

Report

Title	Case study 5-2: A 400kV LPOF Cable (flat, cb)
Project	Verification CIGRE TB 880
Created	Date: 2025-05-26 Time: 13:09 Software version: f8c9 (2025-05-24)

Arrangement

Arrangement	buried project (#46706)
Options	None
CIGRE TB 880, guidance points	02, 06, 09, 26, 31
Systems	A

Statistics

Number of iterations of the solver	N_{calc}	10
Sum of currents from all systems	I_{sum}	1585.2 A
Sum of average conductor temperatures from all systems	θ_{sum}	81.06 °C
Number of overheated electrical systems		0
Sum of losses from all systems	W_{sum}	117.53 W/m



Systems

Following systems are active in the arrangement:

#	Object	Current [A]	Temp. [°C]	Losses [W/m]	Load
		I_c	$\theta_c \mid \theta_e$	W_{sys}	LF
A	16320 CIGRE TB 880 Case 5 400kV LPOF Cable	1585.2	85.0 59.2	117.5	1.00

Objects

Following objects are used:

16320 CIGRE TB 880 Case 5 400kV LPOF Cable

Ambient

Calculation method		IEC Standard (directly buried)
Ambient temperature	θ_a	20 °C
Thermal resistivity soil	ρ_4	1 K.m/W
Thermal conductivity soil	k_4	1 W/(m.K)
Volumetric heat capacity soil material	$c_{p,soil}$	2136.8 J/(kg.K)
$10^{-4} \frac{k_4^{0.2}}{4.68}$		
Thermal diffusivity soil	δ_{soil}	5.00e-7 m ² /s
Ratio thermal resistivity dry/moist soil	v_4	1
$\frac{\rho_{4d}}{\rho_4}$		

Constants

Standard acceleration of gravity	g	9.80665 m/s ²
Archimedes' constant π	π	3.141592653589793
Absolute temperature	θ_{abs}	273.15 K
Stefan Boltzmann constant	σ	5.67036713e-8 W/m ² K ⁴
Vacuum permeability	μ_0	1.2566370614359173e-6 H/m
Vacuum permittivity	ϵ_0	8.854187817620389e-12 F/m

System A (Extra high voltage cable)

Warning! The conductor temperature exceeds the maximum allowable temperature of 80.0 °C under emergency overload operation.

Ampacity

Cable CIGRE TB 880 Case 5 400kV LPOF Cable

Rounded value, CIGRE TB 880

I_c 1580 A

Conductor current

I_c 1585.2 A

$$\sqrt{\frac{\theta_c - \theta_a + (v_4 - 1) \Delta\theta_x - v_4 \Delta\theta_p - \Delta\theta_d}{R_c (T_1 + n_{ph} (1 + \lambda_1) T_2 + (1 + \lambda_1 + \lambda_2 + \lambda_3) (n_{ph} T_3 + n_{cc} (T_{4i} + T_{4ii} + T_{4\mu} v_4)) + n_{cc} \lambda_4 \left(\frac{T_{4ii}}{2} + T_{4\mu} v_4 \right))}}$$

Operating voltage

U_o 400 kV

Angular frequency

ω 314.2 rad/s

$$2\pi f$$

Number of sources in system

N_c 3

Number of conductors combined

n_{cc} 1

Load

System frequency

f 50 Hz

Continuous load

LF 1 p.u.

