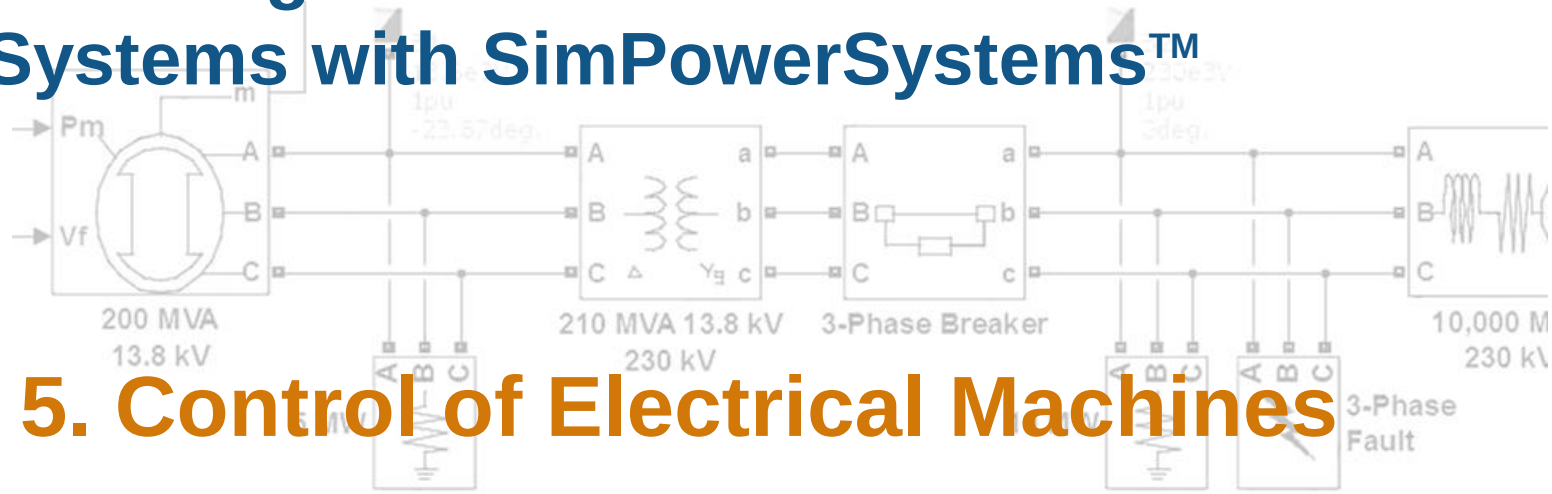
SimPowerSystems Hands-on Workshop:
Modeling and Simulation of Electrical Power Systems with SimPowerSystems™



5. Control of Electrical Machines

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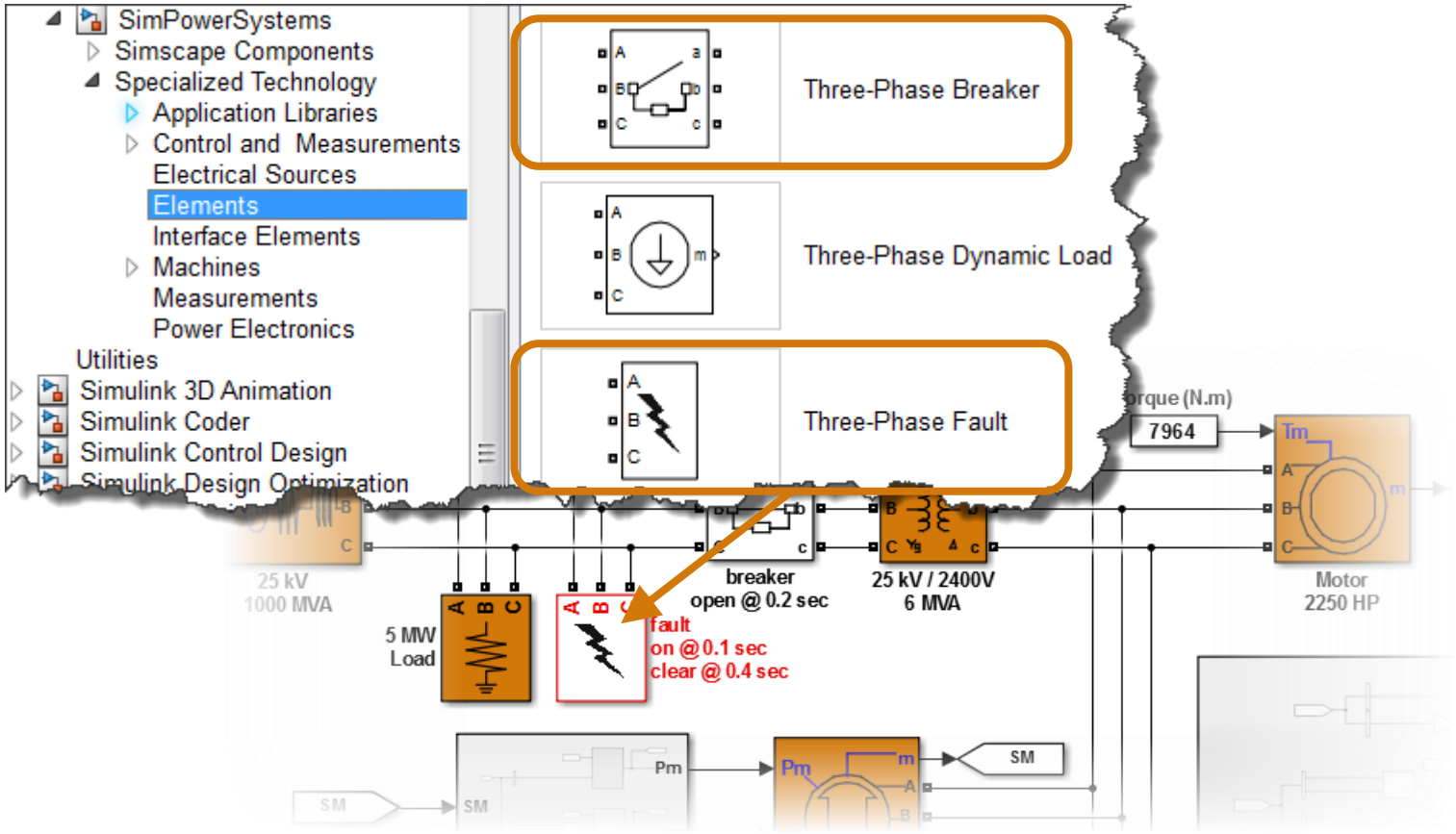
Outline

- Electrical disturbances
  - Emergency generator example
- Control of synchronous generators
  - Generator droop control example
  - Load sharing example
  - Breaker synchronization example
- Electric motor drives

