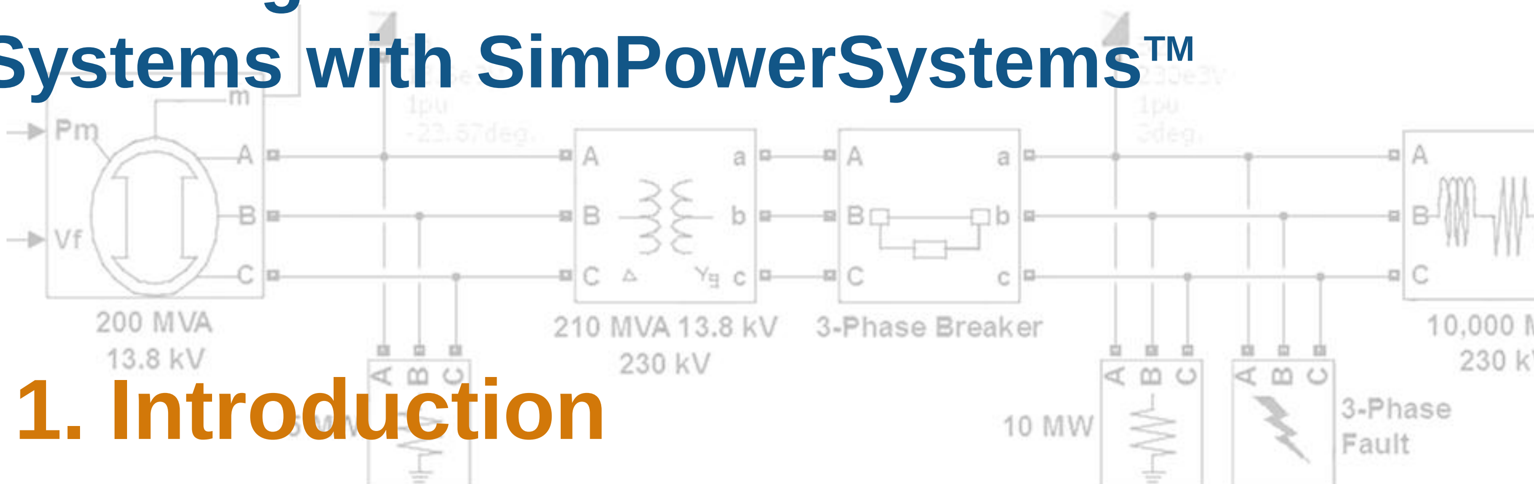
SimPowerSystems Hands-on Workshop:
Modeling and Simulation of Electrical Power Systems with SimPowerSystems™



1. Introduction

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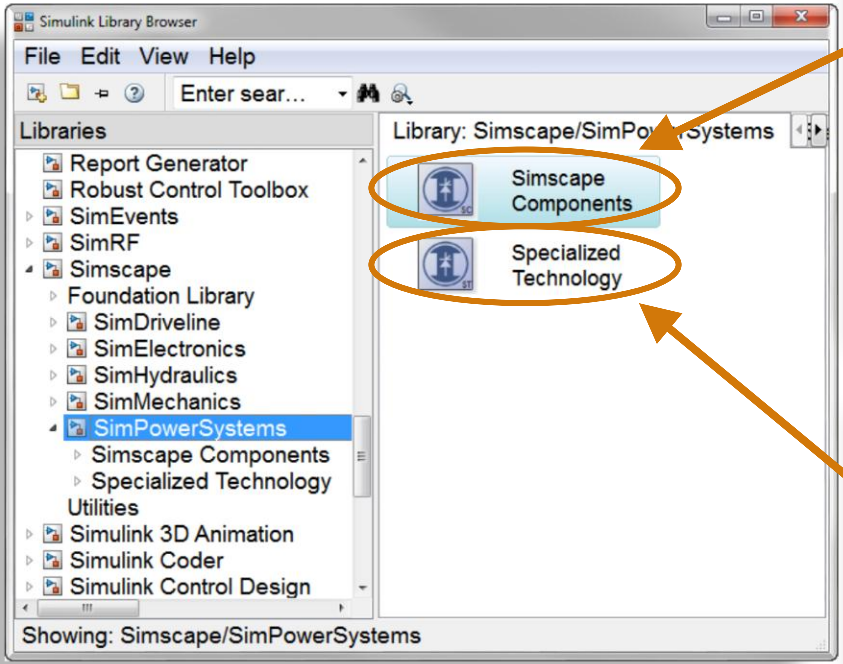
Outline

- SimPowerSystems component libraries
- How does SimPowerSystems work?