Arrangement

Arrangement

flat

Position cable 1

$x_1|y_1$ 0.0 | 1000.0 mm

Position cable 2

$x_2|y_2$ -500.0 | 1000.0 mm

Position cable 3

$x_3|y_3$ 500.0 | 1000.0 mm

Separation of conductors in a system

s_c 500 mm

Mean distance between the phases

a_m 629.96 mm

Geometric mean distance between phases of the same system

GMD 0.62996 m

$$2^{\frac{1}{3}} S_m$$

Depth of laying of sources

L_c 1000 mm

Depth of laying

L_{cm} 1 m

Outer diameter

D_o 0.148 m

Substitution coefficient u

u 13.5135

$$\frac{2L_{cm}}{D_o}$$

Geometric constant of circle buried

g_u 26.99

$$u + \sqrt{u^2 - 1}$$

Temperature

Temperature conductor

θ_c 1: 85 | 2: 79.07 | 3: 79.1 °C

$$\theta_a + \Delta\theta_c - (v_4 - 1) \Delta\theta_x + v_4 \Delta\theta_p$$

Temperature screen/sheath

θ_s 1: 63.67 | 2: 58.04 | 3: 58.07 °C

Temperature sheath

θ_{sh} 1: 63.67 | 2: 58.04 | 3: 58.07 °C

$$\theta_c - T_1 \left(W_c + \frac{W_d}{2} \right)$$

External temperature object

θ_e 1: 59.23 | 2: 53.94 | 3: 53.96 °C

$$\theta_c - T_1 \left(W_c + \frac{W_d}{2} \right) - n_{ph} T_2 (W_c (1 + \lambda_1) + W_d) - n_{ph} T_3 (W_I + W_d)$$

Temperature rise

Temperature rise conductor	$\Delta\theta_c$	1: 65 2: 59.0671 3: 59.0993 K
$n_{ph} (W_c T_{int} + W_d T_d) + n_{cc} \left(W_d (T_{4i} + T_{4ii} + v_4 T_{4ss}) + (W_c + W_s + W_{ar} + W_{sp}) (T_{4i} + T_{4ii} + v_4 T_{4\mu}) + W_{duct} \left(\frac{T_{4ii}}{2} + v_4 T_{4\mu} \right) \right)$		
Temperature rise dielectric losses	$\Delta\theta_d$	1: 8.1182 2: 7.7697 3: 7.7653 K
$W_d (n_{ph} T_d + n_{cc} (T_{4i} + T_{4ii} + T_{4ss} v_4))$		
Temperature rise by other buried objects	$\Delta\theta_p$	0 K
$\sum_{k=1}^q \Delta\theta_{kp}$		
Critical soil temperature rise	$\Delta\theta_x$	0 K

Losses**Ohmic**

Conductor losses (phase)	W_c	1: 31.655 2: 31.177 3: 31.18 W/m
$I_c^2 R_c$		
Screen/sheath losses (phase)	W_s	1: 3.704 2: 0.959 3: 1.016 W/m
$\lambda_1 W_c$		
Duct losses	W_{duct}	0 W/m
Ohmic losses (phase)	W_I	1: 35.359 2: 32.137 3: 32.196 W/m
$W_c (1 + \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4)$		

Dielectric

Dielectric losses (phase)	W_d	5.946 W/m
$\omega C_b \left(1000 \frac{U_o}{\sqrt{3}} \right)^2 \tan \delta_i$		

Total

Total losses (phase)	W_t	1: 41.305 2: 38.083 3: 38.142 W/m
$W_I + W_d$		
Total losses (object)	W_{tot}	1: 41.305 2: 38.083 3: 38.142 W/m
$n_{ph} W_t$		
Total losses (system)	W_{sys}	117.53 W/m

Thermal resistance

Thermal resistance ambient	$T_{4\mu}$	1: 0.9498 2: 0.8912 3: 0.8905 K.m/W
$= T_{4ss} = T_{4iii} = \frac{\rho_4}{2\pi} (\ln(g_u) + \ln(F_{mh}))$		
Mutual heating coefficient	F_{mh}	1: 14.474 2: 10.015 3: 9.969
$\prod_{k=1}^q \frac{d_{pk1}}{d_{pk2}}$		

Cable

Internal thermal resistance for current losses	T_{int}	1: 0.736 2: 0.7267 3: 0.7269 K.m/W
$\frac{T_1}{n_{ph}} + (1 + \lambda_1) T_2 + (1 + \lambda_1 + \lambda_2 + \lambda_3) T_3$		
Internal thermal resistance for dielectric losses	T_d	0.41548 K.m/W
$\frac{T_1}{2n_c} + T_2 + T_3$		

Other characteristics

Earthing

earthing screen/sheath		Cross-bonding
Length of sections	a_S	1.0 1.0 1.0 p.u.
Minor ratio of section lengths $\frac{a_{S2}}{a_{S1}}$	p_{cb}	1
Major ratio of section lengths $\frac{a_{S3}}{a_{S1}}$	q_{cb}	1