Electrical disturbances

Emergency generator example

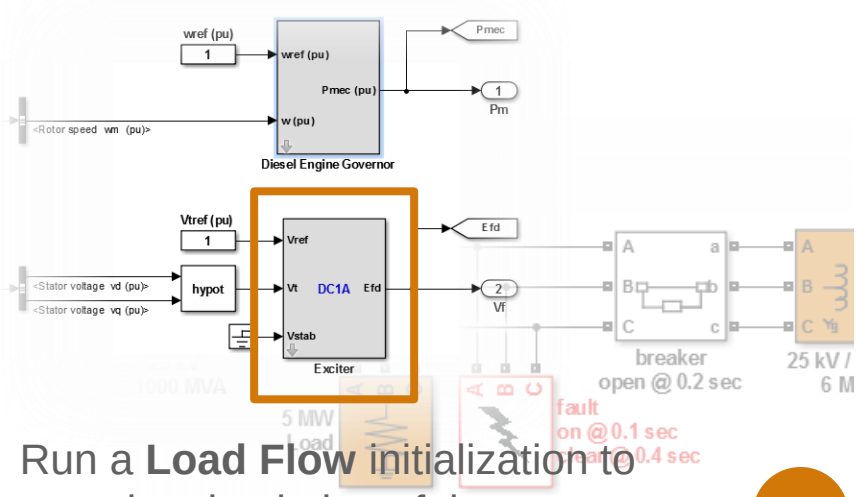



```
>> emergency_generator
```

Electrical disturbances

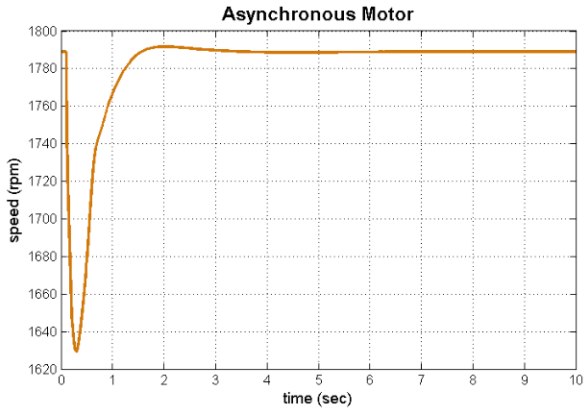
Emergency generator example

1. Examine the components in the generator control subsystem and identify the library that contains additional exciter models



2. Run a **Load Flow** initialization to start the simulation of the system from steady-state

3. Verify the performance of the generator after the fault occurs at 0.1 seconds and identify how long it takes for the motor to fully recover

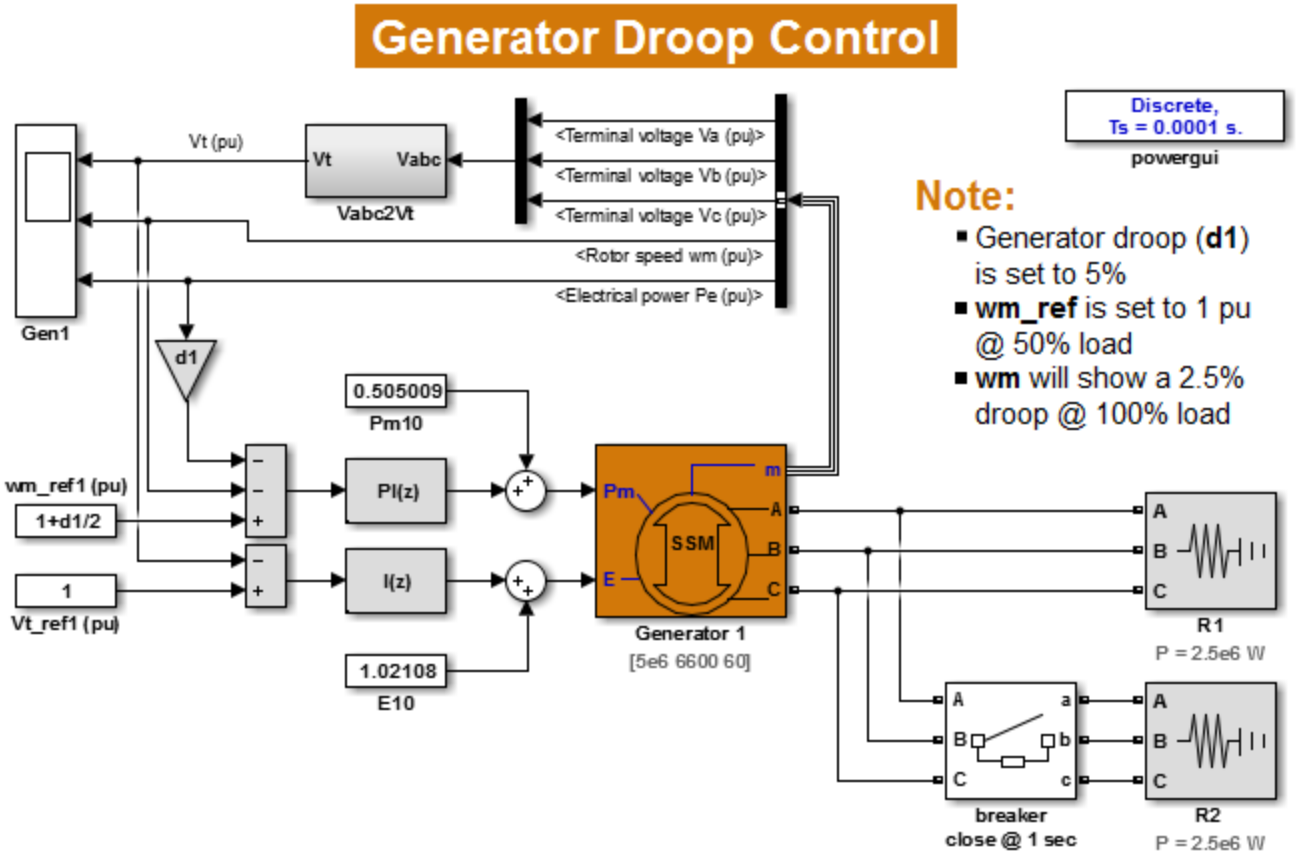


4. Switch the simulation to **phasor mode** to speed up any additional testing of the system

```
>> emergency_generator
```

