Report

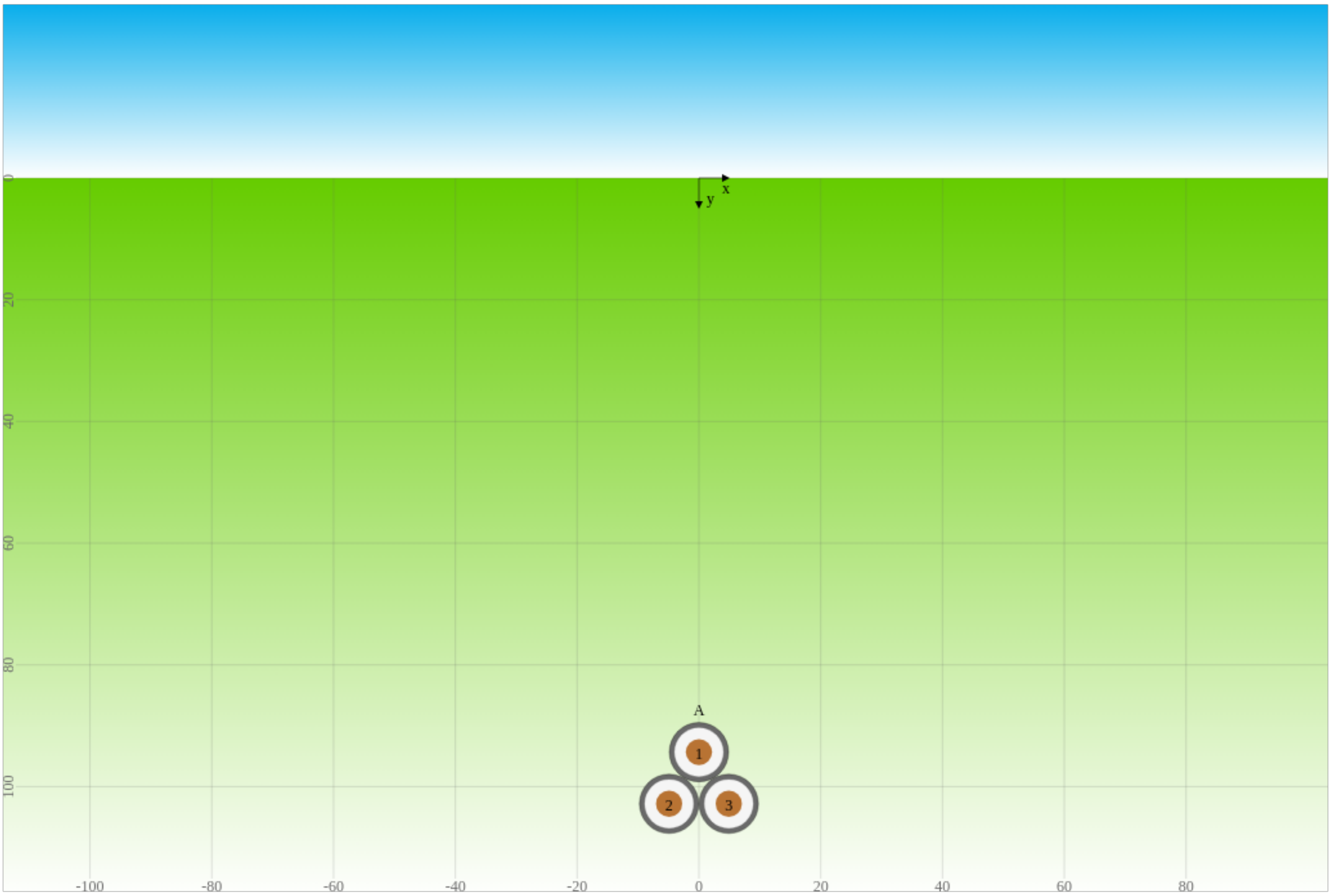
Title	Case study 1-1: Direct buried 132kV cables (trefoil, sb)
Project	Verification CIGRE TB 880
Created	Date: 2025-05-14 Time: 20:41 Software version: 3b07c (2025-05-14)

