

# Graphical Model Builder (GMB)

Powerful and easy to use model development tool based on block diagrams

## At a glance

Accurate and efficient power system planning requires the usage of suitable models in different calculation methods in the simulation software. The software tools of the PSS® portfolio (PSS®E, PSS®SINCAL and PSS®NETOMAC) are specifically designed for modeling of complex systems and already provide appropriate models for a large variety of network equipment. The libraries incorporate well accepted and standardized models for both steady-state and dynamic analyses.

The Graphical Model Builder (GMB) also enables the user to individualize the model behavior in order to meet user-specific requirements. It is a powerful and easy-to-use model development tool based on block diagrams. Furthermore, the GMB allows the implementation of customized code and is able to encode the models.

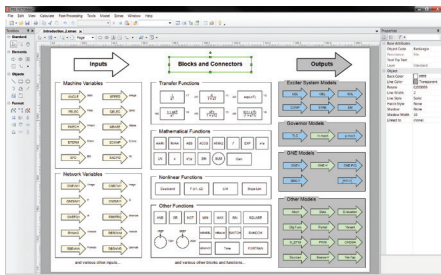


Figure 1: Graphical Model Builder (GMB)

## Advantages of the GMB include:

- Can be used to individualize model behavior in load flow, load profile and dynamic calculations
- No compilation or other third-party tools are needed within the PSS® portfolio
- Provides interfaces to DLLs
- Modeling flexibility using 100+ pre-defined blocks and functions
- Supports the model initialization by sophisticated algorithms
- Provides various open and closed loop model debugging functions

## The challenge

The successful operation of a power system largely depends on the engineer's ability to design a system that provides safe, reliable and economic service to the customer. Advanced simulation technologies provide the means for the engineer to design and analyze power systems, and assist in making key decisions.

With powerful simulation tools as provided by the PSS® portfolio, it is possible to simulate the steady-state and dynamic behavior of transmission and distribution systems and to verify the performance of these complex systems in a fast and very accurate manner.

However, as new technologies gain importance within power system analysis, it is necessary to develop reliable user-defined models to represent their steady-state and dynamic behavior. Thereby, new models have to be developed with time and accuracy considered. Furthermore, they should be fully tested prior to the use in the power system simulation.

## Our solution

The Graphical Model Builder (GMB) is a development and testing environment, integrated in the PSS®NETOMAC user interface, which supports users especially in modeling of user-defined behavior within the PSS® portfolio tools.

The user-friendly GMB guides the engineer through the model development workflow (Figure 2). It supports the phases of development, validation, test and documentation of various model types for steady-state and dynamic analyses. Additionally, it provides a close link to the power system models.

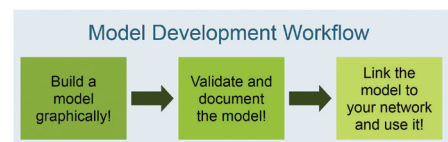


Figure 2: Model Development Workflow in GMB

The graphical GMB models may cover different phenomena in appropriate applications for network equipment including:

- Automatic voltage regulators (AVR), containing excitation system and optionally different types of limiters and power system stabilizers

- Turbine governors (GOV), linked to an Automatic Generation Control or optionally turbine load controllers
- HVDC, FACTS and other controlled compensation equipment
- Renewable energies as wind, photovoltaic, fuel cells and others
- Battery Energy Storage Systems
- Demand Side Management and Virtual Power Plants using communication
- Static and dynamic loads
- Transformers' tap changers

In addition to the familiar CAD functions (i.e., aligning, copying, shifting, rotating, zooming, etc.) the GMB provides a rich symbol library which contains more than 100 function blocks (i.e., transfer, mathematical and logical functions). Additionally, it is capable of integrating individual FORTRAN-like code and offers different standard conformal DLL interfaces.

GMB's output blocks define the type of each model depending on the intended usage purpose. It allows accessing the model containers of machine models as well as equipment models. Several input block types for any signal from network and machine models close the loop to the system and enable influence of control.

### Build a model graphically

At the beginning of the model development workflow GMB assists the user through formal preparation of parameters, their default values and descriptions.