SimPowerSystems component libraries

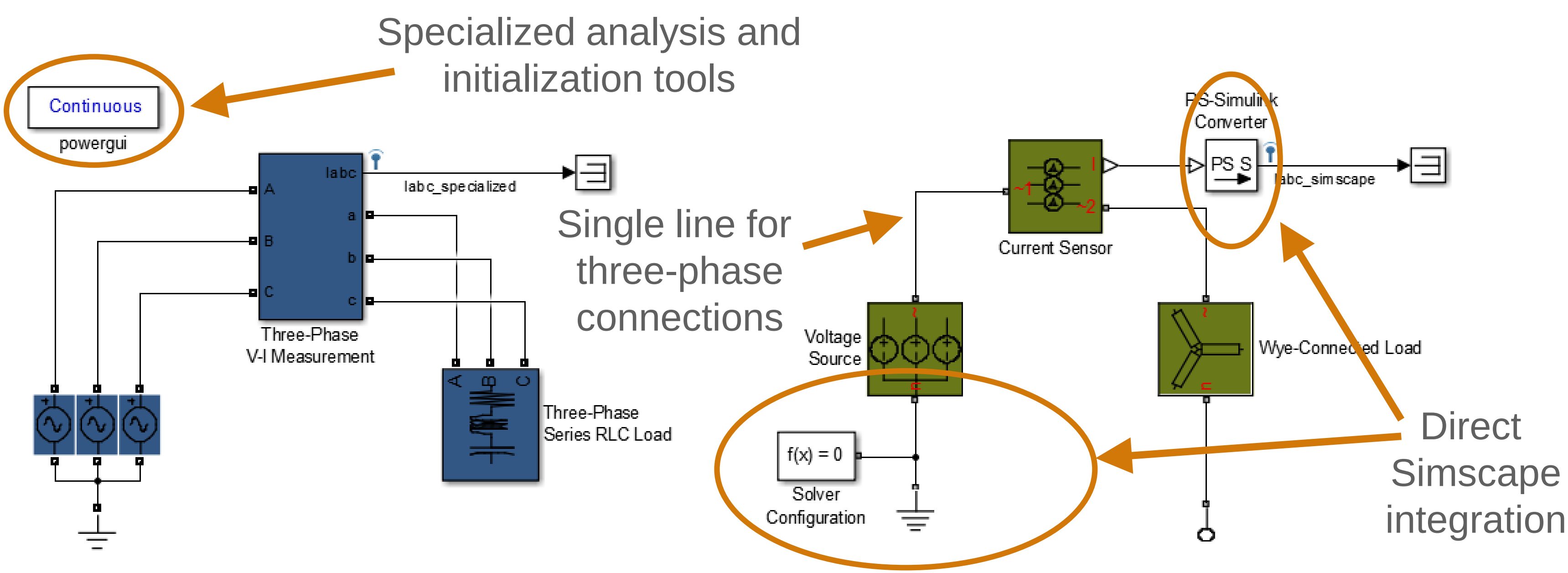


- Simscape based components
- Simultaneous linear and nonlinear network equations solution
- Direct Simscape integration for multi-domain modeling
- Create custom components using the Simscape Language

- Simulink based components
- Sequential solution of linear and nonlinear equations
- Continuous, discrete and phasor solver modes
- Large number of detailed electric and electronic components library
- Specialized analysis and initialization tools

SimPowerSystems component libraries

```
>> threephase_specialized
>> threephase_simscape
```

