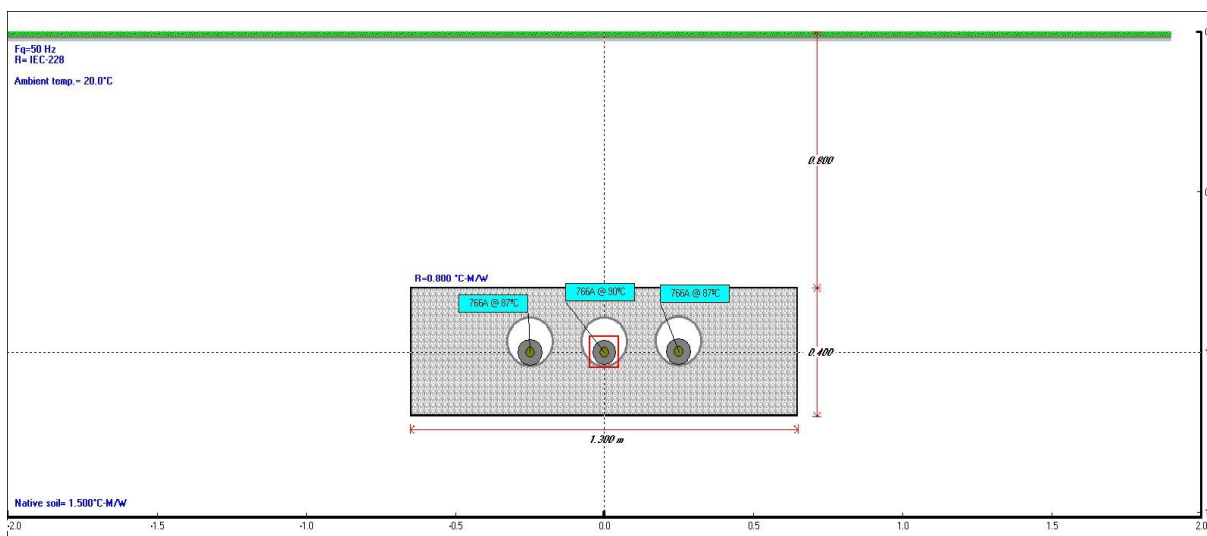


Study: N2XS(FL)2Y 110 kV Cableizer
Execution: Cables in individual ducts, flat, not touching, backfill
Date: 23.06.2014
Frequency: 50 Hz
Conductor Resistances: IEC-228
Fraction of conductor current returning through sheath for single phase cables: 1

Installation Type: Duct Bank		
Parameter	Unit	Value
Ambient Soil Temperature at Installation Depth	°C	20
Thermal Resistivity of Native Soil	°C.m/W	1.5
Duct Bank Width	m	1.3
Duct Bank Height	m	0.4
Duct Bank X Center	m	0
Duct Bank Y Center	m	1
Thermal Resistivity of Duct Bank	°C.m/W	0.8



Summary Results							
Solution converged							
Cable \ Cable type no	Circuit	Phase	Location		Load Factor [p.u.]	Temperature [°C]	Ampacity [A]
			X[m]	Y[m]			
1 \ 1	1	A	-0.25	1	1	87.4	766.2
2 \ 1	1	B	0	1	1	90	766.2
3 \ 1	1	C	0.25	1	1	87.4	766.2

Cables input data

Study: N2XS(FL)2Y 110 kV Cableizer
Execution: Cables in individual ducts, flat, not touching, backfill
Date: 23.06.2014

No	Description	Unit	1
General cable information			
1	Cable type no		1
2	Number of cores		1
3	Voltage	kV	110
4	Conductor area	mm ²	500
5	Maximum Steady-State Conductor Temperature	°C	90
6	Maximum Emergency Conductor Temperature	°C	90
Construction			
Conductor			
7	Material		copper
8	Resistivity @20°C	uΩ.cm	1.7241
9	Temperature coefficient	1/K	0.00393
10	Reciprocal of temperature coefficient of resistance (BETA)	°C	234.5
11	Volumetric specific heat (SH)	J/K.m ³	3.45
12	Construction		stranded (round)
13	Number of wires composing stranded conductor		61
14	Is cable dried?		No
15	ks (Skin effect coefficient)		1
16	kp (Proximity effect coefficient)		1
17	Diameter	mm	26.2
Conductor shield			
18	Is layer present?		Yes
19	Thickness	mm	1.3
20	Diameter	mm	28.8
Insulation			
21	Is layer present?		Yes
22	Material		XLPE (unfilled)
23	Thermal resistivity	K.m/w	3.5
24	Dielectric loss factor - (tan δ)		0.001
25	Relative permittivity (ε)		2.5
26	Thickness	mm	19.4
27	Diameter	mm	67.6
Insulation screen			
28	Is layer present?		Yes
29	Material		semi-conducting

