

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 steadystate and dynamic analyses.

The Graphical Model Builder (GMB) also enables the user to individualize the model behavior in order to meet userspecific 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.

× / 10	eduction.2.email: 12			· heater	
	- 12+12 Page - 0 0 (2 (2 12 + 4			20 81 17 ×	1
1.444	Sectore Station Stations	Westman Westman 1994 and and 1997	and a state of Principal and Principal and Principal	Chart Coly	Referrir
1.488	D.	• •	N.	CH_HIT LONG	ana
				lesi lip let	
	Inputs >	 Blocks and Connectors 	Outputs	Line	20rdw2
				C Ogen	Cen
	v		P	Beck Color Live Color	Concept 1
	Machine Variables	Transfer Functions	Exciter System Models	Decer-	EQ INVESTIGATION
16	NN			Los Tren	2
	ALL	in the second of		Line State	Solo
				Planck Style	Acres 1
	MAC THE GAR OF	- 14 ² 1 ² /2 92/2 -		Station	80m
				Deditor Middle	20
	THE AND AND AND		Governor Models	L'est to	1014
	and - and -	- Mathematical Electrica			
1.88	N		The second secon		
	EnDer Jam 2004 Jam	4480 R.MA 420 4000 4500 / 507 /*			
			- ONE Models		
1.8	20 m 2000 m		- UNE MODER		
1.88		14 1 174 M (MA) 540	Der Der Deres		
			Lot Lot Lot of the		
1.1	- Network Variables	Nonlinear Functions			
100		The state of the s	and a second sec		
	Castor - Castor -	Gasteri Fat.42 UM Buster	V V		
1.300	1 1				
	Conner)*		Other Models		
		Cher Functions			
1.0			the lines		
	and	MD 00 107 WW MX 8N 80.00			
1.48			Opt on State Vant		
1.50	anat assist	7 7 week were surrow autor			
			2.00 mm 2000		
138	and and and and		1000 1000 1000m		
			- N - N - N		
148			Sector > Sector > Taria >	-	
	and various other inputs	and various offer blocks and functions			

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.

Y	🐑 🗙 🤹	Common		
Name	Value	Equation		
Variables		Copanion.		
#TATB	0.3	Name:	#TA	
#TB	10	Value:	#TATB*#TB	*
-#K	50			
#TE	0.5			
#EMIN	0			~
#EMAX	5			
Equations		Description:		
ATA .	#TATB*#TB	English	Derivative Time Constant [sec]	
		German		
		ound.		
				OK Cancel

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.

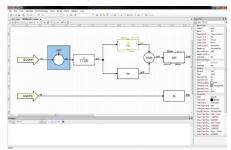


Figure 4: Graphical Model Development

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.

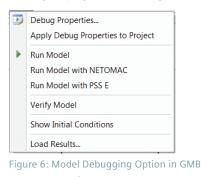
			operties			1	
/Τ Q(V)	Q	ref [2 2 S	r - 1			
			Input Da	ata			
			Output		dVf		=
			Input		dV		
. 1	d/	/f	Lag time	e cons	#tr		
1 + sTr	•••		Gain		1		
			Upper li	mit			
_			Lower li	mit			-
	_			_	_		×
t1(Vz1) - First Order Dela	/ Element					?	x
	/ Element					?	x
Pt1(Vz1) - First Order Dela Topology Data Limit	/ Element					?	x
	/ Element					?	x
Topology Data Limit						?	x
Topology Data Limit	y Element T	#tr		s		?	x

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.



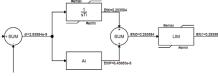
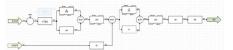


Figure 7: Displaying Results Directly in GMB

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.





Published by Siemens AG 2018 Energy Management Division Freyeslebenstrasse 1 91058 Erlangen, Germany

©2018 Siemens AG

ECCN=EAR99

For more information, please contact: pti-software-sales.ptd@siemens.com The technical data presented in this document is based on an actual case or on as-designed parameters, and therefore should not be relied upon for any specific application and does not constitute a performance guarantee for any projects. Actual results are dependent on variable conditions. Accordingly, Siemens does not make representations, warranties, or assurances as to the accuracy, currency or completeness of the content contained herein. If requested, we will provide specific technical data or specifications with respect to any customer's particular applications. Our company is constantly involved in engineering and development. For that reason, we reserve the right to modify, at any time, the technology and product specifications contained herein.