

Introduction to PowerWorld Simulator: Interface and Common Tools



I16: TransLineCalc



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TransLineCalc Tool



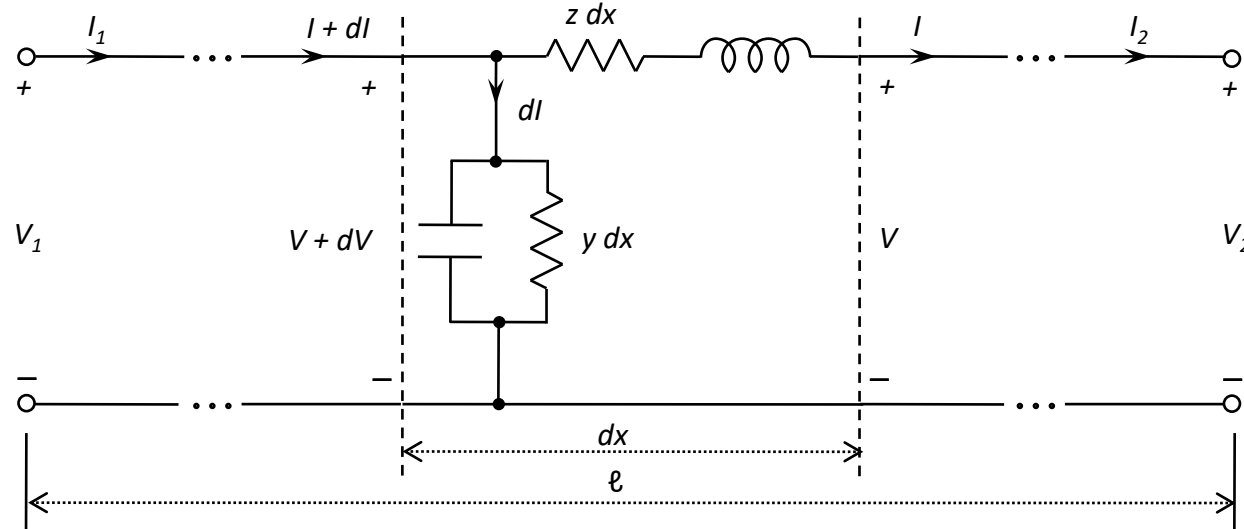
- The Transmission Line Parameter Calculator (TransLineCalc) is a tool designed to compute characteristic line parameters
 - Input data: Type of conductor and tower configuration of a three-phase overhead transmission line
 - Output data: Resistance R , reactance X , susceptance B , conductance G
 - Values computed as distributed, lumped or total, and in per-unit
- As a stand-alone program or as an automation server that interacts with Simulator or from an external application

Distributed Transmission Line Model



- Distributed parameter line

$z = r + j\omega l =$ series impedance per unit length/phase
 $y = g + j\omega c =$ shunt admittance per unit length/phase
 $\ell =$ length of the line



Distributed Transmission Line Model (cont'd)



- The relationship between the per-phase voltages and currents at the two ends of the transmission line is specified by:

$$\begin{aligned} V_1 &= V_2 \cosh \gamma \ell + Z_C I_2 \sinh \gamma \ell \\ I_1 &= I_2 \cosh \gamma \ell + \frac{V_2}{Z_C} \sinh \gamma \ell \end{aligned}$$

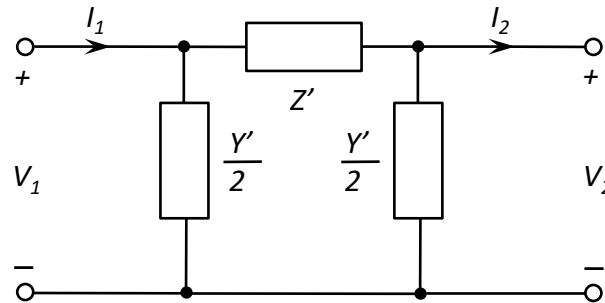
where

- z is the series impedance
- y is the shunt admittance
- γ is the propagation constant $= \sqrt{zy}$
- Z_C is the characteristic impedance $= \sqrt{z/y}$

Π Transmission Line Model



- Use of equivalent Π circuit of a transmission line



- The same relationship between terminal voltages and currents in a matrix form:

$$\begin{aligned} V_1 &= AV_2 + BI_2 \\ I_1 &= CV_2 + DI_2 \end{aligned}$$

Π Transmission Line Model (cont'd)



