TECHNICAL INFORMATION

MATERIALS

INSULATION MATERIALS

XLPE

Cross-linked polyethylene compound.
Excellent mechanical and electrical characteristics

HF90

Low smoke zero halogen flame retardant
Crosslinked polyolefine compound.

SHEATHING MATERIALS

LSZH THERMOPLASTIC

Low smoke zero halogen thermoplastic compound. Flame retardant and self-extinguishing in the event of fire.

SHF1

LSZH thermoplastic. Low smoke zero halogen thermoplastic compound. Flame retardant and self-extinguishing in the event of fire.

SHF2

Cross-linked polyolefine. Low smoke zero halogen cross-linked thermoset oil-resistant compound. Flame retardant and self-extinguishing in the event of fire.

MARKING ON THE SHEATH

Lot number, Cable type, Cable size (number of cores x size of conductors mm2), Voltage, Temperature, Standards, Manufacturer's name, Production month and year, Meter marking.

NOTE!

Cables that are cut and stored, the cable ends must be sealed with moisture-proof end caps. E.g. Heat shrink end caps with glue inside.

TESTS AND DEFINITIONS OF TERMS

HALOGEN-FREE

Halogen-free refers to the absence of halogens, such as chlorine and fluorine. Determined on the basis of the halogen content and the acidity of cable´s gases.
Halogen-free IEC 60754-series consists of standards IEC 60754-1 and IEC 60754-2.

IEC 60754-1

Determines halogen content of material. Halogen content of material may not exceed 0.5% or 5 mg/g.

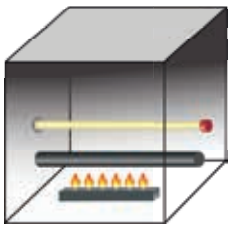
IEC 60754-2

Determines degree of acidity of combustion gases. Limit values >4.3 for pH and <10 µS/mm for conductivity.

SMOKE EMISSION

IEC 61034-1, IEC 61034-2

Smoke emission refers to visibility in a fire. Greater light transmittance means better visibility.
Smoke Emission IEC 61034-series consists of standards IEC 61034-1 and IEC 61034-2.



27 m³ cube smoke chamber

Requirements: 60% light transmittance

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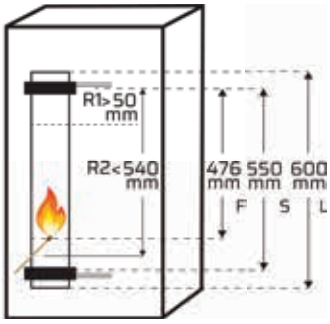
FIRE PERFORMANCE

IEC 60332-1, IEC 60332-3

Cables must withstand the test specified in IEC standard 60332-3 or IEC 60332-1. Flame-retardant cables do not propagate fire and are self-extinguishing.

IEC 60332-1

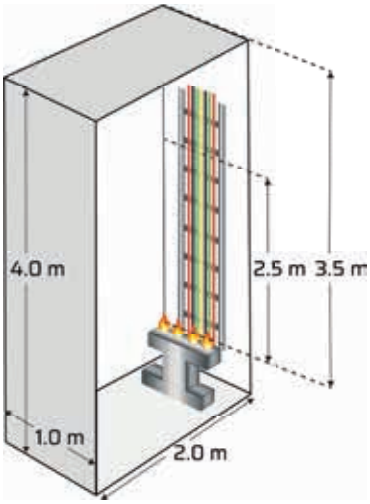
Test for single cable.
Test procedure and requirements according to picture below.



Min. 50 mm of the cable, measured from upper support, must remain unburned after specified time.

IEC 60332-3

Test for bunched cables with three categories - A, B and C. Categories are defined by different limits for flammable material and burning times. Cables must extinguish themselves once the burner has been removed.
Test procedure and requirements according to picture below.



Burning allowed up to max. 2.5 meters from the burner within specified time.

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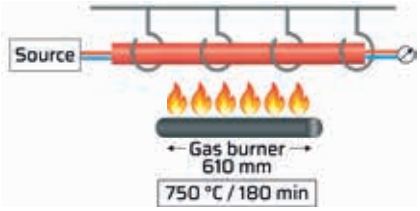
FIRE-RESISTANT

All fire-resistant cables are also flame-retardant.

