Recommended PSCAD model requirements Rev. 4

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Specific model requirements for a PSCAD study depends on the type of study being done. A study with a scope covering weak system interconnection, ride-through evaluation, voltage control and event response, control interaction with nearby devices, and islanding performance (for example) would require a model which has the following characteristics. Some specialty studies may require other features.

Model Accuracy Features

For the model to be sufficiently accurate, it must:

A. *Represent the full detailed inner control loops of the power electronics.* The model cannot use the same approximations classically used in transient stability modeling, and should fully represent all fast inner controls, as implemented in the real equipment. It is possible to create models which embed the actual hardware code into a PSCAD component, and this is the recommended type of model.[1] [2]

B. *Represent all control features pertinent to the type of study being done.* This may include external voltage controllers, plant level controllers, customized PLLs, ride-through controllers, SSCI damping controllers or others. As in point A, actual hardware code is recommended to be used for most control features. Operating modes that require system specific adjustment should be user accessible. In some cases, plant level voltage control should be represented along with adjustable droop characteristics. If the plant level controllers are very slow, these may be approximated using constant Q modes.

C. *Represent all pertinent electrical and mechanical configurations*. This includes any filters and specialized transformers. There may be other mechanical features (such as gearboxes, pitch controllers, etc.) which should be modelled if they impact electrical performance.

D. *Have all pertinent protections modeled in detail for both balanced and unbalanced fault conditions.* Typically this includes various OV and UV protections (individual phase and RMS), frequency protections, DC bus voltage protections, and overcurrent protection. There may be others. As in point A, actual hardware code is recommended to be used for these protection features.

Model Usability Features

In order to allow study engineers to perform system analysis using the model, the PSCAD model must:

[1] The model must be a full IGBT representation (preferred), or may use a voltage source interface that mimics IGBT switching (ie. A firing pulse based model). A three phase sinusoidal source representation is not acceptable. Models manually (ie. block-by-block) translated from MATLAB or control block diagrams are often unacceptable because the method used to model the electrical network and interface to the controls may not be accurate, or portions of the controls (such as protection) are omitted. Note, however, that Matlab may be used to generate C code which is used in the real control hardware, and if this approach is used by the developer, the same C code may be directly used to create an extremely accurate PSCAD model of the controls. The controller source code may be compiled into DLLs or binary if the source code is unavailable due to confidentiality restrictions.

[2] If the model is assembled using standard blocks available in the PSCAD master library, approximations are usually introduced, and specific implementation details for important control blocks may be lost. In addition, there is a risk that errors will be introduced in the process of manually assembling the model. NOTE: For this type of manually assembled model, (not using a direct “real code” embedding process), validation is recommended.

E. *Have control or hardware options which are pertinent to the study accessible to the user.* (For example, adjustable protection thresholds or real power recovery ramp rates) Diagnostic flags (eg. flags to show control mode changes or which protection has been activated) should be accessible to aid in analysis.

F. *Be capable of running at a minimum time step of 10 us*. Most of the time, requiring a smaller time step means that the control implementation has not used the interpolation features of PSCAD, or is using inappropriate interfacing between the model and the larger network. Lack of interpolation support introduces inaccuracies into the model at higher time-steps.

G. *Include documentation and a sample implementation test case.* Access to technical support engineers is desirable.

H. *Be capable of initializing itself.* Model must initialize and ramp to full output without external input from simulation engineers.

I. *Accept external reference values.* This includes real and reactive power reference values (for Q control modes), or voltage reference values (for V control modes).

Model Efficiency Features

In addition, the following elements are required to improve study efficiency, model compatibility, and enable other studies which include the model to be run as efficiently as possible. If these features are not supported, additional discussion is required[3]:

J. Is compiled using Intel Fortran compiler version 9 or higher.

K. Uses PSCAD version 4.5.3 or higher.

L. Initializes as quickly as possible (<1-3 seconds) to user supplied terminal conditions.

M. Support multiple instances of the model in the same simulation.

N. Support the PSCAD “snapshot” feature.

O. Support the PSCAD “multiple run” feature.

[3] Electranix has tools available (E-Tran Plus) which can circumvent compatibility concerns in some cases