Arrangement

Arrangement	**buried project** (#46689)
Options	None
CIGRE TB 880, guidance points	02, 06, 26, 31
Systems	A

Statistics

Number of iterations of the solver	N_{calc}	10
Sum of currents from all systems	I_{sum}	990.54 A
Sum of average conductor temperatures from all systems	θ_{sum}	90 °C
Number of overheated electrical systems		0
Sum of losses from all systems	W_{sum}	118.06 W/m



Systems

Following systems are active in the arrangement:

#	Object	Current [A]	Temp. [°C]	Losses [W/m]	Load
		I_c	θ_c | θ_e	W_{sys}	LF
A	16301 CIGRE TB 880 Case 1 132kV cable	990.5	90.0 | 77.8	118.1	1.00

Objects

Following objects are used:

16301 CIGRE TB 880 Case 1 132kV 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 $10^{-4}\frac{{k_4}^{0.2}}{4.68}$	$c_{p,soil}$	2136.8 J/(kg.K)
Thermal diffusivity soil	δ_{soil}	5.00e-7 m^2/s
Ratio thermal resistivity dry/moist soil $\frac{\rho_{4d}}{\rho_4}$	v_4	1

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^2K^4
Vacuum permeability	μ_0	1.2566370614359173e-6 H/m
Vacuum permittivity	ϵ_0	8.854187817620389e-12 F/m

System A (High voltage cable)

Ampacity

Cable		CIGRE TB 880 Case 1 132kV cable
Rounded value, CIGRE TB 880	I_c	990 A
Conductor current	I_c	990.54 A

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

Operating voltage	U_o	132 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		trefoil
Position cable 1	$x_1\|y_1$	0.0 | 943.4 mm
Position cable 2	$x_2\|y_2$	-49.0 | 1028.3 mm
Position cable 3	$x_3\|y_3$	49.0 | 1028.3 mm
Separation of conductors in a system	s_c	98 mm
Mean distance between the phases	a_m	98 mm
Geometric mean distance between phases of the same system	GMD	0.098 m

S_m

Depth of laying of sources	L_c	1000 mm
Depth of laying	L_{cm}	1 m
Outer diameter	D_o	0.098 m
Substitution coefficient u	u	20.4082

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

Geometric constant of circle buried	g_u	40.7918

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

Temperature

Temperature conductor	θ_c	90 °C

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

Temperature screen/sheath	θ_s	81.47 °C

$$\frac{\theta_{sc} + \theta_{sh}}{2}$$

Temperature screen	θ_{sc}	81.68 °C

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

Temperature sheath	θ_{sh}	81.25 °C

$$\theta_{sc} - T_{scs}\left(W_c\,(1+\lambda_{11,sc}) + \frac{W_d}{2}\right)$$

External temperature object θ_e 77.84 °C

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

Temperature rise

Temperature rise conductor $\Delta\theta_c$ 70 K

$$n_{ph}\left(W_cT_{int} + W_dT_d\right) + n_{cc}\left(W_d\left(T_{4i}+T_{4ii}+v_4T_{4ss}\right) + \left(W_c+W_s+W_{ar}+W_{sp}\right)\left(T_{4i}+T_{4ii}+v_4T_{4\mu}\right) + W_{duct}\left(\frac{T_{4ii}}{2}+v_4T_{4\mu}\right)\right)$$

Temperature rise dielectric losses $\Delta\theta_d$ 0.8176 K

$$W_d\left(n_{ph}T_d + n_{cc}\left(T_{4i}+T_{4ii}+T_{4ss}v_4\right)\right)$$

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 21.733 W/m

$${I_c}^2R_c$$

Screen/sheath losses (phase) W_s 17.155 W/m

$$\lambda_1W_c$$

Duct losses W_{duct} 0 W/m

Ohmic losses (phase) W_I 38.888 W/m

$$W_c\left(1+\lambda_1+\lambda_2+\lambda_3+\lambda_4\right)$$

Dielectric

Dielectric losses (phase) W_d 0.465 W/m

$$\omega C_b\left(1000\frac{U_o}{\sqrt{3}}\right)^2\tan\delta_i$$

Total

Total losses (phase) W_t 39.353 W/m

$$W_I + W_d$$

Total losses (object) W_{tot} 39.353 W/m

$$n_{ph}W_t$$

Total losses (system) W_{sys} 118.06 W/m

Thermal resistance

Thermal resistance ambient $T_{4\mu}$ 1.4699 K.m/W

$$= T_{4ss} = T_{4iii} = 3\frac{\rho_4}{2\pi}\left(\ln\left(g_u\right) - 0.63\right)$$

