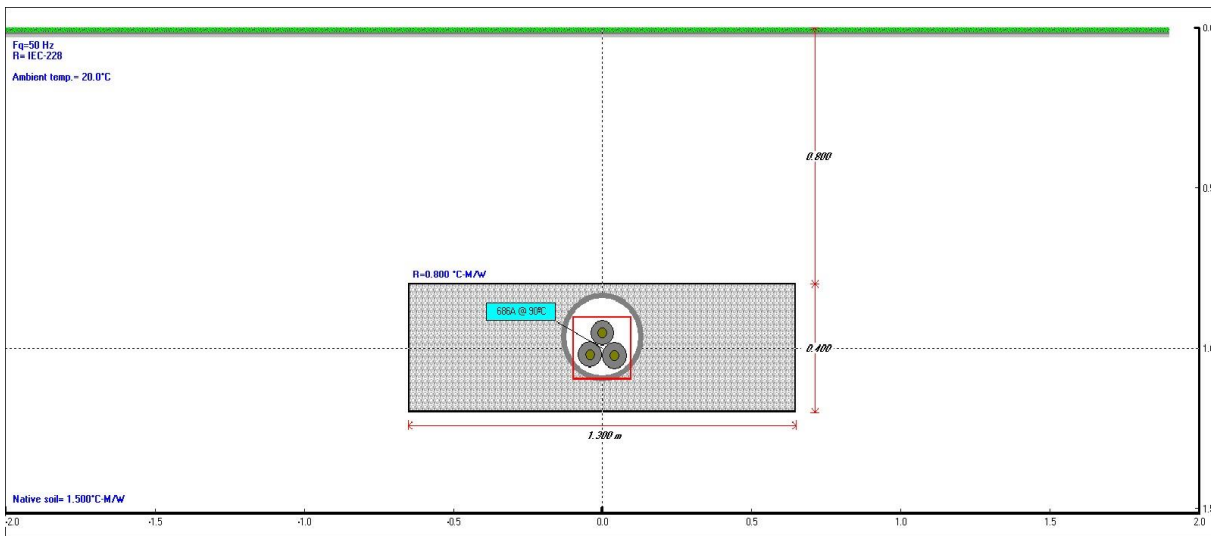


**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables in common duct, trefoil, touching, backfill  
**Date:** 03.07.2014  
**Frequency:** 50 Hz  
**Conductor Resistances:** IEC-228  
**Fraction of conductor current returning through sheath for single phase cables:** 1

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	1	1	90	685.6

## Cables input data

**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables in common duct, trefoil, touching, backfill  
**Date:** 03.07.2014

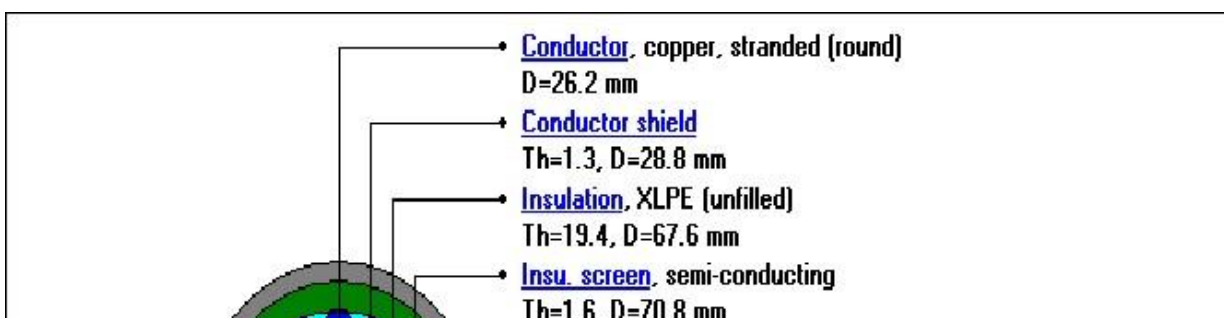
No	Description	Unit	1
<b>General cable information</b>			
1	Cable type no		1
2	Number of cores		1
3	Voltage	kV	110
4	Conductor area	mm <sup>2</sup>	500
5	Maximum Steady-State Conductor Temperature	°C	90
6	Maximum Emergency Conductor Temperature	°C	90
<b>Construction</b>			
<b>Conductor</b>			
7	Material		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