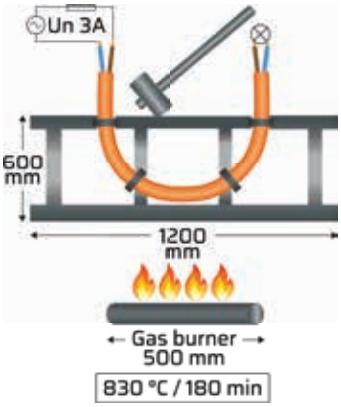
IEC 60331-25

Test method for fire at a temperature of 750 °C for 180 min. The cable must maintain its function for min. 180 min with flame and shall remain connected for further 15 min without flame (cooling time). During the test the max. increase in attenuation shall be measured and recorded.



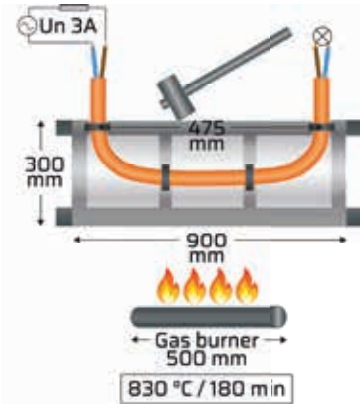
IEC 60331-1

Test method for fire with shock at a temperature of min. 830 °C for 180 min for cables with rated voltage up to and including 0.6/1.0 kV, and with Ø > 20 mm.



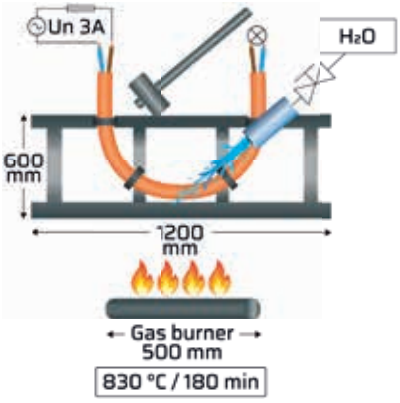
IEC 60331-2

Test method for fire with shock at a temperature of min. 830 °C for 180 min for cables with rated voltage up to and including 0.6/1.0 kV, and with Ø < 20 mm.



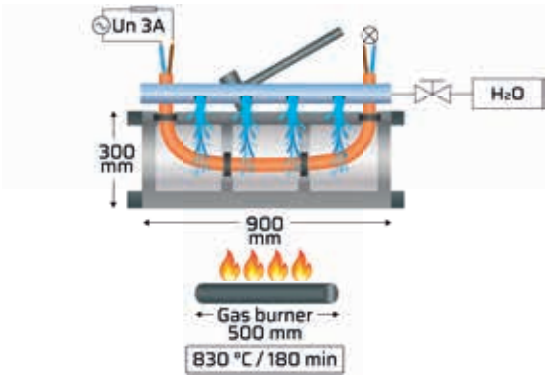
IEC 60331-1 + BS 8491

Based on IEC 60331-1 with adds from BS 8491 Test method for fire with shock at a temperature of min. 830 °C for 180 min. For cables with Ø > 20 mm. 5 min before the end of the flame application the water jet is activated and apply a burst of water of 5 s duration. Water burst is repeated until a total of 5 bursts of water been applied.



IEC 60331-2 + EN 50200 ANNEX E

Based on IEC 60331-2 with adds from EN 50200 Annex E Test method for fire with shock at a temperature of min. 830 °C for 180 min. For cables with Ø < 20 mm. 15 min before the end of the flame application the water spray is activated and shall spray until the end of flame application time.



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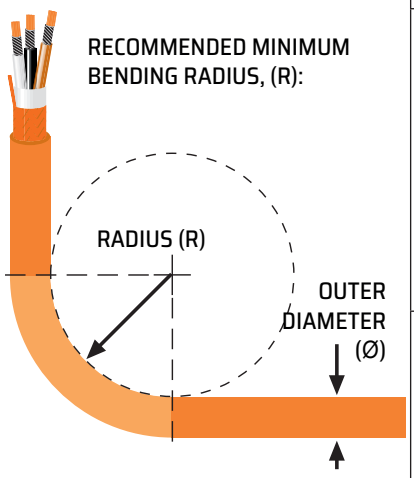
BENDING RADIUS



LKM-HF LKMM-HF LKEM-HF	During installation During installation Fixed installation Fixed installation	R = 6 x Ø R = 9 x Ø R = 4 x Ø R = 6 x Ø	< 25 mm > 25 mm < 25 mm > 25 mm
LKSM-HF LKMSM-HF LKM-FRHF LKMM-FRHF LKSM-FRHF LKMSM-FRHF RFE-HF, RFE-HF(i) RFE-FRHF, RFE-FRHF(i) RFE-FRHF+WSR/WJR RFE-FRHF(i)+WSR/WJR	During installation Fixed installation	R = 9 x Ø R = 6 x Ø	All Diameters
LKSM-EMC LKSM-EMC-FRHF LKSM-VFD LKAM-HF LKAM-FRHF RFE-EMC-FRHF RFE-EMC-FRHF(i) RFA-HF, RFA-HF(i) RFA-FRHF, RFA-FRHF(i) RFA-FRHF+WSR/WJR RFA-FRHF(i)+WSR/WJR	During installation Fixed installation	R = 12 x Ø R = 8 x Ø	All Diameters

