

# **Power Systems Lab**

## **Experiment 6** **Laboratory Report**

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# Experiment 6

## 1 Objective

Study and describe the various elements in the SimPowerSystems library of Simulink.

## 2 Background

### 2.1 About the Library

Simscape Electrical (formerly SimPowerSystems) provides component libraries for modeling and simulating electronic, mechatronic, and electrical power systems. It includes models of semiconductors, motors, and components for applications such as electromechanical actuation, smart grids, and renewable energy systems.

These components can be used to evaluate analog circuit architectures, develop mechatronic systems with electric drives, and analyze the generation, conversion, transmission, and consumption of electrical power at the grid level.

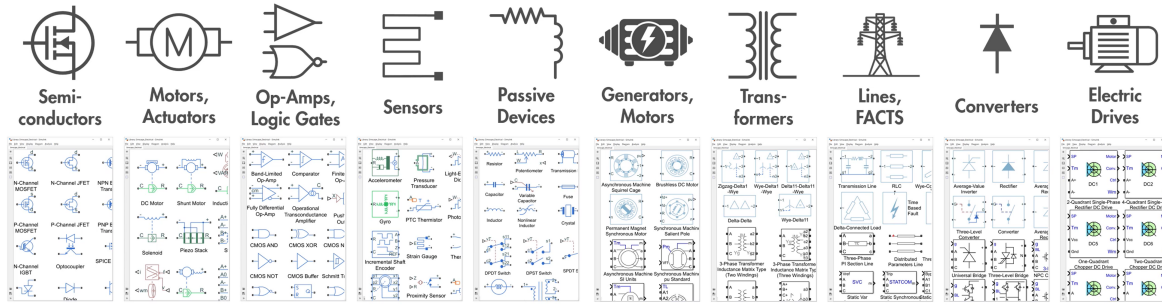
The SimPowerSystems library contains more than 150 blocks distributed in sublibraries such as:

- **Electrical sources:** voltage and current sources
- **Circuit elements:** transformers, RLC branches, loads, transmission lines, etc.
- **Machinery:** AC and DC motors, generators, turbines and governors
- **Power electronics:** power switches (diodes, thyristors, GTOs, IGBTs, etc.)
- **Measurement:** voltage, current and impedance measurement instruments

SimPowerSystems open architecture allows models to be adapted to specific needs. This flexibility, combined with the wide variety of easy-to-use blocks, makes SimPowerSystems the ideal prototyping platform for studying new power system models and for understanding complex control systems.

### 2.2 Usage

Simscape Electrical helps to develop control systems and test system-level performance. One can parameterize your models using MATLAB variables and expressions, and design control systems for electrical systems in Simulink. One can integrate mechanical, hydraulic, thermal, and other physical systems into the model using components from the Simscape family of products. To deploy models to other simulation environments, including hardware-in-the-loop (HIL) systems, Simscape Electrical supports C-code generation.



## 3 Simscape Electrical

### 3.1 Block Libraries

Simscape Electrical libraries include **blocks** and models of semiconductors, motors, and components for applications such as electromechanical actuation, smart grids, and renewable energy systems. You can use these component libraries for modeling and simulating electronic, mechatronic, and electrical power systems.

These are also used to evaluate analog circuit architectures, develop mechatronic systems with electric drives, and analyze the generation, conversion, transmission, and consumption of electrical power at the grid level.

### 3.2 Some Elements in the Libraries

#### Connectors and References

- Busbar: Load flow analysis busbar connector
- Delta Reference ( $3\phi$ ): Internal reference point for delta-connected network
- Floating Neutral ( $3\phi$ ): Internal floating neutral point for wye-connected network
- Grounded Neutral ( $3\phi$ ): Connect phases of three-phase system to reference
- Neutral Port ( $3\phi$ ): Connect phases of three-phase system to neutral
- Open Circuit ( $3\phi$ ): Three-phase terminator that draws no current
- Phase Permute: Permute phases of three-phase system
- Phase Splitter: Expand or combine three electrical conserving ports

#### Integrated Circuits (General Circuits)

- Band-Limited Op-Amp Model
- Comparator: Behavioral model of a comparator integrated circuit
- Controlled PWM Voltage: Pulse-width modulated voltage source
- Finite-Gain Op-Amp: Gain-limited operational amplifier model with optional noise
- Fully Differential Op-Amp: Operational amplifier with fully differential output, that is, not referenced to ground

- Multiplier: Integrated circuit multiplier
- Timer: Behavioral model of a timer integrated circuit
- Voltage-Controlled Oscillator: Behavioral model of voltage-controlled oscillator

### **Switches and Breakers**

- Circuit Breaker Single-pole single-throw circuit breaker
- Circuit Breaker (Three Phase) Three-phase circuit breaker controlled by external signal
- Circuit Breaker (with arc) Single-pole single-throw circuit breaker with Mayr arc representation
- DPDT Switch Double-pole double-throw switch
- Fuse Fuse that protects against excessive current

### **Relays**

- SPDT Relay: Single-pole, double-throw relay with delays and faults
- SPST Relay: Single-pole single-throw relay with delays and faults

### **Lines**

- PI Section Line: transmission line with lumped parameters
- Distributed Parameters Line: N-phase distributed parameter transmission line model with lumped losses
- Three-Phase PI Section Line: three-phase transmission line section with lumped parameters

## **4 Result**

We studied and described a few block elements from the libraries in SimPowerSystems application of SIMULINK, now known as Simscape Electrical.