Technical Information

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Copper and Alu-Price Calculation

The material price for cables and wires is usually based on a copper price of 150,00 EUR/100 kg.
For invoicing, as copper surcharge – the difference to the daily copper rate will be calculated.

The **Formula for calculating** the copper surcharge:

Copper surcharge in EUR/km = Copper value (kg/km) x $\frac{\text{(DEL+1\% delivery charge)} - \text{copper basis}}{100}$

DEL

The DEL (German electrolytic copper for guiding purpose) is the Stock Exchange Quotation for 99,5% pure copper. The value is given per EUR/100 kg in the economic part of daily newspapers.

Example: DEL quotation = 194,29 i. e.,
100 kg copper cost 194,29 EUR and
1% delivery charge is added to the daily quotation for cables and wires.

Copper basis

In our catalogue, for almost all cables and wires, a certain portion of copper price is already included.

- Standard cables – copper basis = EUR 150,0/100 kg
- Telephone cables – copper basis = EUR 100,0/100 kg
- Power cables – copper basis = EUR 0, – /100 kg (copper base = 0)

Copper value

The copper value is stated in our catalogue. It is the copper weight of a cable or a wire.

Example: JZ-500 8 x 0,75 mm^2, Part-No. 10040
Copper value 58 kg/km

Calculation example: for

JZ-500 8 x 0,75 mm^2

DEL 194,29 EUR/100 kg (assuming value)

Copper basis 150,0 EUR/100 kg
Copper value 58 kg/km

Copper surcharge = $\frac{(194{,}29 + 1{,}9429) - 150{,}0}{100}$ x 58 kg/km (calculated value 1,9429 = 1% of 194,29)

= 26,82 EUR/km

The net price including copper is calculated as follows:

Gross price
. /. individual discount
\+ Copper surcharge

Note: The copper surcharge is indicated separately in our invoices.

Continuation ▶

Copper and Alu-Price Calculation

Calculation examples:

Assumption:
- DEL-Quotation 194,29 EUR/100 kg for copper
- Daily rate 173,84 EUR/100 kg for aluminium
- Individual discount, e. g. 20%

1. NYY-J 3 x 70/35 sm, 0,6/1 kV, Part no. 32038

Quantity ordered 1000 m

Copper base = 0	9300,00 EUR/km
minus 20% (discount)	1860,00 EUR/km
	7440,00 EUR/km

+ Copper surcharge:

$\frac{(194{,}29 + 1{,}9429) - 0}{100}$ x Copper value

equal, 1,962 EUR/kg x 2352 kg/km =	4614,62 EUR/km
	12054,62 EUR/km

2. NYCWY 3 x 70/35 sm, 0,6/1 kV, Part No. 32268

Quantity ordered 1000 m

Copper base = 0	14780,00 EUR/km
minus 20% (discount)	2956,00 EUR/km
	11824,00 EUR/km

+ Copper surcharge (Conductor + screen):

$\frac{(194{,}29 + 1{,}9429) - 0}{100}$ x Copper value

equal, 1,962 EUR/kg x 2410 kg/km =	4728,42 EUR/km
	16552,42 EUR/km

3. NA2XSY 1 x 70 sm/16, 12/20 kV, Part No. 32454

Quantity ordered 1000 m

– Aluminium conductor
– Copper screen

Copper base = 0	9500,00 EUR/km
minus 20% (discount)	1900,00 EUR/km
	7600,00 EUR/km

+ Copper surcharge (screen):

$\frac{(194{,}29 + 1{,}9429) - 0}{100}$ x Copper value

equal, 1,962 EUR/kg x 182 kg/km =	357,08 EUR/km

+ Aluminium (Conductor):

Aluminium value x daily rate	
203 kg/km x 1,74 EUR/kg	353,22 EUR/km
	8310,30 EUR/km

Reference to DIN VDE Standards

Power Installations

• DIN VDE 0100	– Erection of power installations with rated voltages below 1000
• DIN VDE 0100 part 100	– General requirements, scope
• DIN VDE 0100 part 410	– Protective measures and protection against electric shock
• DIN VDE 0100 part 430	– Protection of cables against overcurrent
• Supplement 1 to part 430	– Recommended values for current-carrying capacity
• DIN VDE 0100 part 482	– Choice of protective measures, protection against fire
• DIN VDE 0100 part 520/part 530	– Selection and erection of equipment – cable, wires and wiring systems – Erection electrical equipment – switch- and controlgear
• DIN VDE 0100 part 559	– Luminiaries and lighting equipment
• DIN VDE 0100 part 701 to part 705	– Rooms containing a bath tub or shower basin – Roofed swimming pools (swimming baths) and open air swimming baths – Rooms containing electrical sauna-heaters – Installations site – Agricultural and horticultural premises
• DIN VDE 0100 part 720	– Fire-hazards locations
• DIN VDE 0100 part 726 up to 0 part 738	– Lifting and hoisting devices – Laying of cables in hollow walls and in buildings made up mainly flammable building materials – Cable entries into buildings in public cable network – Humid and wet areas, outdoor installation
• DIN VDE 0101	– Erection of power installations with rated voltages above 1 kV
• DIN VDE 0105	– Operation of power installations
• DIN VDE 0107	– Electrical installations in hospitals and locations for medical use outside hospitals
• DIN VDE 0108 part 1 up to part 100	– Power installations and safety power supply in comunal facilities, stores and shops and exhibition rooms, multi-storey buildings, Restaurants, closed car parks and working or business premises
• DIN VDE 0113	– Electrical equipment of industrial machines
• DIN VDE 0118	– Erection of electrical installations in mines
• DIN VDE 0165	– Installation of electrical apparatus in hazardous areas
• DIN VDE 0166	– Electrical installations and apparatus thereof for use in atmospheres potentially endangered by explosive material
• DIN VDE 0168	– Erection of electrical installation in open cast mines quarries and similar plants
• DIN VDE 0170/0171	– Electrical apparaturs for potentially explosive atmospheres
• DIN VDE 0185	– Lightning protection system, protection of structures against lightning
• DIN VDE 0207 part 1 up to part 24	– Insulating and sheathing compounds for cables and flexible cords
• DIN VDE 0245 part 1	– Cables and cords for electrical and electronic equipment in power installations
• DIN VDE 0245 part 101 up to part 202	– Flexible PVC-insulated control cable
• DIN VDE 0250 part 1 up to part 819	– Cables, wires and flexible cords for power installation
• DIN VDE 0253	– Heating – cables

Power guides

• DIN VDE 0262	– XLPE (cross linked PE) insulated and PVC sheathed installationscable up to 0,6/1 kV
• DIN VDE 0265	– Cables with plastic-insulated lead-sheat for power installation
• DIN VDE 0266 part 3 and part 4	– Halogen-free cables with improved characteristics in the case of fire, with reduced fire propagation and continuance of isolation for use in the containment of nuclear power plants

Reference to DIN VDE Standards

Power guides

- DIN VDE 0267 – Halogen-free cables with improved characteristics in the case of fire, nominal voltages up to 6 to 30 kV
- DIN VDE 0271 – PVC-insulated cables and sheathed power cables for rated voltages up to and including 3,6/6 (7,2) kV
- DIN VDE 0276 part 603 – Distribution cables of nominal voltages U_0 /U 0,6/1 kV
- DIN VDE 0276 part 604 – Power cables of nominal voltages U_0 /U 0,6/1 kV with special fire performance for use in power stations
- DIN VDE 0276 part 604/605 – Additional test methods
- DIN VDE 0276 part 620 – Distribution cables of nominal voltages U_0 /U 3,6 kV to 20,8/36 kV
- DIN VDE 0276 part 1000 – Current-carrying capacity, general; conversion factors
- DIN VDE 0276 part 1001 – Tests on cables laid with nominal voltages U_0 /U 6/10 kV, 12/20 kV and 18/30 kV with PVC-insulation, VPE-insulation or paper insulation.
- DIN VDE 0277 – Primary cables for airport lighting
- DIN VDE 0281 part 1 to part 404 – PVC-cables, wires and flexible cords for power installation
- DIN VDE 0282 part 1 to part 808 – Rubber cables and flexible cords for power installation, heat-resistant silicon rubber insulated cable, halogen-free insulated cable arc welding cable, rubber insulated lift cable, rubber-sheathed flexible cables
- DIN VDE 0284 – Mineral insulated cables with a rated voltages not exeeding 750 V
- DIN VDE 0289 part 1 to part 101 – Definations for cables, wires and flexible cords for power installation
- DIN VDE 0292 – Code designation for harmonized cables and flexible cords for power installations
- DIN VDE 0293 – Core identification for cables and flexible cords used in power installation
- DIN VDE 0295 – Conductors of cables, wires and flexible cords for power installation
- DIN VDE 0298 part 1 to part 300 – Application of cables and flexible cords in power installations

Testing, measurement

- DIN VDE 0472 part 1 to part 818 – Testing of cables, wires and flexible cords
- DIN VDE 0473 up to part 811 – Insulating and sheating materials of electric cables; Common test methods
- DIN VDE 0482 up to part 268 – Measurement of smoke density of cables

Telecommunications, Switchboard and Installations-cable

- DIN VDE 0800 part 1 to part 10 – Telecommunications
- DIN VDE 0811 – Ribbon cables with round conductors, with a pitch of 1,27 mm
- DIN VDE 0812 – Equipment wires and stranded equipment wires of telecommunications system
- DIN VDE 0813 – Switchboard cables for telecommunications system
- DIN VDE 0814 – Cords for telecommunications system
- DIN VDE 0815 – Wiring cables for telecommunications system (indoor cable)
- DIN VDE 0816 part 1 to part 3 – Outdoor cables for telecommunications system
- DIN VDE 0817 – Cables with stranded conductors for increased mechanical stress for telecommunications system
- DIN VDE 0818 – Self-supporting telecommunication aerial cables on overhead power lines above 1 kV
- DIN VDE 0839 – Electromagnetic compatibility
- DIN VDE 0881 – Equipment wires and flexible equipment wires with extended temperature
- DIN VDE 0891 part 1 to part 10 – Special directions and guidings principles of cables and insulated wires
- DIN VDE 0899 part 1 up to part 5 – Special specification for optical fiber, single cores, indoor and outdoor cables

Harmonized Identification

The harmonized identifications for cables and wires come to an agreement with the CENELEC-structure (HAR-agreement) are determined by the certification institute. These identifications conform the harmonized standards.
The harmonized identification must be visible on the core or the sheath in form of an imprint or embossing, or contained with a three-coloured black-red-yellow protected identification thread of different colour lengths (dimension in cm).

Harmonized identification				**Country**	**Certification institute**	
Kind of imprint or embossing	**Colour of identification thread black red yellow (dimension in cm)**				**Name**	**Designation**
CEBEC <HAR>	1	3	1	Belgium	Comite´ Electrotechnique Belge	CEBEC
<VDE> <HAR>	3	1	1	Germany	Verband Deutscher Elektrotechniker e.V. VDE Prüf- und Zertifizierungsinstitut	VDE
USE <HAR>	3	3	1	France	Union Technique de l'Electricité	UTE
IEMMEQU <HAR>	1	3	5	Italy	Instituto Italiano de Marchio Qualitá	IMQ
BASEC <HAR>	1	1	3	Great Britain and North Ireland	British Approvals Service for Cables	BASEC
KEMA-KEUR <HAR>	1	3	3	Netherlands	N.V. tot Keuring van Elektrotechnische Materialien	KEMA
SEMKO <HAR>	1	1	5	Sweden	Svenska Elektriska Materielkontrollanstalten	SEMKO
<ÖVE> <HAR>	3	1	5	Austria	Österreichischer Verband für Elektrotechnik	ÖVE
<DEMKO> <HAR>	3	1	3	Denmark	Danmarks Elektriske Materialkontroll	DEMKO
<NSAI> <HAR> <IIRS> <HAR>	3	3	5	Ireland	National Standards Authority of Ireland old: Institute for Industrial Research and Standards	NSAI (IIRS)
NEMKO <HAR>	1	1	7	Norway	Norges Elektriske Materiellkontroll	NEMKO
<>UNE<> <HAR> ((<>UNE<>))	3	1	7	Spain	up to 31. 12. 1992: Asociación Electrotécnica y Electrónica Española	AEE
AENOR <HAR>	3	1	9		from 01.01.1993: Asociación Española de Normalización y Certificación	AENOR
ELOT <HAR>	3	3	7	Greece	Hellenic Organization for Standardization	ELOT
<IPQ> <HAR>	1	1	9	Portugal	Instituto Portugués da Qualidade	IPQ
SEV <HAR>	1	3	9	Switzerland	Schweizerischer Elektrotechnischer Verein	SEV
FIMKO	1	3	7	Finnland	FIMKO LTD	FIMKO
MEEI <HAR>	3	3	9	Hungarian	Magyar Elektrotechnikai Ellenörzö Intézet	MEEI

Designation code for harmonized cables

according to DIN VDE 0281/DIN VDE 0282/DIN VDE 0292

Construction reference

H	05	V		V5		—	F		25	G	0,75

Identifications of destignation

A	authorised national standards
H	harmonized standards

Nominal voltage U

01	100 V
03	300/300 V
05	300/500 V
07	450/750 V

Insulation material

B	(EPR) Ethylene-propylene-rubber
G	(EVA) Ethylene-Vinylacetat-Copolymer
N2	(CR) Chloroprene rubber for welding cables
R	(NR a./o. SR) Natural a./o. synthetic rubber
S	(SiR) Silicone rubber
V	(PVC) Polyvinyl chloride
V2	(PVC) Polyvinyl chloride heat-resistant
V3	(PVC) Polyvinyl chloride low-temperature
V4	(PVC) Polyvinyl chloride cross-linked
Z	(PE) Polyethylene cross-linked

Structural elements

C	Screen
Q4	(PA) Additional polyimide core jacket
T	Additional textile braiding over laid-up cores
T6	Additional textile braiding over individual cores

Sheath/jacket material

B	(EPR) Ethylene-propylene rubber
J	Glass fibre braid
N	(CR) Chloroprene rubber
N2	(CR) Chloroprene rubber for welding cables
N4	(CR) Chloroprene rubber heat-resistant
Q	(PUR) Polyurethane
R	(NR a./o. SR) Natural- a./o. synthetic rubber
T	Textile braid
T2	Textile braid with flame retardant compound
V	(PVC) Polyvinyl chloride
V2	(PVC) Polyvinyl chloride heat-resistant
V3	(PVC) Polyvinyl chloride low-temperature
V4	(PVC) Polyvinyl chloride cross-linked
V5	(PVC) Polyvinyl chloride oil resistant

Special structural features

D3	Stress-relieving elements (support wire)
D5	Centre core (no supporting element)
FM	Telecommunications cores integrated in power cables
H	Flat, separable cable (twin cable)
H2	Flat, non-separable cable (two-core sheathed cable)
H6	Flat, non-separable cable (multi- and multiple sheathed cable)
H7	Two-layer insulating jacket
H8	Spiral cables

Conductor type

D	Finely stranded, for welding cables
E	(very) finely stranded, for welding cables
F	Finely stranded, for cables for fixed installation
H	(Very) finely stranded, for flexible cables
K	Finely stranded, for cables for fixed installation
R	Multiple-wire, round, class 2
U	Single-wire, round, class 1
Y	Tinsel wire, DIN 47104

Number of cores

Earth core

G	With earth core
X	Without earth core

Conductor nominal cross section in mm²

Examples:

H07V-U 2,5 black (according to DIN VDE 0281)
Harmonized PVC-insulated single-core sheathed cable, 2,5 mm² single-core, nominal voltage 750 V

H07RN-F 3G 1,5 (according to DIN VDE 0282)
Harmonized rubber-sheathed-cable for medium tensile loads, three-core 1,5 mm², finely stranded, green-yellow earth core, nominal voltage 750 V

Code-designation for harmonized cables and flexible cords to DIN VDE 0292 and HD 361 S2/S3

This system of code-designation is prepared by CENELEC for harmonized cables as flexible cords for power installations and published in Harmonization Document 361 S3.

Kind of Standards

Code-designation	Classified to Standards
H	cables and wires to harmonized documents
A	authorised national standards

Conductor material

without designation	Copper
– A	Aluminium
– Z	Conductor of special material and/or special shape

Type and shape of conductor

– D	fine wire stranded conductor for welding cables
– E	extra fine wire stranded conductor for welding cables
– F	fine wire stranded conductor for flexible cables according to DIN VDE 0295, class 5
– H	extra fine wire stranded conductor for flexible cables according to DIN VDE 0295, class 6
– K	fine wire stranded conductor for fixed installation (if not specified, equivalent to DIN VDE 0295, classe 5)
– M	Milliken conductor
– R	conductor of multistranded wires
– S	sector-shaped conductor of multistranded wires
– U	round conductor of single wire
– W	sector-shaped conductor of single wire
– Y	tinsel conductor
– Z	conductor of special material and/or special shape

Core numbers and cross-section of conductor

Number	number of cores n
X	Multiplication sign without green-yellow core
G	Multiplication sign for green-yellow core
Y	tinsel conductor, whereby the cross-section is not specified

Insulation and sheath materials

B	Ethylene-propylene-rubber for Temp. of +90°C
B2	Ethylene-propylene rubber, hardend
B3	Butyl rubber (isobutylene-isoprene rubber)
E	Polyethelene
E2	Polyethelene, high density
E4	Polytetrafluorethylene
E5	Perfluor (Ethylene-propylene – copolymers)
E6	Ethylene-tetrafluorethylene – copolymers
E7	Polypropylene

Insulation and sheath materials

Code-designation	Materials
G	Ethylene-vinylacetate – copolymers
J	braiding of glass fibre
J2	wrapping of glass fibre
M	mineral insulation
N	chloroprene-rubber (or equivalent material)
N2	special compound of chloroprene-rubber
N4	Sulfonated chlor or chlorinated polyethelene
N5	Nitril-rubber
N6	Florinated rubber
N7	PVC-Nitril-rubber compound
N8	Special-polychloroprene-rubber, water resistant
P	Cables with impregnated paper insulation for multicore belted cable
Q	Polyurethane
Q2	Polyethyleneterephthalate
Q3	Polystyrole
Q4	Polyamide
Q5	Polyimide
Q6	Polyvinylidene fluoride
R	Ethylene-propylene rubber or equivalent synthetic elastomer for +60°C temperature of +60°C, for permanent temperature of +60°C
S	Silicon-rubber
T	textile braiding over twisted cores, impregnated/unimpregnated
T2	textile braiding with flamme retardant impregnated composition
T3	layer of textile as core wrapping or tape
T4	layer of textile as core wrapping or tape with flame retardant impregnated composition
T5	corrosion protection
T6	textile braiding over individual core or multicore cable, impregnated/unimpregnated
V	PVC soft
V2	PVC soft, resistant to increased temperature, +90°C
V3	PVC soft, for low temperatures
V4	PVC soft, cross-linked
V5	PVC soft, oil resistant
X	cross-linked polyethylene
Z	cross-linked compound to a basis of polyolefine, for low corrosiv gas and low smoke emission in case of fire
Z1	Thermoplastic compound to a basis of polyole-fine, for low corrosiv gas and low smoke emission in case of fire

Continuation ▶

Code-designation for harmonized cables and flexible cords to DIN VDE 0292 and HD 361 S2/S3

Metal sheath, concentric conductor and screens

Code-designation	Metal sheath
A2	Aluminium sheath, pressed or welded, smooth
A3	Aluminium sheath, pressed or welded, corrugated
A4	Aluminium sheath over individual core
A5	Aluminium sheath of Band
C2	Copper sheath
C3	Copper sheath, corrugated
F	Steel sheath
F3	Steel sheath, corrugated
K	Zinc sheath
L	Alloyed lead sheath for general use
L2	non-alloyed lead sheath, normal pure lead
L4	alloyed lead sheath over individual core
L5	non-alloyed lead sheath over individual core
L6	alloyed lead sheath, but other composition than above

Concentric conductors

A	concentric aluminium conductor
A6	concentric aluminium conductor, meander-shaped
C	concentric copper-conductor
C6	concentric copper-conductor, meander-shaped
C9	divided concentric copper conductor

Screens

A7	Aluminium screen
A8	Aluminium screen of individual core
C4	Copper screen as braid over the stranded cores
C5	Copper screen braiding over individual core
C7	Copper screen of tape, round or profile-wires over twisted cores
C8	Copper screen as C7, over individual core
D	screen of one or more thin steel tapes, laying direkt over twisted cores, in contact with a stranded plain conductor

Armouring

Code-designation	Armouring**
Z2	Armouring of round steel wires*, galvanized/ ungalvanized
Z3	Armouring of flat steel wires*, galvanized/ ungalvanized
Z4	Armouring of steel tape, galvanized/ ungalvanized
Z5	Braiding of steel wires, galvanized, ungalvanized
Z6	Supporting braid of steel wires
Z7	Armouring of sectional steel wires
Y2	Armouring of round aluminium wires*
Y3	Armouring of flat aluminium wires*
Y5	Armouring of special materials
Y6	Armouring of steel wires and/or steel tape and copper wires

* counter helix, if specified
** see remarks DIN VDE 0292

Special constructive supporting elements

D2	Supporting elements of textile or steel wires over cable core
D3	Textil supporting elements of one or more elements, stranded in the core of circular cable or placed in a flat cable
D4	self-supporting cables and wires, where the conductor permits the strain-relieving function
D5	central core element (not as supporting element), used for lift cable
D7	as D3, the supporting element however is connected externally
D8	as D7, however a section horizontal to the axis of the cable forming the number "8"

Special versions

without designation	round cable construction
H	flat type as seperable cables with or without sheath
H2	flat type of cables unseperable
H3	building cable, flat webbed
H4	multicore flat cable with one plain conductor
H5	two or more single core stranded, non-sheathed cables
H6	flat cables according to HD 359 or EN 50214 with 3 or more cores
H7	Cable with two-sheathed extruded insulation
H8	Coiled conductor

Comparison of harmonized cables with IEC, DIN VDE and HD

PVC-insulated cables according to DIN VDE 0281 in comparison with IEC and HD

Designation	accord. to VDE part . . .	short designation new	short designation old VDE 0250	nominal cross-section (mm²)	nominal voltage U_0/U (V)	according to HD	comparative design to IEC
PVC-wiring cables single wire fine wires	 0281 part 3 0281 part 3	 H 05V-U H 05V-K	 NYFA, NYA NYFAF, NYAF	 0,5 to 1,0	 300/500	 HD 21.3 S3	 227 IEC 01 227 IEC 01
PVC-insulated cables single wire multi-stranded wires fine wires	 0281 part 3 0281 part 3 0281 part 3	 H 07V-U H 07V-R H 07V-K	 NYA NYA NYAF	 1,5 to 10 1,5 to 400 1,5 to 240	 450/750	 HD 21.3 S3	 227 IEC 01 227 IEC 01 227 IEC 02
Light PVC-Twin cables	0281 part 5	H 03VH-Y	NLYZ	0,1	300/300	HD 21.5 S3	227 IEC 41
Twin cables	0281 part 5	H 03VH-H	NYZ	0,5+0,75	300/300	HD 21.5 S3	227 IEC 42
PVC-sheathed cables 03VV-F round flat	 0281 part 5 0281 part 5	 H 03VV-F H 03VVH2-F	 NYLHY rund NYLHY flach	 0,5+0,75 0,5+0,75	 300/300	 HD 21.5 S3	 227 IEC 43 227 IEC 43
PVC-sheathed cables 05 VV-F round flat	 0281 part 5 0281 part 5	 H 05VV-F H 05VVH2-F	 NYMHY rund NYMHY rund NYMHY flach	 0,75 to 2,5 1 to 2,5 0,75	 300/500 300/500	 HD 21.5 S3	 227 IEC 53 227 IEC 53
PVC-Flat-cable 05VV-H6 PVC-Flat-cable 07VV-H6	0281 part 403 0281 part 404	H 05VVH6-F H 07VVH6-F	NYFLY NYFLY	0,75 to 1 1,5 to 25	300/500 450/750	–	– –

Rubber insulated power cables according to DIN VDE 0282 in comparison with IEC and HD

Designation	according to VDE	short designation new	short designation old VDE 0250	nominal cross-section (mm²)	nominal voltage U_0/U (V)	according to HD	comparative design to IEC
Heat-resistant rubberinsulated cable H 07G	0282 part 7 0282 part 7	H 07G-U H 07G-K	N4GA N4GAF	1,5+2,5 0,5 to 95	450/750	HD 22.7 S2	– –
Heat-resistant siliconerubber cable	0282 part 3	H 05SJ-K	N2GAFU	0,5 to 95	300/500	HD 22.3 S2	245 IEC 03
Braided flexible cord	0282 part 4	H 03RT-F	NSA	0,75 to 1,5	300/500	HD 22.4 S3	245 IEC 51
Rubber sheathed flexible cord 05RR	0282 part 4	H 05RR-F	NLH, NMH	0,75 to 2,5	300/500	HD 22.4 S3	245 IEC 53
Polychloroprene sheathed flexible cable 05RN	0282 part 4	H 05RN-F	NYMHöu NYMHöu NYMHöu	0,75+1 0,75+1 0,75	300/500	HD 22.4 S3	245 IEC 57 245 IEC 57 245 IEC 57
Polychloroprene sheathed flexible cable 07RN	0282 part 4	H 07RN-F	NMHöu NSHöu	1,5 to 500 1 to 25 1 to 300 1,5+2,5	450/750	HD 22.4 S3	245 IEC 65 245 IEC 66
Rubber insulated lift cable with textile braid 05RT2D5 Rubber insulated lift cable with polychloroprene sheath 05RND5	0282 part 807 0282 part 807	H 05RT2D5-F H 05RND5-F	NFLG NFLGC	0,75 0,75	300/500 300/500	– –	– –
Rubber insulated lift cable with textile braid 07RT2D5 Rubber insulated lift cable with polychloroprene sheath 07RND5	0282 part 808 0282 part 808	H 07RT2D5-F H 07RND5-F	NFLG NFLGC	1 1	450/750 450/750	– –	– –

IEC-defination
IEC 227: Polyvinylchloride insulated flexible cables and cords with circular conductors and a rated voltage not exceeding 750 V
IEC 245: Rubber insulated flexible cables and cords with circular conductors and a rated voltage not exceeding 750 V

Designation code for power cables
according to DIN VDE 0271/0276

Construction reference

Identifications of designation
N DIN VDE standard
(N) similar to DIN VDE standard

Conductor material
A aluminium conductor
– copper conductor

Insulating materials
Y PVC
2X cross-linked PE (XLPE)
impregnated paper

Concentric conductor (screen)
C concentric conductor of copper
CW concentric conductor of copper in waveconal formation
CE concentric conductor of copper over each individual core
S screen of copper wires
SE screen of copper wires over each individual core
H conductive layers
(F) longitudinally water-proof screen

Armouring
B steel tape armouring
F armour of galvanized flat steel wires
G counter helix of galvanized steel tape
R armour of galvanized round steel wires

Sheath Material
A oversheath made of fibrous material
K ead sheath
KL aluminium sheath
Y PVC
2Y PE

Protective Conductor
I with protective conductor
O without protective conductor

Number of cores

Conductor cross section in mm²

Conductor type
r ... circular conductor
s ... sector conductor
o ... oval conductor
e ... circular, solid conductor
..m stranded conductor
..h hollow circular conductor
/V compact conductor

Rating Voltage
0,6/1 kV
3,6/6 kV
6,0/10 kV
12/20 kV
18/30 kV

Examples

NA2XS2Y 1x 35 RM/16 6/10 kV
Single core XLPE-insulated cable with PE-sheath according to standard, circular, stranded aluminium conductor with nominal cross-section 35 mm², covered with copper-screen 16 mm² and rating voltage (U_0 /U) 6/10 kV

NYY-J 12x 1,5 RE 0,6/1 kV
Cable according to standard, PVC-insulated, sheath PVC, with green-yellow marked core, 12 cores with nominal cross-section 1,5 mm², circular conductor, solid, rating voltage 0,6/1 kV

Designation code for telephone cables, jumper wires and stranded hook-up wires

Construction reference

Basic cable type with additional information

A	outdoor cable	**IE**	installation cable for industrial electronic
AB	outdoor cable with lightning protection requirements	**IE-H**	installation cable for industrial electronic, halogen-free
AJ	outdoor cable with induction protection requirements	**S**	switchboard cable
G	mining cable	**T**	distribution cable
I	installation cable	**YV/Li...**	jumper wires/hook-up wires

Insulation

P	dry paper	**3Y**	Styroflex
Y	PVC (Polyvinylchloride)	**5Y**	PTFE
2Y	PE (Polyethylene)	**6Y**	FEP
02Y	foamed PE (cellular)	**7Y**	ETFE
02YS	foam-skin insulation		

Screening

C	screen of braided copper wires	**(ms)**	magnetic screen steel tape
D	copper screen, helically stranded	**(St)**	screen of plastic coated metallic foil
F	filling of cable core with petrol-jelly	**(Z)**	high tensile steel wire braiding
(K)	screen of copper tape with PE-inner sheath		
(L)	aluminium tape		

Sheath Material

L	smooth aluminium sheath	**M**	lead sheath
(L)2Y	copolymer coated aluminium moisture barrier sheath	**Mz**	lead alloy sheath
LD	corrugated aluminium sheath	**W**	corrugated steel sheath

Protective coating

Y	PVC sheath	**2Y**	PE sheath
Yv	reinforced protective sheath of PVC	**2Yv**	reinforced protective PE sheath
Yw	PVC sheath heat-resistant	**E**	compound with embeded plastic tape
Yu	PVC flame resistant (non-flammable)	**C**	protective covering of jute and compound

Number of stranding elements

.. x1x	single core	**.. x4x**	quad
.. x2x	pair (double cores)	**.. x5x**	five-core
.. x3x	triple		

Conductor diameter in mm

Type of stranding components

F	star quad with phantom circuit in railway cables	**St V**	star quad for transmission of f = 550 kHz
S	signal core in railway signal cable	**St VI**	star quad for transmission of f = 17 MHz
StO	star quad general	**DM**	Dieselhorst-Martin quad
St	star quad with phantom circuit for long distance	**TF**	carrier frequency star quad
St I	star quad without phantom circuit	**P**	twisted pair
St II	star quad like St III, but with increased capacitance unbalances	**PiMF**	pair in metal foil
St III	star quad in local (Subscriber) cable	**ViMF**	quad in metal foil
St IV	star quad for transmission of f = 120 kHz	**BdiMF**	unit in metal foil
		Kx	coaxial cable

Stranding layout

Lg	ayer stranding concentric
Bd	unit stranding

Armouring wire

A	layer of Al-wires for inductive protection	**2B 0,5**	2 layers steel tape, thickness 0,5 mm
b	armouring	**D**	layer of copper wires for inductive protection
B	armouring of steel band for inductive protection	**(T)**	strain bearing of steel wires for aerial cable
1B 0,3	1 layer steel tape, thickness 0,3 mm		

Code-designation-explanations for cables and insulated wire

A-	Outdoor cable
A	approved national design
AB	Outdoor cable with lighting protection
AD	Outdoor cable with differential protection
AJ-	Outdoor cable with induction protection
ASLH	self-supporting communication cables for high voltage overhead lines
B	armouring
B	spinning of textile yarn
b	armouring
(1B...)	one layer of steel tape... thickness of the steel tape in mm
(2B...)	two layers of steel tape... thickness of the steel tape in mm
BD	unit-type stranding
BLK	bare copper-conductor without insulation
BZ	bronze conductor
C	screen of copper wire braiding
C	screen of copper wire spinning
C	outer protection of jute and viscous compound
Cu	copper wire
(-Cu)	total cross-section of copper screens (mm^2)
D	screen of copper wires
(D)	screen of helically applied copper wires
DM	Dieselhorst-Martin quad
Dreier	three cores in triple stranded
E	copper drain wire
E(e)	protective covering of viscous compound with embedded layer of plastic tape
e	single wire, solid
F	cable cores assembly with petrol-jelly
F	foil wrapping
F	flat cable
F	star quad for railway cable
F	star quad for phantom circuits
(F...)	flat wire armouring... thickness in mm
OF	jelly filled cable core, filling compound of hard substances
FR	flame retardant
f	flexible, fine wire stranding
ff	extra fine wire stranding
G	insulation or sheath material of rubber (NR) or (SBR)
G-	Mining cable
GJ	Mining cable with induction protection
GS	glass fibre whipping or braiding
2G	insulation or jacket of silicone rubber, (SIR)
3G	insulation or jacket of ethylene propylene rubber, (EPR)
4G	insulation or jacket of ethylene vinylacetate rubber (EVA)
5G	insulation or jacket of chloroprene rubber (CR)
6G	insulation or jacket of chlorosulphonated polyethylene (CSM), Hypalon
7G	insulation or jacket of Flouroelastomer (FKM)
8G	insulation or jacket of Nitrile rubber (NBR)
9G	PE-C rubber (CM)
53G	CM, chlorinated Polyethylene
H	insulation or jacket of halogen-free compound
H	Harmonized Documents
(H...)	maximal value of mutual capacitance (nF /km)
(HS)	semi-conducting tape of layer
HX	cross-linked, halogen-free polymer compound
...IMF	individual stranding element (pairs or single cores etc.) in metal foil and drain wire
IMF	several stranding elements in metalfoil and drain wire
-J	cable with green-yellow earth core
-JZ	cable with green-yellow earth core and cores with inprinted numbers
K	copper-tape
(K)	inner sheath and longitudinally folded copper tape
LA	tinsel conductor (flat copper wire stranded over the thread of synthetic fibres)
LD	corrugated aluminium sheath
Lg	in layers stranding
Li	stranded wires conductor
(L)Y	laminated sheath Al-tape and PVC-jacket
(L)2Y	laminated sheath Al-tape and PE-jacketl
2L	double enamel coating as insulation
M	plastic-sheath cable
M	lead sheath
Mz	alloyed lead sheath
(mS)	magnetic shield
N	VDE standard
(N)	in adapted to VDE standard
NC	non-corrosiv, smoke-gase
NF	natural colour
-O	cable without green-yellow earth core
-OZ	cable without green-yellow earth core and cores with imprinted numbers
ö	oil-resistant
02Y	Foam-PE, insulation (cellular PE)
Q	Steel wire braiding
(R...)	round wire, diameter in mm
RAGL-	Compensating cable for thermocoupling
RD-	Rhenomatic cable
RE	Computer cable
RG-	Coaxial cable according MIL specification
re	round, single wire
rm	round, multiwire
RS-	computer switchboard cable
S	silk whipping
S	signal cables for railways
(S...)	nominal value of mutual capacitance (nF /km)
-S	signal cable for German Railway
S-	Switchboard cable
SL	flexible sheathed cable
2S	two layers of silk whipping
St	star quad for phantom circuits
St I	star quad in telephone cables for lager distance
St III	star quad in local cables
(St)	static screen
Staku	copper clad steel wire
Staku-Li	copper clad steel stranded wires
...t	termite protection
T	supporting element for overhead cable
T-	fan out cable
TF	carrier frequency of pairs or quads triple
TiC	triple in copper wire braid
TiMF	triple in metal foil
U	braiding of textile fibres
VGD	gold-plated
VN	ickel-plated; VS silver-plated
VZK	galvanized; VZN tinned
W	corrugated steel sheath
W	high heat resistant
W	corrugated steel sheath
X	cross-linked polyvinylchlorid (X-PVC) or other materials
XPE	cross-linked polyethylene (X-PE)
2X	cross-linked polyethylene
7X	cross-linked Ethylentetrafluorethylen (X-ETFE)
10X	cross-linked Polyvinylidenfluorid (X-PVDF)
Y	PVC, polyvinylchloride
Yu	PVC, polyvinylchloride, non-flammable, flame-retardant
Yv	PVC, polyvinylchloride, with reinforced sheath
YV	Equipment wires with tinned conductor
Yw	PVC, polyvinylchlorid, heat resistant upto 90°C
2Y	Polyethylene (PE)
2Yv	Polyethylene, reinforced sheath
02Y	Cellular polyethylene
02YS	insulation of cellular polyethylene with outer PE-skin
2YHO	insulation of air-spaced polyethylene
3Y	insulation polystyrene (PS), Styroflex
4Y	insulation or jacket of polyamide (PA)
5Y	insulation or jacket of polytetrafluorethylene (PTFE), HELUFLON®
5YX	Perfluoralkoxy (PFA)
6Y	Perfluoroethylene-propylene (FEP), HELUFLON®
7Y	insulation or jacket of ethylentetrafluorethylen (ETFE)
8Y	insulation of polyimid (PI), Kapton®
9Y	polypropylen (PP)
10Y	PVDF, Polyvinylidene fluoride
11Y	polyurethan (PUR)
12Y	TPE-E, TPE
13Y	TPE-EE, TPE on base of Polyester-Ester
31Y	TPE-S, TPE on base of Polystyrol
41Y	TPE-A, TPE on base of Polyamide
51Y	PFA, Perfluor-Alkoxylalkane
71Y	ECTFE, Monochlortrifluorethylene
91Y	TPE-0, TPE on base of Polyester-Ester
-Z	core imprinted with numbers
Z	twin cable
(Z)	high-tensile braid of steel wires
(ZG)	high-tensile element of glass fibre yarn
(ZN)	high-tensile of non-metallic elements

Conductor-diameters according to VDE 0295 (DIN EN 60228)

The indicated values are stated in the following table containing the conductor diameters according to the dimension of cross-sections and conductor classes in VDE 0295 (DIN EN 60228).

Single-wire round (Cu und Alu) **class 1**			Multi stranded wires, round compacted (Cu) **class 2**	Fine and extra-fine copper wires **class 5 and 6**
Nominal-cross-section mm^2	min-ø[3] mm	max-ø mm	max-ø mm	max-ø mm
0,5	–	0,9	1,1	1,1
0,75	–	1,0	1,2	1,3
1	–	1,2	1,4	1,5
1,5	–	1,5	1,7	1,8
2,5	–	1,9	2,2	2,4
4	–	2,4	2,7	3,0
6	–	2,9	3,3	3,9
10	–	3,7	4,2	5,1
16	–	4,6	5,3	6,3
25	5,2[1]	5,7[2]	6,6	7,8
35	6,1[1]	6,7[2]	7,9	9,2
50	7,2[1]	7,8[2]	9,1	11,0
70	8,7[1]	9,4[2]	11,0	13,1
95	10,3[1]	11,0[2]	12,9	15,1
120	11,6[1]	12,4[2]	14,5	17,0
150	12,9[1]	13,8[2]	16,2	19,0
185	–	15,4	18,0	21,0
240	–	17,6	20,6	24,0
300	–	19,8	23,1	27,0
400	–	22,2	26,1	31,0
500	–	–	29,2	35,0
630	–	–	33,2	39,0
800	–	–	37,6	–
1000	–	–	42,2	–

[1] only for Aluminium round conductor
[2] for mineral-insulated round conductor, only for copper
[3] min-ø for round Cu-conductor are not scheduled

Conductor resistance (extracted from DIN VDE 0295, IEC 60228 and HD 383)

The values are extracted from DIN VDE 0295 (equivalent with the international standard IEC 60228 and HD 383), according to cross-sections and conductor classes, beginning with nominal cross-section of 0,5 mm^2. The diameters of the single wires of each bunched conductor are not permitted to exceed the maximum stated values (ref. DIN VDE 0295), which are required to conform the maximum resistance value of the bunched conductors at 20° C.

Nominal cross-section	Copper conductor **plain** wires (Ohm/km)		Copper conductor **tinned** wires (Ohm/km)	
mm^2	**class 1** and **2**	**Class 5** and **6**	**Class 1** and **2**	**Class 5** and **6**
0,05	–	~380	–	~392
0,08	–	~237	–	244
0,11	–	~170	–	~175
0,126	–	~150	–	~155
0,14	–	~134	–	~138
0,22	–	~ 96	–	~ 99
0,25	–	~ 76	–	~ 79
0,34	–	~ 53	–	~ 56
0,5	36,0	39,0	36,7	40,1
0,75	24,5	26,0	24,8	26,7
1,0	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
4,0	4,61	4,95	4,70	5,09
6,0	3,08	3,30	3,11	3,39
10,0	1,83	1,91	1,84	1,95
16,0	1,15	1,21	1,16	1,24
25,0	0,727*	0,780	0,734	0,795
35,0	0,524*	0,554	0,529	0,565
50,0	0,387*	0,386	0,391	0,393
70,0	0,268*	0,272	0,270	0,277
95,0	0,193*	0,206	0,195	0,210
120,0	0,153*	0,161	0,154	0,164
150,0	0,124*	0,129	0,126	0,132
185,0	0,0991	0,106	0,100	0,108
240,0	0,0754	0,0801	0,0762	0,0817
300,0	0,0601	0,0641	0,0607	0,0654
400,0	0,0470	0,0486	0,0475	0,0495
500,0	0,0366	0,0384	0,0369	0,0391
630,0	0,0283	0,0287	0,0286	0,0292

class 1 = single core conductor for single and multi core cables
class 2 = multi core conductors for single and multi core cables
class 5 = fine wire copper conductors for single and multi core cables
class 6 = extra fine wire copper conductors for single and multi core cables
* for mineral-insulated cables (class 1 up to 150 mm^2)

Strand make-up according to DIN VDE 0295, IEC 60228 and HD 383

	stranded wires	**multistranded wires**	**fine wires**	**extra-fine wires**			
	class 2 DIN VDE 0295		**class 5 DIN VDE 0295**	**class 6 DIN VDE 0295**			
	column 1	column 2	column 3	column 4	column 5	column 6	column 7
cross section mm²	Number[3] of wires x single wire ø mm	Number of wires x single wire ø mm	Number[1] of wires x single[2] wire ø mm	Number[1] of wires x single[2] wire ø mm	Number[1] of wires x single wire ø mm	Number[1] of wires x single wire ø mm	Number[1] of wires x single wire ø mm
0,05						~14 x 0,07	~26 x 0,05
0,08							~40 x 0,05
0,09						~24 x 0,07*	
0,14			~18 x 0,1	~18 x 0,1	~18 x 0,1	~36 x 0,07	~72 x 0,05
0,25			~14 x 0,15	~32 x 0,1	~32 x 0,1	~65 x 0,07	~128 x 0,05
0,34		7 x 0,25	~19 x 0,15	~42 x 0,1	~42 x 0,1	~88 x 0,07	~174 x 0,05
0,38		7 x 0,27	~12 x 0,2	~21 x 0,15	~48 x 0,1	~100 x 0,07	~194 x 0,05
0,5	7 x 0,30	7 x 0,30	~16 x 0,2	~28 x 0,15	~64 x 0,1	~131 x 0,07	~256 x 0,05
0,75	7 x 0,37	7 x 0,37	~24 x 0,2	~42 x 0,15	~96 x 0,1	~195 x 0,07	~384 x 0,05
1,0	7 x 0,43	7 x 0,43	~32 x 0,2	~56 x 0,15	~128 x 0,1	~260 x 0,07	~512 x 0,05
1,5	7 x 0,52	7 x 0,52	~30 x 0,25	~84 x 0,15	~192 x 0,1	~392 x 0,07	~768 x 0,05
2,5	7 x 0,67	19 x 0,41	~50 x 0,25	~140 x 0,15	~320 x 0,1	~651 x 0,07	~1280 x 0,05
4	7 x 0,85	19 x 0,52	~56 x 0,3	~224 x 0,15	~512 x 0,1	~1040 x 0,07	
6	7 x 1,05	19 x 0,64	~84 x 0,3	~192 x 0,2	~768 x 0,1	~1560 x 0,07	
10	7 x 1,35	49 x 0,51	~80 x 0,4	~320 x 0,2	~1280 x 0,1	~2600 x 0,07	
16	7 x 1,70	49 x 0,65	~128 x 0,4	~512 x 0,2	~2048 x 0,1		
25	7 x 2,13	84 x 0,62	~200 x 0,4	~800 x 0,2	~3200 x 0,1		
35	7 x 2,52	133 x 0,58	~280 x 0,4	~1120 x 0,2			
50	19 x 1,83	133 x 0,69	~400 x 0,4	~705 x 0,3			
70	19 x 2,17	189 x 0,69	~356 x 0,5	~990 x 0,3			
95	19 x 2,52	259 x 0,69	~485 x 0,5	~1340 x 0,3			
120	37 x 2,03	336 x 0,67	~614 x 0,5	~1690 x 0,3			
150	37 x 2,27	392 x 0,69	~765 x 0,5	~2123 x 0,3			
185	37 x 2,52	494 x 0,69	~944 x 0,5	~1470 x 0,4			
240	61 x 2,24	627 x 0,70	~1225 x 0,5	~1905 x 0,4			
300	61 x 2,50	790 x 0,70	~1530 x 0,5	~2385 x 0,4			
400	61 x 2,89		~2035 x 0,5				
500	61 x 3,23		~1768 x 0,6				
630	91 x 2,97		~2228 x 0,6				

[1] The number of individual wires are without obligation.
[2] The diameters of the single wires for each conductor are not allowed to exceed the values stated to DIN VDE 0295. The single wires of a stranded conductor must have all the same nominal diameters.
[3] Minimum-number of single wires of stranded conductor. The single wires of a stranded conductor must have all the same nominal diameters.