Synchronous generator control

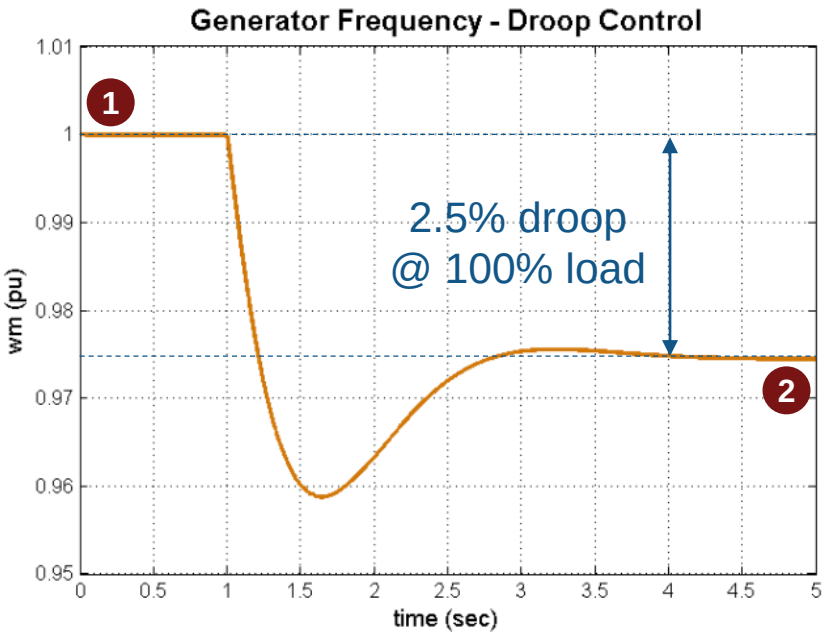
Generator droop control example

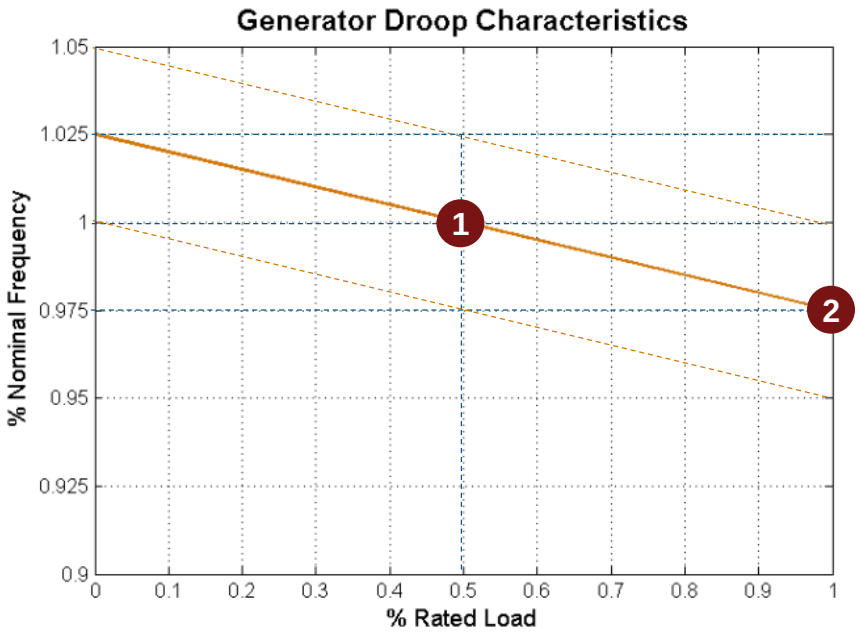



```
>> single_generator_droop
```

Synchronous generator control

Generator droop control example

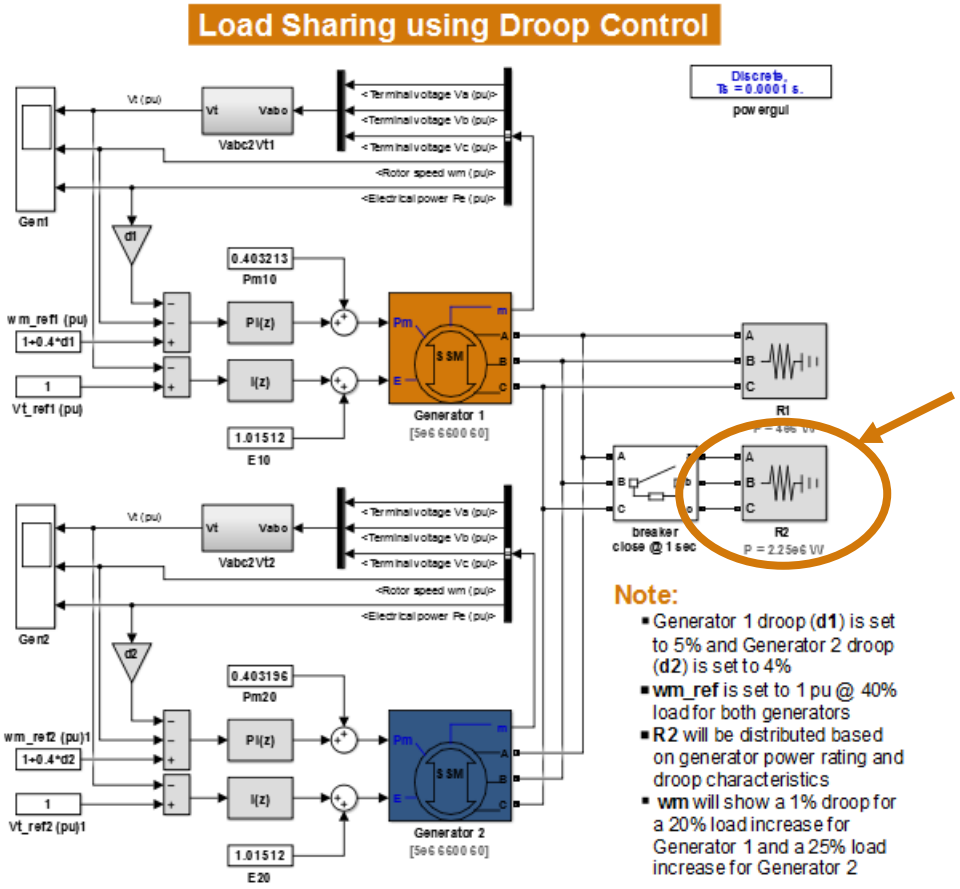





```
>> single_generator_droop
```

Synchronous generator control

Load sharing example

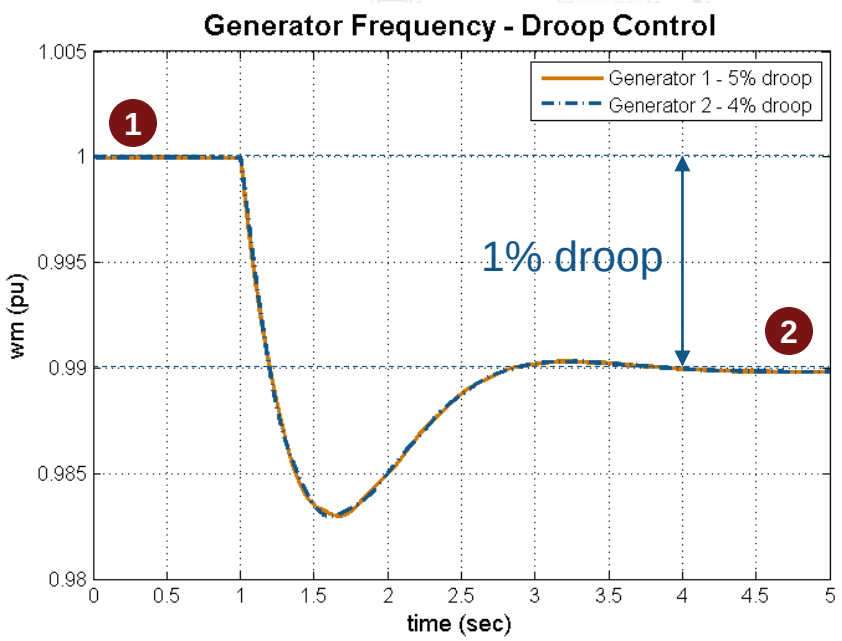


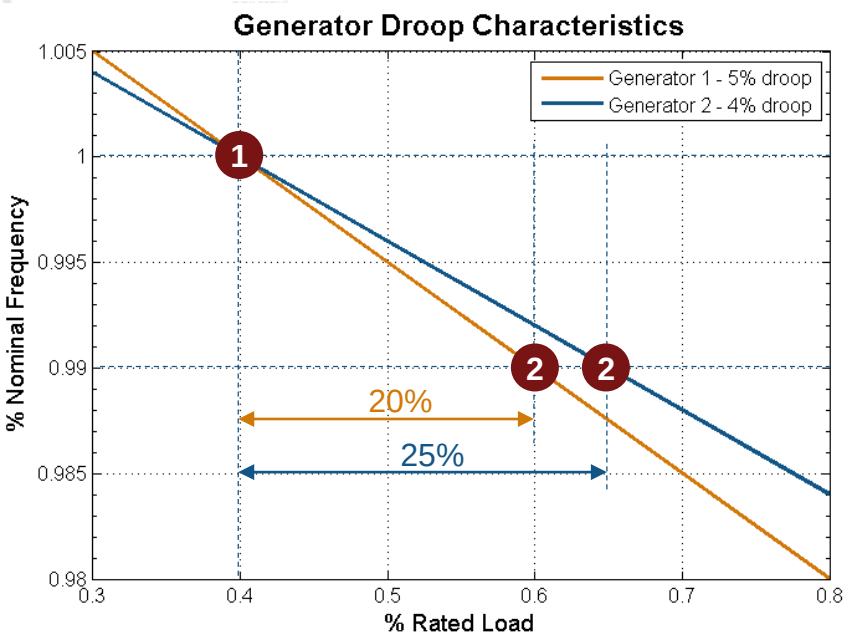
The increase in load will be shared by the two generators based on their power ratings and their droop settings

```
>> two_generator_droop
```