Loss factor

Loss factor shield (screen/sheath) $\lambda_{11} + \lambda_{12}$	λ_1	1: 0.117 2: 0.0308 3: 0.0326
Loss factor shield, circulating currents	λ_{11}	0
Loss factor shield, eddy currents $\frac{R_{sh}}{R_c} \left(g_s \lambda_0 (1 + \Delta_1 + \Delta_2) + \frac{(\beta_1 t_{sh})^4}{12 \cdot 10^{12}} \right)$	λ_{12}	1: 0.117 2: 0.0308 3: 0.0326
Electrical resistance shield/armour	R_e	1: 3.3393e-2 2: 3.2747e-2 3: 3.2751e-2 Ω/km
Substitution coefficient λ_0 for eddy-currents $6 \frac{m_0^2}{1 + m_0^2} \left(\frac{d_e}{2s_c} \right)^2$ $1.5 \frac{m_0^2}{1 + m_0^2} \left(\frac{d_e}{2s_c} \right)^2$ $1.5 \frac{m_0^2}{1 + m_0^2} \left(\frac{d_e}{2s_c} \right)^2$	λ_0	1: 0.0422 2: 0.0108 3: 0.0108
Substitution coefficient Δ_1 for eddy-currents $0.86m_0^{3.08} \left(\frac{d_e}{2s_c} \right)^{1.4m_0+0.7}$ $\frac{-0.74(m_0+2)\sqrt{m_0}}{2+(m_0-0.3)^2} \left(\frac{d_e}{2s_c} \right)^{m_0+1}$ $4.7m_0^{0.7} \left(\frac{d_e}{2s_c} \right)^{0.16m_0+2}$	Δ_1	1: 0.0103 2: -0.0144 3: 0.0495
Substitution coefficient Δ_2 for eddy-currents 0 $0.92m_0^{3.7} \left(\frac{d_e}{2s_c} \right)^{m_0+2}$ $21m_0^{3.3} \left(\frac{d_e}{2s_c} \right)^{1.47m_0+5.06}$	Δ_2	1: 0 2: 0.0015 3: 0
Substitution coefficient m_0 for eddy-currents $10^{-7} \frac{\omega}{R_{sh}}$	m_0	1: 0.9408 2: 0.9593 3: 0.9592 Hz.m/ Ω
Substitution coefficient β_1 for eddy-currents $\sqrt{\frac{4\pi\omega}{10^7 \rho_{sh} (1 + \alpha_{sh} (\theta_{sh} - 20))}}$	β_1	1: 108.7215 2: 109.7874 3: 109.7816

Substitution coefficient g_s for eddy-currents	g_s	1: 1.016655 2: 1.016839 3: 1.016838
$1 + \left(\frac{t_{sh}}{D_{sh}} \right)^{1.74} (10^{-3} \beta_1 D_{sh} - 1.6)$		
Factor F_e eddy-current losses	F_e	1
Loss factor armour	λ_2	0

Drying-out of soil

Characteristic diameter drying zone	D_{dry}	0.148 m
Depth characteristic diameter drying zone	L_{dry}	1 m
Geometric constant of circle drying zone	g_{dry}	1 p.u.
Substitution coefficient g	g_a	1

