GRIDSCALE X ADVANCED PROTECTION ASSESSMENT

Short Circuit Module

More than an ordinary Short Circuit program

SIEMENS

At a glance

The Advanced Protection Assessment team has redefined what you can expect from a short circuit program. With Short Circuit you can instantly compute any fault quantities for any type of fault in a network of any size. That is quite a statement once you understand what “any type of fault” means. It means Advanced Protection Assessment not only simulates standard faults but also faults involving any number of buses at one time with user-specified connections and impedances among the phases of those buses. With Advanced Protection Assessment you may design your own fault type.

The challenge

Protection engineers need to study a variety of “normal” faults when setting relays or very complex fault conditions such as faults between voltage levels in a post-mortem mode. The ability to quickly and easily check a number of conditions or move between conditions is often not easily accomplished. Automation is needed to increase the number of studies that can be done within a given timeframe as well as reducing the possibility of introducing human error into the study process.

Our solution

Whether you need to study “normal” faults when setting relays or very complex fault conditions such as faults between voltage levels in a post-mortem mode, the Short Circuit (SC) program has the horsepower for the job. Since this program has Advanced Protection Assessment’s full macro facility, set facility, and Advanced Protection Assessment User’s Programming Language, it has the flexibility to automate studies you have not dreamed of yet. That is why we say that Short Circuit is the computational foundation of the entire Advanced Protection Assessment system.

One-Line Diagram interface

The easiest way to work with SC is through its One-Line Diagram interface. To open or close a breaker, click on a line end or a switch/tie symbol. Then, when you are ready to apply a fault, click on a bus. Results are automatically displayed everywhere on the diagram. The actual quantities and their format are controlled by previously defined Style Templates that you build with a pop-up form. You can display any quantities already known to Short Circuit or quantities that you tell the software how to compute. You can zoom and pan the diagram to show any part of your system or split the screen to show several different parts of it at once. For convenience, you can turn on or off any voltage level in your diagram. You can also access and edit your data from the diagram or from the Data Tree and then tell SC to rebuild its network model.

Data tree, menu, and keyboard interfaces

Advanced Protection Assessment does not require you to build a one-line diagram to perform fault studies. Use the Explorer-like Data Tree, click the lightning bolt icon, or click “Apply Fault” in the Action Bar to begin a fault study. Advanced Protection Assessment helps you find any bus, line, tie, or generator with only a few clicks of the mouse no matter how large your case. Just follow the prompts to get immediate, productive results. A pop-up will help you choose other buses to report or simply drag a bus from the Data Tree to the report area. More experienced users may prefer to dispense with the mouse and enter abbreviated commands in the Advanced Protection Assessment Command Line.

Multiple text and graphics displays

At times you may want Short Circuit to display a one-line diagram, at other times textual displays, and sometimes both at once. Or you may want to compare two studies side-by-side. Advanced Protection Assessment has a multiple window interface that allows you to see as many or as few graphics as you wish. You may have one, two, or four graphics and text windows. Just click “Split” in the Window menu and drag the window boundaries to set their sizes to suit your needs. The text font and size and the magnification level of graphics are all separately
controllable in each window.

Advanced fault analysis algorithm

The admittance matrix model and sophisticated solution algorithms employed by Advanced Protection Assessment Short Circuit allow you to study any size network without reduction. Faults on systems with thousands of buses are computed just as quickly as on systems of only a few buses, in a fraction of a second. There is no compromise in accuracy. Through its graphical interface, SC produces reports when and where requested; there is generally no need to store massive printouts of entire system studies for future reference. Phase and sequence voltages and currents are reported in terms of engineering units, per unit, or a mixture of the two.

Unlimited fault types

Conventional programs handle only balanced three-phase, phase-to-phase (line-to-line), balanced two-phase-to-ground and one-phase-to-ground (single-line-to-ground) faults. While these are usually adequate for routine studies, they cannot be used to simulate many “real life” faults in detail (so-called post-mortem analysis). SC allows you to construct your own fault definitions, consisting of any connection among phases and ground with arbitrary impedances, then to apply the fault anywhere in the network. In Advanced Protection Assessment, a “fault” is defined very generally as any kind of unbalanced condition or network. This includes series faults such as open or fallen conductors, arbitrary simultaneous faults involving any number of buses, and faults with arbitrary impedances or current injections.