30	Thickness	mm	1.6
31	Diameter	mm	70.8

Sheath

32	Is layer present?		Yes
33	Is around each core? (Only for Three core cable)		No
34	Material		copper
35	Resistivity @20°C	uΩ.cm	1.7241
36	Temperature coefficient	1/K	0.00393
37	Reciprocal of temperature coefficient of resistance (BETA)	°C	234.5
38	Volumetric specific heat (SH)	J/K.m ³	3.45
39	Corrugated construction		Non-corrugated
40	Thickness	mm	0.25
41	Diameter	mm	73.14

Concentric neutral/Skid wires

42	Is layer present?		Yes
43	Is around each core? (Only for Three core cable)		No
44	Material		copper
45	Resistivity @20°C	uΩ.cm	1.7241
46	Temperature coefficient	1/K	0.00393
47	Reciprocal of temperature coefficient of resistance (BETA)	°C	234.5
48	Volumetric specific heat (SH)	J/K.m ³	3.45
49	Length of lay	mm	
50	Number of wires		74
51	Wire gauge		Unknown
52	Thickness	mm	0.92
53	Diameter	mm	72.64

Jacket

54	Is layer present?		Yes
55	Material		polyethylene
56	Thermal resistivity	K.m/w	3.5
57	Thickness	mm	4.7
58	Diameter	mm	82.54

Overall cable diameter

59	Diameter	mm	82.54
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No	Description/Value	Unit	1
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SPECIFIC INSTALLATION DATA

Bonding

1	1-CON, sheaths single point bonded, flat configuration		Yes
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Loss factor constant

2	Loss factor constant		0.3
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Duct construction

3	PVC duct in concrete or buried		Yes
4	Resistivity (RH)		6
Cables touching			
5	Single conductor cables NOT touching		Yes
Duct/Pipe dimensions			
6	Inside diameter of Duct/Pipe	mm	150.6
7	Outside diameter of Duct/Pipe	mm	160

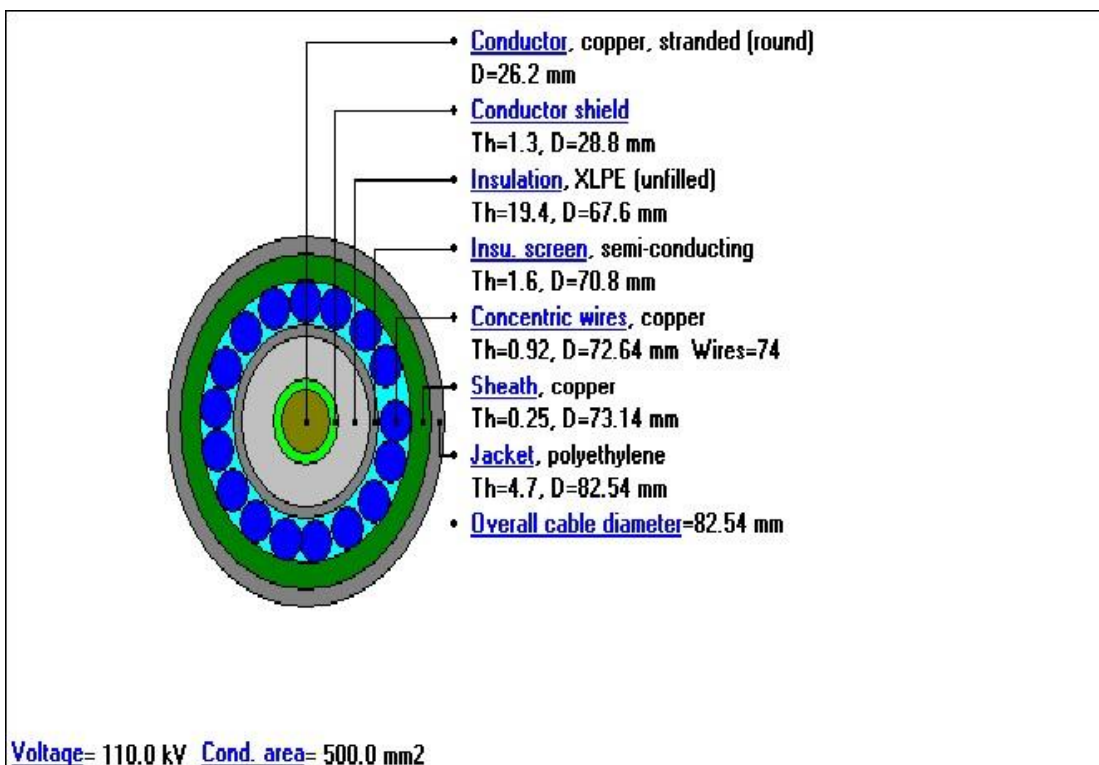
No	Symbol	Description	Unit	1	2	3
Temperature calculations						
1		Cable type no		1	1	1
2		Circuit no		1	1	1
3		Phase		A	B	C
4	θ_c	Conductor temperature	°C	87.4	90	87.4
5	θ_i	Sheath/Shield temperature	°C	71.7	74.2	71.7
6	θ_j	Armour/Pipe or Jacket temperature	°C	69.7	72.3	69.7
7	θ_s	Exterior duct temperature	°C	0	0	0
8	θ_a	Ambient temperature	°C	20	20	20