- The A, B, C, D parameters are given by:

$$A = 1 + \left(\frac{Z'Y'}{2} \right) \quad B = Z'$$
$$C = Y' \left(1 + \frac{Z'Y'}{4} \right) \quad D = 1 + \frac{Z'Y'}{2}$$

where

- $Z \square z\ell$ is the total series impedance of the line, and
- $Y \square y\ell$ is the total line-neutral admittance of the line, and

$$\frac{Y'}{2} = \frac{Y}{2} \frac{\tanh(\gamma\ell/2)}{\gamma\ell/2} \quad Z' = Z \frac{\sinh \gamma\ell}{\gamma\ell}$$

TransLineCalc Calculations



- Three types of calculations available in TransLineCalc:
 - Parameters Calculation. Computes distributed and lumped or total values of R, X, G and B
 - Amp to MVA Conversion. Converts the limits of transmission lines from Amps to MVA's, and viceversa, given the voltage base
 - Reverse Lookup. Given the tower configuration and the characteristic line parameters in per unit, lists the conductors that match those characteristic line parameter given values

Parameters Calculation



Edit conductors table and tower configurations

Select Conductor Type

Select Tower Configuration

Line length and units

Automatic calculation of parameters when any of the input data changes

PowerWorld Transmission Line Parameters Calculation

Calculations | Conductor Type | Tower Configuration

Parameters Calculation | Amp to MVA Conversion | Reverse Lookup

Input Data

Conductor Type: Bittern

Tower Configuration: Default

Line Length: 10.000 mi

Length Units: English

Power Base: 100.000 MVA

Voltage Base: 138.000 kV

Impedance Base: 190.440 Ohms

Admittance Base: 0.00525 Mhos

Results

Lumped Results | Distributed Results | Intermediate Results

R = 0.75889093 Ohms per phase
X = 5.4981041 Ohms per phase
B = 7.8482692E-05 Siemens per phase
G = 3.8988057E-10 Siemens per phase

R = 0.0039849345 PU per phase
X = 0.028870532 PU per phase
B = 0.014946244 PU per phase
G = 7.4248856E-08 PU per phase

Surge Impedance Loading 71.608762 MVA

Note: Calculated using the long-line model of a transmission line (hyperbolic equations)

OK Cancel Select Conductors and Configurations Database Help

Characteristic line parameters (lumped, per-unit, distributed and intermediate values)

Editing Conductors and Tower Configurations



Area (cm ²)	1272000	Approximate Current Carrying Capacity (A)	0.00
Aluminum strands	45	DC Resistance (20°C) (Ohms/Mile)	0.071460
Steel Strands	7	AC Resistance (25°C) (Ohms/Mile)	0.075900
Aluminum layers	3	AC Resistance (50°C) (Ohms/Mile)	0.082800
External diameter (inches)	1.345000	AC Resistance (75°C) (Ohms/Mile)	0.089800
GMR (feet)	0.044500	Inductive Reactance (Ohms/Mile)	0.378000
		Capacitive Reactance (MegaOhms/Mile)	0.085500

Create a new conductor, modify or delete an existing one

Values can be changed for the specific conductor/tower configuration or as a table form

Phase	x-Coordinate	y-Coordinate
A: ●	0.00000 m	0.00000 m
B: ○	1.00000 m	0.00000 m
C: ●	2.00000 m	0.00000 m

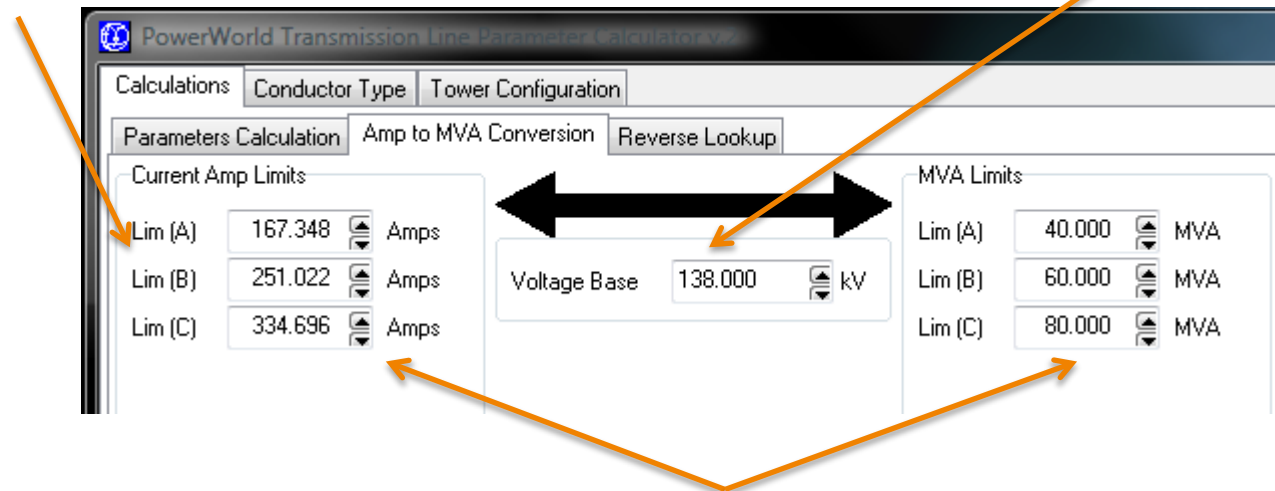
Element	x-Coordinate	y-Coordinate
1: ●	0.00000 m	0.00000 m