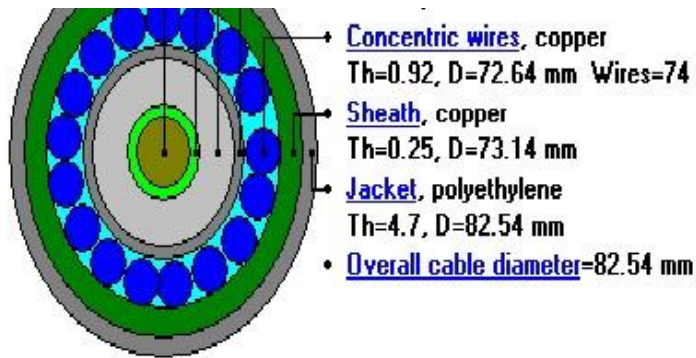
27	Diameter	mm	67.6
<b>Insulation screen</b>			
28	Is layer present?		Yes
29	Material		semi-conducting
30	Thickness	mm	1.6
31	Diameter	mm	70.8
<b>Sheath</b>			
32	Is layer present?		Yes
33	Is around each core? (Only for Three core cable)		No
34	Material		copper
35	Resistivity @20°C	uΩ.cm	1.7241
36	Temperature 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
<b>Concentric neutral/Skid wires</b>			
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
<b>Jacket</b>			
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
<b>Overall cable diameter</b>			
59	Diameter	mm	82.54

No	Description/Value	Unit	1
<b>SPECIFIC INSTALLATION DATA</b>			
<b>Bonding</b>			
1	1-CON, sheaths single point bonded, triang. configuration		Yes
<b>Loss factor constant</b>			
2	Loss factor constant		0.3
<b>Duct construction</b>			
3	PVC duct in concrete or buried		Yes
4	Resistivity (RH)		6
<b>Cables touching</b>			
5	Single conductor cables touching		Yes
<b>Duct/Pipe dimensions</b>			
6	Inside diameter of Duct/Pipe	mm	250
7	Outside diameter of Duct/Pipe	mm	280

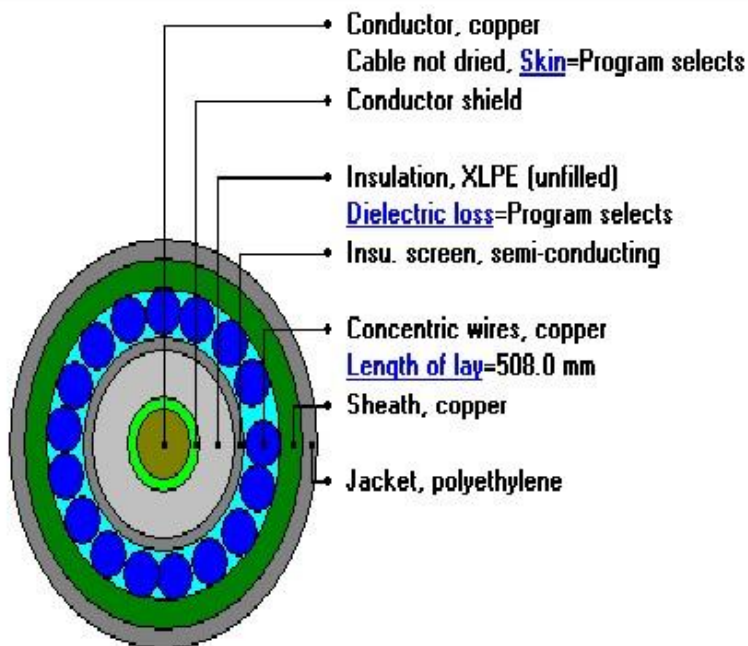
No	Symbol	Description	Unit	1
<b>Temperature calculations</b>				
1		Cable type no		1
2		Circuit no		1
3		Phase		A
4	$\theta_c$	Conductor temperature	°C	90
5	$\theta_i$	Sheath/Shield temperature	°C	77.2
6	$\theta_j$	Armour/Pipe or Jacket temperature	°C	75.6
7	$\theta_s$	Exterior duct temperature	°C	0
8	$\theta_a$	Ambient temperature	°C	20

