MiPower

Steady State & Dynamic Wind Turbine Model

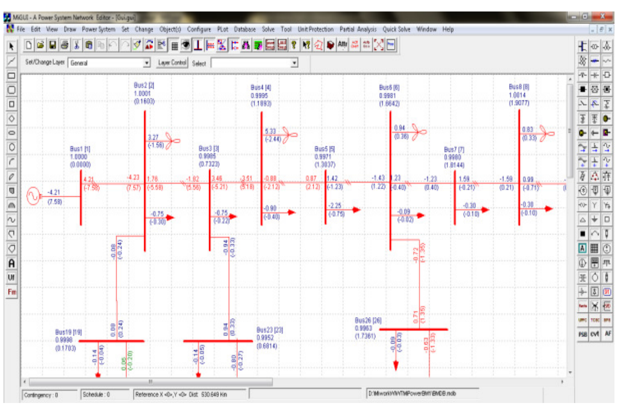
INTRODUCTION

MiPower is highly interactive, user-friendly windows based Power System Analysis Software Package. It includes a set of modules for performing various studies like Load Flow, Short Circuit, Dynamic studies, etc. Numerous elements of the power systems can be modeled in it. In the recent developments Wind Turbine Generator Model is also added as a new element. Wind Turbine Generator Model required for steady state and dynamic applications are developed as per IEEE/WECC standards. Steady state model include load flow (LFA) and short circuit (SCS) studies. Dynamic model include transient simulation (TRS) studies.

A Wind Turbine Generators broadly classified into four different types. They are

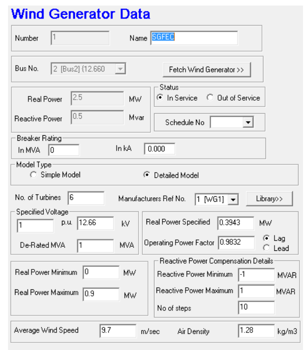
- Fixed speed, Induction Generator (WT1)
- Variable slip, Induction Generator with variable rotor resistance (WT2)
- Variable speed, doubly-fed Induction Generator with rotor side converter (WT3)
- Variable speed generator with full converter interface (WT4)

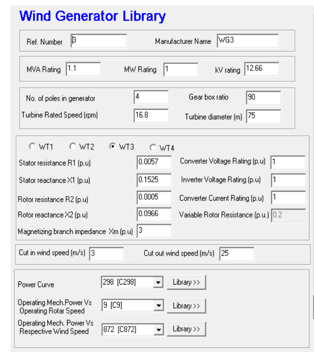
This Wind Turbine Generator Model is suitable for performing Grid Interconnected studies, Wind Plant planning studies, general transmission planning studies, etc. The performance behavior of Wind Turbine Generator like fault ride through capability, dynamic reactive power management, etc. can also be observed.



STEADY STATE MODEL

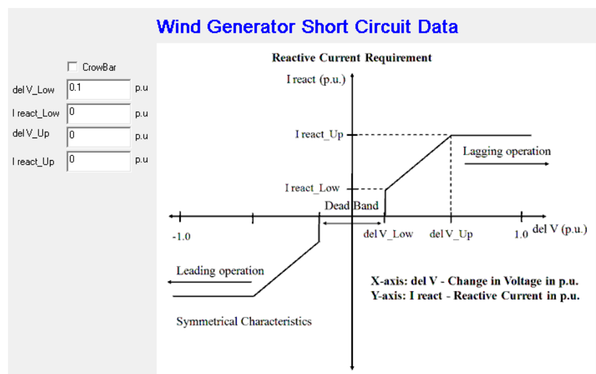
- All standard models WT1, WT2, WT3 and WT4 can be represented.
- The real power output is the reflection of wind speed at the site.
- Aerodynamic system behavior and controls are represented through various WTG characteristic curves.
- The reactive power compensation behavior of WT1 and WT2 models reflect automatic power factor correction as seen with mechanically switchable capacitor banks.
- The reactive power compensation behaviors of WT3 and WT4 models reflect the behavior of dynamic compensation by devices like SVC/STATCOM.





SHORT CIRCUIT MODEL

- Appropriate modeling satisfying IEEE standard models.
- Fault ride through capability characteristics are represented.