Synchronous generator control

Load sharing example

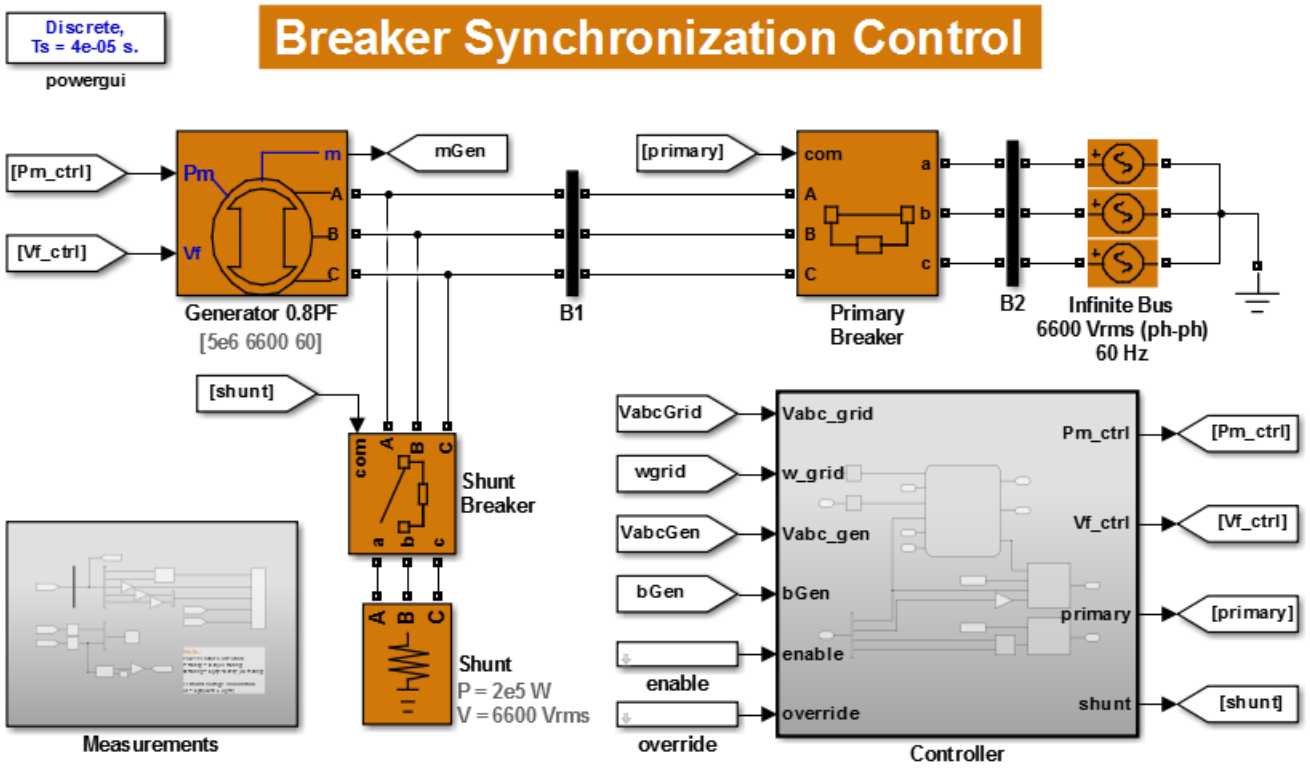





```
>> two_generator_droop
```

Synchronous generator control

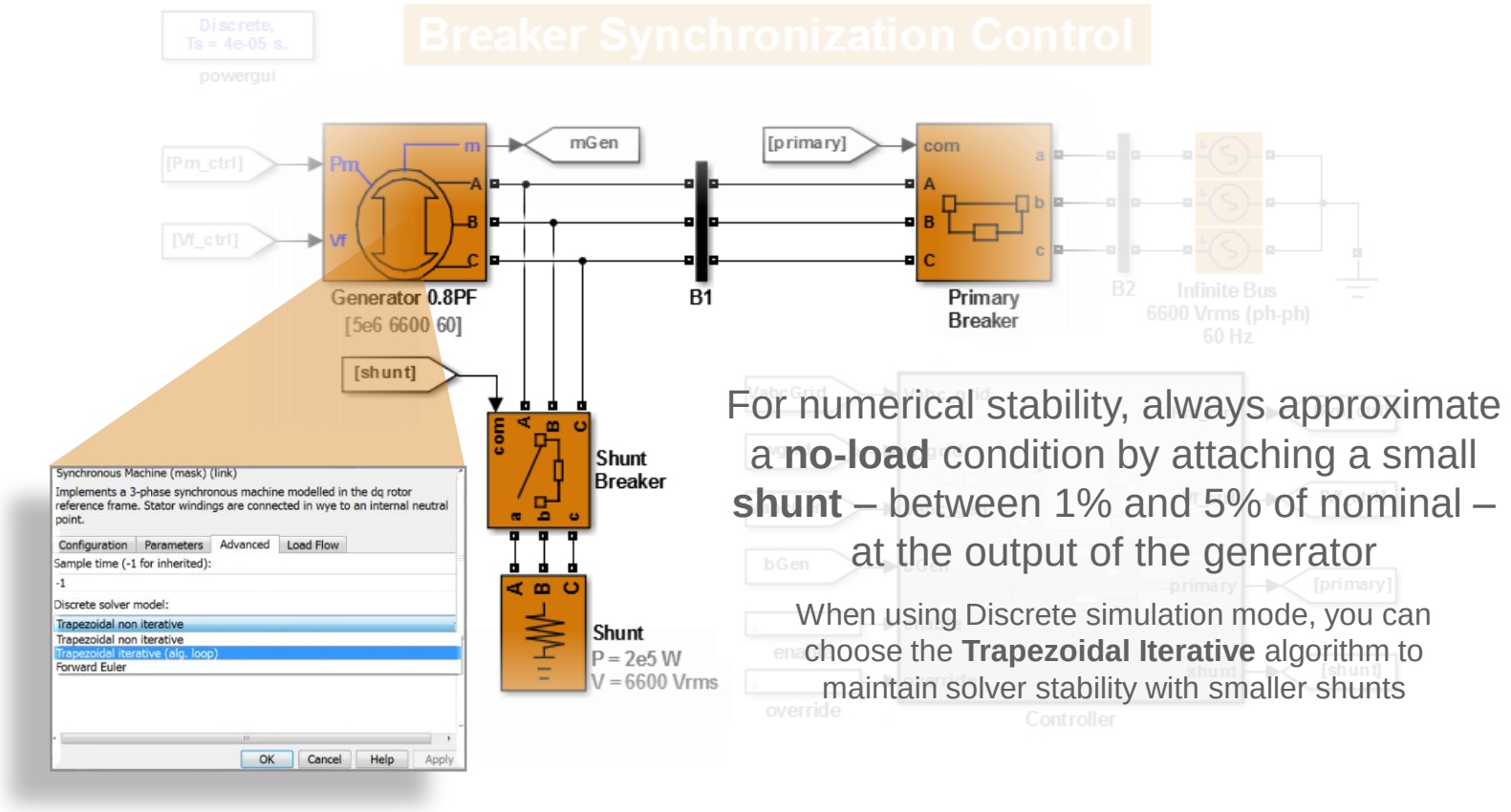
Breaker synchronization example




```
>> synchronizing_breaker
```

Synchronous generator control

Breaker synchronization example



For numerical stability, always approximate a **no-load** condition by attaching a small **shunt** – between 1% and 5% of nominal – at the output of the generator

When using Discrete simulation mode, you can choose the **Trapezoidal Iterative** algorithm to maintain solver stability with smaller shunts

```
>> synchronizing_breaker
```

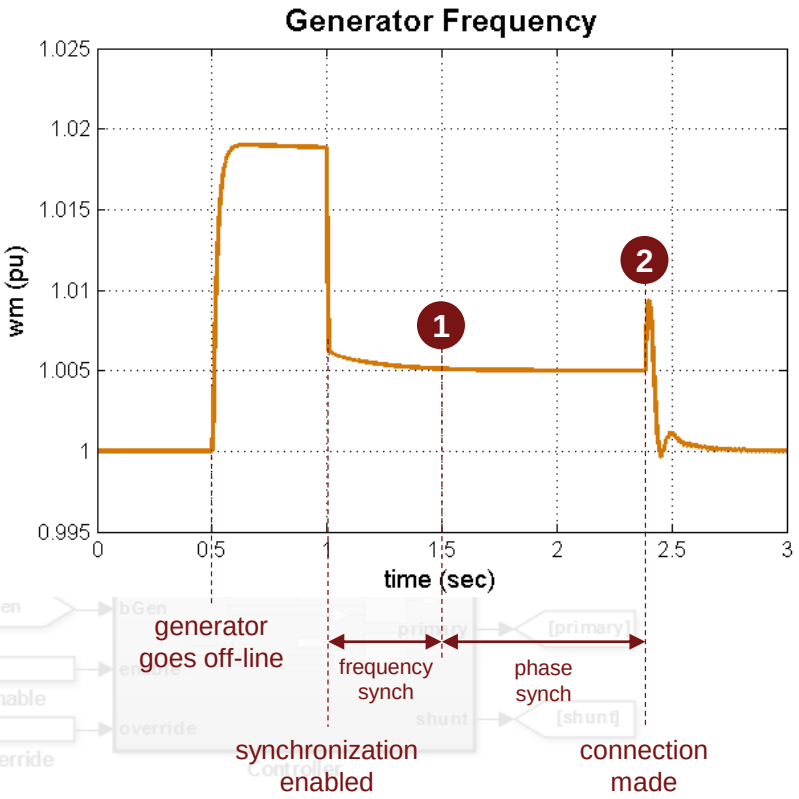
Synchronous generator control

Breaker synchronization example

There are two stages for synchronizing an incoming generator:

1. Establish the frequency of the incoming generator slightly above the bus frequency – within some tolerance

2. Connect when the voltage of the incoming generator is in-phase and equal in magnitude to the bus voltage – within some tolerance

