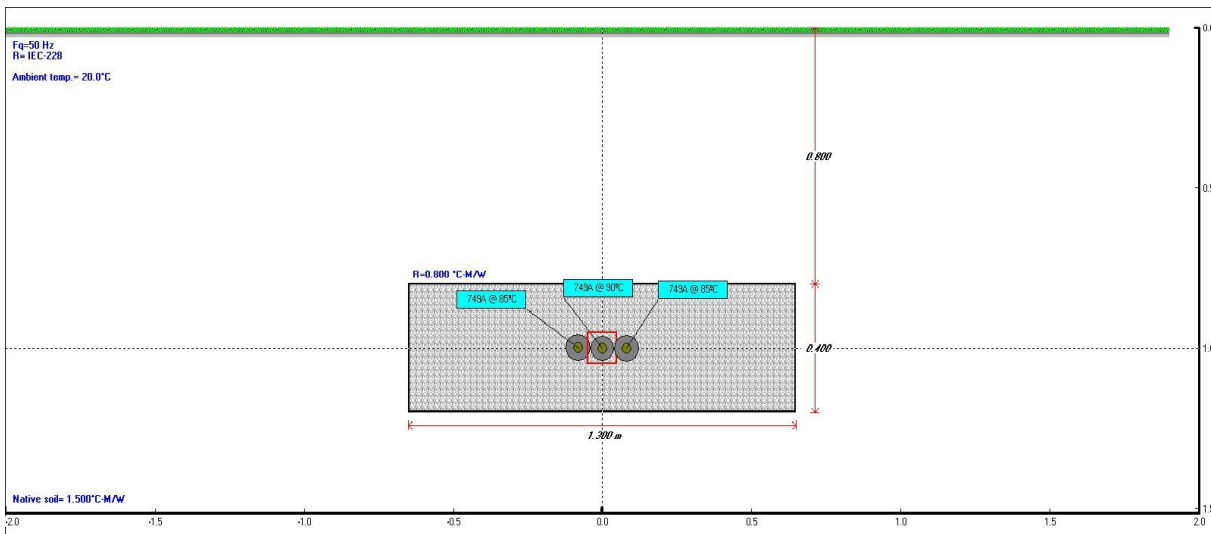


**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables not in ducts, flat, touching, backfill  
**Date:** 03.07.2014  
**Frequency:** 50 Hz  
**Conductor Resistances:** IEC-228  
**Fraction of conductor current returning through sheath for single phase cables:** 1

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	-0.082	1	1	85	748.7
2 \ 1	1	B	0	1	1	90	748.7
3 \ 1	1	C	0.082	1	1	85.2	748.7

## Cables input data

**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables not in ducts, flat, touching, backfill  
**Date:** 03.07.2014

No	Description	Unit	1
<b>General cable information</b>			
1	Cable type no		1
2	Number of cores		1
3	Voltage	kV	110
4	Conductor area	mm <sup>2</sup>	500
5	Maximum Steady-State Conductor Temperature	°C	90
6	Maximum Emergency Conductor Temperature	°C	90
<b>Construction</b>			
<b>Conductor</b>			
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 <sup>3</sup>	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
<b>Conductor shield</b>			
18	Is layer present?		Yes
19	Thickness	mm	1.3
20	Diameter	mm	28.8
<b>Insulation</b>			
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
<b>Insulation screen</b>			
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 <sup>3</sup>	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 <sup>3</sup>	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
----	----------	----	-------