Thermal resistance jacket T_3 0.0853 K.m/W

$$1.6T_3$$

Cable

Internal thermal resistance for current losses T_{int} 0.5532 K.m/W

$$\frac{T_1}{n_{ph}} + \left(1+\lambda_1\right)T_2 + \left(1+\lambda_1+\lambda_2+\lambda_3\right)T_3$$

Internal thermal resistance for dielectric losses $\frac{T_1}{2n_c} + T_2 + T_3$	T_d	0.28684 K.m/W

Other characteristics

Earthing

earthing screen/sheath	both-side bonding
Variation of spacing	No variation

Loss factor

Loss factor shield (screen/sheath) $\lambda_{11,sc} + \lambda_{11,sh} + F_e\lambda_{12}$	λ_1	0.7893
Loss factor shield, circulating currents $\frac{\frac{R_e}{R_c}}{1 + \left(\frac{R_e}{X_e}\right)^2}$	λ_{11}	0.7497
Loss factor shield, eddy currents $\frac{R_{sh}}{R_c}\left(g_s\lambda_0\left(1 + \Delta_1 + \Delta_2\right) + \frac{\left(\beta_1 t_{sh}\right)^4}{12{\cdot}10^{12}}\right)$	λ_{12}	0.0451
Electrical resistance shield/armour	R_e	1.3640e-1 Ω/km
Substitution coefficient λ_0 for eddy-currents $3\frac{{m_0}^2}{1 + {m_0}^2}\left(\frac{d_e}{2s_c}\right)^2$	λ_0	0.0014
Substitution coefficient Δ_1 for eddy-currents $\left(1.14{m_0}^{2.45} + 0.33\right)\left(\frac{d_e}{2s_c}\right)^{0.92m_0+1.66}$	Δ_1	0.0833
Substitution coefficient Δ_2 for eddy-currents	Δ_2	0
Substitution coefficient m_0 for eddy-currents $10^{-7}\frac{\omega}{R_{sh}}$	m_0	0.0494 Hz.m/Ω
Substitution coefficient β_1 for eddy-currents $\sqrt{\frac{4\pi\omega}{10^7\rho_{sh}\left(1 + \alpha_{sh}\left(\theta_{sh} - 20\right)\right)}}$	β_1	105.5875
Substitution coefficient g_s for eddy-currents $1 + \left(\frac{t_{sh}}{D_{sh}}\right)^{1.74}\left(10^{-3}\beta_1 D_{sh} - 1.6\right)$	g_s	1.000192
Factor F_e eddy-current losses $\frac{4{M_e}^2{N_e}^2 + \left(M_e + N_e\right)^2}{4\left({M_e}^2 + 1\right)\left({N_e}^2 + 1\right)}$	F_e	0.8782
Substitution coefficient M_e to calculate factor F_e $\frac{R_e}{X_e}$	M_e	2.6858
Substitution coefficient N_e to calculate factor F_e $\frac{R_e}{X_e}$	N_e	2.6858
Loss factor armour	λ_2	0

Drying-out of soil

Characteristic diameter drying zone	D_{dry}	0.098 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_c — 2.2151e-5 Ω/m → 0.0222 Ω

$$R_{cDC}\left(1 + y_s + y_p\right)$$

Electrical resistance DC conductor — R_{cDC} — 1.9254e-5 Ω/m → 0.0193 Ω

$$R_{c20}\left(1 + \alpha_c\left(\theta_c - 20\right)\right)$$

Skin effect factor conductor — y_s — 0.12751

$$\frac{{x_s}^4}{192 + 0.8{x_s}^4}$$

Factor for skin effect on conductor — x_s — 2.28502

$$\sqrt{10^{-7}\frac{8\pi f}{R_{cDC}}k_s}$$

Proximity effect factor conductor — y_p — 0.02293

$$\frac{{x_p}^4}{192 + 0.8{x_p}^4}\left(\frac{d_c}{s_c}\right)^2\left(0.312\left(\frac{d_c}{s_c}\right)^2 + \frac{1.18}{\frac{{x_p}^4}{192+0.8{x_p}^4} + 0.27}\right)$$