[2] **Note:** permissible maximal diameter of single wires:

nominal value mm	maximal value mm
0,2	0,21
0,25	0,26
0,3	0,31
0,4	0,41
0,5	0,51
0,6	0,61

Conversion AWG to (mm²)

AWG	mm²	AWG	mm²	AWG	mm²	kcmil	mm²
30	0,05	18	0,75	6	16	300 kcmil	150
28	0,08	17	1,00	4	25	350 kcmil	185
26	0,14	16	1,50	2	35	500 kcmil	240
24	0,25	14	2,50	1	50	600 kcmil	300
22	0,34	12	4	2/0	70	750 kcmil	400
21	0,38	10	6	3/0	95	1000 kcmil	500
20	0,50	8	10	4/0	120		

This cross reference list shows equivalent nominal values. Actual cross sections may vary. The AWG values are approximate, if the cables are made to European Standards (mm²) and vice versa. In critical applications, where the current reaches upper limits. The deviating operation conditions for installation and laying according to standards are to be taken into consideration.

Nominal voltage and Operating voltage

Nominal voltage

Voltage of cables and wires, by which the construction and the tests in respect of electrical characteristics are to be refered.
According to DIN VDE 0298 and IEC 183 the cables are specified **U_0/U** ,where

U_0 = cable nominal voltage between the conductor and the metal covering or earth and
U = cable nominal voltage between the phase conductors, for 3-phase **U** = $\sqrt{3}\ U_0$.

According to IEC regulations, the maximum permissible voltage **U_m** is given in brackets. The identification is: **$U_0/U\ (U_m)$**.
As the insulation of plastic insulated cables are measured with a nominal voltage U_0/U = 0,6/1 kV and all radial field cables for the voltage U_0, these cables are suitable for installation:
- in single phase systems, in which the both phase conductors are insulated, with nominal voltage **$U_N = 2\ U_0$**
- in single phase systems, in which one phase conductor is earthed, with the nominal voltage **$U_N = U_0$**

Operating voltage

Voltage between conductors of a power system or between a conductor and earth under specified condition in a given time during an undisturbed operation.

Coordination of cable-**Nominal voltages**

Nominal-voltages U_0/U kV	for 3-phase system kV	for 1-phase alternating current both phase conductors insulated kV	for 1-phase alternating current one phase conductor earthed kV
0,6/1	1	1,2	0,6
3,6/6	6	7,2	3,6
6/10	10	12	6
12/20	20	24	12
18/30	30	36	18

Coordination of maximum permissible **Operating voltages**

Nominal voltages U_0/U kV	maximum voltage for 3-phase system kV	maximum voltage for 1-phase alternating current both phase conductors insulated kV	maximum voltage for 1-phase alternating current one phase conductor earthed kV
0,6/1	1,2	1,4	0,7
3,6/6	7,2	8,3	4,1
6/10	12	14	7
12/20	24	28	14
18/30	36	42	21

Note:
Cable with U_0/U 0,6/1 kV is allowed for **Direct Current Systems**, of those the maximum operating voltage conductor/conductor 1,8 kV or conductor/earth 1,8 kV not to be exceeded.

Current carrying capacity and indications for calculation of Power Cables and Wires

The guidelines for current carrying capacities of copper and aluminium are valid DIN VDE 0298 part 4 as well as DIN VDE 0276 part 603 and for the conversion factors DIN VDE 0276 part 1000.

The current carrying capacity of a cable should limited in such a degree that at all locations in a cable system which causes the generated heats under given proportions to lead safely in the environment. The heat flow depends on the inner heat-resistance between conductor and outer surface of the cable and as well as from the heat emission to the surroundings.

The following recommended values are the current carrying capacity of cables for laying in earth and in air at normal operating conditions. Hints for the deviated operating conditions, see DIN VDE 0298 table 4 and DIN VDE 0276 part 603 and part 1000.

Indications for Calculation

- **For laying in earth**

– Deviating operating conditions with both conversion factors are to be considered, as these depend on both of specific heat-resistance and the grade of load.
– EVU-load (load grade) is the maximum load factor of 0,7. The conversion factors for the load grades 0,5, 0,6, 0,85 and 1,0 are to be taken in tables DIN VDE 0276 part 603 and part 1000. Intermediate values can be interpolate (1,0 used for permanent load).
– Laying depth 0,7 m. The load capacity decreases with increasing of the laying depth. Usual depth of laying is 0,7 to 1,2 m.
– As normal value of the specific ground thermal resistivity in moist areas is selected with 1,0 K · m/W . For dry areas the choiced value is 2,5 K · m/W, under consideration of the applied usual bedding materials of sands.
– For favourable ground conditions or with thermal resisted bedding materials, lower value under well consolidation can be achieved. For individual case, the values and upon that the resulted current carrying loads are to be determined.

- **For laying in air**

– The values stated in the tables for outdoor laying in the air are defined for permanent operation.
– The arrangement of the cables is corresponded the presentation in table 3, DIN VDE 0276 part 1000.
– Conversion factors for other laying conditions and the heaping of cables are shown in table 10 and 11, DIN VDE 0276 part 1000.
– The current carrying capacities of multi-core cables can be calculated by using the current load value for 3-core cables according to table 13 with help of the conversion factors.
– By using the cable channels or cable board underlays etc. the air temperature will be increased. In this case the conversion factors according to table 12 for deviating air temperature should be used.
– For outdoor installation in air, the ambient temperature is based on 30° C.

- Radiation of heats and solar influence must be taken into consideration, where a good air circulation is needed.

- A sufficient large distance is to retain between the cables and the heating elements, because badly insulated heating elements often raise additionally the temperature of the cable.

- Distance between the cable from the wall, floor or ceiling = 2 cm
- Distance between the cables being laid one above the other = 2 x D
- Distance between the cable systems being laid one above the other = 20 cm
- Distance between the cables being laid side by side = 2 x D

- **Specific ground thermal resistivity**
  – very moist area = 0,7 K · m/W
  – moist area = 1,0 K · m/W
  – dry area = 2,0 K · m/W
  – very dry area = 3,0 K · m/W

Installation Methods and Operating Conditions
– Power cables and insulated wires for fixed installation –

Installation method type A1

- Single core cables in insulation tube in a thermally insulated wall.

Installation method A2

- Multicore cables or multicore plastic sheathed cables in the insulation tube in a thermally insulated wall, whereby the walls for the methods of installation employed comprise an outer weatherproof board, thermal insulation and an inner board of wood or materials similar to wood, having a temperature lag of 0,1 $m^2 \cdot K/W$. The plastic or metal insulation tube is mounted such that this is very close to the inner wall without actually being in conduct with the wall.

Installation method B1

- Single core cables in insulation tube on a wooden wall.

Installation method B2

- Multicore cables or multicore plastic-sheathed cables in insulation tube on a wooden wall.

  For both installation methods, the insulation tube must be secured such that the space between conduit and the wall surface is less than 0,3 times the diameter of the insulation tube. The plastic or metal insulation tube can be installed directly on the masonry construction or plastered surface, whereby the current carrying capacity of the cables or wires can then be higher.
  This problem is still being investigated by CENELEC.

Installation method C

- Single core or multicore cables, or single core or multicore plastic-sheathed cables, on a wooden wall.

  The cables or insulated wires shall be mounted such that the space from the wall surface is less than 0,3 times the outer diameter of the cable or insulated wire. The current carrying capacity can be increased when installed directly on or in the masonry construction as well as underneath the plaster.
  This problem is still being investigated by CENELEC.

Installation methods E, F and G

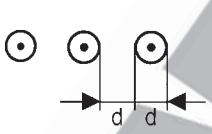
- Single core or multicore cables, or single core or multicore plastic-sheathed cables, installed in the open air.

  The cable or insulated wire shall be installed such that the dissipation of heat is not impeded, whereby allowance shall be made for heating by other sources and for irradiation by sunshine. Natural convection shall not be obstructed. The space from the cable or insulated wire by each bordering surface shall be 0,3 times that of the outside diameter. A space equal to that of the outside diameter is sufficient for single core cables and plastic-sheathed wires in order to meet the current carrying requirements for an installation in the open-air.

Laying Conditions for Power Cables

As laying depth, the mathematical distance to the cable axis – for tringular bunched laying the distance of the bundle axis to the earth surface with 70 cm is choised. With increased laying depth the load ratings will be mathematically reduced. Hereby the same temperature and the same thermal earth resistances are to be presumed.
Normal operation conditions and indications for deviating operation conditions.

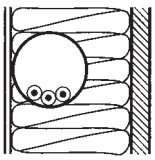
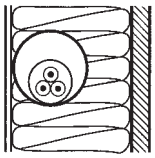
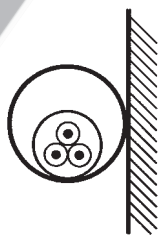
Normal operation conditions

Laid in **Earth**	Laid in **Air**	Indications
1 Multicore cable 	1 Multicore cable 	Conversions factors see the following tables
1 Single core cable in direct current-system 	1 Single core cable in direct current system 	as of collective laying conditions see the following tables
3 Single core cables in 3-phase system, side by side, with a space of 7cm 	3 Single core cables in 3-phase system, side by side, with a space of a cable ø 	
3 Single core cables in 3-phase system, in bundle form[1] 	3 Single core cables in 3-phase system in bundle form[1] 	
Bedding in sand or earth shove and if necessary covering with bricks, cement plates or with flat to light curved thin covering of plastic 	– Laid in open air, i.e. unhindered heat radiation will be ensured at: Distance of cable from wall, floor or ceiling ≧ 2 cm – For cables laying side by side: Space at least two times of the cable ø – For cables laying one above the other: Vertical space of the cable atleast two times of the cable ø cable length at least 30 cm – Consideration of thermal loss in cable, the increased air temperature of sufficient big and ventilated rooms – Protection against direct heatradiation of sunlight etc. – Air temperature 30°C Adequate big or ventilated rooms, due to that the power loss of the cable not be noticeable increased	• Conversion factors for laying in earth: – covering hood with air cavat y = 0,9 laid in conduit = 0,85 • Conversion factors for laying in air: – alternating ambient temperatures – as of collecting laying conditions – for laying in conduits – see tables and indications according to DIN VDE 0298
Ambient conditions – Ground temperature at installation depth: 20°C – Soil-thermal resistivity of moist area: 1,0 K · m/W – Soil-thermal resistivity of dry area: 2,5 K · m/W		
Connecting and **earthing** of metal sheaths or screens on both ends	**Connecting** and **earthing** of metal sheaths or screens on both sides	

[1] in "bunched" or triangle touching arrangement

Current ratings for installation A1, A2, B1 and B2
Cables for fixed installation within buildings

Operating temperature at conductor 70°C; Ambient temperature 30°C

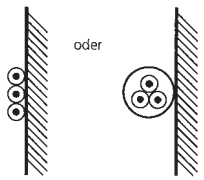
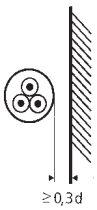
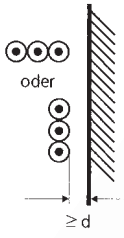
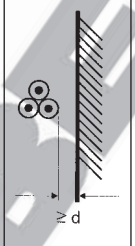
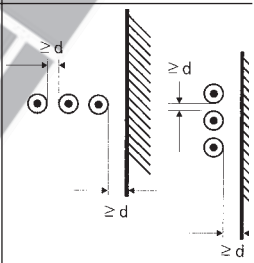
Type Designation	H07V-U, -R, -K H07V3-U, -R, -K		NYM, NYMZ, NYMT NHYRUZY, NYBUY NYDY N05VV-U, N05VV-R NHXMH NYY, NYCY [1]		H07V-U, -R, -K H07V3-U, -R, -K		NYM, NYMZ, NYMT NHYRUZY, NYBUY NYDY N05VV-U, N05VV-R NHXMH NYY, NYCY [1]	
Installation: • in thermally insulated walls • in insulating tubes	Single core cables in insulating tubes, in a thermally insulated walls		Multicore sheathed cables in insulating tubes, in a thermally insulated walls		Single core cables in insulating tubes on a wall		Multicore cables or multicore sheathed cables in insulating tubes oa a wall	
								
	Installation in thermally insulated walls				Installation in insulating tubes			
Installation method [2]	A1		A2		B1		B2	
Nuber of loaded cores	2	3	2	3	2	3	2	3
Cross-section, mm²	Current ratings in Ampere (A)							
1,5	15,5 [3]	13,5	15,5 [3]	13,0	17,5	15,5	16,5	15,0
2,5	19,5	18,0	18,5	17,5	24	21	23	20
4	26	24	25	23	32	28	30	27
6	34	31	32	29	41	36	38	34
10	46	42	43	39	57	50	52	46
10	–	–	–	–	–	–	–	47,17 [4]
16	61	56	57	52	76	68	69	62
25	80	73	75	68	101	89	90	80
35	99	89	92	83	125	110	111	99
50	119	108	110	99	151	134	133	118
70	151	136	139	125	192	171	168	149
95	182	164	167	150	232	207	201	179
120	210	188	192	172	269	239	232	206
150	240	216	219	196	–	–	–	–
185	273	245	248	223	–	–	–	–
240	320	286	291	261	–	–	–	–
300	367	328	334	298	–	–	–	–

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

[1] The current ratings are valid for cables with concentric conductor, only for multicore versions
[2] for further installation methods – see DIN VDE 0298 part 4
[3] see DIN VDE 0298 part 4
[4] not permitted for the installation on a wooden wall and not for application of the conversion factors, see DIN VDE 0298 part 4

Current ratings for installation conditions C, E, F and G
Cabel for fixed installation within buildings

Operating temperature at conductor 70°C; Ambient temperature 30°C

Type designation	NYM, NYMZ, NYMT, NYIF, NYIFY NHYRUZY, NYBUY, NYDY N05VV-U, N05VV-R NHXMH, NYY, NYCY [1]				NYY				
Installation: ● directly ● in open air	Singlecore or multicore cables or single or multicore sheathed cables on a wall 		Multicore cables or multicore sheathed cables with a space of minimum 0,3 x diameter d to wall 		Single core cables or single core sheathed cables with a space of minimum 1 x diameter d to wall				
					with contact 			with gap d 	
	direct installation		installation in open air						
installation method[2]	C		E		F			G	
Number of loaded cores	2	3	2	3	2	3			
Cross-section, mm²	Current ratings in Ampere (A)								
1,5	19,5	17,5	22	18,5	–	–	–	–	–
2,5	27	24	30	25	–	–	–	–	–
4	36	32	40	34	–	–	–	–	–
4	–	33,02[3]	–	–	–	–	–	–	–
6	46	41	51	43	–	–	–	–	–
10	63	57	70	60	–	–	–	–	–
10	–	59,43[3]	–	–	–	–	–	–	–
16	85	76	94	80	–	–	–	–	–
25	112	96	119	101	131	114	110	146	130
35	138	119	148	126	162	143	137	181	162
50	168	144	180	153	196	174	167	219	197
70	213	184	232	196	251	225	216	281	254
95	258	223	282	238	304	275	264	341	311
120	299	259	328	276	352	321	308	396	362
150	344	299	379	319	406	372	356	456	419
185	392	341	434	364	463	427	409	521	480
240	461	403	514	430	546	507	485	615	569
300	530	464	593	497	629	587	561	709	659
400	–	–	–	–	754	689	656	852	795
500	–	–	–	–	868	789	749	982	920
630	–	–	–	–	1005	905	855	1138	1070

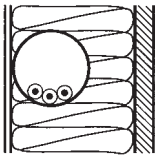
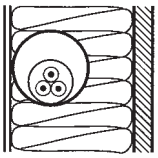
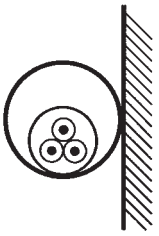
Conversion factors for deviating ambient temperature, grouping, installation under the ceiling, multicore cables and insulated wires see DIN VDE 0298 part 4.

[1] The current ratings are valid for cables with concentric conductor, only for multicore versions
[2] for further installation methods – see DIN VDE 0298 part 4
[3] see DIN VDE 0298 part 4

Current ratings for installation conditions

Cables for fixed installation within buildings A1, A2, B1 and B2

Operating temperature at Conductor 90°C; Ambient temperature 30°C

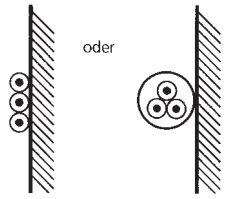
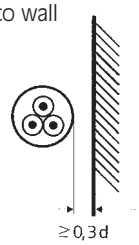
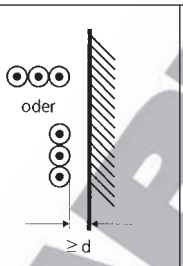
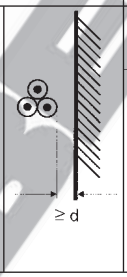
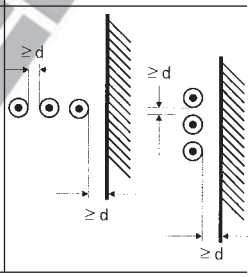
Type designation	H07V2-U, -K NHXA, NHXAF H07Z-U, -R, -K		NI2XY, N2XY, N2X2Y N2XH, N2XCH NHXHX FE180 NHXCHX FE180 NHXH FE180 NHXCH FE180 NHXHX, NHXCHX		H07V2-U, -K NHXA, NHXAF H07Z-U, -R, -K		NI2XY, N2XY, N2X2Y N2XH, N2XCH NHXHX FE180 NHXCHX FE180 NHXH FE180 NHXCH FE180 NHXHX, NHXCHX	
Installation: ● in thermally insulated walls ● in insulating tubes	Single core cables in insulating tubes in a thermally insulated walls		Multicore sheathed cables in insulating tubes, in a thermally insulated walls		Single core cables in insulating tubes on a wall		Multicore cables or multicore sheathed cables in insulating tubes on a wall	
								
	Installation in thermally insulated walls				Installation in insulating tubes			
Installation method[1)]	A1		A2		B1		B2	
Number of loaded cores	2	3	2	3	2	3	2	3
Cross-section, mm²	Current ratings in Ampere (A)							
1,5	19,0	17,0	18,5	16,5	23	20	22	19,5
2,5	26	23	25	22	31	28	30	26
4	35	31	33	30	42	37	40	35
6	45	40	42	38	54	48	51	44
10	61	54	57	51	75	66	69	60
16	81	73	76	68	100	88	91	80
25	106	95	99	89	133	117	119	105
35	131	117	121	109	164	144	146	128
50	158	141	145	130	198	175	175	154
70	200	179	183	164	253	222	221	194
95	241	216	220	197	306	269	265	233
120	278	249	253	227	354	312	305	268
150	318	285	290	259	–	–	–	–
185	362	324	329	295	–	–	–	–
240	424	380	386	346	–	–	–	–
300	486	435	442	396	–	–	–	–

Conversion factors for devating ambient temperature, grouping, installation under the ceiling, multicore cables and insulated wires – see DIN VDE 0298 part 4 .

[1)] for further installation conditions – see DIN VDE 0298 part 4

Current ratings for installation conditions
Cables for fixed installation within buildings C, E, F and G

Operating temperature at conductor 90°C; Ambient temperature 30°C

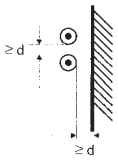
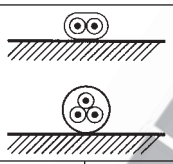
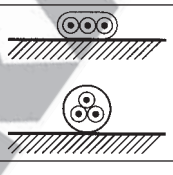
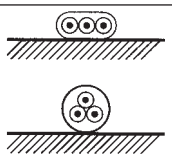
Type designation	NI2XY, N2XY, N2X2Y N2XH, N2XCH[1)] NHXH FE180, NHXCH FE180[1)] NHXHX FE180, NHXCHX FE180[1)] NHXHX, NHXCHX[1)]				NI2XY, N2XY, N2X2Y N2XH NHXH FE180 NHXHX FE180 NHXHX				
Installation: • directy • in open air	Singlecore or multicore cables or single or multicore sheathed cables on a wall 		Multicore cables or multicore sheathed cables with a space of minimum 0,3 x diameter d to wall 		Single core cables or single core sheathed cables with a space of minimum 1 x diameter d to wall				
					with contact 			with gap d 	
	direct installation		installation in open air						
Instalation method[2)]	C		E		F			G	
Number of loaded cores	2	3	2	3	2	3			
Cross-section, mm²	Current ratings in Ampere (A)								
1,5	24	22	26	23	–	–	–	–	–
2,5	33	30	36	32	–	–	–	–	–
4	45	40	49	42	–	–	–	–	–
6	58	52	63	54	–	–	–	–	–
10	80	71	86	75	–	–	–	–	–
16	107	96	115	100	–	–	–	–	–
25	138	119	149	127	161	141	135	182	161
35	171	147	185	158	200	176	169	226	201
50	209	179	225	192	242	216	207	275	246
70	269	229	289	246	310	279	268	353	318
95	328	278	352	298	377	342	328	430	389
120	382	322	410	346	437	400	383	500	454
150	441	371	473	399	504	464	444	577	527
185	506	424	542	456	575	533	510	661	605
240	599	500	641	538	679	634	607	781	719
300	693	576	741	621	783	736	703	902	833
400	–	–	–	–	940	868	823	1085	1008
500	–	–	–	–	1083	998	946	1253	1169
630	–	–	–	–	1254	1151	1088	1454	1362

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

[1)] The current ratings are valid for cables with concentric conductor, only for multicore versions
[2)] for further installation methods – see DIN VDE 0298 part 4

Current ratings for cables and insulated wires
up to 1000 V and heat resistant cables

Permissible operating temperature at conductor 40°C to 180°C as per type Ambient temperature 30°C to 150°C, as per type

Type designation	H05V-U, -K H07V-U, -R, -K H07V3-U, -R, -K N05XAFX, N07XAFX NFYW H05RN-F, H07RN-F H05V2-U, H05V2-K H07V2-U, H07V2-K H05Z-U H07Z-U, -R, -K NHXA, NHXAF H05G-U, H05G-K H07G-U, -R, -K N7YA, N7YAF N2GFA, N2GFAF H05S-U, H05S-K H05SJ-K, A05SJ-U, -K H07ZZ-F	H03RT-F, A03RT-F H05RR-F, A05RR-F, A05RRT-F H05RN-F, A05RN-F H05RNH2-F H07RN-F, A07RN-F H03VH-Y[1], H03VH-H H03VV-F, A03VV-F, H03VVH2-F H05VV-F, A05VV-F, H05VVH2-F H03VVH8-F H03VVH2H8-F H05VVH8-F H05VVH2H8-F H07ZZ-F [2]	NPL, NMHCÖU, NYMHYV NSHCÖU, NGFLGÖU, NSHTÖU H05RTD5-F, H05RND5-F H05RTD3-F, H05RND3-F H07RTD5-F, H07RND5-F H07RTD3-F, H07RND3-F H07RN-F, A07RN-F NYMH11YÖ, NGMH11YÖ H05VVH6-F, H05VVD3H6-F H07VVH6-F, H07VVD3H6-F A07VVH6-F, A07VVD3H6-F NXMHX H05VV5-F, H05VVC4V5-K NYSLY, NYSLYCY NLSY, NLSCY NSY, NSCY NYPLYW, NYFAZW N2GSA, N2GMH2G	JZ-500, -JB, -OZ, -OB JZ-600, -CY, JZ-750 SY-JZ, -JB JZ-602, -CY, -RC, -RC-CY JZ-HF, -CY, PURÖ -JZ F-C-PURÖ-JZ, YÖ-C-PURÖ-JZ PUR-750, PURÖ-JZ-HF, -CY MULTIFLEX 512 PUR, C-PUR PUR-ORANGE, YELLOW PUR-C-PUR TRONIC (≤ 0,5mm²)[2] TRONIC-CY (≤ 0,5mm²)[2] F-CY-JZ, -OZ, Y-CY-JZ THERM 120 JZ-500 HMH, -C BAUFLEX, MULTIFLEX-PLUS Lift-Hoist cable Lift-2S, PVC-Flat, -CY NEO-Flat, -CY TOPSERV®, TOPFLEX
Installation: ● in open air ● upon or on surface	in open air  	upon or on surface 		

Number of loaded cores	1	2	3	2 or 3	
Cross-section, mm²	Current ratings in Ampere (A)				
0,5	–	3	3	~9	9
0,75	15	6	6	12	12
1	19	10	10	15	15
1,5	24	16	16	18	18
2,5	32	25	20	26	26
4	42	32	25	34	34
6	54	40	–	44	44
10	73	63	–	61	61
16	98	–	–	82	82
25	129	–	–	108	108
35	158	–	–	135	135
50	198	–	–	168	168
70	245	–	–	207	207
95	292	–	–	250	250
120	344	–	–	292	292
150	391	–	–	335	335
185	448	–	–	382	382
240	528	–	–	453	453
300	608	–	–	523	523
400	726	–	–	–	–
500	830	–	–	–	–

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

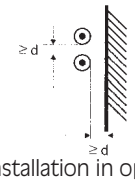
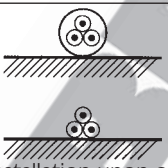
[1] Nominal cross-sectional area 0,1 mm², loadable with 0,2 A, independent of the ambient temperature

[2] The current ratings are valid for the application of household equipment conductor cross-section ≤0,34 mm² – see table page X 28

Current ratings for cables ≤0,6/1kV

Special rubber-insulated single core cables, multicore rubber cables and trailing cables

Operating temperature at conductor 90°C (80°C); Ambient temperature 30°C

Type designation	NSGAÖU, NSGAFÖU NSHXAÖ, NSHXAFÖ[1)]	NSGAÖU, NSGAFÖU NSGAFCMÖU NSHXAÖ, NSHXAFÖ NSHXAFCMÖ[1)]	NSSHÖU NT...	NT...
Nominal voltage	0,6/1 kV and 1,8/3 kV	3,6/6 kV	up to 6/10 kV	≧ 6/10 kV
Permissible operating temperature at conductor	90°C		–	
Recommended operating temperature	–		80°C	
Installation:: ● in open air ● upon or on surface	 Installation in open air		 Installation upon or on surface	
Number of loaded cores	1	1	3	3
Cross-section, mm²	Current ratings in Ampere (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
25	176	174	131	139
35	218	215	162	172
50	276	270	202	215
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	–	540	–
300	898	–	–	–

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

[1)] – when a bunched installation with single cores or multi-cored cables are used on floor the conversion factors for the rating values should be considered – see table page X 33
factor 0,76 for one-phase a.c. and direct current circuits or
factor 0,67 for three-phase circuits, is to be multiplied.
– when a bunched installation with single cores or multi-cored cables are used in open air, or cable trays, the conversion factors for the rating values should be considered – see table in page X 35
factor 0,8 for one-phase a.c. and direct current circuits or
factor 0,7 for three-phase circuits, is to be multiplied.
– when a bunched installation with single cores or multi-cored cables are used in insulating tubes or conduits, the conversion factors for the rating values should be considered – see table page X 33
factor 0,61 for one-phase a.c. and direct current circuits or
factor 0,54 for three-phase circuits, is to be multiplied.

Current ratings (general) for flexible cables, for non-existing cable types in the previous tables

The indicated values stated in the following table considered as guiding values in an abbreviate form, extracted from DIN VDE 0298 part 4 and DIN VDE 0100 part 430. In critical situation the DIN VDE recommendations should be considered.
For industrial machines the DIN VDE 0113, part 1 (EN 60204 part 1/IEC 204-1) is valid; for telephone and information systems DIN VDE 0891 part 1; for telephone aerial cables DIN VDE 0891 part 8 and for flat cables DIN VDE 0891 part 10. General terms and recommendated values are contained in DIN VDE 0298 part 2 and part 4.

Power rating values for 1,5–120 mm² (group 3 up to 35 mm²) according to DIN VDE 0100 part 430 at an

Ambient temperature up to 30°C

Nominal cross-section	**Group 1**		**Group 2**		**Group 3**	
	power rating	protective fuse	power rating	protective fuse	power rating	protective fuse
mm²	A	A	A	A	A	A
0,05	1	–	1	–	2	–
0,14	2	–	2	–	3,5	–
0,25	4	–	4,5	–	6	–
0,34	6	–	6	–	9	–
0,5	9	–	9	–	12	–
0,75	12	–	12	10	15	10
1	15	10	15	10	19	16
1,5	18	16	18	16	24	20
2,5	26	25	26	25	32	25
4	34	25	34	25	42	35
6	44	35	44	35	54	50
10	61	50	61	50	73	63
16	82	80	82	63	98	80
25	108	100	108	80	129	100
35	135	125	135	100	158	125
50	168	160	168	125	198	160
70	207	200	207	160	245	200
95	250	250	250	200	292	250
120	292	250	292	250	344	315
150	335	315	335	315	391	355
185	382	355	382	355	448	400
240	–	–	453	425	528	500
300	–	–	523	500	608	600
400	–	–	–	–	726	630

group 1 One or more single core cables and insulated wires laid in duct i. e. PVC-sheathed single cores H 03V. ./H 05V. ./H 07V. . according to VDE 0281.

group 2 Multi core cables, i. e. light PVC-sheathed cables, flexible cables, metal-clad wiring cables in open or ventilated conduits.

group 3 Single core cables, laid open in air with a spacing at least equal to cable diameter, such as single core wirings for switch- and distribution cabinets and rail line distributors.

Conversion factors*) for deviating ambient temperatures:

Ambient temperature over 30°C

Ambient temperature °C	Conversion factors, applied to the above current ratings table **Rubber insulation** Permissible operating temp. at conductor Conversion factors up to **60°C**	**PVC insulation** Permissible operating temp. at conductor Conversion factors up to **70°C**
over 30 bis 35	0,91	0,94
over 35 bis 40	0,82	0,87
over 40 bis 45	0,71	0,79
over 45 bis 50	0,58	0,71
over 50 bis 55	0,41	0,61
over 55 bis 60	–	0,50
over 60 bis 65	–	0,35

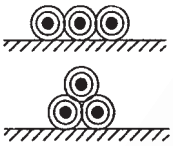
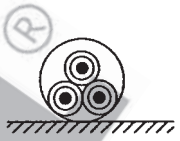
Ambient temperature over 50°C (heat-resistant)

Conversion factors, applied to the above current ratings table Permissible operating temperture at conductor Conversion factors up to **90°C**		Permissible operating temperture at conductor Conversion factors up to **110°C**	
over 50 bis 55	0,94	over 50 bis 55	1,00
over 55 bis 60	0,87	over 55 bis 60	1,00
over 60 bis 65	0,79	over 60 bis 65	1,00
over 65 bis 70	0,71	over 65 bis 70	1,00
over 70 bis 75	0,61	over 70 bis 75	1,00
over 75 bis 80	0,50	over 75 bis 80	1,00
over 80 bis 85	0,35	over 80 bis 85	0,91
over 85 bis 90	–	over 85 bis 90	0,82
		over 90 bis 95	0,71
		over 95 bis 100	0,58
		over 100 bis 105	0,41
		over 105 bis 110	–

* Further informations see page X 34.

Current ratings for HELUTHERM® 145

For permanent operating to the ambient temperature of 30° C. Conversion factors for the deviating site operation conditions – see tables below.
Sufficiently large or ventilated rooms in which the ambient temperature is not noticeably increased by the heat losses from the cables. Protection should be taken from the solar radiation etc.

Installation	 in open air	 on face without inter-contact	 on surface with inter-contact	 in tubes, conduites, cabinets
Conversion factors for grouping	–	to table 1	to table 2	to table 3
Cross-section, mm^2	Current ratings in Ampere (A) up to 30° C ambient temperature			
0,25	13	12	9	7
0,33	17	15´	11	9
0,50	19	18	12	10
0,75	24	23	17	13
1,0	31	30	20	17
1,5	39	36	25	20
2,5	51	48	33	26
4	68	65	45	36
6	88	84	58	46
10	121	116	80	64
16	160	152	106	85
25	211	200	140	111
35	261	248	172	138
50	320	304	211	169
70	411	391	272	217
95	502	476	331	265
120	587	558	387	310
150	680	646	449	359
185	781	743	516	413
240	931	884	614	492

Conversion factors for grouping

Number of single core cables for 2-phase or 3-phase systems		1	2	3	4	5	6	7	8	9	10	12
Table 1	Factor	1,00	0,94	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
Table 2	Factor	1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70	–	–
Table 3	Factor	1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,48	0,45

Conversion factors for deviating ambient temperatures

Temperature in °C	20	30	40	50	60	70	80	90	95	100	105	110	115
Factor	1,05	1,00	0,94	0,88	0,82	0,75	0,67	0,58	0,53	0,47	0,41	0,35	0,24

Current ratings for silicone cables and wires

The indicated values stated in the following table are considered as guiding values. These are to be selected each particularly for the individual application.

Heat-resistance at an ambient **temperature up to 150°C**

	Group 1		Group 2		Group 3	
Nominal-cross-section	current-carrying capacity A	protective fuse A	current-carrying capacity A	protective fuse A	current-carrying capacity A	protective fuse A
0,25	2,8	–	–	–	5	–
0,5	6	–	7	–	10	–
0,75	9	6	12	6	15	10
1,0	12	10	15	10	19	20
1,5	16	16	18	16	24	25
2,5	21	20	26	25	32	35
4	28	25	34	35	42	50
6	36	35	44	50	54	63
10	49	50	61	63	73	80
16	65	63	82	80	98	100
25	85	83	108	100	129	125
35	105	100	135	–	158	160
50	140	125	168	–	198	200
70	175	160	207	–	245	250
95	210	200	250	–	292	300
120	250	250	292	–	344	335
150	–	–	335	–	391	–
185	–	–	382	–	448	–
240	–	–	453	–	528	–
300	–	–	523	–	608	–

Group 1: One or more single core cables laid in duct.
Group 2: Multicore cables, flexible cables laid in open or ventilated conduits.
Group 3: Single core cables laid in open air with a spacing at least equal to cable diameter.

Power ratings for
ambient temperature over 150°C
The following conversion factors are valid:

Temperature °C	current-carrying capacity values in %
up to 150	100
over 150 to 155	91
over 155 to 160	82
over 160 to 165	71
over 165 to 170	58
over 170 to 175	41

Current ratings for NYY, NAYY, NYCY, NYCWY, NAYCWY 0,6/1 kV

Current carrying capacity in Ampere (A), laying **in ground** (20°C)

Nominal Cross-section mm²	Copper conductor					Aluminium conductor				
	NYY			NYCWY		NAYY			NAYCWY	
			 [1]					 [1]		
1,5	30	27	41	31	27	–	–	–	–	–
2,5	39	36	55	40	36	–	–	–	–	–
4	50	47	71	51	47	–	–	–	–	–
6	62	59	90	63	59	–	–	–	–	–
10	83	79	124	84	79	–	–	–	–	–
16	107	102	160	108	102	–	–	–	–	–
25	138	133	208	139	133	106	102	160	108	103
35	164	159	250	166	160	127	123	193	129	123
50	195	188	296	196	190	151	144	230	153	145
70	238	232	365	238	234	185	179	283	187	180
95	286	280	438	281	280	222	215	340	223	216
120	325	318	501	315	319	253	245	389	252	246
150	365	359	563	347	357	284	275	436	280	276
185	413	406	639	385	402	322	313	496	314	313
240	479	473	746	432	463	375	364	578	358	362
300	541	535	848	473	518	425	419	656	397	415
400	614	613	975	521	579	487	484	756	441	474
500	693	687	1125	574	624	558	553	873	489	528
630	777	–	1304	636	–	635	–	1011	539	–
800	859	–	1507	–	–	716	–	1166	–	–
1000	936	–	1715	–	–	796	–	1332	–	–

[1] Rated current for direct current systems with a far-distanced return conductor

Current carrying capacity in Ampere (A), laying **in air** (30°C)

Nominal Cross-section, mm²	Copper conductor					Aluminium conductor				
	NYY			NYCWY		NAYY			NAYCWY	
			 [1]					 [1]		
1,5	21	19,5	27	22	19,5	–	–	–	–	–
2,5	28	25	35	29	26	–	–	–	–	–
4	37	34	47	39	34	–	–	–	–	–
6	47	43	59	49	44	–	–	–	–	–
10	64	59	81	67	60	–	–	–	–	–
16	84	79	107	89	80	–	–	–	–	–
25	114	106	144	119	108	87	82	110	91	83
35	139	129	176	146	132	107	100	135	112	101
50	169	157	214	177	160	131	119	166	137	121
70	213	199	270	221	202	166	152	210	173	155
95	264	246	334	270	249	205	186	259	212	189
120	307	285	389	310	289	239	216	302	247	220
150	352	326	446	350	329	273	246	345	280	249
185	406	374	516	399	377	317	285	401	321	287
240	483	445	618	462	443	378	338	479	374	339
300	557	511	717	519	504	437	400	555	426	401
400	646	597	843	583	577	513	472	653	488	468
500	747	669	994	657	626	600	539	772	556	524
630	858	–	1180	744	–	701	–	915	628	–
800	971	–	1396	–	–	809	–	1080	–	–
1000	1078	–	1620	–	–	916	–	1258	–	–

[1] Rated current for direct current systems with a far-distanced return conductor

Conversion factors for multicore cable (≧ 5 cores)

The conversion factors are to be used for laying the cables in ground or in air, to the values given in above tables.

Number of loaded cores n	laying in ground f	laying in air f
5	0,70	0,75
7	0,60	0,65
10	0,50	0,55
14	0,45	0,50
19	0,40	0,45
24	0,35	0,40
40	0,30	0,35
61	0,25	0,30

Note: valid for cross-section 1,5 to 10 mm²

Current carrying capacity for NYKY 0,6/1 kV

The guidelines for current carrying capacities of copper and aluminium are valid DIN VDE 0265 and 0276 part 1000.

The current carrying capacity of a cable should be limited in such a degree that at all locations in a cable system which causes the generated heats under given proportions to lead safely in the environment. The heat flow depends on the inner heat-resistance between conductor and outer surface of the cable and as well as from the heat emission to the surroundings.

For cables laid in earth, the assumption for the calculation are chosen in a way that the given values for current loading at normal operation can be used in most of the cases **without conversion**.

For single cables laid directly in earth at EVU-Loading and a specific earth heat-resistance of 100 K · cm/W, mostly of the soil conditions are to be taken into consideration.

Calculation basis

EVU-load (current loading grade)	0,7 (1,0 for air)
Specific earth heat-resistance	100 K · cm/W
Specific heat-resistance of the insulation and sheath	600 K · cm/W
Bedding depth in earth	0,7 m
Earth temperature	20° C
Ambient temperature in the air	30° C

Current carrying capacity of 3-, 4- and multicore (5 cores and more) cables at ambient temperature of 20°C in earth, 30°C for the air.

Current carrying capacity in ampere (A):

cross-section mm²	3- and 4-core cable		5- to 61-core cable	
	Earth A	Air A	Earth A	Air A
1,5	28	18,5	Number of loading cores and the conversion factors from 1,5 to 10 mm² see the following table	
2,5	37	27		
4	48	36		
6	60	45		
10	80	62		
16	103	81		
25	134	110		
35	162	134		
50	192	163		
70	235	205		
95	283	253		
120	323	294		
150	363	334		
185	412	386		
240	478	457		
300	542	529		
400	615	610		

Current loading for multicore cables (5 cores and more)

The current loading of each core for cables with a conductor cross-section of 1,5 to 10 mm², depends on the number of cores and the number of loaded cores respectively and is calculated by means of the following conversion factors.

The conversion factors according to the number of loaded cores are to be multiplied with the loading values of the above table.

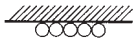
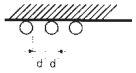
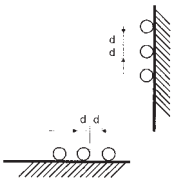
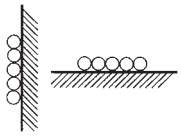
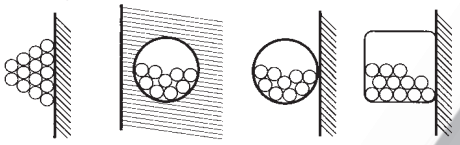
Number of loading conductors	Conversion factors for the value to 1,5 to 10 mm² of the above table	
	Earth	Air
5	0,70	0,75
7	0,60	0,65
10	0,50	0,55
14	0,45	0,50
19	0,40	0,45
24	0,35	0,40
40	0,30	0,35
61	0,25	0,30

Note

During the installation in earth or in the air, for the operation and the laying performance occur any deviations or unfavourable relations (e. g. bundling of cables, in the wall, under plaster, on the wall or on trays, on cable troughs or on cable racks), the specified conversion factors to DIN VDE 0276 part 1000 table 12 and 13 must be taken into consideration.

Current ratings – Conversion factors

for grouping on the wall, on the floor, in insulation tubes or in conduit and under the ceiling

Number of multicore cables or number of a.c. or 3-phase circuits of single core cables	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
Installation method	Conversion factors														
One layer under the ceiling with contact 	0,95	0,81	0,72	0,68	0,66	0,64	0,63	0,62	0,61	0,61	0,61	0,61	0,61	0,61	0,61
One layer under the ceiling, with a space equal to the outer diameter d 	0,95	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85
One layer on the wall or on the floor with a space equal to the outer diameter d 	1,00	0,94	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
One layer on the wall or on the floor with contact 	1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70	0,70	0,70	0,70	0,70	0,70	0,70
Bunched directly on the wall, on the floor, in insulating tubes or trunking or in the wall 	1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,48	0,45	0,43	0,41	0,39	0,38

○ Symbol for one single core or one multicore cable

Notes:

- when these factors are to be applied for the calculation of power ratings, the same type of cables and with equal loaded cores in the same installation method shall correspond. At the same time the cross-section are permitted to differ maximum one grade of cross-section.
- If the actual horizontal-space between the adjacent cables is more than double of the outer diameter, no reduction factor is necessary.
- The same reduction factors are to be applied for grouping of two or three-core or multicore cables. For a system consisting of two or as well as three-core cables, firstly the total number of cables will be assumed as the number of circuits. For that the applicable factor is to be used either in the tables for two-cores loaded cables or the tables for three-cores loaded cables.

If the grouping of single core cables consist of n loaded single core cables, the rating factor shall be determinated for n/2 or n/3 circuits and applied to the current carrying capacity of two or three loaded cores.

Current ratings – Conversion factors
for deviating ambient temperature

- Conversion factors for deviating ambient temperature

Permissible operating temperature	40°C	60°C	70°C	80°C	85°C	90°C
Ambient temperature °C	Conversion factors, used to the current ratings data in tables of the following pages					
10	1,73	1,29	1,22	1,18	1,17	1,15
15	1,58	1,22	1,17	1,14	1,13	1,12
20	1,41	1,15	1,12	1,10	1,09	1,08
25	1,22	1,08	1,06	1,05	1,04	1,04
30	1,00	1,00	1,00	1,00	1,00	1,00
35	0,71	0,91	0,94	0,95	0,95	0,96
40	–	0,82	0,87	0,89	0,90	0,91
45	–	0,71	0,79	0,84	0,85	0,87
50	–	0,58	0,71	0,77	–	0,82
55	–	0,41	0,61	0,71	–	0,76
60	–	–	0,50	0,63	–	0,71
65	–	–	0,35	0,55	–	0,65
70	–	–	–	0,45	–	0,58
75	–	–	–	0,32	–	0,50
80	–	–	–	–	–	0,41
85	–	–	–	–	–	0,29

- Conversion factors for multicore cables with cross-section up to 10 mm^2

Number of loaded cores	Conversion factors
5	0,75
7	0,65
10	0,55
14	0,50
19	0,45
24	0,40
40	0,35
61	0,30

- Conversion factors for reeled cables

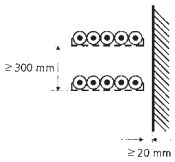
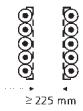
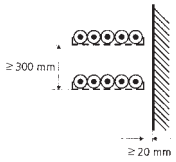
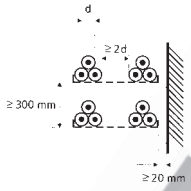
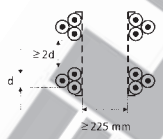
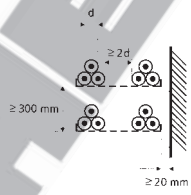
Number of layers on drums	1	2	3	4	5
Conversion factors	0,80	0,61	0,49	0,42	0,38

Note: For spiral-reeling the conversion factor 0,80.