Electrical parameters

System

System length	L_{sys}	1000 m
Power factor	$\cos\varphi$	1

Resistance

Electrical resistance conductor $R_{cDC} (1 + y_s + y_p)$	R_c	1: 1.2597e-5 2: 1.2407e-5 3: 1.2408e-5 Ω /m
Electrical resistance DC conductor $R_{c20} (1 + \alpha_c (\theta_c - 20))$	R_{cDC}	1: 1.1299e-5 2: 1.1089e-5 3: 1.1090e-5 Ω /m
Skin effect factor conductor $\frac{x_s^4}{192 + 0.8x_s^4}$	y_s	1: 0.11107 2: 0.11492 3: 0.1149
Factor for skin effect on conductor $\sqrt{10^{-7} \frac{8\pi f}{R_{cDC}} k_s}$	x_s	1: 2.19952 2: 2.22024 3: 2.22012
Proximity effect factor conductor $\frac{x_p^4}{192 + 0.8x_p^4} \left(\frac{d_c}{s_c} \right)^2 \left(0.312 \left(\frac{d_c}{s_c} \right)^2 + \frac{1.18}{\frac{x_p^4}{192 + 0.8x_p^4} + 0.27} \right)$	y_p	1: 0.00382 2: 0.00392 3: 0.00392
Factor for proximity effect of conductors $\sqrt{10^{-7} \frac{8\pi f}{R_{cDC}} k_p}$	x_p	1: 2.02855 2: 2.04765 3: 2.04754
Electrical resistance sheath $R_{sh} (1 + \alpha_{sh} (\theta_{sh} - 20))$	R_{sh}	1: 3.3393e-5 2: 3.2747e-5 3: 3.2751e-5 Ω /m
Electrical resistance shield	R_s	1: 3.3393e-5 2: 3.2747e-5 3: 3.2751e-5 Ω /m
Reduction factor $\frac{R_s}{\sqrt{R_s^2 + X_s^2}}$	RF	1: 0.0551 2: 0.054 3: 0.0541

Electrical field strength, capacitive load current

Electrical field strength insulation inner/outer $\frac{U_e}{1000} \frac{1}{r_x \ln \left(\frac{r_{osc}}{r_{isc}} \right)}$	E_i	12.503 6.769 kV/mm
Radius to point x in insulation	r_x	30.1 55.6 mm

Line-to-ground voltage $\frac{1000U_o}{\sqrt{3}}$	U_e	230940.11 V
Capacitance insulation $\frac{1}{2\pi\epsilon_0} \frac{10^{-9}}{18} C_b$	C_b	2.535e-10 F/m $\rightarrow$ 0.2535 μ F
Capacitive load current $U_e \omega C_b$	I_C	1.839e-2 A/m $\rightarrow$ 18.3911 A
Charging capacity $n_{ph} U_e^2 \omega C_b$	P_C	4247.2488 var/m $\rightarrow$ 4247.2488 kvar
Capacitive earth short-circuit current $U_e \omega C_E$	I_{Ce}	1.839e-2 A/m

Reactance

Self reactance conductor $\omega \frac{\mu_0}{2\pi} \ln \left(\frac{D_E}{GMR_c} \right)$	X_a	6.668e-4 Ω /m $\rightarrow$ 0.6668 Ω
Self reactance screen/sheath $\omega \frac{\mu_0}{2\pi} \ln \left(\frac{2s_c}{d_s} \right)$	X_e	1.320e-4 Ω /m $\rightarrow$ 0.132 Ω
Mutual reactance between conductors flat formation without transposition $\omega \frac{\mu_0}{2\pi} \ln 2$	X_m	4.355e-5 Ω /m

Induced current (approximate)

Induced circulating current shield $\max \left(I_c \sqrt{\frac{\lambda_{11, sb} R_c}{R_s}} \right) I_k$	I_s	1: -23.169+40.129j 2: 46.338+0.000j 3: -23.169-40.129j A
Loss factor shield, circulating currents	$\lambda_{11, sb}$	1: 0.0020+0.0000j 2: 0.0023+0.0000j 3: 0.0019+0.0000j

Load, Voltage drop

Apparent power generator-side $\sqrt{3} U_o I_c$	S_G	1.098 GVA
Voltage drop $\sqrt{3} (R_c \cos \varphi + \omega L_m \sin \varphi)$	V_{drop}	0.022 V/(A.km) $\rightarrow$ 34.6 V = 0.01%
Inductance (mean) $\frac{\mu_0}{2\pi} \ln \left(\frac{GMD}{GMR_c} \right)$	L_m	6.629e-7+0.000e0j H/m $\rightarrow$ 0.6629 mH

