

# Introduction to PowerWorld Simulator: Interface and Common Tools

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## I16: TransLineCalc



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# TransLineCalc Tool

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- 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

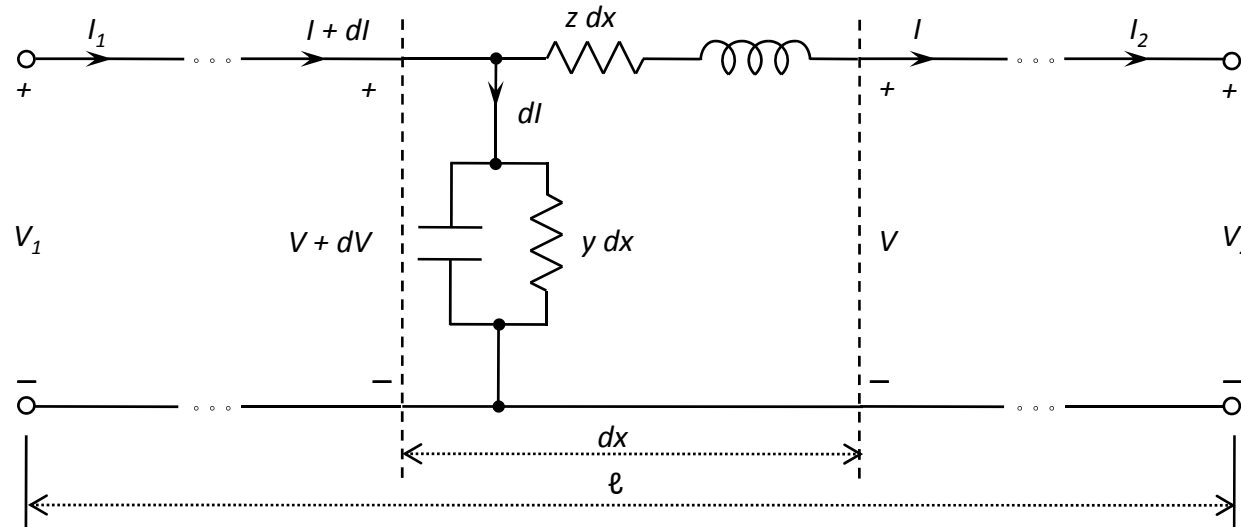


- Distributed parameter line

$z = r + j\omega l =$  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:

$$V_1 = V_2 \cosh \gamma \ell + Z_C I_2 \sinh \gamma \ell$$

$$I_1 = I_2 \cosh \gamma \ell + \frac{V_2}{Z_C} \sinh \gamma \ell$$

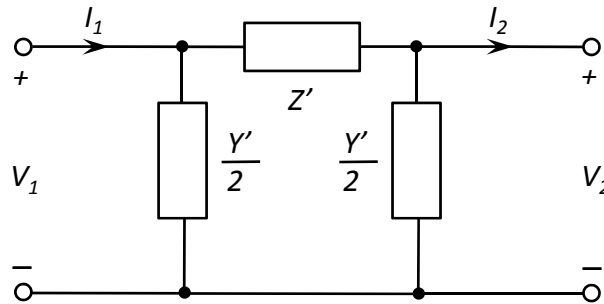
where

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

# $\Pi$ Transmission Line Model



- Use of equivalent  $\Pi$  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

$$Z' = Z \frac{\sinh \gamma\ell}{\gamma\ell}$$

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

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

# 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



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

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

Parameter	Value	Unit
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

Parameter	Value	Unit
Surge Impedance Loading	71.608762	MVA



# Editing Conductors and Tower Configurations



PowerWorld Transmission Line Parameter Calculator v.2

Calculations | Conductor Type | Tower Configuration

Edit by Form | Edit by Table

Conductor Code Word: **Bittern**

New Save Save As Rename Delete

Area (cmil)	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

PowerWorld Transmission Line Parameter Calculator v.2

Calculations | Conductor Type | Tower Configuration

Edit by Form | Edit by Table

Tower Configuration Name: **Default**

New Save Save As Rename Delete

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

Draw axis

Bundle Configuration

Conductors per bundle: 1

Use Regular Spacing of: 0.10000 m

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

Draw axis

System Information

Temperature: 25.000 °C Frequency: 60.000 Hz System of Units: Metric (SI)

# 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

Current Amp Limits	Voltage Base	MVA Limits
Lim (A) 167.348 A	138.000 kV	Lim (A) 40.000 MVA
Lim (B) 251.022 A		Lim (B) 60.000 MVA
Lim (C) 334.696 A		Lim (C) 80.000 MVA

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 'Reverse Lookup' tab in the PowerWorld Transmission Line Parameter Calculator. 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

The 'Results' table on the right lists 12 conductors with their respective match percentages and parameters:

	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	Oritolan	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 open 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**.

Transmission Line/Transformer Options

From Bus: 3, To Bus: 4, Circuit: 1

Number: 3, Name: Three, Area Name: Top (1), Nominal kV: 138.0

To Bus: 4, Name: Four, Area Name: Top (1), Nominal kV: 138.0

Labels ...: no labels

Display Parameters Fault Info Owner, Area, Zone, Sub Custom

Status:  Open,  Closed

Length (mi): 0.00

Calculate Impedances >

From Per Distance Impedances

From Conductor Type and Tower Configuration

Convert Line to Transformer

Per Unit Impedance Parameters

Series Resistance (R): 0.01000

Series Reactance (X): 0.03000

Shunt Charging (B): 0.0200

Shunt Conductance (G): 0.0000

Has Line Shunts:  Line Shunts

MVA Limit: Limit, Limit, Limit, Limit, Limit, Limit, Limit, Limit, Limit