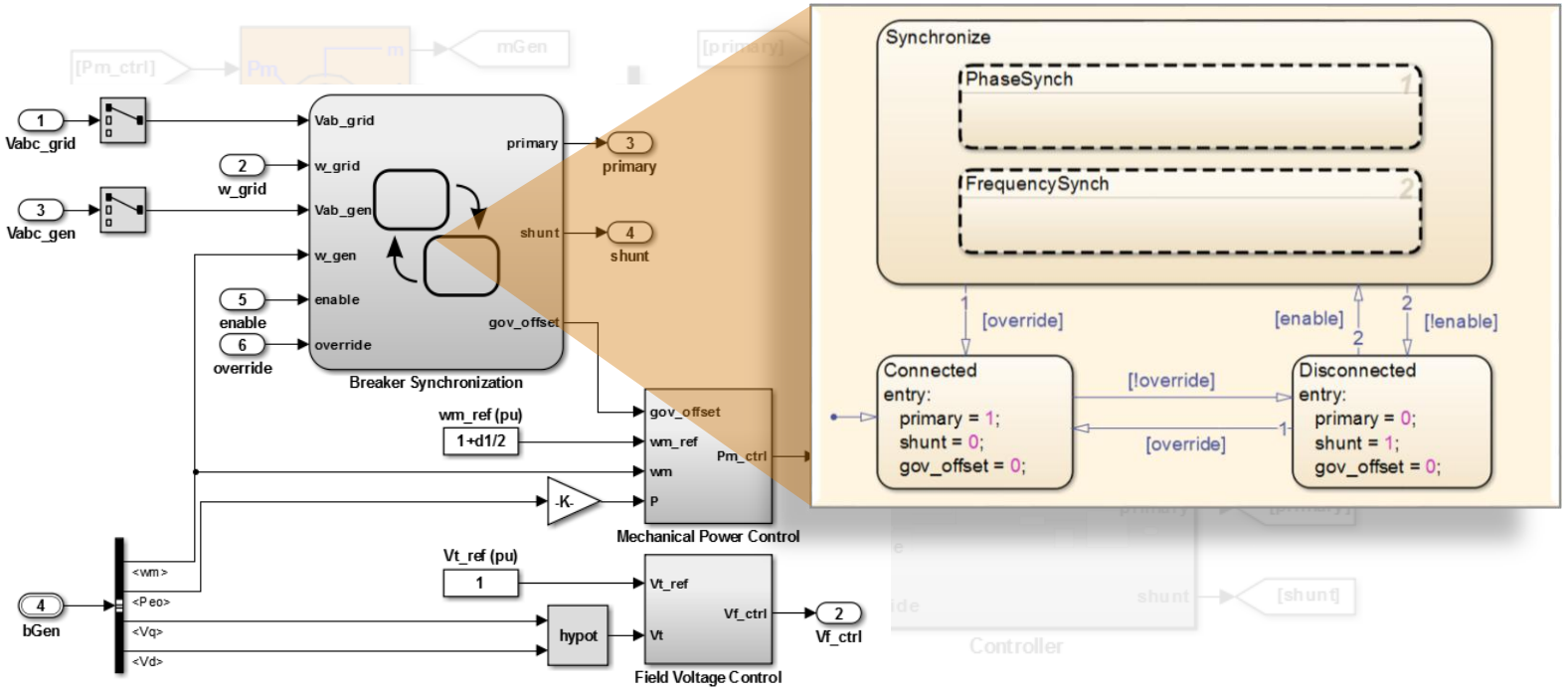



```
>> synchronizing_breaker
```

Synchronous generator control

Breaker synchronization example

3 Examine the controller and see an example of how management strategies for multiple circuit breakers can be easily implemented using state machines logic




```
>> synchronizing_breaker
```