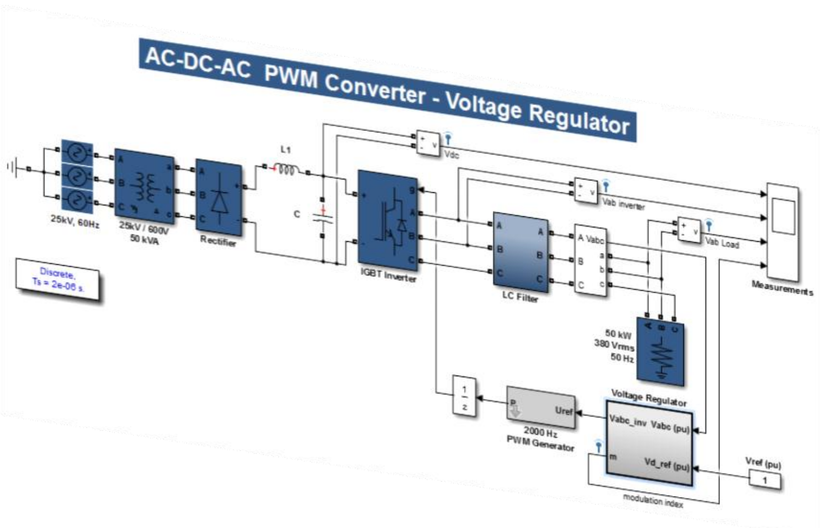


Specialized Technology

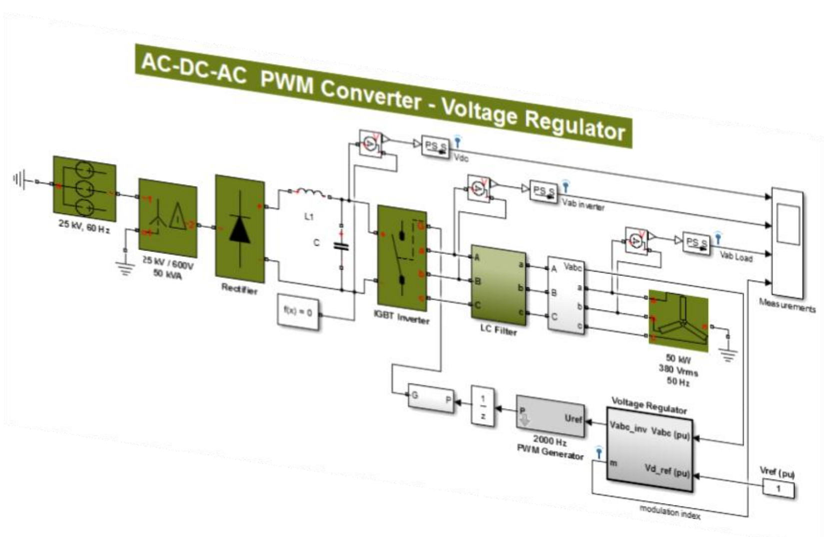
Simscape Components

SimPowerSystems component libraries

```
>> acdcac_specialized
>> acdcac_simscape
```



