



GRIDSCALE X ADVANCED PROTECTION ASSESSMENT

Line Constants Module

Perform line impedance and mutual coupling computation using a schematic design with the Advanced Protection Assessment Database, Database Editor and One-line diagram

SIEMENS

At a glance

Short circuit studies require reliable transmission line models. Transmission line models require correct characterization of their impedances, including positive-sequence and zero-sequence self-impedances and mutual impedances. These impedances are computed from data associated with the transmission line right-of-way arrangement, soil resistivity, tower design, and geometrical arrangement of conductors and cables in their length. Advanced Protection Assessment Line Constant module facilitates maintaining this information in an orderly manner using the Advanced Protection Assessment database, consolidating this information with the data of entire system and protection models in one single file.

Employ Advanced Protection Assessment Line Constant module when you need to study a proposed expansion of your transmission network, or when you need to review or to upgrade your transmission system, or simply when you require a reliable model of your existing or projected transmission lines.

The challenge

Storing and maintaining data related to the physical and electrical arrangement of transmission line information, while providing easiness of line parameters computation is a requirement in the industry nowadays. Protection and planning engineers have under their responsibility the management of this data, as well as of the correctness of its use for characterization of transmission lines. Depending on the utility, this information might be related to hundreds, or even thousands, of transmission lines, which need to be checked, reviewed, and evaluated as the system grows and evolves.

The correct handling of this information impacts the quality of the short circuit studies. Providing clear process to store, manage and maintain the line constant data ensure that all the protection study results reflect the behavior of the physical system under normal operation or under fault scenarios with fidelity.

Our solution

Our team has designed Line Constants to compute the self- and mutual coupling impedances of overhead lines and to do so for realistic combinations of circuits in dense or sparse rights-of-way. Moreover, all your data resides in one place, your database.

The clear, organized data structures employed by Line Constants and the outstanding data entry forms in Advanced Protection Assessment's Database Editor make Line Constants ideally suited for studying today's dense transmission corridors. Database Editor's excellent graphics support during data entry shows you what you have as you enter it. Typos are easy to find when you can see the layout at every step. Advanced Protection Assessment's "Database Doctor" finds even subtle data errors.

Since the Advanced Protection Assessment database is SQL-based, line constant data is searched easily, allowing better data reporting, automation, and classification.

Easy forms for complex configurations

The real work in a line constants study – for the user if not the computer – is the data preparation, not the calculation. In Advanced Protection Assessment, the data preparation is natural, easy, and intuitive. You build a transmission line in the database much as you would construct one in the physical world. First you decide what tower designs you are going to use, adding them to your library if needed. Just give each design a name and specify the positions of the phase and shield wires. Then you prepare the rights-of-way; that is, you assign a name and soil resistivity to each one of these. Next you place strings of empty towers in the rights-of-way. (We do not mean that you spot each tower! You simply choose the tower design and the start and stop point of the string.) Lastly, you string the conductors. That means you assign each section of line to a tower string and, with the mouse, choose the conductor and tower position of each phase. When the line sections have been defined, Advanced Protection Assessment Line Constants has all it needs to compute the series and shunt self- and mutual impedances. It is ready to go! The computation of transmission impedances takes nothing but a few fractions of seconds.