- Conversion temperature for heat-resistant cables

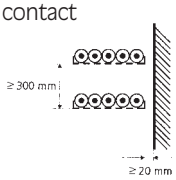
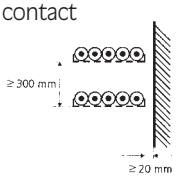
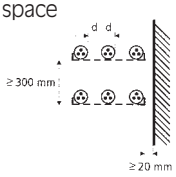
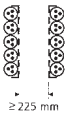
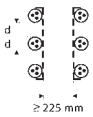
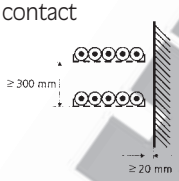
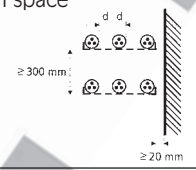
Permissible operating temperature	80°C	90°C	110°C	135°C	180°C
Ambient temperature °C	Conversion factors, used to the current ratings data for heat-resistant cables in the tables of the following pages				
bis 50	1,00	1,00	1,00	1,00	1,00
55	0,91	0,94	1,00	1,00	1,00
60	0,82	0,87	1,00	1,00	1,00
65	0,71	0,79	1,00	1,00	1,00
70	0,58	0,71	1,00	1,00	1,00
75	0,41	0,61	1,00	1,00	1,00
80	–	0,50	1,00	1,00	1,00
85	–	0,35	0,91	1,00	1,00
90	–	–	0,82	1,00	1,00
95	–	–	0,71	1,00	1,00
100	–	–	0,58	0,94	1,00
105	–	–	0,41	0,87	1,00
110	–	–	–	0,79	1,00
115	–	–	–	0,71	1,00
120	–	–	–	0,61	1,00
125	–	–	–	0,50	1,00
130	–	–	–	0,35	1,00
135	–	–	–	–	1,00
140	–	–	–	–	1,00
145	–	–	–	–	1,00
150	–	–	–	–	1,00
155	–	–	–	–	0,91
160	–	–	–	–	0,82
165	–	–	–	–	0,71
170	–	–	–	–	0,58
175	–	–	–	–	0,41

Current ratings – Conversion factors
for grouping of single core cables or cables on troughs and trays

Number of three-phase systems with single core cables		Used as multiplier for the ratings value for	Number of throughs or trays	1	2	3
Installation method				Conversion factors		
Perforated cable troughs	with contact 	Three-cores cable in horizontal-surface arrangement	1	0,98	0,91	0,87
			2	0,96	0,87	0,81
			3	0,95	0,85	0,78
	with contact 	Three-cores cable vertical-surface arrangement	1	0,96	0,86	–
			2	0,95	0,84	–
Cable trays	with contact 	Three-cores cable in horizontal-surface arrangement	1	1,00	0,97	0,96
			2	0,98	0,93	0,89
			3	0,97	0,90	0,86
Perforated cable troughs		Three-core cables in vertical-surface triangle arrangement	1	1,00	0,98	0,96
			2	0,97	0,93	0,89
			3	0,96	0,92	0,86
			1	1,00	0,91	0,89
			2	1,00	0,90	0,86
Cable trays			1	1,00	1,00	1,00
			2	0,97	0,95	0,93
			3	0,96	0,94	0,90

Note:
The conversion factors are used only for cables of one layer grouping arrangement. These are not valied when the cables are installed with contact one upon another or the given sprees between the cable toughs or cable trays are not followed. In such cases the conversion factors can be reduced.
To parallel current circuits each group of three conductors of the parallel circuit is regarded as single circuit.

Current ratings – Conversion factors
for grouping of multicore cables or cables on troughs and trays

Number of multicore cables			1	2	3	4	6	9
Installation method		Nuber of troughs and trays	Conversion factors					
Non-perforted cable troughs	with contact 	1	0,97	0,84	0,78	0,75	0,71	0,68
		2	0,97	0,83	0,76	0,72	0,68	0,63
		3	0,97	0,82	0,75	0,71	0,66	0,61
		6	0,97	0,81	0,73	0,69	0,63	0,58
Perforated cable troughs	with contact 	1	1,00	0,88	0,82	0,79	0,76	0,73
		2	1,00	0,87	0,80	0,77	0,73	0,68
		3	1,00	0,86	0,79	0,76	0,71	0,66
		6	1,00	0,84	0,77	0,73	0,68	0,64
	with space 	1	1,00	1,00	0,98	0,95	0,91	–
		2	1,00	0,99	0,96	0,92	0,87	–
		3	1,00	0,98	0,95	0,91	0,85	–
	with contact 	1	1,00	0,88	0,82	0,78	0,73	0,72
		2	1,00	0,88	0,81	0,76	0,71	0,70
	with space 	1	1,00	0,91	0,89	0,88	0,87	–
		2	1,00	0,91	0,88	0,87	0,85	–
Cable trays	with contact 	1	1,00	0,87	0,82	0,80	0,79	0,78
		2	1,00	0,86	0,81	0,78	0,76	0,73
		3	1,00	0,85	0,79	0,76	0,73	0,70
		6	1,00	0,83	0,76	0,73	0,69	0,66
	with space 	1	1,00	1,00	1,00	1,00	1,00	–
		2	1,00	0,99	0,98	0,97	0,96	–
		3	1,00	0,98	0,97	0,96	0,93	–

Note:
The conversion factor are used for cables of one layer grouping arrangement. These are not valid when the cables are installed with contact one upon another or the given spaces between the cable troughs or cable trays can not meet. In such cases the conversion factor can be reduced.

Power ratings for XLPE-insulated Medium Voltage Power Cables 6/10 kV, 12/20 kV, 18/30 kV

N2XSY **N2XS2Y** **N2XS(F)2Y**
NA2XSY **NA2XS2Y** **NA2XS(F)2Y**

Current carrying capacity* in Amperes (A) in ground (20°C)

Conductor material	Copper conductor						Aluminium conductor					
Arrangement												
U_0/U	6/10 kV		12/20 kV		18/30 kV		6/10 kV		12/20 kV		18/30 kV	
cross section mm²	Current ratings in Ampere (A)											
25	157	179	–	–	–	–	–	–	–	–	–	–
35	187	212	189	213	–	–	145	165	–	–	–	–
50	220	249	222	250	225	251	171	194	172	195	174	195
70	268	302	271	303	274	304	208	236	210	237	213	238
95	320	359	323	360	327	362	248	281	251	282	254	283
120	363	405	367	407	371	409	283	318	285	319	289	321
150	405	442	409	445	414	449	315	350	319	352	322	354
185	456	493	461	498	466	502	357	394	361	396	364	399
240	526	563	532	568	539	574	413	452	417	455	422	458
300	591	626	599	633	606	640	466	506	471	510	476	514
400	662	675	671	685	680	695	529	558	535	564	541	570
500	744	748	754	760	765	773	602	627	609	634	616	642

*This factors are also valid for longitudinally water-tight cable

Current carrying capacity* in Amperes (A) in air (30°C)

Conductor material	Copper conductor						Aluminium conductor					
Arrangement												
U_0/U	6/10 kV		12/20 kV		18/30 kV		6/10 kV		12/20 kV		18/30 kV	
cross section mm²	Current ratings in Ampere (A)											
25	163	194	–	–	–	–	–	–	–	–	–	–
35	197	235	200	235	–	–	153	182	–	–	–	–
50	236	282	239	282	241	282	183	219	185	219	187	219
70	294	350	297	351	299	350	228	273	231	273	232	273
95	358	426	361	426	363	425	278	333	280	332	282	331
120	413	491	416	491	418	488	321	384	323	384	325	382
150	468	549	470	549	472	548	364	432	366	432	367	429
185	535	625	538	625	539	624	418	496	420	494	421	492
240	631	731	634	731	635	728	494	583	496	581	496	578
300	722	831	724	830	725	828	568	666	569	663	568	659
400	827	920	829	923	831	922	660	755	660	753	650	750
500	949	1043	953	1045	953	1045	767	868	766	866	764	861

*This factors are also valid for longitudinally water-tight cable

Electrical characteristics of XLPE-insulated Medium Voltage Power Cables, 6 – 30 kV

Conductor resistance 20°C

cross-section mm²	maximum value Cu-conductor Ohm/km	Alu-conductor Ohm/km
25	0,727	1,20
35	0,524	0,868
50	0,387	0,641
70	0,268	0,443
95	0,193	0,320
120	0,153	0,253
150	0,124	0,206
185	0,0991	0,164
240	0,0754	0,125
300	0,0601	0,100
400	0,0470	0,0778
500	0,0366	0,0605

Conversion factors for the conductor temperatures

Temperature at °C	60	65	70	80	90
Cu-conductor	1,157	1,177	1,196	1,236	1,275
Alu-conductor	1,161	1,181	1,202	1,242	1,282

Conversion formula:

$$R\delta = R_{20} \cdot \frac{234{,}5 + \delta}{254{,}5}$$ for Cu-conductor

$$R\delta = R_{20} \cdot \frac{228 + \delta}{248}$$ for Alu-conductor

Conductor temperature at °C = δ
Conductor resistance at δ °C in Ohm/km = Rδ
Conductor resistance at 20 °C in Ohm/km = R_{20}

Electrical characteristics of XLPE-insulated Medium Voltage Power Cables, 6 – 30 kV

Effective resistance at 50 Hz (Alternating-current resistance)

Copper conductor

Nominal voltage	6/10 kV		12/20 kV		18/30 kV	
Cross-section	approx Ohm/km					
mm²						
35	0,671	0,673	0,671	0,672	–	–
50	0,497	0,498	0,496	0,498	0,496	0,497
70	0,345	0,346	0,345	0,346	0,344	0,346
95	0,249	0,251	0,249	0,250	0,249	0,250
120	0,198	0,200	0,198	0,200	0,198	0,199
150	0,163	0,165	0,163	0,165	0,162	0,164
185	0,132	0,134	0,131	0,133	0,131	0,133
240	0,102	0,104	0,101	0,103	0,101	0,103
300	0,082	0,085	0,082	0,084	0,082	0,084
400	0,068	0,071	0,067	0,070	0,067	0,069
500	0,055	0,058	0,055	0,058	0,054	0,057

Aluminium conductor

Nominal voltage	6/10 kV		12/20 kV		18/30 kV	
Cross-section	approx Ohm/km					
mm²						
35	1,12	1,12	1,12	1,12	–	–
50	0,825	0,826	0,825	0,826	0,824	0,826
70	0,571	0,572	0,571	0,572	0,571	0,572
95	0,413	0,415	0,413	0,414	0,413	0,414
120	0,327	0,329	0,327	0,329	0,327	0,328
150	0,269	0,271	0,268	0,270	0,268	0,270
185	0,215	0,217	0,215	0,217	0,214	0,216
240	0,165	0,167	0,165	0,167	0,164	0,166
300	0,133	0,135	0,133	0,135	0,133	0,135
400	0,106	0,109	0,106	0,109	0,106	0,108
500	0,085	0,088	0,084	0,087	0,084	0,087

Inductive resistance at 50 Hz

Nominal voltage	6/10 kV		12/20 kV		18/30 kV	
Cross-section	Ohm/km					
mm²						
35	0,144	0,158	0,153	0,168	–	–
50	0,136	0,150	0,145	0,159	0,154	0,169
70	0,129	0,143	0,138	0,152	0,147	0,161
95	0,123	0,137	0,131	0,145	0,139	0,154
120	0,118	0,132	0,126	0,140	0,134	0,148
150	0,114	0,128	0,121	0,135	0,129	0,143
185	0,110	0,124	0,117	0,131	0,125	0,139
240	0,105	0,120	0,112	0,126	0,120	0,134
300	0,102	0,116	0,108	0,123	0,115	0,130
400	0,097	0,111	0,103	0,117	0,110	0,124
500	0,094	0,108	0,100	0,114	0,106	0,120

Electrical characteristics of XLPE-insulated Medium Voltage Power Cables, 6 – 30 kV

Mutual capacitance

Nominal voltage	6/10 kV	12/20 kV	18/30 kV
Cross-section mm²	µF/km	µF/km	µF/km
35	0,22	0,16	–
50	0,25	0,18	0,14
70	0,28	0,20	0,15
95	0,31	0,22	0,17
120	0,34	0,23	0,18
150	0,37	0,25	0,19
185	0,40	0,27	0,20
240	0,44	0,30	0,22
300	0,48	0,32	0,24
400	0,55	0,36	0,27
500	0,60	0,40	0,29

Inductance

Nominal voltage	6/10 kV		12/20 kV		18/30 kV	
Cross-section mm²	 mH/km	 mH/km	 mH/km	 mH/km	 mH/km	 mH/km
35	0,45	0,76	0,48	0,76	–	–
50	0,42	0,73	0,45	0,74	0,48	0,75
70	0,39	0,70	0,43	0,70	0,45	0,71
95	0,38	0,67	0,41	0,68	0,43	0,68
120	0,36	0,65	0,39	0,65	0,42	0,66
150	0,35	0,63	0,38	0,63	0,41	0,64
185	0,34	0,61	0,36	0,62	0,39	0,63
240	0,32	0,59	0,35	0,59	0,37	0,60
300	0,31	0,57	0,33	0,58	0,36	0,59
400	0,30	0,55	0,33	0,55	0,34	0,56
500	0,29	0,53	0,31	0,53	0,33	0,54

Electrical characteristics of XLPE-insulated Medium Voltage Power Cables, 6 – 30 kV

Short-circuit current carrying capacity up to 30 kV

Conductor temperature: 90° C

Short-circuit temperature: 250° C

Cable with Cu-conductors

Cross-section	short-circuit time in s (seconds)														
	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,5	2,0	3,0	4,0	5,0
mm²	permissible short-circuit in kA														
25	11,3	8,0	6,5	5,7	5,1	4,6	4,3	4,0	3,8	3,6	2,9	2,5	2,1	1,8	1,6
35	15,8	11,2	9,1	7,9	7,1	6,5	6,0	5,6	5,3	5,0	4,1	3,5	2,9	2,5	2,2
50	22,6	16,0	13,1	11,3	10,1	9,2	8,5	8,0	7,5	7,2	5,8	5,1	4,1	3,6	3,2
70	31,7	22,4	18,3	15,8	14,2	12,9	12,0	11,2	10,6	10,0	8,2	7,1	5,8	5,0	4,5
95	43,0	30,4	24,8	21,5	19,2	17,5	16,2	15,2	14,3	13,6	11,1	9,6	7,8	6,8	6,1
120	54,3	38,4	31,3	27,1	24,3	22,2	20,5	19,2	18,1	17,2	14,0	12,1	9,9	8,6	7,7
150	67,8	48,0	39,2	33,9	30,3	27,7	25,6	24,0	22,6	21,5	17,5	15,2	12,4	10,7	9,6
185	83,7	59,2	48,3	41,8	37,4	34,2	31,6	29,6	27,9	26,5	21,6	18,7	15,3	13,2	11,8
240	108,5	76,7	62,7	54,3	48,5	44,3	41,0	38,4	36,2	34,3	28,0	24,3	19,8	17,2	15,3
300	135,7	95,9	78,3	67,8	60,7	55,4	51,3	48,0	45,2	42,9	35,0	30,3	24,8	21,5	19,2
400	180,9	127,9	104,4	90,4	80,9	73,8	68,4	64,0	60,3	57,2	46,7	40,4	33,0	28,6	25,6
500	226,1	159,9	130,5	113,1	101,1	92,3	85,5	79,9	75,4	71,5	58,4	50,6	41,3	35,8	32,0

Cable with Alu-conductors

Cross-section	short-circuit time in s (seconds)														
	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,5	2,0	3,0	4,0	5,0
mm²	permissible short-circuit in kA														
25	7,4	5,3	4,3	3,7	3,3	3,0	2,8	2,6	2,5	2,4	1,9	1,7	1,4	1,2	1,1
35	10,4	7,4	6,0	5,2	4,7	4,2	3,9	3,7	3,5	3,3	2,7	2,3	1,9	1,6	1,5
50	14,9	10,5	8,6	7,4	6,6	6,1	5,6	5,3	5,0	4,7	3,8	3,3	2,7	2,4	2,1
70	20,8	14,7	12,0	10,4	9,3	8,5	7,9	7,4	6,9	6,6	5,4	4,7	3,8	3,3	2,9
95	28,2	20,0	16,3	14,1	12,6	11,5	10,7	10,0	9,4	8,9	7,3	6,3	5,2	4,5	4,0
120	35,7	25,2	20,6	17,8	16,0	14,6	13,5	12,6	11,9	11,3	9,2	8,0	6,5	5,6	5,0
150	44,6	31,5	25,7	22,3	19,9	18,2	16,9	15,8	14,9	14,1	11,5	10,0	8,1	7,1	6,3
185	55,0	38,9	31,7	27,5	24,6	22,5	20,8	19,4	18,3	17,4	14,2	12,3	10,0	8,7	7,8
240	71,3	50,4	41,2	35,7	31,9	29,1	27,0	25,2	23,8	22,6	18,4	16,0	13,0	11,3	10,1
300	89,2	63,1	51,5	44,6	39,9	36,4	33,7	31,5	29,7	28,2	23,0	19,9	16,3	14,1	12,6
400	118,9	84,1	68,6	59,5	53,2	48,5	44,9	42,0	39,6	37,6	30,7	26,6	21,7	18,8	16,8
500	148,6	105,1	85,8	74,3	66,5	60,7	56,2	52,5	49,5	47,0	38,4	33,2	27,1	23,5	21,0

Electrical characteristics of XLPE-insulated Medium Voltage Power Cables, 6 – 30 kV

Short-circuit to ground

Nominal voltage	6/10 kV	12/20 kV	18/30 kV
cross-section mm²	A/km	A/km	A/km
35	1,2	1,7	–
50	1,4	1,9	2,3
70	1,5	2,1	2,5
95	1,7	2,4	2,7
120	1,9	2,6	2,9
150	2,0	2,7	3,1
185	2,2	3,0	3,3
240	2,4	3,3	3,7
300	2,6	3,5	4,0
400	3,0	4,0	4,4
500	3,3	4,3	4,8

Short-circuit current carrying capacity of copper screens Short-circuit temperature: 350°C

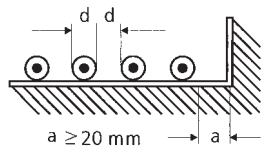
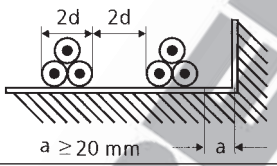
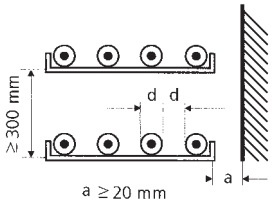
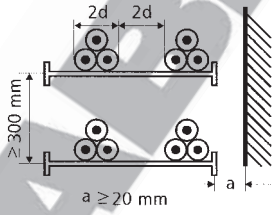
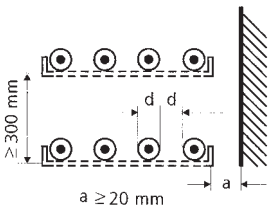
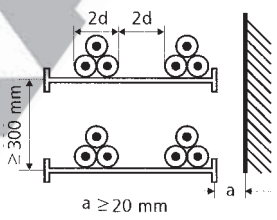
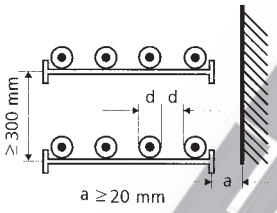
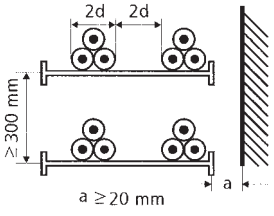
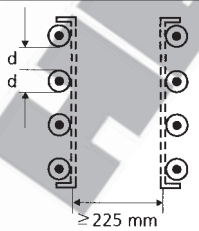
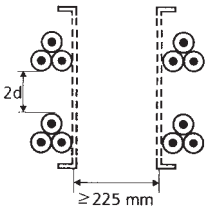
short-circuit time in seconds	load of short-circuit current in kA		
	up to 16 mm²	25 mm²	35 mm²
s	kA	kA	kA
0,1	9,7	15,1	21,2
0,2	6,9	10,7	15,1
0,3	5,7	8,9	12,5
0,4	5,0	7,7	10,9
0,5	4,5	7,0	9,8
0,6	4,2	6,4	9,0
0,7	3,9	6,0	8,4
0,8	3,5	5,6	7,9
0,9	3,4	5,3	7,5
1,0	3,3	5,1	7,2
1,5	2,7	4,2	5,9
2,0	2,3	3,6	5,1
3,0	1,9	2,9	4,2
4,0	1,7	2,6	3,6
5,0	1,5	2,3	3,2

Coordination of screen-cross-section

conductor cross-section mm²	screen-cross-section mm²
35 to 120	16
150 to 300	25
400 and 500	35

Rating conversion factors for installation of Medium Voltage Cables, 6 – 30 kV

Rating conversion factors for laying in air*)
Single core cables in 3-phase systems

Arrangement of cables in laying condition	Number of cables troughs or trays on top of each other	**For laying on plain surface** Space = cable ø d Distance from wall ≧ 2 cm				**For installation in grouping** Space = 2 x cable ø d Distance from wall ≧ 2 cm			
		Installation method	Number of systems 1	2	3	Installation method	Number of systems 1	2	3
on the ground			0,92	0,89	0,88		0,98	0,96	0,94
on non-perforated cable troughs (restricted air circu-lation)	1		0,92	0,89	0,88		0,98	0,96	0,94
	2		0,87	0,84	0,83		0,95	0,91	0,87
	3		0,84	0,82	0,81		0,94	0,90	0,85
	6		0,82	0,80	0,79		0,93	0,88	0,82
on perforated cable troughs	1		1,00	0,93	0,90		1,00	0,98	0,96
	2		0,97	0,89	0,85		0,97	0,93	0,89
	3		0,96	0,88	0,82		0,96	0,92	0,85
	6		0,94	0,84	0,80		0,95	0,90	0,83
on cable trays or on cable ladders (unrestric-ted air circu-lation)	1		1,00	0,97	0,96		1,00	1,00	1,00
	2		0,97	0,94	0,93		0,97	0,95	0,93
	3		0,96	0,93	0,92		0,96	0,94	0,90
	6		0,94	0,91	0,90		0,95	0,93	0,87
on platform or on the wall	1		0,94	0,91	0,89		1,00	0,91	0,89
	2		0,94	0,90	0,86		1,00	0,90	0,86
Arrangements, for which a reduction not necessary[1]		For the installation on plain surface with greater distance, the muntual heating is lower, for this occur the additional sheath or screen-losses. Because of that no particulars can be made for reduction-free arrangements. .				———			

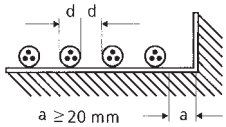
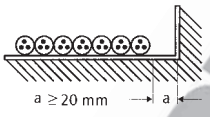
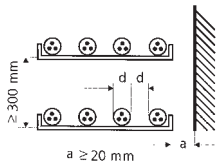
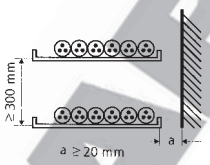
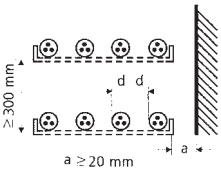
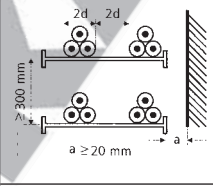
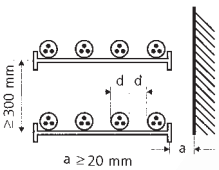
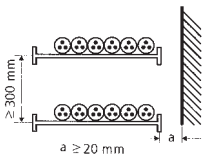
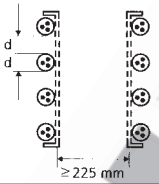
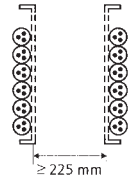
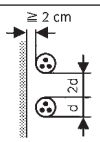
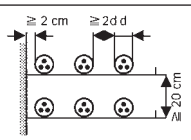
*Conversion factors for deviating ambient temperature

Temperature °C	10	15	20	25	30	35	40	45	50
VPE-cable	1,15	1,12	1,08	1,04	1,0	0,96	0,91	0,87	0,82
PVC-cable	1,22	1,17	1,12	1,06	1,0	0,94	0,87	0,79	0,71

[1] In narrow rooms or for bigger grouping, the air temperature is increased due to energy losses of cable, so the additional conversion factors for deviating air-temperatures are to be taken in the given table.

Rating conversion factors for installation of Medium Voltage Cables 6 – 30 kV

Rating conversion factors for laying in <u>air</u>*)
Multicore cable and single core direct current cable

Arrangement of cables in laying condition	Number of cables troughs or trays	**Without inter-contact** Space = cable Ø d Distance from wall ≧ 2cm						**With inter-contact** contact with wall						
		Installation method	Number of cables 1	2	3	4	6	Installation method	Number of cables 1	2	3	4	6	9
on the ground	1		0,97	0,96	0,94	0,93	0,90		0,97	0,85	0,78	0,75	0,71	0,68
on non-perforated cable troughs (restricted air circulation)	1		0,97	0,96	0,94	0,93	0,90		0,97	0,85	0,78	0,75	0,71	0,68
	2		0,97	0,95	0,92	0,90	0,86		0,97	0,84	0,76	0,73	0,68	0,63
	3		0,97	0,94	0,91	0,89	0,84		0,97	0,83	0,75	0,72	0,66	0,61
	6		0,97	0,93	0,90	0,88	0,83		0,97	0,81	0,73	0,69	0,63	0,58
on perforated cable troughs	1		1,00	1,00	0,98	0,95	0,91		1,00	0,88	0,82	0,79	0,76	0,73
	2		1,00	0,99	0,96	0,92	0,87		1,00	0,87	0,80	0,77	0,73	0,68
	3		1,00	0,98	0,95	0,91	0,85		1,00	0,86	0,79	0,76	0,71	0,66
	6		1,00	0,97	0,94	0,90	0,84		1,00	0,84	0,77	0,73	0,68	0,64
on cable trays or on cable ladders (unrestricted air circulation)	1		1,00	1,00	1,00	1,00	1,00		1,00	0,87	0,82	0,80	0,79	0,78
	2		1,00	0,99	0,98	0,97	0,96		1,00	0,86	0,80	0,78	0,76	0,73
	3		1,00	0,94	0,97	0,96	0,93		1,00	0,85	0,79	0,76	0,73	0,70
	6		1,00	0,97	0,96	0,94	0,91		1,00	0,83	0,76	0,73	0,69	0,66
on platform or on wall or on perfo-rated cable-tray	1		1,00	0,91	0,89	0,88	0,87		1,00	0,88	0,82	0,78	0,73	0,72
	2		1,00	0,91	0,88	0,87	0,85		1,00	0,88	0,81	0,76	0,71	0,70
laid on platform or on the wall	———	———	———						0,95	0,78	0,73	0,72	0,68	0,66
Arrangements, for which a reduction not necessary[1)]		Number of cable arranged one over another is optional						Number of cable arranged side-by-side is optional						

Note
Conversion factors for deviating ambient temperature – see page **X 38**

[1)] In narrow rooms or for bigger grouping, the air temperature is increased due to energy losses of cable, so the additional conversion factors for deviating air temperatures are to be taken in the given table.

Conversion factor for Medium Voltage Power Cables, 6 – 30 kV

Load rating for cables laid in ground
Load factor 0,7 and 1,0

Fundamental conditions*

Ground temperature 20° C
Thermal resistivity 1,0 K · m/W
Distance between cables or systems 7 cm
Single core cables laid in trefoil touching arrangement

Load factor 0,7

Type of insulation	Cable design	Nominal voltage	Number of cables or systems 2	4	6	8	10
PVC	Multicore cables	0,6/1 to 3,6/6 kV	0,86	0,71	0,64	0,60	0,57
	Three-core cables	to 6/10 kV	0,87	0,71	0,63	0,59	0,54
	Single core cables	0,6/1 to 3,6/6 kV	0,85	0,70	0,63	0,59	0,56
	Single core cables	to 6/10 kV	0,83	0,66	0,57	0,53	0,49
VPE	Multicore cables	0,6/1 to 18/30 kV	0,85	0,70	0,63	0,59	0,56
	Three-core cables	0,6/1 to 18/30 kV	0,85	0,70	0,63	0,58	0,56

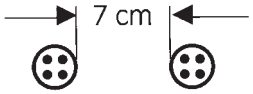
Load factor 1,0

Type of insulation	Cable design	Nominal voltage	Number of cables or systems 1	2	4	6	8	10
PVC	Multicore cables	0,6/1 to 3,6/6 kV	0,81	0,66	0,52	0,46	0,43	0,40
	Three-core cables	to 6/10 kV	0,82	0,67	0,51	0,45	0,41	0,37
	Single core cables	0,6/1 to 3,6/6 kV	0,79	0,65	0,51	0,46	0,42	0,40
	Single core cables	to 6/10 kV	0,78	0,62	0,47	0,40	0,36	0,33
VPE	Multicore cables	0,6/1 to 18/30 kV	0,83	0,67	0,53	0,47	0,44	0,41
	Single core cables	0,6/1 to 18/30 kV	0,81	0,66	0,52	0,47	0,43	0,41

Build-up of systems:

- for single core cables

- for multicore cables



*Conversion factors for multicore cables (≦ 5 cores), Conductor cross-section from 1,5 to 10 mm²

Number of loaded cores	Conversion factors for the values of 1,5 to 10 mm² to the belonging table	
	Earth	Air
5	0,7	0,75
7	0,6	0,65
10	0,5	0,55
14	0,45	0,5
19	0,4	0,45
24	0,35	0,4
40	0,3	0,35
61	0,25	0,3

*For other conditions e.g. ground temperature, grouping, load factor, thermal resistance, the rating factors should be calculated according to DIN VDE 0276 part1000.

Colour code according to DIN VDE 0293[1] (old)

Multicore flexible cables

Number of cores	Cores **with** green-yellow protective conductor **(–J)**	Cores **without** green-yellow protective conductor **(–O)**
2	–	brown/blue
3	green-yellow/brown/blue	black/blue/brown
4	green-yellow/black/blue/brown	black/blue/brown/black
5	green-yellow/black/blue/brown/black	black/blue/brown/black/black
6 and more	green-yellow/others black with white numbering	black with white numbering

Multicore cables for fixed installation

Number of cores	Cores **with** green-yellow protective conductor **(–J)**	Cores **without** green-yellow protective conductor **(–O)**	with protective conductor
2	green-yellow/black*	black/blue	black/blue
3	green-yellow/black/blue	black/blue/brown	black/blue/brown
4	green-yellow/black/blue/brown	black/blue/brown/black	black/blue/brown/black
5	green-yellow/black/blue/brown/black	black/blue/brown/black/black	–
6 and more	green-yellow/others black with white numbering	black with white numbering	black with white numbering

* This type is according to DIN VDE 0100 part 540, table 2 valid only for copper cross-section of 10 mm² and more or Alu 16 mm²À

Colour code according to DIN VDE 0293-308[2] (new)

Number of cores	Cores **with** green-yellow protective conductor **(–J)**	Cores **without** green-yellow protective conductor **(–O)**
2	–	brown/blue
3	green-yellow/brown/blue	brown/black/grey
3[3]	–	blue/brown/black
4	green-yellow/brown/black/grey	blue/brown/black/grey
4[3]	green-yellow/blue/brown/black	–
5	green-yellow/blue/brown/black/grey	blue/brown/black/grey/black
6 and more	green-yellow/others black with white numbering	black with white numbering

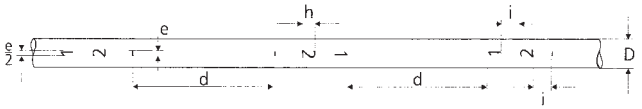
[1] Coding in accordance with VDE 0293: 1990-01 / transitional periods until 1 April 2006, beyond that only the coding for 6 or more conductors will continue to exist.
[2] Coding in accordance with VDE 0293-308 (valid as of 1 January 2003).
[3] Only for certain applications.

Core marking with numbering (in direction to longitudinal axis)

Height and gap of numbers

Core-nominal-ø mm	e*) mm	h mm	i mm	d mm
D ≤ 2,4	≥ 0,6	≥ 2,3	ca. 2	≤ 50
2,4 < D ≤ 5,0	≥ 1,2	≥ 3,2	ca. 3	≤ 50
5,0 < D	≥ 1,6	≥ 4,6	ca. 4	≤ 50

*) when the number in only 1, the smallest breadth is half of the given dimension to this column.



e: breadth of number
h: height of number
i : gap between two successive numbers and between number and dash
d: gap between two successive numbers

Colour code according to E DIN VDE 0245 part 1

Application for types: **NLSY** **NSY**
NLSCY **NSYCY**

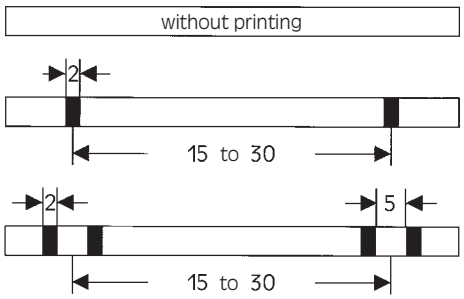
According to DIN-Norm 0245 series, the core identification is stated whether the code is to be marked with colours or with numberings.

Identification with colours
The core colour is given in basic colour and ring colour. For the identification of two or three colours, the first underlined colour is the basic colour.

The identification of the basic colours must be followed through colouring of the insulation or the oversurface of insulation cores.

The second and the third colour is printed over the basic colour as a form of ring.

Counting
The cores are to be counted continuously through all layers at the same direction, beginning with core 1 in inner layer towards outside. Measures of rings and distances are given in mm.



coloured

basic colour + ring colour

basic colour + ring colour

Core No.	Basic- and ring colour	Core No.	Basic- and ring colour	Core No.	Basic- and ring colour
1	white	22	brownblue	43	blueblack
2	brown	23	whitered	44	redblack
3	green	24	brownred	45	whitebrownblack
4	yellow	25	whiteblack	46	yellowgreenblack
5	grey	26	brownblack	47	greypinkblack
6	pink	27	greygreen	48	redblueblack
7	blue	28	yellowgrey	49	whitegreenblack
8	red	29	pinkgreen	50	browngreenblack
9	black	30	yellowpink	51	whiteyellowblack
10	violet	31	greenblue	52	yellowbrownblack
11	greypink	32	yellowblue	53	whitegreyblack
12	redblue	33	greenred	54	greybrownblack
13	whitegreen	34	yellowred	55	whitepinkblack
14	browngreen	35	greenblack	56	pinkbrownblack
15	whiteyellow	36	yellowblack	57	whiteblueblack
16	yellowbrown	37	greyblue	58	brownblueblack
17	whitegrey	38	pinkblue	59	whiteredblack
18	greybrown	39	greyred	60	brownredblack
19	whitepink	40	pinkred		
20	pinkbrown	41	greyblack		
21	whiteblue	42	pinkblack		

Example: Core 21 whiteblue

basic colour ring colour

The given colours are corresponded to DIN IEC 60304 and HD 402.S2.

Identification through numberings as per DIN VDE 0293.

Colour code according to DIN 47100
with colour repetition from core no. 45 and above

Electronic control and computer cable: **single cores** stranding

The insulation of the conductor gives the first basic colour. The codes of the multi-coloured identification are combined with a basic colour and colour rings. The second and third colour is printed on the basic colour as a form of ring.

The ring width is 2–3 mm. A less unsharpness on the edge of the identification colour and a minor pledging of both half-rings are permitted.

The cores are to be counted continuously through all layers at the same direction, beginning with the outer layer towards inside.

No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours
1	white	17	white-grey	33	green-red	45	white
2	brown	18	grey-brown	34	yellow-red	46	brown
3	green	19	white-pink	35	green-black	47	green
4	yellow	20	pink-brown	36	yellow-black	48	yellow
5	grey	21	white-blue	37	grey-blue	49	grey
6	pink	22	brown-blue	38	pink-blue	50	pink
7	blue	23	white-red	39	grey-red	51	blue
8	red	24	brown-red	40	pink-red	52	red
9	black	25	white-black	41	grey-black	53	black
10	violet	26	brown-black	42	pink-black	54	violet
11	grey-pink	27	grey-green	43	blue-black	55	grey-pink
12	red-blue	28	yellow-grey	44	red-black	56	red-blue
13	white-green	29	pink-green			57	white-green
14	brown-green	30	yellow-pink			58	brown-green
15	white-yellow	31	green-blue			59	white-yellow
16	yellow-brown	32	yellow-blue			60	yellow-brown
						61	white-grey

Colour code adapted* to DIN 47100
whitout colour repetition

No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours
1	white	17	white-grey	33	green-red	45	white-brown-black
2	brown	18	grey-brown	34	yellow-red	46	yellow-green-black
3	green	19	white-pink	35	green-black	47	grey-pink-black
4	yellow	20	pink-brown	36	yellow-black	48	red-blue-black
5	grey	21	white-blue	37	grey-blue	49	white-green-black
6	pink	22	brown-blue	38	pink-blue	50	brown-green-black
7	blue	23	white-red	39	grey-red	51	white-yellow-black
8	red	24	brown-red	40	pink-red	52	yellow-brown-black
9	black	25	white-black	41	grey-black	53	white-grey-black
10	violet	26	brown-black	42	pink-black	54	grey-brown-black
11	grey-pink	27	grey-green	43	blue-black	55	white-pink-black
12	red-blue	28	yellow-grey	44	red-black	56	pink-brown-black
13	white-green	29	pink-green			57	white-blue-black
14	brown-green	30	yellow-pink			58	brown-blue-black
15	white-yellow	31	green-blue			59	white-red-black
16	yellow-brown	32	yellow-blue			60	brown-red-black
						61	black-white

* deviation to DIN, without colour repetition, from core no. 45 and above

Pair-Colour code according to DIN 47100
with colour repetition from pair no. 45 and above

Electronic control and computer cable: **pair** stranding

The insulation of the conductor gives the first basic colour. The codes of the multi-coloured identification are combined with a basic colour and colour rings. The second colour is printed on the basic colour as a form of ring.
The ring width is 2–3 mm. A less unsharpness on the edge of the identification colour and a minor pledging of both half-rings are permitted.
The cores are to be counted continuously through all layers at the same direction, beginning with the outer layer towards inside.

Pair-stranding Pair-no.			core	colour
1	23	45	a	white
			b	brown
2	24	46	a	green
			b	yellow
3	25	47	a	grey
			b	pink
4	26	48	a	blue
			b	red
5	27	49	a	black
			b	violet
6	28	50	a	grey-pink
			b	red-blue
7	29	51	a	white-green
			b	brown-green
8	30	52	a	white-yellow
			b	yellow-brown
9	31	53	a	white-grey
			b	grey-brown
10	32	54	a	white-pink
			b	pink-brown
11	33	55	a	white-blue
			b	brown-blue

Pair-stranding Pair-no.			core	colour
12	34	56	a	white-red
			b	brown-red
13	35	57	a	white-black
			b	brown-black
14	36	58	a	grey-green
			b	yellow-grey
15	37	59	a	pink-green
			b	yellow-pink
16	38	60	a	green-blue
			b	yellow-blue
17	39	61	a	green-red
			b	yellow-red
18	40	62	a	green-black
			b	yellow-black
19	41	63	a	grey-blue
			b	pink-blue
20	42	64	a	grey-red
			b	pink-red
21	43	65	a	grey-black
			b	pink-black
22	44	66	a	blue-black
			b	red-black

Colour code as per DIN 47002

YV-Equipment wires
(for twin colour cables, the base colour is underlined)

ws	white	br	brown
gn	green	ge	yellow
gr	grey	rs	pink
bl	blue	rt	red
sw	black	vi	violet
wsbr	white-brown	wsgn	white-green
wsge	white-yellow	wsbl	white-blue
wsrt	white-red	wssw	white-black
brgn	brown-green	brge	brown-yellow
brbl	brown-blue	brsw	brown-black
gnge	green-yellow	gnrt	green-red
gnsw	green-black	gebl	yellow-blue
gert	yellow-red	gesw	yellow-black
grrt	grey-red	grsw	grey-black
rssw	pink-black	rsvi	pink-violet
blrt	blue-red	rtsw	red-black
virt	violet-red		

Colour code for YR-Bell Sheathed Cables

2 x 0,8: bk, bu
3 x 0,8: bk, bu, bn
4 x 0,8: bk, bu, bn, ye
5 x 0,8: bk, bu, bn, ye, gn
6 x 0,8: bk, bu, bn, ye, gn, vt
8 x 0,8: bk, bu, bn, ye, gn, vt, wh, og
10 x 0,8: bk, bu, bn, ye, gn, vt, wh, og, tr, gy
12 x 0,8: bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu
14 x 0,8: bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu, cog, lgn
16 x 0,8: bk, bu, bn, ye, gn, vt, wh, og, tr, gy, rd, lbu, cog, lgn, lrd, lye

Colour code according to international standard

Electronic control UL-version: **single cores** stranding

The insulation of the conductor gives the first basic colour. The codes of the multi-coloured identification are combined with a basic colour and colour rings. The second colour is printed on the basic colour as a form of ring.

The ring width is 2–3 mm. A less unsharpness on the edge of the identification colour and a minor pledging of both half-rings are permitted.

The cores are to be counted continuously through all layers at the same direction, beginning with the inside layer towards outer.

No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours	No.	Basic-Ring-colours
1	black	16	white-green	31	green-red	46	grey-brown
2	brown	17	white-blue	32	green-orange	47	grey-red
3	red	18	white-violet	33	green-blue	48	grey-orange
4	orange	19	white-grey	34	green-violet	49	grey-yellow
5	yellow	20	brown-black	35	green-grey	50	grey-green
6	green	21	brown-red	36	green-white	51	grey-blue
7	blue	22	brown-orange	37	yellow-black	52	grey-violet
8	violet	23	brown-yellow	38	yellow-brown	53	grey-white
9	grey	24	brown-green	39	yellow-red	54	orange-black
10	white	25	brown-blue	40	yellow-orange	55	orange-brown
11	white-black	26	brown-violet	41	yellow-blue	56	orange-red
12	white-brown	27	brown-grey	42	yellow-violet	57	orange-yellow
13	white-red	28	brown-white	43	yellow-grey	58	orange-green
14	white-orange	29	green-black	44	yellow-white	59	orange-blue
15	white-yellow	30	green-brown	45	grey-black	60	orange-violet

Pair-colour code according to international standard

Electronic control UL-version: **pair** stranding

The insulation of the conductor gives the first basic colour. The codes of the multi-coloured identification are combined with a basic colour and colour rings. The second colour is printed on the basic colour as a form of ring.
The ring width is 2–3 mm. A less unsharpness on the edge of the identification colour and a minor pledging of both half-rings are permitted.
The cores are to be counted continuously through all layers at the same direction, beginning with the inside layer towards outer.

Pair-stranding Pair-no.	core	colour
1	a	black
	b	brown
2	a	black
	b	red
3	a	black
	b	orange
4	a	black
	b	yellow
5	a	black
	b	green
6	a	black
	b	blue
7	a	black
	b	violet
8	a	black
	b	grey

Pair-stranding Pair-no.	core	colour
9	a	black
	b	white
10	a	brown
	b	red
11	a	brown
	b	orange
12	a	brown
	b	yellow
13	a	brown
	b	green
14	a	brown
	b	blue
15	a	brown
	b	violet
16	a	brown
	b	grey

Pair-stranding Pair-no.	core	colour
17	a	brown
	b	white
18	a	red
	b	orange
19	a	red
	b	yellow
20	a	red
	b	green
21	a	red
	b	blue
22	a	red
	b	violet
23	a	red
	b	grey
24	a	red
	b	white

Colour code for single wire vehicle cables

one-colour

black, white, blue, orange, brown, green, violet, red, pink, yellow, grey

two-colours

● preferred colours

base colour	marking colour longitudinal stripe	base colour	marking colour longitudinal stripe
white	grey	red	white
white	red	red	yellow
white	brown	red	grey
white	blue	red	green
white	black	red	blue
		red	black
yellow	grey		
yellow	red	brown	white
yellow	brown	brown	yellow
yellow	blue	brown	green
yellow	black	brown	black
grey	green	blue	white
grey	red	blue	yellow
grey	brown	blue	green
		blue	red
green	white		
green	grey	black	white
green	brown	black	yellow
green	blue	black	green
green	black	black	red

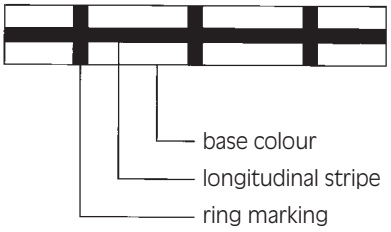
three-colours

● preferred colours

base colour	1. marking colour longitudinal stripe	2. marking colour longitudinal stripe
grey	green	yellow
grey	red	yellow
grey	brown	yellow
red	white	yellow
red	yellow	yellow
red	grey	yellow
red	green	yellow
red	blue	yellow
red	black	yellow
brown	white	yellow
brown	yellow	yellow
brown	green	yellow
brown	black	yellow
blue	white	yellow
blue	yellow	yellow
blue	green	yellow
blue	red	yellow
black	white	yellow
black	yellow	yellow
black	green	yellow
black	red	yellow

Minimum quantities for one or two-coloured combinations per cross-section and colour combination:
0,5 to 2,5 mm² = 3 km
4,0 to 25,0 mm² = 1 km. Remaining cross-sections on request

For three-coloured combination we manufacture **only** on request.
Minimum quantities per cross-sections and colour combinations:
0,5 to 2,5 mm² = 5 km
4,0 to 25,0 mm² = 3 km. Remaining cross-sections on request.



● further colour combinations

base colour	marking colour longitudinal stripe	base colour	marking colour longitudinal stripe
white	yellow	brown	grey
white	green	brown	violet
white	violet	brown	blue
yellow	white	blue	grey
yellow	green	blue	violet
yellow	violet	blue	brown
grey	white	black	grey
grey	yellow	black	violet
grey	violet	black	brown
green	yellow	orange	white
green	red	orange	yellow
green	violet	orange	grey
		orange	green
red	brown	orange	violet
		orange	blue
violet	white	orange	black
violet	yellow		
violet	grey		
violet	green		
violet	brown		
violet	blue		
violet	black		

● further colour combinations

base colour	1. marking colour longitudinal stripe	2. marking colour longitudinal stripe
grey	white	yellow
grey	yellow	yellow
grey	violet	yellow
red	brown	yellow
violet	white	yellow
violet	yellow	yellow
violet	grey	yellow
violet	green	yellow
violet	brown	yellow
violet	blue	yellow
violet	black	yellow
brown	grey	yellow
brown	violet	yellow
brown	blue	yellow
blue	grey	yellow
blue	violet	yellow
blue	brown	yellow
black	grey	yellow
black	violet	yellow
black	brown	yellow
orange	white	yellow
orange	yellow	yellow
orange	grey	yellow
orange	green	yellow
orange	violet	yellow
orange	blue	yellow
orange	black	yellow

X

Colour code HELUKABEL®-JB

Colour coded Control Cables **JB** and **SY-JB** with green-yellow protective conductor

The combination of colour identification up to 102 cores consists of 11 basic colours. For core-no. 12 and more, one or two additional colour rings or longitudinal stripes are printed on the basic colour. The ring width is approximately 2 mm.