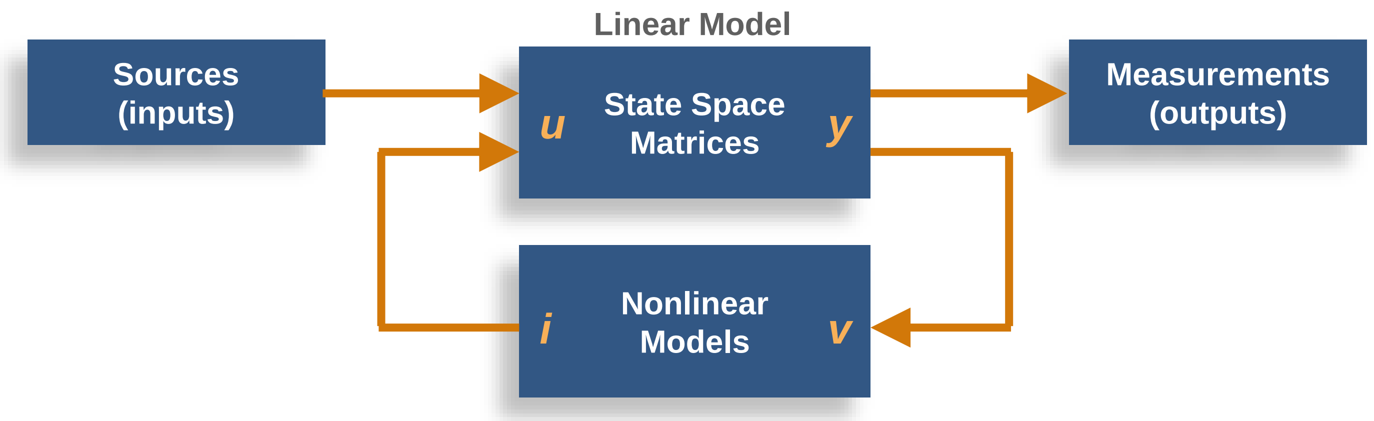
Specialized Technology



Simscape Components

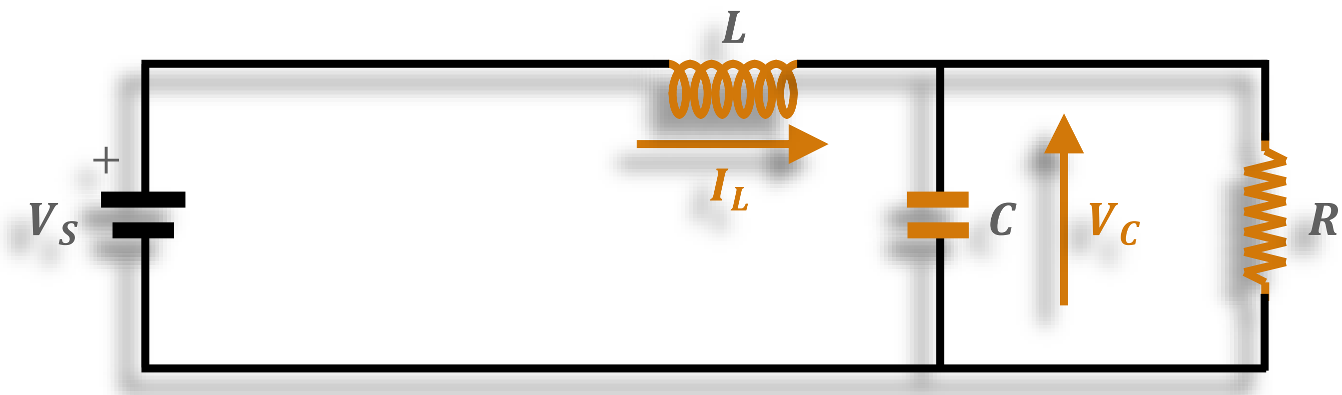
How does SimPowerSystems work?
Specialized Technology

- The SimPowerSystems network is analyzed and a state-space model of the linear part of the network is created
- Any nonlinear elements are integrated as feedback elements around the linear state-space model



- This is all handled automatically by the **powergui**, but the user can also access the relevant analysis functions

How does SimPowerSystems work?
Consider a simple RLC network



$$I_C = C\frac{dV_C}{dt}, \quad V_L = L\frac{dI_L}{dt}, \quad V_R = RI_R = V_C$$

node currents: $I_C = I_L - I_R$

loop voltages: $V_L = V_S - V_C$

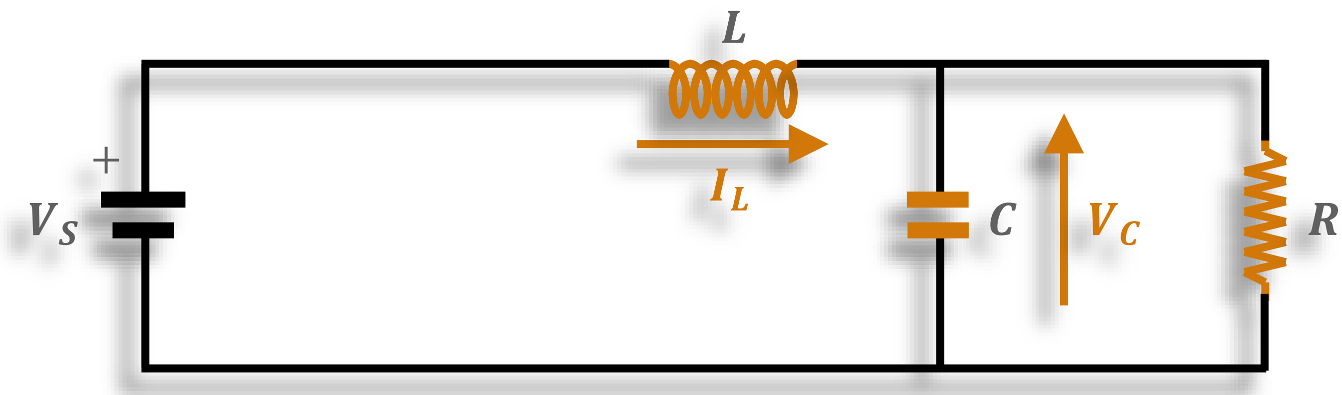
$$C\frac{dV_C}{dt} = I_L - \frac{1}{R}V_C$$

$$L\frac{dI_L}{dt} = V_S - V_C$$

```
>> rlc_simulinkFinish
```

How does SimPowerSystems work?