No	Description/Value	Unit	1
----	-------------------	------	---

#### **SPECIFIC INSTALLATION DATA**

##### **Bonding**

1	1-CON, sheaths single point bonded, flat configuration		Yes
---	--	--	-----

##### **Loss factor constant**

2	Loss factor constant		0.3
---	----------------------	--	-----

##### **Cables touching**

3	Single conductor cables NOT touching		Yes
---	--------------------------------------	--	-----

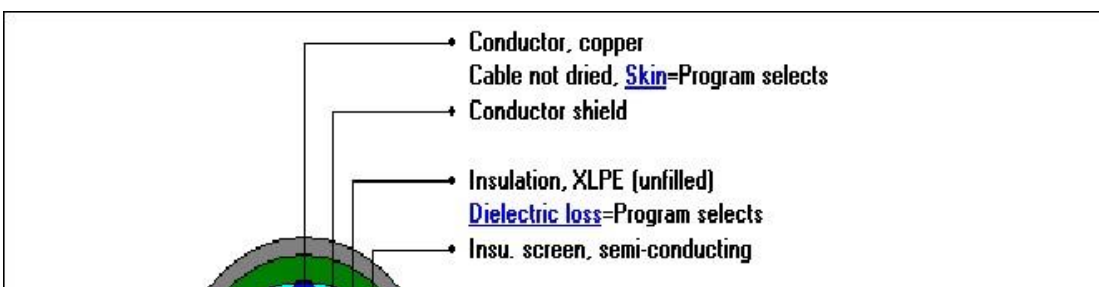
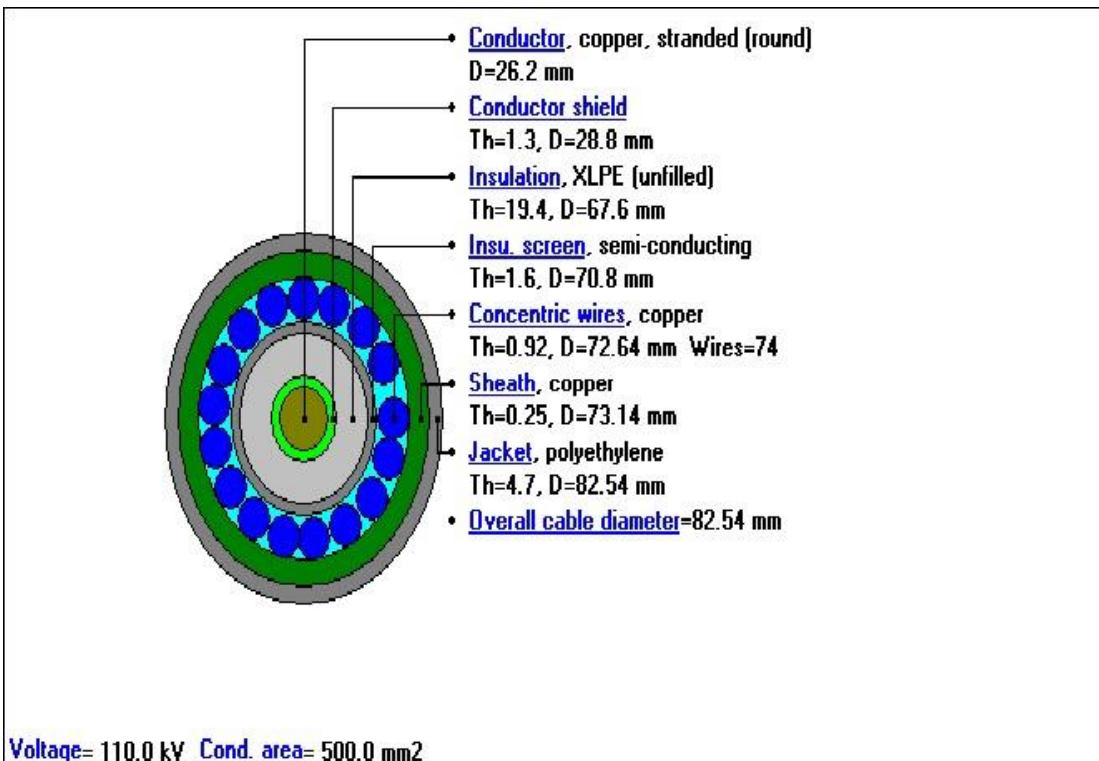
No	Symbol	Description	Unit	1	2	3
<b>Temperature calculations</b>						
1		Cable type no		1	1	1
2		Circuit no		1	1	1
3		Phase		A	B	C
4	$\theta_c$	Conductor temperature	°C	85	90	85.2
5	$\theta_i$	Sheath/Shield temperature	°C	69.8	74.8	70
6	$\theta_j$	Armour/Pipe or Jacket temperature	°C	67.9	72.8	68.1
7	$\theta_s$	Exterior duct temperature	°C	67.9	72.8	68.1
8	$\theta_a$	Ambient temperature	°C	20	20	20

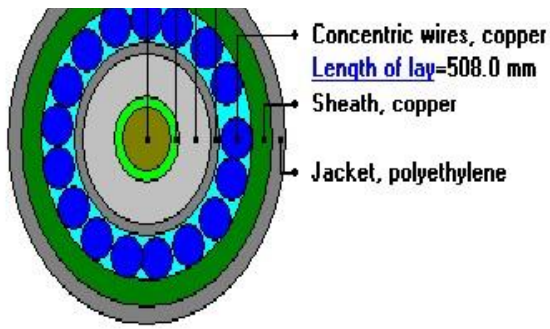
**Cable type no:** 1

**Cable type:** COMBINED SHEATH

**Cable ID:** AEG053

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





- Concentric wires, copper
- Length of lay=508.0 mm
- Sheath, copper
- Jacket, polyethylene

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

Voltage= 110.0 kV Cond. area= 500.0 mm<sup>2</sup> Max. Transient Cond. Temp.=90 deg.

