

Conductor data in Line Data device

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1 Conductor Data tab

The Data tab allows entering the geometrical and electrical data of the transmission line. This include the electrical data of the conductors, their geometrical placement as well as a general description of the construction of the towers.

The normal required information to characterize the transmission line is the geometric location of the conductors and their electrical characteristics. However, when the line geometry is not known, it is still possible to generate reasonably accurate line models from the 60-Hz (or any other specific frequency) positive and zero sequence impedances.

The parameters entered on the Data tab are:

- **Module:** allows to specify the type of data to be generated
 - **Line Model:** to generate transmission line models for steady-state and for time-domain studies.
 - **Line Parameters:** to determine the resistance, inductance, and capacitance matrices for a multiphase overhead transmission line consisting of an arbitrary configuration of conductors. This module has an option for generating a nominal-pi model.
- **Units:** identify the units used for conductor and line data. To facilitate the data entry, the units are mentioned next to each parameter. Two type of unit systems are allowed:
 - Metric: The S.I. system of units is used for conductor and line data.
 - English: The English system of units is used for conductor and line data.
- **Input option:** The geometry of the conductors and the line data is either:
 - Specified directly with the **Conductor data** option
 - Rebuilt (**Line Rebuild**) from the electrical parameters.
- **Number of conductors:** selects the (N) number of conductors in the current system.
- **Conductor data** table:
 - **Wire:** the wire number
 - **Phase number:** The phase number to which the conductor belongs. If more than one conductor is given the same phase number, this means that the conductors are electrically connected (connected in parallel). This is the case, for instance, of individually specified conductors in a bundle. It could also be used, for instance, to internally unite two parallel lines when it is not desired to preserve their individual identity. Phase numbers for conductors must follow the sequence 1, 2, 3,..., N with no missing phases. Set the phase number to 0 for a ground wire (ground is phase number zero, by definition) when the ground wire is not to be considered separately.
 - **DC resistance:** of the conductor in the specified unit.
 - **Outside diameter:** of the conductor.
 - **Horizontal distance:** of the conductor from the reference point $x=0$.
 - **Vertical Height at tower** (VH_{tower}): of the conductor above the ground at the tower.

- **Vertical Height at Midspan** (VH_{mid}): of the conductor above the ground at the middle of the span. When both VH_{tower} and VH_{mid} are specified, an average height is calculated using the following formula

$$VH_{average} = \frac{(2VH_{mid} + VH_{tower})}{3}$$

- **Additional data for Wire:** allows specifying the data in the next items for each specified wire selected from the number list.
- **Skin effect correction:** Skin effect correction of an equivalent tubular conductor.
 - **Thick/Diam:** specify the Thickness/Diameter (T/D) factor which has to be less or equal of 0.5
 - **None:** to neglect the skin effect correction.
 - **Solid conductor:** assume a solid conductor.
 - **Galloway-Wedepohl:** use Galloway-Wedepohl's correction formula for stranded conductors. This option is only available for Line Parameters.
- **Bundled conductor:** Specify a symmetrical bundle using (see Figure 1–1):
 - **Number of conductors in the bundle**
 - **Spacing** (SEPAR) between adjacent conductors in the bundle.
 - **Angular position** (ALPHA) of the first conductor (or any conductor) of the bundle. Positive angles are measured counter-clock wise.

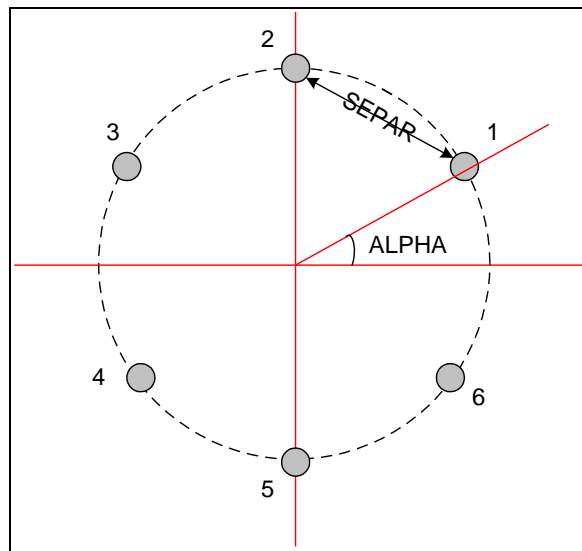


Figure 1–1 Sample sketch of a bundle with 6 conductors

- **Reactance model data.** Specify the model used for the calculation of the internal inductance of the conductor. With the default options the conductor internal inductance is corrected for skin effect assuming tubular conductor geometry. Alternative inductance options are possible that do not correct the conductor's internal inductance.
 - **Relative permeability:** This is the standard case used in both Line Model and Line Parameters calculation. The internal reactance is calculated and corrected for skin effect assuming tubular conductor geometry.
 - **Permeability of outer strand:** For use with Galloway-Wedepohl's equation for stranded conductors. The user must specify the relative permeability μ_r of the outer strand as well as the number of the outer strands in the conductor. This option is only available with Line Parameters.
 - **Reactance for unit spacing:** The reactance (not the inductance) is assumed to remain constant regardless of the frequency that may be specified in the

