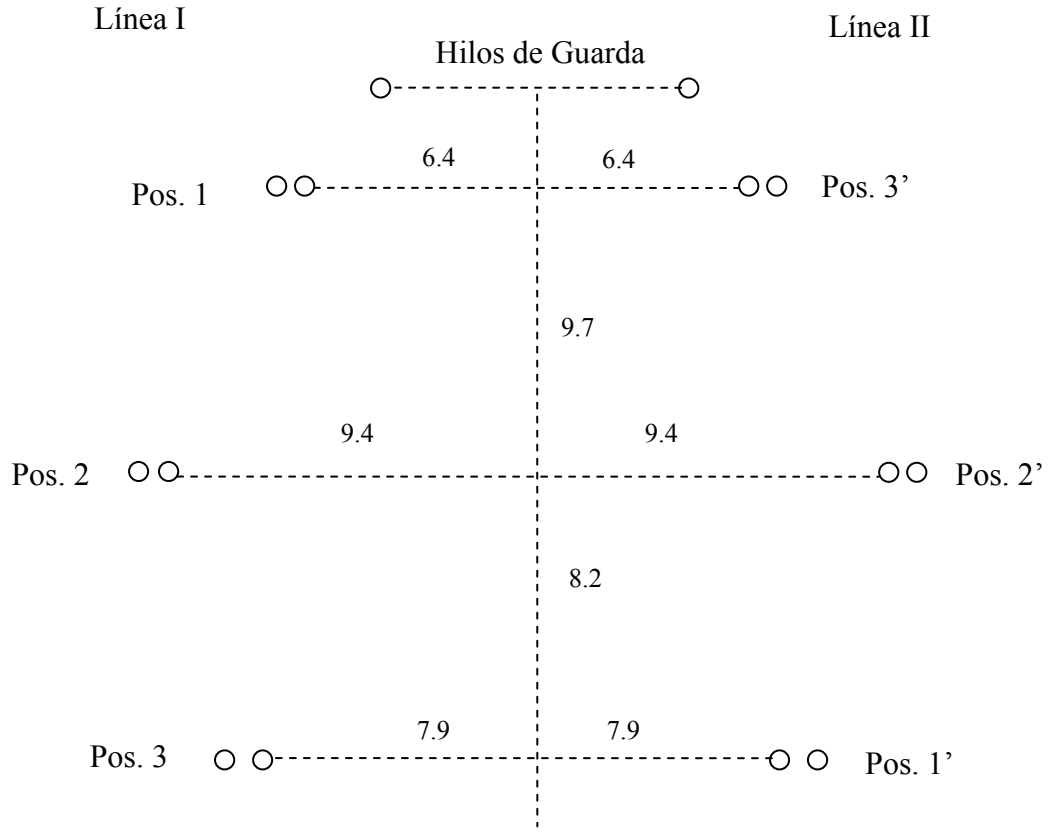
LINEA DOBLE DE 400 kV

Datos:

Tipo: Duplex
Conductor:
Denominacion: Cardinal
Seccion Total = 546.10 mm^2
" Aluminio = 483.42 "
" Acero = 62.64 "
Composición:
Aluminio: 54 x 3.40 mm diámetro
Acero: 7 x 3.20 mm diámetro
Diámetro Total = 30.38 mm
Resistencia (20ºC) = 0.0598 Ω / km (a.c.)
Resistividad del Terreno:
ρ = 5 -10 - 20 -50 – 100 - 200 – 500 – 1000 Ω m^2 /m

Línea Doble con Transposiciones
Apoyo Típico (Cotas en m.)