Telegrapher equation

Surge impedance $\sqrt{\frac{Z_1}{Y_1}}$	Z_C	1: 51.1627-1.5459j 2: 51.1620-1.5226j 3: 51.1620-1.5227j Ω
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Propagation constant	γ_C	1: 1.231e-7+4.074e-6j 2: 1.213e-7+4.074e-6j 3: 1.213e-7+4.074e-6j
$\sqrt{Z_1 Y_1}$		
Impedance valid up to 100 Hz without earth return		
Positive sequence admittance	Y_1	0.000e0+7.964e-8j S/m → 0.0000+0.0001j S
$G + j\omega C_b$		
Positive sequence impedance	Z_1	1: 1.260e-5+2.083e-4j 2: 1.241e-5+2.083e-4j 3: 1.241e-5+2.083e-4j Ω/m
$R_1 + jX_1$		
Positive sequence reactance	X_1	2.083e-4 Ω/m → 0.2083 Ω
$\omega \frac{\mu_0}{2\pi} \ln \left(\frac{GMD}{GMR_c} \right)$		

Cable datasheet

Title

CIGRE TB 880 Case 5 400kV LPOF Cable (#16320)

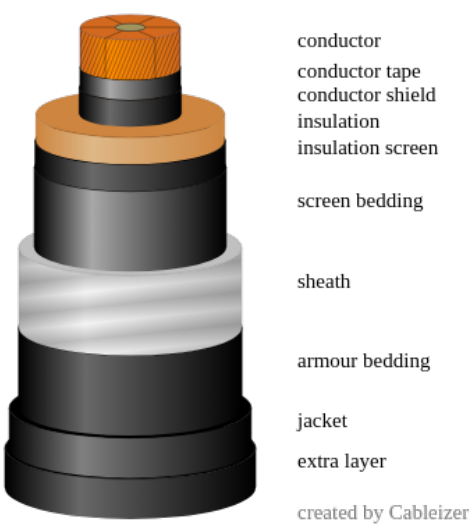
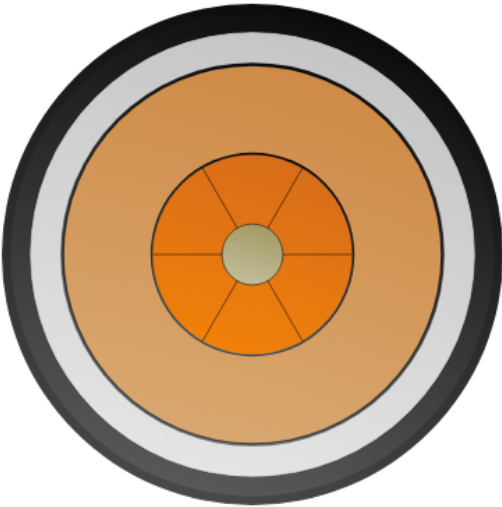
Cable is used in following systems: [A](#)

CIGRE TB 880, guidance points

15, 20, 23, 25, 30, 32, 33, 34, 38, 39, 42, 44, 45

General Data

Rated line-to-line voltage	U_n	400 kV
Base voltage for tests	U_0	230 kV
Highest voltage for equipment	U_m	420 kV
Nominal system frequency	f	50 Hz
Number of conductors cable	n_c	1
Number of phases in a cable	n_{ph}	1



Cable elements

Conductor

Cross-sectional area conductor	A_c	1 x 2461 mm ²
Conductor material	M_c	Copper, round Milliken, compacted
External diameter conductor	d_c	58.8 mm
Internal diameter conductor	d_{ci}	18 mm
Radius conductor	r_c	29.4 mm
$\frac{d_c}{2}$		
Thickness of hollow conductor	t_c	20.4 mm
$\frac{d_c}{2} - \frac{d_{ci}}{2}$		

Insulation

Insulation material	M_i	Polypropylene laminated paper (PPLP)
Thickness conductor tape	t_{ct}	0.25 mm
Thickness conductor shield	t_{cs}	0.45 mm
Thickness insulation	t_{ins}	25.5 mm
Thickness insulation screen	t_{is}	0.6 mm