Consider a simple RLC network



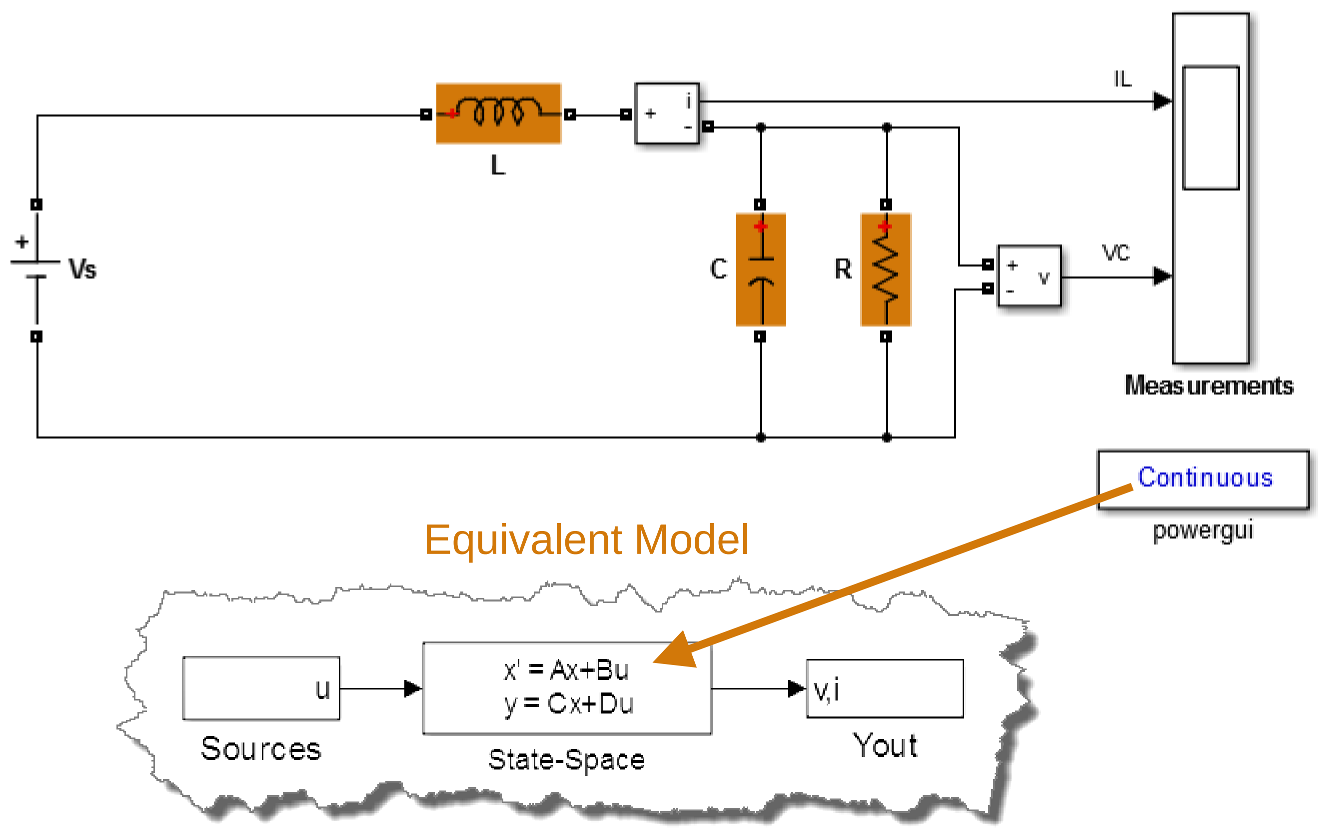
$$\frac{d}{dt}\begin{bmatrix} V_C \\ I_L \end{bmatrix} = \underbrace{\begin{bmatrix} -1/RC & 1/C \\ -1/L & 0 \end{bmatrix}}_{A}\begin{bmatrix} V_C \\ I_L \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ 1/L \end{bmatrix}}_{B} V_S$$

$$y = \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}}_{C}\begin{bmatrix} V_C \\ I_L \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ 0 \end{bmatrix}}_{D} V_S$$

```
>> rlc_sps
```

How does SimPowerSystems work?