Separación entre Conductores de la misma fase = 0.40 m

D_{12} = 10.22 m D_{23} = 8.37 m D_{31} = 18.04 m

$D_{11'}$ = 22.99 m $D_{12'}$ = 18.61 m $D_{13'}$ = 12.80 m

$D_{21'}$ = 19.22 m $D_{22'}$ = 18.90 m $D_{23'}$ = 18.61 m

$D_{31'}$ = 15.84 m $D_{32'}$ = 19.22 m $D_{33'}$ = 22.99 m

Impedancia de Secuencia Positiva:

$Z_1 = R_1 + jX_1$

Resistencia del Conductor Cardinal a 20ºC = 0.0598 Ω / km (Tabla)
Resistencia del Conductor Cardinal a 50ºC = 0.0692 Ω / km

$$R_1 = \frac{0,0692}{2} = 0.0346\left(\Omega / km\right)$$

$$X_1\left(\Omega / km\right) = 0.1447.\log_{10}\frac{DGM}{RGM}$$

$DGM = \sqrt[3]{D_{12}D_{23}D_{31}}$
$D_{12} =$ 10.22 m $D_{23} =$ 8.37 m $D_{31} =$ 18.04 m
$DGM = 11.56m$

$RGM = \sqrt{RGM_c.D_{aa'}}$
$RGM_c =$ RGM del Conductor Cardinal
$RGM_c = 0.0123$ m
$D_{aa'} = 0.40$ m
$RGM = 0.0701$ m

$X_1 = 0,3208\left(\Omega / km\right)$

$Z_1 = 0,0346 + j0,3208\ \Omega$ / km

Impedancia de Secuencia Negativa:

Igual a la Impedancia de Secuencia Positiva

Impedancia de Secuencia Cero:

$$Z_0 = R_0 + jX_0$$

$$Z_0\left(\Omega/km\right) = R_1 + 0.1482 + j0.4341.\log_{10} 93.09\frac{\sqrt{\rho}}{RGM_{3f}}$$

$$R_1 = 0,0346\left(\Omega/km\right)$$

$$RGM_{3f} = \sqrt[9]{RGM_{1f}^3 D_{12}^2 D_{23}^2 D_{31}^2}$$

$RGM_{1f} = 0.0701$ m

$D_{12} =$ 10.22 m $\quad D_{23} =$ 8.37 m $\quad D_{31} =$ 18.04 m

$RGM_{3f} = 2.1075$ m

$$Z_0\left(\Omega/km\right) = 0,1828 + j0,4341.\log_{10} 44,17\sqrt{\rho}$$

$$R_0 = 0.1828\left(\Omega/km\right)$$

ρ	5	10	20	50	100	200	500	1000
X_0	0.8659	0.9312	0.9965	1.0829	1.1482	1.2136	1.3000	1.3653
X_0/X_1	2.70	2.90	3.11	3.38	3.58	3.78	4.05	4.26

ρ (Ω m^2 /m)
X_0 (Ω /km)

Impedancia Mutua de Secuencia Cero:

$$Z_{0m} = R_{0m} + jX_{0m}$$

$$\left(Z_{0m}\right)_{abc,a'b'c'}\left(\Omega / km\right) = 0{,}1482 + j0{,}4341.\log_{10} 93{,}09\frac{\sqrt{\rho}}{DGM_{abc,a'b'c'}}$$

$$DGM_{abc,a'b'c'} = \sqrt[9]{D_{11'}D_{12'}D_{13'}D_{21'}D_{22'}D_{23'}D_{31'}D_{32'}D_{33'}}$$

$D_{11'} =$ 22.99 m $D_{12'} =$ 18.61 m $D_{13'} =$ 12.80 m
$D_{21'} =$ 19.22 m $D_{22'} =$ 18.90 m $D_{23'} =$ 18.61 m
$D_{31'} =$ 15.84 m $D_{32'} =$ 19.22 m $D_{33'} =$ 22.99 m

$$DGM_{abc,a'b'c'} = 18.54 \text{ m}$$

$$Z_{0m} = 0.1482 + j0.4341.\log_{10} 5.02\sqrt{\rho}\left(\Omega / km\right)$$

$$R_{0m} = 0.1482\left(\Omega / km\right)$$

ρ	5	10	20	50	100	200	500	1000
X_{0m}	0.4559	0.5212	0.5866	0.6729	0.7383	0.8036	0.8900	0.9553
X_{0m}/X_1	1.42	1.62	1.83	2.10	2.30	2.50	2.77	2.98

ρ (Ω m^2 /m)
X_0 (Ω /km)