

**TECHNICAL PARAMETERS OF
HALOGEN-FREE CABLES
HDXSP-J(O); HDHP-J(O)**



HANDBOOK FOR DESIGNERS



Fire resistance of construction products is a very important aspect of building fire safety, which is why the European Commission introduced common legislation throughout the European Union imposing an obligation to classify construction products as fire resistant and defining test methods for cables intended for installation in buildings. In practice, this results in projects in which the use of PVC cables is significantly reduced in favour of halogen-free designs. The ELPAR Cable Factory, in order to meet the new requirements in terms of fire safety of cables and wires in accordance with the CPR Directive, introduces new halogen-free flame-retardant cables to its product portfolio: HDXSp-J(O) and HDHp-J(O) in two voltage variants: 300/500 V and 450/750 V. There is an extensive list of benefits of using these designs. An important feature of halogen-free cables is the possibility of using them in modern electrical installations and smart buildings, where the comfort of use is just as important as safety.

As the name suggests, halogen-free cables do not contain halogens, i.e. compounds of fluorine, chlorine, bromine, iodine – this means that in case of fire, insulation materials and external coatings will not emit corrosive toxic fumes that are dangerous to human life and health. The only product of burning these plastics is carbon dioxide and water. It is important that in the event of a fire, these cables will not increase the ambient temperature. In view of the above features, halogen-free cables can be used in buildings with a high occupancy and in facilities where valuable material goods are protected. In simple terms, they can be described as a halogen-free version equivalent to the well-known YDYp 450/750 V copper installation cables. The HDXSp cable can be considered a more advanced version of HDHp due to the use of cross-linked polyethylene insulation.

HDXSp-J(O) and HDHp-J(O) cables are produced at the ELPAR production plant under a private brand. The high quality of these products has been acknowledged by tests performed by Accredited Bodies and European Notified Bodies. Test our halogen-free cables in your installations – we are convinced that our designs will fully meet your expectations.





HDXSp-J(O) 300/500 V; 450/750 V **HDHp-J(O) 300/500 V; 450/750 V**

halogen-free cables

STANDARD

NF-EP-86:2017



INFORMACJE TECHNICZNE:

Cable with single-wire cores (D) in polyethylene (XS) or halogen-free (H) insulation and a halogen-free (H) sheath (p) with a green and yellow protective core (J) or without a green and yellow protective core (O).

DESIGN:	HDXSp-J(O) 300/500 V; 450/750 V	HDHp-J(O) 300/500 V; 450/750 V
Core	copper single-wire cl. 1, according to PN-EN 60228	
Insulation	cross-linked polyethylene	special halogen-free polymer
Colour of insulation	HDXSp-O / HDHp-O 2-core: blue, brown 3-core: brown, black, grey or blue, brown, black 4-core: blue, brown, black, grey 5-core: blue, brown, black, grey, black HDXSp-J / HDHp-J 3-core: green and yellow, blue, brown 4-core: green and yellow, brown, black, grey or green and yellow, blue, brown, black 5-core: green and yellow, blue, brown, black, grey	
Coating	special halogen-free polymer, white	
Operating temperature	-40°C to +70°C	
Rated voltage	300/500 V; 450/750 V	
Minimum bending radius	outer cable diameter D [mm] 6xD	
Permissible operating core temperature	+90°C	+70°C
Permissible temperature of cores during short-circuit	+250°C	+160°C
Reaction to fire at 300/500 V	Dca s1 d0 a1 according to PN-EN 50575:2015+A1:2016	
Reaction to fire at 450/750 V	Dca s2 d0 a1 according to PN-EN 50575:2015+A1:2016	
Hazardous substances emitted	NPD according to PN-EN 50575:2015+A1:2016	
Properties	self-extinguishing according to: PN-EN 60332-1-2:2010 halide content: PN-EN 60754-1:2014 acidity and conductivity: PN-EN 60754-2:2014 smoke density: PN-EN 61034-2:2010 the lowest permissible temperature for cables laid without heating: +5°C storage: max. 40°C	
Intended use	halogen-free power cables for installations in facilities where human life or property must be protected in the event of fire (hotels, hospitals, schools, airports, underground stations, railway stations, industrial installations), cables are intended for installation in dry and damp rooms, on plaster, in plaster and under plaster, in masonry walls and directly in concrete, for permanent installation only, in the case of installation outside or underground, cables must be placed in cable ducts or tubing	
Packaging	discs with a length of 100 m and other forms according to the customer's request	

