# Conductor data in Cable Data device



## 1 Basic cable data

The data tab allows the user to specify the geometrical and electrical characteristics of the cable system. This includes the geometrical description of the cable, the electrical and geometrical data of the conductors as well as the electrical properties of the insulation material. The data information required to describe a pipe-type cable is somewhat different than the data required for a single-core coaxial cable. Although many data fields are similar, their description will be presented separately to facilitate readability.

The parameters entered on the first section of Conductor Data tab are:

- **Cable type**: allows to choose the type of cable
    - **Single core** coaxial cables.
    - **Pipe type** cable where a metallic pipe encloses the coaxial cables.
- **Number of cables** in the system.
- **Cross-bond the Sheaths**: In order to model a cross-bonded cable accurately, each major section must be modeled in detail. This means that each minor section of the cable must be modeled (preferably with an FDQ model), and the sheath bonding and sheath grounding connections must be made explicitly using the EMTP node names.
  Such a detailed representation can be computationally intensive because modeling short cable segments of the order of 400 meters or so, requires a very small time step (a fraction of the travel time of the fastest propagation mode). Furthermore, a number of these major sections must be connected to represent the entire cable. For example, a 12 km cable with 400 m minor sections, would require a total of 30 6-phase FDQ cable models. Nevertheless, this type of detailed representation is necessary when sheath currents and voltages have to be assessed.
  The detailed representation of each minor section of a cross-bonded cable is in some ways analogous to modeling a transposed overhead transmission line by representing each transposition section explicitly, and connecting the sending and receiving node names accordingly with EMTP node names. In the case of transmission lines this situation can be approximated by assuming that the line is balanced, and using a single line where the elements of impedance and admittance matrices have been averaged to account for the effect of transposition.
  A cross-bonding option is available in the Cable Data device to provide this type of approximation. If “Cross-bond the Sheaths” is selected, then the elements of the impedance and admittance matrices of the cable are averaged to reflect the effect of cross-bonding. The grounding of the sheaths is then controlled using the KPH parameter in the "Conductor data" table. Setting KPH = 0 for the sheaths, is equivalent to assuming

that the sheaths are continuously grounded (at zero potential throughout the entire cable length). In this case, the sheaths can be eliminated and a three-conductor approximation of a cross-bonded cable is obtained. This three-conductor approximation compares quite favourably with the detailed modelling of each minor section of a cross-bonded cable, and it is ideally suited for switching transient studies of cross-bonded cables, because of its computational speed and accuracy.

# 2 Single-Core (SC) coaxial cables

## *2.1 Cable data*

The general structure of this type of cable system is shown in Figure 2–1

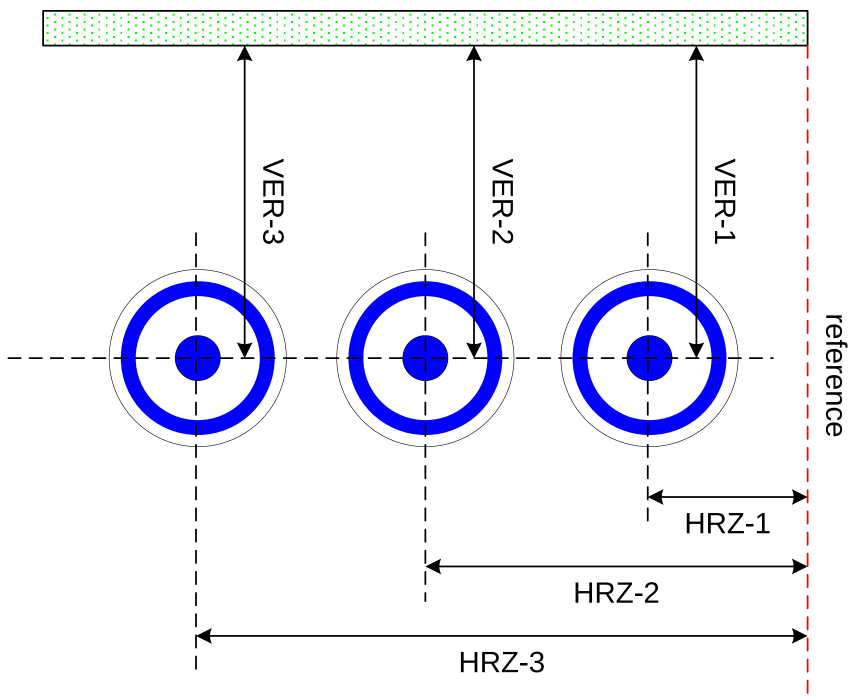


**Figure 2–1 Single-Core cable system**

The required data for each cable:

