped conductors and may safely be applied to ciecular conductors.

Conversion factor for deviating ambient temperature, grouping, installation under the celling, multicore cables and insulated wires see DIN VDE 0298 part 4.

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Recommended values according to table IEC 60364-5-52 table B.52.3 and B52.5
Operating temperature at conductor 90°C (XLPE / EPR insulation) ; Ambient temperature 30°C in air, 20 °C in ground

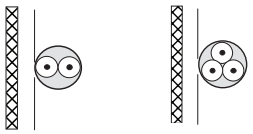
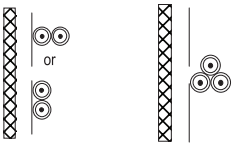
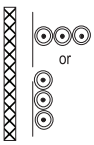
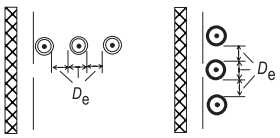
Installation methods as per Table B.52.1	A1		A2		B1		B2		C	
										
Number of loaded cores	2	3	2	3	2	3	2	3	2	3
Nominal cross-sectional area of conductor (mm^2)	Current Carrying Capacity (A)									
1,5	19	17	18,5	16,5	23	20	22	19,5	24	22
2,5	26	23	25	22	31	28	30	26	33	30
4	35	31	33	30	42	37	40	35	45	40
6	45	40	42	38	54	48	51	44	58	52
10	61	54	57	51	75	66	69	60	80	71
16	81	73	76	68	100	88	91	80	107	96
25	106	95	99	89	133	117	119	105	138	119
35	131	117	121	109	164	144	146	128	171	147
50	158	141	145	130	198	175	175	154	209	179
70	200	179	183	154	253	222	221	194	269	229
95	241	216	220	197	306	269	265	233	328	278
120	278	249	253	227	354	312	305	268	382	322
150	318	285	290	259	393	342	334	300	441	371
185	362	324	329	295	449	384	384	340	506	424
240	424	380	386	346	528	450	459	398	599	500
300	486	435	442	396	603	514	532	455	693	576

NOTE: In columns of A2, B2, and C installation method circular conductors are assumed for sizes up to and including 16 mm2. Values for larger sizes relate to shaped conductors and may safely be applied to ciecular conductors.

Conversion factor for deviating ambient temperature, grouping, installation under the celling, multicore cables and insulated wires see DIN VDE 0298 part 4.

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Recommended values according to table IEC 60364-5-52 table B.52.10
Operating temperature at conductor 70°C (PVC insulation) reference Ambient temperature: 30°C

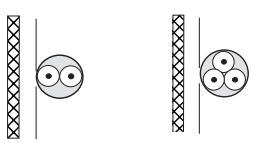
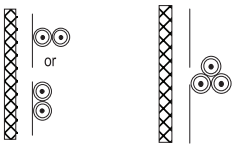
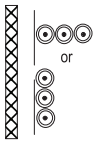
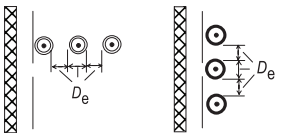
	Multi-core cables		Single-core cables				
Installation methods as per Table B.52.1	Method E 		Method F 		Method F 	Method G 	
Number of loaded cores	2	3	2 - touching	3 - trefoil	3 - flat touching	3 - flat spaced Horizontal	3 - flat spaced Vertical
Nominal cross-sectional area of conductor (mm^2)	Current Carrying Capacity (A)						
1,5	22	18,5	-	-	-	-	-
2,5	30	25	-	-	-	-	-
4	40	34	-	-	-	-	-
6	51	43	-	-	-	-	-
10	70	60	-	-	-	-	-
16	94	80	-	-	-	-	-
25	119	101	131	110	114	146	130
35	148	126	162	137	143	181	162
50	180	153	196	167	174	219	197
70	232	196	251	216	225	281	254
95	282	238	304	264	275	341	311
120	328	276	352	308	321	396	362
150	379	319	406	356	372	456	419
185	434	364	463	409	427	521	480
240	514	430	546	485	507	615	569
300	593	497	629	561	587	709	659
400	-	-	754	656	689	852	795
300	-	-	868	749	789	982	920
630	-	-	1005	855	905	1138	1070

NOTE 1: Circular conductors are assumed for sizes up to and including 16 mm2. Values for larger sizes relate to shaped conductors and may safely be applied to ciecular conductors.

NOTE 2: D_e is the external diaeter of the cable

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Recommended values according to table IEC 60364-5-52 table B.52.12
Operating temperature at conductor 90°C (XLPE / EPR insulation) reference Ambient temperature: 30°C

	Multi-core cables		Single-core cables				
Installation methods as per Table B.52.1	Method E 		Method F 		Method F 	Method G 	
Number of loaded cores	2	3	2 - touching	3 - trefoil	3 - flat touching	3 - flat spaced Horizontal	3 - flat spaced Vertical
Nominal cross-sectional area of conductor (mm^2)	Current Carrying Capacity (A)						
1,5	26	23	-	-	-	-	-
2,5	36	32	-	-	-	-	-
4	49	42	-	-	-	-	-
6	63	54	-	-	-	-	-
10	86	75	-	-	-	-	-
16	115	100	-	-	-	-	-
25	149	127	161	135	141	182	161
35	185	158	200	169	176	226	201
50	225	192	242	207	216	275	246
70	289	246	310	268	279	353	318
95	352	298	377	328	342	430	389
120	410	346	437	383	400	500	454
150	473	399	504	444	464	577	527
185	542	456	575	510	533	661	605
240	641	538	679	607	634	781	719
300	741	621	783	703	736	902	833
400	-	-	940	823	868	1085	1008
300	-	-	1083	946	998	1253	1169
630	-	-	1254	1088	1151	1454	1362

NOTE 1: Circular conductors are assumed for sizes up to and including 16 mm2. Values for larger sizes relate to shaped conductors and may safely be applied to ciecular conductors.

NOTE 2: D_e is the external diaeter of the cable

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Recommended values according to table IEC 60364-5-52 table C.52.1
Simplification of the tables

Reference methods in Table B.52.1	Number of loaded conductors and type of insulation											
A1		3 PVC	2 PVC		3 XLPE	2 XLPE						
A2	3 PVC	2 PVC		3 XLPE	2 XLPE							
B1				3 PVC	2 PVC		3 XLPE		2 XLPE			
B2			3 PVC	2 PVC		3 XLPE	2 XLPE					
C					3 PVC		3 PVC	3 XLPE		3 XLPE		
E						3 PVC		3 PVC			3 XLPE	
F							3 PVC		3 PVC	3 XLPE		3 XLPE
Size (mm^2) Copper	Current Carrying Capacity (A)											
1,5	13	13,5	14,5	15,5	17	18,5	19,5	22	23	24	26	-
2,5	17,5	18	19,5	21	23	25	27	30	31	33	36	-
4	23	24	26	28	31	34	36	40	42	45	49	-
6	29	31	34	36	40	43	46	51	54	58	63	-
10	39	42	46	50	54	60	63	70	75	80	86	-
16	52	56	61	68	73	80	85	94	100	107	115	-
25	68	73	80	89	95	101	110	119	127	135	149	161
35	-	-	-	110	117	126	137	147	158	169	185	200
50	-	-	-	134	141	153	167	179	192	207	225	242
70	-	-	-	171	179	196	213	229	246	268	289	310
95	-	-	-	207	216	238	258	278	298	328	352	377
120	-	-	-	239	249	276	299	322	346	382	410	437
150	-	-	-	-	285	318	344	371	395	441	473	504
185	-	-	-	-	324	362	392	424	450	506	542	575
240	-	-	-	-	380	424	461	500	538	599	641	679

NOTE : The appropriate table of current-carrying capacity given in Annex B of IEC 60364-5-52 should be consulted to determine the range of conductor sizes for which the above current-carrying capacities are applicable, for each installation method

CURRENT RATINGS FOR FIXED INSTALLATION AS PER IEC 60364-5-52

Correction factors for ambient air temperature other than 30 °C according to IEC 60364-5-52 table B.52.14

Ambient air temperature ^{0}C	Insulation type	
	PVC	XLPE and EPR
10	1,22	1,15
15	1,17	1,12
20	1,12	1,08
25	1,06	1,04
30	1,00	1,00
35	0,94	0,96
40	0,87	0,91
45	0,79	0,87
50	0,71	0,82
55	0,61	0,76
60	0,50	0,71
65	-	0,65
70	-	0,58
75	-	0,50
80	-	0,41

Reduction factors of different installation methods for one circuit or one multi-core cable or for a group of more than one circuit, or more than one multi-core cable
Please refer to table IEC 60364-5-52 tables from B.52.17 to B.52.21

SHORT CIRCUIT CURRENT RATINGS

The short-circuit capacity of a cable shall be such that all short-circuit current occurring at any point of a circuit shall not cause the cable conductor temperature to exceed the maximum permissible limit. During a short-circuit, the conductor temperature will increase due to the heat energy produced. The theoretical temperature that arises in the conductor during a short circuit, which is used as a basis of the calculation, is in accordance with IEC 60724.