Thickness insulation $t_{ct} + t_{cs} + t_{ins} + t_{is}$	t_i	26.8 mm
Material of conductor tapes		Semiconducting tapes
Screen bedding		
Screen bedding material		Water-blocking tapes, semi-conducting
Thickness screen bedding	t_{scb}	0.45 mm
Sheath		
Sheath material	M_{sh}	Aluminium
Thickness sheath corrugated	t_{sh}	2.9 mm Yes
Depth of corrugation	H_{sh}	5.9 mm
Length corrugated sheath (pitch)	L_{pitch}	28 mm
Armour bedding		
Armour bedding material	M_{ab}	PVC/bitumen tapes
Thickness armour bedding	t_{ab}	0.2 mm
Jacket		
Jacket material	M_j	Polyethylene (LD/MDPE, ST3)
Thickness jacket	t_j	5.5 mm
Thickness of additional layer over jacket	t_{jj}	2.6 mm
Overall		
External diameter object	D_e	148 mm
Absorption coefficient solar radiation	σ_{sun}	0.4
Emissivity cable	ϵ_e	0.9
Reflectivity cable $1 - \epsilon_e$	η_e	0.1
Mass cable $m_{hollow} + m_{metal}$	m_{tot}	34.957 kg/m
Electrical		
Conductor		
Electrical resistance DC conductor 20°C	R_{c20}	9.0000e-6 Ω /m
Standard DC resistance of conductor	R_{co}	0.009 Ω /km
Coating of wires		plain
Insulation of wires		bare uni-directional wires
Skin effect coefficient	k_s	0.435
Proximity effect coefficient	k_p	0.37
Geometric mean radius conductor $K_{GMR} r_{z1}$	GMR_c	0.0229 m
Factor geometric mean radius	K_{GMR}	0.779
Constant relating to conductor formation	K_{BICC}	0.051
Number of wires conductor	n_{cw}	127
Diameter of wires conductor (average)	d_{cw}	58.8 mm

Insulation

Capacitance, with approximation (CIGRE TB 880)	C_b	2.535e-10 F/m
$\frac{1}{2\pi\epsilon_0} \frac{10^{-9}}{18} C_b$		
Capacitance (exact)	C_b	2.538e-10 F/m
$\frac{2\pi\epsilon_0\epsilon_i}{\ln\left(\frac{r_{osc}}{r_{isc}}\right)}$		
Capacitance to earth	C_E	2.535e-10 F/m
C_b		
Vacuum permittivity	ϵ_0	8.854187817620389e-12 F/m
Radius above the inner semi-conducting layer	r_{isc}	30.1 mm
$\frac{d_c}{2} + t_{ct} + t_{cs}$		
Radius over capacitive insulation layers	r_{osc}	55.6 mm
$\frac{D_{ins}}{2}$		
Velocity of propagation	v_{prop}	179160.3 km/s
$\frac{1}{1000\sqrt{\mu_0\epsilon_0\epsilon_i}}$		

Screen + Sheath

Electrical resistance sheath	R_{sh}	2.8395e-5 Ω/m
$10^6 \frac{F_{cor,sh}\rho_{sh}}{A_{sh}}$		
Length corrugated sheath	$L_{cor,sh}$	31.2 mm
$\frac{0.25L_{pitch}^2 + H_{sh}^2}{H_{sh}} \left(\arcsin\left(\frac{L_{pitch}H_{sh}}{0.25L_{pitch}^2 + H_{sh}^2}\right) + 0 \right)$		
Effective length per unit pitch length corrugated sheath	$F_{cor,sh}$	1.1145
$\frac{0.25L_{pitch}^2 + H_{sh}^2}{L_{pitch}H_{sh}} \left(\arcsin\left(\frac{L_{pitch}H_{sh}}{0.25L_{pitch}^2 + H_{sh}^2}\right) + 0 \right)$		
Electrical resistance screen/sheath 20°C	R_{so}	2.839e-2 Ω/km

Radius

Radius conductor	r_{z1}	0.0294 m
Radius shield (inner)	r_{z2}	0.0552 m
Radius shield (outer)	r_{z3}	0.0552 m
Radius sheath (inner)	$r_{z2,sh}$	0.0552 m
Radius sheath (outer)	$r_{z3,sh}$	0.06715 m
Radius outersheath	r_{z6}	0.074 m