- **Cable number**: given in increasing order for the entire cable system
- **Number of conductors** indicating the number of concentric tubular conductors in this cable. For example, the cable shown in Figure 2–2 has 3 conductors: the core, the sheath and the armour.
- **Vertical Distance (m)**: depth (see VER-1 in Figure 2–1) measured from the center of this cable to the earth's surface. This is a positive number.
- **Horizontal Distance (m)**: measured from the center of this cable to an arbitrary point of reference (see HRZ-1 in Figure 2–1).
- **Outer Insulation Radius (m)**: indicating the outside radius of the insulation layer surrounding the cable. Use 0 if there is no surrounding insulation. This the ROUT variable shown in Figure 2–2

## 2.2 Conductor data

The term conductor is used to designate both conductor and insulator data.

This section describes the tubular conductor and their surrounding insulation ordered from inside out (the core conductor comes first, followed by sheath, etc.) as shown in Figure 2–2. The required data for each conductor is:

- **Inside Radius Rin [m]**: Inside radius of the conductor.
- **Outside Radius Rout [m]**: Outside radius of the conductor.
- **Resistivity Rho [Ohm-m]**: Resistivity of the conductor.
- **Relative Permeability MUE**: Relative permeability of the conductor.
- **Insulator Relative Permeability MUE-IN**: Relative permeability of the surrounding insulation.
- **Insulator Relative Permittivity EPS-IN**: Relative permittivity of the surrounding insulation.
- **Insulator Loss Factor LFCT-IN**: Loss factor of the surrounding insulation.
- **KPH**: Phase-number of the conductor. Conductors of all cables must be given phase numbers starting from 1, with no gaps in phase numbering. For example, for a three-conductor cable KPH = 1, 2, 3 is a legitimate numbering arrangement, while KPH = 1, 3, 4 is not. Conductors with KPH = 0 will be grounded and all conductors with identical phase number will be bundled into a single equivalent conductor. The order of conductors in the Model Data File will be made according to the sequence defined by KPH.

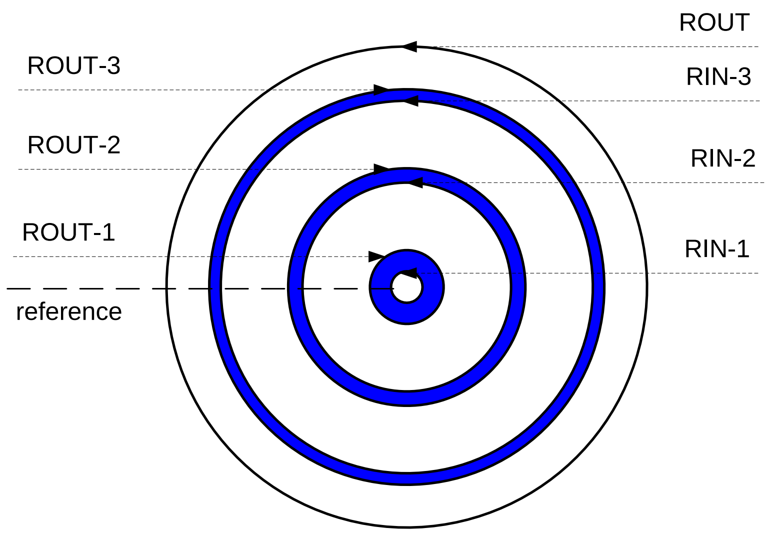


**Figure 2–2 A single-core cable with 3 conductors**

## 2.3 Example

Figure 2–3 shows a sample case of complete cable and conductor data for single-core. This case can be found in the design Example\Cable_Data\tcase2.ecf.

The data case contains 3 identical single-core cables, each one has two conductors. The complete layout is shown in Figure 2–4. Only the outside radius of the conductors and the outer insulation radius are shown in this figure. Each conductor is associated with a non-zero phase number, thus the generated model for this example will have 6 different modes (6 wires).

