

# Short-circuit calculations

PSS®E

## At a glance

PSS®E Short Circuit module has a number of short circuit calculation algorithms to meet the diverse needs of fault analyses. All algorithms are self-contained analyses in PSS®E. They require a valid power flow working case and the power system sequence data. The following types of unbalances or faults can be applied at any bus / transmission line on any phase.

- three-phase (3PH) faults
- single-line-to-ground (LG) faults with specified fault impedances
- double line-to-ground (LLG) faults with specified fault impedances
- line-to-line (LL) faults with specified fault impedances
- one phase opened or two phases closed
- two phases opened or one phase closed
- one end opened

One or more of these faults can be applied simultaneously. It can simulate one or all fault types at one bus or all system or sub-system buses in one run, thereby reducing the analysis time.

## The challenge

The electrical utilities and industries need to design, operate, protect and maintain the electrical installations as per fault current duties. To determine the worst fault duties, one needs to consider various types of faults and number of network scenarios; potentially leading to a large number of short circuit calculations. Assembling and validating the vast electrical network data required for fault analyses is cumbersome and time consuming.

## Our solution

Fault analysis in PSS®E is based on a symmetrical component system representation. The positive-sequence system model as established in power flow is used directly in fault analysis. The negative- and zero-sequence system data are appended to and saved with the power flow case data, needing only one data file to carry out both power flow and short-circuit analysis. No additional validation of such data is required. The various network elements, such as generators, motors, transmission lines, transformers, loads, shunts, DC devices, are modeled in the highest level of detail. There are provisions and access toward applying simplified models for these components, thereby giving the highest degree of freedom in modeling different network elements. PSS®E handles special network simulations such as:

- Symmetrical and asymmetrical breaking three-phase short-circuit currents for a given circuit breaker contact parting time that includes machine internal flux decay effects
- Isolated ungrounded subsystems where one or more of the sequence networks is separated into unconnected subsystems
- Singular fault constraints which arise by the application of simultaneous faults, especially in combinations involving open phases
- Two and one-phase systems

The fault sequence and phase currents ( $I_{a1}$ ,  $I_{a2}$ ,  $I_{a0}$ ,  $I_A$ ,  $I_B$ ,  $I_C$ ) and voltages ( $V_{a1}$ ,  $V_{a2}$ ,  $V_{a0}$ ,  $V_A$ ,  $V_B$ ,  $V_C$ ) are available in text reports and can also be displayed on one line diagrams of the network model or exported to Python lists. Reports presenting "Total Fault Currents" and "Fault Currents Contributions" at N levels away from faulted bus are also available.

#### FLAT

- Sets up classical short-circuit assumptions to a power flow working case.

#### SCEQ

- Calculates positive-, negative- and zero-sequence short circuit system equivalents.

#### SCMU

- Calculates instantaneous fault currents for one or more simultaneous shunt or series imbalance with and without initial system loading conditions included.

#### ASCC

- Calculates instantaneous fault currents for a series of faults at one bus or all system or sub-system buses with and without initial system loading conditions included.

#### BKDY

- Calculates the following circuit breaker interrupting duty currents for a given pre-disturbance condition:
  - RMS Symmetrical initial fault current
  - Peak DC component of fault current at breaker fault duty time and
  - RMS symmetrical breaking fault current at breaker fault duty time
  - RMS asymmetrical fault current at breaker fault duty time
  - Peak asymmetrical fault current at breaker fault duty time

#### ANSI

- Calculates the following fault quantities according to the ANSI C37.5 -1979 standard:
  - Symmetrical fault MVA at breaker fault duty time
  - Symmetrical fault current at breaker fault duty time
  - Asymmetrical fault current at breaker fault duty time
  - ANSI X/R ratio
  - ANSI multiplying factor

#### IECS

- Calculates the following fault currents per IEC 60909 - 2001 standard:
  - I<sup>k</sup> Initial RMS symmetrical short-circuit current
  - ip(B) Peak short-circuit current by IEC 60909 Method B
  - ip(C) Peak short-circuit current by IEC 60909 Method C
  - ib (DC) DC component of asymmetrical breaking current
  - ib (SYM) RMS Symmetrical short-circuit breaking current
  - ib (ASYM) RMS Asymmetrical short-circuit breaking current

The fault calculations can be launched from PSS®E GUI or PSS®E batch scripts (BAT\_, Python, IDEV, or IPLAN)

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