HDXSp-J(O) 300/500 V		
Core quantity and nominal cross-section [n x mm²]	Approximate cable outer dimension [mm]	Approximate cable weight [kg/km]
2 x 1	3,9 x 6,0	41
2 x 1,5	4,2 x 6,5	51
2 x 2,5	4,6 x 7,3	71
2 x 4	5,4 x 8,8	107
3 x 1	3,9 x 8,2	58
3 x 1,5	4,2 x 8,9	74
3 x 2,5	4,8 x 10,3	109
3 x 4	5,4 x 12,2	155
4 x 1	3,9 x 10,3	75
4 x 1,5	4,4 x 11,4	99
4 x 2,5	4,8 x 13,0	138
4 x 4	5,4 x 15,6	215

HDXSp-J(O) 450/750 V		
Core quantity and nominal cross-section [n x mm²]	Approximate cable outer dimension [mm]	Approximate cable weight [kg/km]
2 x 1	4,9 x 7,4	55
2 x 1,5	5,2 x 7,9	67
2 x 2,5	5,6 x 8,7	89
2 x 4	6,0 x 9,6	120
3 x 1	4,9 x 10,0	77
3 x 1,5	5,2 x 10,7	94
3 x 2,5	5,6 x 11,9	127
3 x 4	6,0 x 13,2	173
4 x 1	4,9 x 12,5	99
4 x 1,5	5,2 x 13,4	121
4 x 2,5	5,6 x 15,0	165
4 x 4	6,2 x 17,0	244
5 x 1	4,9 x 15,0	120
5 x 1,5	5,2 x 16,2	148
5 x 2,5	5,6 x 18,2	203
5 x 4	6,2 x 20,6	302

HDHp-J(O) 300/500 V		
Core quantity and nominal cross-section [n x mm²]	Approximate cable outer dimension [mm]	Approximate cable weight [kg/km]
2 x 1	4,1 x 6,4	47
2 x 1,5	4,4 x 6,9	58
2 x 2,5	4,8 x 7,7	79
2 x 4	5,6 x 9,2	118
3 x 1	4,1 x 8,8	67
3 x 1,5	4,4 x 9,5	84
3 x 2,5	5,0 x 10,9	121
3 x 4	5,6 x 12,8	171
4 x 1	4,1 x 11,1	87
4 x 1,5	4,6 x 12,2	113
4 x 2,5	5,0 x 13,8	154
4 x 4	5,6 x 16,4	237

HDHp-J(O) 450/750 V		
Core quantity and nominal cross-section [n x mm²]	Approximate cable outer dimension [mm]	Approximate cable weight [kg/km]
2 x 1	4,9 x 7,4	60
2 x 1,5	5,2 x 7,9	72
2 x 2,5	5,8 x 9,1	100
2 x 4	6,2 x 10,0	132
3 x 1	4,9 x 10,0	84
3 x 1,5	5,2 x 10,7	101
3 x 2,5	5,8 x 12,5	143
3 x 4	6,2 x 13,8	191
4 x 1	4,9 x 12,5	107
4 x 1,5	5,2 x 13,4	131
4 x 2,5	5,8 x 15,8	186
4 x 4	6,4 x 17,8	270
5 x 1	4,9 x 15,0	131
5 x 1,5	5,2 x 16,2	161
5 x 2,5	5,8 x 19,2	229
5 x 4	6,4 x 21,6	335

■ Selection of conductors and cables for long-term load-carrying capacity and overload capacity

The current flowing through the conductors of wires or cables causes heat generation and an increase of core temperature, which causes heating of the insulation, screen, sheath and plaster, ground or other medium in which they are laid. This heat can be dissipated by convection, conductivity or radiation, depending on how the cable or wire is laid.