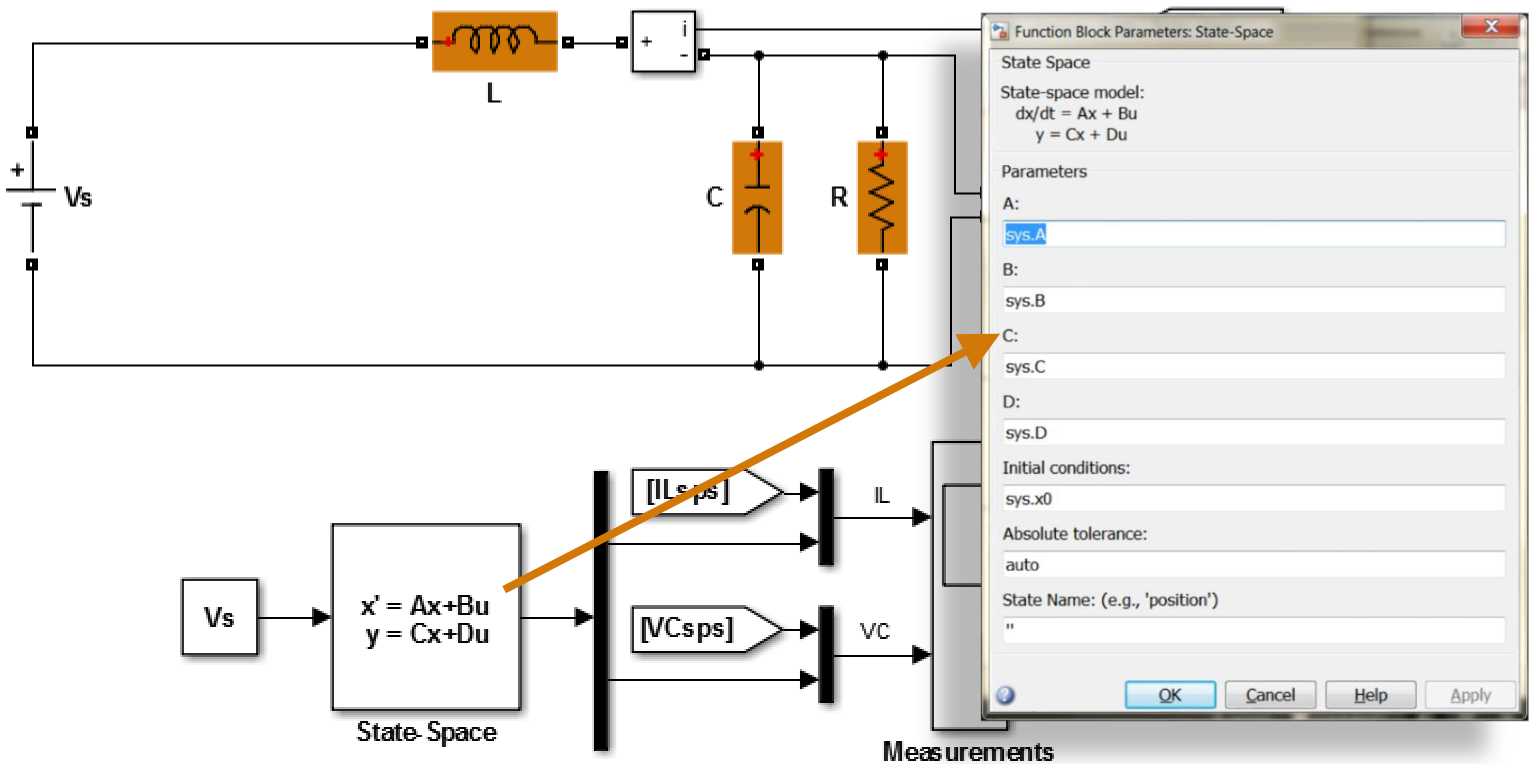
Consider a simple RLC network




```
>> sys = power_analyze('rlc_sps','structure');
```

How does SimPowerSystems work?