frequency data. The reactance is in units of Ω/km for Metric units and Ω/mile for English units. The unit spacing is 1 meter for Metric units and 1 foot for English units. This option is only available with Line Parameters. The name 1-foot spacing is for the case where the spacing among the three phases (expressed as geometric mean distance GMD) is 1 foot, with GMR given in feet as well.

- **Reactance for unit spacing at 60 Hz:** Reactance for unit spacing (as above) at 60 Hz. As opposed to the case above where the reactance is assumed to remain constant, it is now the inductance that is assumed to remain at its 60-Hz value. If frequencies other than 60 Hz are specified in the frequency data, the reactance will be changed proportionately. This option is only available with Line Parameters.

Note that the relationship between reactances for 1'-spacing and GMR (geometric mean radius) is given by:

$$X_{1\text{-ft}} \Omega/\text{mile} = \frac{f \text{ Hz}}{100} 0.20223653 \log\left(\frac{12}{\text{GMR}(\text{inches})}\right)$$

$$X_{1\text{-ft}} \Omega/\text{mile} = 2\omega 1.609344e-04 \log\left(\frac{12}{\text{GMR}(\text{inches})}\right)$$

- **GMR:** geometric mean radius of the conductor, in units of cm if Metric or inches if English. This option is only available with Line Parameters.
- **GMR/r:** Dimensionless ratio, where r is the conductor outer radius. For solid conductors, this ratio is equal to 0.7788. This option is only available with Line Parameters.

1.1 Example

Figure 1–2 shows the conductor data taken from the drawings in Figure 1–3 and Figure 1–4. This example evaluates an FD-line model for a 3-phase transmission line system having the following properties:

- The units are metric.
- The conductor data is specified directly.
- The system has 8 conductors: 2 tubular conductors for each phase and 2 solid conductors for the ground wire.

The complete view of conductor data is listed as:

1	0.0324	4.06908	-6.3246	15.24	15.24
1	0.0324	4.06908	-5.8674	15.24	15.24
2	0.0324	4.06908	-0.2286	23.622	23.622
2	0.0324	4.06908	0.2286	23.622	23.622
3	0.0324	4.06908	5.8674	15.24	15.24
3	0.0324	4.06908	6.3246	15.24	15.24
0	1.6216	0.98044	-3.9319	30.023	30.023
0	1.6216	0.98044	3.9319	30.023	30.023

Since the ground wires are numbered as 0, they will not appear in the model data. Wires with the same phase number are also counted as 1. In this case the generated model will only have 3 wires (3 modes).

This example can be found in the design Examples\Line_Data\LTC5A.ecf.

Transmission line data

Data | Model | Line length | Output options | Optional | Fitting | Save and run this case | Help

Geometrical and electrical data

Module: Line Model
 Units: Metric
 Input option: Standard Conductor data

Conductor Data
 Number of conductors: 8

Wire	Phase Number	DC resistance [Ohm/km]	Outside diameter [cm]	Horizontal distance [m]	Vertical Height at tower [m]	Vertical Height at Midspan [m]
1	1	0.0324	4.06908	-6.3246	15.24	15.24
2	1	0.0324	4.06908	-5.8674	15.24	15.24
3	2	0.0324	4.06908	-0.2286	23.622	23.622
4	2	0.0324	4.06908	0.2286	23.622	23.622
5	3	0.0324	4.06908	5.8674	15.24	15.24
6	3	0.0324	4.06908	6.3246	15.24	15.24

Additional data for Wire 1

Skin effect correction

Thick/Diam 0.3636
 None
 Solid conductor
 Galloway Wedepohl

Bundled Conductor

Relative permeability: 1

OK Cancel

Figure 1–2 EMTPWorks conductor data form usage example

The geometry and the dimension of the conductors are detailed in Figure 1–3.