Power P emitted on the wire is directly proportional to the square of the intensity of the flowing current I and to the resistance R the core (L – length, γ – conductivity of the core material, S – cross-section of the core).

$$P=I^2 \cdot R=I^2 \cdot \frac{L}{\gamma \cdot S}$$

The first step in selecting cables for long-term load-carrying capacity and current overload capacity is to calculate the expected load current, which should be determined using the following formulas, depending on the type of circuit:

- for single-phase circuits:

$$I_B = \frac{S_n}{U_{nf}} = \frac{P_n}{\cos\varphi \cdot U_{nf}}$$

- for three-phase circuits:

$$I_B = \frac{S_n}{\sqrt{3} \cdot U_n} = \frac{P_n}{\sqrt{3} \cdot \cos\varphi \cdot U_n}$$

where:

I_B [A] – calculated load current of cable or wire,

U_{nf} [V] – rated phase voltage,

U_n [V] – rated phase-to-phase voltage,

$\cos\varphi$ – power factor (in sinusoidal current circuits

$\cos\varphi = P_n/S_n$),

S_n [VA] – apparent power of the cable or wire load,

P_n [W] – active power of the cable or wire load.

In the calculation of I_b in residential buildings, in the absence of precise data, $\cos\varphi = 0,95$ can be assumed.

If we know the load current, selection the cross-section of cables in view of the long-term load-carrying capacity is made based on the long-term load-carrying capacity tables provided in PN-IEC 60364-5-523:2001 "Electrical Installations for Buildings. Selection and erection of electrical equipment."

This standard contains tables for the long-term load-carrying capacity of cables for ambient air temperature of 30°C in the Mediterranean area and for the long-term load capacity of cables laid in the ground for soil resistivity of 2.5 K-m/W. All values are based on a long-term, unchanging over time, DC or AC load with a frequency of 50 Hz or 60 Hz.

The long-term load-carrying capacity of cables is determined from the tables contained in the standard after the application of correction factors for Polish conditions and after taking into account the type of cables, conditions of installation and the average 24-hour load.

Values specific for Poland are given in IEC 60287-3-1:1999:

The calculated ambient temperature in Poland is:

- a) for cables laid indoors 25°C,
- b) for insulated cables in external spaces:
 - not exposed to direct sunlight at 25°C,
 - exposed to direct sunlight at 40°C,
- c) for cables laid in the ground depending on the season: 5°C, 15°C, 20°C.

Thermal resistivity of the soil in Poland is: 1.0 K-m/W.

Long-term current in any cable conductor under normal operating conditions should be such that the appropriate limit temperature is not exceeded. This value depends on the insulation material:

Insulation material	Permissible temperature limit [°C]	
	long-term	when shorted
Halogen-free material (HFFR)	70	160
Cross-linked polyethylene (XLPE)	90	250

The temperature limit may be permissible temporarily, e.g. in case of emergency overloads of electrical equipment for a limited period of their duration.

Core resistance

Rated core cross-section [mm²]	Copper cores [Ω/km]
	Class 1
1	18,1
1,5	12,1
2,5	7,41
4	4,61

Selection of the cable cross-section according to the permissible voltage drop

Electric energy loads work correctly when supplied with voltage close to the rated value. Sometimes it is necessary to use cables with a core cross-section greater than the cross-section resulting from the required long-term load-carrying capacity so that the voltage deviations in individual parts of the network and installation do not exceed the limits defined by the relevant standards, assuming that voltage deviations caused by voltage drops should not cause interference in the operation of loads.

According to SEP-E-002, the voltage drop in final circuits, from the electricity meter to the load connection point, should not exceed 3%, while the total voltage drop from the electrical installation connector to the terminals of any load should not exceed 4%. Voltage drops in the internal power supply line should not exceed the values given in the table below. The voltage drop must be calculated for the rated current of the overcurrent protection.