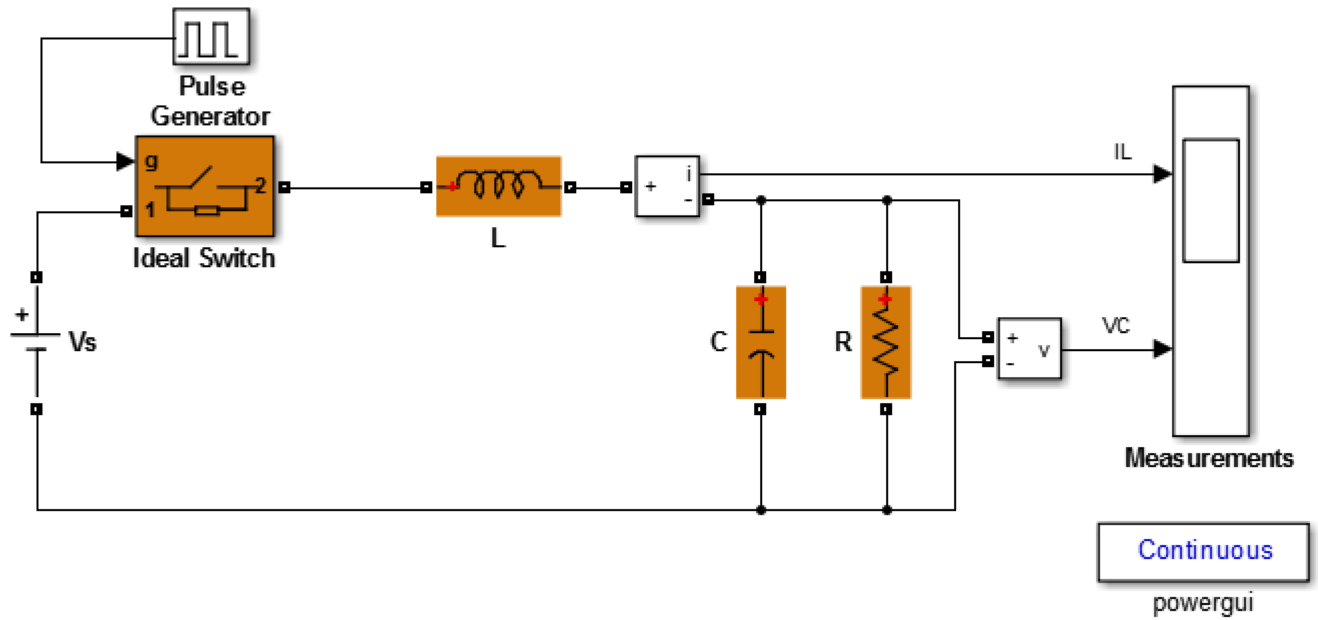
Consider a simple RLC network




```
>> rlc_sps_sl
```

How does SimPowerSystems work?

Introduce an ideal switch



$[A,B,C,D]$

system with the switch open

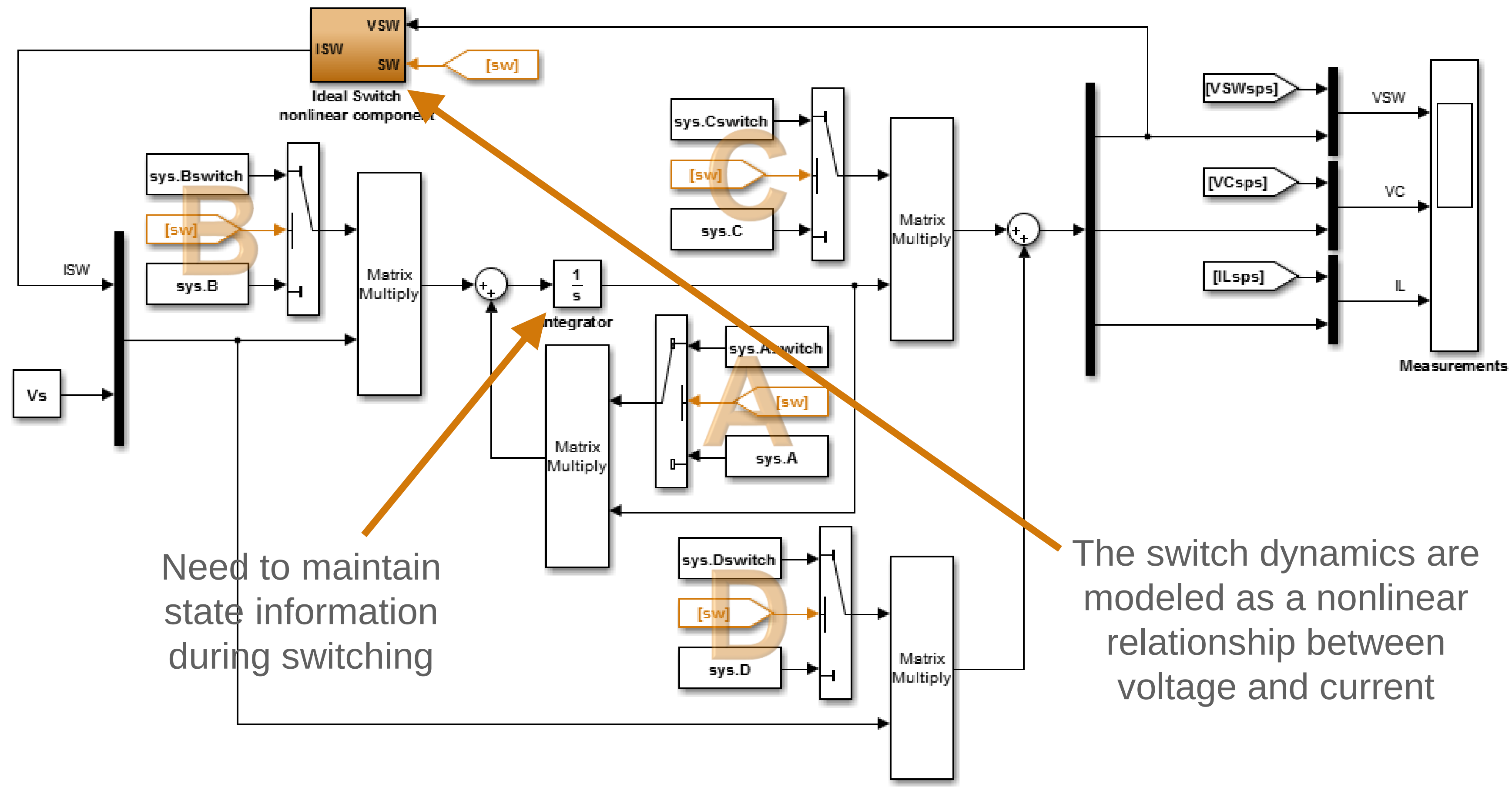
$[A_{switch},B_{switch},C_{switch},D_{switch}]$