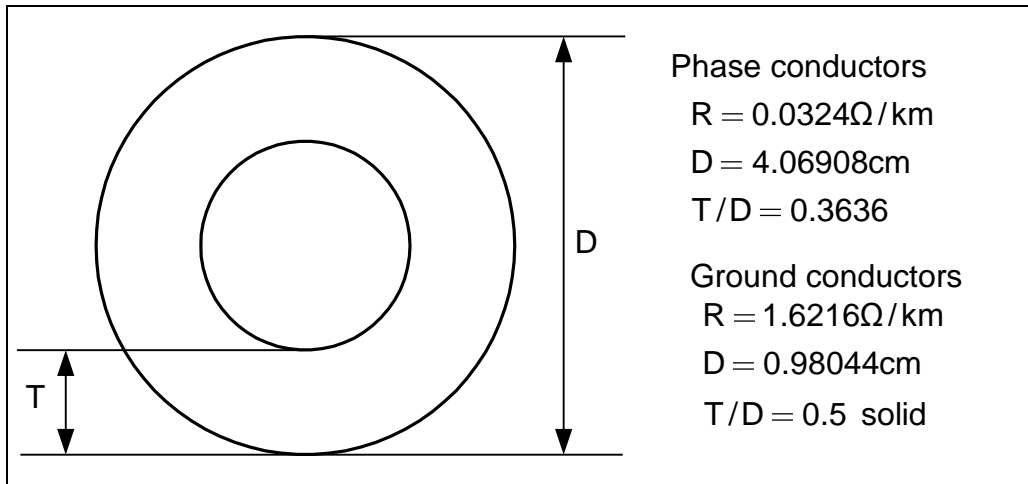


Figure 1–3 Phase conductor data

The geometrical layout of the transmission line is given in Figure 1–4:

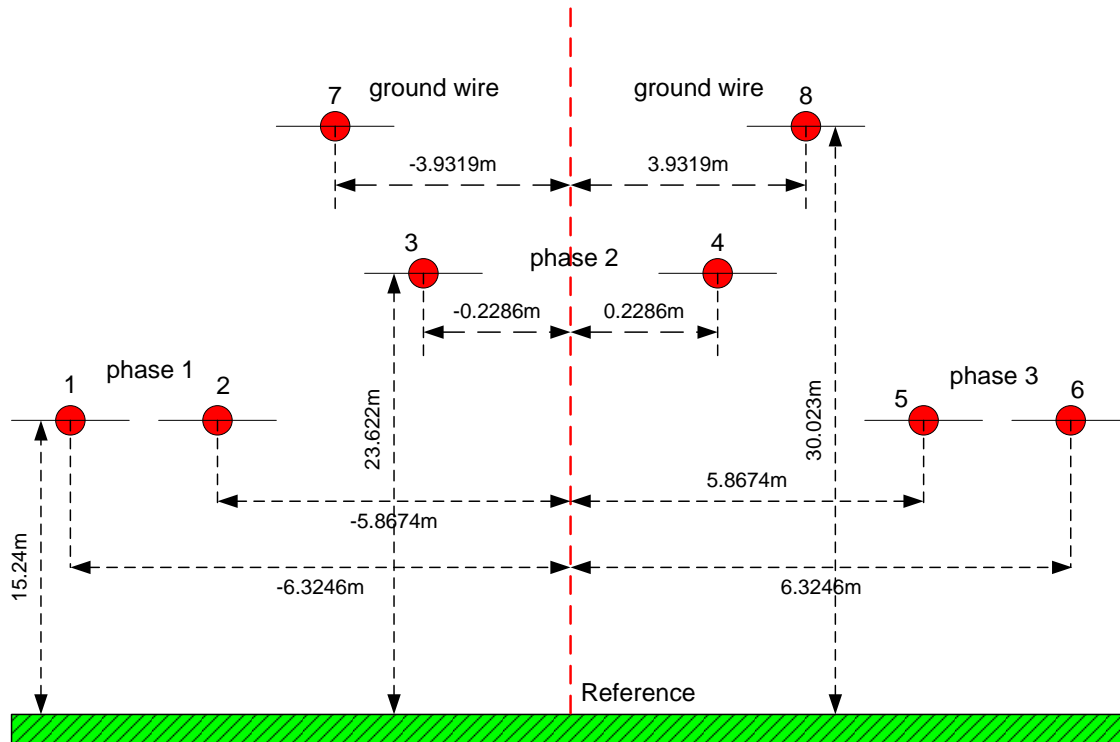


Figure 1–4 Geometry of the test system

2 Line Rebuild option

The conductor data for this option does not contain the line geometry as in the standard case, but the 60 Hz (or any other specific frequency) values of the zero and positive sequence impedances: R_0 , L_0 , C_0 , and R_1 , L_1 , C_1 . Optionally, for extra accuracy, the conductor's dc resistance can be supplied.

From the 60 Hz parameter information, EMTP builds an equivalent balanced arrangement of phase conductors that matches the specified 60 Hz sequence parameters. It also estimates the skin effect characteristics of the conductors. This estimate is better if the conductor's dc resistance is specified.

After rebuilding the line geometry and conductor characteristics, the requested line model is processed as in the ordinary case. Since the reconstructed line is assumed to be balanced, the transformation matrix is the same one used for balanced lines (generalized Clarke).

The data fields required for this option are self-explanatory. It is noticed that if the dc resistance is set to 0, it will be automatically estimated by the program.