DIAMETER TOLERANCE

NOMINAL OUTER	TOLERANCE	NOMINAL OUTER	TOLERANCE
1 - 10	±0.5 mm	30.1 - 40	±2.0 mm
10.1 - 20	±1.0 mm	40.1 - 50	±2.5 mm
20.1 - 30	±1.5 mm	50.1 - 60	±3.0 mm

CORE IDENTIFICATION

250 V pair cables	250 V triad cables	250 V quad cables	250 V multicore cables
Pairs numbered Pair 1 1 2 Pair 2 3 4 Pair 3 5 6 Each pair white - blue. Pairs numbered 1, 2, 3, 4..	Built up as triple with the following identification: Triple white-blue-red	(Quad)cable is built up as a star quad with the following identification: 1 core white 2 core blue 3 core white 4 core blue	2-cores Black numbers on white base 3-cores Black numbers on white base 4-cores to 37-cores Black numbers on white base

0.6/1 kV	NORMAL TYPE	G-TYPE (with earth conductor)	1.8/3 kV LKSM-VFD
1-CORE	BK		BK
2-CORES	BN BU		
3-CORES	BN BK GY	Y/G BU BN	BN BK GY
3-CORES + 3-GROUND CORES			BN BK GY Y/G
4-CORES	BU BN GY BK	Y/G BN GY BK	
5-CORES	1 2 3 4 5	Y/G BU BN BK GY	
7-CORES AND ABOVE	1 2 3 4 5 6 7 *	Y/G 1 2 3 4 5 6 **	

BU = Blue, **BN** = Brown, **BK** = Black, **GY** = Grey, **Y/G** = Yellow/Green

* Black numbers on white base.
** G-TYPE: Last core yellow/green.

CURRENT RATING

Current rating (A) at an ambient temperature of 45 °C according to standard IEC 60092-352 0.6/1 kV marine cables.
Current carrying capacities in continuous service at maximum rated conductor temperature of 90 °C.

FOR CONTINUOUS SERVICE

Continuous service for a cable is to be considered as a current-carrying service (with constant load) having a duration longer than three times the thermal time constant of the cable, i.e. longer than the critical duration (see short time duty).

NUMBER OF CONDUCTORS														
Size	**1**	**2**	**3**	**4**	**5**	**7**	**10**	**12**	**14**	**16**	**19**	**24**	**27**	**37**
1.0 mm²	18	15	13	13	10	9	8	8	7	7	7	6	6	5
1.5 mm²	23	20	16	16	13	12	11	10	9	9	9	8	7	7
2.5 mm²	30	26	21	21	17	16	14	13	12	12	11	11	10	9
4 mm²	40	34	28	28	23									
6 mm²	52	44	36	36	30									
10 mm²	72	61	50	50	42									
16 mm²	96	82	67	67	56									
25 mm²	127	108	89	89	74									
35 mm²	157	133	110	110	91									
50 mm²	196	167	137	137										
70 mm²	242	206	169	169										
95 mm²	293	249	205	205										
120 mm²	339	288	237	237										
150 mm²	389	331	272	272										
185 mm²	444	377	311	311										
240 mm²	522	444	365	365										
300 mm²	601	511	421	421										

CORRECTION FACTORS FOR AMBIENT TEMPERATURE

AMBIENT TEMPERATURE	35 °C	40 °C	**45 °C**	50 °C	55 °C	60 °C	65 °C	70 °C	75 °C	80 °C
CORRECTION FACTOR	1.10	1.05	**1.00**	0.94	0.88	0.82	0.74	0.64	0.58	0.47

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SHORT CIRCUIT CURRENT

Maximum permissible short circuit current. 0.6/1 kV and 1,8/3 kV 90 °C marine cables.

Based on formula:

$$Ik = 226 \times \frac{S}{\sqrt{t}} \times \sqrt{\ln \frac{234 + Tk}{234 + Tb}}$$

Formula 1:

$$Ik = 146 \times \frac{S}{\sqrt{t}}$$

Ik = Max. permissible short circuit current.
S = Cross-section of the conductor in mm²
t = Duration of the short circuit in s.
Tk = Max. rated conductor temperature
Tb = Max. rated conductor temperature, norm., °C

Formula 1: For 0.6/1 kV and 1.8/3 kV cable with XLPE with max. operating temperature of 90 °C (**Tb**) and short circuit temperature of 250 °C (**Tk**).