The maximum permissible short circuit current of cables up to 1kV with copper conductors could be calculated with the following formula

$$I_{(sc)} = \frac{S}{\sqrt{t}} \times k$$

Isc = Short Circuit Current (A)
t = Duration of Short Circuit (s)
k = Insulation Material Specific Constant
S = Nominal Conductor Area (mm^2)

Maximum allowable short circuit current duration is 5 seconds.

k constant values for copper conductors are dependent on the temperature difference between start and end of short-circuit

Table for k constant values

Initial temperature (C^0)	**Final temperature** (C^0)					
	140	**160**	**180**	**200**	**220**	**250**
90	86	100	112	122	131	143
85	90	104	115	125	134	146
80	94	108	119	129	137	149
75	99	111	122	132	140	151
70	103	115	125	135	143	154
65	107	119	129	138	146	157
60	111	122	132	141	149	160
50	118	129	139	147	155	165
40	126	136	145	153	161	170
30	133	143	152	159	166	176

Permissible operating temperature, short-circuit temperature and short-circuit current for cables with copper conductors

Insulation Type of Cable	Permissible operating temperature ^0C	Permissible short-circuit temperature ^0C	Conductor temperature at the beginning of short-circuit C^0						
			90	80	70	60	50	40	30
			Short-circuit current for 1 sec A/mm^2						
XLPE / HEPR	90	250	143	149	154	160	165	170	176
PVC ≤ 300mm²	70	160	-	-	115	122	129	136	143
> 300mm²	70	140	-	-	103	111	118	126	133
EPR / Rubber	60	200	-	-	-	141	147	153	159

Short Circuit Ratings for Low Voltage Cables

Cross section (mm^2)	Short Circuit Current Carrying Capacities kA (1 Sec.)		
	PVC Initial 70 °C Final 160 °C	XLPE / HEPR Initial 90°C Final 250 °C	EPR / RUBBER Initial 60°C Final 200 °C
1	0,115	0,143	0,141
1,5	0,173	0,215	0,212
2,5	0,288	0,358	0,352
4	0,460	0,572	0,564
6	0,690	0,858	0,846
10	1,150	1,430	1,410
16	1,840	2,288	2,256
25	2,875	3,575	3,525
35	4,025	5,005	4,935
50	5,750	7,150	7,050
70	8,050	10,010	9,870
95	10,925	13,585	13,395
120	13,800	17,160	16,920
150	17,250	21,450	21,150
185	21,275	26,455	26,085
240	27,600	34,320	33,840
300	34,500	42,900	42,300
400	41,200	57,200	56,400
500	51,500	71,500	70,500
630	64,890	90,090	88,830

VOLTAGE DROP

In the absence of specific design limits set by a regulatory body, the cross-sectional areas of conductors shall be so determined that when the conductors are carrying tha maximum current under normal conditions of service, the drop in voltage from the main or emergency switchboard bus-bars to any and every point on the installation does not exceed the limitation given in Clause 36 of IEC 60092-201

Current carrying in cable core(s) induce(s) a voltage drop and value of this voltage drope is the difference between the measured voltages at booth ends of the cable

Generally accepted values for voltage drop are 3% for lighting and 5% for motors and other applications.

Voltage drop depends on:

- Type of current (DC) or (AC)
- Single or three-phased systems.
- Length of the cable
- Carrying current capacity and power factor.
- Electrical resistance and inductance.

$$\text{Voltage drop in percent} = \frac{\text{Voltage drop in V x 100}}{\text{Circuit voltage in V}}$$

In DC system

$Vd = 2 \times I \times L \times R$

In AC Single Phase System

$Vd = 2 \times I \times L \times (R.\cos Ø + X. \sin Ø)$

In AC Three Phase System

$V d = \sqrt{3} \times I \times L \times (R.\cos Ø + X. \sin Ø)$

Where

Vd	Voltage drop (V)
R	D. C. conductor resistance at operating temperature (Ω /km)
X	Reactance (Ω / km)
L	Cable length (km)
I	Current rating value or load current (A)
Cos Ø	Power factor if no details, power factor is Cos Ø = 0.8 and Sin Ø = 0.6.

Cos Ø	1,0	0,9	0,8	0,71	0,6	0,5
Sin Ø	0,0	0,44	0,6	0,71	0,8	0,87

PROPERTIES* OF INSULATON AND SHEATH MATERIALS

	Designation			Electrical				Thermal					
	VDE des.	Code	Material	Density	Electr. strength Break down voltage	Specific insulation Volume resitivity	Dielectr. constant	Service working temperture		Melting point	Flame resistivity	Oxygen LOI	Heating value Ho
				g/cm^3	kV/mm	Ω • cm 20 °C	50 Hz/ 20 °C	contin. °C	contin. °C	+°C		% O_2	$MJ \cdot kg^{-1}$
Thermoplastics	Y	PVC	Polyvinyl chloride	1,35-1,5	25	10^{13}-10^{15}	3,6-6	-30 +70	+100	>140	self exthin-guishing	23-42	17-25
	Yw	PVC	Heat resistance to 90°C	1,3-1,5	25	10^{12}-10^{15}	4-6,5	-20 +90	+120	>140		24-42	16-22
	Yw	PVC	Heat resistance to 105°C	1,3-1,5	25	10^{12}-10^{15}	4,5-6,5	-20 +105	+120	>140		24-42	16-20
	Yk	PVC	Cold resistance	1,2-1,4	25	10^{12}-10^{15}	4,5-6,5	-40 +70	+100	>140		24-42	17-24
	2Y	LDPE	PE (low density)	0,92-0,94	70	10^{17}	2,3	-50 +70	+100	105*110	combus-tible	≤22	42-44
	2Y	HDPE	PE (high density)	0,94-0,98	85	10^{17}	2,3	-50 +100	+120	130		≤22	42-44
	2X	XLPE	Cross-linked polyethylene	0,92	50	10^{12}-10^{16}	4-6	-35 +90	+100	-		≤22	42-44
	02Y		Polyethylene foam	~0,65	30	10^{17}	~1,55	-40 +70	+100	105		18-30	42-44
	3Y	PS	Polystyrene	1,05	30	10^{16}	2,5	-50 +80	+100	>120		≤22	40-43
	4Y	PA	Polyamide	1,02-1,1	30	10^{15}	4	-60 +105	+125	210		≤22	27-31
	9Y	PP	Polypropylene	0,91	75	10^{16}	2,3-2,4	-10 +100	+140	160		≤22	42-44
	11Y	PUR	Polyurethane	1,15-1,2	20	10^{10}-10^{12}	4-7	-55 +80	+100	150		20-26	20-26
	TPE-E (12Y/13Y)		Polyester elastomer	1,2-1,4	40	$>10^{10}$	3,7-5,1	-50 +100	> 140	190		≤29	20-25
	TPE-O (18 Y)		Polyolefin elastomer	0,89-1,0	30	$>10^{14}$	2,7-3,6	-50 +100	+130	150		≤25	23-28
Elastomers	G	NR SBR	Natural rubber styrene-butadiene rubber	1,5-1,7	20	10^{12}-10^{15}	3-5	-65 +60	+120		combus-tible	≤22	21-25
	2G	SIR	Sillicone rubber	1,2-1,3	20	10^{15}	3-4	-60 +180	+260	-	low flam-ability	25-35	17-19
	3G	EPR	Ethylene-propylene mixed polymer	1,3-1,55	20	10^{14}	3-3,8	-30 +90	+160	-	combus-tible	≤22	21-25
	4G	EVA	Ethylene-vinyl acetate copolymer	1,3-,1,5	30	10^{12}	5-6,5	-30 +125	+200	-		≤22	19-23
	5G	CR	Polychloroprene	1,4-1,65	20	10^{10}	6-8,5	-40 +100	+140	-	self extin-guishing	30-35	14-19
	6G	CSM	Chlorosulfonated polyethylene	1,3-1,6	25	10^{12}	6-9	-30 +80	+140	+160		30-35	19-23
Hightemp. materials	10Y	PVDF	Polyvinylidene fluoride Kynar® / Dyflor®	1,7-1,9	20	10^{14}	9-7	-40 +135	+160	>170	noncom-bustible	40-45	15
	7Y	ETFE	Ethylentetrafluorethylene Tefzel®	1,6-1,8	36	10^{16}	2,6	-100 +150	+180	>265		30-35	14
	6Y	FEP	Fluorinated ethylene propylene	2,0-2,3	25	10^{18}	2,1	-100 +205	+230	>225		>95	5
	5YX	PFA	Perfluoralkoxy polimer	2,0-2,3	25	10^{18}	2,1	-190 +260	+280	>290		>95	5
	5Y	PTFE	Polytetrafluorethylene	2,0-2,3	20	10^{18}	2,1	-190 +260	+300	>325		>95	5
halogen-free mixtures	H	Not cross linked	Halogen-free polymer mixture	1,4-1,6	25	10^{12}-10^{14}	3,4-5	-30 +70	+100	>130	self extin-guishing	≤40	17-22
	HX	Cross linked	Halogen-free polymer mixture	1,4-1,6	25	10^{13}-10^{14}	3,4-5	-30 +70	+150	-		≤ 40	16-25