3- to 5-core cables

Colour identification according to VDE 0293 for flexible cables

3 cores = green-yellow/brown/blue
4 cores = green-yellow/brown/black/grey
5 cores = green-yellow/blue/brown/black/grey

6- and more core cables

Colour identification as per following table.
The insulation of the conductor gives the first basic colour. The second and the third colour is printed on the basic colour as a form of ring or longitudinal stripe. The cores are to be counted continuously through all layers at the same direction, beginning with inner layer towards outside.

No.	Basic-Ring-Colour
0	green-yellow
1	white
2	black
3	blue
4	brown
5	grey
6	red
7	violet
8	pink
9	orange
10	transparent
11	beige
12	black-white
13	blue-white
14	brown-white
15	grey-white
16	red-white
17	violet-white
18	pink-white
19	orange-white
20	transparent-white
21	beige-white
22	blue-black
23	brown-black
24	grey-black
25	red-black
26	violet-black
27	pink-black
28	orange-black
29	transparent-black
30	beige-scwarz
31	brown-blue
32	grey-blue
33	red-blue
34	pink-blue
35	orange-blue
36	transparent-blue
37	beige-blue
38	grey-brown
39	red-brown
40	violet-brown
41	pink-brown
42	orange-brown
43	transparent-brown
44	beige-brown
45	red-grey
46	violet-grey
47	pink-grey
48	orange-grey
49	transparent-grey
50	beige-grey
51	orange-red
52	transparent-red
53	beige-red
54	pink-violet
55	orange-violet
56	transparent-violet
57	beige-violet
58	transparent-pink
59	beige-pink
60	transparent-orange
61	beige-orange
62	blue-white-black
63	brown-white-black
64	grey-white-black
65	red-white-black
66	violet-white-black
67	pink-white-black
68	orange-white-black
69	transparent-white-black
70	beige-white-black
71	brown-white-blue
72	grey-white-blue
73	red-white-blue
74	violet-white-blue
75	pink-white-blue
76	orange-white-blue
77	transparent-white-blue
78	beige-white-blue
79	grey-white-brown
80	red-white-brown
81	violet-white-brown
82	pink-white-brown
83	orange-white-brown
84	transparent-white-brown
85	beige-white-brown
86	red-white-grey
87	violet-white-grey
88	pink-white-grey
89	orange-white-grey
90	transparent-white-grey
91	beige-white-grey
92	blue-white-red
93	brown-white-red
94	violet-white-red
95	pink-white-red
96	orange-white-red
97	brown-white-violet
98	orange-white-violet
99	brown-black-blue
100	grey-black-blue
101	red-black-blue

Colour code HELUKABEL®-OB

Colour coded Control Cables **OB** and **SY-OB** without green-yellow protective conductor

The combination of colour identification up to 101 cores consists of 11 basic colours. For core-no. 12 and more, one or two additional colour rings or longitudinal stripes are printed on the basic colour. The ring width is approximately 2 mm.

2- to 5-core cables

Colour identification according to VDE 0293 for flexible cables

2 cores = brown/blue
3 cores = brown/black/grey
4 cores = blue/brown/black/grey
5 cores = blue/brown/black/grey/black

6- and more core cables

Colour identification as per following table. The insulation of the conductor gives the first basic colour. The second and the third colour is printed on the basic colour as a form of ring or longitudinal stripe.
The cores are to be counted continuously through all layers at the same direction, beginning with inner layer towards outside.

No.	Basic-Ring-colour
1	white
2	black
3	blue
4	brown
5	grey
6	red
7	violet
8	pink
9	orange
10	transparent
11	beige
12	black-white
13	blue-white
14	brown-white
15	grey-white
16	red-white
17	violet-white
18	pink-white
19	orange-white
20	transparent-white
21	beige-white
22	blue-black
23	brown-black
24	grey-black
25	red-black
26	violet-black
27	pink-black
28	orange-black
29	transparent-black
30	beige-black
31	brown-blue
32	grey-blue
33	red-blue
34	pink-blue
35	orange-blue

No.	Basic-Ring-colour
36	transparent-blue
37	beige-blue
38	grey-brown
39	red-brown
40	violet-brown
41	pink-brown
42	orange-brown
43	transparent-brown
44	beige-brown
45	red-grey
46	violet-grey
47	pink-grey
48	orange-grey
49	transparent-grey
50	beige-grey
51	orange-red
52	tranparent-red
53	beige-red
54	pink-violet
55	orange-violet
56	tranparent-violet
57	beige-violet
58	transparent-pink
59	beige-pink
60	transparent-orange
61	beige-orange
62	blue-white-black
63	brown-white-black
64	grey-white-black
65	red-white-black
66	violet-white-black
67	pink-white-black
68	orange-white-black

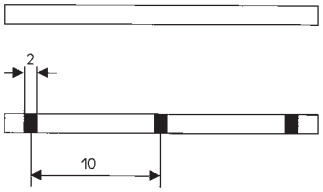
No.	Basic-Ring-colour
69	transparent-white-black
70	beige-white-black
71	brown-white-blue
72	grey-white-blue
73	red-white-blue
74	violet-white-blue
75	pink-white-blue
76	orange-white-blue
77	transparent-white-blue
78	beige-white-blue
79	grey-white-brown
80	red-white-brown
81	violet-white-brown
82	pink-white-brown
83	orange-white-brown
84	transparent-white-brown
85	beige-white-brown
86	red-white-grey
87	violet-white-grey
88	pink-white-grey
89	orange-white-grey
90	transparent-white-grey
91	beige-white-grey
92	blue-white-red
93	brown-white-red
94	violet-white-red
95	pink-white-red
96	orange-white-red
97	brown-white-violet
98	orange-white-violet
99	brown-black-blue
100	grey-black-blue
101	red-black-blue

Colour code according to DIN VDE 0813

Switchboard cable S-YY Lg

Core identification

Dimensions in mm



single coloured
no ring marking

with ring marking,
ring width and ring
distance

The cores are identified in colour-groups with each 4, 5, 6, 10 different core colour combinations which is repeate continuously according to the following scheme:

No. of cores in each colour-group	Core colours
4	blue, red, grey, green
5	blue, red, grey, green, brown
6	blue, red, grey, green, brown, black
10	blue, red, grey, green, brown, black, yellow, white, pink, violet

Example

S-YY 30 (5 x6) x1x 0,6 Lg
= 5x colour-groups with 6 different core colours.

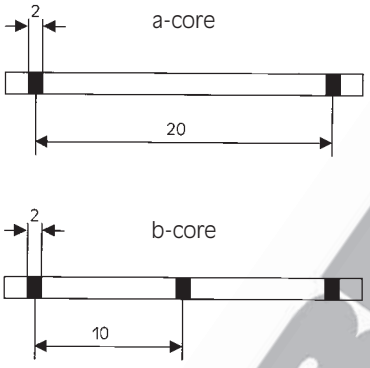
The colour-groups of same identification codes are only permitted to apply in a cable. In each layer, the blue core of the first completed colour-group is identified with red colour ring markings.
The remaining cores of the previous colour-group are laying before the blue cores with red markings.

Counting: from outside towards inside.
The cores of the switchboard cable are stranded in layers. The cores are to be counted continuously through all layers at the same direction, beginning with outer layer towards inside.

Switchboard cable S-Y(St)Y Bd

Core identification

Dimensions in mm



The colour identifications of the a- and b-cores of switchboard cables are coded with a basic colour and colour rings.

Identification of ring- and basic colours

No. of Unit	Serial no. of twistet elements					Ring-colours a-core	GBasic colour a- and b-core
1	1	2	3	4	5	blue	
2	6	7	8	9	10	yellow	
3	11	12	13	14	15	green	white
4	16	17	18	19	20	brown	
5	21	22	23	24	25	black	
6	26	27	28	29	30	blue	
7	31	32	33	34	35	yellow	
8	36	37	38	39	40	green	grey
9	41	42	43	44	45	brown	
10	46	47	48	49	50	black	
	blue	yellow	green	brown	black		
	Ring-colours b-core						

all c-cores: red;
all d-cores: pink;
all e-cores: black

Cables with more than 50 twisted elements, the identifications code of 51 and above elements are to be counted again from serial no. 1.

The twisted elements are pairs, triples, five-core units
Pairs a- and b-cores
triple a-, b- and c-ores
five-core units a-, b-, c-, d- and e-cores
The cores of 5 twisted elements with same ring markings of a-cores are bunched to a unit.

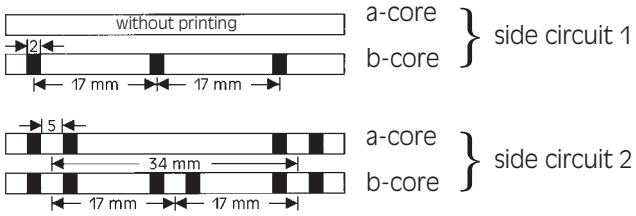
Counting: from outside towards inside.
The units are to be counted continuously through all layers at the same direction with correct colour countings, beginning with outer layer towards inside.

Colour code according to DIN VDE 0815

Installation Cables

J-YY . . . Bd, J-HH . . . Bd, J-Y(St)Y . . . Bd, J-H(St)H . . . Bd and **J-2Y(St)Y . . . Bd**

The Insulating coverings of single cores of a star quad are marked with black rings:



The cores of 5 star quads of a sub unit are counted according to the sequence of basic colours:

Quad 1: basic colour of all cores red
Quad 2: basic colour of all cores green
Quad 3: basic colour of all cores grey
Quad 4: basic colour of all cores yellow
Quad 5: basic colour of all cores white

The marker of units are identified with a red helix, the others with white or uncoloured.
The quads of sub units are counted according to the sequence of basic colours. The units are counted continuously through all layers beginning in the inner layer.

Installation Cables

J-Y(St)Y . . . Lg

2-paired installation cables are stranded to a star quad.

circuit 1 a-core red, b-core black
circuit 2 a-core white, b-core yellow

4- and multi-paired installation cables

a-core of 1. pair in each layer is red
other pairs are white

b-core blue, yellow, green, brown, black in continuous repeat

Counting: from outside to inside

Installation Cables

JE-Y(St)Y . . . Bd, JE-LiYCY . . . Bd, JE-H(St) . . . and **JE-HCH...Bd**

Pair-colour-identification

The insulating cores are identified with different basic colours which are repeated sequencely in each unit.

Basic colours of pairs

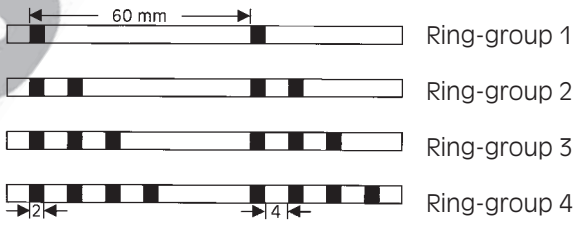
Pair	1	2	3	4
a-core b-core	blue red	grey yellow	green brown	white black

2-paired cables: the cores are stranded to a star quad:
circuit 1: a-core blue, b-core red
circuit 2: a-core grey, b-core yellow

Each unit is assigned to one group of ring. All cores in each unit are marked with coloured rings and ring-groups.

Counting direction in all units is from inside to outside.

Ring-colour and Ring-group



Unit-identification

Unit-No.	Ring-colour	Ring-group	Colour-identification tape
1 2 3 4	pink	I II III IIII	–
5 6 7 8	orange	I II III IIII	–
9 10 11 12	violet	I II III IIII	–
13 14 15 16	pink	I II III IIII	blue
17 18 19 20	orange	I II III IIII	red

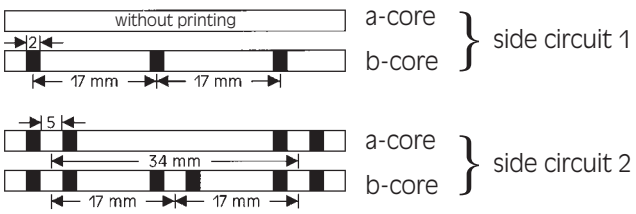
Cables with more than 12 units contain coloured plastic helix in addition to ring code.

Colour code according to DIN VDE 0816 and extended

Outdoor Telephone Cables

A-2Y(L)2Y...Bd and **A-2YF(L)2Y...Bd**
A-02Y(L)2Y . . . Bd, A-02YSF(L)2Y . . Bd and **A-2Y0F(L)2Y . . . Bd**

The Insulating coverings of single cores of a quad are to be marked with black rings:

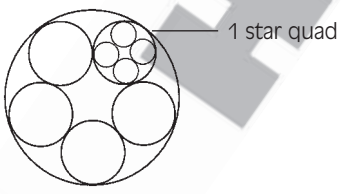


The insulating cores of five star quads of a sub-unit must have the following colours:

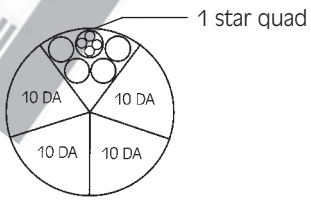
Quad 1: basic colours of all conductors red
Quad 2: basic colours of all conductors green
Quad 3: basic colours of all conductors grey
Quad 4: basic colours of all conductors yellow
Quad 5: basic colours of all conductors white

The first sub- or main-unit in each layer is to be marked by an open helix of plastic tape of red (marker). All other sub- or main-units must be whipped with an open helix of white or uncoloured plastic tape. The quads of a sub-unit are to be counted according to the sequence of basic colours.
In cables with more than 5 star quads, the sub- and main-units must be counted continuously beginning with maker-unit at inner layer towards outside.

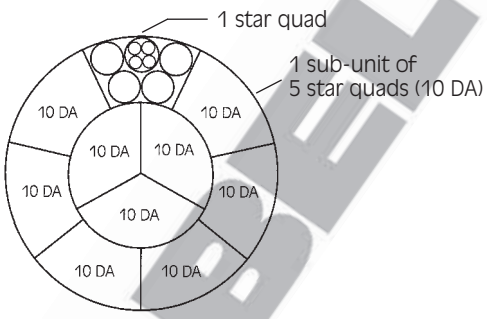
Design of a sub-unit:
Consist of 5 star quads = 10 pairs (DA)
(DA = double core or pair)



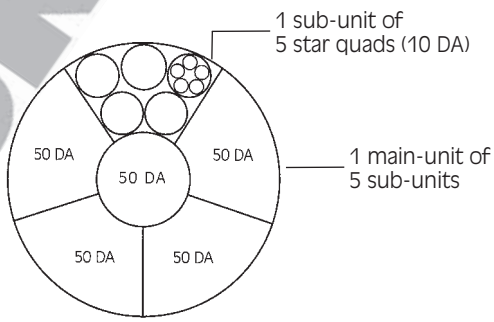
Design of a main-unit:
Consist of 5 sub-units = 50 pairs (DA)



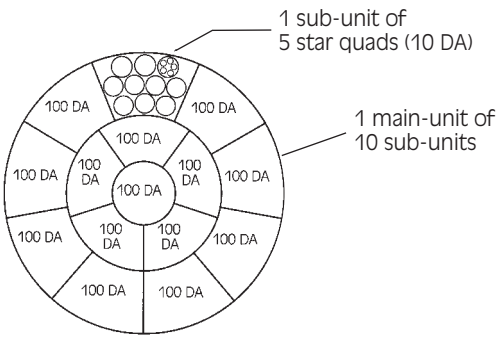
Desing of a main-unit:
Consist of 10 sub-units = 100 pairs (DA)



Design of a 300-pairs cable:
Consist of 6 main-units, each of 50 pairs (DA)



Design of a 1500-pairs cable:
Consist of 15 main-units, each of 100 pairs (DA)



Colour Abbreviations according to VDE and IEC

It is planned to use in future an uniform common colour abbreviations according to IEC 60757 (identical to CENELEC-harmonized document HD 457).
The following table shows the comparison of German and IEC colour abbreviations:

colour	German abbreviation		Abbreviation
	new	old	according to IEC 60757
black	SW	sw	BK
brown	BR	br	BN
red	RT	rt	RD
orange	OR	or	OG
yellow	GE	ge	YE
green	GN	gn	GN
blue	BL	bl	BU
violet	VI	vi	VT
grey	GR	gr	GY
white	WS	ws	WH
pink	RS	rs	PK
turquoise	TK	tk	TQ

IEC = International Electredechnical Commission

Identification of the core according to DIN VDE 0293 and core colour to DIN 47002 and IEC 60304

• Wiring cable with a nominal voltage U_0/U 300/500 V

The following colours have been recommended: black, white, blue, grey, brown, red, orange, turquoise, violet and pink.
Exceptions are green and yellow which are only admitted to be used, if the safety regulations permit.
The colour green is allowed to use for illuminations and light decorations.
All two-colour combinations of the above single colours are allowed to be used.

• Single core cables with a nominal voltage U_0/U 450/750 V

The following single colours have been recommended (only of one colour)
black, white, blue, grey, brown, red, orange, turquoise, violet and pink.
Two-colour combinations are not allowed to be used, with the exception of green-yellow.

• Single core cables and single core sheathed cables

The colour is black or green-yellow.
The exception is for illumination and light decorations where the core colour brown is permitted.

Identification of the cores through colours

are allowed:
a) through colouring the whole insulation compound or
b) through colouring the outer surface or
c) through coloured tapes, so far it is specified in the standards

By identification through colouring only on outer surface (item b) but not allowed to have any colour additives beneath the insulation with an exception by double colour coding.
By core identification with green-yellow, one of the colours have to cover not less than 30% and the other not more than 70% of the surface.

Identification through number coding

The printing of numberings on cores consists of repeating codes (with number and dashes), printed longitudinally on core (for coordination and dimensions see DIN VDE 0293)

Note

The following core identifications are valid for power cables with nominal voltage up to 1000 V. Scopes for valid DIN VDE prescription:

- DIN VDE 0250 – Insulated power cables
- DIN VDE 0255 – Cables with paper-insulation and metal sheath
- DIN VDE 0265 – Cables with PVC-insulation and lead sheath
- DIN VDE 0266 – Halogene-free cable with improved characteristics in case of fire
- DIN VDE 0271 – Cable with PVC-insulation and PVC outer jacket 0,6/1 kV
- DIN VDE 0272 – XLPE-insulated cable
- DIN VDE 0281 – PVC-insulated power cable
- DIN VDE 0282 – Rubber-insulated power cable

Identification of insulated wires by colours according to DIN 40705 and CEI/IEC 60446

Core identification

The core identification of different conductors such as **Phase conductor, Mid-point conductor, PEN-conductor and Predective conductor** are distinguished by the indicating letters and colours of the core.

An universal international norm exists only for the green-yellow earthing (grounding) conductor.

For new installation it is not allowed to use the old core colours.

Conductor designation	Alphanumerical type		Colour identification		Symbol
Alternating current	old	**new**	old	**new**	
Phase conductor 1	R	L1	black	not defined (preferred colour black[1])	
Phase conductor 2	S	L2	red	not defined (e. g. brown[1])	
Phase conductor 3	T	L3	blue	not defined	
Mid-point conductor	MP	N	grey	light blue[2]	
Direct current					
Positive	L +	+		not defined	
Negative	L –	–		not defined	
Mid-point conductor	M			light blue[2]	
Protective conductor		PE		green-yellow[3]	⏚
Neutral conductor with protection		PEN		green-yellow[3]	⏚
Earth (ground)		E		not defined	⏚
Earth for external voltage		TE		not defined	
Load-Connecting clamps		to L1 to L2 to L3 to N			U V W N

[1] **Application of conductors by colours "black" or "brown" for internal wiring of single core cables**
For the internal wiring of apparatus, distributor boards and equipment with the insulated single cores, only the "black"-colour is preferred. Application of other colours or combinations of two other colours are also provided, if these for the purpose of manufacturing or services are necessary.
If only an additional colour for the individual identification of separated conductor group is necessary, the colour "brown" is preferred.

[2] **Application of the colour "light blue"**
Where a circuit includes a neutral or mid-point conductor identified by colour, the colour used for this purpose shall be blue. In order to avoid confusion with other colours it is recommended to use an unsaturated colour blue, called here "light blue". Light blue shall not be used for identifying any other conductor where confusion is possible.
In the absence of a neutral or mid-point conductor, a conductor identified by light blue within the whole wiring system may also be used for any other purposes, except as a predective conductor.
If identification by colour is used, bare conductors used as neutral or mid-wire conductors shall be either coloured by a light blue stripe, 15 mm to 100 mm wide in each unit or enclosure and each accessible position, or coloured light blue throughout their length.

[3] **Application of bi-colour combination "green-yellow"**
The bi-colour combination green-and-yellow shall be used for identifying the predective conductor and for no other purposes. Green-and-yellow is the only colour combination recognised for identifying the predective conductor, according to DIN VDE 0293. The combination of the colours green-and-yellow shall be such that, on any 15 mm length of the conductor where colour coding is applied, one of these colours cover at least 30% and not more than 70% of the surface of the conductor, the other colour covering the remainder of that surface.
If bare conductors, used as predective conductors, are provided with colouring they shall be coloured green-and-yellow, either throughout the whole length of each conductor or in each compartment or unit or at each accessible position. If adhesive tape is used, only bi-coloured tape shall be applied.

Permissible minimum bending radius according to DIN VDE specifications

The indicated values for bending radius stated in the following table are not permitted to fall below the value. For non-complience of the values a short longevity is to be expected.

Permissible minimum bending radius for power cables according to DIN VDE 0298 – part 3 – Nominal voltage 0,6/1 kV

• Cables for fixed installation

method of laying	Outer Ø of cables or thickness of flat cable in mm (D) up to 10 mm	> 10 to 25 mm	> 25 mm
– for permanent laying	4 x D	4 x D	4 x D
– to form out	1 x D	2 x D	3 x D

• **for flexible cables**	up to 8 mm	> 8 bis 12 mm	> 12 to 20 mm	> 20 mm
– for fixed installation	3 x D	3 x D	4 x D	4 x D
– for free movement	3 x D	4 x D	5 x D	5 x D
– to the inlet	3 x D	4 x D	5 x D	5 x D
– for forced guiding operation (such as trailing)	5 x D	5 x D	5 x D	6 x D
– operation for trolly cable	3 x D	4 x D	5 x D	5 x D
– operation in power drag chain	4 x D	4 x D	5 x D	5 x D
– operation for return sheave	7,5 x D	7,5 x D	7,5 x D	7,5 x D

D = outer Ø of cables or thickness of flat cable

Permissible minimum bending radius according to DIN VDE 0891 – part 5 for installation cable and wires according to DIN VDE 0815

Type	for transport	repeated bending under stress	bending for one time without stres
J-Y(St)Y . . . Lg			5 x D
JE-Y(St)Y . . . Bd			
JE-H(St)H . . . Bd			
JE-H(St)H . . . Bd FE			
JE-YCY . . . Bd			
JE-HCH . . . Bd			
JE-LiYCY . . . Bd	7,5 x D	7,5 x D	2,5 x D
JE-LiHCH . . . Bd			
JE-LiYY . . . Bd			
JE-LiHH . . . Bd			
J-YY . . . Bd			
J-HH . . . Bd			
J-Y(St)Y . . . Bd			
J-H(St)H . . . Bd			

D = outer Ø of cable
Note: For the individual application above the range of specification, the indications in respect of cable recommendations should be considered.

Chemical Resistance

Substance
Inorganic chemicals

Substance	Concentration (%)	Temperature up to --- °C	PVC: JZ-500/600/750, JB, OZ-BL, JZ-HF PVC-Flach, TRONIC (LiYY), SUPERTRONIC-PVC	PVC: JZ-603, JZ 603-CY, Li-TPC-Y, PAAR-CY-OZ, N05W5-F, CEI 20-22	PVC: H05W5-F, H 05WC4V5-K	PVC: LifY, Trago, Lift-2S, BAUFLEX BUS-cables-PVC, DAT-cables-PVC	PVC: JZ-602, JZ-602-CY, TGRONIC-CY, LiYCY, JZ-602 RC, PAAR-TRONIC-CY, SY-JZ, SY-JB, JZ-602 RC-CY	PVC: F-CY-JZ, Y-CY-JZ, JZ-HF-CY, J-Y(St)Y, J-YY, JE-Y(St)Y S-YY, S-Y(St)Y, TOPFLEX-PVC	PVC: ESUY, LifY, PVC-Single cores, EDV-PiMF-CY ESY, LiFDY, TUBEFLEX/-CY	PVC: H 05 V-K, H 07 V-K, H 03 W-F, H05 W-F	PVC: THERM 120, THERM 105, H05V2-K, H07V2-K	PE: Coaxial-cable (PE), L2-BUS-cable (PE) A-2Y(L)2Y, A-2YF(L)2Y, HELUCOM® ... 2Y	PUR: PUR-JZ, PUR-JZ-HF, TOPFLEX-PUR, ROBOFLEX, SUPERTRONIC-PUR, MULTIFLEX-PUR, TOPSERV®	H: J-H(St)H, Security Cable ..E 30/E 90, HELUCOM-H JZ-500-HMH/MXMHX, N2XH, H072-K, RG-H	Silicone: SiHF, SiHF/GL-P, SiF, SiD, SiFF, SiF/GL, SiD/GL, SiHF-C-Si, FZ-LS, FZ-LSi, N2GMH2G	Neoprene Rubber: Neoprene-Round/Flat, NSHTÖU, AIRPORT 400 Hz H01N2-D/E, H 05/H 07-, A 05/A 07 RN-F	HELUFLON®: FEP-6Y, PTFE-5Y, Compensating cables-FEP
Alums	colts.	20	●	●	●	●	●	●	●	●	●		○	◑	○	●	●
Aluminium salts	each	20	●	●	●	●	●	●	●	●	●			◑			●
Ammonia, wat.	10	20	●	●	●	●	●	●	●	●	●		●	○	●	●	●
Ammonium acetate, wat.	each	20	●	●	●	●	●	●	●	●	●				●		●
Ammonium carbonate, wat.	each	20	●	●	●	●	●	●	●	●	●		○			●	●
Ammonium chloride, wat.	each	20	●	●	●	●	●	●	●	●	●		●			●	●
Barium salts	each	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Boric acid	100	20	●	●	●	●	●	●	●	●	●	●	◑	◑	●	●	●
Calcium chloride, wat.	colts.	20	●	●	●	●	●	●	●	●	●	●	◑	◑		●	●
Calcium chloride, wat.	10 – 40	20											●				
Calcium nitrate, wat	colts.	20	●	●	●	●	●	●	●	●	●	●		◑		●	●
Chromium salts, wat.	colts.	20	●	●	●	●	●	●	●	●	●						●
Potassium carbonate, wat.		20	●	●	●	●	●	●	●	●	●	●			●	●	●
Potassium chlorate, wat.	colts.	20	●	●	●	●	●	●	●	●	●	◑		◑		●	●
Potassium chloride, wat.	colts.	20	●	●	●	●	●	●	●	●	●	●	○		●		●
Potassium dicromate, wat.		20	●	●	●	●	●	●	●	●	●				●	●	●
Potassium iodie, wat.		20	●	●	●	●	●	●	●	●	●	●		◑	●	●	●
Potassium nitrate, wat.	colts.	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Potassium permanganate, wat.		20	◑	◑	◑	◑	◑	◑	◑	◑	◑	●	○			●	●
Potassium sulphate, wat.		20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Copper salts	colts.	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Megnesium salts	colts.	20	●	●	●	●	●	●	●	●	●	●	◑	◑			●
Sodium bicarbonate (Natron), wat.		20	●	●	●	●	●	●	●	●	●		◑		●	●	●
Sodium bisulphite (Soda), wat.		20	●	●	●	●	●	●	●	●	●	●	○		●	●	●
Sodium chloride (Cook salt), wat.		20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Sodium thiosulfat, wat.		20	●	●	●	●	●	●	●	●	●	●	◑		●	●	●
Soda Lye	50	50	●	●	●	●	●	●	●	●	●						●
Nickel salts, wat.	colts.	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Nitrobenzene	100	50	○	○	○	○	○	○	○	○	○		○				
Phosphoric acid	50	20	●	●	●	●	●	●	●	●	●	●	○		◑		●
Mercury	100	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Mercury salts	colts.	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Nitric acid	30	20	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
Hydrochlorid acid	conc.	20	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●
Sulfur dioxide		20	●	●	●	●	●	●	●	●	●	◑	○		○	○	●
Carbon disulfide		20	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
Sulfuric acid	50	50	●	●	●	●	●	●	●	●	●						●
Hydrogen sulfide		20	●	●	●	●	●	●	●	●	●	●				●	●
Sea water		20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Silver salts, wat.		20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
Cleaning fluid lye	2	100	○	○	○	○	○	○	○	○	○		○		○		
Water (dest.)		20	●	●	●	●	●	●	●	●	●						
Hydrogen peroxide, wat.		20	●	●	●	●	●	●	●	●	●		◑		●	●	●
Zinc salts, wat.		20	●	●	●	●	●	●	●	●	●		○	◑		●	●
Stannous chloride		20	●	●	●	●	●	●	●	●	●			◑	●	●	●

● resistant
◑ conditionally resistant
○ not resistant
* **for individual case, please verify**

each = each concentration
colts. = cold saturated
wat. = watery, liquid

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Chemical Resistance			PVC									PE	PUR	H	Silicone	Neoprene Rubber	HELU-FLON®
Substance **Organic chemicals**	Concentration (%)	Temperature up to ... °C	JZ-500/600/750, JB, OZ-BL, JZ-HF PVC-Flat, TRONIC (LiYY), SUPERTRONIC-PVC	JZ-603, JZ 603-CY, LI-TPC-Y, PAAR-CY-OZ, NO5W5-F, CEI 20-22	H05W5-F, H05WC4V5-K	LiFy, Trago, Lift-2S, BAUFLEX BUS-cables-PVC, DAT-cables-PVC	JZ-602, JZ-602-CY, TGRONIC-CY, LiYCY, JZ-602 RC, PAAR-TRONIC-CY, SY-JZ, SY-JB, JZ-602 RC-CY	F-CY-JZ, Y-CY-JZ, JZ-HF-CY, J-Y(St)Y, J-YY, JE-Y(St)Y S-YY, S-Y(St)Y, TOPFLEX-PVC	ESUY, LiFY, PVC-Single cores, EDV-PIMF-CY ESY, LiFDY, TUBEFLEX/-CY	H 05 V-K, H 07 V-K, H 03 W-F, H 05 W-F	THERM 120, THERM 105, H05V2-K, H07V2-K	Coaxial-Cable (PE), L2-BUS-cable (PE) A-2Y(L)2Y, A-2YF(L)2Y, HELUCOM®... 2Y	PUR-JZ, PUR-JZ-HF, TOPFLEX-PUR, ROBOFLEX, SUPERTRONIC-PUR, MULTIFLEX-PUR, TOPSERV®	J-H(St)H, Security Cable ..E 30/E 90, HELUCOM-H JZ-500-HMH/MXMHX, N2XH, H072-K, RG-H	SiHF, SiHF/GL-P, SiF, SiD, SiFF, SiF/GL, SiD/GL, SiHF-C-SI, FZ-LS, FZ-LSi, N2GMH2G	Neopren-Round/Flat, NSHTÖU, AIRPORT 400 Hz H01N2-D/E, H 05/H 07-, A 05/A 07 RN-F	FEP-6Y, PTFE-5Y, Compensating cables-FEP
Aceton		20	○	○	○	○	○	○	○	○	○		○		◑		●
Formic acid	30	20	○	○	○	○	○	○	○	○	○	●	○			●	●
Aniline		50	○	○	○	○	○	○	○	○	○		○				●
Petrol		20	○	○	○	○	○	○	○	○	○	○	◑[1]	○	◑	○	●
Benzene		50	○	○	○	○	○	○	○	○	○		○		○		
Succinic acid, wat.	colds.	20	●	●	●	●	●	●	●	●	●						●
Brake fluid		100	◑	◑	◑	◑	◑	◑	◑	◑	◑		○				
Butane		20	●	●	●	●	●	●	●	●	●				◑		
Butter		50	●	●	●	●	●	●	●	●	●		◑		●		●
Chlorobenze		30	○	○	○	○	○	○	○	○	○		○		○		
Chloroprene		20	○	○	○	○	○	○	○	○	○		○		○		
Diethylether		20	◑	◑	◑	◑	◑	◑	◑	◑	◑		●		○		
Diethylprestone		50	●	●	●	●	●	●	●	●	●		●		●		
Diesel oil			○	○	○	○	○	○	○	○	○		◑	○	◑		●
Glacial acetic acid	20	50	○	○	○	○	○	○	○	○	○		○		●		●
Acetic acid	20		◑	◑	◑	◑	◑	◑	◑	◑	◑	◑		○			●
Ethyl alcohol	100	20	○	○	○	○	○	○	○	○	○	●	◑	○	●	●	●
Ethyl chloride		50	○	○	○	○	○	○	○	○	○		○		◑		
Ethylene glycol		100	◑	◑	◑	◑	◑	◑	◑	◑	◑		○		●		●
Freon		20	○	○	○	○	○	○	○	○	○		◑		○		
Gear oil		100	●	●	●	●	●	●	●	●	●		◑		◑		
Glycerin	each	50	●	●	●	●	●	●	●	●	●		●		●		
Hydraulic oil		20	○	○	○	○	○	○	○	○	○		◑*	○	○		●
Isopropyl alcohol	100	20	○	○	○	○	○	○	○	○	○	●	◑*		◑	◑	●
Kerosene		20											●				
Machine oil		20	◑	●	◑	◑	◑	◑	◑	◑	◑		◑	○	●	◑	●
Methanol		20	○	○	○	○	○	○	○	○	○		○		●		
Methyl alcohol	100		◑	◑	◑	◑	◑	◑	◑	◑	◑	●	◑	◑		◑	●
Methylen chloride		20	○	○	○	○	○	○	○	○	○		○		○		
Lactic acid	10		○	○	○	○	○	○	○	○	○		○		○		●
Mineral oil													◑*				
Motor oil		120	○	●	○	○	○	○	○	○	○		○		●		
Olive oil		50	●	●	●	●	●	●	●		●	●	●		●		●
Oxal acid	colds.	20	●	●	●	●	●	●	●	●	●	◑		◑		◑	●
Paraffin oil													●				
Vegetable oils			●	●	●	●	●	●	●	●	●	●	●	○		◑	●
Vegetable fats			●	●	●	●	●	●	●	●	●	●	●	○		◑	●
Cutting oil			◑	◑	◑	◑	◑	◑	◑	◑	◑		●*	○	●	◑	●
Tar acid		20	●	●	●	●	●	●	●	●	●		○				
Carbon tetrachloride	100	20	●	●	●	●	●	●	●	●	●		○		○		
Toluene															○		
Trichloroethylene	100	20	●	●	●	●	●	●	●	●	●				●		●
Tartaric acid, wat.			●	●	●	●	●	●	●	●	●			◑	●	●	●
Citric acid			●	●	●	●	●	●	●	●	●			◑	●	●	●

● resistant
◑ conditionally resistant
○ not resistant
* **for individual case, please verify**
[1] PUR-material is resitant

each = each concentration
colds. = cold saturated
wat. = watery, liquid

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Chemical Resistance of PUR (Polyurethane)

Substance	Concen-tration (%)	Classification of requirement
Aceton		○
Alums		○
Aluminium chloride	10	◕
Formic acid	30	○
Ammonia	10	●
Ammonium carbonate		○
Ammonium chloride		◕
Aniline		○
ASTM-Oil I		●
ASTM-Oil II		●
ASTM-Oil III		●
ASTM-Fuel No. I		●
ASTM-Fuel No. II		◑
ASTM-Fuel No. III		◑
Benzene		○
Brake fluid ATE		○
Butanol		○
Butyl acetate		○
Calcium chloride	40	◕
Chlorobenzene		○
Chloroform		○
Chloroprene		○
Chromic acid		○
Cyclohexan		◑
Cyclohexanon		○
Diethylether		●
Diethylprestone		●
Diesel oil		◕
Dimethylformamide		○
Ferric-III-chloride	10	◕
Acetic acid 20–80	10	◑
Ethanol	100	◑
Ethyl ether		◑
Ethylacetate		○
Ethylencloride		◕
Freon 12		◑
Freon 22		◑
Hydraulic oil SAE 90		◑*
Glycerin		●
Glycol		●
Isopropanol		○
Potash lye	10	●
Bichromate of potash		◕
Potassium nitrate		◕
Potassium permanganate		○
Kerosene		●

Substance	Concen-tration (%)	Classification of requirement
Magnesium chloride	30	◕
Methanol	< 5	◑
Mythyl acetate		○
Mythyl chloride		○
Methylethylketon		◑
Mythylglycol		○
Mythylglycolacetate		○
Lactic acid	10	○
Mineral oil		◑*
Motor oil		○
Sodium chloride	10	◕
Sodium perchlorate solut.		●
Soda lye	10	●
Olive oil		●
Ozone		●
Paraffin oil		●
Perchlore ethylene		○
Petroleum ether		●
Petroleum		◕
Vegetable oils		●
Vegetable fats		●
Phosphoric acid	50	○
Nitric acid	30	○
Hydrochlorid acid, concen.		○
Cutting oil		◑*
Carbon disulfide		○
Sulfuric acid	30	●
Sea water		●
Silver salts	20	●
Tetrachloroethylene		○
Carbon tetrachloride	100	○
Tetrahydrofuran		○
Toluene		○
Trichlorethylene		○
Tataric acid	< 10	●
Xylon		○

resistant ●
vastly resistant ◕
conditionally resistant ◑
not resistant ○

*for individual case, please verify

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Chemical Resistance of Fluorinated polymeric materials

● The **Fluorinated polymeric** is resistent against following chemical materials

Abietin acid
Acetone
Acetone phenon
Acetic anhydride
Acetic acid
Acryl hydride
Allylic acetate
Allylic metacrylacid
Aluminium chloride
Ammonia, liquid
Ammonium chloride
Aniline

Benzene chloride
Benzonitrile
Benzyl alcohol
Borax
Bromine
Butyl acetate
Butyl

Calcium chloride
Carbon bisulfide
Cetane
Chlorine
Chloroform
Chlorosulfonic acid
Chromic acid
Cyclohexan
Cyclohexanon

Diethyl Carbonate
Dibutyl-Phthalide
Dibutyl-Sebacat
Di-isobutyl Adipt
Dimethyl ether
Dimethyl Formamide
Dimethyl hydrazine
Dioxane

Esachloroethane
Ethyl Exoate
Ethyl ether
Ethyl alcohol
Ethyl acetate
Ethylene bromide
Ethylene glycol

Ferric chloride
Fluoride naphthalene
Fluoride nitrobenzene
Fomaldehyde
Formic acid
Furan

Hexane hydrazine
Hydrochlorid acid
Hydrogen superoxide

Iron phosphide

Lead

Magnesium chloride
Mercury
Metacryl acid
Methanol
Methyl ethyl keton
Methyl metacryl acid

Naphtalene
Naphthole
N-Butylamine
Nitric acid
Nitromethane
Nitrogen tetroxyde
not synthetic nitrobenze
N-octadecyal alcohol
2-Nitro butanol
2-Nitro-Methyl propanol

Oils, from vegetables
Oils, from animals
Ozone
Pentachloro benzamide
Perchloro ethylene
Permanganate
Petrol Phenol
Phosphorus pentachloride
Phosphoric acid
Phthalic acid
Pinene
Piperidine
Potassium
Potassium acetate
Potassium hydroxide
Polyacryonitril
Pyridine

Stannous chloride
Sodium hydroxide
Sodium hydochloride
Sodium peroxide
Solvents
Soaps
Sulfur
Sulfuric acid

Tetra bromothane
Tetrachlorethane
Triethanolamine
Trichloracetic acid
Trichloroethylene
Tricresylic phosphate

Vinylmetracrylate

Washing mediums
Water

Xylol

Zinc chloride

● The following chemical substance attack no **Fluorinated polymeric**

Ethyl alcohol
Vapour
Hydrofluoric acid
Aviation gasoline
Hydraulic liquid-Skydrol
Isopropyl alcohol
Carbon chlorid
Soda
Crude petroleum
Nitric acid concentr.
Sea water
Sulfuric acid (30%)
Transformer Oil
Turbine fuel JP 4

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Fluorinated polymeric materials: PTFE, FEP, PFA, ETFE

The chemical resistance of polymers with a high fluorine content is exceptionally high. The electrical insulating and dielectric properties of these materials are also very good.

Fluorpolymere Werkstoffe sind: HELUFLON®-PTFE, HELUFLON®-FEP, HELUFLON®-PFA, HELUFLON®-ETFE

- HELUFLON®-PTFE – Polytetrafluoroethylene (5Y)
- HELUFLON®-FEP – Tetrafluoroethylene –perfluoropropylene –copolymer (6Y)
- HELUFLON®-PFA – Tetrafluoroethylene –perfluoroalkoxy –copolymer (51Y)
- HELUFLON®-ETFE – Ethylene–tetrafluoroethylene –copolymer (7Y)

Fluorpolymere is resistant against nearly all known chemical compounds.
Fluorpolymere has a smooth surface of extremely low surface tension which is why virtually nothing adheres to this material.
Fluorpolymere is moisture rejecting, doesn't swell and is not be damaged by welding.
Fluorpolymere is used, where conventional material wouldn't resist the environmental conditions.
Fluorpolymere is applied in the civil and military sector as well as in the aviation- and astronautics technology.
Fluorcarbonresins have following important characteristics::

- high heat-resistance during permanent operation
  - HELUFLON®-FEP up to 250°C
  - HELUFLON®-PTFE up to 260°C
- outstanding resistant against dielectric strength
- constant dielectric characteristics
- no moisture absorption
- resistant against nearly all chemical products
- insensitive to environmental influences, weatherproof and resistant to irradiation from the sun and temperature fluctuations
- good mechanical characteristics, no formation of cracks, wear-resistant
- low coefficient of friction
- no action of light (also uv)

Characteristics

Insulation material	Material initial code	Nominal temperature permanent (°C) approx. 25000 h	Nominal temperature temporary (°C) (hours)	Break-down temperature, melting point (°C)	Dielectric number at 60 Hz (20°C)	Density 10^3 kg/ m^3 (20°C)	Specific resistance Ohm · cm (20°C)	Break-down resistance kV/ mm (20°C)	Tension MPa (20°C)	Breaking point %(20°C)	Porosity %(20°C)	Environmental resistance	Flammability	Resistance to chemicals	Radiation resistance [1] x10^4 GY
ETFE	7Y	–100 +150	+180	+270	2,6	1,70	10^{16}	36	45	150 – 300	0,02	very good	n.e.f.	very good	200
FEP	6Y	–100 +205	+230	+290	2,1	2,15	10^{18}	25	20 – 25	250 – 300	0,01	very good	n.e.f.	very good	0,02
PTFE	5Y	–190 +260	+300	+327	2,0	2,18	10^{18}	20	35 – 45	350 – 400	0,01	very good	n.e.f.	very good	0,02
PFA	51Y	–190 +260	+280	+310	2,1	2,20	10^{16}	25	30	300	0,01	very good	n.e.f.	very good	0,02

[1] Values shown include high dosage and ca. 50% rest smoldering values

n.e.f. = no flammable

Insulation and jacket type abbreviations

DIN/VDE	Material
7Y	ETFE
6Y	FEP
5Y	PTFE
51Y	PFA

Chemical Resistance of Silicone

Substance	Test period 7 days Temperature °C	Classification of requirement
Acetamide	150	●
Acetone	20	◑
Aniline	100	●
Petrol	20	◑
Brake fluid AT	100	●
Butanol	117	◑
Butylacetate	20	◑
Calcium hydroxide, (saturated)	20	●
Chlorbenzene	20	◑
Cloroform	20	○
Clophene	150	●
Vapour up to 2,5 atü	138	●
Diphenyl	150	◑
Diesel oil	20	◑
Dinamo oil	150	◑
Mineral oil	20	◑
Acetic acid	20	●
Hydrofluor acid 5%	20	○
Gear oil DTE BB	150	●
Gear oil DTE HH	150	●
Gear oil DTE extra heavy	150	●
Gear oil Type SEA 90	150	●
Prestone	20	●
Glycerin	100	●
Hexa ethoxydisiloxane	20	◑
High pressure compressor oil	150	●
Isopropyl alcohol	82	◑
Potassium 20%	20	●
Potassium hydroxide 50%	20	●
Potassium permanganate solution	20	●
Carbolineum	20	●
Cooking salt solution 10%	20	●
Carbon tetrachloride	20	◑
Compressor oil, light	150	●
Ball bearing fat	150	●
Linseed oil	100	●

Substance	Test period 7 days Temperature °C	Classification of requirement
Methanol	65	◑
Methylen chloride	20	○
Mineral oil ASTM No. 1	150	●
Mineral oil ASTM No. 3	150	◑
Mineral oil SEA 10	150	●
Mineral oil SEA 20	150	●
Mineral oil SEA 30	150	●
Motor oil viscose static	150	●
Sodium 20%	20	●
Soda 50%	20	●
Nitrobenzene	20	●
Oleic acid	150	○
Olive oil	150	●
Perchlor	20	○
Petroleum ether	20	○
Petroleum	20	◑
Phenol	60	●
Phosphoric acid 30%	20	●
Pyridine	20	◑
Regulator oil	150	○
Castor oil	150	●
Hydrochlorid acid 10%	20	●
Nitric acid conc.	20	○
Nitric acid 10%	20	◑
Sulfuric acid, conc.	20	○
Sulfuric acid, 10%	20	●
Shock absorber oil	20	●
Styrol	20	◑
Turbentine oil	20	◑
Toluene	20	◑
Transformer oil	150	◑
Tri	20	○
Tri glycol	20	●
Vaseline	150	●
Water	100	●

● Iresistant
◑ conditionally resistant
○ not resistant

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Resistance of substances against solvents, oils and fats

Substance	PVC Y	PA 4 Y	PTFE 5 Y	FEP 6 Y	ETFE 7 Y
Alcohol, methylated spirit	○	◑	●	●	●
Brake fluid for vehicles	○	◑	●	●	●
Bromide chloridfluormethane	○	○	●	●	●
Jet gasoline IP4	○	◑	●	●	●
de-icing and icing protective agent	○	◑	●	●	●
Aircraft lubricating grease	◑	◑	●	●	◑
Hydraulic oil on bas of mineral oil	◑	●	●	●	◑
Hydraulic liquid (chlor-free silicone liquid)	○	○	●	●	●
Hydraulic liquid (synthetic)	○	◑	●	●	●
Methylethylketon	○	○	●	●	●
Otto-gasoline, diesel gasoline	○	◑	●	●	●
Lubricating oil for recebrocating engine SAE 10 W	◑	◑	●	●	◑
Lubricating oil for jet engine (synthetic)	◑	◑	●	●	◑
Toluene-Isooctane (Toluene 30%, Isooctane 70%)	○	◑	●	●	●
Trichlorethane	○	○	●	●	●
Urine	●	●	●	●	●

● Iresistant
◑ conditionally resistant
○ not resistant

PVC = Polyvinylchloride Y
PA = Polyamid 4 Y
PTFE = Polytetrafluorethylene 5 Y
FEP = Fluorethylenepropylene 6 Y
ETFE = Tetrafluorethylene 7 Y

Halogen-free Security Cables and Wires

What are halogens?