Synchronous generator control

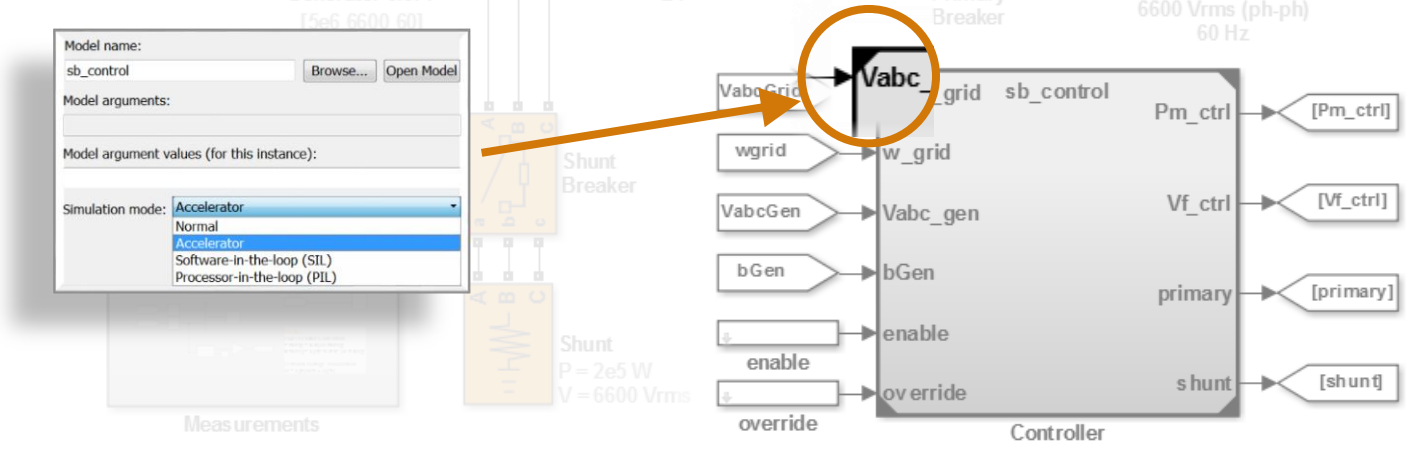
Breaker synchronization example

4 Place the controller in a separate model by converting the subsystem to a **Model Reference**

Subsystem & Model Reference → Convert Subsystem to → Referenced Model

5 Switch the simulation mode for the controller to **Accelerator**

Block Parameters (Model Reference) → Simulation mode

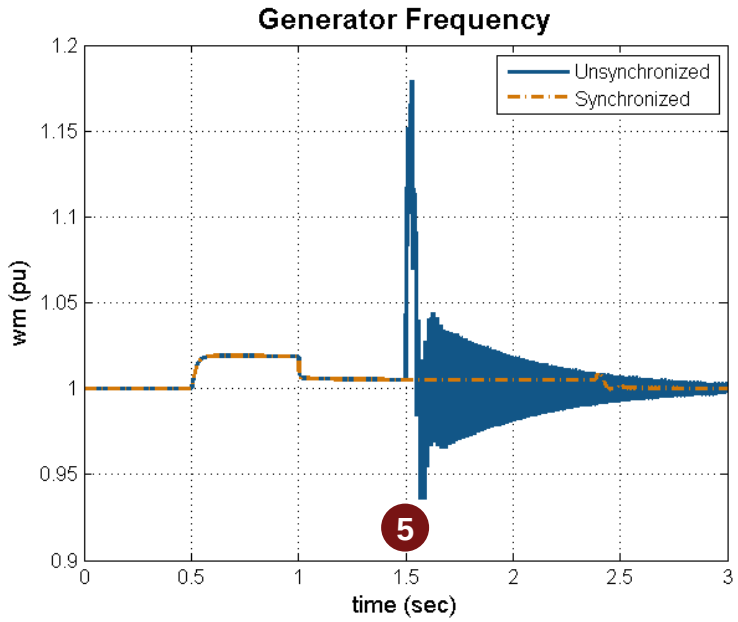


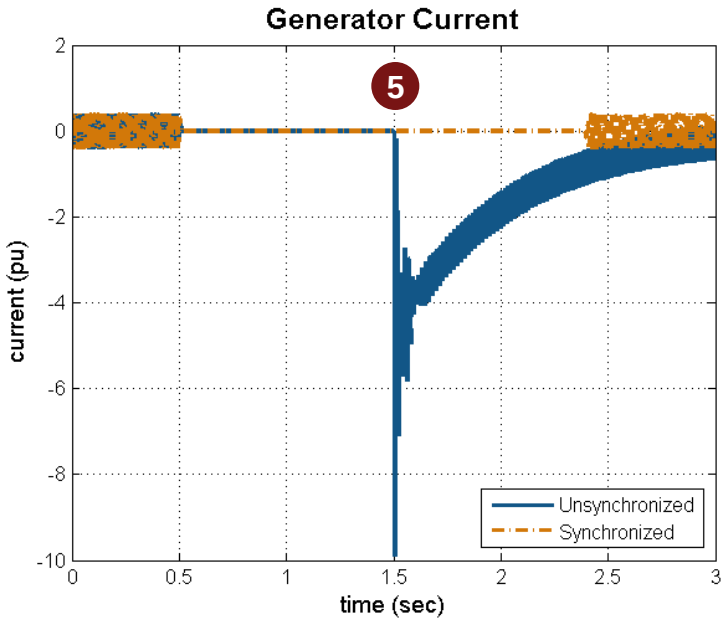

```
>> synchronizing_breaker_mref