* The characteristics are valid for unprocessed material

PROPERTIES* OF INSULATION AND SHEATH MATERIALS

	Designation			Thermal			Mechanical					Free from halogens	Weathering	
	VDE des.	Code	Material	Thermal conductivity W·K-1 · m-1	Corrosive gases in case of fire	Radiation resist. max. Mrad	Tensile strength N/mm2	Elongation at break %	Shore hardness	Abrasion performance	Water absorption %	halogen free	Weathering resist.	Cold resistance
Thermoplastics	Y	PVC	Polyvinyl chloride mixtures	0,17	Hydrogen chloride	80	10 - 25	130 - 350	70-95 (A)	average	0,4	no	moderate	medium-good
	Yw	PVC	temperature resistance to 90°C											
	Yw	PVC	temperature resistance to 105°C											
	Yk	PVC	low temperature resistance											very good
	2Y	LDPE	PE (low density)	0,3	no	100	10 - 20	400 -600	43-50 (D)	average	0,1	yes		good
	2Y	HDPE	PE (high density)	0,4			20 - 30	500 - 1000	60-63 (D)	good				
	2X	XLPE	Cross-linked polyethylene	0,3			12,5-20	300 - 400	40-45 (D)	average			good	
	02Y		Polyethylene foam	0,25			8 - 12	350 - 450	-	-	-	restrict.(1)	-	
	3Y	PS	Polystyrene	0,25		80	55 - 65	300 - 400	35-50 (D)	good	0,4	yes	medium good	moderately good
	4Y	PA	Polyamide	0,23		10	50 - 60	50 - 170	-	very good	1,0-1,5		good	good
	9Y	PP	Polypropylene	0,19			20 - 35	300	55-60 (D)	average	0,1		moderate	
	11Y	PUR	Polyurethane	0,25		100 -500	30 - 45	500 - 700	70 - 100 (A)	very good	1,5	yes/no (2)	very good	very good
	TPE-E (12Y/13Y)		Polyester elastomer	0,5		10	30	> 300	85 (A) 70 (D)	good				
	TPE-O (18 Y)		Polyolefin elastomer	1,5			20		55 (A) 70 (D)					
Elastomers	G	NR SBR	Natural rubber styrene-butadiene rubber	-	no	100	5 - 10	300 - 600	60-70 (A)	mod.	1,0	no	moderate	very good
	2G	SIR	Sillicone rubber	0,22		50		300 - 600	40-80 (A)			yes	good	
	3G	EPR	Ethylene-propylene mixed polymer	-		200		200 - 400	65-85 (A)				very good	good
	4G	EVA	Ethylene-vinyl acetate copolymer	-		100	8 - 12	250 - 350	70-80 (A)				good	
	5G	CR	Polychloroprene- mixtures	-	Hydrogen chloride	50	10 - 20	400 - 700	55-70 (A)	average	1,0	no	very good	moderately good
	6G	CSM	Chlorosulfonated polyethylene	-				350 - 600	60-70 (A)		1,5			moderate
Hightemp. materials	10Y	PVDF	Polyvinylidene fluoride Kynar® / Dyflor®	0,17	Hydrogen fluoride	10	50 - 80	150	75-80 (D)	very good	0,01			very good
	7Y	ETFE	Ethylen tetrafluorethylene Tefzel®	0,24	yes	10	40 - 50	150	70-75 (D)		0,02			
	6Y	FEP	Fluorinated ethylene propylene	0,26	yes	1	15 - 25	250	55-60 (D)		0,01			
	5YX	PFA	Perfluoralkoxy	0,21	yes	0,1	25 - 30	250	55-60 (D)					
	5Y	PTFE	Polytetrafluorethylene	0,26	yes	0,1	80	50	55-60 (D)					
Halogen-free mixtures	H	Not cross linked	Halogen-free polymer mixture	0,17	no	100	8 - 13	150 -	65-95 (A)	average	0,2-1,5	yes	moderate	average
	HX	Cross-linked	Halogen-free polymer mixture	0,2	no	200	8 - 13	150 - 250						

* The characteristics are valid for unprocessed material
(1) The propellent may be fluorinated chlorinated hydrocarbons
(2) Depend on type of compound.

PROPERTIES OF INSULATION AND SHEATH MATERIALS

Designation			Properties				
VDE des.	Code	Material	Oxidation resistance	Heat resistance	Oil resistance	Ozone resistance	Abrasion resistance
Y	PVC	Polyvinylchloride	E	G-E	F	E	F-G
Yw	PVC	Heat resistance to 90°C					
Yw	PVC	Heat resistance to 105°C					
Yk	PVC	Cold resistance					
2Y	LDPE	PE (low density)	E	G	G-E	E	G
2Y	HDPE	PE (high density)	E	E	G-E	E	E
2X	XLPE	Cross-linked polyethylene	E	G	G	E	F-G
02Y		Polyethylene foam	E	G	G	F	G
3Y	PS	Polystrene	E	E	G	F	G
4Y	PA	Polyamide	E	E	E	E	E
9Y	PP	Polypropylene	E	E	F	E	F-G
11Y	PUR	Polyurethane	E	G	E	E	O
12Y/13Y	TPE-E	Polyester elastomer	E	E	E	E	E
18Y	TPE-O	Polyolefin elastomer	E	E	F	E	F
G	NR	Natural rubber	F	F	P	P	E
	SBR	Styrene butadine rubber	G	F	P	P	E
2G	SIR	Sillicone rubber	E	G	F-G	O	F
3G	EPR	Ethylene-propylene mixed polymer	G	E	F	E	G
4G	EVA	Ethylene-vinyl acetate copolymer	G	G	G	G	G-E
5G	CR	Polychloroprene	G	G	G	G	G-E
6G	CSM	Chlorosulfonated polyethylene	E	E	G	E	G
	CPE	Chlorinated Polyethylene	E	E	E	E	E-O
	EPDM	Ethylene propylene-diene elastomer	E	E	P	E	G
	NBR	Nitrile butadine rubber	F	G	G-E	P	G-E
	NBR/ PVC	Nitrile butadine rubber / Polyvinylchloride	E	G	G	G	E

P= Poor | F= Fair | G= Good | E= Excellent | O= Outstanding

PROPERTIES OF INSULATION AND SHEATH MATERIALS

Designation			Properties						
VDE des.	Code	Material	Water resistance	Acid resistance	Alkali resistance	Aliphatic hydrocarbons resistance (Gasoline, kerosene etc.)	Aromatic hydrocarbons resistance (Benzol, tuluol, etc.)	Halogenated hydrocarbons resistance (Degreaser solvents)	Alcohol resistance
Y	PVC	Polyvinylchloride compounds	F-G	G-E	G-E	P	P-F	P-F	P-F
Yw	PVC	Heat resistance to 90°C							
Yw	PVC	Heat resistance to 105°C							
Yk	PVC	Cold resistance							
2Y	LDPE	PE (low density)	E	G-E	G-E	G-E	P	G	E
2Y	HDPE	PE (high density)	E	E	E	G-E	P	G	E
2X	XLPE	Cross-linked polyethylene	G-E	G-E	G-E	F	F	F	E
02Y		Polyethylene foam	E	G-E	G-E	G	P	G	E
3Y	PS	Polystrene	G	G-E	E	P	P	P	E
4Y	PA	Polyamide	P-F	P-F	E	G	G	G	P
9Y	PP	Polypropylene	E	E	E	P-F	P-F	P	E
11Y	PUR	Polyurethane	P-G	F	F	P-G	P-G	P-G	P-G
12Y/13Y	TPE-E	Polyester elastomer	E	F	F	G-E	E	E	E-O
18Y	TPE-O	Polyolefin elastomer	E	G	G	G-E	E	E	E-O
G	NR	Natural rubber	G-E	F-G	F-G	P	P	G	G-E
	SBR	Styrene butadine rubber	E	F-G	F-G	P	P	P	G
2G	SIR	Sillicone rubber	G-E	F-G	F-G	P-F	P	P-G	G
3G	EPR	Ethylene-propylene mixed polymer	G-E	G-E	G-E	P	F	P	P
4G	EVA	Ethylene-vinyl acetate copolymer	G	G	G	G	P-F	P	F
5G	CR	Polychloroprene	G	G	G	G	P-F	P	F
6G	CSM	Chlorosulfonated polyethylene	G-E	E	E	F	F	P	P
	CPE	Chlorinated Polyethylene	E	E	E	G-E	E	E	E-O
	EPDM	Ethylene propylene-diene elastomer	G-E	G-E	G-E	P	F	P	P
	NBR	Nitrile butadine rubber	G-E	G	F-G	E	G	P	E
	NBR/ PVC	Nitrile butadine rubber / Polyvinylchloride	E	G	G	G-E	G	G	G

P= Poor | F= Fair | G= Good | E= Excellent | O= Outstanding

CHEMICAL RESISTANCE OF INSULATION AND SHEATH MATERIALS

Chemical	Material							
	EPR	PVC	CSM	PCP	PUR	PE	H	SIR
Aceton	+	-	0	0	-	*	*	0
Acetic acid, 20 %	-	-	0	0	0	0	-	*
Aluminium chloride solution	+	+	+	+	*	*	*	-
Aluminium sulfate solution	+	+	0	0	*	*	-	-
Ammonia, analhydrous	+	0	+	+	*	*	*	*
Ammonium chloride solution	+	+	+	+	*	*	+	*
Ammonium hydroxide solution	+	*	+	+	*	*	*	*
Ammonium sulfate solution	+	+	+	+	*	*	*	*
Amyl acetate	0	*	0	0	*	*	*	*
Aniline	0	-	-	-	-	*	*	*
Asphalt	-	0	0	0	+	*	*	*
Benzene	*	-	*	*	-	*	*	-
Benzine	-	-	0	+	+	*	*	*
Benzole	-	-	-	-	-	*	*	*
Borax solution	+	+	+	+	*	*	*	*
Boric acid solution	+	+	+	+	0	+	0	+
Butyl acetate	0	-	-	-	*	*	*	*
Calcium bisulphite solution	+	*	0	0	*	*	*	*
Calcium chloride solution	+	+	+	+	*	*	0	*
Calcium hydroxide solution	+	*	+	+	*	*	*	*
Carbon disulphide	-	-	-	-	*	-	-	-
Carbon tetrachloride	-	+	-	-	-	-	*	-
Chlorobenzene	-	-	-	-	-	*	*	-
Chloroacetic acid	0	*	0	0	*	*	*	*
Chlorine gas, wet	0	-	-	0	*	*	*	*
Chlorine gas, dry	0	-	0	0	*	*	*	*
Chloroform	-	-	-	-	*	*	*	*
Copper chloride solution	+	+	+	+	+	+	0	0
Copper sulphate solution	+	+	+	+	+	+	0	0
Cyclohexane	-	-	0	-	*	*	*	*
Dibutylphtalate	0	-	*	-	*	*	*	*
Diesel oils	*	0	+	+	+	*	-	0
Ethyl acetate	0	-	-	-	*	*	*	*
Ethyl alcohol	+	-	*	*	0	+	-	+
Ethylene glycol	+	0	+	+	*	*	+	*