Halogens "formation of salt" are the elements as fluorine, chlorine, bromine and iodine.
Fluorine and chlorine are important for cables and wires as atoms in the plastic molecules, for example fluorine plastics or PVC (polyvinyl chloride) are of significance; and bromine as component of flame protection additives.

When is a cable halogen-free ?

The burning behaviour of cables and wires is very important for the installation in buildings and also in control plants.

Thereby the following points are very important:

- Behaviour under flame influence i. e. the inflammability as well as the propagation of fire
- Subsequent damage by formation of corrosive and toxic gases
- Development of smoke density (darkening of emergency exits hindered the fire extinguishing works)

Cables produced of not halogen-free (halogenated) materials such as mainly the materials with chlorine in the molecule-chain: Polyvinyl chloride (PVC),chloroprene rubber (CR), chlorinated polyethylene (CM), chlorsulfonated polyethylene (CSM) and fluorhydrocarbons.

Polytetrafluorethylene (PTFE)
Fluorethylenepropylene (FEP)
Perfluoralkoxypolymeric (PFA)

These materials have a better behaviour in case of fire.

These are hardly combustible or not flammable and vastly self-extinguishing. Due to this effect and in case of fire the released molecules constituents chlorine and fluorine, which hinder the admittance of oxygen to the fire location and suffocate the flame.

The remarkable disadvantages of these materials are existing in the fact that the released chlorine and florine atoms composite themselves with hydrogen which is decomposed from plastic material as well as with hydraulic acid or hydrofloric acid from the existing air.

These compositions are extremely corrosive and also toxic. In consequence the damages by corrosion are often higher than the actual damage caused by fire.

Halogen-free cables contain no halogens, i. e. the insulation and sheath materials of these cables are composed with polymers on the basis of pure hydrocarbons. By burning such kind of materials, produce no corrosive and toxic gases but only water vapour and carbondioxide.
Polymers like polyethelene (PE) or polypropylene (PP) are halogen-free. These materials are easy flammable and not self-extinguishing.

Halogen-free cables for the security requirements must be hardly flammable and self-extinguishing. This happens by using the special polymer compounds, containing the considerable percentage of flame protective materials.

Such kind of protective materials consist for example, of an aluminium hydroxide which on one side cools the fire location by setting free of crystal water and on the other side the released water vapour hinders the admittance of oxygen and thereby this suffocates the flame. By using of additional supporting tapes and filling yarns of glass web, mica and similar materials the functionallity for example of E 90 can be realised with the suitable cable accessories.

Application

The application of halogen-free security cables and wires are specified more and more with increasing numbers for the buildings where people gather or everywhere, where safety conciousness to protect the human life and valuable materials take a special significance. For example,

- Hospitals, airports, in multi-storey buildings, stores and shops, hotels, theaters, cinemas, schools etc.
- Fire warning plants, alarm systems, ventilation systems, escalators, lifts, safety lights, operation and intensive stations, maintenance equipment
- Underground railways and other railway plants
- Data processing installations
- Power stations and industrial plants with high valuable machines and materials or risky potentials
- Mining works
- Shipbuilding and offshore plants
- Emergency power supply works

HELUKABEL-Security Cables and Wires and the advantages

- Flame retardant and hardly combustibility so that no flame propagation in case of fire can be resulted
- Halogen-free; no evolution of corrosive gases
- In case of burning, the halogen-free cables emits low smoke

Halogen-free Security Cables and Wires

- The danger of toxic gases caused by fire is far inferior
- Low caloric load
- Remarkable longer electrical functionallity and flame influence
- Insulation integrity for at least 30 minutes as well as 180 minutes at 800°C under fire condition
- Suitable for emergency service up to 180 minutes
- Radiation resistance up to 200 x 10^6 cJ/kg (up to 200 Mrad)

These characteristics are obtained by using of a flexible halogen-free basis material – aluminium hydroxide $Al(OH)_3$.

Caloric load values (heat of combustion)

For designing a building the criterions of the caloric load values are very important. The caloric load values of the modern halogen-free cables are reduced by corresponding additives.

The specific heating values of the non-metallic raw materials for cables are specified to DIN 51900. The values of the caloric load or heat of combustion for electrical cables are given per running meter in the following tables.

Combustible cable insulations or open building materials of class B1 are regarded as harmless so far as the resulted caloric load is distributed as proportionale as possible and is valid ≧ 7 kWh/m²

The conversion of the values:

1 MJ/m² ≙ 0,278 kWh/m²
1 kWh/m² ≙ 3,6 MJ/m²

Regulations

According to DIN VDE 0108 supplement 1:

- The total caloric load of the cables are allowed up to 14 kWh per m² of the field areas if only halogen-free cables with improved characteristics in the case of fire are used.

If you use PVC cables the total caloric load is only up to 7 kWh per m²

Tests

The characteristics of the security cables are tested according to DIN VDE specifications:

Behaviour in fire

According to DIN VDE 0472 part 804, test method A, test method B and test method C.

- **Test method A – test on single cable ≙IEC 60332-2**
- Test sample of 600 mm cable length shall be in a position vertically hanging. A propane gas burner (Ø 8 mm) shall be at an angle of 45° to the axis and the flame of approx. 100 mm below the lower edge of the sample. Flame influence max. 20 s.
- The test is passed, if the sample has not burned or the flame extinguished by itselfs and the damage by fire doesnt reach the remotest upper side of the sample.
- **PVC self-extinguishing and flame retardant according to VDE 0482-332-1-2 DIN EN 60332-1-2 7 / IEC 60332-1 (equivalent to DIN VDE 0472 Teil 804 test method B).**
- Test sample of 600 mm cable length shall be in a position vertically hanging. A propane gas burner (ø 8 mm) shall be at an angle of 45° to the axis and the flame of approx. 100 mm below the lower edge of the sample. Flame influence, depending on cable weight, 1 to 2 minutes.
- The test is passed, if the sample has not burned or the flame extinguished by itselfs and the damage by fire doesnt reach the remotest upper side of the sample.
- **Test method C – test on bunched cables similar IEC 60332-3, HD 405.3, EN 50266-2, DIN VDE 0482 part 2**
- Test samples of 360 cm cable length are laying parallel side-by-side attached to a test-ladder, which is hanging vertically with a distance of 150 mm to the furnace. The sample should be flamed with a flame length of 60 cm on the test sample at approx. temperature 800°C by a burner width of approx. 250 mm. The test duration should be 20 minutes.
- The test is passed, if the sample has not burned or the flame extinguished by itself and the damage by fire does not reach the remotest upper side of the sample.

Corrosivity of cumbustion gases

According to VDE 0482 part 267/DIN EN 50267-2-2 / IEC 60754-2 (is equivalent to DIN VDE 0472 part 813). For the performance of the test procedure the insulation and sheath materials are to be put in the moveable furnace, preheated to 750 to 800°C. The burning gas is conducted through two gas-washing bottles.

- The test shall be regarded as passed when the measured pH-value is ≧ 4,3 and the electrical conductivity ≧ 100 $\mu S.cm^{-1}$.
- During this test all the not desired components of the materials are precipitated such as all halo-

Halogen-free Security Cables and Wires

Continuance of insulation effect under direct fire conditions

According to DIN VDE 0472 partl 814 ΔIEC 60331

Test sample of 1200 mm cable length is fixed in a horizontal position, 75 mm over the gas brenner. The rated voltage of 3 A fuse is fixed between the core groups. The burner flame is so to regulate that the temperature on cable should be 800±50°C. The measuring can be effected until the fuse is blown.
Test voltage 400 V for power cables and wires
Test voltage 110 V for telecommunication cables

- The test shall be regarded as passed when no 3 A fuse has blown during the test period between 20 to 180 minutes.

Non-Halogen verification

According to VDE 0482 part 267/DIN EN 50267-2-1/ IEC 60754-1 (is equivalent to DIN VDE 0472 part 815).

The corrosion test of gases caused by fire is carried out to the test materials, not of complete cable samples. The proof of halogen is effected by chemical analysis.
Materials with a content of:
≦ 0,2% chlorine and
≦ 0,1% fluorine
are regarded as halogen-free.

Smoke density

According to VDE 0482 part 1034-1+2 / IEC 61034-1+2 / DIN EN 61034-1+2 / BS 7622 Teil 1+2
(is equivalent to DIN VDE 0472 part 816).

The test of smoke density is effected to a single cable, laid in a horizontal position within a room of 3 meter cube. The photometrically measured absorption of light is a measuring unit (in %) of light transmittance for the smoke density.

The test is regarded as passed when the light absorbtion appears within 40 minutes and the following values shall be obtained for light transmission.

Cable Ø	Transmission of Light
> 3– 5 mm	40%
> 5–10 mm	50%
> 10–20 mm	60%
> 20–40 mm	60%
> 40	70%

Functionality of electric cable systems

According to DIN 4102 part 12 (system test)
DIN 4102 part 12 describes the requirements and measurements necessary in achieving circuit integrity of a complete electric cable system in case of fire.

Cable systems

Regarded as cable systems are power cables, insulated power cables and wires, telecommunication installation cables for telephone and data transmission and rail-distributors including their corresponding connecting devices such as the necessary ducts and conduits, coatings and coverings, connecting elements, supporting devices, cable trays and clamps.

Functionality

According to DIN VDE 4102 part 12

The functionality is given, when during the test under fire no short circuit and no interruption of current flow occure in the tested electrical cable system.

According to this standard, the security cables are always to be tested together with the corresponding supporting devices, clamps, holder and mounting accessories.

Note: The above defined functionality has no relationship with the continuance of insulation effect under fire conditions according to DIN VDE 0472 part 814.

Test

During this test under fire a complete cable installation will be tested in a large combustion chamber, i. e. cables and wires including clamps, supporting devices, holders, dowels etc.

Test voltage for power cables:	380 V
Test voltage for telecommunication cables:	110 V
Current load:	3 A

The combustion chamber is to be heated up according to ETK (Standard temperature curve).

The test period is distinguished in 3 classes:
- E30 for the functionality ≧ 30 minutes
- E60 for the functionality ≧ 60 minutes
- E90 for the functionality ≧ 90 minutes

Raise of temperature in combustion chamber:
- For E30 to approx. 820°C
- For E60 to approx. 870°C
- For E90 to approx. 980°C

After passing the functionality test, this will be certified with the class identification as E30, E60 or E90.

Note: At the moment the class E60, which is specified in DIN-VDE standards, is not applied for economical and technical reasons.

Heat-resistance classes as per VDE 0530 part 1

Class	Insulating material	Impregnation material	max. continuous temperature	Cable type
Y	Cotton, Synthetic and natural silk, Polyamide fibres, Paper, Polyvinylchloride (PVC), Polyethylene (PE), Vulkanised rubber	–	90°C	HELUKABEL® PVC + Neoprene cables
A	Cotton, Synthetic and natural silk, Polyamide, Paper, heat-resistant impregnated textiles, Polyester resin	Bitumous varnish Synthetic resin varnish Insulating oil and synthetic dielectrical fluids	105°C	HELUTHERM® single cores, control cables UL + CSA-approved
(E)	Special wire enamel, Special synthetic foils, Compressed material with cellulose fillers, Paper and cotton tapes	Synthetic resin varnish and Polyester resin, both with a permissible continuous withstand temperature of > 120°C	105°C (short time operation 120°C)	HELUTHERM® 120
B	Glass fibre, Micaproducts, Special synthetic foils, Compressed materials with mineral fillers	As under E but with a permissible continuous withstand temperature of > 130°C	145°C	HELUTHERM® 145
F	Glass fibre, Micaproducts, Aromatic polyamides, Impregnated glass fibre braides	Resins with a permissible continuous withstand temperature of > 155°C	155°C	HELUTHERM® 145
H	Glass fibre, Micaproducts, Aromatic polyamides, Silicone rubber, Polyamide foils, PTFE	Silicone resins with a permissible continuous withstand temperature of > 180°C	180°C	Silicone + HELUFLON® tinned conductors
C	Mica, Porcelain, Glass, Quartz, and similar fire resistant materials	As under H but with a permissible continuous withstand temperature of > 225°C	> 180°C	HELUFLON® PTFE+FEP with tinned or nickel plated conductors, HELUTHERM® 400/600/800/1200

Caloric load values (heat of combustion)

For designing a building the criterions of the caloric load values are very important. The caloric load values of the modern halogen-free cables are reduced by corresponding additives.
The specific heating values of the non-metallic raw materials for cables are specified to DIN 51900. The values of the caloric load or heat of combustion for electrical cables are given per running meter in the following tables.
The tables are subdivided according to the different cable designs, with halogen-free or halogenated insulation, number of cores with different cross-sections.
With these tables of the caloric load values of our cables we will give you the possibility to accomodate your calculations for the application of these cables.

Regulations:
According to DIN VDE 108 supplement 1:

– The total caloric load of the cables are allowed up to 14 kWh per m^2 of the field areas if only halogen-free cables with improved characteristics in the case of fire are used. If you use PVC cables the total caloric load is only up to 7 kWh per m^2.

– Cables are according to
- DIN VDE 0250 part 214 – halogen-free installation cable with improved fire behaviour.
- DIN VDE 0266 – halogen-free cables with improved characteristics in the case of fire.
- DIN VDE 0815 – wiring cables for telecommunication and data processing systems.

– The caloric load values – Hu (calculated value):

PVC-core insulation	Hu	6,3 kWh/kg
PVC-sheath material	Hu	5,7 kWh/kg
PVC (lower limint)	Hu	5,6 kWh/kg
H-core insulation	Hu	4,8 kWh/kg
H-sheath material	Hu	4,2 kWh/kg
PE in general	Hu	12,2 kWh/kg
PP in general	Hu	12,8 kWh/kg

The conversion of the values:
1 MJ/m^2 ≙ 0,278 kWh/m^2, 1 kWh/m^2 ≙ 3,6 MJ/m^2

Caloric load values of halogen-free Security Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
NHXAF	1 x 0,75	0,031
	1 x 1,0	0,033
	1 x 1,5	0,049
	1 x 2,5	0,059
	1 x 4	0,074
	1 x 6	0,090
	1 x 10	0,112
	1 x 16	0,137
	1 x 25	0,204
	1 x 35	0,235
	1 x 50	0,323
	1 x 70	0,381
	1 x 95	0,504
NHXMH	2 x 1,5 re	0,30
	2 x 2,5 re	0,35
	3 x 1,5 re	0,33
	3 x 2,5 re	0,38
	3 x 4 re	0,49
	3 x 6 re	0,60
	3 x 10 re	0,78
	4 x 1,5 re	0,37
	4 x 2,5 re	0,42
	4 x 4 re	0,49
	4 x 6 re	0,68
	4 x 10 re	0,90
	5 x 1,5 re	0,42
	5 x 2,5 re	0,49
	5 x 4 re	0,70
	5 x 6 re	0,79
	5 x 10 re	1,04
	7 x 1,5 re	0,48
	7 x 2,5 re	0,64
	10 x 1,5 re	0,61
	12 x 1,5 re	0,69
	24 x 1,5 re	1,14
N2XH	1 x 2,5 re	0,14
	1x 4 re	0,17
	1x 6 re	0,18
	1 x 10 re	0,21
	1 x 16 rm	0,29
	1 x 25 rm	0,39
	2 x 35 rm	0,46
	1 x 50 rm	0,53
	1 x 70 rm	0,55
	1 x 95 rm	0,63
	1 x 120 rm	0,72
	1 x 150 rm	0,90
	1 x 185 rm	1,08
	1 x 240 rm	1,22
	1 x 300 rm	1,32
	2 x 1,5 re	0,45
	2 x 2,5 re	0,50
	2 x 4 re	0,59
	2 x 6 re	0,67
	2 x 10 re	0,81
	2 x 16 rm	1,19
	2 x 25 rm	1,53
	2 x 35 rm	1,79
	2 x 50 rm	2,13

Type	dimension n x mm²	caloric load kWh/m
N2XH	3 x 1,5 re	0,48
	3 x 2,5 re	0,56
	3 x 4 re	0,65
	3 x 6 re	0,73
	3 x 10 re	0,86
	3 x 16 rm	1,19
	3 x 25 rm	1,65
	3 x 35 rm	1,95
	3 x 50 rm	2,31
	4 x 1,5 re	0,54
	4 x 2,5 re	0,63
	4 x 4 re	0,73
	4 x 6 re	0,82
	4 x 10 re	0,99
	4 x 16 rm	1,43
	4 x 25 rm	1,97
	4 x 35 rm	2,31
	4 x 50 rm	2,89
	4 x 70 rm	3,00
	4 x 95 rm	3,90
	4 x 120 rm	4,77
	4 x 150 rm	6,81
	5 x 1,5 re	0,62
	5 x 2,5 re	0,70
	5 x 4 re	0,82
	5 x 6 re	0,91
	5 x 10 re	1,11
	5 x 16 rm	1,68
	5 x 25 rm	2,35
	5 x 35 rm	2,81
	5 x 50 rm	3,42
	7 x 1,5 re	0,51
	7 x 2,5 re	0,58
	10 x 1,5 re	0,68
	10 x 2,5 re	0,78
	12 x 1,5 re	0,76
	12 x 2,5 re	0,88
	14 x 1,5 re	0,84
	14 x 2,5 re	0,97
	19 x 1,5 re	1,05
	19 x 2,5 re	1,21
	24 x 1,5 re	1,31
	24 x 2,5 re	1,53
	30 x 1,5 re	1,54
	30 x 2,5 re	1,80
N2XCH	2 x 1,5/re 1,5	0,44
	2 x 2,5/re 2,5	0,49
	2 x 4/re 4	0,59
	2 x 6/re 6	0,66
	2 x 10/re 10	0,80
	3 x 1,5/re 1,5	0,48
	3 x 2,5/re 2,5	0,55
	3 x 4/re 4	0,64
	3 x 6/re 6	0,72
	3 x 10/re 10	0,85
	3 x 16/rm 16	1,18
	3 x 25/rm 16	1,59
	3 x 35/rm 16	1,91
	3 x 50/rm 25	2,27
	4 x 1,5/re 1,5	0,54
	4 x 2,5/re 2,5	0,62
	4 x 4/re 4	0,72
	4 x 6/re 6	0,82
	4 x 10/re 10	1,00
	4 x 16/rm 16	1,37

Type	dimension n x mm²	Brandlast- kWh/m
N2XCH	4 x 25/rm 16	1,94
	4 x 35/rm 16	2,27
	4 x 50/rm 25	2,77
	7 x 1,5/re 1,5	0,50
	7 x 2,5/re 2,5	0,57
	10 x 1,5/re 2,5	0,66
	10 x 2,5/re 4	0,77
	12 x 1,5/re 2,5	0,74
	12 x 2,5/re 4	0,86
	14 x 1,5/re 2,5	0,81
	14 x 2,5/re 4	0,95
	19 x 1,5/re 4	1,02
	19 x 2,5/re 6	1,19
	24 x 1,5/re 6	1,25
	24 x 2,5/re 10	1,47
	30 x 1,5/re 6	1,47
	30 x 2,5/re 10	1,77
	40 x 1,5/re 10	1,90
	40 x 2,5/re 10	2,23
(N)HXH-E30 orange	1 x 2,5 re	0,22
	1 x 4 re	0,35
	1 x 6 re	0,38
	1 x 10 re	0,43
	1 x 16 rm	0,50
	1 x 25 rm	0,68
	1 x 35 rm	0,76
	1 x 50 rm	0,90
	1 x 70 rm	1,09
	1 x 95 rm	1,29
	1 x 120 rm	1,49
	1 x 150 rm	1,84
	1 x 185 rm	2,24
	1 x 240 rm	2,67
	1 x 300 rm	3,67
	2 x 1,5 re	0,68
	2 x 2,5 re	0,74
	2 x 4 re	0,84
	2 x 6 re	0,95
	2 x 10 re	1,13
	2 x 16 rm	1,34
	2 x 25 rm	1,94
	2 x 35 rm	2,16
	3 x 1,5 re	0,72
	3 x 2,5 re	0,79
	3 x 4 re	0,90
	3 x 6 re	1,03
	3 x 10 re	1,23
	3 x 16 rm	1,47
	3 x 25 rm	1,92
	3 x 35 rm	2,47
	3 x 50 rm	3,03
	3 x 70 rm	3,90
	3 x 95 rm	4,76
	3 x 120 rm	4,63
	3 x 150 rm	5,67
	3 x 185 rm	6,94
	3 x 240 rm	8,84
	4 x 1,5 re	0,85
	4 x 2,5 re	0,94
	4 x 4 re	1,07
	4 x 6 re	1,22
	4 x 10 re	1,46
	4 x 16 rm	1,74
	4 x 25 rm	2,57
	4 x 35 rm	2,96
	4 x 50 rm	3,72
	4 x 70 rm	4,85
	4 x 95 rm	5,83

Caloric load values of halogen-free Security Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
(N)HXH-E 30 orange	4 x 120 rm	7,26
	4 x 150 rm	8,92
	4 x 185 rm	10,38
	4 x 240 rm	11,76
	5 x 1,5 re	0,99
	5 x 2,5 re	1,09
	5 x 4 re	1,25
	5 x 6 re	1,43
	5 x 10 re	1,72
	5 x 16 rm	2,05
	5 x 25 rm	3,05
	7 x 1,5 re	1,16
	7 x 2,5 re	1,29
	10 x 1,5 re	1,47
	10 x 2,5 re	1,63
	12 x 1,5 re	1,84
	12 x 2,5 re	2,05
	14 x 1,5 re	2,09
	14 x 2,5 re	2,42
	19 x 1,5 re	2,52
	19 x 2,5 re	2,79
	24 x 1,5 re	3,30
	24 x 2,5 re	3,66
	30 x 1,5 re	3,77
	30 x 2,5 re	4,19
(N)HXCH-E 30 orange	2 x 1,5/ 1,5 re	0,58
	2 x 2,5/ 2,5 re	0,64
	2 x 4 / 4 re	0,75
	2 x 6 / 6 re	0,85
	2 x 10 /10 re	1,00
	3 x 1,5/ 1,5 re	0,63
	3 x 2,5/ 2,5 re	0,71
	3 x 4 / 4 re	0,84
	3 x 6 / 6 re	0,95
	3 x 10 / 10 re	1,12
	3 x 16 / 16 re	1,35
	3 x 25 / 16 rm	2,09
	3 x 35 / 16 rm	2,74
	3 x 50 / 25 rm	3,04
	3 x 70 / 35 rm	3,90
	3 x 95 / 50 rm	4,62
	3 x 120 / 70 rm	5,66
	3 x 150 / 70 rm	7,19
	3 x 185 / 95 rm	8,71
	3 x 240 /120 rm	10,57
	4 x 1,5/ 1,5re	0,78
	4 x 2,5/ 2,5re	0,82
	4 x 4 / 4 re	0,96
	4 x 6 / 6 re	1,09
	4 x 10 / 10 re	1,30
	4 x 16 / 16 rm	1,56
	4 x 25 / 16 rm	2,40
	4 x 35 / 16 rm	2,74
	4 x 50 / 25 rm	3,50
	4 x 70 / 35 rm	4,49
	4 x 95 / 50 rm	5,35
	4 x 120 / 70 rm	6,51
	4 x 150 / 70 rm	8,35
	4 x 185 / 95 rm	10,13
	4 X 240 /120 rm	12,32

Type	dimension n x mm²	caloric load kWh/m
(N)HXCH-E 30 orange	7 x 1,5/ 2,5 re	1,04
	7 x 2,5/ 2,5 re	1,33
	7 x 4 / 4 re	1,49
	10 x 1,5/ 2,5 re	1,55
	10 x 2,5/ 4 re	1,71
	10 x 4 / 6 re	1,92
	12 x 1,5/ 2,5 re	1,72
	12 x 2,5/ 4 re	1,90
	12 x 4 / 6 re	2,14
	16 x 1,5/ 4 re	2,22
	16 x 2,5/ 6 re	2,41
	21 x 1,5/ 6 re	2,58
	21 x 2,5/ 6 re	2,74
	24 x 1,5/ 6 re	2,80
	24 x 2,5/10 re	3,19
	30 x 1,5/ 6 re	3,26
	30 x 2,5/10 re	3,69
	40 x 1,5/10 re	4,17
	40 x 2,5/10 re	4,68
(N)HXH-E 90 orange	3 x 1,5 re	0,55
	3 x 2,5 re	0,61
	3 x 4 re	0,67
	3 x 6 re	0,85
	3 x 10 re	0,99
	3 x 16 rm	1,23
	3 x 25 rm	1,60
	3 x 35 rm	1,83
	3 x 50 rm	2,30
	3 x 70 rm	3,03
	3 x 95 rm	3,98
	3 x 120 rm	4,70
	3 x 150 rm	5,63
	3 x 185 rm	6,95
	3 x 240 rm	8,44
	4 x 1,5 re	0,67
	4 x 2,5 re	0,73
	4 x 4 re	0,82
	4 x 6 re	0,91
	4 x 10 re	1,06
	4 x 16 rm	1,49
	4 x 25 rm	1,95
	4 x 35 rm	2,30
	4 x 50 rm	2,88
	4 x 70 rm	3,80
	4 x 95 rm	4,96
	4 x 120 rm	5,74
	4 x 150 rm	6,97
	4 x 185 rm	8,58
	5 x 1,5 re	0,79
	5 x 2,5 re	0,88
	5 x 4 re	0,99
	5 x 6 re	1,10
	5 x 10 re	1,29
	5 x 16 rm	1,59
	5 x 25 rm	2,42
	5 x 35 rm	2,84
	7 x 1,5 re	0,92
	10 x 1,5 re	1,25
	12 x 1,5 re	1,40
	19 x 1,5 re	1,96
	24 x 1,5 re	2,47
	27 x 1,5 re	2,69

Type	dimension n x mm²	caloric load kWh/m
(N)HXCH-E 90 orange	3 x 1,5/re 1,5	0,86
	3 x 2,5/re	0,95
	3 x 4 /re 4	1,06
	3 x 6 /re	1,17
	3 x 10 /re 10	1,36
	3 x 16 /rm 16	1,68
	3 x 25 /rm 16	2,18
	3 x 35 /rm 16	2,53
	3 x 50 /rm 25	3,19
	3 x 70 /rm 35	4,04
	3 x 95 /rm 50	4,73
	3 x 120 /rm 70	5,69
	3 x 150 /rm 70	6,80
	3 x 185 /rm 95	8,44
	3 x 240 /rm 120	10,04
	4 x 1,5/ 1,5 re	0,99
	4 x 2,5/ 2,5 re	1,08
	4 x 4 / 4 re	1,22
	4 x 6 / 6 re	1,36
	4 x 10 / 10 re	1,58
	4 x 16 / 16 rm	1,96
	4 x 25 / 16 rm	2,60
	4 x 35 / 16 rm	3,11
	4 x 50 / 25 rm	3,81
	4 x 70 / 35 rm	4,92
	4 x 95 / 50 rm	6,02
	4 x 120 / 70 rm	6,90
	4 x 150 / 70 rm	8,39
	4 x 185 / 95 rm	10,20
	4 x 240 /120 rm	13,00
	7 x 1,5/1,5	1,29
	10 x 1,5/2,5	1,71
	12 x 1,5/2,5	1,86
	16 x 1,5/4	2,26
	21 x 1,5/6	2,74
	24 x 1,5/6	3,42
NYSEY 6/10 kV	3 x 35/16	10,56
	3 x 50/16	11,67
	3 x 70/16	12,78
	3 x 95/16	14,72
	3 x 120/16	16,12
NA2XSEY 6/10 kV	3 x 35/16	10,28
	3 x 50/16	11,67
	3 x 70/16	13,06
	3 x 95/16	14,72
	3 x 120/16	16,68

Caloric load values of halogen-free Security Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
NHXHX black	1 x 2,5	0,22
	1 x 4	0,28
	1x 6	0,28
	1 x 10	0,28
	1 x 16	0,39
	1 x 25	0,53
	1 x 35	0,58
	1 x 50	0,69
	1 x 70	0,81
	1 x 95	1,03
	1 x 120	1,14
	1 x 150	1,39
	2 x 1,5	0,69
	2 x 2,5	0,78
	2 x 4	0,89
	2 x 6	1,00
	2 x 10	1,19
	3 x 1,5	0,78
	3 x 2,5	0,86
	3 x 4	1,00
	3 x 6	1,08
	3 x 10	1,28
	3 x 16	1,53
	3 x 25	2,25
	3 x 35	2,56
	3 x 50	3,19
	3 x 70	3,94
	3 x 95	5,14
	3 x 120	5,89
	3 x 150	7,25
	4 x 1,5	0,89
	4 x 2,5	1,00
	4 x 4	1,14
	4 x 6	1,28
	4 x 10	1,50
	4 x 16	1,86
	4 x 25	2,64
	4 x 35	3,00
	4 x 50	3,92
	4 x 70	4,81
	4 x 95	6,25
	4 x 120	7,14
	4 x 150	7,14
	5 x 1,5	1,03
	5 x 2,5	1,14
	5 x 4	1,31
	5 x 6	1,47
	5 x 10	1,83
	5 x 16	2,17
	5 x 25	3,14
	7 x 1,5	1,17
	7 x 2,5	1,31
	7 x 4	1,50
	12 x 1,5	1,69
	12 x 2,5	2,00
	12 x 4	2,31
	19 x 1,5	2,36
	19 x 2,5	2,69
	19 x 4	3,14
	24 x 1,5	2,86
	24 x 2,5	3,28
	24 x 4	3,97

Type	dimension n x mm²	caloric load kWh/m
NHXHX black	37 x 1,5	3,92
	37 x 2,5	4,69
	37 x 4	5,53
NHXCHX black	3 x 1,5/ 1,5	0,78
	3 x 4 / 4	1,00
	3 x 6 / 6	1,11
	3 x 10 / 10	1,33
	3 x 16 / 10	1,58
	3 x 16 / 16	1,58
	3 x 25 / 16	2,31
	3 x 25 / 25	2,31
	3 x 35 / 16	2,61
	3 x 35 / 35	2,61
	3 x 50 / 25	3,33
	3 x 50 / 50	3,33
	3 x 70 / 35	4,11
	3 x 70 / 70	4,11
	3 x 95 / 50	5,33
	3 x 95 / 95	5,33
	3 x 120 / 70	6,11
	3 x 120 /120	6,11
	3 x 150 / 70	7,50
	3 x 150 /150	7,50
	4 x 1,5/ 1,5	0,89
	4 x 2,5/ 2,5	1,03
	4 x 4 / 4	1,17
	4 x 6 / 6	1,31
	4 x 10 /10	1,53
	4 x 16 /16	1,89
	4 x 25 /16	2,69
	4 x 35 /16	3,06
	4 x 50 /25	4,00
	4 x 70 /35	4,89
	4 x 95 /50	6,44
	4 x 120 /70	7,36
	4 x 150 /70	8,97
(N)HMH-O/J	1 x 1,5	0,16
	1 x 2,5	0,19
	1 x 4	0,23
	1 x 6	0,26
	1 x 10	0,33
	1 x 16	0,41
	2 x 1,5	0,30
	2 x 2,5	0,34
	2 x 4	0,43
	2 x 6	0,51
	2 x 10	0,74
	3 x 1,5	0,33
	3 x 2,5	0,40
	3 x 4	0,52
	3 x 6	0,64
	3 x 10	0,87
	4 x 1,5	0,41
	4 x 2,5	0,48
	4 x 4	0,67
	4 x 6	0,77
	4 x 10	1,02
	4 x 16	1,37
	4 x 25	1,98
	4 x 35	2,35

Type	dimension n x mm²	caloric load kWh/m
(N)HMH-O/J	5 x 1,5	0,45
	5 x 2,5	0,52
	5 x 4	0,77
	5 x 6	0,89
	5 x 10	1,15
	5 x 16	1,67
	5 x 25	2,40
	7 x 1,5	0,55
	7 x 2,5	0,68
HXSLHXOE	3 x 0,75	0,29
	3 x 1,0	0,30
	3 x 1,5	0,33
	3 x 2,5	0,47
	4 x 0,75	0,34
	4 x 1,0	0,35
	4 x 1,5	0,38
	4 x 2,5	0,54
	5 x 0,75	0,39
	5 x 1,0	0,40
	5 x 1,5	0,47
	5 x 2,5	0,63
	7 x 0,75	0,48
	7 x 1,0	0,50
	7 x 1,5	0,54
	7 x 2,5	0,72
	12 x 0,75	0,77
	12 x 1,0	0,80
	12 x 1,5	0,88
	12 x 2,5	1,37
	16 x 0,75	1,02
	16 x 1,0	1,06
	16 x 1,5	1,15
	16 x 2,5	1,65
	19 x 0,75	1,26
	19 x 1,0	1,32
	19 x 1,5	1,43
	19 x 2,5	2,02
	24 x 0,75	1,50
	24 x 1,0	1,57
	24 x 1,5	1,70
	24 x 2,5	2,42

Caloric load values of halogenated Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
NYY	1 x 2,5	0,22
	1 x 4	0,33
	1x 6	0,33
	1 x 10	0,33
	1 x 16	0,42
	1 x 25	0,58
	1 x 35	0,67
	1 x 50	0,81
	1 x 70	0,92
	1 x 95	1,17
	1 x 120	1,31
	1 x 150	1,58
	2 x 1,5	0,69
	2 x 2,5	0,78
	2 x 4	1,00
	2 x 6	1,11
	2 x 10	1,31
	3 x 1,5	0,75
	3 x 2,5	0,83
	3 x 4	1,08
	3 x 6	1,22
	3 x 10	1,42
	3 x 16	1,69
	3 x 25	2,14
	3 x 35	2,47
	3 x 50	2,60
	3 x 70	3,08
	3 x 95	4,06
	3 x 120	4,47
	3 x 150	5,42
	4 x 1,5	0,83
	4 x 2,5	0,94
	4 x 4	1,25
	4 x 6	1,42
	4 x 10	1,67
	4 x 16	2,03
	4 x 25	2,89
	4 x 35	2,61
	4 x 50	3,31
	4 x 70	4,08
	4 x 95	5,11
	4 x 120	5,69
	4 x 150	6,97
	5 x 1,5	0,94
	5 x 2,5	1,08
	5 x 4	1,44
	5 x 6	1,64
	5 x 10	2,00
	5 x 16	2,39
	5 x 25	3,42
	7x 1,5	1,08
	7x 2,5	1,22
	7x 4	1,67
	12 x 1,5	1,56
	12 x 2,5	1,78
	12 x 4	2,53
	19 x 1,5	2,06
	19 x 2,5	2,44
	19 x 4	3,42
	24 x 1,5	2,56
	24 x 2,5	2,94
	24 x 4	4,33
	37 x 1,5	3,39
	37 x 2,5	4,00
	37 x 4	6,03

Type	dimension n x mm²	caloric load kWh/m
NYCY, NYCWY	3 x 1,5/ 1,5	0,78
	3 x 2,5/ 2,5	0,86
	3 x 4 / 4	1,11
	3 x 6 / 6	1,25
	3 x 10 / 10	1,47
	3 x 16 / 10	1,75
	3 x 16 / 16	1,75
	3 x 25 / 16	2,53
	3 x 25 / 25	2,53
	3 x 35 / 16	2,22
	3 x 35 / 35	2,22
	3 x 50 / 25	2,78
	3 x 50 / 50	2,78
	3 x 70 / 35	3,28
	3 x 70 / 70	3,28
	3 x 95 / 50	4,28
	3 x 95 / 95	4,28
	3 x 120 / 70	4,72
	3 x 120 /120	4,72
	3 x 150 / 70	5,72
	3 x 150 /150	5,72
	4 x 1,5/ 1,5	0,86
	4 x 2,5/ 2,5	0,97
	4 x 4 / 4	1,28
	4 x 6 / 6	1,44
	4 x 10 / 10	1,69
	4 x 16 / 16	2,08
	4 x 25 / 16	2,92
	4 x 35 / 16	2,67
	4 x 50 / 25	3,44
	4 x 70 / 35	4,17
	4 x 95 / 50	5,33
	4 x 120 / 70	5,94
	4 x 150 / 70	7,22
A-2Y(L)2Y Bd	2 x 2 x 0,6	0,84
	4 x 2 x 0,6	1,17
	6 x 2 x 0,6	1,25
	10 x 2 x 0,6	1,38
	20 x 2 x 0,6	1,92
	30 x 2 x 0,6	2,32
	40 x 2 x 0,6	2,62
	50 x 2 x 0,6	3,02
	100 x 2 x 0,6	4,71
	150 x 2 x 0,6	6,17
	200 x 2 x 0,6	7,69
	250 x 2 x 0,6	8,88
	300 x 2 x 0,6	10,20
	350 x 2 x 0,6	11,88
	400 x 2 x 0,6	13,19
	500 x 2 x 0,6	15,45
	600 x 2 x 0,6	18,57
	700 x 2 x 0,6	20,82
	800 x 2 x 0,6	24,18
	1000 x 2 x 0,6	28,33

Type	dimension n x mm²	caloric load kWh/m
NYM	1 x 1,5	0,17
	1 x 2,5	0,22
	1 x 4	0,25
	1 x 6	0,28
	1 x 10	0,36
	1 x 16	0,42
	1 x 25	0,58
	2 x 1,5	0,42
	2 x 2,5	0,53
	2 x 4	0,67
	2 x 6	0,75
	2 x 10	1,17
	3 x 1,5	0,44
	3 x 2,5	0,58
	3 x 4	0,72
	3 x 6	0,92
	3 x 10	1,28
	3 x 16	1,53
	3 x 25	2,39
	3 x 35	2,78
	4 x 1,5	0,53
	4 x 2,5	0,67
	4 x 4	0,92
	4 x 6	1,08
	4 x 10	1,50
	4 x 16	1,86
	4 x 25	2,89
	4 x 35	3,28
	5 x 1,5	0,58
	5 x 2,5	0,75
	5 x 4	1,11
	5 x 6	1,28
	5 x 10	1,83
	5 x 16	2,31
	5 x 25	3,42
	6 x 1,5	0,67
	7x 1,5	0,67

X

Caloric load values of halogen-free and halogenated Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
JE-H (St) H Bd	2 x 2 x 0,6	0,12
	4 x 2 x 0,6	0,18
	6 x 2 x 0,6	0,23
	10 x 2 x 0,6	0,33
	20 x 2 x 0,6	0,64
	30 x 2 x 0,6	0,81
	40 x 2 x 0,6	1,05
	50 x 2 x 0,6	1,34
	60 x 2 x 0,6	1,50
	80 x 2 x 0,6	2,01
	100 x 2 x 0,6	2,53
JE-H (St) H Bd	2 x 2 x 0,8	0,28
	4 x 2 x 0,8	0,39
	8 x 2 x 0,8	0,58
	12 x 2 x 0,8	0,86
	20 x 2 x 0,8	1,17
	32 x 2 x 0,8	1,78
	40 x 2 x 0,8	2,08
J-H(St)H Bd	2 x 2 x 0,6	0,12
	4 x 2 x 0,6	0,18
	6 x 2 x 0,6	0,23
	10 x 2 x 0,6	0,33
	20 x 2 x 0,6	0,72
	30 x 2 x 0,6	0,81
	40 x 2 x 0,6	1,05
	50 x 2 x 0,6	1,34
	60 x 2 x 0,6	1,50
	80 x 2 x 0,6	2,01
	100 x 2 x 0,6	2,53
J-H (St) H Bd	2 x 2 x 0,8	0,16
	4 x 2 x 0,8	0,29
	6 x 2 x 0,8	0,35
	10 x 2 x 0,8	0,55
	20 x 2 x 0,8	1,21
	30 x 2 x 0,8	1,36
	40 x 2 x 0,8	1,67
	50 x 2 x 0,8	2,19
	60 x 2 x 0,8	2,44
	80 x 2 x 0,8	3,18
	100 x 2 x 0,8	4,07
J-HLiHCH Bd	2 x 2 x 0,5 mm²	1,0
	4 x 2 x 0,5 mm²	1,4
	8 x 2 x 0,5 mm²	2,1
	12 x 2 x 0,5 mm²	3,1
	20 x 2 x 0,5 mm²	4,2
	32 x 2 x 0,5 mm²	6,4
	40 x 2 x 0,5 mm²	7,5
J-H (St) H Bd E 30 bis E 90 red Fire warning installation cable	2 x 2 x 0,8	0,20
	4 x 2 x 0,8	0,34
	8 x 2 x 0,8	0,72
	12 x 2 x 0,8	0,89
	16 x 2 x 0,8	1,08
	20 x 2 x 0,8	1,36
	32 x 2 x 0,8	2,03
	40 x 2 x 0,8	2,59
	52 x 2 x 0,8	3,06
J-H (St) HRH Bd E 30 bis E 90 red Fire warning installation cable	2 x 2 x 0,8	0,39
	4 x 2 x 0,8	0,66
	8 x 2 x 0,8	1,27
	12 x 2 x 0,8	1,56
	16 x 2 x 0,8	1,81
	20 x 2 x 0,8	2,26
	32 x 2 x 0,8	3,23
	40 x 2 x 0,8	4,15
	52 x 2 x 0,8	4,68

Type	dimension n x mm²	caloric load kWh/m
J-HH Bd	2 x 2 x 0,6	0,22
	4 x 2 x 0,6	0,33
	6 x 2 x 0,6	0,39
	10 x 2 x 0,6	0,53
	16 x 2 x 0,6	0,81
	20 x 2 x 0,6	0,97
	24 x 2 x 0,6	1,11
	30 x 2 x 0,6	1,36
	40 x 2 x 0,6	1,72
	50 x 2 x 0,6	2,00
	60 x 2 x 0,6	2,39
	80 x 2 x 0,6	3,06
	100 x 2 x 0,6	3,72
JE-LiHH Bd	4 x 1 x 0,5 mm²	0,28
	8 x 1 x 0,5 mm²	0,45
	16 x 1 x 0,5 mm²	0,78
	24 x 1 x 0,5 mm²	1,08
	32 x 1 x 0,5 mm²	1,36
	40 x 1 x 0,5 mm²	1,64
I-YY Bd	2 x 2 x 0,6	0,11
	4 x 2 x 0,6	0,17
	6 x 2 x 0,6	0,22
	10 x 2 x 0,6	0,28
	16 x 2 x 0,6	0,39
	20 x 2 x 0,6	0,44
	24 x 2 x 0,6	0,50
	30 x 2 x 0,6	0,67
	40 x 2 x 0,6	0,81
	50 x 2 x 0,6	0,94
	60 x 2 x 0,6	1,17
	80 x 2 x 0,6	1,42
	100 x 2 x 0,6	1,69
JE-Y (St) Y Bd	2 x 2 x 0,8	0,19
	4 x 2 x 0,8	0,28
	8 x 2 x 0,8	0,42
	12 x 2 x 0,8	0,58
	16 x 2 x 0,8	0,72
	20 x 2 x 0,8	0,83
	24 x 2 x 0,8	0,94
	28 x 2 x 0,8	1,17
	32 x 2 x 0,8	1,28
	36 x 2 x 0,8	1,39
	40 x 2 x 0,8	1,50
	44 x 2 x 0,8	1,61
	48 x 2 x 0,8	1,83
	52 x 2 x 0,8	1,94
	56 x 2 x 0,8	2,06
	60 x 2 x 0,8	2,14
	64 x 2 x 0,8	2,25
	68 x 2 x 0,8	2,36
	72 x 2 x 0,8	2,47
	76 x 2 x 0,8	2,72
	80 x 2 x 0,8	2,83