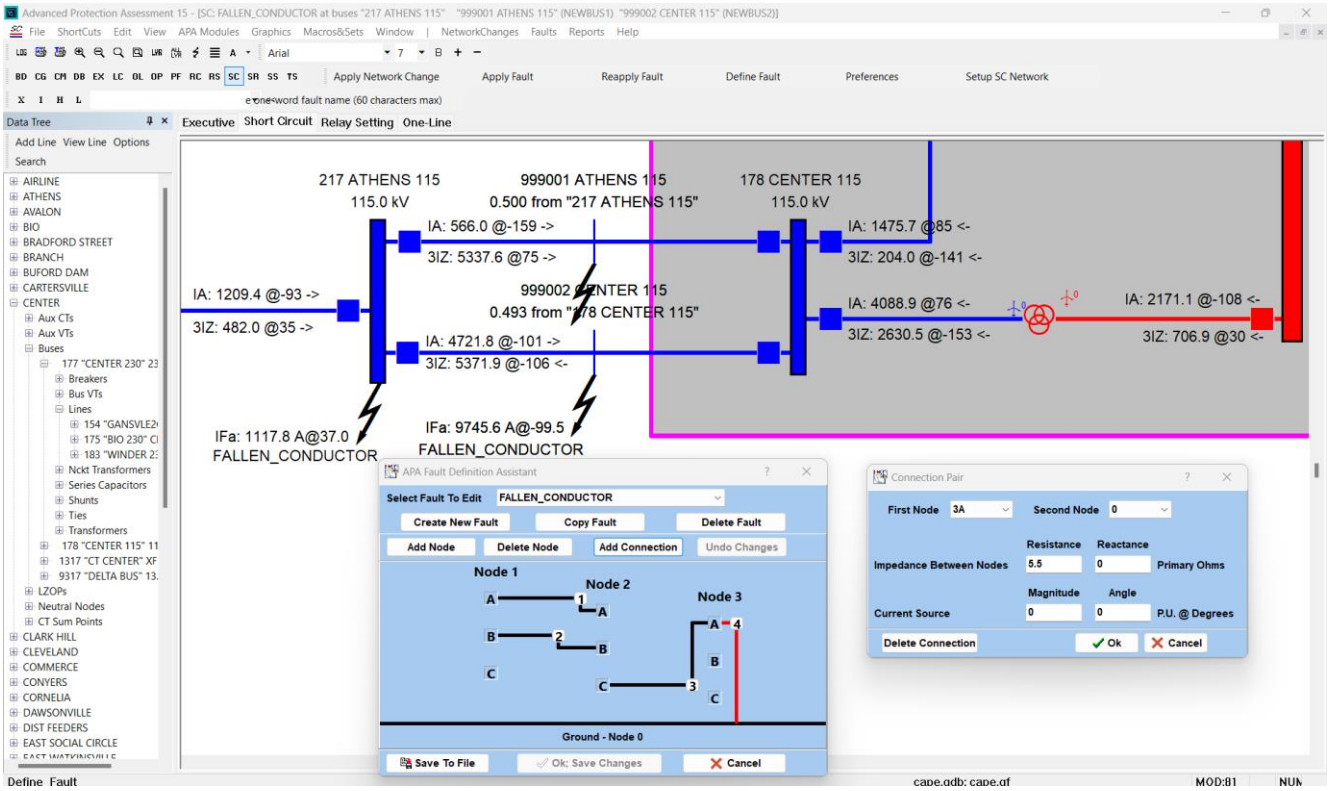

Figure 1: Short Circuit data is integrated with all other Advanced Protection Assessment modules, including One-Line Diagram.