(+)= Resistant | (0)= Limited resistance | (-)= Non-resistance | (*)= Not tested

CHEMICAL RESISTANCE OF INSULATION AND SHEATH MATERIALS

Chemical	Material							
	EPR	PVC	CSM	PCP	PUR	PE	H	SIR
Ethylen oxide	-	*	0	-	*	*	*	*
Formaldehyde, 10%	+	*	+	+	*	*	*	*
Fuel oil	-	0	0	0	0	*	-	*
Glycerine	+	+	+	+	+	*	*	+
Hydraulic oils	-	0	+	+	0	*	-	-
Hydrochloric acid, 20%	+	*	+	0	-	+	-	-
Hydrogen sulphide	+	*	+	0	-	*	-	-
Kerosine	-	0	-	-	+	*	*	*
Lactic acid	+	*	+	0	-	*	*	-
Linseed oil	-	*	0	0	*	*	*	*
Lubricating oils	-	+	0	0	*	*	*	*
Magnesium chloride solution	+	+	+	+	*	*	0	0
Mercury	*	+	+	+	+	+	+	+
Methanol	+	-	+	+	*	-	*	+
Methyl chloride	-	-	-	-	-	*	*	-
Methyl ethyl ketone	+	-	0	0	*	*	*	*
Methyl alcohol	+	0	+	+	0	+	0	*
Mineral oil	-	-	0	0	0	*	*	*
Naphta	-	*	-	0	*	*	*	*
Naphtalene	-	-	-	0	*	*	*	*
Nitric acid, 30%	-	-	-	-	-	-	-	-
Olive Oil	*	*	*	*	+	+	*	+
Perchlor ethylene	-	-	-	-	*	*	*	*
Petroleum	-	-	0	0	0	-	-	-
Phenol	-	-	-	-	*	*	*	*
Phosphoric acid	+	+	+	+	0	+	-	*
Picric acid	+	+	+	+	-	*	*	*
Potassium chloride	+	+	+	+	+	+	-	*
Pyridine	-	-	-	-	*	*	*	*
Sea Water	*	+	+	+	+	+	0	0
Soap solution	+	+	+	+	*	*	*	*
Sodium hydroxide, 25%	+	0	+	+	-	*	*	*
Sodium hypochloride	+	*	+	0	*	*	0	0
Soya bean oil	-	-	0	0	*	*	*	*
Sulphur	+	+	+	+	0	0	*	-

(+)= Resistant | (0)= Limited resistance | (-)= Non-resistance | (*)= Not tested

CHEMICAL RESISTANCE OF INSULATION AND SHEATH MATERIALS

Chemical	Material							
	EPR	PVC	CSM	PCP	PUR	PE	H	SIR
Sulphurous acid	+	+	+	0	*	*	*	*
Sulphuric acid < 50%	+	+	+	+	-	*	*	*
Stearic acid	+	0	+	+	*	*	*	*
Toluene	-	-	-	-	*	*	*	-
Transformer oil	-	+	+	+	+	*	*	*
Tributyl phosphate	0	*	-	0	*	*	*	*
Trichlorethylene	*	0	0	0	-	*	*	+
Triethanolamine	+	*	+	0	*	*	*	*
Turpentine	-	-	-	-	*	*	*	*
Vegetable oils and grease	0	0	+	+	+	+	-	*
Water (dist.)	+	+	+	+	0	*	*	*
Xylene	-	-	-	-	*	*	*	*
Zinc chloride solution	+	+	+	+	-	*	0	*

(+)= Resistant | (0)= Limited resistance | (-)= Non-resistance | (*)= Not tested

BASIC CABLE ELECTRICAL DEFINITIONS AND FORMULAS

Cable
In electrical and electronic systems, a conductor or group of individually insulated conductors in twisted or parallel configuration under common sheath for transmitting electric power, energy or telecommunication signals or data from one place to another

Voltage
Voltage is defined as the electrical potential difference per unit charge between two points in the electric field. The unit of voltage is Volt (V).
For the rated, operating and test voltages of cables, the definitions given in DIN VDE 0298, Part 3, like AC = Alternating Current and
DC = Direct Current

Current
Electric current is defined as a flow of charged particles (electrons and ions) moving through a conductor. It is also defined as the flow rate of electric charge through a conducting medium concerning time.
The unit of electric current is ampere (A). And the electric current is denoted mathematically by the symbol 'I' or 'i'.

Current Carrying Capacity
The maximum current an insulated conductor or cable can continuously carry without exceeding its temperature rating. It is also called Ampacity.

Resistance
Resistance or electrical resistance measures the opposition to current flow in an electrical circuit. Resistance is measured in ohms (Ω).
Resistance of any conducting material is directly proportional to length of material, and inversely proportional to the area of conductor.,

Capacitance
Storage of electrically separated charges between two plates having different potentials. The value depends largely on the surface area of the plates and the distance between them.
Capacitance, Direct: The capacitance measured directly from conductor to conductor through a single insulating layer.
Capacitance, Mutual: The capacitance between two conductors with all other conductors, including shield, short circuited to ground.

Impedance
The total opposition that a circuit offers to the flow of alternating current or any other varying current at a particular frequency. It is a combination of resistance (R) and reactance (X), measured in ohms.
Characteristic Impedance: The impedance that, when connected to the output terminals of a transmission line of any length, makes the line appear infinitely long. The ratio of voltage to current at every point along a transmission line on which there are no stranding waves

Inductance
Inductance is the property of wire which stores electrical current in a magnetic field around the wire and is an electrochemical characteristic of an electric conductor or circuit that induces an electromotive force to be released when the current flowing changes. It refers to the electrical conductor's resistance to change in the electric current travelling through it. It is measured in Henrys.

Reactance
A measure of the combined effects of capacitance and inductance on an alternating current or the opposition offered to the flow of alternating current by inductance or capacitance of a component or circuit. The amount of such opposition varies with the frequency of the current. The reactance of a capacitor decreases with an increase in frequency; the opposite occurs with an inductance.

Electric Power
Power is the rate of energy supplied or consumed by an electric element with respect to time.
The pace at which electrical energy is transferred by an electric circuit is referred to as power, which is measured in Watts. Power can be determined as the Force multiplied by distance divided by the time required.

Power Factor
The power factor is a very important term in case of the AC system. It is defined as a ratio of working power absorb by the load to the apparent power flowing through the circuit.

$$\text{Power Factor Cos}\phi = \frac{\text{Active Power}}{\text{Apparent Power}}$$

The power factor dimensions less number in the closed interval of -1 to 1. When the load is resistive, power factor is near to 1 and when the load is reactive, power factor is near to -1.

Frequency
Frequency is defined as the number of cycles per unit time. It is denoted as f and measured in Hertz (Hz). One hertz is equal to one cycle per second. Generally, the frequency is 50 Hz or 60 Hz.

Electric Field
An electric field is a field or space around an electrically charged object where any other electrically charged object will experience a force.
An electric field is also known as electric field intensity or electric field strength, denoted by E.

Electromagnetic compatibility - EMC
Electromagnetic compatibility is the capability of an electrical or electronic device to function correctly in its electromagnetic environment and not to cause interference to the environment to an impermissible degree.