Factor for proximity effect of conductors — x_p — 1.55398

$$\sqrt{10^{-7}\frac{8\pi f}{R_{cDC}}k_p}$$

Electrical resistance screen — R_{sc} — 1.7363e-4 Ω/m → 0.1736 Ω

$$R_{sc}\left(1 + \alpha_{sc}\left(\theta_{sc} - 20\right)\right)$$

Electrical resistance sheath — R_{sh} — 6.3609e-4 Ω/m → 0.6361 Ω

$$R_{sh}\left(1 + \alpha_{sh}\left(\theta_{sh} - 20\right)\right)$$

Electrical resistance shield — R_s — 1.3640e-4 Ω/m → 0.1364 Ω

$$\frac{R_{sh}R_{sc}}{R_{sh} + R_{sc}}$$

Reduction factor — RF — 0.2128

$$\frac{R_s}{\sqrt{{R_s}^2 + {X_s}^2}}$$

Electrical field strength, capacitive load current

Electrical field strength insulation inner/outer — E_i — 5.994 | 3.477 kV/mm

$$\frac{U_e}{1000}\frac{1}{r_x \ln\left(\frac{r_{osc}}{r_{isc}}\right)}$$

Radius to point x in insulation — r_x — 23.35 | 40.25 mm

Line-to-ground voltage — U_e — 76210.24 V

$$\frac{1000U_o}{\sqrt{3}}$$

Capacitance insulation $\frac{1}{2\pi\epsilon_0}\frac{10^{-9}}{18}C_b$	C_b	2.551e-10 F/m → 0.2551 μF
Capacitive load current $U_e\omega C_b$	I_C	6.107e-3 A/m → 6.1069 A
Charging capacity $n_{ph}{U_e}^2\omega C_b$	P_C	465.41 var/m → 465.41 kvar
Capacitive earth short-circuit current $U_e\omega C_E$	I_{Ce}	6.107e-3 A/m

Reactance

Self reactance conductor $\omega\frac{\mu_0}{2\pi}\ln\left(\frac{D_E}{GMR_c}\right)$	X_a	6.865e-4 Ω/m → 0.6865 Ω
Self reactance screen/sheath $\omega\frac{\mu_0}{2\pi}\ln\left(\frac{2s_c}{d_s}\right)$	X_e	5.078e-5 Ω/m → 0.0508 Ω

Induced current (approximate)

Induced circulating current shield $\max\left(I_c\sqrt{\frac{\lambda_{11,sb}R_c}{R_s}}\right)$	I_s	345.627+0.000j A
Loss factor shield, circulating currents	$\lambda_{11,sb}$	0.7497+0.0000j

Load, Voltage drop

Apparent power generator-side $\sqrt{3}U_oI_c$	S_G	226.468 MVA
Voltage drop $\sqrt{3}\left(R_c\cos\varphi+\omega L_m\sin\varphi\right)$	V_{drop}	0.038 V/(A.km) → 38 V = 0.03%
Inductance (mean) $\frac{\mu_0}{2\pi}\ln\left(\frac{GMD}{GMR_c}\right)$	L_m	3.536e-7+0.000e0j H/m → 0.3536 mH

Telegrapher equation

Surge impedance $\sqrt{\frac{Z_1}{Y_1}}$	Z_C	37.4177-3.6938j Ω
Propagation constant $\sqrt{Z_1Y_1}$	γ_C	2.960e-7+2.998e-6j

Impedance valid up to 100 Hz without earth return

Positive sequence admittance $G+j\omega C_b$	Y_1	0.000e0+8.013e-8j S/m → 0.0000+0.0001j S
Positive sequence impedance R_1+jX_1	Z_1	2.215e-5+1.111e-4j Ω/m → 0.0222+0.1111j Ω