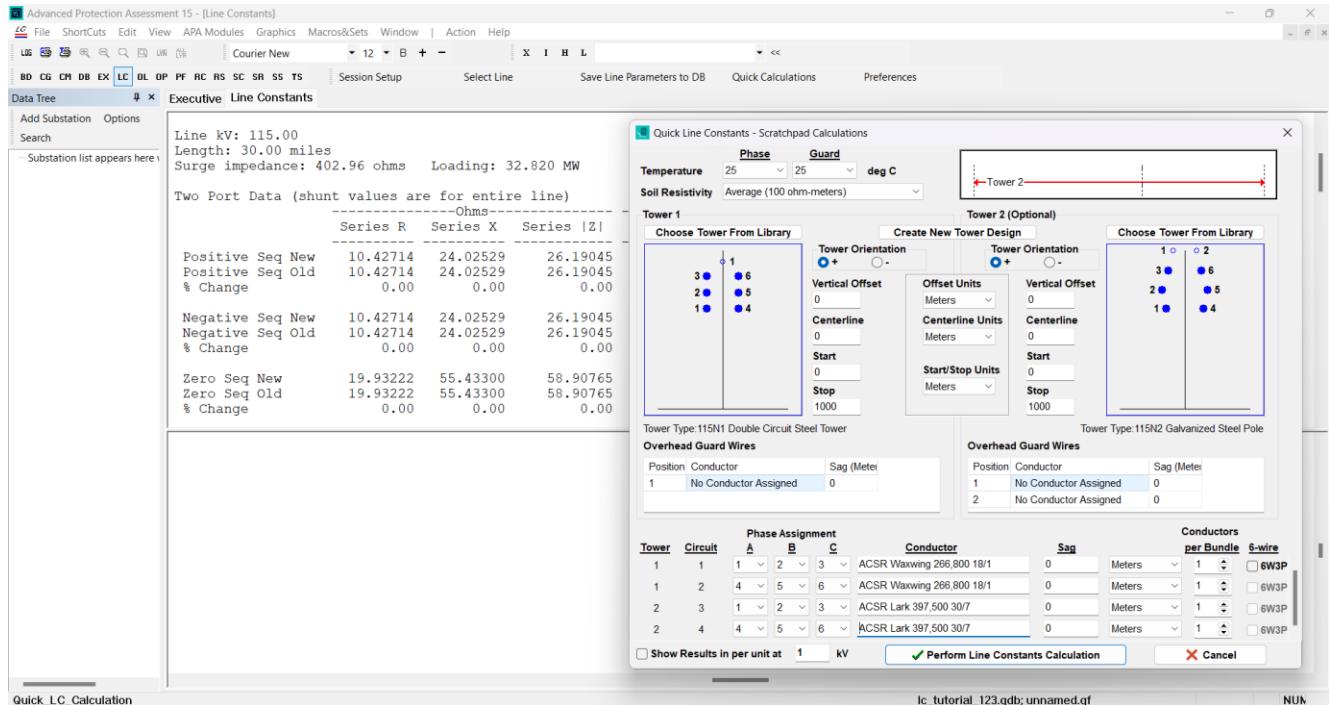


Figure 1: Advanced Protection Assessment helps with line constants data preparation in a natural manner. Prepare the rights-of-way; place strings of towers in these and assign conductors to the towers. Graphical user interface help verify your work. The Database Doctor does a comprehensive review.

Any number of circuits in a right-of-way

There is a joke among planning engineers that one must have computed a transmission line's positive-sequence impedance correctly if it works out to 0.8 ohms per mile. Of course, that is not quite right, but the point is that

a line constants calculation program is best judged on its ability to compute zero-sequence mutual couplings of a group of adjacent lines. Today, with transmission line corridors becoming an endangered species, that often means that large groups of lines use the same right-of-way. Advanced Protection Assessment Line Constants is designed to allow any practical number of circuits on a tower and any practical number of towers in a right-of-way. So, no matter how dense your transmission corridor may be, you can count on Line Constants to make it easy to model and to calculate the mutual couplings accurately.

Powerful graphics for data verification

The well-designed forms of the Database Editor certainly make it easy to enter data, but what if you make a mistake and mistype a number? How will you know? "We've got you covered!" as the expression goes. Special active graphics

displays have been built into the most important edit forms. These show you simple graphical representations of your towers, rights-of-way, tower strings, conductor bundles, and line sections as you build them. Most mistakes show up right away in these graphs. For example, as you design a tower in the library, the phase and overhead shield wire positions are drawn in cross-section; a faulty position caused by a typo or missing sign stands out clearly. Each right-of-way is drawn in a plan view with its start and stop boundary indicated. As strings of towers are added, they are depicted graphically in the right-of-way. Then, as line sections are attached, these are drawn beside the tower strings. Now, if you click on any part of the right-of-way, an elevation view of that point on the right-of-way is added to the display. All towers are shown side by side, and with the proper proportionate spacing. The conductor positions are shown in solid color if you have assigned a conductor or as an empty circle if you have not. If you click on one of the line sections listed below, the phase assignments of that section are added to the drawing. The applications are so simple to understand and work with, that you might not need to assign a specialized engineer to this work.