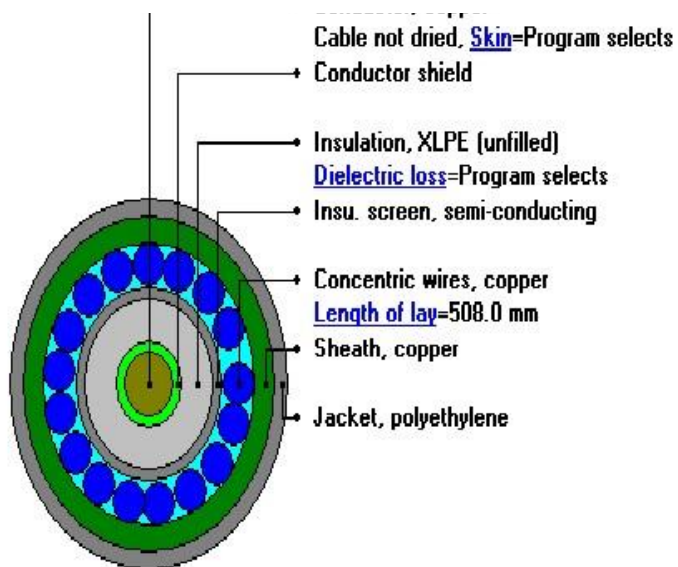
Cable type no: 1

Cable type: COMBINED SHEATH

Cable ID: AEG053

Cable title: N2XS(FL)2Y 110 kV 1x500/50mm²





Max. Steady-State Cond. Temp.=90 deg.

Voltage= 110.0 kV Cond. area= 500.0 mm² Max. Transient Cond. Temp.=90 deg.

Study: N2XS(FL)2Y 110 kV Cableizer
Execution: Cables in individual ducts, flat, not touching, backfill
Date: 23.06.2014

No	Description	Unit	1	2	3
1	Cable type no		1	1	1
Resistances (DC/AC)					
2	DC Resistance of Conductor @ 20°C	Ω/km	0.0366	0.0366	0.0366
3	DC Resistance of Conductor @ Operating Temperature	Ω/km	0.0463	0.04667	0.0463
4	AC Resistance of Conductor @ 20°C	Ω/km	0.03802	0.03802	0.03802
5	AC Resistance of Conductor @ Operating Temperature	Ω/km	0.04809	0.04845	0.04809
6	DC Resistance of Sheath @ 20°C	Ω/km	0.30045	0.30045	0.30045
7	DC Resistance of Sheath @ Operating Temperature	Ω/km	0.36146	0.3645	0.36146
8	DC Resistance of Concentric Wires @ 20°C	Ω/km	0.38381	0.38381	0.38381
9	DC Resistance of Concentric Wires @ Operating Temperature	Ω/km	0.46175	0.46564	0.46175
Losses					
10	Conductor Losses	W/m	28.4454	28.4454	28.4454
11	Dielectric Losses	W/m	0	0	0
12	Metallic Screen Losses	W/m	0.04922	0.20067	0.05149
13	Aarmor/Pipe Losses	W/m	0	0	0
14	Total Losses	W/m	28.49462	28.64606	28.49689
Capacitance, Inductance, Impedance					
15	Capacitance	μF/km	0.16278	0.16278	0.16278
16	Inductance of Conductor	mH/km	0.68739	0.68739	0.68739
17	Reactance of Conductor	Ω/km	0.21595	0.21595	0.21595
18	Inductance of Metallic Sheath (Flat formation, regular transposition and one-point bonded)	mH/km	0.4317	0.4317	0.4317
19	Reactance of Metallic Sheath	Ω/km	0.13562	0.13562	0.13562
20	Positive Sequence Impedance	Ω/km	0.04809 + j0.21595	0.04845 + j0.21595	0.04809 + j0.21595
21	Negative Sequence Impedance	Ω/km	0.04809 - j0.21595	0.04845 - j0.21595	0.04809 - j0.21595
22	Zero Sequence Impedance	Ω/km	0.20649 + j0.13562	0.20649 + j0.13562	0.20649 + j0.13562
23	Surge Impedance	Ω	64.98337	64.98337	64.98337
Others					
24	Dielectric Stress at Conductor Surface	kV/mm	5.1691	5.1691	5.1691
25	Dielectric Stress at Insulation Surface	kV/mm	2.20222	2.20222	2.20222
26	Insulation Resistance @ 20°C	MΩ.km	135.79153	135.79153	135.79153
27	Insulation Resistance @ 90°C	MΩ.km	1.35792	1.35792	1.35792
28	Reduction factor		0.49884	0.49884	0.49884