Detailed and accurate network models

The network model is complete and general. This includes real-life, complex bus structures, the phase shifts introduced by transformers, differing positive- and negative-sequence impedances, off-nominal transformer phase and tap ratios, bus ties and switches, transmission line charging, and mutual coupling between transmission lines. Neutral buses of generators and transformers may be interconnected in any fashion, and any neutral bus may be faulted. (CTs and relays may be placed on neutral networks too.) Multiple generators and motors at a bus may be modeled individually and identified in reports with user-specified names. While a flat prefault voltage profile may be assumed, actual prefault voltages and loads can be obtained from Advanced Protection Assessment Power Flow via the database. If you have transformers modeled with off-nominal tap ratios (as most companies do) and do not have a stored power flow solution, you may initialize with the approximate but more realistic "generator profile" method.

Interactive network contingencies

It is easy to apply one or more network changes, apply one or more faults, and then restore the system to normal. Lines may be removed, grounded, or opened at one end. (A grounded line allows zero sequence currents to circulate if it is mutually coupled to an active line during an earth fault.) New nodes may be inserted anywhere along a line to study close-in, mid-line ("sliding"), and line-end faults. Transformers, tapped lines, and multiterminal lines can be removed in a single step. Bus ties may be opened or closed. Generators, motors, and other shunt devices may be outaged temporarily.

All network changes can be restored on a selective basis. In addition, any "permanently" out of service equipment may be placed back in service until further notice with the mouse. Snapshots of the network condition can be taken, stored, and recalled at any time.

Optional modeling of load currents

In addition to the usual classical analysis in which load currents are neglected, SC can optionally include loads and realistic (non-flat) voltages in its system model. The most practical way to provide correct initial conditions to SC is through a power flow solution. Power flow results are stored in the database for access by SC. The Advanced Protection Assessment Power Flow (PF) is a full, production-grade program for transmission planning, but it also makes possible more accurate fault analyses and therefore more reliable relay settings, particularly in cases of high-impedance faults. More information on PF is given elsewhere under Power Flow.

ANSI standard X/R ratios

Short circuit currents are required for the evaluation of circuit breaker interrupting duties. Special X/R ratios are computed by Short Circuit in accordance with ANSI Standard 37.010-1999. (If resistances have not been modeled well in your data, Advanced Protection Assessment can choose them for you based on the equipment rating, reactance, and the ANSI standard.)

Any set of network changes may be imposed for the calculations. With these ratios and charts contained in the Standard, you can immediately determine the interrupting current requirements at any breaker location. If you have many breakers to evaluate and are not thoroughly familiar with the ANSI or IEC standards, consider acquiring the Advanced Protection Assessment Breaker Duty (BD) analysis module. BD is an excellent tool and automates everything for you.

Generalized monitors

Monitors are "recording meters" that you can define and then place at any location in the system. The monitored quantity is any mathematical expression involving the currents, voltages, and impedances computed by SC. After the monitor has been placed, it will record the maximum and minimum of the monitored quantity and the associated network conditions over all subsequent faults until it is reset. Later, you can display the monitored quantities including an identification of the faults and network changes that produced them. Often, you will know from experience which fault of a given type will produce the maximum current at a point. The relevant fault producing the minimum current will seldom be so obvious and may be just as important in relay setting and determining correct operation under minimum-current conditions. The monitor feature saves searching through printed results for these minimum conditions.

Data conversion

The Advanced Protection Assessment Short Circuit program provides modeling options beyond the capability of most existing programs and so the network data stored in the database is necessarily somewhat different from those programs. However, if your short circuit data already exists in PSS®E, ASPEN, ANAFAS, or similar formats, the data can be loaded directly into an Advanced Protection Assessment database using an Advanced Protection Assessment utility program. Advanced Protection Assessment can import from Excel. Advanced Protection Assessment also writes network data files in PSS®E, ASPEN, and ANAFAS formats to make it convenient to share data with your neighbors.

Features

- One-Line Diagram interface for speed and convenience
- Data Tree, menu, and keyboard interfaces
- Multiple text and graphics displays
- Most advanced fault analysis algorithm in the industry
- Unlimited, user-defined fault types
- Detailed and accurate network models
- Interactive network contingencies
- Modeling of load currents when used with Advanced Protection Assessment Power Flow
- ANSI Standard X/R ratios for breaker-duty evaluation
- Generalized monitors for summarizing large studies
- Optional data conversion services

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