Type	dimension n x mm²	caloric load kWh/m
J-YY Bd	2 x 2 x 0,6	0,11
	4 x 2 x 0,6	0,17
	6 x 2 x 0,6	0,22
	10 x 2 x 0,6	0,28
	16 x 2 x 0,6	0,39
	20 x 2 x 0,6	0,44
	24 x 2 x 0,6	0,50
	30 x 2 x 0,6	0,67
	40 x 2 x 0,6	0,81
	50 x 2 x 0,6	0,94
	60 x 2 x 0,6	1,17
	80 x 2 x 0,6	1,42
	100 x 2 x 0,6	1,69
J-Y(St)Y, JE-Y(St)Y	1 x 2 x 0,6	0,15
	2 x 2 x 0,6	0,17
	3 x 2 x 0,6	0,20
	4 x 2 x 0,6	0,23
	5 x 2 x 0,6	0,26
	6 x 2 x 0,6	0,28
	8 x 2 x 0,6	0,29
	10 x 2 x 0,6	0,33
	12 x 2 x 0,6	0,38
	14 x 2 x 0,6	0,40
	16 x 2 x 0,6	0,43
	20 x 2 x 0,6	0,47
	24 x 2 x 0,6	0,52
	30 x 2 x 0,6	0,69
	40 x 2 x 0,6	0,77
	50 x 2 x 0,6	0,92
	60 x 2 x 0,6	1,20
	80 x 2 x 0,6	1,41
	100 x 2 x 0,6	1,83
J-Y(St)Y, JE-Y(St)Y	1 x 2 x 0,8	0,19
	2 x 2 x 0,8	0,25
	3 x 2 x 0,8	0,31
	4 x 2 x 0,8	0,38
	5 x 2 x 0,8	0,43
	6 x 2 x 0,8	0,50
	8 x 2 x 0,8	0,56
	10 x 2 x 0,8	0,75
	12 x 2 x 0,8	0,81
	14 x 2 x 0,8	0,87
	16 x 2 x 0,8	1,00
	20 x 2 x 0,8	1,13
	24 x 2 x 0,8	1,45
	30 x 2 x 0,8	1,70
	40 x 2 x 0,8	2,08
	50 x 2 x 0,8	2,65
	60 x 2 x 0,8	2,84
	80 x 2 x 0,8	3,92
	100 x 2 x 0,8	4,94

Caloric load values of halogen-free Security Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
HELUTHERM® 145	1 x 0,25	0,00884
	1 x 0,33	0,00973
	1 x 0,50	0,01231
	1 x 0,75	0,01600
	1 x 1,0	0,01958
	1 x 1,5	0,02931
	1 x 2,5	0,04157
	1 x 4	0,05014
	1 x 6	0,05952
	1 x 10	0,10655
	1 x 16	0,13120
	1 x 25	0,21506
	1 x 35	0,25086
	1 x 50	0,33443
	1 x 70	0,40502
	1 x 95	0,53553
	1 x 120	0,61629
	1 x 150	0,77025
	1 x 185	0,94133
	1 x 240	1,18313
HELUTHERM® MULTI 145	1 x 0,50	0,04
	2 x 0,50	0,08
	3 x 0,50	0,09
	4 x 0,50	0,11
	5 x 0,50	0,14
	6 x 0,50	0,16
	7 x 0,50	0,19
	8 x 0,50	0,24
	10 x 0,50	0,27
	12 x 0,50	0,25
	14 x 0,50	0,28
	16 x 0,50	0,32
	19 x 0,50	0,41
	21 x 0,50	0,45
	24 x 0,50	0,48
	25 x 0,50	0,48
	27 x 0,50	0,46
	30 x 0,50	0,51
	33 x 0,50	0,57
	37 x 0,50	0,68
	1 x 0,75	0,05
	2 x 0,75	0,09
	3 x 0,75	0,11
	4 x 0,75	0,13
	5 x 0,75	0,17
	6 x 0,75	0,20
	7 x 0,75	0,22
	8 x 0,75	0,29
	10 x 0,75	0,32
	12 x 0,75	0,30
	14 x 0,75	0,34
	16 x 0,75	0,38
	19 x 0,75	0,48
	21 x 0,75	0,54
	24 x 0,75	0,59
	25 x 0,75	0,58
	27 x 0,75	0,55
	30 x 0,75	0,61
	33 x 0,75	0,66
	37 x 0,75	0,85

Type	dimension n x mm²	caloric load kWh/m
HELUTHERM® MULTI 145	1 x 1	0,05
	2 x 1	0,11
	3 x 1	0,13
	4 x 1	0,16
	5 x 1	0,19
	6 x 1	0,23
	7 x 1	0,29
	8 x 1	0,34
	10 x 1	0,38
	12 x 1	0,35
	14 x 1	0,40
	16 x 1	0,44
	19 x 1	0,59
	21 x 1	0,66
	24 x 1	0,70
	25 x 1	0,69
	27 x 1	0,66
	30 x 1	0,70
	33 x 1	0,83
	37 x 1	1,03
	1 x 1,5	0,06
	2 x 1,5	0,14
	3 x 1,5	0,16
	4 x 1,5	0,20
	5 x 1,5	0,25
	6 x 1,5	0,32
	7 x 1,5	0,38
	8 x 1,5	0,47
	10 x 1,5	0,51
	12 x 1,5	0,46
	14 x 1,5	0,52
	16 x 1,5	0,60
	19 x 1,5	0,83
	21 x 1,5	0,92
	24 x 1,5	1,01
	25 x 1,5	0,98
	27 x 1,5	0,93
	30 x 1,5	1,00
	33 x 1,5	1,12
	37 x 1,5	1,37
	1 x 2,5	0,07
	2 x 2,5	0,17
	3 x 2,5	0,21
	4 x 2,5	0,27
	5 x 2,5	0,34
	6 x 2,5	0,41
	7 x 2,5	0,51
	8 x 2,5	0,63
	10 x 2,5	0,65
	12 x 2,5	0,59
	14 x 2,5	0,72
	16 x 2,5	0,80
	19 x 2,5	1,04
	21 x 2,5	1,24
	24 x 2,5	1,32
	25 x 2,5	1,29
	27 x 2,5	1,22
	30 x 2,5	1,31
	33 x 2,5	1,47
	37 x 2,5	1,88

Type	dimension n x mm²	caloric load kWh/m
HELUTHERM® MULTI 145	1 x 4	0,10
	2 x 4	0,29
	3 x 4	0,27
	4 x 4	0,35
	5 x 4	0,45
	6 x 4	0,54
	7 x 4	0,68
	8 x 4	0,80
	10 x 4	0,90
	12 x 4	0,81
	14 x 4	0,94
	1 x 6	0,16
	2 x 6	0,46
	3 x 6	0,52
	4 x 6	0,57
	5 x 6	0,71
	6 x 6	0,88
	7 x 6	1,02
	1 x 10	0,15
	2 x 10	0,53
	3 x 10	0,58
	4 x 10	0,74
	5 x 10	0,87
	6 x 10	1,00
	7 x 10	1,25
	1 x 16	0,17
	2 x 16	0,64
	3 x 16	0,73
	4 x 16	0,89
	5 x 16	1,07
	6 x 16	1,23
	7 x 16	1,58
	1 x 25	0,24
	2 x 25	1,01
	3 x 25	1,08
	4 x 25	1,30
	5 x 25	1,64
	6 x 25	2,04
	7 x 25	2,46
	1 x 35	0,29
	2 x 35	1,28
	3 x 35	1,32
	4 x 35	1,64
	5 x 35	2,04
	1 x 50	0,36
	2 x 50	1,76
	3 x 50	1,81
	4 x 50	2,15
	5 x 50	2,53
	1 x 70	0,42
	2 x 70	2,28
	3 x 70	2,25
	4 x 70	2,77
	5 x 70	3,36
	1 x 95	0,55
	2 x 95	2,72
	3 x 95	2,81
	4 x 95	3,42
	5 x 95	4,11

Caloric load values of halogen-free Security Cables and insulated wires

Type	dimension n x mm²	caloric load kWh/m
HELUKABEL® MULTI-C 145	1 x 0,50	0,05
	2 x 0,50	0,12
	3 x 0,50	0,12
	4 x 0,50	0,15
	5 x 0,50	0,18
	6 x 0,50	0,21
	7 x 0,50	0,24
	8 x 0,50	0,27
	10 x 0,50	0,31
	12 x 0,50	0,30
	14 x 0,50	0,35
	16 x 0,50	0,39
	19 x 0,50	0,48
	21 x 0,50	0,54
	1 x 0,75	0,05
	2 x 0,75	0,14
	3 x 0,75	0,15
	4 x 0,75	0,18
	5 x 0,75	0,21
	6 x 0,75	0,25
	7 x 0,75	0,31
	8 x 0,75	0,35
	10 x 0,75	0,39
	12 x 0,75	0,38
	14 x 0,75	0,43
	16 x 0,75	0,49
	19 x 0,75	0,62
	21 x 0,75	0,69
	1 x 1	0,07
	2 x 1	0,16
	3 x 1	0,17
	4 x 1	0,20
	5 x 1	0,24
	6 x 1	0,30
	7 x 1	0,36
	8 x 1	0,41
	10 x 1	0,46
	12 x 1	0,44
	14 x 1	0,50
	16 x 1	0,57
	19 x 1	0,74
	21 x 1	0,82
	1 x 1,5	0,08
	2 x 1,5	0,22
	3 x 1,5	0,21
	4 x 1,5	0,28
	5 x 1,5	0,33
	6 x 1,5	0,41
	7 x 1,5	0,48
	8 x 1,5	0,58
	10 x 1,5	0,66
	12 x 1,5	0,63
	14 x 1,5	0,72
	16 x 1,5	0,80
	19 x 1,5	1,08
	21 x 1,5	1,19
	24 x 1,5	1,32
	25 x 1,5	1,30
	27 x 1,5	1,27
	30 x 1,5	1,37
	33 x 1,5	1,53
	36 x 1,5	1,71
	37 x 1,5	1,85

Type	dimension n x mm²	caloric load kWh/m
HELUKABEL® MULTI-C 145	1 x 2,5	0,11
	2 x 2,5	0,29
	3 x 2,5	0,32
	4 x 2,5	0,36
	5 x 2,5	0,45
	6 x 2,5	0,55
	7 x 2,5	0,69
	8 x 2,5	0,82
	10 x 2,5	0,87
	12 x 2,5	0,83
	14 x 2,5	1,01
	16 x 2,5	1,17
	19 x 2,5	1,47
	21 x 2,5	1,61
	1 x 4	0,13
	2 x 4	0,36
	3 x 4	0,39
	4 x 4	0,49
	5 x 4	0,56
	6 x 4	0,66
	7 x 4	0,84
	8 x 4	1,04
	10 x 4	1,16
	12 x 4	1,10
	14 x 4	1,23
	16 x 4	1,42
	1 x 6	0,15
	2 x 6	0,43
	3 x 6	0,48
	4 x 6	0,60
	5 x 6	0,71
	6 x 6	0,82
	7 x 6	1,06
	1 x 10	0,22
	2 x 10	0,67
	3 x 10	0,77
	4 x 10	0,99
	5 x 10	1,21
	6 x 10	1,41
	7 x 10	1,68
	1 x 16	0,28
	1 x 25	0,35

Information and Installation Instructions
for UL and CSA cables

UL/CSA cables must be protected against mechanical, thermal and chemical damages.

Installation in switchboards and control boards

- Inside switchboards, flexible single core cables must be installed in cable channels of plastics
- As american cables are not so flexible, the minimum bending radius must be taken into consideration during flexible installation.

For connections on machinery and equipment

- Permissible tube and conduit ø:
  minimum-Ø = 1/2" (inch)
  maximum-Ø = 4" (inch)
  Minimum wall-thickness of the conduit = 1,9 mm
- Normal steel armoured tubes with transition socket PG-NPT is used. Further metal cable channels must also be used.
- The cables are permitted to be filled with only max. 50% cross-section of the cable channel.
- Flexible single cores must be installed in PVC tubes inside the conduits.
- If connectors are used, both the main and the control cables should be installed separately.

Delivery program:

- PVC tubes
- Metal tubes and glands
- Fixing material
- Steel armoured tubes.

Cable Channels

- Cable channels in switchboards must be made out of a flame resistant PVC and must have enough spare space.
- Cable channels on machineries and equipment must be made out of metal. They must also be closed and oil resistant.

Cable identification

- Cable identification is achieved through continuous numbers, letters or number/letter combination. The beginning and end of the cable have the same identification system.

Cable connections to apparatus

- **Main and Control cables**

  It is depending on the type of connection to the apparatus if screw or press clamps are used.
- In USA, it is normal to install cables without using cable lugs or cable crushing socket. The connection is only possible with the UL-wires sizes. These sizes are not designed with fine wire stranding make-up.

Conductor cross-section

General rules	minimum cross-section for
• Motor Cables	AWG 14
• Control Cables	
– in switchboards	AWG 18
– in the installed system	AWG 16

This rule does not apply to electronic devices and systems.

In case, the electronic cables and other circuits are installed together, all cables must be set for maximum voltage.

Colour identification

- **Black**
  For main circuits, control- and subcircuits, direct connected to main voltage.
- **Blue**
  For direct voltage- (d. c.), control- and subcircuits, which are connected to the main circuit.
- **Red**
  For alternating voltage (a. c.), control and subcircuits.
- **Yellow or brown**
  For interlock circuits from an external power source.
- **White or grey**
  For current conveying earthed conductors at main, control and subcircuits.
- **Green or green-yellow**
  For insulated earth-connectors as protective conductor.

Motor-driving voltages

200 / 230 / 460 / 575 V, 60 Hz

Driving voltage

Normally the driving voltage is 120 V, 60 Hz or lower. Transformers must be operated with separate windings.

AWG-Wires and AWG-stranded conductors

Conductor make-up, cross-section, resistance and weight

AWG No.	AWG-make-up n x AWG	conductor make-up mm	cross-section mm^2	conductor outer-Ø mm	conductor resistance Ohm/km	conductor weight kg/km
36	solid	solid	0,013	0,127	1460,0	0,116
36	7/44	7 x 0,05	0,014	0,152	1271,0	0,125
34	solid	solid	0,020	0,160	918,0	0,178
34	7/42	7 x 0,064	0,022	0,192	777,0	0,196
32	solid	solid	0,032	0,203	571,0	0,284
32	7/40	7 x 0,078	0,034	0,203	538,0	0,302
32	19/44	19 x 0,05	0,037	0,229	448,0	0,329
30	solid	solid	0,051	0,254	365,0	0,45
30	7/38	7 x 0,102	0,057	0,305	339,0	0,507
30	19/42	19 x 0,064	0,061	0,305	286,7	0,543
28	solid	solid	0,080	0,330	232,0	0,71
28	7/36	7 x 0,127	0,087	0,381	213,0	0,774
28	19/40	19 x 0,078	0,091	0,406	186,0	0,81
27	7/35	7 x 0,142	0,111	0,457	179,0	0,988
26	solid	solid	0,128	0,409	143,0	1,14
26	10/36	10 x 0,127	0,127	0,533	137,0	1,13
26	19/38	19 x 0,102	0,155	0,508	113,0	1,38
26	7/34	7 x 0,160	0,141	0,483	122,0	1,25
24	solid	solid	0,205	0,511	89,4	1,82
24	7/32	7 x 0,203	0,227	0,610	76,4	2,02
24	10/34	10 x 0,160	0,201	0,582	85,6	1,79
24	19/36	19 x 0,127	0,241	0,610	69,2	2,14
24	41/40	41 x 0,078	0,196	0,582	84,0	1,74
22	solid	solid	0,324	0,643	55,3	2,88
22	7/30	7 x 0,254	0,355	0,762	48,4	3,16
22	19/34	19 x 0,160	0,382	0,787	45,1	3,4
22	26/36	26 x 0,127	0,330	0,762	52,3	2,94
20	solid	solid	0,519	0,813	34,6	4,61
20	7/28	7 x 0,320	0,562	0,965	33,8	5,0
20	10/30	10 x 0,254	0,507	0,889	33,9	4,51
20	19/32	19 x 0,203	0,615	0,940	28,3	5,47
20	26/34	26 x 0,160	0,523	0,914	33,0	4,65
20	41/36	41 x 0,127	0,520	0,914	32,9	4,63
18	solid	solid	0,823	1,020	21,8	7,32
18	7/26	7 x 0,404	0,897	1,219	19,2	7,98
18	16/30	16 x 0,254	0,811	1,194	21,3	7,22
18	19/30	19 x 0,254	0,963	1,245	17,9	8,57
18	41/34	41 x 0,160	0,824	1,194	20,9	7,33
18	65/36	65 x 0,127	0,823	1,194	21,0	7,32
16	solid	solid	1,310	1,290	13,7	11,66
16	7/24	7 x 0,511	1,440	1,524	12,0	12,81
16	65/34	65 x 0,160	1,310	1,499	13,2	11,65
16	26/30	26 x 0,254	1,317	1,499	13,1	11,72
16	19/29	19 x 0,287	1,229	1,473	14,0	10,94
16	105/36	105 x 0,127	1,330	1,499	13,1	11,84
14	solid	solid	2,080	1,630	8,6	18,51
14	7/22	7 x 0,643	2,238	1,854	7,6	19,92
14	19/27	19 x 0,361	1,945	1,854	8,9	17,31
14	41/30	41 x 0,254	2,078	1,854	8,3	18,49
14	105/34	105 x 0,160	2,111	1,854	8,2	18,79

Continuation ►

AWG-Wires and AWG-stranded conductors

Conductor make-up, cross-section, resistance and weight

AWG No.	AWG-make-up n x AWG	conductor make-up mm	cross-section mm^2	conductor outer-Ø mm	conductor resistance Ohm/km	conductor weight kg/km
12	solid	solid	3,31	2,05	5,4	29,46
12	7/20	7 x 0,813	3,63	2,438	4,8	32,30
12	19/25	19 x 0,455	3,09	2,369	5,6	27,50
12	65/30	65 x 0,254	3,292	2,413	5,7	29,29
12	165/34	165 x 0,160	3,316	2,413	5,2	29,51
10	solid	solid	5,26	2,59	3,4	46,81
10	37/26	37 x 0,404	4,74	2,921	3,6	42,18
10	49/27	49 x 0,363	5,068	2,946	3,6	45,10
10	105/30	105 x 0,254	5,317	2,946	3,2	47,32
8	49/25	49 x 0,455	7,963	3,734	2,2	70,87
8	133/29	133 x 0,287	8,604	3,734	2,0	76,57
8	655/36	655 x 0,127	8,297	3,734	2,0	73,84
6	133/27	133 x 0,363	13,764	4,676	1,5	122,49
6	259/30	259 x 0,254	13,123	4,674	1,3	116,79
6	1050/36	1050 x 0,127	13,316	4,674	1,3	118,51
4	133/25	133 x 0,455	21,625	5,898	0,80	192,46
4	259/27	259 x 0,363	26,804	5,898	0,66	238,55
4	1666/36	1666 x 0,127	21,104	5,898	0,82	187,82
2	133/23	133 x 0,574	34,416	7,417	0,50	306,30
2	259/26	259 x 0,404	33,201	7,417	0,52	295,49
2	665/30	665 x 0,254	33,696	7,417	0,52	299,89
2	2646/36	2646 x 0,127	33,518	7,417	0,52	298,31
1	133/22	133 x 0,643	43,187	8,331	0,40	384,37
1	259/25	259 x 0,455	42,112	8,331	0,41	374,80
1	817/30	817 x 0,254	41,397	8,331	0,42	368,43
1	2109/34	2109 x 0,160	42,403	8,331	0,41	377,39
1/0	133/21	133 x 0,724	54,754	9,347	0,31	487,28
1/0	259/24	259 x 0,511	53,116	9,347	0,32	472,73
2/0	133/20	133 x 0,813	69,043	10,516	0,25	614,48
2/0	259/23	259 x 0,574	67,021	10,516	0,25	596,49
3/0	259/22	259 x 0,643	84,102	11,786	0,20	748,51
3/0	427/24	427 x 0,511	87,570	11,786	0,19	779,37
4/0	259/21	259 x 0,724	106,626	13,259	0,16	948,97
4/0	427/23	427 x 0,574	110,494	13,259	0,15	983,39

AWG-Wires (Solid-conductor)

AWG No.	Wire-Ø mm
44	0,050
41	0,070
40	0,079
39	0,089
38	0,102
37	0,114
36	0,127
35	0,142
34	0,160
33	0,180
32	0,203
31	0,226
30	0,254
29	0,287

AWG No.	Wire-Ø mm
28	0,320
27	0,363
26	0,404
25	0,455
24	0,511
23	0,574
22	0,643
21	0,724
20	0,813
19	0,912
18	1,024
17	1,151
16	1,290
15	1,450

AWG No.	Wire-Ø mm
14	1,628
13	1,829
12	2,052
11	2,304
10	2,588
9	2,906
8	3,268
7	3,665
6	4,115
5	4,620
4	5,189
3	5,827
2	6,543
1	7,348

AWG Nr.	Wire-Ø mm
1/0	8,252
2/0	9,266
3/0	10,404
4/0	11,684

US-American and British units

Conversion of usual measuring units

Units for cables and wires

In the US the measurements are mainly used in AWG-numbers (AWG = American Wire Gauge).
The AWG-numbers conform the british B&S-numbers (B&S = Brown & Sharp)

AWG No.	Cross-section mm²	Dia-meter mm	Conductor resistance Ohm/km
1000 MCM*	507	25,4	0,035
750	380	22,0	0,047
600	304	19,7	0,059
500	254	20,7	0,07
400	203	18,9	0,09
350	178	17,3	0,10
300	152	16,0	0,12
250	127	14,6	0,14
4/0	107,20	11,68	0,18
3/0	85,00	10,40	0,23
2/0	67,50	9,27	0,29
0	53,40	8,25	0,37
1	42,40	7,35	0,47
2	33,60	6,54	0,57
3	26,70	5,83	0,71
4	21,20	5,19	0,91
5	16,80	4,62	1,12
6	13,30	4,11	1,44
7	10,60	3,67	1,78
8	8,366	3,26	2,36
9	6,63	2,91	2,77
10	5,26	2,59	3,64
11	4,15	2,30	4,44
12	3,30	2,05	5,41
13	2,62	1,83	7,02
14	2,08	1,63	8,79
15	1,65	1,45	11,20
16	1,31	1,29	14,70
17	1,04	1,15	17,80
18	0,8230	1,0240	23,0
19	0,6530	0,9120	28,3
20	0,5190	0,8120	34,5
21	0,4120	0,7230	44,0
22	0,3250	0,6440	54,8
23	0,2590	0,5730	70,1
24	0,2050	0,5110	89,2
25	0,1630	0,4550	111,0
26	0,1280	0,4050	146,0
27	0,1020	0,3610	176,0
28	0,0804	0,3210	232,0
29	0,0646	0,2860	282,0
30	0,0503	0,2550	350,0
31	0,0400	0,2270	446,0
32	0,0320	0,2020	578,0
33	0,0252	0,1800	710,0
34	0,0200	0,1600	899,0
35	0,0161	0,1430	1125,0
36	0,0123	0,1270	1426,0
37	0,0100	0,1130	1800,0
38	0,00795	0,1010	2255,0
39	0,00632	0,0897	2860,0

4/0 is also stated: 0000; 1 mil = 0,001 inch = 0,0254 mm
* for bigger cross-section the sizes in MCM (circular mils)

1 CM = 1 Circ. mil. = 0,0005067 mm²
1 MCM = 1000 Circ. mils = 0,5067 mm²

General measuring units

Length

1 mil	= 0,0254 mm
1 in (inch)	= 25,4 mm
1 ft (foot)	= 0,3048 m
1 yd (yard)	= 0,9144 m
1 ch (chain)	= 20,1 m
1 mile (land mile)	= 1,609 km
	= 1760 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 • 10^{-3} mm²
1 MCM	= 0,5067 mm²
1 sq. inch (sq. inch)	= 645,16 mm²
1 sq. ft. (sq. foot)	= 0,0929 m²
1 square yard	= 0,836 m²
1 acre	= 4047 m²
1 square mile	= 2,59 km²

Density

1 cu. in. (cubic inch)	= 16,39 cm³
1 cu. ft. (cubic foot)	= 0,0283 m³
1 cu. yd. (cubic yard)	= 0,7646 m³
1 gal. (US gallon)	= 3,785 l
1 gal. (brit gallon)	= 4,546 l
1 US pint	= 0,473 l
1 US quart	= 0,946 l
1 US barrel	= 158,8 l

Temperature

F (Fahrenheit)	= (1,8 • C) + 3°
C (Celsius)	= 0,5556 • (F–32°)

Weight

1 grain	= 64,8 mg
1 dram	= 1,77 g
1 oz (ounce)	= 28,35 g
1 lb (pound)	= 0,4536 Kp
1 stone	= 6,35 Kp
1 qu (quarter)	= 12,7 Kp
1 US-cwt (hundred-weight)	= 45,36 Kp
1 US ton (short ton)	= 0,907 t
1 brit. ton (long ton)	= 1,016 t

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

Velocity

1 mile/h	= 1,609 km/h
1 Knoten	= 1,852 km/h
1 ft/s	= 0,305 m/s
1 ft/min	= 5,08 • 10^{-3} m/s

Energy

1 lb/mile	= 0,282 kg/m
1 lb/yard	= 0,496 kg/m
1 lb/foot	= 1,488 kg/m

Radiation absorbed dose

1 Gray	= 1 J/kg
1 rad	= 10^{-2} J/kg = 1 Centi Gy
	= 0,01 Gy
1 Centi	= 100 Joule
1 rad	= cJ/kg = 0,01Gy
1 Mrad	= 1 • 10^{6} cJ/kg

Pressure

1 psi (lb/sq.)	= 68,95 mbar
	= 6,895 • 10^{-3} Nmm²
1 lb/sq. ft.	= 0,478 mbar
1 pdl/sq. ft.	= 1,489 N/m²
1 in Hg	= 33,86 mbar
1 ft H_2 O	= 29,89 mbar
1 in H_2 O	= 2,491 mbar
1 N/mm²	= 145 psi
	= 10 bar
1 kp/mm²	= 1422 psi
1 at	= 736 Torr
	= 1 kp/cm²
1 Torr	= 1 mm Hg
1 bar	= 0,1 H Pa
1 Pa	= 1 N/m²

Density

1 lb/cu. ft.	= 16,02 kg/m³
1 lb/cu. in.	= 27,68 t/m³

Horse power

1 hp • h	= 1,0139 PS • h
	= 2,684 • 10^{6} Joule
	= 746 W • h
1 BTU (brit. therm. unit)	= 1055 Joule

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

Power rate

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

Current ratings for UL-CSA cables

Current ratings

PVC-insulated single and multicore wiring cables according to UL-AWM and CSA-TEW standards are used in switchboard and distribution cabinets of electrical equipments and as well as for the installation of machines and transformers in protecting tubes.
PVC-insulation is allowed at maximum temperature range of 105°C.
The indicated values stated in the following tables are considered as guiding values. In critical situation the rules and recommendations for the current ratings should be followed.

● for **single core** cables at ambient temperature **up to 30°C**

AWG No.	Cross-section mm²	Load rating A
24	0,21	3,5
22	0,33	5,0
20	0,52	6,0
18	0,82	9,5
16	1,31	20
14	2,08	24
12	3,32	34
10	5,26	52
8	8,35	75
6	13,29	95
4	21,14	120

AWG No.	Cross-section mm²	Load rating A
3	26,65	154
2	33,61	170
1	42,38	180
1/0	53,43	200
2/0	67,40	225
3/0	84,97	275
4/0	107,17	325
250	127	345
300	152	390
400	178	415

● for **multicore cables** at ambient temperature **up to 30°C**

AWG No.	Cross-section mm²	Load rating up to 3 cores A	Load rating 4–6 cores A	Load rating 7–24 cores A	Load rating 25–42 cores A	Load rating 43 and above A
24	0,21	2	1,6	1,4	1,2	1
22	0,33	3	2,4	2,1	1,8	1,5
20	0,52	5	4	3,5	3	2,5
18	0,82	7	5,6	4,9	4,2	3,5
16	1,31	10	8	7	6	5
14	2,08	15	12	10,5	9	7,5
12	3,32	20	16	14	12	10
10	5,26	30	24	21	18	15
8	8,35	40	32	28	24	20
6	13,29	55	44	38	33	27
4	21,14	70	56	49	42	35
3	26,65	80	64	56	48	40
2	33,61	95	76	66	57	57
1	42,38	110	88	77	66	55

● **Correction-factors** at ambient temperature **over 30°C**

Ambient temperature °C	Load rating values of above tables correction-factors f
31 – 40	0,82
41 – 45	0,71
46 – 50	0,58

List of UL-Styles (single core cables)

UL-Style No.	Insulation Material	Voltage Volt	Temp. °C	Insulation thickness mm	AWG Size
1001	PVC/Nylon	300	80	0,23	30 – 16
1002	PVC	600	60	0,76	26 – 16
1003	PE, FRPE	300	60	0,76	26 – 16
1004	PVC/Nylon	–	80	0,20	30 – 16
1005	PVC/Nylon	–	90	0,20	26 – 16
1006	PVC/Nylon	–	105	0,20	26 – 16
1007	PVC	300	80	0,38	32 – 16
1011	PVC	600	80	0,76	28 – 9
1013	PVC	600	90	0,76	28 – 9
1015	PVC	600	105	0,76	28 – 9
1017	PVC	600	80	1,14	22 – 8
1019	PVC	600	80	1,52	8 – 2
1020	PVC	600	80	2,05	1 – 4/0
1022	PVC	600	80	2,78	–
1023	PVC	600	80	3,17	–
1024	PVC	600	90	1,14	18 – 8
1025	PVC/Nylon	600	90	1,14	8 – 6
1026	PVC	600	90	1,52	8 – 6
1027	PVC	600	90	1,91	1 – 4/0
1028	PVC	600	105	1,14	22 – 8
1029	PVC/Nylon	600	105	1,14	8 – 6
1030	PVC	1000	80	0,76	26 – 10
1031	PVC/Nylon	1000	80	0,76	26 – 10
1032	PVC	1000	90	0,76	26 – 10
1033	PVC/Nylon	1000	90	0,76	26 – 10
1037	PVC	300	60	0,30	24 – 20
1039	PVC	300	80	0,38	22 – 16
1040	P/B	300	80	–	22 – 16
1041	PVC	300	60	0,76	20 – 16
1043	PVC	300	80	0,76	20 – 16
1045	PVC	300	90	0,76	20 – 16
1049	PVC	300	80	1,14	20 – 16
1053	PVC	600	60	1,52	18 – 10
1054	PVC	600	80	1,52	18 – 10
1055	PVC	600	90	1,52	20 – 10
1056	PVC	600	105	1,52	20 – 10
1060	PVC	600	105	1,91	10 – 10
1061	SR PVC	300	80	0,23	30 – 16
1063	PVC	300	60	–	20 – 18
1095	PVC	300	80	0,30	30 – 16
1096	PVC/Nylon	300	80	–	26 – 10
1098	PE	2000	60	0,86	18
1099	PVC	300	80	0,38	28
1107	PE, FRPE	300	60	0,38	30 – 16
1108	PVC	300	80	–	26 – 16
1109	PVC, XPVC	300	90	0,38	26 – 16
1110	PVC; XPVC	300	105	0,38	26 – 16
1113	PE	600	60	–	26 – 16
1115	PVC	300/600	80	0,38	30 – 16
1116	PVC/Nylon	600	80	–	22 – 8
1118	PVC	300	90	0,38	26 – 16
1119	PVC	600	90	0,76	26 – 16
1120	PVC	600	105	0,76	30 – 4/0
1122	SR PVC	300	80	0,23	30
1123	PVC	300	80	0,76	22 – 20
1124	PVC	300	80	0,76	22 – 20
1158	PVC	300	60	0,76	22 – 9
1159	PVC	300	60	1,14	8
1160	PVC	300	60	0,38	22 – 16
1161	PVC	600	60	0,76	22 – 9
1162	PVC	600	60	1,14	22 – 9
1164	PTFE	300	150	0,33	32 – 10
1180	PTFE	300	200	0,38	28 – 10
1181	PVC/Nylon	600	60	0,76	18 – 16
1185	PVC	300	80	0,38	30 – 4/0
1195	PVC	300	80	0,38	26 – 14
1198	PTFE	600	150	0,51	26 – 10
1199	PTFE	600	200	0,51	26 – 10
1206	PVC	300	80	0,33	30 – 16
1208	PVC	300	80	0,33	26 – 16
1227	FEP	not specified*	105	0,20	32 – 14
1228	PVC	600	90	1,14	18 – 8
1229	PVC	600	90	1,52	8 – 2
1230	PVC	600	105	0,76	26 – 8
1231	PVC	600	105	1,14	18 – 8
1232	PVC	600	105	1,52/2,03	8 – 4/0
1233	PVC	600	80	1,52	18 – 8
1235	PVC	600	105	1,52	18 – 8
1237	PVC	600	80	1,14	22 – 19
1239	PVC	600	105	1,14	22 – 19
1270	PVC	600	90	1,14	18 – 9
1271	PVC	600	90	1,52	8 – 2
1272	PVC	600	90	1,91	1 – 4/0
1279	PVC	600	80	1,52	7 – 2
1280	PVC	600	80	1,14	18 – 8
1283	PVC	600	105	1,52	8 – 2
1284	PVC	600	105	1,91	1 – 4/0
1287	PVC	600	105	1,91	18 – 12
1306	PVC	600	80	2,29	8
1308	PVC	600	105	2,29	8

* not specified

UL-Style No.	Insulation Material	Voltage Volt	Temp. °C	Insulation thickness mm	AWG Size
1316	PVC/Nylon	600	105	0,38	26 – 12
1317	PVC/Nylon	600	105	0,51	10
1318	PVC/Nylon	600	105	0,76	8 – 6
1319	PVC/Nylon	600	105	1,02	4 – 2
1320	PVC/Nylon	600	105	1,27	1 – 4/10
1321	PVC/Nylon	600	105	1,78	250 – 1000
1322	PVC	600	90	1,91	14 – 10
1327	PVDF	–	105	0,25	30 – 16
1329	PVC	600	105	1,91	14 – 10
1330	FEP	600	200	variable	30 – 4/0
1331	FEP	600	105	variable	30 – 4/0
1332	FEP	300	200	0,38	30 – 10
1333	FEP	300	150	0,38	30 – 10
1335	PVC	600	90	0,76	22 – 10
1336	PVC	600	90	1,14	8
1337	PVC	600	90	1,52	6 – 2
1338	PVC	600	90	1,98	8 – 4/0
1366	PVC/PVC	600	90	variable	26 – 9
1394	PTFE	–	200	0,15	32 – 20
1400	PVC	600	90	1,14	14 – 10
1401	PVC	600	90	1,52	8
1402	PVC/Nylon	600	90	0,76	22 – 10
1405	PVC/Nylon	600	90	1,98	1 – 4/10
1408	PVC/Nylon	600	90	0,38	22 – 12
1409	PVC/Nylon	600	90	0,51	10
1410	PVC/Nylon	600	90	0,76	8 – 6
1411	PVC/Nylon	600	90	1,02	4 – 2
1412	PVC/Nylon	600	90	1,27	1 – 4/10
1413	PVC/Nylon	600	90	1,52	250 – 500
1414	PVC/Nylon	600	90	1,78	600 – 1000
1429	XPVC	150	80	0,25	32 – 16
1430	XPVC	300	105	0,38	30 – 16
1435	PE	300	80	0,41	26 – 16
1436	PE	300	80	0,79	26 – 16
1437	PE	300	80	1,63	26 – 16
1438	PE	300	80	1,14	26 – 16
1439	PE	300	80	0,81	26 – 16
1444	PVC	1000	90	1,14	18 – 10
1452	PVC/Nylon	1000	90	0,38	18 – 12
1453	PVC/Nylon	1000	90	0,51	10
1498	PCV	600	80	0,76	22 – 9
1499	PVC	600	90	0,76	22 – 9
1500	PVC	600	105	0,76	22 – 9
1508	ETFE	30	105	0,15	32 – 20
1517	ETFE	–	105	0,15	32 – 20
1523	ETFE	–	105	0,13	32 – 20
1533	PVC	–	80	0,23	30 – 10
1536	XPVC	–	80	0,25	30 – 10
1538	FEP	125	105	0,15	32 – 20
1542	PE-PVC	10000	80	–	24 – 10
1546	PE-PVC	600	–	–	20
1558	ETFE	–	125	0,10	32 – 20
1568	PVC	150	80	0,23	30 – 16
1569	PVC	300	105	0,38	28 – 10
1570	ETFE	600	250	–	24 – 8
1575	PVC	48	60	0,76	18 – 8
1581	PVC	300	80	0,38	14
1586	ETFE	–	105	0,20	32 – 6
1591	FEP	300	150	0,41	26 – 16
1592	FEP	300	200	0,41	26 – 16
1605	PVC	30	60	0,10	min. 46
1609	ETFE	125	105	0,13	32 – 6
1610	ETFE	not specified**	105	0,25	32 – 10
1612	PVDF	125	150	–	–
1618	PVC	300	80	0,38	–
1624	PVC	160	80	0,25	30 – 16
1662	PVC	300	80	variable	18 – 1/10
1680	PVC	–	105	–	18 – 1/10
1683	PVC	–	80	–	3/0
1692	PVC	30	80	2,54	min. 42
17107	PFA	30	200	0,127	32 – 20
1708	PFA	not specified**	200	0,127	32 – 20
1722	TPR	600	125	VAR	22 – 4/0
1729	PVC	300	80	0,22	32 – 16
1792	PE, PVC	30	80	0,05	min. 40
1847	FEP	30	105	0,08	min. 40
1848	FEP	300	150 o. 200	0,38	min. 24
1860	PFA	150	200	0,25	32 – 16
1888	TPR	300	125	0,41	–
1908	PVC	300	80	0,38	26 – 4/0
1909	PVC	600	80	0,76	26 – 4/0
1926	PE o. FRPE	300	60+80	0,17	30 – 16
1948	PVC	60	60	0,10	min. 46
1967	PVC	30	60+80	0,38	20 – 4/0
1968	PVC	–	60+80	0,38	20 – 4/0
1986	FEP	30	80	0,05	min. 50
1990	ETFE	600	105	0,50	30 – 4/0
1999	Zell. FEP	300	150	0,45	min. 36
10009	Zell. FEP	300	150	0,45	min. 36
10011	PFA	30	80	0,0254	min. 40
10030	PFA	300	250	0,025	30 – 10
10032	PFA	600	250	0,38	30 – 10
10050	FEP	600	150	0,457	30 – 4/0

List of UL-Styles (Multicore cables)

UL-Style No.	Insulation Material	Voltage Volt	Temp. °C	Insulation thickness mm	AWG Size
2006	PVC	300	80	1,14	20 – 16
2007	PVC	300	90	1,14	20 – 16
2012	PVC	300	80	1,52	18 – 16
2015	PVC	300	80	1,52	18 – 16
2030	PVC	600	80	1,91	14 – 10
2031	PVC	600	90	1,91	14 – 10
2032	PVC	600	105	1,91	14 – 10
2089	PVC	300	60	–	20 – 18
2090	PVC	300	60	–	20 – 18
2091	PVC	300	60	–	20 – 18
2092	PE	300	60	–	26 – 16
2093	PE	300	60	–	26 – 16
2094	PE	300	60	–	26 – 16
2095	PVC	300	90	–	32 – 16
2096	PVC	300	80	–	30 – 16
2097	PVC	300	80	–	30 – 18
2098	PVC	300	90	–	26 – 16
2099	PVC	300	90	–	26 – 16
2100	PVC	300	90	–	26 – 16
2101	PVC	300	105	0,38	30 – 16
2102	PVC	300	105	–	30 – 16
2103	PVC	300	105	0,38	30 – 16
2106	PE	600	60	–	26 – 12
2107	PE	600	60	–	26 – 12
2108	PE	600	60	–	26 – 12
2112	PVC	300	80	0,38	26 – 16
2113	PVC	300	80	0,38	26 – 16
2114	PVC	300	80	0,38	26 – 16
2115	PVC	600	80	–	26 – 16
2116	PVC	600	80	–	26 – 16
2117	PVC	600	80	–	26 – 16
2121	PVC	300/600	90	0,38	26 – 16
2122	PVC	300/600	90	0,38	26 – 16
2123	PVC	300/600	90	0,38	26 – 16
2124	PVC	600	90	0,76	28 – 9
2125	PVC	600	90	0,76	28 – 9
2126	PVC	600	90	0,76	28 – 9
2127	PVC	600	105	0,76	28 – 9
2128	PVC	600	105	0,76	29 – 9
2129	PVC	600	105	0,76	28 – 9
2243	PVC	300	105	1,14	20 – 16
2261	PVC	300	105	0,76	18
2262	PE	600 (isol.) 300 (Jacket)	60	0,76	26 – 16
2263	PE	600 (isol.) 300 (Jacket)	60	0,76	26 – 16
2264	PE	600 (isol.) 300 (Jacket)	60	0,76	26 – 16
2265	PVC	300	80	0,38	26 – 16
2266	PVC	300	80	–	26 – 16
2267	PVC	300	80	–	36 – 30
2268	PVC	300	80	–	26 – 16
2269	PVC	300	80	–	26 – 16
2270	PVC	300	80	–	26 – 16
2271	as for SVT	300	60	as for SVT	26 – 16
2272	as for SVT	300	60	as for SVT	26 – 16
2273	as for SVT	300	60	as for SVT	26 – 16
2274	as for SVT	300	60	as for SVT	26 – 16
2275	as for SVT	300	60	as for SVT	26 – 16
2276	as for SVT	300	60	as for SVT	26 – 16
2277	as for SVT	300	60	as for SVT	26 – 16
2278	as for SVT	300	60	as for SVT	26 – 16
2279	as for SVT	300	60	as for SVT	26 – 16
2280	as for SVT	300	60	as for SVT	26 – 16
2317	PE	600	60	–	26 – 16
2351	PE	600	80	–	26 – 16
2352	PE	300	80	–	26 – 16
2353	PE	300	80	–	26 – 16
2354	PE	600	80	–	26 – 16
2355	PE	600	80	–	26 – 16
2376	PVC	300	105	–	–
2384	variable	30	60	–	30
2385	VAR	30	60	–	30
2386	VAR	30	60	–	30
2387	VAR	30	60	–	30
2388	PVC	30	60	–	–
2405	PVC	300	80	–	30 – 16
2439	PE	600	80	–	26 – 16
2448	variable	30	60	–	30
2461	PVC	30	60	–	26 – 16
2462	PVC	300	60	–	–
2463	PVC	600	80	–	26 – 10

UL-Style No.	Insulation Material	Voltage Volt	Temp. °C	Insulation thickness mm	AWG Size
2464	variable	300	80	–	–
2468	PVC	300	80	0,38	32 – 16
2474	PVC	600	105	–	26 – 16
2477	PVC		60	–	33 – 16
2483	PVC	600	105	–	26 – 16
2489	PVC	600	60	–	18
2490	AWM	not specified*	60	AWM	min. 36
2493	PP		60	–	30 – 16
2498	PE	300	80	–	28 – 16
2501	PVC	600	105	–	30
2502	variable	30	80	–	–
2504	PVC	600	105	–	20 – 14
2507	PVC	600	60	–	26 – 16
2516	PVC	600	105	–	30 – 9
2517	PVC	300	105	–	32 – 16
2532	PVC	30	60	–	30 – 16
2535	PVC	30	80	–	30 – 16
2548	PE	300	80	–	–
2549	PVC	300	90	–	30 – 16
2550	AWM	600	90	AWM	min. 40
2551	AWM	30	105	AWM	min. 40
2560	PVC	30	60	–	30
2564	PVC	125	75	–	22
2567	PVC	600	60	–	–
2570	PVC	600	80	–	30 – 9
2571	PVC	–	80	–	30 – 16
2574	AWM	30	105	AWM	min. 40
2576	PVC	150	80	–	30 – 9
2582	PE	150	60	–	30 – 16
2584	PVC	125	80	–	30 – 9
2586	PVC	600	105	–	30 – 9
2587	PVC	600	90	–	30 – 9
2589	AWM	30	105	AWM	see AWM Requirements
2598	VAR	300	60	–	30 – 16
2606	PE	300	60	–	30
2610	labeled Style 1007	300	80	labeled Style 1007	see 1007 Requirements
2614	AWM	30	105	AWM	min. 40
2623	PE	30	80	–	30 – 20
2626	AWM	30	80	AWM	not specified*
2629	PE	300	80	–	30 – 16
2630	AWM	125	90	AWM	30 – 9
2631	AWM	not specified*	90	AWM	min. 40
2637	AWM	30	90	AWM	min. 40
2653	AWM	600	90	AWM	36 – 6
2654	AWM	300	90	AWM	36 – 6
2655	PVC	300	80	–	33 – 10
2656	AWM	600	80	AWM	36 – 6
2660	AWM	not specified*	60	AWM	–
2661	AWM	300	105	AWM	36 – 6
2662	PVC	600	105	–	33 – 10
2668	AWM	30	60	AWM	min. 40
2678	PVC	30	105	–	–
2704	PVC	30	60	–	30
2778	AWM	150	60	AWM	30 – 16
2789	AWM	30	60	AWM	see AWM
2833	AWM	30	60	AWM	–
2835	PP	30	80	–	22
2919	PP	30	80	–	28 – 18
2920	AWM	30	60	AWM	min. 40
2921	AWM	30	60	AWM	min. 40
2930	AWM	not specified*	105	AWM	min. 40
2931	AWM	125	105	AWM	min. 40
2937	AWM	300	80	AWM	AWM
3071	S/GB	600	200	0,76	18 – 14
3075	S/GB	600	200	0,76	10 – 2
3173	XLPE	600	125	0,76	26 – 9
3199	XLPE	300	105	0,38	22 – 16
3212	SiR	600	150	1,14	26 – 10
3213	SiR	600	150	1,52	8 – 2
3214	SiR	600	150	1,91	1 – 4/0
3239	SiR	VAR	150	VAR	24 – 10
3265	XLPE	150	125	0,25	28 – 20
3266	XLPE	300	125	0,38	26 – 16
3271	XLPE	600	125	VAR	24 – 12
3272	XLPE	600	125	VAR	22 – 4
3291	XPVC	300	105	–	26 – 16
20063	PE	300	80	0,5	28 – 16
20083	PE	300	80	AWM	diverse AWG
20601	AWM	300	80	AWM	AWM