CROSS-SECTION OF CONDUCTOR IN mm²	DURATION OF SHORT CIRCUIT IN s.					
	0.2	0.5	1	2	3	10
1.0	0.3	0.2	0.1	0.1	0.1	0.0
1.5	0.5	0.3	0.2	0.2	0.1	0.1
2.5	0.8	0.5	0.4	0.3	0.2	0.1
4	1.3	0.8	0.6	0.4	0.3	0.2
6	2.0	1.2	0.9	0.6	0.5	0.3
10	3.3	2.1	1.5	1.0	0.8	0.5
16	5.2	3.3	2.3	1.7	1.3	0.7
25	8.2	5.2	3.7	2.6	2.1	1.2
35	11.4	7.2	5.1	3.6	3.0	1.6
50	16.3	10.3	7.3	5.2	4.2	2.3
70	22.9	14.5	10.2	7.2	5.9	3.2
95	31.0	19.6	13.9	9.8	8.0	4.4
120	39.2	24.8	17.5	12.4	10.1	5.5
150	49.0	31.0	21.9	15.5	12.6	6.9
185	60.4	38.2	27.0	19.1	15.6	8.5
240	78.4	49.6	35.0	24.8	20.2	11.1
300	97.9	61.9	43.8	31.0	25.3	13.9
	Short circuit current in kA					

SHORT CIRCUIT FACTOR

Short Circuit Factor can be calculated by following formula:

$$\text{SHORT CIRCUIT FACTOR} = \frac{\text{SHORT CIRCUIT CURRENT}}{\text{CURRENT RATING}}$$

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RATED VOLTAGES

Designating the of the rated voltages of cables are **U_o/U (U_m)**, where

U_o is the rated power-frequency voltage between phase conductor and earth or metallic screen, for which the cable is designed.

U is the rated power-frequency voltage between phase conductors for which the cable is designed.

U_m is the maximum value of the "highest system voltage" for which the cable may be used.

DC For 0,6/1 kV cables, the DC voltages, maximum of 1.5 times the AC voltage may be provided so that the voltage to earth does not exceed U_{ODC}.

CABLE VOLTAGE	AC			DC	
	U_0	U	U_m	U	U_{ODC}
250 V	150 V	250 V	300 V	375 V	250 V
0.6/1 kV	0.6 kV	1.0 kV	1.2 kV	1.5 kV	0.9 kV
1.8/3 kV	1.8 kV	3.0 kV	3.6 KV	4.5 kV	2.7 kV

TEST VOLTAGES FOR ROUTINE TESTS (RT)

Test voltages specified in standard IEC 60092-350

RATED VOLTAGE OF CABLE UO/U, kV	ALTERNATING CURRENT (AC), kV	DIRECT CURRENT (DC), kV
0.15/0.25	1.5	3.6
0.6/1	3.5	8.4
1.8./3	6.5	15.6

The test voltage shall be increased gradually to the specified value and no break-down of the insulation shall occur. Helmacab uses DC test voltage.

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SHORT TIME DUTY

Short time duty according to the standard IEC 60092-352 0.6/1 kV 90 °C marine cables.

If a cable is intended to supply motor or equipment operating for periods of half an hour or one hour, its current rating given in table “current rating”, may be increased using the relevant correction factors given by formula:

$$\text{CORRECTION FACTOR} = \sqrt{\frac{1,2}{1-\exp(-t_s/T)}}$$

t_s = service time, min.
T = Time constant, min.

T = 0.245 x Ø $^{1.35}$
(**Ø** = Overall diameter of the cable, mm)
3 x **T** Critical duration = min. rest time

Ø of the cable, mm.	Service time 30 min.	60 min.	T, Time constant, min.	3 x T Critical duration, min.
1	1.058	1.058	0.245	0.735
2	1.058	1.058	0.625	1.87
3	1.058	1.058	1.08	3.24
4	1.058	1.058	1.59	4.78
5	1.058	1.058	2.15	6.46
6	1.058	1.058	2.75	8.26
7	1.058	1.058	3.39	10.2
8	1.059	1.058	4.06	12.2
9	1.059	1.058	4.76	14.3
10	1.061	1.058	5.48	16.5
20	1.126	1.066	14.0	41.9
30	1.255	1.105	24.2	72.5
40	1.403	1.173	35.6	107
50	1.554	1.254	48.2	145
60	1.705	1.341	61.6	185

Correction factor.