Positive sequence reactance	X_1	1.111e-4 Ω/m → 0.1111 Ω

$$\omega \frac{\mu_0}{2\pi} \ln\left(\frac{GMD}{GMR_c}\right)$$

Cable datasheet

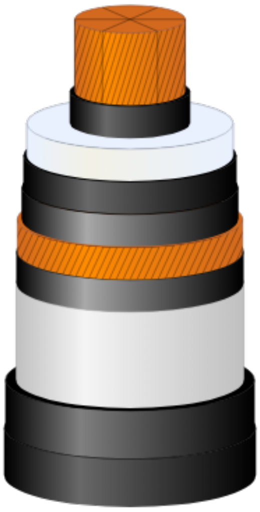
Title CIGRE TB 880 Case 1 132kV cable (#16301)

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	132 kV
Base voltage for tests	U_0	76 kV
Highest voltage for equipment	U_m	145 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 1200 mm^2
Conductor material	M_c	Copper, round Milliken
External diameter conductor	d_c	43.1 mm
Radius conductor $\frac{d_c}{2}$	r_c	21.55 mm

Insulation

Insulation material	M_i	Crosslinked polyethylene (XLPE)
Thickness conductor shield	t_{cs}	1.8 mm
Thickness insulation	t_{ins}	16.9 mm
Thickness insulation screen	t_{is}	1.2 mm
Thickness insulation $t_{ct} + t_{cs} + t_{ins} + t_{is}$	t_i	19.9 mm

Screen bedding

Screen bedding material		Water-blocking tapes, semi-conducting
Thickness screen bedding	t_{scb}	0.7 mm

Screen

Type		round wires
Screen material	M_{sc}	Copper
diameter wires	t_{sc}	1.77 mm
Number of wires screen	n_{scw}	57
Elongation screen	ν_{sc}	0 %

Screen serving

Screen serving material		Water-blocking tapes
Thickness screen serving	t_{scs}	0.28 mm

Sheath

Sheath material	M_{sh}	Aluminium
Thickness sheath	t_{sh}	0.2 mm
corrugated		No

Jacket

Jacket material	M_j	High density polyethylene (HDPE, ST7)
Thickness jacket	t_j	4.1 mm
Thickness of additional layer over jacket	t_{jj}	0.5 mm

Overall

External diameter object	D_e	98 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}	17.127 kg/m

Electrical

Conductor

Electrical resistance DC conductor 20°C	R_{c20}	1.5100e-5 Ω/m
Standard DC resistance of conductor	R_{co}	0.0151 Ω/km
Coating of wires		plain
Insulation of wires		bare bi-directional wires
Skin effect coefficient	k_s	0.8
Proximity effect coefficient	k_p	0.37
Geometric mean radius conductor $K_{GMR} r_{z1}$	GMR_c	0.01672 m
Factor geometric mean radius	K_{GMR}	0.776
Constant relating to conductor formation	K_{BICC}	0.051
Number of wires conductor	n_{cw}	127
Diameter of wires conductor (average)	d_{cw}	3.47 mm

Insulation

Capacitance, with approximation (CIGRE TB 880) $\frac{1}{2\pi\epsilon_0}\frac{10^{-9}}{18}C_b$	C_b	2.551e-10 F/m
Capacitance (exact) $\frac{2\pi\epsilon_0\epsilon_i}{\ln\left(\frac{r_{osc}}{r_{isc}}\right)}$	C_b	2.554e-10 F/m
Capacitance to earth C_b	C_E	2.551e-10 F/m
Vacuum permittivity	ϵ_0	8.854187817620389e-12 F/m
Radius above the inner semi-conducting layer $\frac{d_c}{2}+t_{ct}+t_{cs}$	r_{isc}	23.35 mm
Radius over capacitive insulation layers $\frac{D_{ins}}{2}$	r_{osc}	40.25 mm
Velocity of propagation $\frac{1}{1000\sqrt{\mu_0\epsilon_0\epsilon_i}}$	v_{prop}	189605.4 km/s