* not specified

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91	Electric cables, soldering buckets
125	Electric conductors, copper & copper-cadmium, for overhead transmission
215	Electric conductors, aluminium & steel-cored aluminium
801	Cable sheaths, lead and lead alloy
1441	Galvanised steel wire, for submarine cables
1442	Galvanised steel wire, for land cables
1791	Electric conductors, copper, cotton-covered
1843	Insulated cables, twin compensating cables, thermocouples, colour codes
1990	Communication transmission lines, wood poles
2316	Coaxial cables, radio frequency
2848	Cable sheaths, flexible
3242	Electric conductors, aluminium alloy, stranded, for power transmission
3573	Communication cables, polyolefin insulated & sheathed copper-conductor cables
3858	Electric cables, sleeves, binding & identification
3988	Electric conductors, aluminium solid conductors, for insulated cables
4066	Superseded by BSEN 50266-1:2001
4553	Insulated cables, PVC-insulated, split concentric copper
4565	Electric conductors, steal wire for reinforcing aluminium conductors
4579	Electric cables, mechanical & compression joints in connectors
4653	Electric conductors, copper, paper covered
4799	Electric conductors, copper glass fibre lapped
4801	Electric conductors, copper, glass fibre braided
4808	Communication cables, LE, PVC insulated & sheathed
4927	Electric conductors, copper, textile covered
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5055	Insulated cables, PVC & elastomer-insulated, for discharge-tube installations
5099	Cable sheaths, spark testing
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5372	Electric cables, terminations for 3 & 4 core insulated cables, dimensions
5425	Communication cables, coaxial
5467	Power cables, armoured thermosetting-polymer insulated, for electricity supply
5593	Sheathed cables, aluminium-sheathed CONSAC cables
5819	Communication cables for interconnection between video recorder and television receivers
6004	Insulated cables, PVC insulated, non-armoured
6007	Insulated cables, rubber-insulated, non-armoured
6116	Flexible cables, elastomer-insulated flexible trailing cables, for mines and quarries
6141	Flexible conductors, for high temperature zones
6195	Flexible cables, insulated, for coil leads
6207	Mineral-insulated cables, copper sheathed, with copper conductors
6231	Single-core cables, PVC insulated, for switchgear and controlgear
6234	Insulated cables, polyethylene
6346	Power cables, PVC-insulated, for electricity supply
6360	Electric conductors, insulated cables
6387	Electric cables, fire-resistant, tests
6425	Electric cables, combustion gases, test methods
6469	Insulated cables, insulation and sheaths, test methods
6480	Power cables, impregnated paper-insulated, lead or lead alloy sheathed electric cables
6485	Electric conductors, PVC covered overhead power line conductors
6500	Flexible cables, insulated cords and cables
6622	Power cables, thermosetting-polymer insulated, high voltage
6708	Flexible cables, trailing cables, mining equipment
6724	Thermosetting polymer insulated, for electricity supply, low smoke
6726	Flexible conductors, for festoon and temporary lighting
6746	Cable sheaths, PVC

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6862	Electric cables, road vehicles
6883	Insulated cables, elastomer insulated cables, for ships
6899	Cable sheaths, rubber
6946	Electric cables, metal channel support systems
6977	Multicore cables, insulated flexible cables, for lifts
7211	Power cables, thermosetting polymer insulated, non-armoured, low smoke
7365	Electric conductors, hard drawn aluminium wire, for overhead lines
7919	Electric cables, flexible cables rated up to 450/750v for use with appliances and equipment intended for indutrial and similar environments
9530	Electric cables, cable fitting accessories, assessed quality, for circular electrical connectors
4737	Insulated cables, PVC-insulated, for intruder alarm systems
5425	Coaxial cables, for wideband distribution systems
638	Flexible cables, arc welding
6746C	Insulated cables, PVC insulation, colour chart
Aero 2E21	Pren type electric cables, for aircraft
Aero G177	Insulated cables, Nyvin type for aircraft
Aero G189	Tersil electric cables, for aircraft, imperial units
Aero G192	Specification for Efglas type electric cables with copper conductors, for aircraft
Aero G195	Insulated cables, Minyvin type, for aircraft, imperial units
Aero G206	Fepsil-type cables, for aircraft
Aero G210	Specification for PTFE insulated equipment wires (with silver plated copper conductors)
Aero G212	Electric cables, for aircraft
Aero G215	Insulated cables, thermocouple extension cables, for aircraft
Aero G221	Insulated cables, Minyvin-type, for aircraft, metric units
Aero G222	Insulated cables, Efglas-type, for aircraft, metric units
Aero G227	Tersil electric cables, for aircraft, metric units
Aero G230	Specification for general requirements for aircraft electrical cables (second series)
Aero G231	Electric conductors, copper and copper alloy, for aircraft cables
Aero G232	Insulated cables, lightweight thin-wall, wrapped for aircraft
Aero G233	Insulated cables, lightweight thin-wall, extruded for aircraft
Aero G235	Insulated cables, lightweight thin-wall, wrapped, silver plated copper conductors for aircraft
Aero G236	Insulated cables, lightweight thin-wall, wrapped, nickel plated copper conductors for aircraft
Aero G237	Insulated cables, lightweight thin-wall, extruded, nickel plated copper conductors for aircraft
Aero G238	Insulated cables, lightweight thin-wall, wrapped, nickel plated copper conductors for aircraft
Aero G241	Electric cables, fire-proof, for aircraft
Aero G242	Communication cables, for aircraft data bus interconnecting systems
Aero G243	Electric cables, ignition, for aircraft engines
Aero G291	Insulated cables, Efglas-type, for aircraft, imperial units
AU231	Specification for seven-core connecting cable for road vehicles
AU237	Flexible conductors, jumper lead sets, for automotive starting
AU7	Electric cables, automotive, colour codes
AU88	Electric cables, automobile, light duty, ratings
AU88a	Recommendations for ratings for light duty cables for automobile use
PD2379	Electric cables, manufacturers' identification threads, Commonwealth, South Africa, colour register

Characteristics* of insulating and sheath materials

Designation				Electrical					Thermic						
	VDE Initial-code	Abbreviations	Materials	Density g/m³	Breakdown-voltage- KV/mm (20°C)	Spezific volume resistivty Ohm · cm 20°C	Dielectric constant 50 Hz/20°C	Dielectric loss-factor tan δ	Working temperature permanent °C	Working temperature short time °C	Melt-temperrature +°C	Flame-resistance	Oxygen index LOI (% O_2)	Heating value H_0 MU · kg^{-1}
Thermoplastic	Y	PVC	Polyvinylchloride compounds	1,35–1,5	25	10^{13}–10^{15}	3,6–6	4×10^{-2} to 1×10^{-1}	– 30 + 70	+100	>140	self-extinguishing	23–42	17–25
	Yw	PVC	Heat-resistant 90°C	1,3–1,5	25	10^{12}–10^{15}	4–6,5		– 20 + 90	+120	>140			16–22
	Yw	PVC	Heat-resistant 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 resistant	1,2–1,4	25	10^{12}–10^{15}	4,5 –6,5		– 40 + 70	+100	>140			17–24
	2Y	LDPE	Low density Polyethylene	0,92–0,94	70	10^{17}	2,3	2×10^{-4}	– 50 + 70	+100	105–110	flammable	≦22	42-44
	2Y	HDPE	High density Polyethylene	0,94–0,98	85	10^{17}	2,3	3×10^{-4}	– 50 +100	+120	130			
	2X	VPE	Cross-linked Polyethylene	0,92	50	10^{12}–10^{16}	4–6	2×10^{-3}	– 35 + 90	+100	–			
	O2Y		Foamed Polyethylene	~0,65	30	10^{17}	~1,55	5×10^{-4}	– 40 + 70	+100	105		18–30	
	3Y	PS	Polystrole	1,05	30	10^{16}	2,5	1×10^{-4}	– 50 + 80	+100	>120		≦22	40–43
	4Y	PA	Polyamide	1,02 –1,1	30	10^{15}	4	2×10^{-2} bis 1×10^{-3}	– 60 +105	+125	210		≦22	27–31
	9Y	PP	Polypropylene	0,91	75	10^{16}	2,3 –2,4	4×10^{-4}	– 10 +140	+140	160			42–44
	11Y	PUR	Polyurethane	1,15 –1,2	20	10^{10} –10^{12}	4–7	$2,3 \times 10^{-2}$	– 55 + 80	+100	150		20–26	20–26
	TPE-E (12Y)		Polyester Elastomer	1,2 –1,4	40	$>10^{10}$	3,7 –5,1	$1,8 \times 10^{-2}$	– 50 +100	+140	190		≦29	20–25
	TPE-O		Polyolefine Elastomer	0,89–1,0	30	$>10^{14}$	2,7–3,6			+130	150		≦25	23–28
Elastomere	G	NR SBR	Natural rubber Styrol-butadiene-rubber-compounds	1,5–1,7	20	10^{12}–10^{15}	3–5	$1,9 \times 10^{-2}$	– 65 + 60	+120	–	flammable	≦22	21–25
	2G	SiR	Silicone rubber	1,2 –1,3	20	10^{15}	3–4	6×10^{-3}	– 60 +180	+260	–	high flash point	25–35	17–19
	3G	EPR	Ethylen-propylene rubber-compounds	1,3–1,55	20	10^{14}	3–3,8	$3,4 \times 10^{-3}$	– 30 + 90	+160	–	flammable	≦22	21–25
	4G	EVA	Ethylen-vinylacetat copolymer-compunds	1,3–1,5	30	10^{12}	5–6,5	2×10^{-2}	– 30 +125	+200	–			19–23
	5G	CR	Polychloroprene compounds	1,4–1,65	20	10^{10}	6–8,5	5×10^{-2}	– 40 +100	+140	–	self-extinguishing	30–35	14–19
	6G	CSM	Chlorsulfonated Polyethylene compunds	1,3–1,6	25	10^{12}	6–9	$2,8 \times 10^{-2}$	– 30 + 80	+140	+160			19–23
High temp. materials	10Y	PVDF	Polyvinylidene fluoride Kynar/Dyflor	1,7–1,9	25	10^{14}	9–7	$1,4 \times 10^{-2}$	– 40 +135	+160	>170	self-extinguishing	40–45	15
	7Y	ETFE	Ethylene-Tetrafluor ethylene	1,6–1,8	36	10^{16}	2,6	8×10^{-4}	–100 +150	+180	>265	self-extinguishing	30–35	14
	6Y	FEP	Fluorine ethylene propylene	2,0–2,3	25	10^{18}	2,1	3×10^{-4}	–100 +205	+230	>225	self-extinguishing	>95	5
	5YX	PFA	Perfluoralkoxypolimeric	2,0–2,3	25	10^{18}	2,1	3×10^{-4}	–190 +260	+280	>290	self-extinguishing	>95	5
	5Y	PTFE	Polytetrafluorethylene	2,0–2,3	20	10^{18}	2,1	3×10^{-4}	–190 +260	+300	>325	self-extinguishing	>95	5
halogen-free compouns	H	not cross-linked	halogen-free polymer-compounds	1,4–1,6	25	10^{12}–10^{14}	3,4–5	~10^{-3}	– 30 + 70	+100	>130	self-extinguishing	≦40	17-22
	HX	cross-linked	halogen-free polymer-compounds	1,4–1,6	25	10^{13}–10^{14}	3,4–5	10^{-2}–10^{-3}	– 30 + 90	+150	–	self-extinguishing	≦40	16–25

* The characteristics valid for unprocessed material

Characteristics* of insulating and sheath materials

Thermic			Mechanical					Halogen	Weather		Designation			
Thermal-conductivity $W \cdot K^{-1} \cdot m^{-1}$	Corrosive gases in case of fire	Radiation-resistance-max Mrad	tensile strength N/mm^2	Elongation at break %	Shore-hardness	Corrosion behaviour	Abrasion resistance	halogen-free	Weather resistance	Cold resistance	VDE-Initial-code	Abbreviations	Material	
0,17	Hydrogen chloride	80	10–25	130–350	70–95 (A)	medium	0,4	no	medium in black	moderate-good	Y	PVC	Polyvinylchloride-compounds	Thermoplastic
											Yw	PVC 90°C	Heat-resistant	
											Yw	PVC 105°C	Heat-resistant	
										very good	YK	PVC	Cold resistant	
0,3	no	100	10–20	400–600	43–50 (D)	medium	0,1	yes	good	good	2Y	LDPE	Low density Polyethylene	
0,4			20–30	500–1000	60–63 (D)	good					2Y	HDPE	High density Polyethylene	
0,3			12,5–20	300–400	40–45 (D)	medium			good		2X	VPE	Cross-linked Polyethylene	
0,25			8–12	350–450	–	–	–	conditional[1]	–		O2Y		Foamed Polyethylene	
0,25	no	80	55–65	300–400	35–50 (D)	good	0,4	yes	medium - good	moderate - good	3Y	PS	Polystrole	
0,23	no	10	50–60	50–170	–	very good	1,0–1,5		good	good	4Y	PA	Polyamide	
0,19			20–35	300	55–60 (D)	medium	0,1		moderate		9Y	PP	Polypropylene	
0,25	no	100 (500)	30–45	500–700	70–100 (A)	very good	1,5	yes[2]	very good	very good	11Y	PUR	Polyurethane	
0,5	no	10	30	>300	85 (A) 70 (D)	good	1,5	yes			TPE-E (12Y)		Polyester Elastomer	
1,5	no	10	20		55 (A) 70 (D)						TPE-O		Polyolefine Elastomer	
–	no	100	5–10	300–600	60–70 (A)	moderate	1,0	no	moderate	very good	G	NR SBR	Natural rubber Styrol-butadiene-rubber-compounds	Elastomere
0,22	no	50			40–80 (A)			yes	good		2G	SiR	Silicone rubber	
–	no	200		200–400	65–85 (A)				very good	good	3G	EPR	Ethylen-Propylene rubber-compounds	
–	no	100	8–12	250–350	70–80 (A)				good		4G	EVA	Ethylen-vinylacetat copolymer-compunds	
–	Hydrogen chloride	50	10–20	400–700	55–70 (A	medium		no	very good	moderate - good	5G	CR	Polychloroprene compounds	
–	Hydrogen chloride	50	10–20	350–600	60–70 (A)	medium	1,5	no	very good	moderate	6G	CSM	Chlorsulfonated Polyethylene compunds	
0,17	Hydro-fluoric	10	50–80	150	75–80 (D)	very good	0,01	no	very good	very good	10Y	PVDF	Polyvinylidene fluoride Kynar/Dyflor	High temp. materials
0,24	yes	10	40–50	150	70–75 (D)	very good	0,02		very good	very good	7Y	ETFE	Ethylene-Tetrafluor ethylene	
0,26	yes	1	15–25	250	55–60 (D)	very good	0,01		very good	very good	6Y	FEP	Fluorine ethylene propylene	
0,21	yes	0,1	25–30	250	55–60 (D)	very good	0,01		very good	very good	5YX	PFA	Perfluoralkoxypolimeric	
0,26	yes	0,1	80	50	55–60 (D)	very good	0,01		very good	very good	5Y	PTFE	Polytetrafluorethylene	
0,17	no	100	8–13	150–250	65–95 (A)	medium	0,2–1,5	yes	medium in black: good	average	H	not cross-linked	halogen-free polymer-compounds	halogen-free compouns
0,20	no	200	8–13	150–250		medium					HX	cross-linked	halogen-free polymer-compounds	

[1] The propellent may be e.g. Fluor-Chlor-Hydrcarbon

[2] depend on the type compound

International abbreviations

AFNOR	**A**ssociation **F**rançaise de **NOR**malisation (France)
ANSI	**A**merican **N**ational **S**tandards **I**nstitute (USA)
AS	**A**ustralian **S**tandard (Australia)
ASTM	**A**merican **S**tandard of **T**esting **M**aterials (USA)
BS	**B**ritish **S**tandard (Great Britain)
BSI	**B**ritish **S**tandard **I**nstitution (Great Britain)
BV	**B**ureau **V**eritas (France)
CATV	**C**ommunity **A**ntenna **T**elevision (International)
CEBEC	**C**omité **E**lectrotechnique **B**elge (Belgium)
CEE	International **C**ommission on Ruls for the Approval of **E**lectrical **E**quipment (International Commission)
CEI	**C**ommission **E**lectrotechnique **I**nternationale (International)
CEMP	**C**entre d'**E**tude des **M**atières **P**lastiques (France)
CEN	**C**omité **E**uropéen de **N**ormalisation **E**lectrotechniques
CENELEC	**C**omité **E**uropéen de **N**ormalisation **E**lectrotechniques
CNET	**C**entre **N**ational d'**E**tude de **T**élécommunication (France)
CNOMO	**C**omité de **N**ormalisation des **M**oyens de **P**roduction
CSA	**C**anadian **S**tandards **A**ssociation (Canada)
CSTB	**C**entre **S**cientifique et **T**echnique du **B**âtiment (France)
DEMKO	**D**anmarks **E**lektriske **M**aterielkontrol (Denmark)
DIN	**D**eutsches **I**nstitut für **N**ormung (Germany)
DKE	**D**eutsche **E**lektrotechnische **K**ommission im DIN und VDE (Germany)
EN	**E**uropean **S**tandards (Germany)
FAR	**F**ederal **A**ir **R**egulation (USA)
FTZ	**F**ernmeldetechnisches **Z**entralamt (Germany)
GOST	**USSR**-**S**tandards
HD	**H**armonisierungs-**D**okumente (International)
HN	**H**armonisation des **N**ormes (France)
IEC	**I**nternational **E**lectrotechnical **C**ommission (International)
IEE	**I**nstitution of **E**lectrical **E**ngineers (Great Britain)
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
ISDN	**I**ntegrated **S**ervices **D**igital **N**etwork (International)
ISO	**I**nternational **O**rganization for **S**tandardization (International)
KEMA	**K**euring van **E**lektrotechnische **M**aterialien (Netherlands)
LCIE	**L**aboratoire **C**entral des **I**ndustries **E**lectriques (France)
MIL	**M**ilitary **S**pecification (USA)
NEC	**N**ational **E**lectrical **C**ode (USA)
NEMA	**N**ational **E**lectrical **M**anufacturers **A**ssociation (USA)
NEMKO	**N**orges **E**lektriske **M**ateriellkontroll (Norway)
NEN	**N**ederlands **N**ormalisatie-Instituut (Netherlands)
NF	**N**ormes **F**rançaises (France)
NFC	**N**ormes **F**rançaises **C**lass C (France)
ÖVE	**Ö**sterreichischer **V**erband für **E**lektrotechnik (Austria)
SAE	**S**ociety of **A**utomotive **E**ngineers
SEK	**S**venska **E**lektriska **K**ommissionen (Sweden)
SEMKO	**S**venska **E**lektriska **M**aterielkontrollanstalten (Sweden)
SETI	Sähkötarkastuslatios (Finland)
SEV	**S**chweizerischer **E**lektrotechnischer **V**erein (Swizerland)
SNV	**S**chweizerischer **N**ormenverband (Swizerland)
TGL	**DDR**-**S**tandards: Technische Normen, Gütevorschriften und Lieferbedingungen (ehemalige GDR)
UL	**U**nderwriters **L**aboratories Inc. (USA)
UNI	**U**nificazione **N**azionale **I**taliana (Italy)
UTE	**U**nion **T**echnique de l'**E**lectricité (France)
VDE	**V**erein **D**eutscher **E**lektroingenieure (Germany)
VDEW	**V**ereinigung **D**eutscher **E**lektrizitätswerke e. V. (Germany)
ZVEH	**Z**entralverband der **D**eutschen **E**lektrohandwerke e. V. (Germany)
ZVEI	**Z**entralverband der **E**lektrotechnik- und Elektronik **I**ndustrie e. V. (Germany)

Definitions: Classes of Stress (Duty) in Flexible Cables and Insulated Wires

The application of a flexible cable in certain areas as, or in, operating materials as well as for certain combinations of external influences that can occur in these areas, is described by the collective term “stress” or “duty”. Suitable flexible cables and insulated wires are defined in the applicable equipment standards for the devices in question. On the basis of mechanical influences, as well the general expressions used, the term “stress” or “duty” is divided into the following categories.

Normal stress / Ordinary duty

– Normal stress is present when the cables are subject to low mechanical stresses in the areas of application, and the risk of mechanical damage is low, as is the case to be expected in the normal use of small to medium size equipment in domestic and commercial as well as in light industrial premises.
Such equipment includes amongst others, vacuum cleaners, toasters, washing machines, refrigerators.

Low stress / Light duty

– Low stress is then present when the risk of mechanical damage and mechanical stress is low in the areas of application, as is the case to be expected for normal use of lightweight hand-held devices and lightweight operating materials in domestic households.
Included in such equipment are radios, floor lamps, hairdryers, small desktop office equipment.

Very low stress / Extra light duty

– Very low stress is then present when the risk of mechanical damage and mechanical stress is very low and can be considered negligible, i.e. under those influences that are to be expected for lightweight appliances in households and offices; Cases of applications where the cables having a greater mechanical protection would restrict the freedom of movement by the appliance. Included in such types of appliances are electric clocks and electric shavers.

High stress / Heavy duty

– High stress is then present when the risk of mechanical damage or a mechanical stress is of medium severity appreciable, e.g. for normal use of equipment in moderately heavy branches of industry or agricultural workshops, and the temporary use of such at building sites.
Included in such equipment are, amongst others, moderately heavy portable machinery and motors at a building site or in agricultural workings, large hot-water boiling installations, hand-held lamps, hoists, and fixed installations in temporary buildings.

High stress (Heavy duty) in multi-core cables

– Applications as for high stress, though primarily for use in areas of manufacturing facilities including tool-making machinery, or mechanical handling equipment. The cables can be used inside or outside buildings for an ambient temperatures ranging from between –25°C and +50°C and the stabilised conductor temperatures do not exceed +60°C Examples are for connecting a control unit to a production machine, connections between a control unit and a machine, e.g. in hoists or cranes where the cable length does not normally exceed 10 m. Longer cable lengths are permissible for fixed inter-connections.

Application: Indoor and outdoor use

The terms are in conjunction with the limiting conditions, such as for example, minimum and maximum operating temperatures, or the influence of the ambient temperatures, understood as being limited by the design and intended usage. This context is defined by “the intended environment”.

Indoor use

– The cables are installed or connected to an apparatus device and can be used permanently in the building at all times, namely in “the intended environment”. The building can be used for commercial, industrial or residential purposes.

Outdoor use for a limited period

– The cables may be used outdoors as “the intended environment” for short periods of time, e.g. connected to electric lawnmowers or drills.

Permanent outdoor use

– The cables are designed to resist the various stresses that can occur outdoors in “the intended environment” (including weather conditions).

Safety Requirements in the Use of Cables and Insulated Wires

Fundamental requirements

The cables and insulated wires shall be of adequate safety for proper use in the intended manner such that these do not constitute any unacceptable risk to life or damage to property. The prevention of danger to persons and property during usage and storage of operating equipment means safety to include the detection of stress, risk and potential faults, as well as their rectification or a limitation to a minimum risk level.
Unless otherwise specified, cables and insulated wires should only be used for the conductance and distribution of electricity.

General requirements

The choice in the selection of cables and insulated wires should be such that the voltages and currents prevailing in the operating equipment, a system or device used shall meet all operating conditions to be expected.
The cables shall be constructed, installed, protected, used and maintained to prevent danger as far as its reasonably practical.

Limiting conditions

The limiting conditions in the DIN VDE and HD specifications shall be taken into account. An acceptable service life will be attained by compliance with the limiting conditions, depending on the circuit designed under defined conditions for use. The usable life of a permanently installed cable for power distribution is longer than that of a flexible cable.
The influence by all of the factors given in the following sections must be considered as an interrelationship and not on an individual basis.

Selection of cables and insulated wires

The choice in the selection of cables and insulated wires shall be made such that these are suitable for the operating conditions as well as for all other external influences and compliance with the respective protection class.

a) Operating conditions are, for example:
   – voltage
   – protective measures
   – grouping of cables
   – current
   – method of installation
   – accessibility

b) External influences are, for example:
   – ambient temperature
   – presence of rain, water vapour or the accumulation of water
   – presence of corrosive, contaminating or other chemical substances
   – mechanical stresses (such as holes or sharp edges from metal constructions for example)
   – animal world (such as rodents)
   – plant world (such as fungal growths)
   – irradiation (such as sunlight).

Note: The colour black provides a higher degree of protection than other colours.

Safety Requirements in the Use of Cables and Insulated Wires

Requirements for cables

– for permanent installation, and
– for flexible applications

Requirements for fixed installation

In the normal case, cables for permanent installation have solid single wire or stranded conductors. In certain circumstances, e.g. for greater ease of installation, the conductor may be Class 5 according to HD 383 or DIN VDE 0295.
Cables should not be in contact with, or close to, hot surfaces if the cables are not intended for such conditions.
Cables should not be buried directly in the earth and should be fastened by a suitable means while making allowance for the maximum spacing between fixing points.
The cable should not be damaged by any mechanical restraint used for its support . Cables which have been in use over longer periods of time may become damaged by movement. This can be caused by the natural effects of ageing on the physical properties of the materials used for the insulation sheath and jacket which can become brittle with time.

For flexible applications

Flexible cables are made up conductors consisting of multiplicity of small wires and are either stranded or bunched. These cables meet either Class 5 or Class 6 of HD 383 and DIN VDE 0295.
Flexible cables should be used for connections to mobile operating equipment. The length of the connecting cable must be chosen such that response by the short-circuit protecting device is assured.
The cable length should be as short as is needed for the practical application so as to reduce the risk of mechanical damage. In cases of applications where flexible PVC-sheathed cables are permissible, the use of spiral cables can be considered for shortening the effective length.
Flexible PVC-sheathed cables are not necessarily suitable for processing further to spiral cables. Multicore control cables shall be protected against permanent bending stress. Abrasion, notches and sharp bends are to be avoided.

Except for cables for connections to permanently installed operating equipment, flexible cables should not be permanently fixed (with the exception of heavy-duty cable designs for permanent installation in temporary facilities) unless these are contained in an enclosure affording mechanical protection. For a fixed installation, at least one cable should be used for “normal” stress.

Flexible cables should not be subjected to excessive straining from tensile forces, compression, twisting or kicking. This applies in particular at the point of entry into the device, and strain relief or the point of connection to the fixed wiring. These should not be damaged by any strain relief or clamping device at points to the permanent installation.

Flexible cables should not be placed under floorcoverings or carpets because there is the danger that this can cause thermal insulating effects, leading to increased temperatures, or that the weight of furniture from traffic can damage the cables.

Flexible cables should neither be in contact with, or close to, hot surfaces nor extend into the immediate vicinity of such, as they are not suitable for this purpose.

On account of their characteristics, this also applies in particular for PVC-sheathed and/or jacketed cables. The suitability of flexible cables for outdoor applications, either for short periods or continuous operation, is defined in the tables of the HD 516 and in DIN VDE Part 300.

Flexible PVC-sheathed cables are not suitable for permanent use in outdoor applications.
The types of structures for PVC-sheathed cables for short-term use in outdoor applications should not however be operated in conditions others than these, e.g. at temperatures lower than the specified temperature.

Safety Requirements in the Use of Cables and Insulated Wires

Cables without a jacket may neither be used as a substitute for a jacketed cable nor as an extension cable. These shall principally not be used for connecting Class 2 equipment unless the cable in the constructional standard has been defined as a cable for extra light duty and the equipment standard explicitly permits this cable type.

The corresponding VDE and HD regulations shall be observed for the cables used in deep mining operations, in quarrying as well as for moveable equipment, such as in cranes with spring-loaded reeling devices for example.

Voltage

The rated voltage for a cable is the reference voltage for which the cable is designed and which serves to define the electrical testing requirements.
The rated voltage is expressed as the ratio of two values, U_0 /U, whereby U_0 is the effective value (r.m.s.) of the voltage between any insulated conductor and the "earth" (metal covering of the cable or surrounding medium)
U is the effective value (r.m.s.) between any two phase conductors of a multicore cable or of a system of single core cables. In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage to the value U_0 and U. In direct current system, the rated voltage of the system shall not be higher than 1,5 times that of the nominal voltage of the cable.
Note: The operating voltage of a system may permanently exceed the rated voltage for the cable by 10 %.

Current carrying capacity

The nominal cross-section of each conductor should be selected such that the current carrying capacity is not less than the maximum continuous current that flows through the conductor under normal conditions of operation. The limiting temperature with respect to the current carrying capacity should not be exceeded for the cable insulation and sheath concerned.

Included in the defined conditions is also the method of installation for the cable used. The regulations for the permissible current rating shall be observed here for the current.
Correction factors may also be included in the values given for the load rating to allow for other conditions, such as for example:
1. cable grouping
2. type of overcurrent protection
3. ambient temperature
4. reeled / drummed cables
5. thermal insulation
6. frequency of the current (if other than 50 Hz)
7. effects of harmonic waves

Serious damage can be caused if cables are operated for longer periods of time above those limits given in the tables and can lead to early failure or considerable deterioration in the cable characteristics.

Thermal influences

Cables should be selected, located and installed so that the intended heat dissipation is not inhibited and they do not present a fire hazard to adjacent materials.

The limiting temperatures for the individual cables are given separately in our catalogue. Under no circumstances may these values be exceeded by an interaction of internal joulean heat (to the material of the cable, connections and terminals) by the ambient conditions.

Safety Requirements in the Use of Cables and Insulated Wires

Mechanical stress

Allowance shall be made for all possible mechanical stress that can arise during a normal installation process for laying cable in order to assess the risk of mechanical damage to cables.

Tension

The following values for tension should not be exceeded for each conductor in use. This applies up to a maximum value of 1000 N for the tensile stress of all conductors unless HELUKABEL® has approved limits deviating from this value.
50 N/mm^2 by permanent operation for fixed installation.
15 N/mm^2 for flexible cables under static tension for fixed installation that are used in current circuits.
It is recommended for those cases where the above values are exceeded, that a separate strain-relieving element or similar protection should be used. The connection of such a strain-relieving element to the cable shall be made such that the cable is not damaged.
If flexible cables are subjected to dynamic tensile stress (including those due to the mass inertia, e.g. for reeling drums), the permissible tension or the fatigue life should be agreed between the user and HELUKABEL®.
Notes for cables which are installed vertically, without any intermediate support, can be found in DIN VDE 0298 part 300 and HD 516 S2, item 5.4.1, and Table 6.

Bending stress

The internal bending radius of a cable should be chosen such that the cable is not damaged by this.
The internal bending radii are given in Table 6 of HD 516 S2 and DIN VDE 0298 part 300.
The choice of bending radii smaller than specified shall be concurred with HELUKABEL®.
Attention shall be given when stripping the insulation that the conductor is not damaged by this as the bending characteristics will otherwise seriously deteriorate.
The bending radii given apply for ambient temperatures of (20 ±10)°C. The recommendations from HELUKABEL® shall be enquired for ambient temperatures other than those given.
For flexible cables and cords, particularly at terminations and at the point of entry of moveable appliances, it may be necessary to use a device which ensures that the cable is not bent to an internal bending radius less than that specified in Table 6 of HD 516 S2 and DIN VDE 0298 part 300.

Bending too close to any internal and/or external anchorage shall be avoided.

Kink-protection sleeves or other devices shall not impede the movement of the cores within the cable.

Compression

Cables shall not be compressed to an extent that this will damage the cable.

Torsional stress

In general, flexible cables are not designed for torsional stress. In those cases where such torsional stress cannot be avoided, then the design of the cable and the installation arrangements should be agreed between user and HELUKABEL®.

Safety Requirements in the Use of Cables and Insulated Wires

Compatibility

The following points shall be considered in the selection and installation of cables:
– The avoidance of interference mechanical and electrical influences between adjacent circuits.
– Dissipation of heat from cables, or the chemical/physical influences from the materials used for the cables on bordering materials, such as for example, constructional and decorative materials, insulation tubes, supports, etc.
– Mutual interference by adjacent materials and the materials used for the cables. This applies for instance, for an absorption of plasticiser from PVC-sheathed cables by certain materials that are used for thermal insulation purposes, for strapping materials or for the equipment.

Dynamic stress

The possibility should be taken into consideration of damage to cables and fastenings for these, by the dynamic forces that can be caused by any current including short-circuit currents.

Storage/Handling/Transportation

Cables that are not intended for outdoor applications should be stored in dry indoor environments. A number of constructional types of flexible cables are particularly susceptible to moisture, such as screened cables for example.

The ends of the cables should be sealed for the application and the expected duration of outdoor storage in order to prevent the penetration of moisture. The temperatures given in the tables in HD 516 S2 for storage shall be taken into account.

If the temperature of the cable falls below recommended values, then all types of mechanical stresses, in particular vibrations, shock, impact, bending and torsional twist shall be avoided.

Glossary of Terms: Cables and Wires

A

Acceptance angle - The half-angle of the cone within which incident light is totally internally reflected by the fiber core. It is equal to arcsin (NA).

$$\ominus = \text{arc sin} \sqrt{n_1^2 - n_2^2}$$

Aerial cable - A cable suspended in the air on poles or other overhead structure.

Appliance Wire and Cable - A classification covering insulated wire and cable for internal wiring of appliances and equipment.

Armoured Cable - A cable provided with a wrapping of metal for mechanical protection.

ASA - Abbreviation for American Standards Association. Former name of ANSI.

ASME - Abbreviation for American Society of Mechanical Engineers.

ASTM - Abbreviation for the American Society for Testing and Materials.

ATM (Asynchronous Transfer Mode) - A new emerging data standard that uses many of the same data rates as Fiber Channel and SONET.

Attenuation - The power drop or signal loss in a circuit, expressed in decibels (db). Generally attenuation increases (signal level decreases) with both frequency and cable length.

AWG - Abbreviation for American Wire Gauge. A standard measurement of the size of a conductor.

AWM - Designation for Appliance Wiring Material.

B

Bit - A binary digit, smallest element of information in binary system.

Bit (Binary Digit) - A basic unit for the datas of a digital transmitting system. A group of 8 Bit is usually expressed as one Byte.

Bit rate - The number of bits of data transmitted over a phone line per second.

B & S Gauge - Standard for Brown & Sharpe Gauge. The wire diameter standard is same as AWG.

Breakdown Voltage - The voltage at which the insulation between two conductors will break down. Performed as a type test in the laboratory.

British Standard Wire Gauge - A modification of the Birmingham Wire Gauge and the legal standard of Great Britain for all wires. It is variously known as Standard Wire Gauge (SWG), New British Standard (NBS), English Legal Standard, and Imperial Wire Guide.

Building Wire - Insulated wires used in building for light and power, 600 volts or less, usually not exposed to outdoor environment.

Buffer - A protective coating over an optical fibre. A soft material extruded tightly over the fibre coating, mechanically isolates individual fibres.

BUS - A network which functions like a signal line and is shared by a number of nodes.

C

Cable - Multicore stranded insulated wires under protective sheath to conduct electrical energy e.g. power cable, telecommunication cable, installation cable, data cable etc.

Cable Core - The portion of an insulated cable lying under the protective covering.

Cable Sheath - A protecting covering over the cable core to prevent outer damages.

Capacitance (Capacity) - That property of a system of conductors and a dielectric which permits the storage of electricity when potential difference exists between the conductors. A capacitance value is always positive.

Capacitive Coupling - Electrical interaction between two conductors caused by the capacitance between them.

CATV - Acronym for Community Antenna Television.

CEBEC - Belgium approval agency; Comite Electrotechnique Belge Service de la Marque.

CEE - European standards agency; International Commission on Rules for the Approval of Electrical Equipment.

Cellular insulation - Insulating material in foamed or sponge form with the cells closed or interconnected.

CENELEC - European standards agency; European Committee for Electrotechnical Norms.

Chromatic dispersion - The speed of an optical pulse travelling in a fiber changes if its wavelength changes. Chromatic dispersion can be measured by the measurement of travel time at different wavelength.

Circuit - The entire route of an electrical current. A complete path over which electrons can flow from the negative terminals of a voltage source through parts and wires to the positive terminals of the same voltage source.

Glossary of Terms: Cables and Wires

C

Circuit Sizes - A popular term for building wire sizes 14 through 10 AWG.

Circular Mil (CM) - Used to define cross-sectional areas of conductors. Area of a circle 1/1000 inches in a diameter. 1 mil (0,001 inch) is equal to square mil x 0,78540.

Cladding - A low-refractive index, glass or plastic that surrounds the core of a fiber. Optical cladding promotes total internal reflection for the propagation of light in a fiber.

Coaxial Cable - A cable consisting of two cylindrical conductors with a common axis, separated by a dielectric. The outer conductor or shield is commonly used to prevent external radiation from affecting the current flowing in the inner conductor.

Coherent waves - The phenomenon related to the existence of a correlation between the phases of the corresponding components of two waves or between the values of the phase of a given component of one wave at two instants in time or two points in space.

Colour Code - A system of identifying different insulated cores by means of colours, numbers, printing etc.

Concentric lay - Cable core composed of a central core surrounded by one or more layers of helically laid insulated wires or cores.

Conductor - A material capable of easily carrying an electrical conductivity. A wire or combination of wires not insulated from one another, suitable for carrying electric current.

Control Cable - A multi-conductor cable made for operation in control of signal circuits.

Copolymer - A compound resulting from the polymerization of two different monomers.

Copperweld - Copper covered steel wire. Copper and steel welded together. The trade name of Flexo Wire Division (Copperweld Steel Corp.) for their copper-clad steel conductors.

Cord - A small, flexible insulated cable.

Cord Set - Portable cords fitted with a wiring device at one or both ends. Cord is a small flexible insulated conductor or group of conductors, normally not larger than AWG 10 - up to 4 cores.

Core - In cables, a component or assembly of components over which other materials are applied, such as additional components, shield, sheath, or armour.

Corona - A discharge due to ionization of air around a conductor with a potential gradient exceeding a certain critical value. A high voltage electrical discharge that attacks insulation.

Crimp - Act of compressing a connector barrel around a cable in order to make an electrical connection.

Cross-linked - Setting up the chemical links between the molecular chains. A form of polyethylen material whose moleculars are more closely linked to produce a greater balance of physical and electrical properties. (XLPE - compound)

Crosstalk - Interference caused by audio frequencies. Undesired electrical currents in conductors caused by electromagnetic or electrostatic coupling from other conductors or from external sources. Also, leakage of optical power from one optical conductor to another.

CSA - Abbreviation for Canadian Standards Association, a non-profit independent organization which operates a listing service for electrical and electronic materials and equipment. The Canadian counterpart of the Underwriter's Laboratories.

Current - Flow of electricity measured in amperes. Practical unit is the ampere which represents the transfer of one coulomb per second.

Current rating - The maximum continuous electrical flow of current recommended by a given wire in a given situation, expressed in amperes.

Cut off wavelength - For a singlemode fiber, the wavelength above which the fiber exhibits singlemode operation.

D

dB - see decibel

D. C. - Abbreviation for direct current (D – C), Electricity that flows in one direction only.

Decibel (dB) - One-tenth of a bel. Unit to express differences of power level. Example: The decibel is 10 times the common logarithm of the power ratio. It is used to express power gain in amplifiers or power loss in passive circuits or cables.

DEMKO - Approval agency of Denmark. Denmarks Elektriske Material Kontrol.

Dielectric Breakdown - The voltage required to cause an electrical failure or breakthrough of the insulation.

Glossary of Terms: Cables and Wires

Dielectric Strength - The maximum voltage insulation can withstand without rapture. Usually expressed as a voltage gradient, e. g. volts per mil.

Dispersion - A general term for those phenomena that cause a broadening or spreading of light as it propagates through an optical fiber. The three types are modal, material, and waveguide

Drain Wire - An uninsulated wire used as an earth connection. This is generally laid over the component or under the screening, braiding etc.

Duct - An underground or overhead tube or conduit for carrying electrical cables.

E

EIA - Abbreviation for Electronic Industries Association.

Elastomer - Any material that will return to its original size after stretching. Elastomer is a rubber or rubber-like material which will stretch repeatedly to 200 percent or more and return rapidly with force to its approximate original shape.

Electromagnetic Coupling - Energy transfer by means of a varying magnetic field.

Electromagnetic Induction - The production of a voltage in a coil due to a change in the number of magnetic lines of force (flux linkages) passing through the coil.

Elongation - The fractional increase in the length of a material stressed in tension.

EMC - Electromagnetic Compatibility (EMV).

EMF - Abbreviation for Electro Motive Force – force determinating flow of electricity (voltage).

EMI - Any electrical or electromagnetic interference that causes undesirable response, degradation, or failure in electronic equipment. Optical fibers neither emit or receive EMI.

EMV - Designation for electromagnetic compatibility (EMC).

EPR - Ethylene-propylene copolymer rubber. The copolymer is chemically cross-linked.

ETFE - Ethylene tetrafluoroethylene

F

FDDI - Fiber Distributed Data Interface. Very high speed Computer Network working with fiber optics.

FEP - Fluorinated ethylene propylene

Ferrule - A component of a connector that holds fiber in place and aids in its alignment, usually cylindrical in shape with a hole through the center.

Filled Cable - A telephone cable construction in which the cable core is filled with a material that will prevent moisture from entering or passing through the cable.

Fine Stranded Wire - Stranded wire with component strands of 36 AWG or smaller.

Flame Resistance - The ability of a material not to propagate flame once the heat source is removed.

Flammability - The measure of the material's ability to support combustion.

Flat Cable - A cable in flat form, where the cores lying parallel longitudinally but essentially with flat surfaces.

Foamed Plastics - Insulations having a cellular structure.

Foils - A thin supporting film of continuous sheet such as plastic foil, metal foil, laminated foil etc. for static shielding, contacts and other electrical applications.

FR-1 - A flammability rating established by Underwriters Laboratories for wires and cables that pass a specially designed vertical flame test. This designation has been replaced by VW-1.

FRNC - Flame Retardant Non Corrosive

G

Gauge - A term used to denote the physical size of a wire.

Graded-index fiber - An optical fiber whose core has a nonuniform index of refraction. The core is composed of concentric rings of glass whose refractive indices decrease from the center axis. The purpose is to reduce modal dispersion and thereby increase fiber bandwidth.

Ground Conductor - An electrical conductor for the connection to the earth, making a complete electrical circuit.

H

Helix - A continuous spiral winding.

Henry - The unit of inductance (H).

Hertz (Hz) - A unit of measurements of the frequency equal to one cycle per second.

High Temperature Wire and Cable - Electrical wire and cables having thermal operating characteristics of 150°C and higher.

Glossary of Terms: Cables and Wires

Hi-Pot - A test designed to determine the highest voltage that can be applied to a conductor without electrically breaking down the insulation.

High Voltage - Generally, a wire or cable with an operating voltage of 600 volts and above.

Hook-up Wire - Single conductor used to hook-up electrical parts of instruments for low current and voltage (under 1000 volts).

Hybrid Cable - Multi-conductor cable containing two or more types of components.

Hypalon - Du Pont's trade name for their chlorosulfonated polyethylene, an ozone resistant synthetic rubber (90°C).

Hz - Abbreviation for Hertz.

I

ICEA - Abbreviation for Insulated Cable Engineers Association.

IEC - European Standardization agency; International Electrotechnical Commission.

IEEE - Abbreviation for Institute of Electrical and Electronics Engineers.

Impedance - Resistance to flow of an alternating current at a particular frequency, expressed in ohms. It is a combination of resistance R and reactance X, measured in ohms.

Index profile - A graded-index optical fiber, the refractive index as a function of radius.

Induction - An influence exerted by a charged body or by a magnetic field on adjacent bodies without apparent communication.

Inductive Coupling - Crosstalk resulting from the action of the electromagnetic field of one conductor on the other.

Insulation - A non-conducting substance, named as dielectric, surrounding the conductor.

Interface - The two surfaces on the contact side of both halves of a multiple-contact connector which face each other when the connector is assembled. Common interconnection point for devices, e.g. RS232 Interface: Mouse-Personalcomputer.