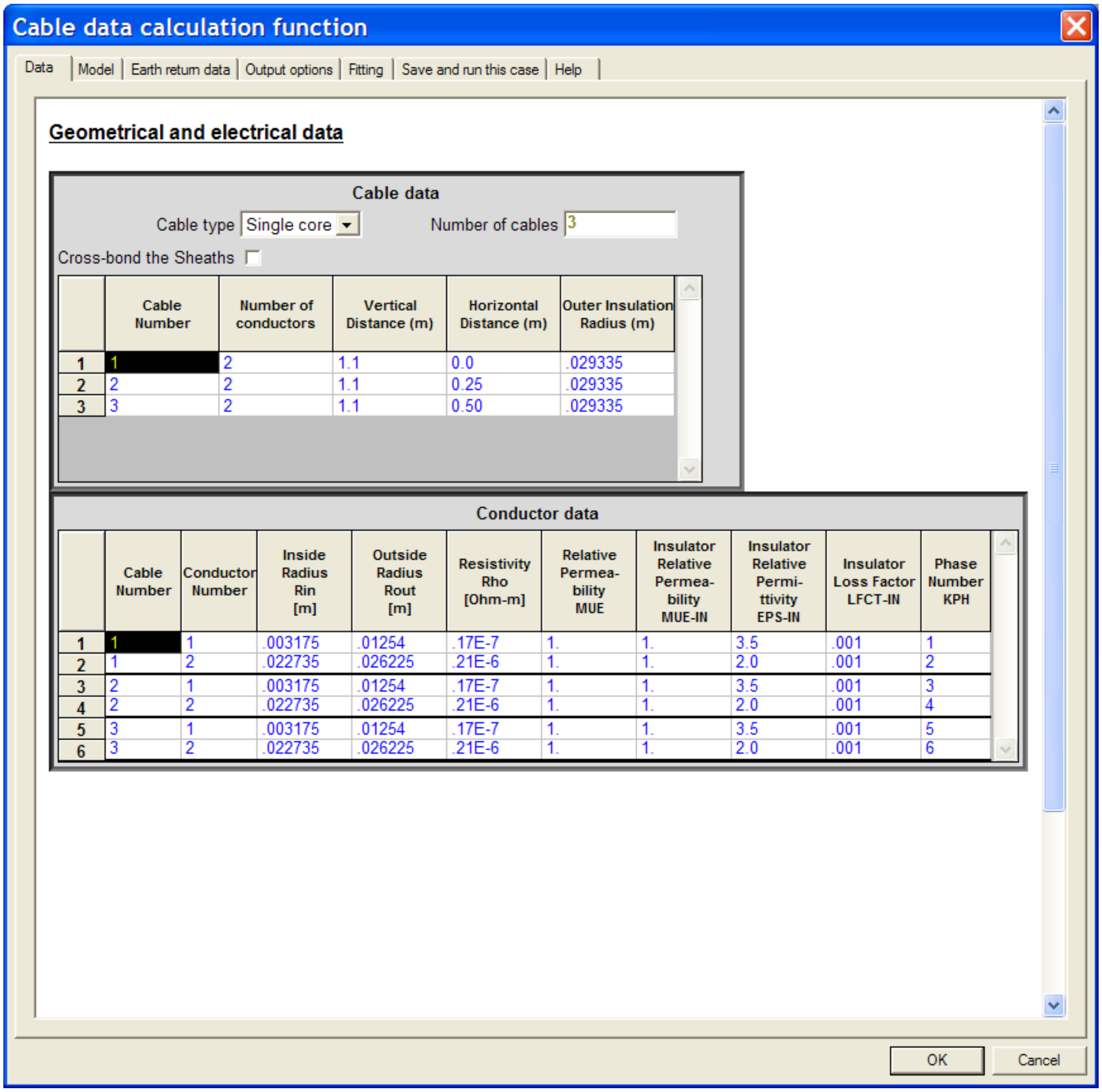


**Figure 2–3 Single-core cable system example**

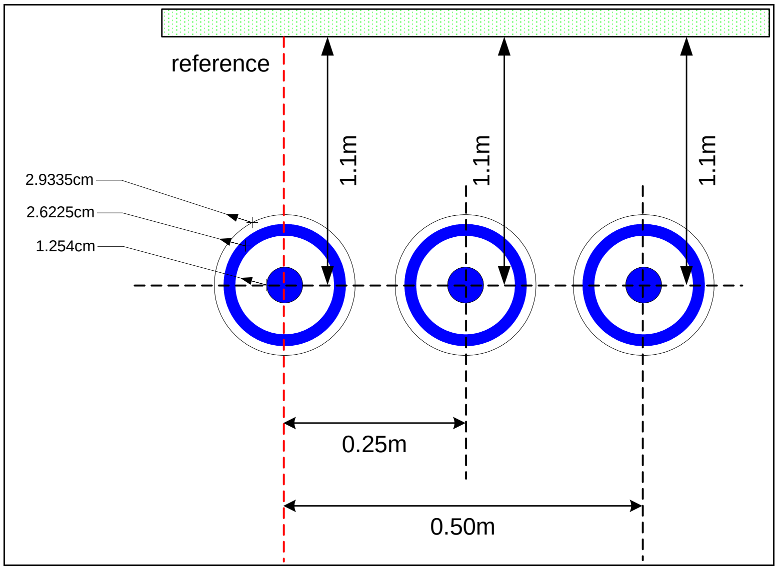


**Figure 2–4 Single-core test case layout.**

# 3 Pipe-Type cables

Beside the two data sections of the single-core cables, the pipe-type system requires an extra section describing the geometrical and electrical property of the pipe. Since the individual cables are the same as in single-core system, the conductor and insulator data definition is the same as above.