BASIC CABLE ELECTRICAL DEFINITIONS AND FORMULAS

Resistance

The values of conductor DC resistance are dependant on the temperature and it is calculated by the following formula:

$$R_\theta = R_{20}[1 + \alpha (\theta - 20)] \qquad \Omega/km$$

where,

R_θ	:	The conductor DC resistance at θ°C	Ω/km
R_{20}	:	The conductor DC resistance at 20°C	Ω/km
θ	:	Operating temperature	°C
α	:	Temperature coefficient = 0.00393 for Copper = 0.00403 for Aluminum	1/°C

Generally the Dc resistance is based on IEC 60228 and to calculate the AC resistance of the conductor at the operating temperature the following

$$R_{AC} = R_\theta(1+ Y_S + Y_P) \qquad \Omega/km$$

where,

YS	:	Skin effect factor
YP	:	Proximity effect factor

Inductance

$$L = K + 0.2 \ln (2S/d)$$

where,

L	:	The Inductance	mh/km
K	:	Constant depend on number of wires	
d	:	Conductor diameter	
S	:	Axial Spacing = 1.26 x axial spacing between cables in case of flat formation	

Reactance

$$X = 2 \pi f L \times 10^{-3} \qquad \Omega/km$$

where,

X	:	The Cable Reactance	Ω/km
L	:	The Inductance	mh/km
f	:	Frequency	Hz

Impedance

$$Z = \sqrt{X^2 + R^2_{AC}} \qquad \Omega/km$$

Capacitance

$$C = \frac{\varepsilon_r}{18 \ln \frac{D}{d}} \qquad \Omega/km$$

where,

C	:	Capacitance	μF/Km
ε_r	:	Relative permitivity of insulation material	
ε_r	:	4,8 for PVC 2,3 for XLPE	
D	:	Diameter over insulation	mm
d	:	Diameter under insulation	mm

General Information

Insulation resistance

The insulation resistance is formualted as following:

$$R = K \ln(D/d) \quad M\Omega/km$$

where,

R	:	Insulation resistance	MΩ/km
K	:	Constant depending on the insulation material	
d	:	diameter under the insulation	mm
D	:	diameter over the insulation	mm

Charging Current

The charging current is the capacitive current which flows through the dielectric layers when AC voltage is applied. The value can be calculated from the following equation:

$$I_c = U_0 \omega C 10^{-6} \quad A/Km$$

where,

Ic	:	Charging current	A/Km
U_0	:	Rated phase voltage	V
ω	:	Angular of velocity (2πf)	
f	:	Frequency	Hz
C	:	Capacitance	μf/Km

Dielectric losses

The dielectric losses of an AC cable are proportional to the capacitance, the frequency, the phase voltage squared and the power factor. The value can derived from the following equation:

$$W_d = \omega C U_0^2 \tan\delta \, 10^{-6} \quad watt/Km/phase$$

where,

Wd	:	Dielectric losses	watt/Km/phase
f	:	Frequency	Hz
C	:	Capacitance	μf/Km
U_0	:	Rated phase voltage	V
tanδ	:	Dielectric power factor	
ω	:	Angular of velocity (2πf)	

Conductor resistance

$$R = \frac{\rho \cdot L}{S} \qquad R = \frac{L}{\kappa \cdot S}$$

$$G = \frac{1}{R} \qquad \rho = \frac{1}{K}$$

R = electrical resistance in Ω
G = electrical conductivity in S
S = conductor cross-section in mm^2
L = length of conductor in m
ρ = specific resistance (Rho)
κ = conductivity (Kappa)

Materials	Conductivity $\frac{m}{\Omega \cdot mm2}$	Spec. resistance $\frac{\Omega \cdot mm2}{m}$
Copper	58,00	0,01724
Aluminium	33,00	0,0303

Cross section for single wire round

$$q = \frac{D^2 \cdot \pi}{4} \quad \text{or} \quad D^2 \cdot 0{,}7854$$

Cross section for bunched wire

$$q = \frac{d^2 \cdot \pi}{4} \cdot n \quad \text{or} \quad d^2 \cdot 0{,}7854 \cdot n$$

Diameter for single wires cross-section

$$q = \sqrt{\frac{q \cdot 4}{\pi}} \quad \text{or} \quad \sqrt{q \cdot 1{,}2732}$$

Diameter for bunched wires

$$D = \sqrt{1{,}34 \cdot n \cdot d}$$

q = cross-section (mm^2)
D = conductor diameter (mm)
d = single wire diameter (mm)
n = number of wires

Current - Voltage - Power - Resistance Equations

Quantitty	DC	Single Phase AC	Three Phase AC
Current (I)	$I = V / R$ $I = P / V$ $I = \sqrt{P / R}$	$I = P / (V \times \cos\theta)$ $I = (V / Z)$	$I = P / \sqrt{3} \times V \times \cos\theta$
Voltage (V)	$V = I \times R$ $V = P / I$ $V = \sqrt{(P \times R)}$	$V = P / (I \times \cos\theta)$ $V = I / Z$	$V_L = \sqrt{3} \times V_{PH}$
Power (P)	$P = I \times V$ $P = I^2 \times R$ $P = V^2 / R$	$P = V \times I \times \cos\theta$ $P = I^2 \times R \times \cos\theta$ $P = (V^2/R) \times \cos\theta$	$P = \sqrt{3} \times V_L \times I_L \times \cos \Phi$ $P = 3 \times V_{Ph} \times I_{Ph} \times \cos \Phi$
Resistance (R)	$R = V / I$ $R = P / I^2$ $R = V^2 / P$	$Z = \sqrt{(R^2 + X_L^2)}$ $Z = \sqrt{(R^2 + X_C^2)}$ $Z = \sqrt{(R^2 + (X_L - X_C)^2}$	

Where:

I = Current in Amperes (A)
V = Voltage in Volts (V)
P = Power in Watts (W)
R = Resistance in Ohm (Ω)
Z = impedance = Resistance of AC Circuits in Ohms
Cosθ = Power factor = Phase difference between voltage and current in AC circuits
V_{PH} = Phase Voltage
V_L = Line Voltage
X_L = Inductive reactance
X_L = 2πfL…Where L = Inductance in Henry
X_C = Capacitive reactance
X_C = 1/2πfC… Where C = Capacitance in Farads. Also, ω = 2πf

CONVERSION OF MEASUREMENT UNITS

Length				
1	mil	=	0,0254	mm
1	in (inch)	=	25,4	mm
1	ft (foot)	=	0,305	m
1	yd (yard)	=	0,914	m
1	ch (chain)	=	20,1	m
1	mile (land mile)	=	1609 1760	km yards
1	mile (nautic mile)	=	1,852	km
1	mm	=	0,039370	inches
1	m	=	39,370079	inches

Area				
1	CM (circ. mil)	=	$0,507 \cdot 10^{-3}$	mm^2
1	MCM	=	0,5067	mm^2
1	sq. inch (sq. inch)	=	645,16	mm^2
1	sq. ft. (sq. foot)	=	0,0929	m^2
1	square yard	=	0,836	m^2
1	acre	=	4047	m^2
1	square mile	=	2,59	km^2

Volume				
1	cubic inch	=	16,39	cm^3
1	cubic foot	=	0,0283	m^3
1	cubic yard	=	0,765	m^3
1	pint	=	0,473	l
1	quart	=	0,946	l
1	Brit. gallon	=	4,55	l
1	US gallon	=	3,79	l
1	US barell	=	158,8	l

Mass				
1	grain	=	64,8	mg
1	dram	=	1,77	g
1	ounce (oz)= 16 drams	=	28,35	g
1	pound (lb)= 16 oz	=	453,59	g
1	stone = 14 lbs	=	6,35	kg
1	US ton (short ton)	=	907	kg
1	Brit. ton (long ton)	=	1,016	kg

Density				
1	lb/cu.ft	=	16,02	kg/m^3
1	lb/cu.in	=	27,68	t/m^3

Temperature			
	F (Fahrenheit)	=	$(1.8 \times C) + 3^0$
	C (Celcius)	=	$0,5556 \times (F-32^0)$

Force				
1	lb	=	4,448	N
1	brit. ton	=	9954	N
1	pdl (Poundal)	=	0,1383	N
1	kp	=	9,81	N
1	N	=	0,102	kp

Energy				
1	hp x h	=	1,0139	PS x h
		=	2,684x100000	J
		=	746	W x h
1	BTU (brit. therm.unit)	=	1055	Joul

Power				
1	PS	=	0,736	kW
1	kW	=	1,36	PS
1	hp	=	0,7457	kW
1	kW	=	1,31	hp

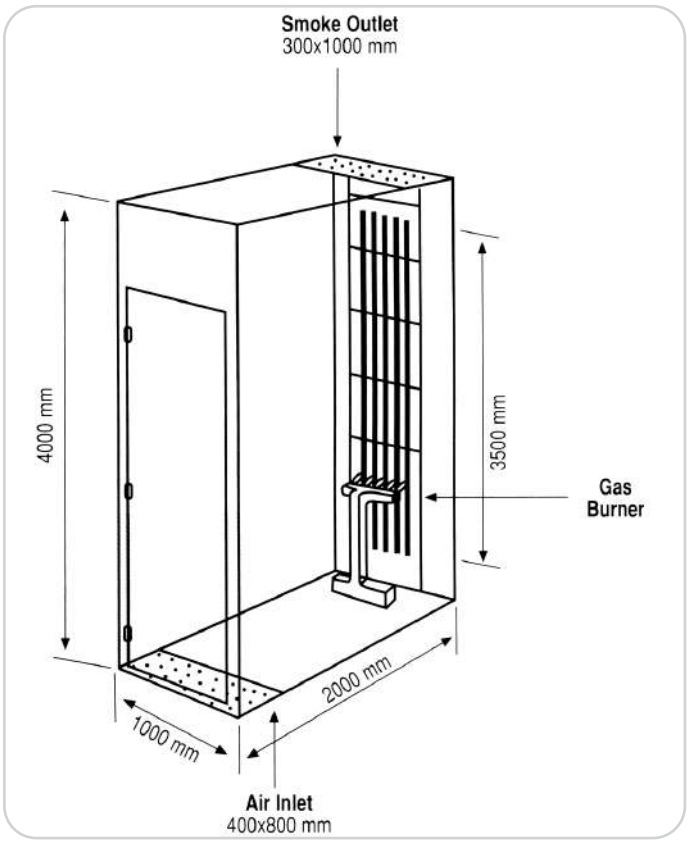
Electrical units				
1	ohm/1000 yd	=	1,0936	Ω/km
1	ohm/1000 ft	=	3,28	Ω/km
1	µF/mile	=	0,62	µF/km
1	megohm/mile	=	1,61	MΩ/km
1	µµf/foot	=	3,28	pF/m
1	decibel/mile	=	71,5	mN/m