**Cable type no:** 1  
**Cable type:** COMBINED SHEATH  
**Cable ID:** AEG053  
**Cable title:** N2XS(FL)2Y 110 kV 1x500/50mm<sup>2</sup>





**Voltage= 110.0 kV Cond. area= 500.0 mm<sup>2</sup>**



**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 in common duct, trefoil, touching, backfill  
**Date:** 03.07.2014

No	Description	Unit	1
1	Cable type no		1
<b>Resistances (DC/AC)</b>			
2	DC Resistance of Conductor @ 20°C	Ω/km	0.0366
3	DC Resistance of Conductor @ Operating Temperature	Ω/km	0.04667
4	AC Resistance of Conductor @ 20°C	Ω/km	0.03847
5	AC Resistance of Conductor @ Operating Temperature	Ω/km	0.04905
6	DC Resistance of Sheath @ 20°C	Ω/km	0.30045
7	DC Resistance of Sheath @ Operating Temperature	Ω/km	0.36803
8	DC Resistance of Concentric Wires @ 20°C	Ω/km	0.38381
9	DC Resistance of Concentric Wires @ Operating Temperature	Ω/km	0.47015
<b>Losses</b>			
10	Conductor Losses	W/m	23.05201
11	Dielectric Losses	W/m	0
12	Metallic Screen Losses	W/m	0.72972
13	Aarmor/Pipe Losses	W/m	0
14	Total Losses	W/m	23.78172
<b>Capacitance, Inductance, Impedance</b>			
15	Capacitance	μF/km	0.16278
16	Inductance of Conductor	mH/km	0.41953
17	Reactance of Conductor	Ω/km	0.1318
18	Inductance of Metallic Sheath	mH/km	0.16384
19	Reactance of Metallic Sheath	Ω/km	0.05147
20	Positive Sequence Impedance	Ω/km	0.04905 + j0.13180
21	Negative Sequence Impedance	Ω/km	0.04905 - j0.13180
22	Zero Sequence Impedance	Ω/km	0.20647 + j0.05147
23	Surge Impedance	Ω	50.76725
<b>Others</b>			

24	Dielectric Stress at Conductor Surface	kV/mm	5.1691
25	Dielectric Stress at Insulation Surface	kV/mm	2.20222
26	Insulation Resistance @ 20°C	MΩ.km	135.79153
27	Insulation Resistance @ 90°C	MΩ.km	1.35792
28	Reduction factor		0.50561
29	Charging Capacity of three phase system at U <sub>o</sub>	kVAR/km	618.83612
30	Charging Current for One Phase	A/km	3.24795
31	Voltage Drop for Three Phase System	V/A/km	0.08495
32	Induced Voltage on Metallic Sheath	V/km	35.23864

### Short-Circuit Current

33	Short Circuit Time	s	0.1
34	Non Adiabatic Short Circuit Current of Conductor	kA	226.56406
35	Non Adiabatic Short Circuit Current of Sheath	kA	24.12749
36	Non Adiabatic Short Circuit Current of Armour	kA	0

# Cable Parameters under Normal Operation

**Study:** N2XS(FL)2Y 110 kV Cableizer  
**Execution:** Cables in common duct, trefoil, touching, backfill  
**Date:** 03.07.2014