DYNAMIC MODEL

- All standard models WT1, WT2, WT3 and WT4 can be represented.
- The behavior of the WTG can be observed for various disturbances from the network side with constant wind speed.
- Pseudo governor model represents the behavior of WTG’s Aerodynamic system for WT1 and WT2.
- For WT2 model, machines optimum operating behavior will be tracked using operating mechanical power Vs rotor speed curve.
- For WT3 and WT4 models the power electronic drive control behavior is represented through control blocks.
- These blocks represent the behavior of SVC/STATCOM for reactive power compensation.
- The control blocks also represent the operational behavior of WT3/WT4 models for fault ride through capability, like current limiting, real power limiting, and dynamic reactive power compensation.

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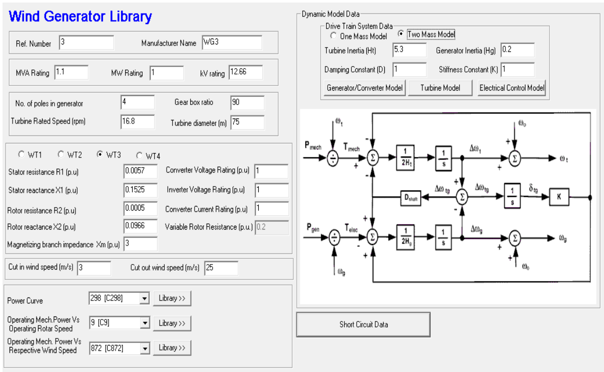
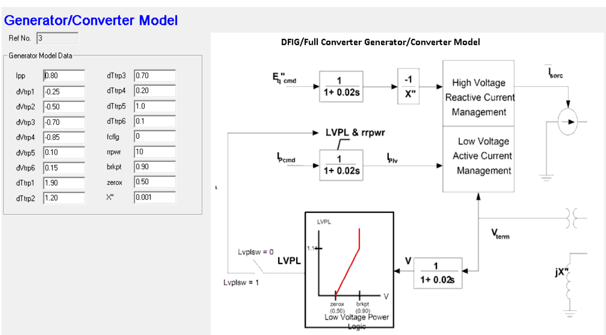
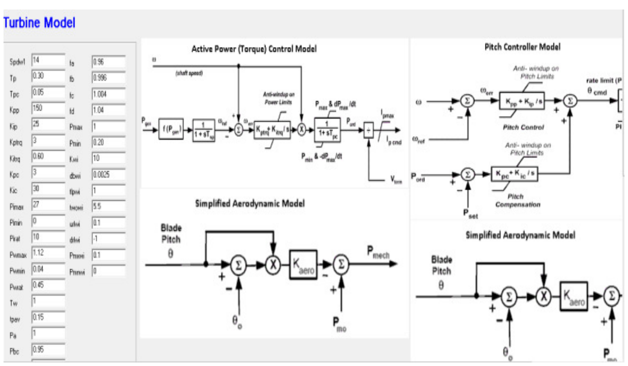