Material parameters**Conductor**

Electrical resistivity conductor material	ρ_c	1.724e-8 Ω.m
Temperature coefficient conductor material	α_c	3.93e-3 1/K
Reciprocal of temperature coefficient conductor material	β_c	2.345e2 K
Volumetric heat capacity conductor material	σ_c	3.45e6 J/(K.m ³)
Thermal conductivity conductor material	k_c	384.62 W/(m.K)
Density conductor material	ζ_c	8.94 g/cm ³

Insulation

Relative permittivity insulation material	ϵ_i	2.8
Loss factor insulation material	$\tan\delta_i$	0.0014
Thermal resistivity insulation material	ρ_i	5.42 K.m/W
Volumetric heat capacity insulation material	σ_i	2.00e6 J/(K.m ³)
Density insulation material	ζ_i	0.9 g/cm ³
Max. temperature conductor	θ_{cmax}	70 °C
Max. temperature conductor, emergency overload	θ_{cmaxeo}	80 °C
Max. temperature conductor, short-circuit	θ_{cmaxsc}	130 °C

Conductor tape

Thermal resistivity conductor tape	ρ_{ct}	6 K.m/W
Density tape material	ζ_{tape}	0.34 g/cm ³

Conductor shield

Thermal resistivity conductor shield	ρ_{cs}	5 K.m/W
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Insulation screen

Thermal resistivity insulation screen	ρ_{is}	5 K.m/W
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Screen bedding

Thermal resistivity screen bedding	ρ_{scb}	6 K.m/W
Volumetric heat capacity screen bedding	σ_{scb}	2.00e6 J/(K.m ³)
Density tape material	ζ_{tape}	0.34 g/cm ³

Sheath

Specific electrical resistivity sheath material	ρ_{sh}	2.840e-8 Ω .m
Temperature coefficient sheath material	α_{sh}	4.03e-3 1/K
Reciprocal of temperature coefficient sheath material	β_{sh}	2.281e2 K
Volumetric heat capacity sheath material	σ_{sh}	2.50e6 J/(K.m ³)
Thermal conductivity sheath material	k_{sh}	208.3 W/(m.K)
Density sheath material	ζ_{sh}	2.712 g/cm ³

Armour bedding

Thermal resistivity armour bedding	ρ_{ab}	6 K.m/W
Volumetric heat capacity armour bedding	σ_{ab}	2.00e6 J/(K.m ³)
Density armour bedding material	ζ_{ab}	1.2 g/cm ³

Jacket

Thermal resistivity jacket material	ρ_j	3.5 K.m/W
Thermal resistivity additional layer	ρ_{jj}	2.5 K.m/W
Volumetric heat capacity jacket material	σ_j	2.40e6 J/(K.m ³)
Electrical conductivity jacket material	κ_j	1.00e-16 S/m
Density jacket material	ζ_j	0.93 g/cm ³

Thermal resistance**Internal thermal resistances for rating calculation**

Thermal resistance conductor—sheath $T_{ct} + T_{cs} + T_{ins} + T_{is} + T_{scb} + T_{scs} + T_{dsh}$	T_1	0.6158 K.m/W
Thermal resistance armour bedding	T_2	0 K.m/W
Thermal resistance jacket $T_{ab} + T_j + T_{jj}$	T_3	0.1076 K.m/W

Thickness conductor—sheath $t_i + t_{scb} + t_{scs} + \frac{H_{sh} + \Delta H}{2}$	t_1	30.32 mm
Thickness sheath—armour $\frac{H_{sh} + \Delta H}{2} + t_{ab}$	t_2	3.28 mm
Thickness armour—surface $t_j + t_{jj}$	t_3	8.1 mm