29	Charging Capacity of three phase system at U _o	kVAR/km	618.83612	618.83612	618.83612
30	Charging Current for One Phase	A/km	3.24795	3.24795	3.24795
31	Voltage Drop for Three Phase System	V/A/km	0.0833	0.08392	0.0833
32	Induced Voltage on Metallic Sheath	V/km	113.14449	92.70652	113.14446

Short-Circuit Current

33	Short Circuit Time	s	0.1	0.1	0.1
34	Non Adiabatic Short Circuit Current of Conductor	kA	228.81239	226.56406	228.80898
35	Non Adiabatic Short Circuit Current of Sheath	kA	24.61584	24.38944	24.6155
36	Non Adiabatic Short Circuit Current of Armour	kA	0	0	0

Cable Parameters under Normal Operation

Study: N2XS(FL)2Y 110 kV Cableizer
Execution: Cables in individual ducts, flat, not touching, backfill
Date: 23.06.2014

No	Symbol	Description	Unit	1	2	3
1		Cable type no		1	1	1
Normal Operation IEC 60287-1-1						
2	R_o	Conductor DC Resistance at 20°C	Ω/m	3.66E-05	3.66E-05	3.66E-05
3	R'	Conductor DC Resistance at Max Temp	Ω/m	4.63E-05	4.67E-05	4.63E-05
4	R	Conductor AC Resistance at Max Temp	Ω/m	4.81E-05	4.85E-05	4.81E-05
5	K_s	Factor Used in Calculating X_s (Skin Effect)		1.00E+00	1.00E+00	1.00E+00
6	K_p	Factor Used in Calculating X_p (Proximity Effect)		1.00E+00	1.00E+00	1.00E+00
7	γ_s	Skin Effect Factor		3.72E-02	3.67E-02	3.72E-02
8	γ_p	Proximity Effect Factor		1.57E-03	1.55E-03	1.57E-03
9	d_c	Conductor Diameter	m	2.62E-02	2.62E-02	2.62E-02
10	c	Distance Between Conductor Axes	m	0.00E+00	0.00E+00	0.00E+00
11	C	Cable Capacitance	F/m	1.63E-10	1.63E-10	1.63E-10
12	$\tan \delta$	Dielectric Loss Factor		1.00E-03	1.00E-03	1.00E-03
13	ϵ	Insulation Relative Permittivity		2.50E+00	2.50E+00	2.50E+00
14	W_d	Cable Dielectric Losses Per Phase	W/m	0.00E+00	0.00E+00	0.00E+00
15	λ_1	Screen Loss Factor		1.73E-03	7.05E-03	1.81E-03
16	λ'_1	Screen Loss Factor Caused by Circulating Current		0.00E+00	0.00E+00	0.00E+00
17	λ''_1	Screen Loss Factor Caused by Eddy Current		1.73E-03	7.05E-03	1.81E-03
18	λ_2	Armour Loss Factor		0.00E+00	0.00E+00	0.00E+00
19	R_s	Screen AC Resistance at Cable Normal Operation	Ω/m	3.61E-04	3.65E-04	3.61E-04
20	g_s	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.00E+00	1.00E+00	1.00E+00
21	β_1	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.51E+02	1.51E+02	1.51E+02
22	ρ_s	Screen Electrical Resistivity @ Operating Temp.	Ω.m	1.72E-08	1.72E-08	1.72E-08
23	D_s	External diameter of Screen (Sheath)	m	7.31E-02	7.31E-02	7.31E-02
24	t_s	Screen (Sheath) Thickness	m	2.50E-04	2.50E-04	2.50E-04
25	m	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		8.69E-02	8.69E-02	8.69E-02
Centre Phase						
26	λ_0	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		9.53E-04	9.53E-04	9.53E-04
27	Δ_1	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		9.53E-05	9.53E-05	9.53E-05
28	Δ_2	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00	0.00E+00	0.00E+00
Leading Phase						
29	λ_0	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.38E-04	2.38E-04	2.38E-04
30	Δ_1	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.75E-02	1.75E-02	1.75E-02
31	Δ_2	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		3.01E-07	3.01E-07	3.01E-07
Lagging Phase						
32	λ_0	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.38E-04	2.38E-04	2.38E-04
33	Δ_1	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		-2.74E-02	-2.74E-02	-2.74E-02
34	Δ_2	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.96E-06	1.96E-06	1.96E-06