Amp to MVA Limit Conversion



The stand-alone version displays only three limits. When used from Simulator, it will display the current 8 line limits of a transmission line

The voltage base is the only input data



As the user modify either the Amp Limits or the MVA Limits, they are automatically converted

Reverse Lookup



Enter the Tower Configuration, line length and units, and per-unit characteristic line parameter values

Conductors are listed according to the match found

The screenshot shows the 'PowerWorld Transmission Line Parameter Calculator' window. The 'Reverse Lookup' tab is selected. The 'Input Data' section on the left contains the following values:

- Tower Configuration: Default
- Line Length: 10.000 mi
- Length Units: English
- Power Base: 100.000 MVA
- Voltage Base: 138.000 kV
- R: 0.0054 PU per phase
- X: 0.03 PU per phase
- B: 0 PU per phase
- G: 0 PU per phase

A green 'Calculate' button is located next to the input fields. The 'Results' table on the right lists the following data:

	Conductor	% Match	R	X	B	G
1	Ruddy	98.76	0.0055652579	0.029977997	0.014367344	9.5621737E-08
2	Rail	97.956	0.0052187419	0.029793309	0.014463091	9.0828979E-08
3	Crane	97.592	0.0056177647	0.029760315	0.014409776	9.7135349E-08
4	Canary	97.568	0.0054602575	0.029678526	0.014454703	9.4843809E-08
5	Cardinal	95.787	0.0051609929	0.029486404	0.014546303	9.0845767E-08
6	Oriolan	94.586	0.0048407244	0.02953387	0.014595685	8.5757577E-08
7	Drake	94.468	0.0061427901	0.029961015	0.014301666	1.047147E-07
8	Condor	94.443	0.0061427889	0.030081071	0.014258426	1.0411615E-07
9	Mallard	94.337	0.0060902896	0.029678554	0.014392837	1.0522819E-07
10	Cuckoo	93.895	0.0061952881	0.030203418	0.014255533	1.0488536E-07
11	Tern	93.138	0.0062477912	0.030364276	0.014170946	1.0464812E-07
12	Curlew	92.689	0.0047777239	0.029238942	0.014685182	8.5954721E-08

Interaction with Simulator



- TransLineCalc can be opened from Simulator.
 - Transmission/Line/Transformer options dialog for each line in Edit Mode
 - **Parameters** tab,
 - Click on **Calculate Impedances** button,
 - Select **From Conductor Type and Tower Configuration**.

The screenshot shows the 'Transmission Line/Transformer Options' dialog box with the 'Parameters' tab selected. The 'From Bus' is 3, 'To Bus' is 4, and 'Circuit' is 1. The 'Name' is 'Three' and 'Four', and the 'Area Name' is 'Top (1)'. The 'Nominal kV' is 138.0. The 'Labels' are 'no labels'. The 'Status' is 'Closed'. The 'Length (mi)' is 0.00. The 'Calculate Impedances >' button is highlighted. The 'Per Unit Impedance Parameters' section shows: Series Resistance (R) 0.01000, Series Reactance (X) 0.03000, Shunt Charging (B) 0.0200, and Shunt Conductance (G) 0.0000. The 'Has Line Shunts' checkbox is unchecked. The 'Line Shunts' button is visible. The 'Convert Line to Transformer' button is at the bottom.

Field	Value
From Bus	3
To Bus	4
Circuit	1
Name	Three
Name	Four
Area Name	Top (1)
Area Name	Top (1)
Nominal kV	138.0
Nominal kV	138.0
Labels	no labels
Status	Closed
Length (mi)	0.00
Series Resistance (R)	0.01000
Series Reactance (X)	0.03000
Shunt Charging (B)	0.0200
Shunt Conductance (G)	0.0000
Has Line Shunts	Unchecked