Abbreviations for multiples and submultiples			
Prefix	mark	power	name
Tera	T	10^{12}	billion*
Giga	G	10^9	milliard*
Mega	M	10^6	million
Kilo	k	10^3	thousandth
Hekto	h	10^2	hundred
Deka	da	10^1	ten
Piko	p	10^{-12}	billionth*
Nano	n	10^{-9}	milliarth*
Mikro	µ	10^{-6}	millionth
Milli	m	10^{-3}	thousandth
Zenti	c	10^{-2}	hundredth
Dezi	d	10^{-1}	tenth

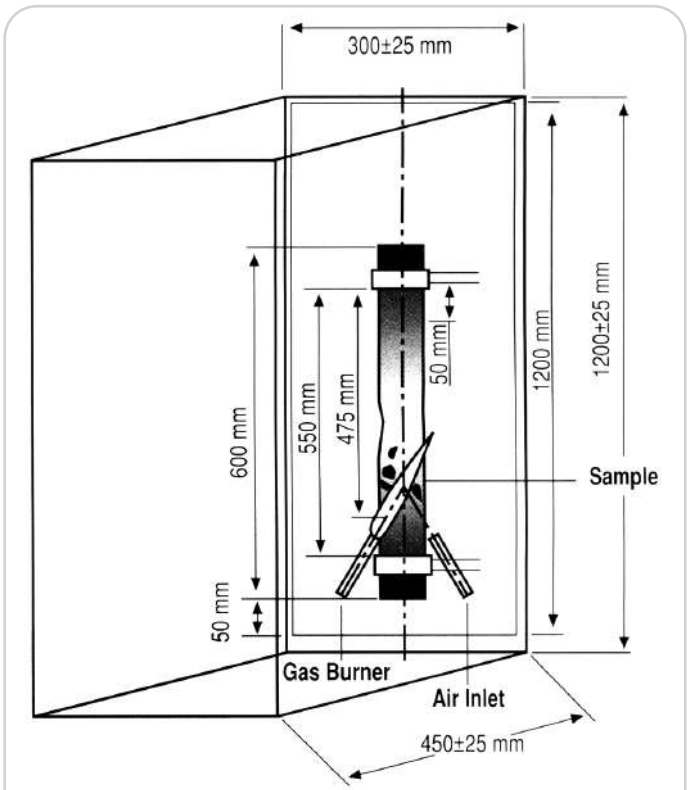
* In USA 10^9 indicates a billion and 10^{12} indicates a trillion

SOME OF MAIN TESTS FOR HFFR CABLES

IEC 60332/3 Fire test on bunched and vertical laid cables.
Test chamber



IEC 60332/1 Fire test on a vertical laid single cable.Test chamber



Flame application time

Required volume of combustible material
per 1 m of cable bunch (lt) : V

Flame application time

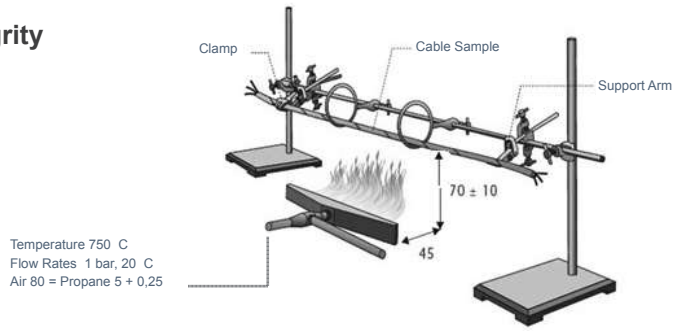
Weight of test piece (kg) : m
Flame application time (s) = 60+m/25

IEC 60332/3 CATEGORY	V	MINIMUM BURNING TIME
A	7lt.	40 minutes
B	3.5lt.	40 minutes
C	1.5lt	20 minutes

Test Conditions of IEC 60332/3

This test is to determine the fire propagation characteristics of a bunch of cables. The test should be carried out if the external wind speed measured by an anemometer fitted on the top of the test rig is not greater than 5 m/s and the temperature of the walls of the test chamber is in between 5 ºC and 40 ºC. The temperature inside of the chamber should be 23±5 ºC before the test

IEC 60331 - 21
Fire Test for circuit integrity



Smoke Intensity

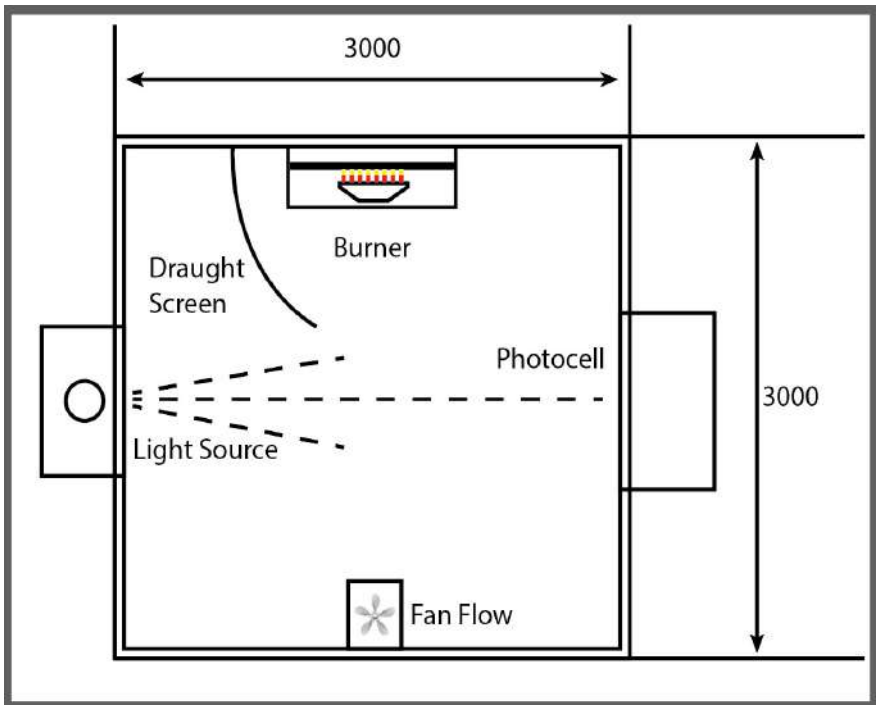
IEC 61034-2 / EN 61034-2 / DIN VDE 0482-1034-2

Cable bundle to be tested will be placed inside a metal tray containing ±%1 alcohol mixture per 1 liter and will be ignited inside a cabinet with a size of 3 m^3.

100W standard halogen and photocell based lamp and photometric system is positioned inside a cube with a height of 215 cm (± 10 cm), in the horizontal position on a medium vertical axis. Light transmission of the generated smoke is measured optically.

• Test equipment and flame verification must be in compliance with IEC/EN 61034-1 Standard.

Overall Diameter mm	Sample Number	Light Transmission
D > 40	1	> 60 %
20 < D ≤ 40	2	> 60 %
10 < D ≤ 20	3	> 60 %
5 < D ≤ 10	N_1	> 60 %
1 < D ≤ 5	N_2	> 60 %



Compliance Requirement

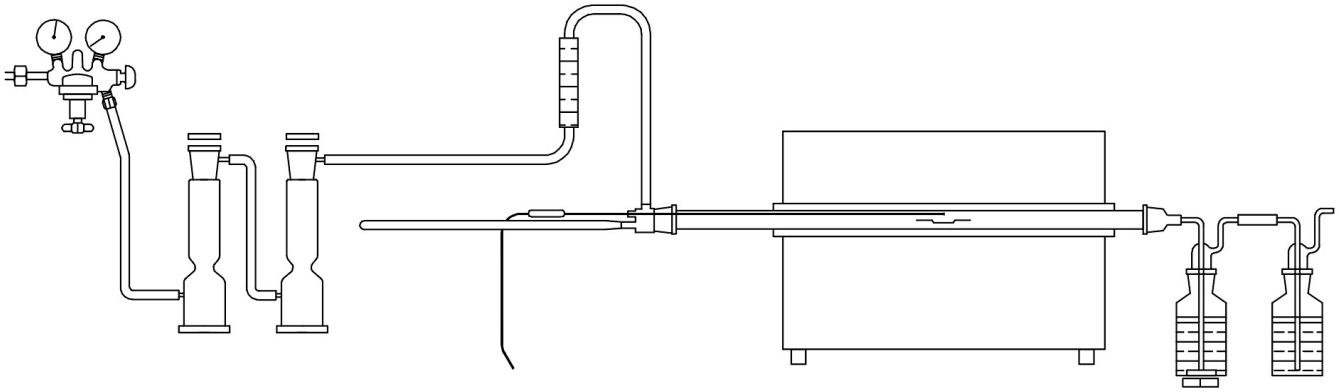
In order for the cable to pass the test, light absorption assessed in photometric terms should be seen within 40 minutes. Also minimum 60% light transmission should be obtained. In such a case, the cable passes the test.

pH Measurement and Conductivity Test

IEC 60754-2 / EN 60754-2

Cable to be subjected to this test which allows measuring corrosive gas emission of insulation or outer sheath composition must be 1 gram. Cable's insulation or outer sheath composition is heated at a temperature of 935°C. Gases formed as the result of test that lasts for 30 minutes are dissolved in distilled water with pH and conductivity. Halogen is calculated accordingly.