35	d	Screen or sheath mean diameter	m	7.28E-02	7.28E-02	7.28E-02
36	X	Screen (Sheath) Reactance	Ω/m	1.36E-04	1.36E-04	1.36E-04
37	M	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00	0.00E+00	0.00E+00
38	N	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00	0.00E+00	0.00E+00
39	X_m	Coefficient Used in IEC 60287-1-1 Clause 2.3.5	Ω/m	0.00E+00	0.00E+00	0.00E+00
40	F	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00	0.00E+00	0.00E+00

Normal Operation IEC 60287-2-1

41	T_1	Thermal Resistance Between Conductor-Screen	$^{\circ}C.m/W$	0.55375	0.55375	0.55375
42	t_1	Insulation Thickness Between Conductor-Screen	m	0	0	0
43	ρ_{Ti}	Thermal Resistivity of Insulation	$^{\circ}C.m/W$	3.5	3.5	3.5
44	T_2	Thermal Resistance Between Screen and Sheath	$^{\circ}C.m/W$	0	0	0
45	t_2	Thickness of Bedding	m	0	0	0
46	ρ_{Tb}	Thermal Resistivity of Bedding	$^{\circ}C.m/W$	0	0	0
47	T_3	Thermal Resistance of Outer Serving	$^{\circ}C.m/W$	0	0	0
48	t_3	Thickness of Serving	m	0	0	0
49	ρ_{Ts}	Thermal Resistivity of Serving	$^{\circ}C.m/W$	0	0	0
50	T_3	Thermal Resistance of Jacket	$^{\circ}C.m/W$	0.06735	0.06735	0.06735
51	t_3	Thickness of Jacket	m	0.0047	0.0047	0.0047
52	ρ_{Tj}	Thermal Resistivity of Jacket	$^{\circ}C.m/W$	3.5	3.5	3.5

F. Ducts

53	T'_4	Thermal Resistance of the Air	$^{\circ}C.m/W$	0.33639	0.33163	0.33639
54	T''_4	Thermal Resistance of the Pipe	$^{\circ}C.m/W$	0.05782	0.05782	0.05782
55	T'''_4	Thermal Resistance of the medium surrounding the duct(or pipe)	$^{\circ}C.m/W$	1.35156	1.35156	1.35156
56	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
57	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
58	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
59	θ_m	Mean Temperature of the Medium Filling the Space	$^{\circ}C$	64.95465	67.56917	64.95814
60	D_o	Outside Diameter of the Pipe	m	0.16	0.16	0.16
61	D_d	Inside Diameter of the Pipe	m	0.1506	0.1506	0.1506
62	ρ_T	Thermal Resistivity of the Pipe Material	$^{\circ}C.m/W$	6	6	6

F.4 Ducts Buried in Concrete

63	ρ_c	Thermal Resistivity of the Concrete	$^{\circ}C.m/W$	0.8	0.8	0.8
64	T_4	Total Thermal Resistance	$^{\circ}C.m/W$	1.74577	1.82639	1.74577
65	N	Number of Loaded Cables in the Duct Bank		3	3	3
66	ρ_e	Thermal Resistivity of Earth Around the Bank	$^{\circ}C.m/W$	1.5	1.5	1.5
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2		0	0	0
68	L_G	Depth of Laying to Centre of Duct Bank	m	0	0	0
69	r_b	Equivalent Radius of Concrete Duct Bank	m	0	0	0
70	x	Shorter Side of the Bank	m	0	0	0
71	y	Longer Side of the Bank	m	0	0	0
72	I	Cable Current Ampacity	A	766.2	766.2	766.2