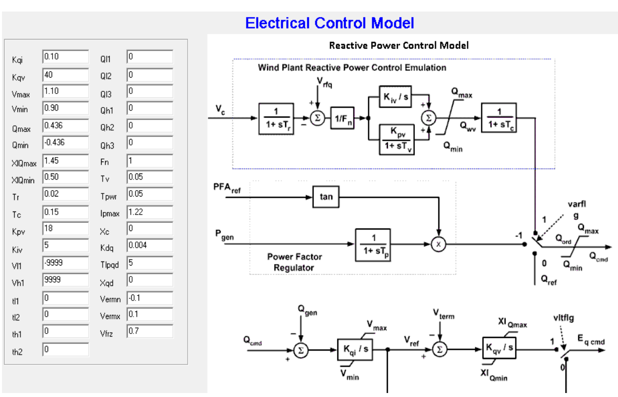
Wind Generator Library



Convertor Model Library

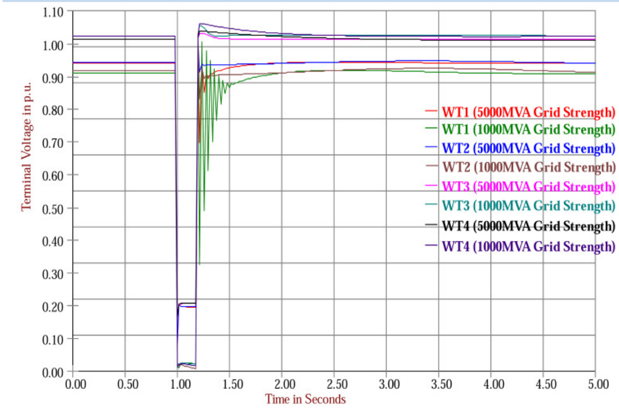


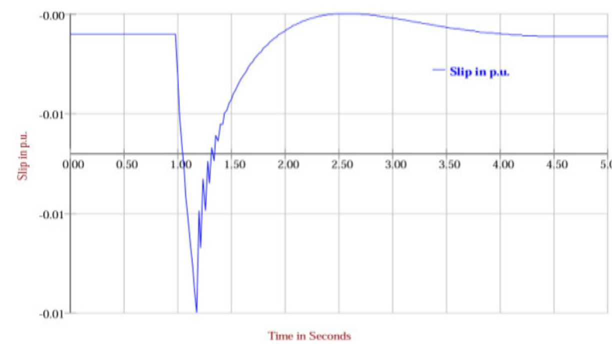
Turbine Model Library

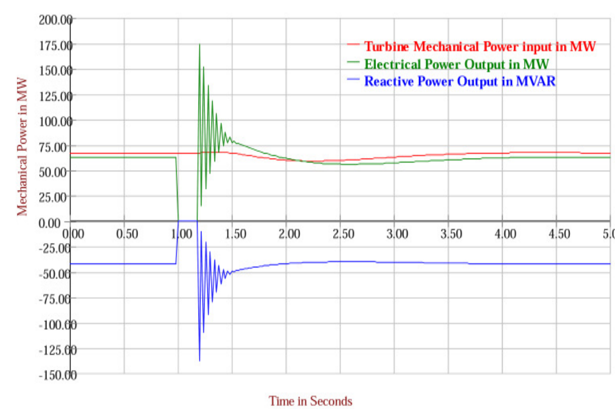


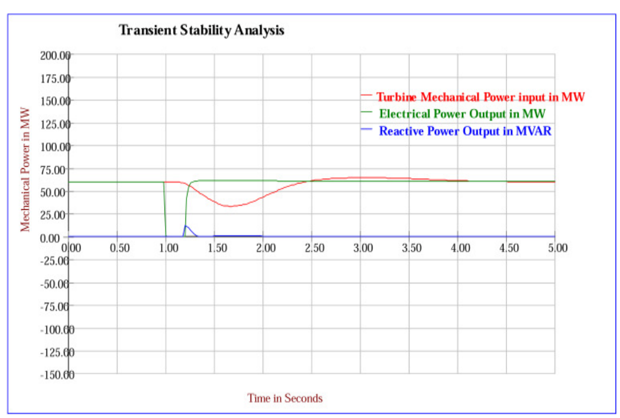
Electrical Control Model

DYNAMIC SIMULATION GRAPHS









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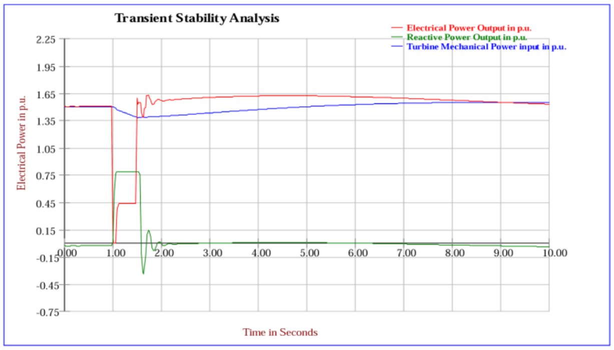
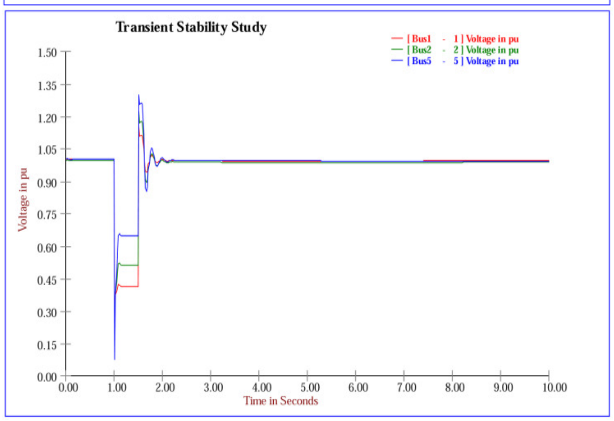
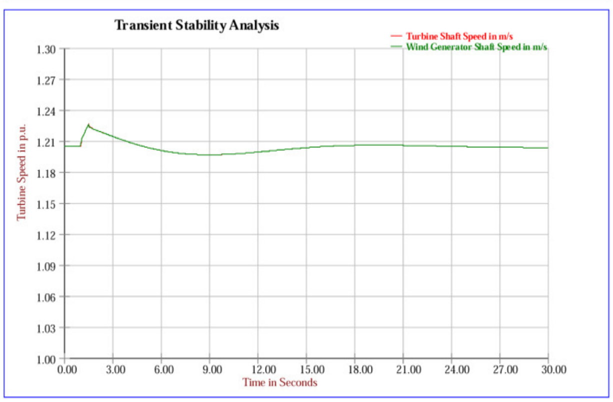
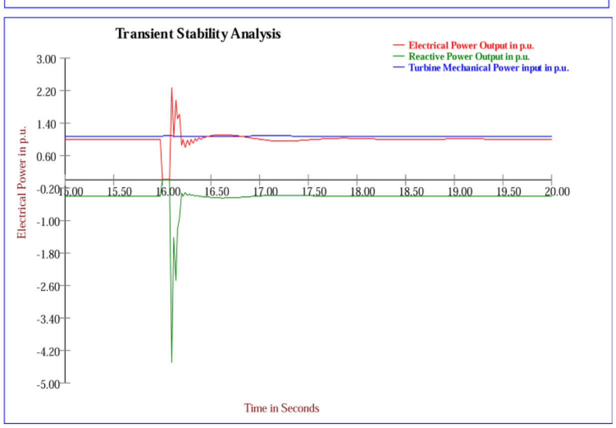