• Test equipment and flame verification must be in compliance with EN 50267-1 Standard.



Test apparatus - method 2

Compliance Requirement

In order for the cable to pass the test, pH value measured should be 4.3 or higher. Also it is expected for the electrical conductivity to be 10µS/mm or less.

CONSTRUCTION PRODUCTS REGULATION - CPR

What is the CPR?

CPR is an acronym for the European Construction Product Regulation (CPR). Any product manufactured and launched on the market that will constitute a permanent part of a building, and which performance will affect the performance of the Building.

The fire properties of cables are important for fire safety in buildings and due to this importance cables have been included in the European classification system under the CPR (Construction Products Regulation) and EN 50575:2014 standard describes "Power, control and communication cables – Cables for general applications in construction works subject to reaction to fire requirements".

EN 50575:2014 standard describes "Power, control and communication cables – Cables for general applications in construction works subject to reaction to fire requirements". Effective 1 July 2016, cable manufacturers may include CE marking on those of their products that have been tested and certified by a notified body, and issue a corresponding Declaration of Performance.

Power, Control, Communication and Optical Fiber cables which are permanently installed in structures is governed by EU Regulation 305/2011 (known as the "Construction Products Regulation"). The Construction Products Guideline 89/10/EEC has been superseded by the Construction Products Regulation (CPR) 305/2011.

At the moment the Regulation does not apply to lift cables, cables inside machinery and cables for use in industrial plant and marine, shipboard and offshore cables as well.

The EU Construction Products Regulation defines the conditions for CE marking and also requires manufacturers to issue a Declaration of Performance regarding the following key product features derived from the protection goals: fire safety (flame propagation, heat development, smoke production, acid formation, and flaming droplets) and the absence of harmful constituents.

Starting from 01 July 2017, the inclusion of CE marking and the issuing of a Declaration of Performance will become mandatory.

The Declaration of Performance certifies compliance with the fire classes and thus forms the requirement for using the cables for the applications defined by the EU countries.

Cables offering insulation and total system integrity (resistance to fire) will be treated in a separate standard to be harmonized in the future. Accordingly, they are neither governed by the current implementation of the Construction Products Regulation (CPR) nor is an application of the CPR to these kinds of cables expected before 2017.

For detailed information you can refer to below web-links;
http://eur-lex.europa.eu/eli/reg/2011/305/oj
https://ec.europa.eu/growth/sectors/construction/product-regulation_en

EN 50399 Common test methods for cables under fire conditions

EN 50399 specifies the test apparatus and test procedures for the assessment of the reaction to fire performance of cables to enable classification under the Construction Products Directive to be achieved.

The test method describes an intermediate scale fire test of multiple cables mounted on a vertical cable ladder and is carried out with a specified ignition source to evaluate the burning behavior of such cables and enable a direct declaration of performance.

The following parameters may be determined under defined conditions during the test:

- flame spread;
- heat release rate;
- total heat release;
- smoke production rate;
- total smoke production;
- fire growth rate index;
- occurrence of flaming droplets/particles

CONSTRUCTION PRODUCTS REGULATION - CPR

Euro Classification of Cables:

The fire behavior classes are summarized in the following table, which classifies the requirements from Aca (non-flammable) to B1ca or B2ca (very high), Cca (high), Dca (moderate), Eca (low) and Fca (no requirement).
The index "**ca**" stands for cable.

Digit 1: Fire propagation and heat emission performance, cable class (Aca, B1ca, B2ca, Cca, Dca, Eca, Fca).

Aca	They do not contribute to the fire.
B1ca -B2ca	Minimum contribution to the fire.
Cca – Dca – Eca	Combustible, they contribute the fire, from lower to higher contribution.
Fca	Undetermined contribution properties.

Digit 2: Smoke emission properties (s1, s1a, s1b, s2, s3).
This classification provides information about the opacity of the emitted smoke (s: smoke).

s1	Little smoke production and slow smoke propagation.
s1a	Transmittance >80%.
s1b	Transmittance >60% and <80%.
s2	Average smoke production and propagation.
s3	None of the above.

Digit 3: Burning droplets/particles (d0, d1, d2).
This classification provides information about the dripping of burning material during the fire (d: droplet).

d0	No burning droplets or particles.
d1	No burning droplets or particles that last more than 10 seconds.
d2	None of the above.

Digit 4: Acidity performance (a1, a2, a3) in addition applying the test described in standard EN 50267-2-3.
This classification provides information about the emission of acid gases during the fire (a: acidity).

a1	Conductivity < 2,5 µS/mm and pH > 4,3.
a2	Conductivity < 10 µS/mm and pH > 4,3.
a3	None of the above.

This performance code (fire reaction class and additional classification) according to the CPR must appear in the cable marking and in packing together with the rest of the marks. This classification system ranks equally in all European Union countries.

Assessment and Verification of Constancy of Performances

Depending on the main class of a product, a specific conformity procedure (AVPC) must be applied by the manufacturer. The systems 1+, 3 and 4 have been assigned for cable products. Depending on the system, different tasks are required of the manufacturer and the notified body. These tasks include production control and sample testing by the manufacturer, as well as an evaluation of the product performance, ongoing monitoring and product audits by the notified body.

System 1+
Classes B2ca and Cca–**Third Party Notified Body** issues a Certificate based on:
•Initial Type Test
•Factory Audit and regular factory production control (2 times per year)
•Audit Test (once per year on up to4 families) on product taken from the warehouse

System 3
Classes Dca and Eca-Third party **Notified Laboratory** issues a Laboratory report based on:
•Initial Type Test on product sent by Manufacturer

System 4
Class Fca – The producer prepares and shows on demand an AVCP (similar in future to LVD)

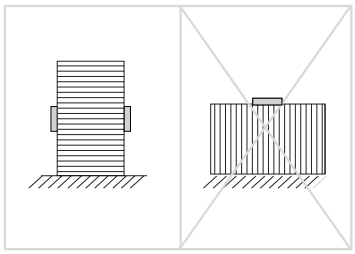
CLASSES OF REACTION TO FIRE PERFORMANCE FOR ELECTRIC CABLES

Class	Test method(s)	Classification criteria	Additional classification
A_{ca}	EN ISO 1716	PCS ≤ 2,0 MJ/kg(1)	
$B1_{ca}$	EN 50399 (30 kW flame source) and	FS ≤ 1,75 m and THR_{1200s} ≤ 10 MJ and Peak HRR ≤ 20 kW and FIGRA ≤ 120 Ws^{-1}	Smoke production (2,5) and Flaming droplets/particles (3) and Acidity (4)
	EN 60332-1-2	H ≤ 425 mm	
$B2_{ca}$	EN 50399 (20,5 kW flame source) and	FS ≤ 1,5 m; and THR1200 ≤ 15 MJ; and Peak HRR ≤ 30 kW; and FIGRA ≤ 150 Ws^{-1}	Smoke production (2,6) and Flaming droplets/particles (3) and Acidity (4)
	EN 60332-1-2	H ≤ 425 mm	
C_{ca}	EN 50399 (20,5 kW flame source) and	FS ≤ 2.0 m; and THR_{1200s} ≤ 30 MJ; and Peak HRR ≤ 60 kW; and FIGRA ≤ 300 Ws^{-1}	Smoke production (2,6) and Flaming droplets/particles (3) and Acidity (4)
	EN 60332-1-2	H ≤ 425 mm	
D_{ca}	EN 50399 (20,5 kW flame source) and	THR_{1200s} ≤ 70 MJ; and Peak HRR ≤ 400 kW; and FIGRA ≤ 1300 Ws^{-1}	Smoke production (2,6) and Flaming droplets/particles (3) and Acidity (4)
	EN 60332-1-2	H ≤ 425 mm	
E_{ca}	EN 60332-1-2	H ≤ 425 mm	
F_{ca}	No performance determined		

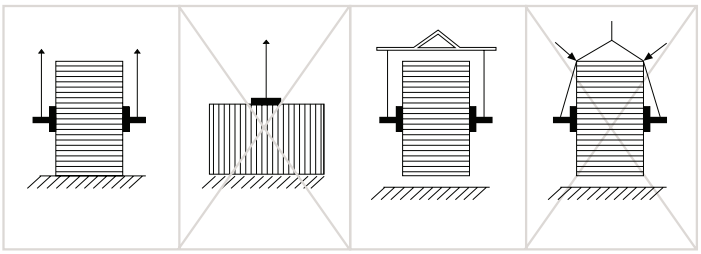
(1) For the product as a whole, excluding metallic materials, and for any external component (i.e. sheath) of the product.
(2) s1 = TSP_{1200s} ≤ 50 m2 and Peak SPR ≤ 0.25 m^2/s
s1a = s1 and transmittance in accordance with EN 61034-2 ≥ 80 %
s1b = s1 and transmittance in accordance with EN 61034-2 2 ≥ 60 % < 80 %
s2 = TSP_{1200s} ≤ 400 m^2 and Peak SPR ≤ 1,5 m^2/s
s3 = not s1 or s2
(3) d0 = No flaming droplets/particles within 1200 s; d1= No flaming droplets/ particles persisting longer than 10s within 1200 s; d2 = not d0 or d1.
(4) EN 50267-2-3: a1 = conductivity < 2,5 µS/mm and pH > 4,3; a2 = conductivity < 10 µS/mm and pH > 4,3; a3 = not a1 or a2. No declaration= No Performance Determined.
(5) The smoke class declared for class B1ca cables shall originate from the test according to EN 50399 (30 kW flame source)
(6) The smoke class declared for class B2ca, Cca, Dca cables shall originate from the test according to EN 50399 (20,5 kW flame source)