**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables not in ducts, flat, touching, backfill  
**Date:** 03.07.2014

No	Description	Unit	1	2	3
1	Cable type no		1	1	1
<b>Resistances (DC/AC)</b>					
2	DC Resistance of Conductor @ 20°C	Ω/km	0.0366	0.0366	0.0366
3	DC Resistance of Conductor @ Operating Temperature	Ω/km	0.04595	0.04667	0.04598
4	AC Resistance of Conductor @ 20°C	Ω/km	0.03853	0.03853	0.03853
5	AC Resistance of Conductor @ Operating Temperature	Ω/km	0.04837	0.04906	0.0484
6	DC Resistance of Sheath @ 20°C	Ω/km	0.30045	0.30045	0.30045
7	DC Resistance of Sheath @ Operating Temperature	Ω/km	0.35916	0.36513	0.3594
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	0.45881	0.46645	0.45913
<b>Losses</b>					
10	Conductor Losses	W/m	27.49922	27.49922	27.49922
11	Dielectric Losses	W/m	0	0	0
12	Metallic Screen Losses	W/m	0.40998	1.77784	0.52638
13	Aarmor/Pipe Losses	W/m	0	0	0
14	Total Losses	W/m	27.9092	29.27706	28.0256
<b>Capacitance, Inductance, Impedance</b>					
15	Capacitance	μF/km	0.16278	0.16278	0.16278
16	Inductance of Conductor	mH/km	0.46444	0.46444	0.46444
17	Reactance of Conductor	Ω/km	0.14591	0.14591	0.14591
18	Inductance of Metallic Sheath (Flat formation, regular transposition and one-point bonded)	mH/km	0.20875	0.20875	0.20875
19	Reactance of Metallic Sheath	Ω/km	0.06558	0.06558	0.06558
20	Positive Sequence Impedance	Ω/km	0.04837 + j0.14591	0.04906 + j0.14591	0.04840 + j0.14591
21	Negative Sequence Impedance	Ω/km	0.04837 - j0.14591	0.04906 - j0.14591	0.04840 - j0.14591
22	Zero Sequence Impedance	Ω/km	0.20651 + j0.06558	0.20651 + j0.06558	0.20651 + j0.06558
23	Surge Impedance	Ω	53.4154	53.4154	53.4154
<b>Others</b>					
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		0.49645	0.49645	0.49645

29	Charging Capacity of three phase system at U <sub>o</sub>	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	0.08378	0.08497	0.08383
32	Induced Voltage on Metallic Sheath	V/km	61.338	38.14745	61.338
<b>Short-Circuit Current</b>					
33	Short Circuit Time	s	0.1	0.1	0.1
34	Non Adiabatic Short Circuit Current of Conductor	kA	230.92236	226.56406	230.74223
35	Non Adiabatic Short Circuit Current of Sheath	kA	24.78267	24.3435	24.7645
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 not in ducts, flat, touching, backfill  
**Date:** 03.07.2014

No	Symbol	Description	Unit	1	2	3
1		Cable type no		1	1	1
<b>Normal Operation IEC 60287-1-1</b>						
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	4.59E-05	4.67E-05	4.60E-05
4	$R$	Conductor AC Resistance at Max Temp	Ω/m	4.84E-05	4.91E-05	4.84E-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	$\gamma_s$	Skin Effect Factor		3.78E-02	3.67E-02	3.77E-02
8	$\gamma_p$	Proximity Effect Factor		1.49E-02	1.45E-02	1.49E-02
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	$\epsilon$	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	$\lambda_1$	Screen Loss Factor		1.49E-02	6.47E-02	1.91E-02
16	$\lambda'_1$	Screen Loss Factor Caused by Circulating Current		0.00E+00	0.00E+00	0.00E+00
17	$\lambda''_1$	Screen Loss Factor Caused by Eddy Current		1.49E-02	6.47E-02	1.91E-02
18	$\lambda_2$	Armour Loss Factor		0.00E+00	0.00E+00	0.00E+00
19	$R_s$	Screen AC Resistance at Cable Normal Operation	Ω/m	3.59E-04	3.65E-04	3.59E-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	$\beta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.51E+02	1.51E+02	1.51E+02
22	$\rho_s$	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		8.74E-02	8.74E-02	8.74E-02
<b>Centre Phase</b>						
26	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		8.96E-03	8.96E-03	8.96E-03
27	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.42E-04	2.42E-04	2.42E-04
28	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00	0.00E+00	0.00E+00
<b>Leading Phase</b>						
29	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.24E-03	2.24E-03	2.24E-03
30	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.66E-01	1.66E-01	1.66E-01
31	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		9.96E-05	9.96E-05	9.96E-05
<b>Lagging Phase</b>						
32	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.24E-03	2.24E-03	2.24E-03
33	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		-9.23E-02	-9.23E-02	-9.23E-02
34	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		2.05E-05	2.05E-05	2.05E-05



35	d	Screen or sheath mean diameter	m	7.28E-02	7.28E-02	7.28E-02
36	X	Screen (Sheath) Reactance	$\Omega/m$	6.56E-05	6.56E-05	6.56E-05
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	$\Omega/m$	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	$\rho_{Ti}$	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	$\rho_{Tb}$	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	$\rho_{Ts}$	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	$\rho_{Tj}$	Thermal Resistivity of Jacket	$^{\circ}C.m/W$	3.5	3.5	3.5

### C. Cable Direct Buried

53	$T_4$	Thermal Resistance of Surrounding	$^{\circ}C.m/W$	1.71554	1.80347	1.71554
54	L	Depth of cable axis	m	1	1	1
55	u	Coefficient Used in IEC 60287-2-1 Clause 2.2		24.23068	24.23068	24.23068
56	I	Cable Current Ampacity	A	748.7	748.7	748.7