No.	Power transmitted by the WLZ line in kVA	Permissible voltage drop ΔU%
1	do 100	0,5
2	100 - 250	1,0
3	250 - 400	1,25
4	powyżej 400	1,5

The voltage drop expressed in % at any section of the track with a length of l made with a conductor with a cross-section of S and the conductivity of the γ -core material is determined by the relation:

- for single-phase circuits:

$$\Delta U_{\%} = \frac{200}{U_{nf}} \cdot I_B \cdot (R \cdot \cos\varphi + X_L \cdot \sin\varphi)$$

- for three-phase circuits:

$$\Delta U_{\%} = \frac{\sqrt{3} \cdot 100}{U_n} \cdot I_B \cdot (R \cdot \cos\varphi + X_L \cdot \sin\varphi)$$

where:

I_B [A] – calculated load current of cable or wire,

U_{nf} [V] – rated phase voltage,

U_n [V] – rated phase-to-phase voltage,

$\cos\varphi$ – power factor (in sinusoidal current circuits $\cos\varphi = P_n/S_n$),

S [mm²] – ductor cross section,

l [m] – line length,

γ [m/Ω·mm²] – conductivity of the core material,

X_L [Ω] – cable reactance and R [Ω] – cause resistance, expressed by formulas:

$$X_L = x' \cdot L$$

$$R = \frac{l}{\gamma \cdot S}$$

where:

x' [mΩ] – unit reactance of cables.

Conductivity γ for cable lines should be 0.10 mΩ/m, whereas for installations in pipes and for low-voltage overhead lines – 0.25–0.30 mΩ/m.

You can also directly calculate the required cable cross-section:

- for single-phase circuits:

$$S \geq \frac{1}{\gamma \cdot \left(\frac{\Delta U_{\%} \cdot U_{nf}}{200 \cdot I_B \cdot l \cdot \cos\varphi} - X_L \cdot 10^{-3} \cdot \tan\varphi \right)}$$

- for three-phase circuits:

$$S \geq \frac{1}{\gamma \cdot \left(\frac{\Delta U_{\%} \cdot U_{nf}}{100 \cdot \sqrt{3} \cdot I_B \cdot l \cdot \cos\varphi} - X_L \cdot 10^{-3} \cdot \tan\varphi \right)}$$

In the above formulas, $\tan\varphi$ means the value of the tangent function related to the above value of the $\cos\varphi$ function.

If the voltage drop calculations apply to lines (installations) up to 1 kV consisting of cables, multi-core or single-core lines laid in tubes with a conductor cross-section of 50 mm² Cu or 70 mm² Al, or less, the impact of the reactance of the cables is disregarded and the voltage drop is calculated using a simplified formula:

- for single-phase circuits:

$$\Delta U = \frac{2 \cdot P \cdot l \cdot 100}{\gamma \cdot S \cdot U_{nf}^2}$$

- for three-phase circuits:

$$\Delta U = \frac{P \cdot l \cdot 100}{\gamma \cdot S \cdot U_n^2}$$

where:

P [W] – active power transferred by the analysed section of the installation.

Other markings – as above.

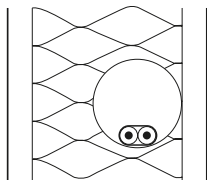
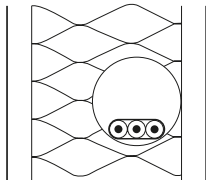
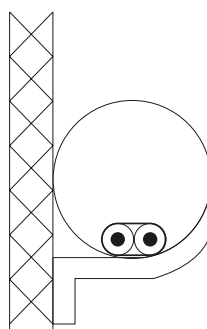
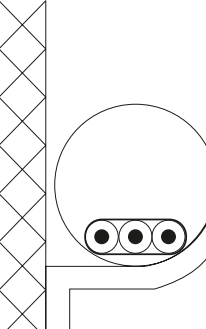
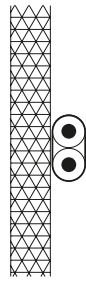
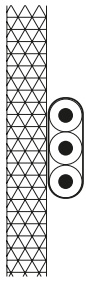
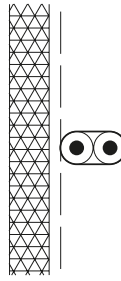
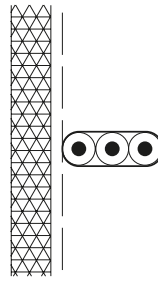
You can also directly calculate the required cable cross-section for this case:

- for single-phase circuits:

$$S \geq \frac{200 \cdot I_B \cdot l \cdot R \cdot \cos\varphi}{\gamma \cdot \Delta U_{\%} \cdot U_{nf}}$$

- for three-phase circuits:

$$S \geq \frac{100 \cdot \sqrt{3} \cdot I_B \cdot l \cdot \cos\varphi}{\gamma \cdot \Delta U_{\%} \cdot U_n}$$

Cable laying	Load-carrying capacity								
	Type of conductor: HDXSp-J(O) / HDHp-J(O)								
	Insulation: XLPE / HFFR								
	Method of installation								
	Multi-core cables in an installation pipe in a thermally insulated wall				Multi-core cables in a wall-mounted installation pipe				
									
2 cores		3 cores			2 cores		3 cores		
Rated core cross-section [mm²]	Long-term load-carrying capacity (A) Conductor temperature: 90°C (XLPE); 70°C (HFFR) Ambient temperature: 30°C in the air, 20°C in the ground								
	XLPE	HFFR	XLPE	HFFR	XLPE	HFFR	XLPE	HFFR	
1,5	18,5	14	16,5	13	22	16,5	19,5	15	
2,5	25	18,5	22	17,5	30	23	26	20	
4	33	25	30	23	40	30	35	27	
Cable laying	Multi-core cables on the wall				Multi-core cables in air, distance to the wall of >0.3 cable diameter				
									
	2 cores		3 cores			2 cores		3 cores	
Rated core cross-section [mm²]	Long-term load-carrying capacity (A) Conductor temperature: 90°C (XLPE); 70°C (HFFR) Ambient temperature: 30°C in the air, 20°C in the ground								
	XLPE	HFFR	XLPE	HFFR	XLPE	HFFR	XLPE	HFFR	
1,5	24	19,5	22	17,5	26	22	23	18,5	
2,5	33	27	30	24	36	30	32	25	
4	45	36	40	32	49	40	42	34	

Load-carrying capacity correction factors depending on the ambient temperature (above 30°C)									
Ambient temp (°C)	30	35	40	45	50	55	60	65	75
XLPE correction factor	1	0,96	0,91	0,87	0,82	0,76	0,71	0,65	0,58
Correction factor HFFR	1	0,94	0,87	0,79	0,71	0,61	0,5	-	-

Adjustment factors	
Number of loaded cores	Coefficient for core cross-section up to 10 mm²
5	0,75

Table 1. Recommended reaction to fire performance class of cables and other general purpose conductors installed outside escape routes in buildings of a certain type.