INTERMITTENT SERVICE

Correction factor for intermittent service according to the standard IEC 60092-352

The correction factor given hereby has been roughly calculated for periods of 10 min, of which 4 min are with constant load and 6 min without load.

Intermittence period = 10 min.
Intermittence ratio = 40%.

$$Fi = \sqrt{\frac{1-\exp(-10/T)}{1-\exp(-4/T)}}$$

Ø of the cable, mm.	Correction factor.
1	1.000
2	1.001
3	1.012
4	1.042
5	1.083
6	1.127
7	1.170
8	1.208
9	1.242
10	1.273
20	1.433
30	1.490
40	1.518
50	1.534
60	1.544

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VOLTAGE DROP

Cable types: All 0.6/1 kV and 1.8/3.0 kV cables

Size	Resistance at 20 °C ohm/km	Resistance at 90 °C ohm/km	Voltage reduction mV/Am*	Resistance at 45 °C ohm/km	Current rating A**	Voltage reduction V/m***
1.0 mm²	18.1	23.1	46.2	19.9	18	0.72
1.5 mm²	12.1	15.4	30.9	13.3	23	0.61
2.5 mm²	7.41	9.45	18.9	8.14	30	0.49
4 mm²	4.61	5.88	11.8	5.06	40	0.41
6 mm²	3.08	3.93	7.85	3.38	52	0.35
10 mm²	1.83	2.33	4.67	2.01	72	0.29
16 mm²	1.15	1.47	2.93	1.26	96	0.24
25 mm²	0.727	0.927	1.85	0.798	127	0.20
35 mm²	0.524	0.668	1.34	0.575	157	0.18
50 mm²	0.387	0.493	0.987	0.425	196	0.17
70 mm²	0.268	0.342	0.683	0.294	242	0.14
95 mm²	0.193	0.246	0.492	0.212	293	0.12
120 mm²	0.153	0.195	0.390	0.168	339	0.11
150 mm²	0.124	0.158	0.316	0.136	389	0.11
185 mm²	0.0991	0.1264	0.253	0.1088	444	0.097
240 mm²	0.0754	0.0961	0.192	0.0828	522	0.086
300 mm²	0.0601	0.0766	0.153	0.0660	601	0.079

* at 90 °C
** For continuous service (single core, ambient temperature 45 °C)
*** at max. current rating for continuous service at 45 °C

Cable types: LKSM-HF 250V, RFE-HF, RFE-HF(i), RFA-HF, RFA-HF(i), RFE-FRHF, RFE-FRHF(i), RFA-FRHF, RFA-FRHF(i)

Size	Resistance at 20 °C ohm/km	Maximum conductor temperature, °C	Resistance at 45 °C ohm/km	Voltage reduction mV/Am at 45 °C*	Resistance at 90 °C ohm/km	Voltage reduction mV/Am at 90 °C*
0.5 mm²	40.4	90	44.4	88.7	51.5	103.0
0.75 mm²	26.0	90	28.6	57.1	33.2	66.3
1.5 mm²	12.8	90	14.1	28.1	16.3	32.6

* at 90 °C
** For continuous service (single core, ambient temperature 45 °C)
*** at max. current rating for continuous service at 45 °C

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PE-RULES

PE-Rules **according to the standard IEC 60092-352.** Table shows how to determinate sizes of earth continuity conductors and equipment earthing connections.

ARRANGEMENT OF EARTH CONDUCTOR	CROSS-SECTION AREA OF MAIN CURRENT CARRYING CONDUCTOR	MIN. CROSS-SECTION AREA OF EARTH CONDUCTOR
Insulated yellow/green earth conductor in cable	Q ≤ 16 mm² 25 mm² Q ≥ 35 mm²	Q 16 mm² 50 % of Q
Insulated yellow/green earth conductor in cable split into three separate.	Q ≤ 16 mm² 25 mm² Q ≥ 35 mm²	3 pcs Q/3 3 pcs 6 mm² 50 % of Q
Use copper wire braid armour, e.g. LKSM- type cables	Q ≤ 16 mm² 25 mm² Q ≥ 35 mm²	Q 16 mm² 50 % of Q
"Separately installed earth conductor for fixed installation, e.g. LKEM-HF 0.6/1 kV yellow/green coloured."	2.5 < Q < 120 mm² Q ≥ 120 mm²	50 % of Q, min. 4 mm² 70 mm²

Q= Cross-section area of main current carrying conductor

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