Cable elements

Thermal resistance, transient $T_1 + T_2 + T_3$	T_{tot}	0.7234 K.m/W
Thermal resistance insulation $T_{ct} + T_{cs} + T_{ins} + T_{is}$	T_i	0.55775 K.m/W
Thermal resistance conductor tape $\frac{\rho_{ct}}{2\pi} \ln \left(\frac{d_c + 2t_{ct}}{d_c} \right)$	T_{ct}	0.00809 K.m/W
Thermal resistance conductor shield $\frac{\rho_{cs}}{2\pi} \ln \left(\frac{D_{cs}}{D_{cs} - 2t_{cs}} \right)$	T_{cs}	0.01199 K.m/W
Thermal resistance insulation $\frac{\rho_i}{2\pi} \ln \left(\frac{D_{ins}}{D_{ins} - 2t_{ins}} \right)$	T_{ins}	0.52914 K.m/W
Thermal resistance insulation screen $\frac{\rho_{is}}{2\pi} \ln \left(\frac{D_{ins} + 2t_{is}}{D_{ins}} \right)$	T_{is}	0.00854 K.m/W
Thermal resistance screen bedding $\frac{\rho_{scb}}{2\pi} \ln \left(\frac{D_{scb}}{D_i} \right)$	T_{scb}	0.00762 K.m/W
Thermal resistance corrugation filling $\frac{\rho_{scs}}{2\pi} \ln \left(1 + \frac{2 \frac{H_{sh} + \Delta H}{2}}{D_{scs}} \right)$	T_{dsh}	0.05048 K.m/W
Thermal resistance armour bedding $\frac{\rho_{ab}}{2\pi} \ln \left(\frac{D_{ab}}{D_{shj} - (H_{sh} + \Delta H)} \right)$	T_{ab}	0.04868 K.m/W
Thermal resistance jacket $\frac{\rho_j}{2\pi} \ln \left(\frac{D_j - 2t_{jj}}{D_j - 2(t_j + t_{jj})} \right)$	T_j	0.04465 K.m/W
Thermal resistance additional layer $\frac{\rho_{jj}}{2\pi} \ln \left(\frac{D_j}{D_j - 2t_{jj}} \right)$	T_{jj}	0.01423 K.m/W

Dimensions**Diameter**

External diameter conductor d_c	d_c	58.8 mm
Diameter over conductor shield $d_c + 2(t_{ct} + t_{cs})$	D_{cs}	60.2 mm

Diameter over insulation $d_c + 2(t_{ct} + t_{cs} + t_{ins})$	D_{ins}	111.2 mm
Diameter over insulation incl. insulation screen $d_c + 2(t_{ct} + t_{cs} + t_{ins} + t_{is})$	D_i	112.4 mm
Diameter over insulation screen $d_c + 2t_i$	D_{is}	112.4 mm
Diameter over screen bedding $d_c + t_{i1} + 2t_{scb}$	D_{scb}	113.3 mm
Equivalent diameter of screen and sheath	d_s	122.35 mm
Mean diameter sheath $D_{shb} + t_{sh} + H_{sh} + \Delta H$	d_{sh}	122.35 mm
Diameter over sheath $D_{shb} + 2(t_{sh} + H_{sh} + \Delta H)$	D_{sh}	131.4 mm
Diameter over sheath jacket	D_{shj}	131.4 mm
Diameter over armour bedding $D_{sh} + 2t_{ab}$	D_{ab}	131.8 mm
Diameter over jacket $D_{ar} + 2(t_j + t_{jj})$	D_j	148 mm

Area

Cross-sectional area conductor	A_c	2461 mm ²
cross-sectional area (calculated) $\frac{\pi}{4}(d_c^2 - d_{ci}^2)$	A_c	2461 mm ²
Cross-sectional area insulation $\frac{\pi}{4}(D_{is}^2 - d_c^2)$	A_i	7207.1 mm ²
Cross-sectional area screen bedding $\pi t_{scb}(D_{scb} - t_{scb})$	A_{scb}	159.5 mm ²
Cross-sectional area sheath $d_{sh} t_{sh} \pi$	A_{sh}	1114.68 mm ²
Cross-sectional area armour bedding $\frac{\pi}{4}(D_{ab}^2 - (D_{ab} - t_{ab})^2)$	A_{ab}	41.4 mm ²
Cross-sectional area jacket $\frac{\pi}{4}(D_j^2 - (D_j - 2(t_j + t_{jj}))^2)$	A_j	3560 mm ²