Right of Way Data: Query

Right

Length 48.28 Kilometers **Tag:** 6

Soil Resistivity Average

Filter Graphic by Category / Date:

Filter By Date

Include Categories <unassigned>

Exclude Categories <unassigned>

Graphic Options

Overhead **Cross-Section**

Show Overhead Graphic

Magnification (Ratio:1) X 1 Y 1

Show Tower String IDs

Show Line Section IDs

Right Way: Right

Starts at 0.00 Kilometers; Ends at 56.33 Kilometers

String_1 String_2

1 2 3 6 5 4

String_1 String_2

ROW Centerline

Tower String Data **Line Data**

Line Name	Orientation	<input checked="" type="radio"/> List all sections	<input type="radio"/> List sections in this ROW
None			
From: (3000 Bus_E_230) To: (3010 Bus_G_230) Cir: 1 "Line_EG"	-		
From: (2000 Bus_F_115) To: (2010 Bus_H_115) Cir: 1 "Line_FH"	-		
From: (2000 Bus_F_115) To: (2020 Bus_I_115) Cir: 1 "Line_FI"	-		

Figure 2: The plan and elevation views in this Right-of-Way form help detect mistakes in data entry.

Extensive conductor Library

Years ago, gathering basic conductor data was one of the annoying prerequisites for computing transmission line impedances. Not today. In Advanced Protection Assessment, you will have a library of all conductors we know about at your fingertips. (Currently, there are over 500 conductor types and sizes.) If we missed one, you can add it to your library in seconds. All you need is the actual radius, the geometric mean radius (GMR) or the inductance (X_a), and the resistivity at one or more

temperatures, as appears in the technical manual of the cable manufacturer.

Company-specific library of tower design

Historically, most companies have designed and built their own transmission towers. While it would not have been useful to offer a standard tower library with Advanced Protection Assessment, we have made it quick and easy for you to enter your company's standard designs. Tower designs are easy to find because they are organized by voltage level and drawing identification, and

when a choice is made the tower drawing appears automatically.

Often, a company will use the same basic “tower top” over and over but will change the tower height to fit the terrain. In Advanced Protection Assessment, you only need one form of the tower design in your library. When you use that design in a tower string, you may specify a positive or negative vertical offset to make the overall tower taller or shorter.

Printed reports and direct transfer to your database

In the Advanced Protection Assessment Line Constants module, you search to the line of interest; the calculation of impedances is done automatically. The report of self- and mutual coupling impedances is written both to the screen and to your report file, depending on options you previously selected. These computed impedances are temporary. If you like what you see, you can save them to your database to be stored permanently with a single mouse click.

No keyboard entry is required! The next time Advanced Protection Assessment forms your network model, the new impedances will be part of it.

Simple forms for scratchpad calculations and standard pole designs

The Advanced Protection Assessment Line Constants is designed for serious and detailed work. However, accurate detail is not necessary.

- For distribution engineers who prefer to work with pre-computed impedances per unit length for standard pole configurations, and
- for engineers and consultants who are looking for quick, approximate numbers for a line whose detailed design is not available yet. Advanced Protection Assessment offers simplified forms to support quick calculations for these cases.

Pre-computing standard pole configurations – With this form, the engineer describes a single-circuit configuration, gives it a name, and stores it in a line parameters table. Later, when the distribution engineer adds a line to his network model, he picks the configuration by name, enters the line length, and clicks “Calculate.”

Scratchpad line constants calculations – This form supports any user who wishes to compute the self and mutual coupling impedances of simple configurations of single or multiple lines. “Scratchpad” calculations assume a single right-of-way and the results are not intended to be stored automatically in the database. However, circuits on the optional second tower need not run the same length as those on the first tower.

Advanced Protection Assessment in Action – Features

- Special forms for quick calculations and standard designs
- Easy forms for complex configurations
- Any number of circuits in a right-of-way
- Powerful graphics to verify your data
- Extensive library of conductors
- Company-specific library of tower designs
- Clear printed reports and direct transfer to database
- Support for date-specific, in-service, and out-of-service configurations

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