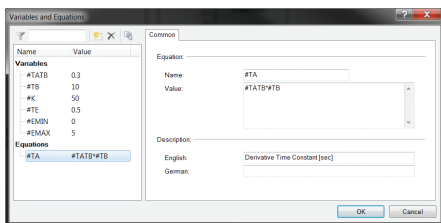


Figure 3: Parameter Definition for the Model

Subsequently, the user develops the model based on a block diagram by connecting the basic library symbols and utilizing the prepared parameters within the blocks.

The data is entered via masks that are object-related and have abbreviated balloon help in addition to detailed help texts. The user can activate or deactivate specific function blocks for the calculation in order to analyze the model.

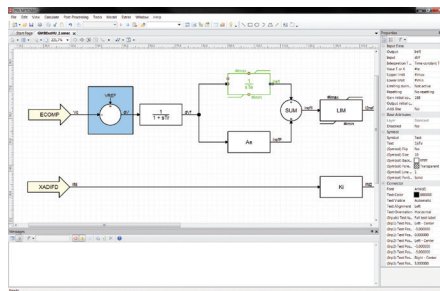


Figure 4: Graphical Model Development

Besides simple blocks as PID controllers, complex function "blocks" as FFT (Fast Fourier Transformation) are also available in GMB. The pre-defined block-oriented structures can be easily combined with FORTRAN-like code, such as mathematical functions, logical terms or conditions, (e.g., IF / THEN / ELSE, GOTO / CONTINUE or DO LOOP) as in Figure 5.

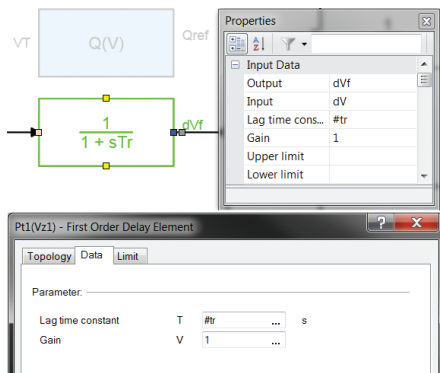


Figure 5: Complementation by Individual Code

The initialization process of models in the GMB simplifies users' work. In case of a model, which already acts in the steady-state calculation, a constant or an adaptive approach can be chosen utilizing the iterations of the load-flow algorithm. For dynamic calculations both the classical method by an analytical backward solution and/or a forward estimation can be used, which constitutes a big advantage especially if models contain nonlinearities.

### Validate and document the model

After finishing the model development, the GMB assists the engineer in the validation, test and documentation phase. Besides basic verification functions it is possible to run the model in an open and even in a closed loop with different PSS® simulation tools (Figure 6). The definition of debug parameters allows the application of parameter deviations from the default values. The results of any debug functionality and even later of the simulation can be directly displayed in the GMB at the associated block outputs (Figure 7). Alternatively, records can be exported to different file formats or directly displayed in the diagram view.

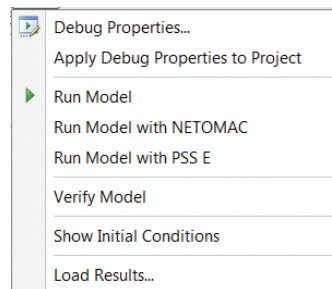


Figure 6: Model Debugging Option in GMB

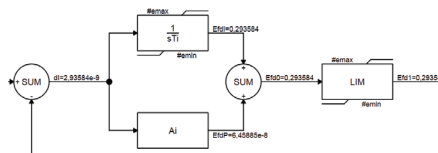


Figure 7: Displaying Results Directly in GMB

After finishing model development and validation, this can be directly used in the tools of the PSS® product suite (PSS®E, PSS®SINCAL and PSS®NETOMAC) without any need of compilation.

### Application example

Figure 8 shows the standard exciter model ExCHU built in GMB. It utilizes the iterative initialization process simplifying the modelling process.

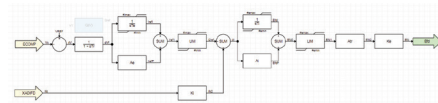


Figure 8: Standard Exciter Model ExCHU