```

Synchronous generator control

Breaker synchronization example

6 Force an unsynchronized connection at 1.5 seconds by using the ***override*** signal

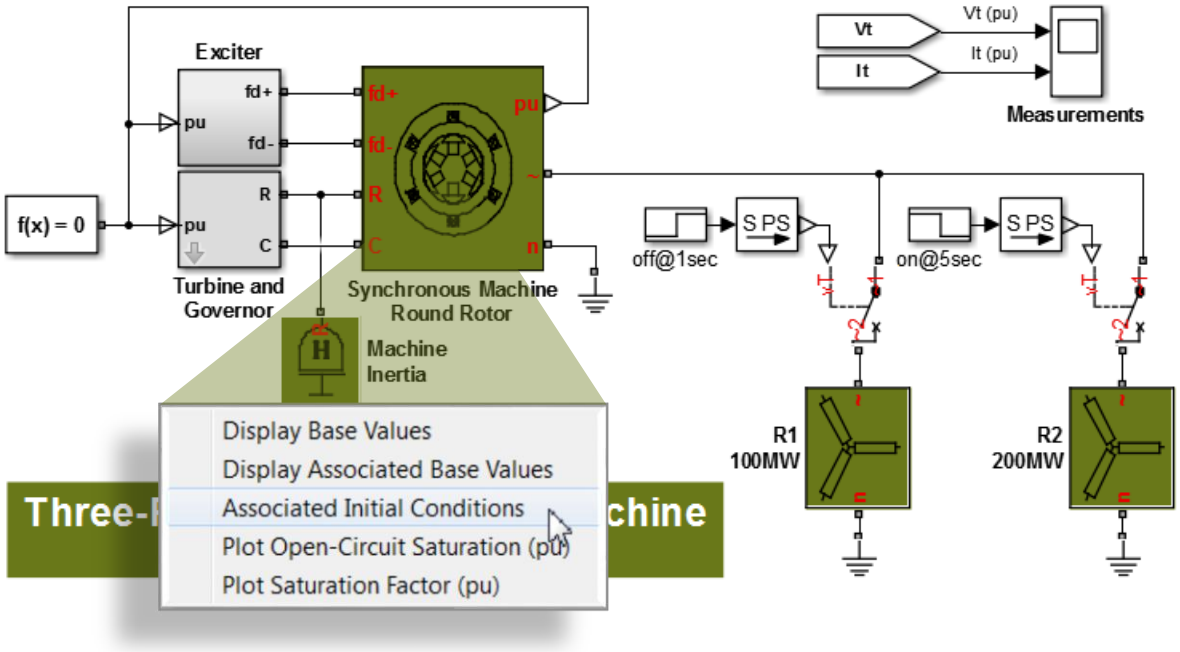





```
>> synchronizing_breaker_mref
```

Synchronous generator control

Generator no-load test – Simscape Components

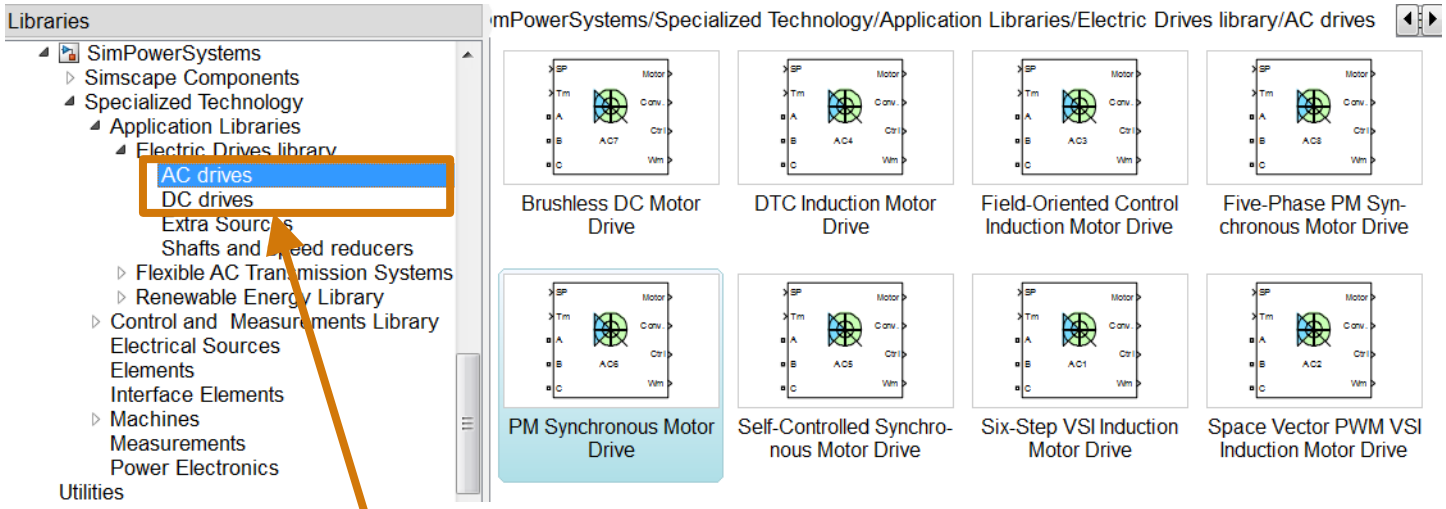


The synchronous machine blocks in the **Simscape Components** library allow testing of no-load conditions without requiring a generator shunt