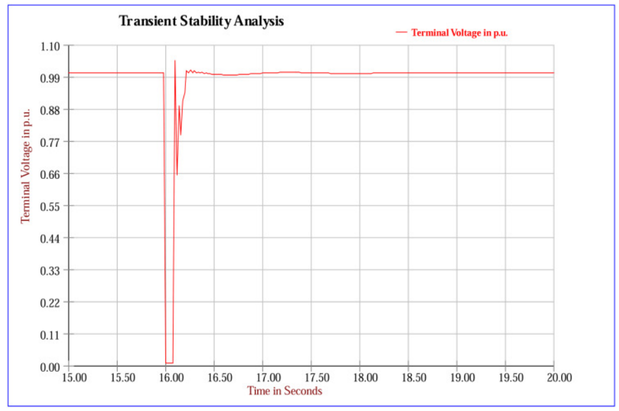




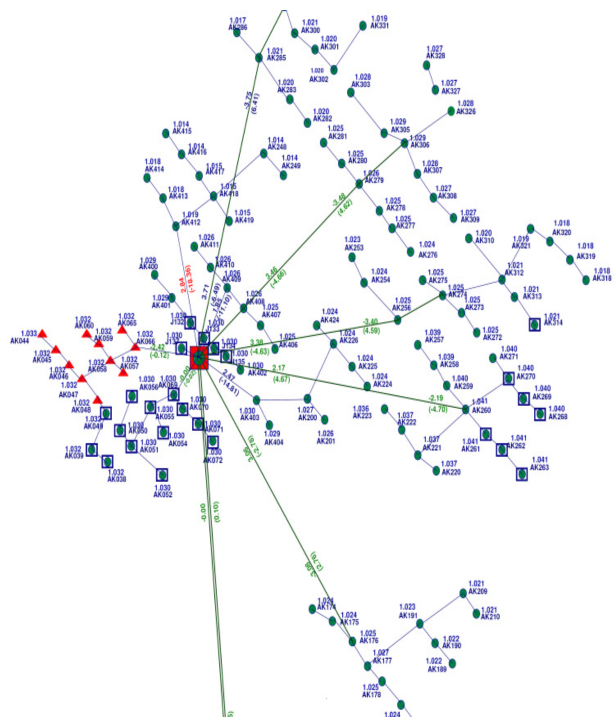






DETAILED & EQUIVALENT MODELING OF WIND PLANT IN MIPOWER

Modeling of each Wind Turbine Generator and Wind Plant can be done in MiPower. While representing Wind Plant in network simulation studies can be in two ways. They are detailed wind plant (representation of individual wind turbine generators in the plant) representation and an equivalent model representation. Type of representation can be based on studies and requirement. Both these representations can be modeled in MiPower.