ISDN - Integrated Services Digital Network. A standard protocol for digital telecommunications transmissions.

J

Jacket - An overall covering of a cable, called also sheath – which protects against the environment and stress.

Jumper - A short length of conductor used to make a temporary connection between terminals, around a break in a circuit, or around an instrument.

K

KEMA KEUR - Approval agency of Netherlands. Keuring van Elektrotechnische Materialien.

KV - Abbreviation for kilovolt = 1000 volts.

KVA - Abbreviation for kilovolt ampere = 1000 volts x amperes.

KW - Abbreviation for kilowatt = 1000 watt.

Kynar - Fluorocarbon insulation rated -65°C to +135°C, typically used as insulation for wire wrapwire. A Pennwalt trade name for polyvinylidene floride.

L

Laser - Light Amplification by Stimulated Emission of Radiation. An electro-optic device that produces coherent light with a narrow range of wavelengths, typically centered around 780 nm, 1310 nm, or 1550 nm.

Laminated Tape - A tape consisting of two or more layers of different materials bonded together.

LAN = Local Area Network - A network located in a localised area e.g. in an office, building, complex buildings whose communication technology provides a high-bandwidth, low-cost medium to which many nodes can be connected.

LED - Light Emitting Diode.

LOCA - Abbreviation for Loss of Coolant Accident, a system malfunction associated with nuclear generating stations.

Loop Resistance - The total resistance of two conductors in a closed circuit, measured round trip from one end.

Loss Factor - The loss factor of an insulating material is equal to the product of its dissipation and dielectric constant.

M

MCM - Cross-section of greater AWG-sizes. 1 MCM= 1000 circular mils = 0,5067 mm^2.

Meg or Mega -
Prefix meaning 1 million = 1.000000 = 10^6.

Glossary of Terms: Cables and Wires

M

Megarad - A unit for measuring radiation dosage. 1 megarad = one million rads = 10^6 rad or 10^6 cJ/kg.

Mho - The unit of conductivity. The reciprocal of an ohm.

MHz - One million cycles per second = megahertz = 10^6 Hz.

Modem - Abbreviation for Modulator/Demodulator. Device which allows to transmit electrical data via analogues transmission paths with limited bandwidth, e. g. Computer data via telephone lines.

MTW - An acronym for thermoplastic insulated Machine Tool Wire.

Multi-conductor - A combination of two or more conductors in a cable under jacket.

Multimode-Fiber - A type of optical fiber that supports more than one propagation mode.

Mutal Capacitance - Capacitance between two conductors when all other conductors are connected together to shield and ground.

Mylar - Du Pont trademark for polyester material.

N

National Electric Code Article 725 - The NEC Article which covers remote control, signal and communication power limited circuits that are not an integral part of the device or appliance.

National Electric Code Article 760 - The NEC Article which covers the fire and burglar alarms installation of wire and equipment operating at 600 Volts or less.

National Electric Code (NEC) - A set of regulations governing construction and installation of electrical wiring and apparatus in the United States, established by the American National Board of Fire Underwriters.

NEMA - National Electrical Manufacturers Association.

NEMKO - Approval agency of Norway. Norges Elektriske Materiellkontroll.

Neoprene - A synthetic rubber of thermosetting material with good resistance to oil, chemical, and flame, known as polychloroprene - mostly used as jacketing.

Neper - An electrical unit similar to decibel, used to express the ratio between two amount of power existing at two distinct points. 1 Neper = 8,686 decibels.

NFPA - Abbreviation for National Fire Protection Association. Administrative Sponsor of the National Electric Code (ANSI Standards Committee CI).

Numerical Aperture NA - The "light-gathering ability" of a fiber, defining the maximum angle to the fiber axis at which light will be accepted and propagated through the fiber. NA = sin ø, where ø is the acceptance angle.

$$NA = \sin \ominus\text{-max} = \sqrt{n_1^2 - n_2^2}$$

Nylon - A group of polyamide polymers, used for wire and cable jacketings with good chemical and abrasion resistance.

O

Ohm - The electrical unit of resistance. The value of resistance through which a potential difference of one volt will maintain a current of one ampere.

Optical Fiber - Any filament or fiber, made of dielectric materials, that guides light, whether or not it is used to transmit signals. Synonym: optical waveguide.

OSHA - Abbreviation for Occupational Safety and Health Act. Specifically the Williams-Steiger law passed in 1970 covering all factors relating to safety in places of employment.

OVE - Approval agency of Austria.

Overlap - A certain portion of a foil or band which laps over the leading edge of a helical or longitudinally wrapping tape.

Ozone - A faintly blue gasious, reactive form of oxygen, obtained by the silent discharge of electricity in ordinary oxygen or in air.

Ozone Index - Percentage of oxygen necessary to support combustion in gas mixture.

P

Pair - 2 insulated wires twisted together in a certain lay-length to built a single circuit of transmission line.

Patch Cable - A cable with plugs or terminals on each end of the conductors to temporarily connect circuits of equipment together. In the IBM Cabling System, a length of Type 6 cable with data connectors on both ends.

Patch Cord - A flexible piece of electrical cord terminated at both ends with plugs, used for interconnecting circuits on a pasteboard.

Patch Panel - Distribution area to rearrange fiber connections and circuits.

Glossary of Terms: Cables and Wires

pH - The measure of acidity or alkalinity of a substance. PH values are described from 0 to 14. Value 7 indicate the neutrality. Numbers below 7 result increasing acidity and number greater than 7 increasing alkalinity.

Pick - Distance between two adjacent crossover points of braiding wires or filaments, measured in picks per inch.

Pigtail - A short length of optical fiber, permanently fixed to a component, used to couple power between the component and a transmission fiber.

Plenum - The air return way of a central air handling system, either ductwork or open space over a dropped ceiling.

Plenum Cable - Cable approved by Underwriters Laboratories for installation in plenums without the need for conduit.

Plug - The part of the two mating halves of a connector which is movable when not fastened to the other mating half.

Polychloroprene - Chemical name of neoprene. A rubber-like compound for jacketing and also for insulating where cables are subject to rough usage, oils, moisture, solvents, greases and chemicals.

Polyester (PETP) - A resin formed by the reaction between a dibasic acid and a dithydroxy alcohol. Polyethylene terephthalate, used extensively as a moisture resistant cable core wrap.

Polyethylene (PE) - This material is basically pure hydrocarbon resins with excellent dielectric properties, i. e. low dielectric constant, low dielectric loss across the frequency spectrum, mechanically rugged and resists abrasion and cold flow. The insulating materials derived from polymerization of ethylene gas.

Polyerm - A material of high molecular weight formed by polymerization of lower molecular weight molecules.

Polyolefin - A group of thermoplastics based upon the unsaturated hydrocarbons, known as olefins. When combined with butylene or styrene polymers, the form compounds such as polyethylene and polypropylene.

Polypropylene (PP) - A thermoplastic similar to polyethylene but stiffer and having higher softening point (temperature); excellent electrical properties.

Polyurethane (PUR) - Class of polymers known for good abrasion and solvent resistance. A copolymer of urethane is similar in properties to neoprene, usually used as a coldcuring moulding compound.

Polyvinyl Chloride (PVC) - This is a group of thermoplastic compounds composed of polymers of polyvinyl chloride or its polymer, vinylacetate, in combination with certain stabilizers, fillers, plasticizers, pigments etc., widely used for wire and cable insulations and several jackets.

Power Cables - Cables of several sizes, construction, and insulation, single or multi-conductor, designed to distribute primary power to various types of equipment, such as cables ≧ 0,6/1 kV.

Power Factor - The ratio between the true power in watts and the apparent power in volts – amperes.

Primary Coating - The plastic coating applied directly to the cladding surface of the fiber during manufacture to preserve the integrity of the surface.

Printed Wiring - A printed circuit intended to provide point-to-point electrical connections.

Propagation - Delay time required for an electrical wave to travel between two points on a transmission line.

R

Rayleigh Scattering - The scattering of light that results of from small inhomogeneities in material density or composition.

Reel - A revolvable flanged device made of wood or metal, used for winding of wires or cables.

Refractive index - The ratio of the velocity of light in a vacuum to its velocity in the medium. Synonym: Index of Refraction.

Resistance - Property of an electric circuit which determines for a given current the rate at which electric energy is converted into a heat and has a value, is measured in ohms.

RG/U - Abbreviation for Radio Government, Universal. RG is the military designation for coaxial cable in Mil-C-17. R = Radio, G = Guide, U = Utility.

Ribbon Cable - A flat cable consisting of two or more insulated conductors laid parallel in one plane and held together by means of adhesive or woven textile yarns.

RMS (Root Mean Square) - The effektive value of an alternating current or voltage.

Rubber (Wire Insulation) - Term used to describe wire insulations made of thermosetting elastomers, occur naturally or may be made synthetically.

Glossary of Terms: Cables and Wires

S

S - Rubber insulated heavy duty flexible cable, stranded copper wires with separator. Two or more colour coded, stranding with filler, wrapped with separator, rubber jacket. 600 V.

Semi-Rigid - A cable containing a flexible inner core and a relatively inflexible sheathing.

Semi-Rigid PVC - A hard semi-flexible polyvinylchloride compound with low plasticizer content, (shore A ≧97), for Termi-Point – connecting technique.

Semi-Solid - An insulation cross-section having a partially open space between the conductor and the insulation perimeter.

SEMKO - Approval agency of Sweden.

Separator - A layer of insulating material which is placed between a conductor and its dielectric, between a cable jacket and the component it covers, or between various components of a multiple-conductor cable.

Silicone - A thermosetting elastomer with excellent heat-resistant. Polymeric materials in which the recuring chemical groups contain silicon and oxygen atoms at links in the main chain.

Simplex - Transmission only in one direction.

Singlemode-Fiber - A small-core optical fiber that supports only one mode of light propagation above the cutoff wavelength. Typical diameter is 9 – 10 mm, the dispersion very low. Singlemode fibers are proper for long distance transmissions.

SJ - Junior hard service, rubber-insulated pendant or portable cord. Same construction as type S, but 300 V. Jacket thickness different.

SJO - Same as SJ, but neoprene, oil resistant compound outer jacket. Can also be made „waterresistant" 300 V, 60°C.

SJT - Junior hard service thermoplastic or rubberinsulated conductors with overall thermoplastic jacket. 300 V, 60°C to 105°C.

SJTO - Same as SJT but oil resistant thermoplastic outer jacket. 60°C.

SO - Hard service cord, same construction as type S except oil resistant neoprene jacket. 600 V, 60°C to 90°C.

Solid Conductor - A conductor consisting of a single wire.

SONET - Synchronous Optical Network.

SP-1 - All rubber, parallel-jacketed, two-conductor light duty cord for pendant or portable use in damp locations. 300 V.

SP-2 - Same as SP-1, but heavier construction, with or without third conductor for grounding purposes. 300 V.

SP-3 - Same as SP-2, but heavier construction for refrigerators or room air conditioners. 300 V.

SPT-1 - Same as SP-1, except all-thermoplastic. 300 V. With or without third conductor for grounding.

SPT-2 - Same as SP-2, except all-thermoplastic. 300 V. With or without third conductor for grounding.

SPT-3 - Same as SP-3, except all-thermoplastic. 300 V. With or without third conductor for grounding.

Spark Test - A test designed to locate pinholes in an insulated wire by application of an electrical potential across the material for a very short period of time while the wire is drawn through an electrode field.

Splice - An interconnection method for joining the ends of two optical fibers in a permanent or semipermanent fashion. Maybe thermally fused or mechanically applied.

ST - Hard service cord, jacketed, same as type S, except all-plastic design. 600 V, 60°C to 105°C.

Step index Fiber - An optical fiber, either multi-mode or singlemode, in which the core refractive index is uniform throughout so that a sharp step in refractive index occurs at the core-to-cladding interface.

STO - Same as ST but with oil resistant thermoplastic outer jacket. 600 V, 60°C.

SV - Vacuum cleaner cord, two or three-conductor, rubber-insulated. Overall rubber jacket. For light duty in damp locations. 300 V, 60°C.

SVO - Same as SV except neoprene jacket. 300 V, 60°C.

SVT - Same as SV except all-plastic, construction. With or without third conductor for grounding purposes only. 300 V, 60°C to 90°C.

T

Tape Wrap - A spirally applied tape over an insulated or uninsulated wire.

Tear Strength - The force required to initiate or continue a tear in a material under specified conditions.

Temperature Rating - The maximum temperature at which an insulating material may be used in continuous operation without loss of its basic properties.

Glossary of Terms: Cables and Wires

TEW - Canadian Standard Association type appliance wires. Solid or stranded single conductor, plastic-insulated. 600 V, 105°C.

TF - Fixture wire, thermoplastic-covered solid or 7 strands. 60°C.

TFE - Tetrafluoroethylene.

TFF - Same as TF but flexible stranding. 60°C.

THHN - 90°C, 600 V nylon jacketed building wire.

Thermocouple Lead Wire - An insulated pair of wires used from the couple to a junction box.

Thermoplastic - A material which softens when heated and becomes firm on cooling.

THW - Thermoplastic vinyl insulated building wire. Flame-retardant, moisture and heat-resistant 75°C. Dry and wet locations.

THWN - Same as THW but with nylon jacket overall. 75°C.

Transmission - Transfer of electric energy from one location to another through conductors or by radiation or induction fields.

Tray Cable - A factory-assembled multi-conductor or multipair control cable approved under the National Electrical Code for installation in cable trays.

Triaxial Cable - A three-conductor cable constructed in three coincident axes, of which one conductor in the centre, second circular conductor concentric with the first and the third circular conductor insulated from the concentric with the first and second, usually with insulation, a braiding and a outer jacket.

TW - Thermoplastic vinyl-jacketed building wire, moisture resistant 60°C.

Twisted Pairs - A cable composed of two small insulated conductors twisted together without a common covering.

U

UL - Abbreviation for Underwriter's Laboratories, Inc.

Ultraviolet - Optical radiation for which the wavelengths are shorter than those for visible radiation, that is approximately between 1 nm and 400 nm.

Unilay Stranding - A conductor constructed in bunch form having more than one layer in a concentric stranding with a common length and direction of lay and contains 19, 27, 37 and any number of strands.

V

VDE - West Germany approval agency.

Velocity of light - The velocity of light is 300.000 km/s in vacuum. In a medium it depends on the refractive index and the wavelength.

Velocity of Propagation - Ratio of speed of flow of electric current in an insulated cable to the speed of light. Usually expressed in percentage.

Volt - A unit of electromotive force.

Voltage - The term most often used in place of electromotive force, potential difference, or voltage drop to designate the electric pressure that exists between two points and is capable of producing a current when a closed circuit is connected between two points.

Voltage Drop - The amount of voltage loss from original input to point of electrical device.

Voltage Rating - The highest voltage that may be continuously applied to a wire in comformance with standards.

VW-1 - A flammability rating established by Underwriters Laboratories for wires and cables that pass a specially designed vertical flame test, (formerly designated FR-1).

W

Wall Thickness - The thickness of the applied insulation or jacket.

WAN - Wide Area Network. A network of connected computers that covers a great geographical area.

Water Absorption - A test to determine the water absorbed by a material after a given immersion period.

Wire - A conductor, either bare or insulated. A slender rod of metal usually referring to a single conductor, such as size 9 AWG and smaller.

Wire Gauge - A system of numerical designation of wire sizes.

X

XLPE - Cross-linked polyethylene.

Y

Yield Strength - The minimum stress at which a material will start to physically deform without further increase in load.

Z

Zytel - Du Pont's trade name for nylon resins.

International Certification Marks and Testing Institute

Country	Certification marks	Testing Institutes/ Registration Agency
Belgium		Comité Electrotechnique Belge Belgisch Elektrotechnisch Comité (CEBEC)
China		Chinesische Zwangsläufige Zertifikation (China Compulsory Certification)
Denmark		Danmarks Elektriske Materielkontrol (DEMKO)
Germany		VDE-Prüfstelle (Verband Deutscher Elektrotechniker e. V.)
Germany		VDE-Prüfstelle (Verband Deutscher Elektrotechniker e. V.)
Germany		Fraunhofer Institut, Produktionstechnik und Automatisierung
Europe		Communauté Européenne
Finland		FIMKO LTD
France		Union Technique de l'Electricité (UTE)
Great Britain		BSI British Standards Institution (Zeichenvergabestelle)
Italy		IMQ Instituto Italiano de Marchio Qualitá
Canada		Canadian Standards Association (CSA)
Netherlands		Naamloze Vennootschap tot Keuring van Electrotechnische Materialen (KEMA)
Norway		Norges Elektriske Materiellkontroll (NEMKO)
Austria		Österreichischer Verband für Elektrotechnik (Registration Agency)
Russia		GOST-R Certification (SGS)
Sweden		Svenska Elektriska Materielkontrollanstalten (SEMKO)
Switzerland		Schweizerischer Elektrotechnischer Verein (SEV)
USA		Underwriters Laboratories (UL)

Formulas of electrotechnic and electronic

Cross-section for **single wire round**

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

Cross-section for **bunched wire**

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

Diameter for
single wires cross-section

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

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

Conductor Resistance

$R = \frac{l}{\kappa \cdot q}$ oder $\frac{\rho \cdot l}{q}$

$R_{Schleife} = \frac{2 \cdot l}{\kappa \cdot q}$ oder $\frac{2 \cdot l\ p}{q}$

R = Electrical direct-current resistant (Ohm)
$R_{Schleife}$ = Resistance of a complete circuit
q = cross-section (mm^2 or q mm)
κ (Kappa) = Conductivity
ρ (Rho) = Specific resistance ($\rho = \frac{1}{\kappa}$)
l = Conductor length (m)

Materials	Conductivity $\frac{m}{\Omega \cdot mm^2}$	Spec. resistance $\frac{\Omega \cdot mm^2}{m}$
Copper	58,00	0,01724
Aluminium	33,00	0,0303
Silver	62,00	0,1613
Iron	7,70	0,1299
Constantan	2,00	0,50

Serial connection

Resistance: $R = R_1 + R_2 + R_3 + \ldots + R_n$

Capacitance: $\frac{1}{C} + \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots + \frac{1}{C_n}$

Inductance: $L = L_1 + L_2 + L_3 + \ldots + L_n$

Parallel connection

Resistance: $R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_n}$

Capacitance: $C = C_1 + C_2 + C_3 + \ldots C_n$

Inductance: $L = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots \frac{1}{L_n}$

Equivalent resistance of 2 parallel connected resistance

$R = \frac{R_1 \cdot R_2}{R_1 + R_2}$

Mutual capacity (C)

• coaxial cable $C = \frac{\xi r \cdot 10^3}{18 \cdot \ln \frac{Da}{d}}$ (nF/km)

• parallel core $C = \frac{\xi r \cdot 10^3}{36 \cdot \ln \frac{Da}{d}}$ (nF/km)

• shielded twisted pair

$C_B = \frac{\xi r \cdot 10^3}{36 \ln \frac{2a}{d} \cdot \frac{(Da^2 - a^2)}{(Da^2 - a^2)}}$ (nF/km)

Da = Outer diameter over insulation
Ds = diameter over shield
d = diameter of conductor
a = distance - mid to mid of both conductors
ξ = dielectric constant

Ohm's Law

The current intensity (I) is proportional to voltage (U) and inversely proportional to resistance (R)

$I = \frac{U}{R}$ $R = \frac{U}{I}$ $U = I \cdot R$

I = current intensity (Amps - A)
R = electrical resistance (Ω)
U = electrical voltage (V)

Conductance

$G = \frac{1}{R}$ $1S = \frac{1}{1\ \Omega}$ or $1\ \mu S = \frac{1}{1\ M\Omega}$

S (Siemens) = reziprocal value of a resistance is used as **conductance**
1 Siemens = 1/Ohm
G = electrical conductance

Capacitance

- Single core against earth

  $C_B = \frac{\xi r \cdot 10^3}{18\ \ln \frac{Di}{d}}$ (nF/km or pF/m)

- Unshielded symmetrical twisted pair

  $C_B = \frac{\xi r \cdot 10^3}{36\ \ln \frac{2a}{d}}$ (nF/km or pF/m)

- Coaxial pair

  $C_B = \frac{\xi r \cdot 10^3}{18\ \ln \frac{Di}{d}}$ (nF/km or pF/m)

- Shielded symmetrical twistet pair

  $C_B = \frac{\xi r \cdot 10^3}{36\ \ln \frac{2a}{d} \cdot \frac{(Da^2 - a^2)}{(Da^2 - a^2)}}$ (nF/km or pF/m)

Di = outer diameter over single core (mm)
Da = outer diameter of multicores (mm)
d = conductor diamete (mm)
a = distance between two conductors mid to mid of both conductors

Inductance of parallel cores

at low frequencies

$L = 0{,}4\ (\ln \frac{Da}{r} + 0{,}25)$ mH/km

at high frequencies

$L = 0{,}4\ (\ln \frac{Da}{r} + 0)$ mH/km

Inductance of coaxial cable

at high frequencies

$L = 0{,}2\ (\ln \frac{Da}{r} + 0)$ mH/km

Da = distance between two conductors mid to mid of both conductors
r = radius of a conductor
ξr = dielectric constant

Impedance (Z)

for coaxial cable $Z = \frac{60}{\sqrt{\xi r}} \cdot \ln \frac{D}{d}$ (Ω)

D = diameter over insulation
d = conductor diameter

for communication cable

at low frequencies $Z = \sqrt{\frac{R}{\omega C}}$ (Ω) $\cdot \tan \varphi = 1$, $\varphi = 45°$

at high frequencies $Z = \sqrt{\frac{L}{C}}$ (Ω)

R = Resistance (Ω/km)
L = Inductance (mH/km)
C = Capacitance (nF/km)
ω = $2 \pi f$

Wave length $\lambda = \frac{V}{f}$

λ = wave length
V = propagation velocity (velocity of light: 300 000 km/s)
f = frequency

units of attenuation - Neper (N), decibel (dB) and Bel (B)

1 Np = 8,686 dB
1 dB = 0,1151 Np = $\frac{1}{10}$Bel
1 Bel = 10 dB = 1,1513 Np

Formulas of power engineering

Cross section

- for direct current and single **phase** alternative current Einphasen-Wechselstrom of known current for three-phase current

$$q = \frac{2 \cdot I \cdot l}{\kappa \cdot u} \ (mm^2)$$

$$q = \frac{1{,}732 \cdot I \cdot \cos\varphi \cdot l}{\kappa \cdot u} \ (mm^2)$$

- for direct current and single **phase** alternative current of known power for three-phase current

$$q = \frac{2 \cdot l \cdot P}{\kappa \cdot u \cdot U} \ (mm^2)$$

$$q = \frac{1 \cdot P}{\kappa \cdot u \cdot U} \ (mm^2)$$

Voltage drop

For low voltage cable network of normal operation, it is advisable of a voltage drop of 3-5%.
On exceptional case, higher values (up to 7%) can be permitted in case of network-extension or in short-circuit.

- for direct **current** of known current

$$u = \frac{2 \cdot I \cdot l}{\kappa \cdot q} \ (v)$$

for single phase alternative current

$$u = \frac{2 \cdot I \cdot \cos\varphi \cdot l}{\kappa \cdot q} \ (v)$$

for three-phase current

$$u = \frac{1{,}732 \cdot I \cdot \cos\varphi \cdot l}{\kappa \cdot q} \ (v)$$

- for direct **current** of known power

$$u = \frac{2 \cdot l \cdot P}{\kappa \cdot q \cdot U} \ (v)$$

for single phase alternative current

$$u = \frac{2 \cdot l \cdot P}{\kappa \cdot q \cdot U} \ (v)$$

for three-phase current

$$u = \frac{1 \cdot P}{\kappa \cdot q \cdot U} \ (v)$$

u = voltage drop(V)
U = operating voltage (V)
P = power (W)
R_w = effective resistance (Ω)/km)
L = Inductance (mH/km)
ωL = induktiver Widerstand (Ω)/km) (ω = 2 · π · f at 50 Hz = 314)
q = cross-section (mm^2)
I = working current (A = Ampere)
l = length of the line in m
κ (Kappa) = electrical conductivity of conductors (m/Ω · mm^2)
κ-copper : 58
κ-Alu : 33

Nominal voltage

The nominal voltage is to be expressed with two values of alternative current U_0/U in V (Volt).
U_0 /U = phase-to-earth voltage
U_0 : Voltage between conductor and earth or metallic covering (shields, armouring, concentric conductor)
U : Voltage between two outer conductors
U_0 : $U/\sqrt{3}$ for three-phase current systems
U_0 : U/2 for single-phase and direct current systems
U_0/U_0 : an outer conductor is earth-connected for A. C.- and Nominal current

Active current

I in (A)

Reactive current

$I_w = I \cdot \cos\varphi$

Blindstrom

$I_0 = I \cdot \sin\varphi$

Apparent power (VA)

$S = U \cdot I$ for single phase current (A. C.)
$S = 1{,}732 \cdot U \cdot I$ for three-phase current

Active power (W)

$P = U \cdot I \cdot \cos\varphi$ for single phase current (A. C.)
$P = 1{,}732 \cdot U \cdot I \cdot \cos\varphi$ for three-phase current
$P = U \cdot I$ for direct current

Reactive power (var)

$Q = U \cdot I \cdot \sin\varphi$ for single phase current (A. C.)
$Q = 1{,}732 \cdot U \cdot I \cdot \sin\varphi$ for three-phase current
(Voltampere reactiv) $Q = P \cdot \tan\varphi$

Phase angle

φ is a phase angle between voltage and current

cos φ =	1,0	0,9	0,8	0,7	0,6	0,5
sin φ =	0	0,44	0,6	0,71	0,8	0,87

Insulation resistance

$$R_{iso} = \frac{S_{iso}}{l} \cdot \ln \frac{Da}{d} \cdot 10^{-8} \ (M\Omega \cdot km)$$

Specific insulation resistance

$$R_s = \frac{R \cdot 2\pi \cdot l \cdot 10^8}{\ln \frac{Da}{di}}$$

D_a = outer diameter over insulation (mm)
d = conductor diameter (mm)
di = inner diameter of insulation (mm)
l = length of the line (m)
S_{iso} = Spec. resistance of insulation materials (Ω · cm)

Mutual capacity (C_B) for single-core, three-core and H-cable)

$$C_B = \frac{\xi r \cdot 10^3}{18 \ln \frac{Da}{d}} \ (nF/km)$$

Inductance

Single-phase $0{,}4 \cdot (\ln \frac{Da}{r} + 0{,}25)$ mH/km

three-phase $0{,}2 \cdot (\ln \frac{Da}{r} + 0{,}25)$ mH/km

D_a = distance - mid to mid of both conductors
r = radius of conductor (mm)
ξr = dielectric constant
0,25 = factor for low frequency

Earth capacitance

$E_C = 0{,}6 \cdot C_B$

Charging current (only for three-phase current)

I_{Lad} = U · 2 π f · C_B · 10^{-6} A/km je Ader bei 50 Hz

Charging power

$P_{Lad} = I_{Lad} \cdot U$

Leakage and loss factor

G = tanδ · ω C (S)

$$\tan\delta = \frac{G}{\omega C}$$

ω = 2 π f
C = Capacity
tanδ = loss factor
S = Siemens = $\frac{1}{1\Omega}$

Dielectric loss

D_v = $U^2 \cdot 2\pi f \cdot C_B \cdot \tan \cdot 10^{-6}$ (W/km)
f on 50 Hz

tanδ PE/VPE cables	~0,0005
EPR	~0,005
Paper-single core, three-core, H-cable	~0,003
Oil-filled and pressure cable	~0,003
PVC-cable	~0,05

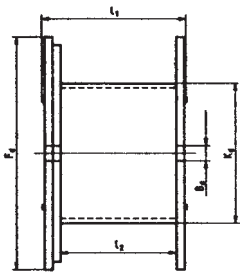
It should be noted that for the current load of the insulated cables and wires of selected cross-section, the power ratings table is also be considered.
To estimate the voltage drop of insulated wires and cables for heavy (big) cross-sections of single- and three-phase-overhead line, the active resistance as well as the inductive resistance must be considered.

The formula for single-phase (A. C.):
$U = 2 \cdot l \cdot I \cdot (R_w \cdot \cos\varphi + \omega L \cdot \sin\varphi) \cdot 10^{-3}$ (V)

Three-phase:

$U = 1{,}732 \cdot l \cdot I \cdot (R_w \cdot \cos\varphi + \omega L \cdot \sin\varphi) \cdot 10^{-3}$ (V)

Capacity of KTG-Pool drums



F_d = Flange-ø
K_d = Drum Barrel-ø
B_d = Bore-ø
l_1 = Width over all
l_2 = Width for windings

Wooden drums (standard)

Drum-code numbers	Drum-size	Flange Ø F_d	Drum-Barrel Ø K_d	Bore Ø B_d	Width over all l_1	Width for windings l_2	Load bearing capacity max.	Drum weight
		mm	mm	mm	mm	mm	kg	kg
051	05	500	150	56	470	410	100	8
061	06	630	315	56	415	315	250	17
071	07	710	355	80	520	400	250	25
081	08	800	400	80	520	400	400	31
091	09	900	450	80	690	560	750	47
101	10	1000	500	80	710	560	900	71
121	12	1250	630	80	890	670	1700	144
141	14	1400	710	80	890	670	2000	175
161	16/8	1600	800	80	1100	850	3000	280
181	18/10	1800	1000	100	1100	840	4000	380
201	20/12	2000	1250	100	1350	1045	5000	550
221	22/12	2240	1400	125	1450	1140	6000	710
250	25/14	2500	1400	125	1450	1140	7500	875
251	25/16	2500	1600	125	1450	1130	7500	900
281	28/18	2800	1800	140	1635	1280	10000	1175

Plastic drums

Drum-code numbers	Flange Ø F_d	Drum-Barrel Ø K_d	Width over all l_1	Width-for windings l_2	Load bearing capacity max.	Drum weight
	mm	mm	mm	mm	kg	kg
050	500	150	456	404	100	4
070	710	355	510	400	250	15
080	800	400	510	400	350	16
090	900	450	680	560	400	23
100	1000	500	704	560	500	32

One-way wooden drums

Drum-code numbers	Flange Ø F_d	Drum-Barrel Ø K_d	Width over all l_1	Width-for windings l_2	Bore Ø max. B_d	Drum weight
	mm	mm	mm	mm	mm	kg
HE 350	350	150	320	300	56	1,8
HE 400	400	150	320	300	56	2,1
HE 401	400	150	425	405	56	2,3
HE 501	500	150	320	300	56	3,0
HE 500	500	150	425	405	56	3,3
HE 600	600	150	425	405	56	4,5
HE 760	760	300	425	400	80	8,0

Cable lengths (m) to KTG-Drums – capacity of pool drums

Drum sizes and code numbers																
Cable Ø D mm	051 05	061 06	071 07	081 08	091 09	101 10	121 12	141 14	161 16/8	181 18/10	201 20/12	221 22/14	250 25/14	251 25/16	281 28/18	Cable Ø D mm
6	1130	1110	2024	2755												6
7	815	840	1480	2340												7
8	630	640	1064	1463	2730											8
9	460	470	890	1152	2202	2866										9
10	390	388	680	980	1768	2349										10
11	320	315	564	760	1404	1910										11
12	260	254	470	643	1206	1540										12
13	220	238	385	542	1032	1339	2727									13
14	190	190	360	454	880	1159	2265	2967								14
15	170	180	300	430	749	1000	1990	2480								15
16	150	140	239	358	632	860	1756	2205								16
17	130	134	228	294	603	736	1545	1960								17
18	110	102	218	280	505	705	1355	1737								18
19	105	96	172	228	485	599	1184	1535	2722							19
20	100	92	165	220	402	576	1139	1352	2435	2830						20
21	80	90	159	210	387	485	990	1304	2172	2527						21
22		65	122	167	315	468	856	1145	1930	2248						22
23		62	117	160	304	389	827	999	1870	2172	2954					23
24		60	113	156	294	377	709	967	1657	1927	2608					24
25		58	110	150	285	365	688	839	1608	1867	2522					25
26		56	80	116	226	299	668	814	1420	1650	2218					26
27			78	113	220	290	567	700	1244	1450	2150	2860				27
28			76	109	215	282	550	680	1210	1410	1880	2777				28
29			73	106	209	226	462	663	1180	1370	1826	2450		2976		29
30			70	103	162	220	450	564	1028	1200	1583	2383		2893		30
31				76	157	214	438	550	1003	1166	1540	2089		2558		31
32				74	153	209	428	537	866	1009	1500	2035	2978	2490		32
33				72	150	204	352	450	846	985	1289	1984	2908	2428		33
34					146	158	344	440	828	962	1257	1726	2605	2134		34
35					108	154	336	430	710	824	1227	1685	2547	2083	2890	35
36					105	150	329	422	692	806	1040	1646	2270	2035	2820	36
37					103	148	265	348	678	788	1017	1418	2223	1774	2760	37
38						144	259	340	664	772	994	1386	1969	1735	2432	38
39						110	254	334	560	653	972	1356	1930	1697	2380	39
40						105	249	327	549	640	812	1328	1892	1486	2330	40
41						102	244	264	539	627	795	1130	1664	1435	2036	41
42						100	190	259	529	615	779	1107	1633	1406	1995	42
43							187	254	437	510	763	1085	1603	1199	1956	43
44							183	249	430	502	750	1065	1574	1175	1692	44
45							180	245	422	492	610	890	1373	1153	1660	45
46							177	240	415	484	600	874	1349	1130	1630	46
47							174	187	408	475	589	858	1326	1110	1600	47
48							130	184	330	386	578	842	1144	930	1366	48
49							127	180	325	380	568	828	1125	914	1342	49
50							125	178	319	373	558	878	1107	898	1320	50
51							123	175	314	367	442	666	1089	883	1298	51
52							120	172	310	360	435	655	1072	869	1276	52
53								170	305	356	428	644	912	715	1072	53
54								126	230	280	420	634	898	700	1056	54
55								124	235	276	414	624	885	690	1040	55
56								122	232	270	408	614	872	680	1022	56
57								121	228	267	400	488	860	668	1006	57
58								119	225	263	304	480	720	658	990	58
59								117	222	260	300	473	710	649	815	59
60									220	256	295	466	700	640	803	60
61									216	252	290	460	690	610	790	61
62									160	190	287	453	680	500	780	62
63									158	187	282	448	670	494	770	63
64									156	184	280	440	662	487	760	64
65									154	182	275	335	640	480	748	65
66									152	180	270	330	534	474	738	66
67									150	178	266	326	528	468	588	67
68										174	264	320	520	462	580	68
69										172	186	317	515	456	574	69
70										170	184	313	510	450	566	70
71										168	182	310	502	342	558	71
72										166	180	305	498	338	552	72
73										164	177	300	490	334	545	73
74										162	175	297	486	330	540	74
75										160	173	294	480	326	532	75
76										112	170	291	380	322	526	76
77										110	168	287	375	318	520	77
78										109	166	284	370	314	514	78
79										108	164	281	367	310	508	79
80										107	163	278	363	306	502	80
81										106	161	196	360	304	382	81
82										105	158	194	356	300	378	82
83										103	156	192	352	297	375	83
84											155	190	349	294	370	84
85											154	188	345	290	367	85
86											152	186	342	288	363	86
87											150	184	338	285	359	87
88											149	182	335	202	355	88
89											147	180	332	200	352	89
90											146	178	329	198	348	90
91											144	176	248	196	345	91
92											90	175	245	194	340	92

min. Drum-Barrel-Ø ≦ 40 · D
min. Drum-Barrel-Ø ≦ 30 · D
min. Drum-Barrel-Ø ≦ 25 · D
min. Drum-Barrel-Ø ≦ 20 · D
min. Drum-Barrel-Ø ≦ 15 · D

Kd = Drum-Barrel-Ø
D = Cable-Ø

Explanatory notes on CE marking
Low Voltage Directive (NSR), EMC Legislation

The Manufacturers must have to identify those products by the CE marking which fall within the applicability of certain EC (European Community) directives.

This applies to products which are covered by these directives in accordance with the new concept to include particular requirements on the technical characteristics of products.

The realization of these requirements is the condition for marketing the products in Europe. Then these CE directives constitute binding legislation for the European Union.

The inclusion of the CE marking confirms the compliance by the products with the basic requirements of all specifications applicable to that product. This means that CE marking is thus the compelling requirement in order of placing the products on the market within the EU. This also applies in the country of manufacture.

These directives are only then binding when these have been implemented in the national legislation of individual EU member states. An implementation in the national legislation of individual members states does not always occurs at the same time and is not always accomplished within the foreseen period.
Furthermore, certain transition rules may apply. If the obligation for implementation of these directives is not met, then these directives can still be directly applicable in certain circumstances.

The validity for these directives are not always clearly formulated and are sometimes abstract and not differentiated such that it cannot always be unambiguously established whether a product is covered by one or more directives and thus requires the CE marking.

The CE marking serves as evidence to the supervisory authorities of compliance with these directives. It is however often misinterpreted as being a "symbol for safety or quality" which is why it is often requested from customers without any legal justification.

EC Low Voltage Directive (NSR)

The EC Low Voltage Directive (NSR) is one of these CE Designation Directives (Article 13 of the CE Marking Directive). This means that electrical equipment used in low voltage range applications must also be identified by the CE marking. The CE marking is affixed on these products since 01.01.1997.

The CE Marking Directive will apply to a large number of electrical products, alone on account of the extensive range of applicability of the Low Voltage (NSR) and Electromagnetic Compatibility (EMC) Directives.

The following directives are of particular significance for the electrical industry:

73/23/EEC and 93/68/EEC
Electrical equipment for use within specified voltage limits (Low Voltage Directive)

89/106/EEC
Construction products

89/336/EEC
Electromagnetic compatibility (EMC Directive)

89/392/EEC
Safety of machinery

91/263/EEC
Telecommunications terminal equipment

For HELUKABEL as manufacturer and supplier of cables and wires, only the Low Voltage Directive is of significance. The EMC directive is of indirect applicability – for customer enquiries – in that queries could arise regarding the immunity of cables to interference, capacitance unbalance values and similar characteristics.

The EMC Directive

The EMC Directive, which applies for the electromagnetic compatibility of electrical and electronic equipment in their environments, can only be applied in complete systems.

For example, systems which are made up of several units, whereby each individual unit alone meet EMC requirements, are tested as a system for EMC together with the interconnecting cables.

EMC testing of a single cable or a single wire cannot be specified.

Title:
73/23/EEC and 93/68/EEC: Directive of the Council dated February 19, 1973, for harmonisation of the legislation in member states regarding electrical equipment for use within specified voltage ranges – with amendments dated July 22, 1993.

Continuation ►

Explanatory notes on CE marking
Low Voltage Directive (NSR), EMC Legislation

Important information regarding the Low Voltage Directive (NSR):

1. General Conditions:

a) The major characteristics required for knowledge and observance, for use in accordance with the intended application, are given on the electrical equipment, or, if this is not possible, in the accompanying instructions.

b) The manufacturer's symbol or trade mark shall be clearly visible on the electrical equipment, or, where this is not possible, shall be affixed on the packaging.

c) The electrical devices as well as the components for these, shall be procured such that these can be connected safely and properly.

d) The electrical equipment shall be designed and constructed such that protection from the hazards listed in item 2 and 3, is assured during use and proper maintenance in accordance with the intended application.

2. Protection against hazards which may arise from electrical equipment – technical measures shall be foreseen in accordance with item 1, such that:

a) Humans and working animals are protected from injury or other harm which can be caused by either direct or indirect contact.

b) No high temperatures, arcs or radiation are generated from which hazards could arise.

c) Humans, working animals and property are adequately protected against non-electrical hazards which, from experience, can arise from electrical equipment.

d) The insulation complies to the property requirements.

3. Protection against hazards which can arise from external influences on electrical equipment – technical measures are foreseen in accordance with item 1, such that the electrical equipment:

a) can withstand the mechanical loads such that humans, working animals or property are not endangered.

b) can withstand the non-mechanical effects under foreseen environmental conditions such that humans, working animals or property are not endangered.

c) cannot endanger humans, working animals or property in any way by the foreseen overloads.

Equipment and areas which do **not** fall within the Directive.

- Electrical equipment for use in explosive atmospheres
- Electrical-radiological and electrical medical equipment
- Electrical components of passenger and goods lifts
- Electricity meters, household plug-in fixtures, radio interference suppression devices
- Installation for supplying power to electrified pasture fencing
- Specified electrical equipment intended for use on ships, in aircraft or railways and which comply with the safety regulations of member states for international installations.

Electrical equipment within the context of the Low Voltage Directive is electrical equipment for applications with a rated voltage between 50 and 1000 V alternating current and between 75 and 1500 V direct current.

For a more **exact** interpretation of the Directive, cables and wires are covered by the regulation, **not** however cables with a rated voltage exceeding 1000 V alternating current or 1500 V direct current.

HELUKABEL as manufacturer and supplier must act in accordance with the Low Voltage Directive, that is to say:

Cables and wires up to 1000 V nominal voltage **must** be identified by the CE marking, refer to page T 101.

The identification can be attached either to the product or on the label.

European Directives WEEE, RoHS and ElektroG

The European Union has approved directives with a view to protecting man and environment. The member states have made these directives into national law.

Directives and Laws

WEEE

Waste **E**lectrical and **E**lectronic **E**quipment
Directive 2002/96/EC of the European Parliament and the Council on used electrical and electronic devices dated January 27, 2003

Aim:

- To attain a consistent level of health and environmental protection throughout the member states.
- To harmonise the responsibility held by the manufacturers.
- To attain equivalent participation by the traders.

The member states are to employ suitable measures for ensuring that used electrical and electronic devices are treated in such a way as to prevent their entry into the waste stream. They are to set out regulations for the dismantling, reuse and recycling of these devices.

RoHS

Restriction **o**f **H**azardous **S**ubstances in electric and electronic equipment
Directive 2002/95/EC of the European Parliament and the Council on restriction of use of certain hazardous substances in electrical and electronic equipment dated January 27, 2003.

Aim:

- To reconcile the legal regulations of the member states on restriction of use of hazardous substances and electrical and electronic equipment.
- Substance bans and restrictions.

The member states guarantee that from July 1, 2006, use of the following substances in electrical and electronic equipment will be restricted:
Lead, Mercury, Cadmium, Chromium VI
Polybrominated biphenyl (PBB)
Polybrominated diphenylether (PBDE)

Law on the use, return and environmentally-compatible disposal of electrical and electronic equipment.

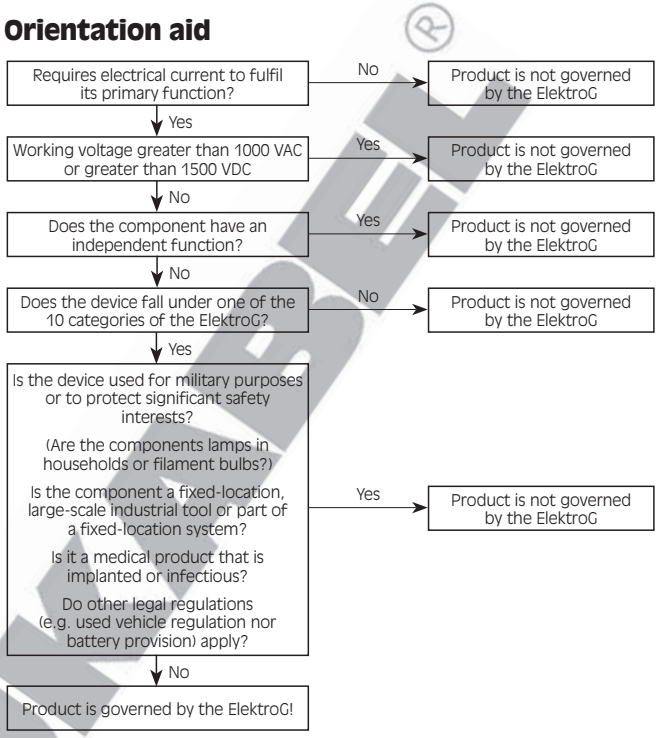
ElektroG (Electrical and Electronic Equipment Act) of March 16, 2005.
This Act enforces the EU Directives 2002/96/EC and 2002/95/EC.

Aims:

- To avoid electrical and electronic equipment waste.
- To reuse and/or recycle the materials from this waste.

Scope:
This Act applies for all electrical and electronic devices that fall under certain categories, insofar as they are not part of another device not covered by the scope of this Act.

Orientation aid



Substance bans

§ 5 from ElektroG (RoHS)
It is forbidden to bring into circulation new electrical and electronic devices containing more than 0.1 percent by weight of lead, mercury, hexavalent chromium, polybrominated biphenyl (PBB) or polybrominated diphenylether (PBDE) for each homogenous material or more than 0.01 percentage by weight of cadmium per homogenous material. Clause 1 does not apply for category 8 and 9 electrical and electronic devices nor for electrical and electronic devices brought into a member state of the European Union for the first time before July 1, 2006. Nor does it apply for spare parts for the repair or reuse of electrical and electronic devices brought into circulation for the first time before July 1, 2006.

Definition

The majority of our products are not governed by the ElektroG (WEEE/RoHS), as they do not have an independent function. As the possibility of our customers using our products in devices that are governed by the ElektroG, and as such are declarable, cannot be ruled out, we have decided to mark in this catalogue the products that either comply with the limit values indicated in accordance with ElektroG (WEEE/RoHS) § 5 and/or do not infringe provisions of the ElektroG (WEEE/RoHS).

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