DRUM HANDLING AND STORAGE

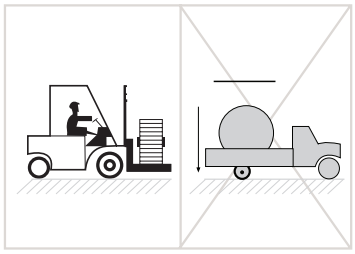
1.1.Position of Drums



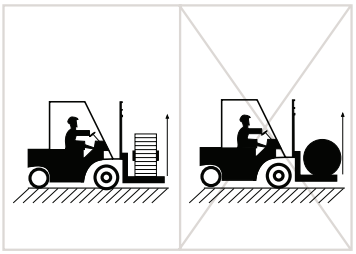
1.2.Loading



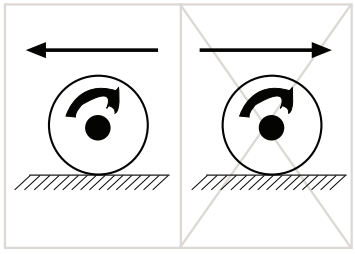
1.3.Unloading



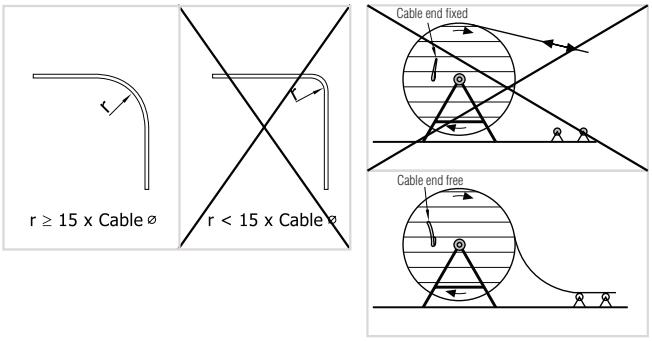
1.4.Handling by forklift



1.5.Rolling

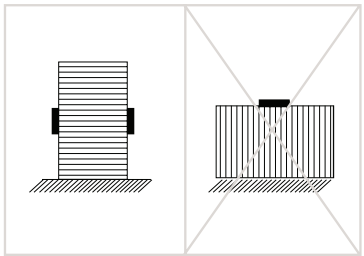


1.6.Paying-off the Cable

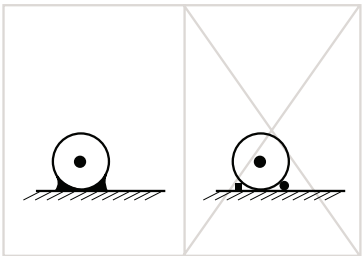


Transport Requirements

2.1.Position of the Drums

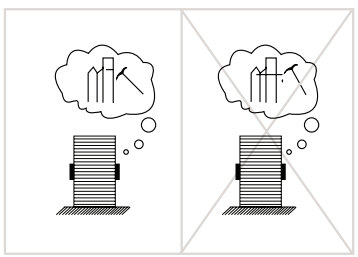


2.2.Fastening Drums

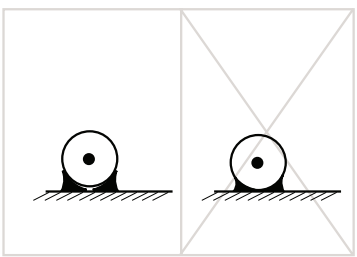


Cables and Drums User Guide

2.3.Use of nails

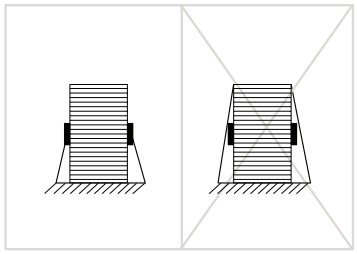


2.4.Bigger Drums

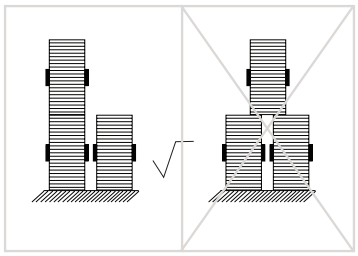


DRUM HANDLING AND STORAGE

2.5.Binding of the Drums

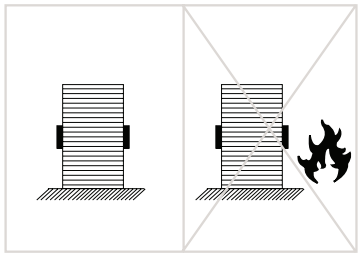


2.6.Multiple Drum Storage

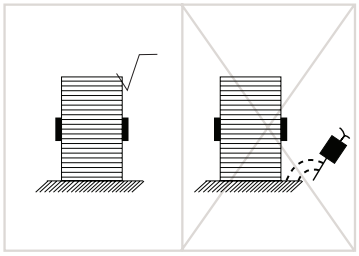


Storage Requirements

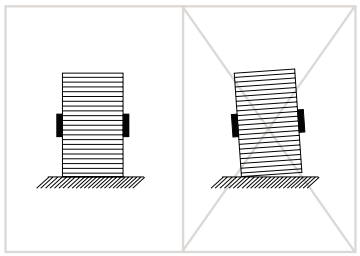
3.1.Do not store near heat sources



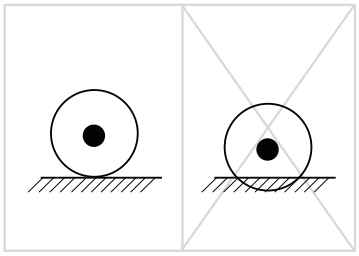
3.2. Do not store on vibrating surfaces. (Ship engine room etc.)



3.3.Do not store on irregular surfaces.



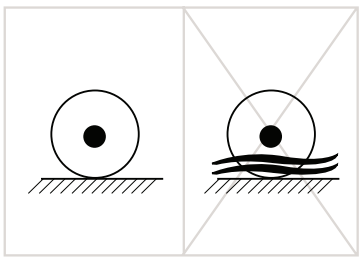
3.4.Do not store on soft surfaces

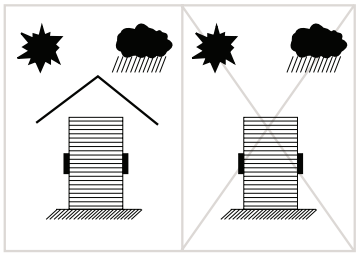


Cables and Drums User Guide

3.5. Do not store on areas liable of flooding. All cable ends must be fully sealed at all times to prevent the ingress of water. It is preferable to store reels off the ground on timbers or other supports. In damp locations, it is advisable to allow at least 3 inches between reels to permit circulation of air.

3.6. If storage is likely to last more than 6 months, drums should be stored in order to be protected from effects like rain, sunlight etc.






THE INTERNATIONAL CERTIFICATION NETWORK
CERTIFICATE
ÜNTEL KABLOLARI SAN. VE TİC. A.Ş.
TS EN ISO 14001:2004
CERTIFICATE OF APPROVAL
ISO 9001:2008
ÜNTEL
KABLOLARI SAN. VE TİC. A.Ş.
ISO/IEC 27001:2013
TS EN ISO 9001:2008
TS 18001:2014
TSE
İŞ SAĞLIĞI ve GÜVENLİĞİ YÖNETİM SİSTEMİ BELGESİ
OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM CERTIFICATE
TSE İSG-OHSAS TS 18001
TÜRK STANDARDLARI ENSTİTÜSÜ
TURKISH STANDARDS INSTITUTION
ÇEVRE YÖNETİM SİSTEMİ BELGESİ
ENVIRONMENTAL MANAGEMENT SYSTEM CERTIFICATE
TSE-ISO-EN 14000
KALİTE YÖNETİM SİSTEMİ BELGESİ
QUALITY MANAGEMENT SYSTEM CERTIFICATE
K - Q TSE-ISO-EN 9000
VDE Prüf- und Zer
TYPE APPROVAL
DET NORSKE V
TÜRK LOYDU
ABS
CERTIFICATE OF DESIGN AS
Type Approval Certificate
RAPOR

ClassNK · KONČAR INSTITUT za elektrotehniku · TSE · TSEK · ABS TYPE APPROVED PRODUCT · DNV·GL · TÜVRheinland · HAR · NetworkRail · Lloyd's Register · AFER · CFR · BUREAU VERITAS · IQNet

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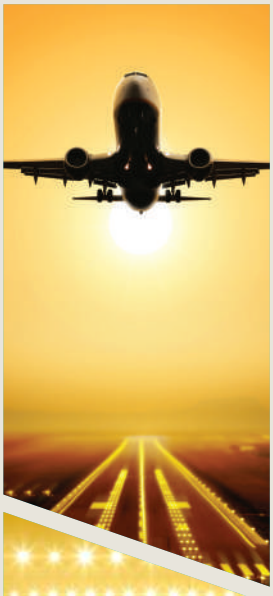
OFFSHORE CABLES

AIRPORT CABLES



CRANE CABLES

MINING CABLES

DEFENSE INDUSTRY CABLES

MARINE CABLES

RAILWAY CABLES

INDUSTRIAL CABLES

TUNNELLING CABLES

INSTRUMENTATION CABLES

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