Building characteristics	Minimum reaction to fire performance class of cables and other conductors
Single-family residential buildings, farmstead and recreational buildings up to and including three storeys above ground level	Eca
Residential and administrative buildings in forest properties up to and including three aboveground storeys	Eca
Detached buildings up to and including two aboveground storeys with gross volume up to 1500 m ³ intended for tourism and leisure purposes	Eca
Detached buildings up to and including two aboveground storeys, single-family farmstead buildings and forest properties	Eca
Detached buildings up to and including two aboveground storeys with a gross volume of up to 1000 m ³ intended for professional, service and commercial activities, including a residential section	Eca
Stand-alone garages with no more than 2 parking spaces	Eca
Detached buildings with a gross volume of up to 1500 m ³ for keeping livestock	Eca
High-rise buildings with a height exceeding 55 m above ground level	Dca-s2, d1, a3
Tall buildings with a height of 25–55 m above ground level or residential buildings with more than 9 up to and including 18 aboveground storeys	Dca-s2, d1, a3
Buildings with a human hazard category of ZL I – containing rooms intended for occupancy of more than 50 persons who are not permanent users and not primarily intended for use by persons with reduced mobility	Dca-s2, d1, a2
Buildings with a human hazard category of ZL II – intended primarily for use by people with reduced mobility, such as hospitals, nurseries, kindergartens, retirement homes	Dca-s2, d1, a2
Buildings with a human hazard category of ZL III – public utility buildings not classified as ZL I or ZL II	Dca-s2, d1, a3
Buildings with a human hazard category of ZL IV – residential	Dca-s2, d1, a3
Buildings with a human hazard category of ZL V – multi-family housing not classified as ZL I or ZL II	Dca-s2, d1, a3
PM and IN buildings (production, storage, livestock, etc.)	Eca

Source: SEP N SEP-E-007:2017-09 Standard

REACTION TO FIRE PERFORMANCE CLASS UNDER THE CPR FIRE RESISTANCE (non-combustibility)



ADDITIONAL CRITERIA:

- s1, s2, s3- emission of smoke,
- d0, d1, d2 - emission of burning droplets/particles,
- a1, a2, a3 - emission of corrosive acids.



Table 1. Basic Euroclass

Euroclass	Tests according to	Additional criterion	Examples of products
Aca	EN ISO 1716		halogen-free cables
B1ca	EN 50399 i EN 60332-1-2	+acidity	halogen-free cables
B2ca	EN 50399 i EN 60332-1-2	+acidity	hard PVC, halogen-free cables
Cca	EN 50399 i EN 60332-1-2	+acidity	halogen-free cables
Dca	EN 50399 i EN 60332-1-2	+acidity	very high quality PVC/halogen-free cables
Eca	EN 60332-1-2	no acidity testing	PVC cables
Fca	-	no special requirements	polyethylene and PVC cables

Table 2. Subclass defining smoke emission

Euroclass	Properties	Examples of products
s1	almost smokeless	halogen-free
s2	average smoke emission	halogen-free
s3	intense smoke emission	rubber, PVC

Table 3. Subclass defining the ability of a burning product to produce burning droplets or waste

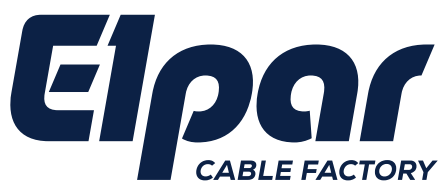
Euroclass	Properties	Examples of products
d0	no burning droplets	halogen-free
d1	few flaming droplets/particles (similar to sparks from burning wood)	PVC/halogen-free
d2	multiple burning droplets/particles that can cause skin burns or spread fire	polyethylene

Table 4. Subclass defining the acidity of the emitted smoke

Euroclass	Properties (conductivity of the smoke water solution and acidity)	Examples of products
a1	less than 2.5 $\mu\text{S}/\text{mm}$ and pH greater than 4.3	halogen-free
a2	less than 10 $\mu\text{S}/\text{mm}$ and pH greater than 4.3	halogen-free
a3	does not meet the above criteria	PCV



Handwriting practice lines consisting of 25 horizontal dotted lines.



LEADING MANUFACTURER

POWER CABLES AND CONDUCTORS



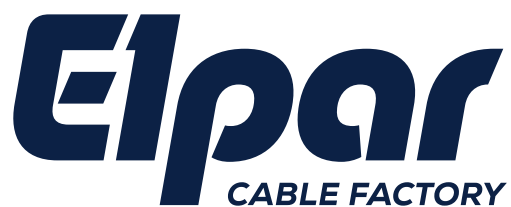
- Polish capital
- many years of experience in the production of cables and wires
- wide range of products
- quality confirmed by European and ISO standards

HALOGEN-FREE CABLES



HDXSp-J (O) 450/750 V

HDHp-J (O) 450/750 V



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