Screen + Sheath

Electrical resistance screen $10^6\frac{F_{lay,sc}\rho_{sc}}{A_{sc}}$	R_{sc}	1.3975e-4 Ω/m
Effective length per unit lay length screen wires $\sqrt{1+\left(\frac{\pi d_{sc}}{L_{lay,sc}}\right)^2}$	$F_{lay,sc}$	1.1369
Length of lay screen wires	$L_{lay,sc}$	500 mm
Geometric mean radius screen $\left(0.7788\frac{t_{sc}}{2}n_{scw}\left(\frac{t_{sc}}{2}\right)^{n_{scw}-1}\right)^{\frac{1}{n_{scw}}}\frac{1}{1000}$	GMR_{sc}	0.00095 m
Electrical resistance sheath $10^6\frac{\rho_{sh}}{A_{sh}}$	R_{sh}	5.1016e-4 Ω/m
Electrical resistance screen/sheath 20°C $\frac{R_{sc}R_{sh}}{R_{sc}+R_{sh}}$	R_{so}	1.097e-1 Ω/km

Radius

Radius conductor	r_{z1}	0.02155 m
Radius shield (inner)	r_{z2}	0.04127 m
Radius shield (outer)	r_{z3}	0.0441 m
Radius screen (inner)	$r_{z2,sc}$	0.04127 m
Radius screen (outer)	$r_{z3,sc}$	0.04481 m
Radius sheath (inner)	$r_{z2,sh}$	0.0441 m
Radius sheath (outer)	$r_{z3,sh}$	0.0445 m
Radius outersheath	r_{z6}	0.049 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	2.5
Loss factor insulation material	$\tan\delta_i$	0.001
Thermal resistivity insulation material	ρ_i	3.5 K.m/W
Volumetric heat capacity insulation material	σ_i	2.40e6 J/(K.m^3)
Density insulation material	ζ_i	0.923 g/cm^3
Max. temperature conductor	θ_{cmax}	90 °C
Max. temperature conductor, emergency overload	θ_{cmaxeo}	105 °C
Max. temperature conductor, short-circuit	θ_{cmaxsc}	250 °C

Conductor shield

Thermal resistivity conductor shield	ρ_{cs}	2.5 K.m/W

Insulation screen

Thermal resistivity insulation screen	ρ_{is}	2.5 K.m/W

Screen bedding

Thermal resistivity screen bedding	ρ_{scb}	12 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

Screen

Specific electrical resistivity screen material	ρ_{sc}	1.724e-8 Ω.m
Temperature coefficient screen material	α_{sc}	3.93e-3 1/K
Reciprocal of temperature coefficient screen material	β_{sc}	2.345e2 K
Volumetric heat capacity screen material	σ_{sc}	3.45e6 J/(K.m^3)
Thermal conductivity screen material	k_{sc}	370.4 W/(m.K)
Density metallic screen material	ζ_{sc}	8.94 g/cm^3

Screen serving

Thermal resistivity screen serving	ρ_{scs}	12 K.m/W
Volumetric heat capacity screen serving	σ_{scs}	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

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	2.00e-15 S/m
Density jacket material	ζ_j	0.941 g/cm^3