Wind Plant Detailed Representation in MiPower

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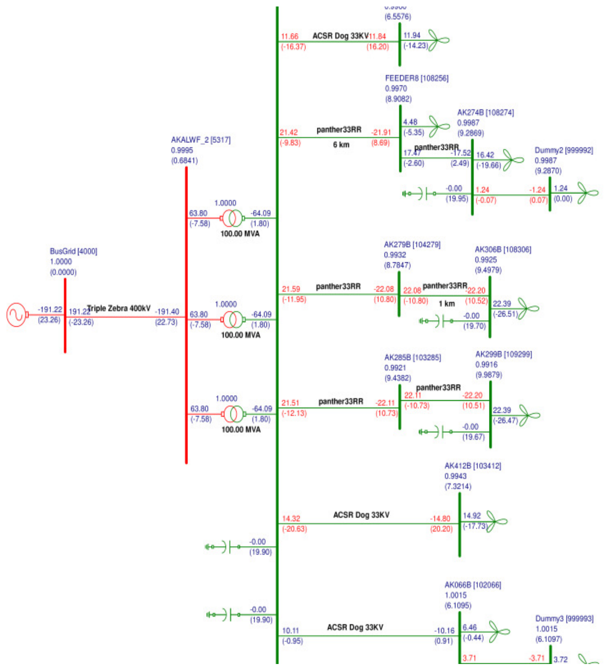
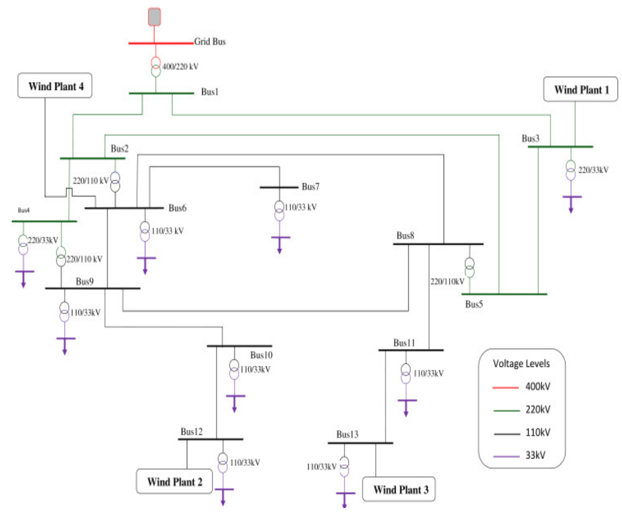
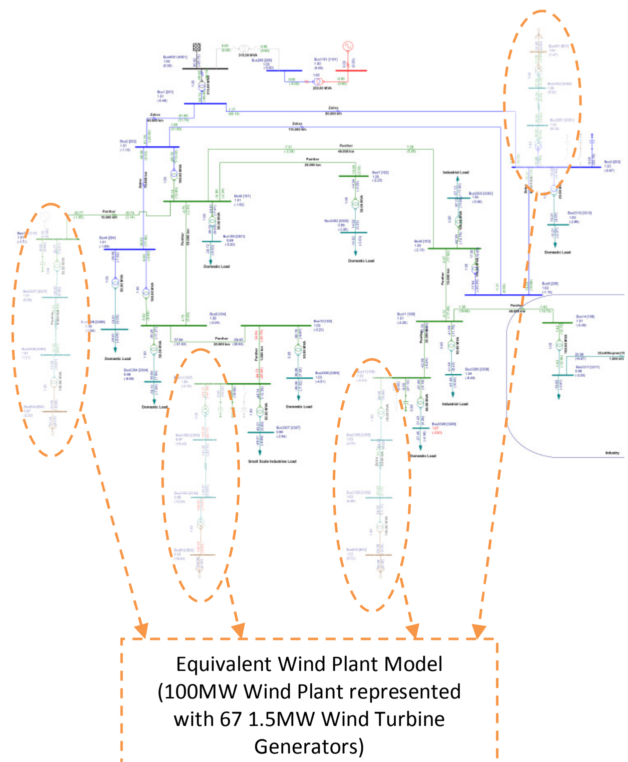


Wind Plant Equivalent Representation





WIND PLANT PLANNING STUDIES

Wind Plant planning studies include the following studies.

- Wind Plant network topology planning (33kV system).
- Wind Plant network reconfiguration.
- Optimal placement of pooling substation.
- Optimal network topology planning based on economic analysis.
- Plant network feeder sizing.
- Reactive power management, include optimal sizing and placement of capacitor bank, consideration of recommending SVC/STATCOM.
- Fault Ride Through capability verification.
- Special Protection Schemes for Wind Plant.

GRID INTERCONNECTION STUDIES

Grid Interconnection studies include the following studies.

- Power flow control & contingency management in networks.
- Frequency response behavior.
- Grid stability analysis studies include voltage, angle and frequency stability, fault ride through capability.
- Reactive power and voltage control.
- Influence on conventional generation and grid.
- Regulation and support strategies.
- Special Protection Schemes for transmission system with Wind Plant.