## *3.1 Cable data*

The general structure of the pipe-type cable is shown in Figure 3–1, where we the individual cables are enclosed inside the pipe.
The required data for each cable is:

- **Cable number**: given in increasing order for the entire cable system
- **Number of conductors** indicating the number of concentric tubular conductors in this cable. For example, this number is 3 for a cable with core, sheath and armour.
- **Distance from center of pipe (m)**: is the distance measured from the center of this cable to the center of the pipe. See variable Dist in Figure 3–1.
- **Position Angle (deg)**: is the angle measured from the line joining the center of this cable and the center of the pipe to an arbitrary reference axis. See variable ANG in Figure 3–1.
- **Outer Insulation radius (m)**: indicating the outside radius of the insulation layer surrounding the cable. See variable ROUT in Figure 3–1.

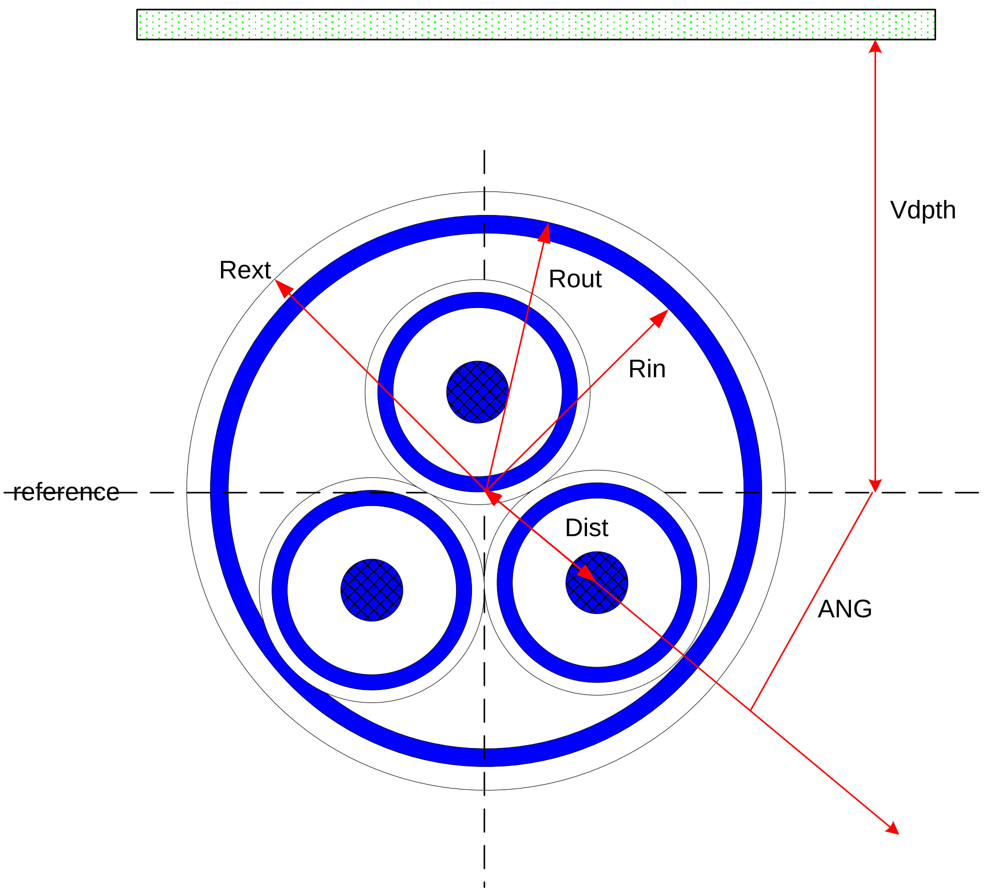


**Figure 3–1 Pipe-type cable system**

## *3.2 Conductor data*

The term conductor is used to designate both conductor and insulator data. This section is identical to the one for single-core cables.

## *3.3 Geometrical pipe data*

The geometrical data variables are shown in Figure 3–1:

- **Inside radius of pipe (Rin)**: inside radius of the pipe in meters.
- **Outside radius of the pipe (Rout)**: Outside radius of the pipe in meters.
- **Outside radius of tubular insulator (Rext)**: Outside radius of the tubular insulator surrounding the pipe. In meters.
- **Vertical distance (depth) of the pipe's center from the surface of the earth** (**Vdpth)**
- **Phase-number of the pipe (zero if it is grounded)**: variable KPH

## *3.4 Electrical data of the pipe*

The electrical data section of the pipe is self-explanatory.