Thermal resistance

Internal thermal resistances for rating calculation

Thermal resistance conductor—sheath T_1 0.3789 K.m/W

$$T_{ct} + T_{cs} + T_{ins} + T_{is} + T_{scb}$$

Thermal resistance armour bedding T_2 0.0121 K.m/W

$$T_{scs} + T_{dsh}$$

Thermal resistance jacket T_3 0.0533 K.m/W

$$T_{ab} + T_j + T_{jj}$$

Thickness conductor—sheath t_1 20.88 mm

$$t_i + t_{scb} + t_{scs} + \frac{H_{sh} + \Delta H}{2}$$

Thickness sheath—armour t_2 0 mm

$$\frac{H_{sh} + \Delta H}{2} + t_{ab}$$

Thickness armour—surface t_3 4.6 mm

$$t_j + t_{jj}$$

Cable elements

Thermal resistance, transient T_{tot} 0.4443 K.m/W

$$T_1 + T_2 + T_3$$

Thermal resistance insulation T_i 0.34692 K.m/W

$$T_{ct} + T_{cs} + T_{ins} + T_{is}$$

Thermal resistance conductor shield T_{cs} 0.03192 K.m/W

$$\frac{\rho_{cs}}{2\pi} \ln\left(\frac{D_{cs}}{D_{cs} - 2t_{cs}}\right)$$

Thermal resistance insulation T_{ins} 0.30332 K.m/W

$$\frac{\rho_i}{2\pi} \ln\left(\frac{D_{ins}}{D_{ins} - 2t_{ins}}\right)$$

Thermal resistance insulation screen T_{is} 0.01169 K.m/W

$$\frac{\rho_{is}}{2\pi} \ln\left(\frac{D_{ins} + 2t_{is}}{D_{ins}}\right)$$

Thermal resistance screen bedding T_{scb} 0.03198 K.m/W

$$\frac{\rho_{scb}}{2\pi} \ln\left(\frac{D_{scb}}{D_i}\right)$$

Thermal resistance screen serving T_{scs} 0.01214 K.m/W

$$\frac{\rho_{scs}}{2\pi} \ln\left(\frac{D_{scs}}{D_{sc}}\right)$$

Thermal resistance jacket T_j 0.0492 K.m/W

$$\frac{\rho_j}{2\pi} \ln\left(\frac{D_j - 2t_{jj}}{D_j - 2\left(t_j + t_{jj}\right)}\right)$$

Thermal resistance additional layer $\frac{\rho_{jj}}{2\pi}\ln\left(\frac{D_j}{D_j-2t_{jj}}\right)$	T_{jj}	0.00408 K.m/W

Dimensions

Diameter

External diameter conductor	d_c	43.1 mm
Diameter over conductor shield $d_c+2\left(t_{ct}+t_{cs}\right)$	D_{cs}	46.7 mm
Diameter over insulation $d_c+2\left(t_{ct}+t_{cs}+t_{ins}\right)$	D_{ins}	80.5 mm
Diameter over insulation incl. insulation screen $d_c+2\left(t_{ct}+t_{cs}+t_{ins}+t_{is}\right)$	D_i	82.9 mm
Diameter over insulation screen d_c+2t_i	D_{is}	82.9 mm
Diameter over screen bedding $d_c+t_{i1}+2t_{scb}$	D_{scb}	84.3 mm
Mean diameter screen $D_{scb}+t_{sc}$	d_{sc}	86.07 mm
Diameter over screen $D_{scb}+2t_{sc}$	D_{sc}	87.84 mm
Equivalent diameter of screen and sheath $\sqrt{\frac{{d_{sc}}^2+{d_{sh}}^2}{2}}$	d_s	87.34 mm
Diameter over screen serving $D_{sc}+2t_{scs}$	D_{scs}	88.4 mm
Mean diameter sheath $D_{shb}+t_{sh}+H_{sh}+\Delta H$	d_{sh}	88.6 mm
Diameter over sheath $D_{shb}+2\left(t_{sh}+H_{sh}+\Delta H\right)$	D_{sh}	88.8 mm
Diameter over sheath jacket	D_{shj}	88.8 mm
Diameter over jacket $D_{ar}+2\left(t_j+t_{jj}\right)$	D_j	98 mm

Area

Cross-sectional area conductor	A_c	1200 mm^2
Cross-sectional area insulation $\frac{\pi}{4}\left({D_{is}}^2-{d_c}^2\right)$	A_i	3938.6 mm^2
Cross-sectional area screen bedding $\pi t_{scb}\left(D_{scb}-t_{scb}\right)$	A_{scb}	183.8 mm^2
Cross-sectional area screen $\left(\frac{t_{sc}}{2}\right)^2\pi n_{scw}\left(1+\frac{\nu_{sc}}{100}\right)$	A_{sc}	140.25 mm^2
Cross-sectional area screen serving $\pi t_{scs}\left(D_{scs}-t_{scs}\right)$	A_{scs}	77.5 mm^2

Cross-sectional area sheath A_{sh} 55.67 mm^2

$d_{sh} t_{sh} \pi$

Cross-sectional area jacket A_j 1349.8 mm^2

$\frac{\pi}{4}\left({D_j}^2 - \left(D_j - 2\left(t_j + t_{jj}\right)\right)^2\right)$