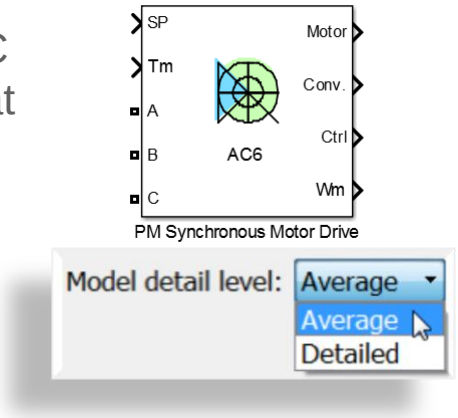
```
>> generator_noload_ssc
```

Electric motor drives

Application libraries

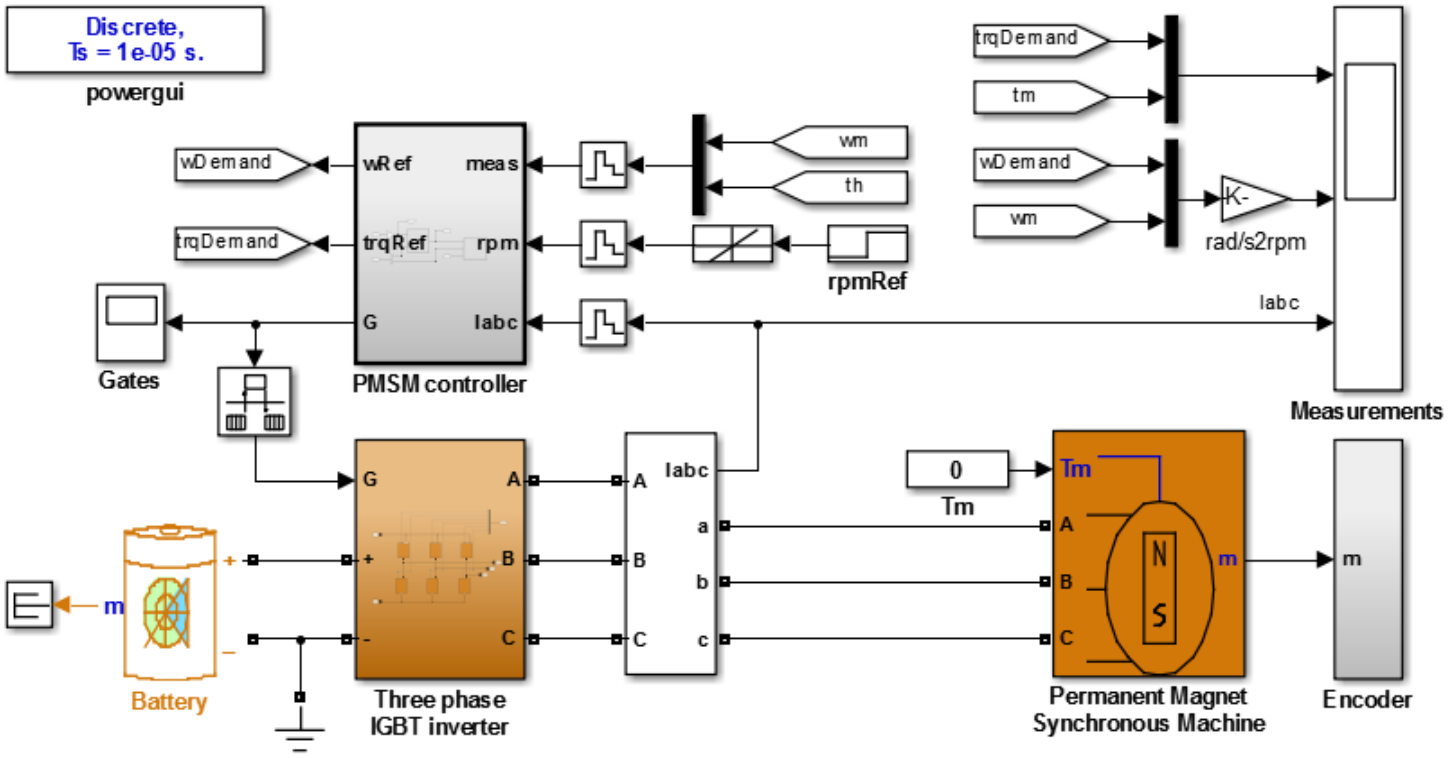


Contain a variety of prebuilt AC and DC motor drive models that can be used directly or as starting templates



Electric motor drives

Variable frequency drive

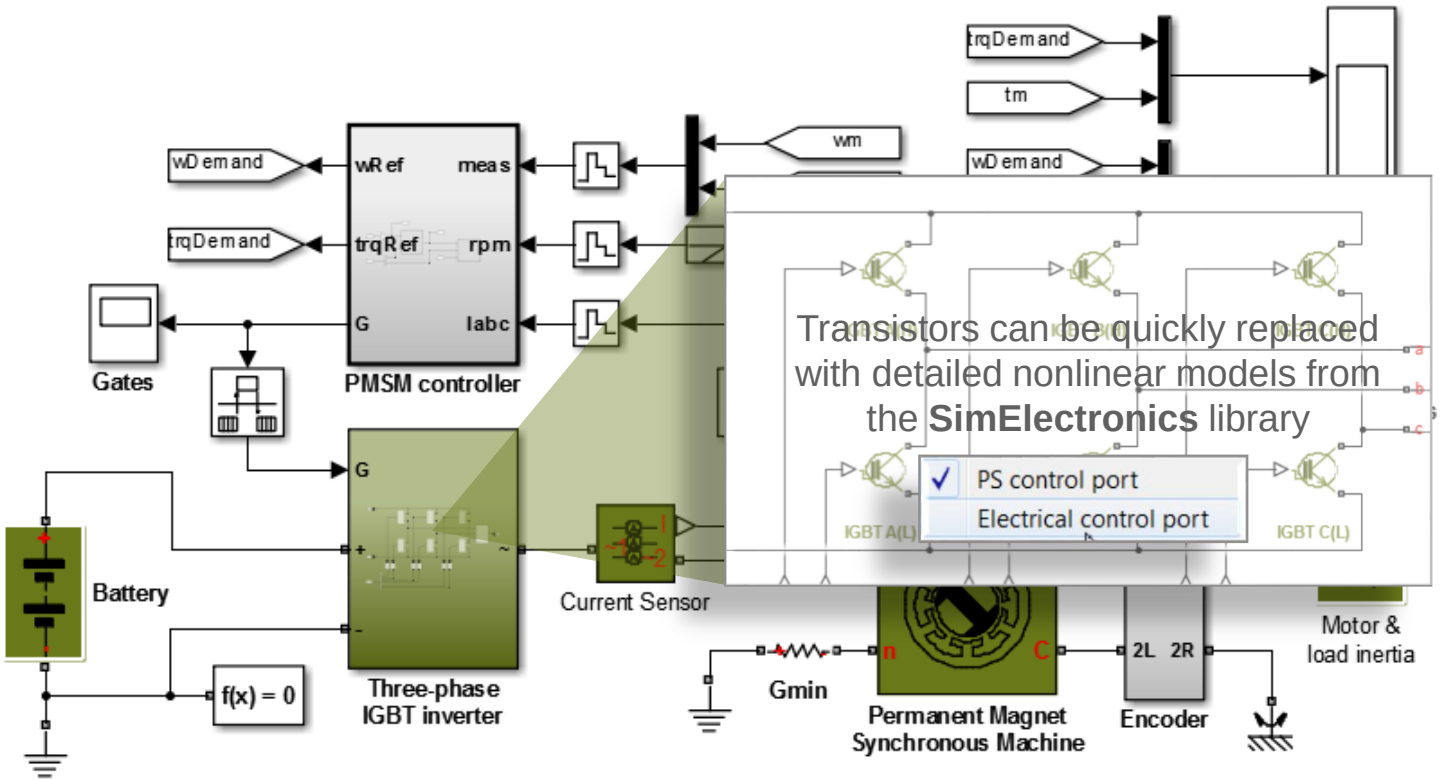


Three-Phase PMSM Drive

```
>> pmsm_drive_st
```

Electric motor drives

Variable frequency drive – Simscape Components



Three-Phase PMSM Drive

```
>> pmsm_drive_ssc
```