No	Symbol	Description	Unit	1
1		Cable type no		1
<b>Normal Operation IEC 60287-1-1</b>				
2	$R_o$	Conductor DC Resistance at 20°C	$\Omega/m$	3.66E-05
3	$R'$	Conductor DC Resistance at Max Temp	$\Omega/m$	4.67E-05
4	$R$	Conductor AC Resistance at Max Temp	$\Omega/m$	4.90E-05
5	$K_s$	Factor Used in Calculating $X_s$ (Skin Effect)		1.00E+00
6	$K_p$	Factor Used in Calculating $X_p$ (Proximity Effect)		1.00E+00
7	$\gamma_s$	Skin Effect Factor		3.67E-02
8	$\gamma_p$	Proximity Effect Factor		1.43E-02
9	$d_c$	Conductor Diameter	m	2.62E-02
10	$c$	Distance Between Conductor Axes	m	0.00E+00
11	$C$	Cable Capacitance	F/m	1.63E-10
12	$\tan \delta$	Dielectric Loss Factor		1.00E-03
13	$\epsilon$	Insulation Relative Permittivity		2.50E+00
14	$W_d$	Cable Dielectric Losses Per Phase	W/m	0.00E+00
15	$\lambda_1$	Screen Loss Factor		3.17E-02
16	$\lambda'_1$	Screen Loss Factor Caused by Circulating Current		0.00E+00
17	$\lambda''_1$	Screen Loss Factor Caused by Eddy Current		3.17E-02
18	$\lambda_2$	Armour Loss Factor		0.00E+00
19	$R_s$	Screen AC Resistance at Cable Normal Operation	$\Omega/m$	3.68E-04
20	$g_s$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.00E+00
21	$\beta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		1.51E+02
22	$\rho_s$	Screen Electrical Resistivity @ Operating Temp.	$\Omega.m$	1.72E-08
23	$D_s$	External diameter of Screen (Sheath)	m	7.31E-02
24	$t_s$	Screen (Sheath) Thickness	m	2.50E-04
25	$m$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		8.54E-02
<b>Centre Phase</b>				
26	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
27	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
28	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
<b>Leading Phase</b>				



29	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
30	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
31	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00

### Lagging Phase

32	$\lambda_0$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
33	$\Delta_1$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
34	$\Delta_2$	Coefficient Used in IEC 60287-1-1 Clause 2.3.6.1		0.00E+00
35	d	Screen or sheath mean diameter	m	7.28E-02
36	X	Screen (Sheath) Reactance	$\Omega/m$	5.15E-05
37	M	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00
38	N	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00
39	$X_m$	Coefficient Used in IEC 60287-1-1 Clause 2.3.5	$\Omega/m$	0.00E+00
40	F	Coefficient Used in IEC 60287-1-1 Clause 2.3.5		0.00E+00

### Normal Operation IEC 60287-2-1

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

### F. Ducts

53	$T'_4$	Thermal Resistance of the Air	$^{\circ}C.m/W$	0.16833
54	$T''_4$	Thermal Resistance of the Pipe	$^{\circ}C.m/W$	0.10822
55	$T'''_4$	Thermal Resistance of the medium surrounding the duct(or pipe)	$^{\circ}C.m/W$	0.50323
56	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87
57	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312
58	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037
59	$\theta_m$	Mean Temperature of the Medium Filling the Space	$^{\circ}C$	69.64035
60	$D_o$	Outside Diameter of the Pipe	m	0.28
61	$D_d$	Inside Diameter of the Pipe	m	0.25
62	$\rho_T$	Thermal Resistivity of the Pipe Material	$^{\circ}C.m/W$	6

### F.4 Ducts Buried in Concrete

63	$\rho_c$	Thermal Resistivity of the Concrete	$^{\circ}C.m/W$	0.8
64	$T_4$	Total Thermal Resistance	$^{\circ}C.m/W$	0.77977

65	N	Number of Loaded Cables in the Duct Bank		1
66	$\rho_e$	Thermal Resistivity of Earth Around the Bank	$^{\circ}\text{C.m/W}$	1.5
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2		0
68	$L_G$	Depth of Laying to Centre of Duct Bank	m	0
69	$r_b$	Equivalent Radius of Concrete Duct Bank	m	0
70	x	Shorter Side of the Bank	m	0
71	y	Longer Side of the Bank	m	0
72	I	Cable Current Ampacity	A	685.6