system with the switch closed

```
>> sys = power_analyze('rlc_switch_sps','structure');
```

How does SimPowerSystems work?

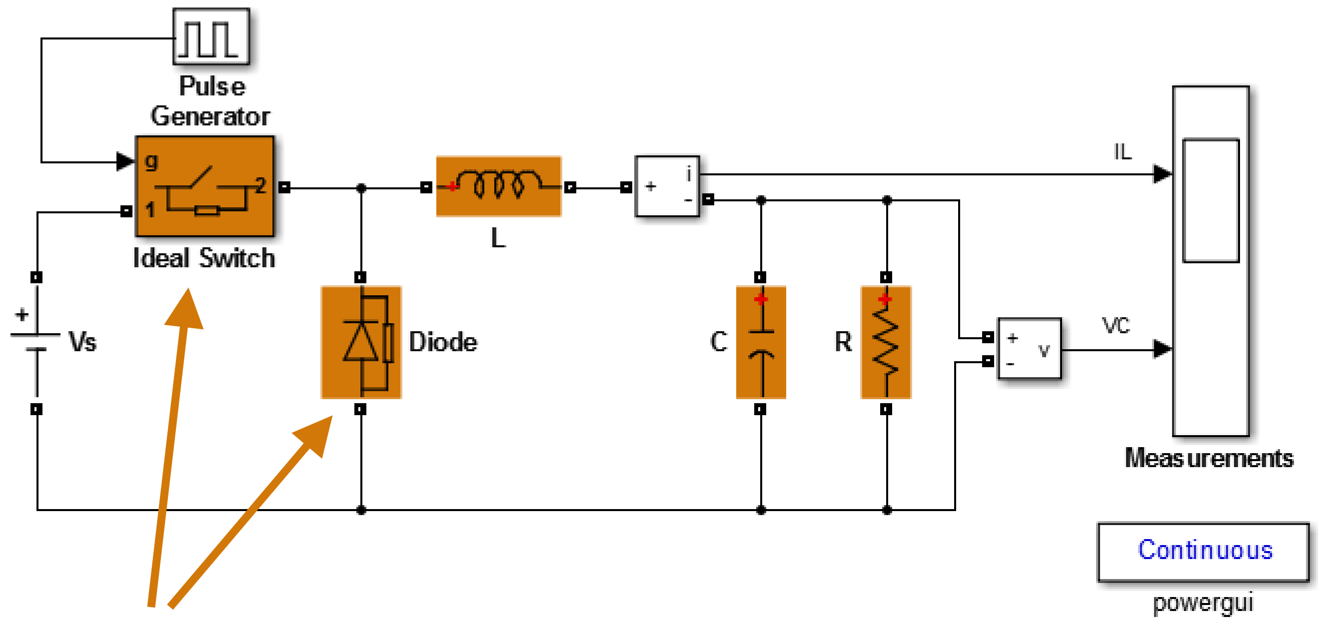
Introduce an ideal switch




```
>> rlc_switch_sps_sl
```

How does SimPowerSystems work?

Introduce a diode to mitigate flyback

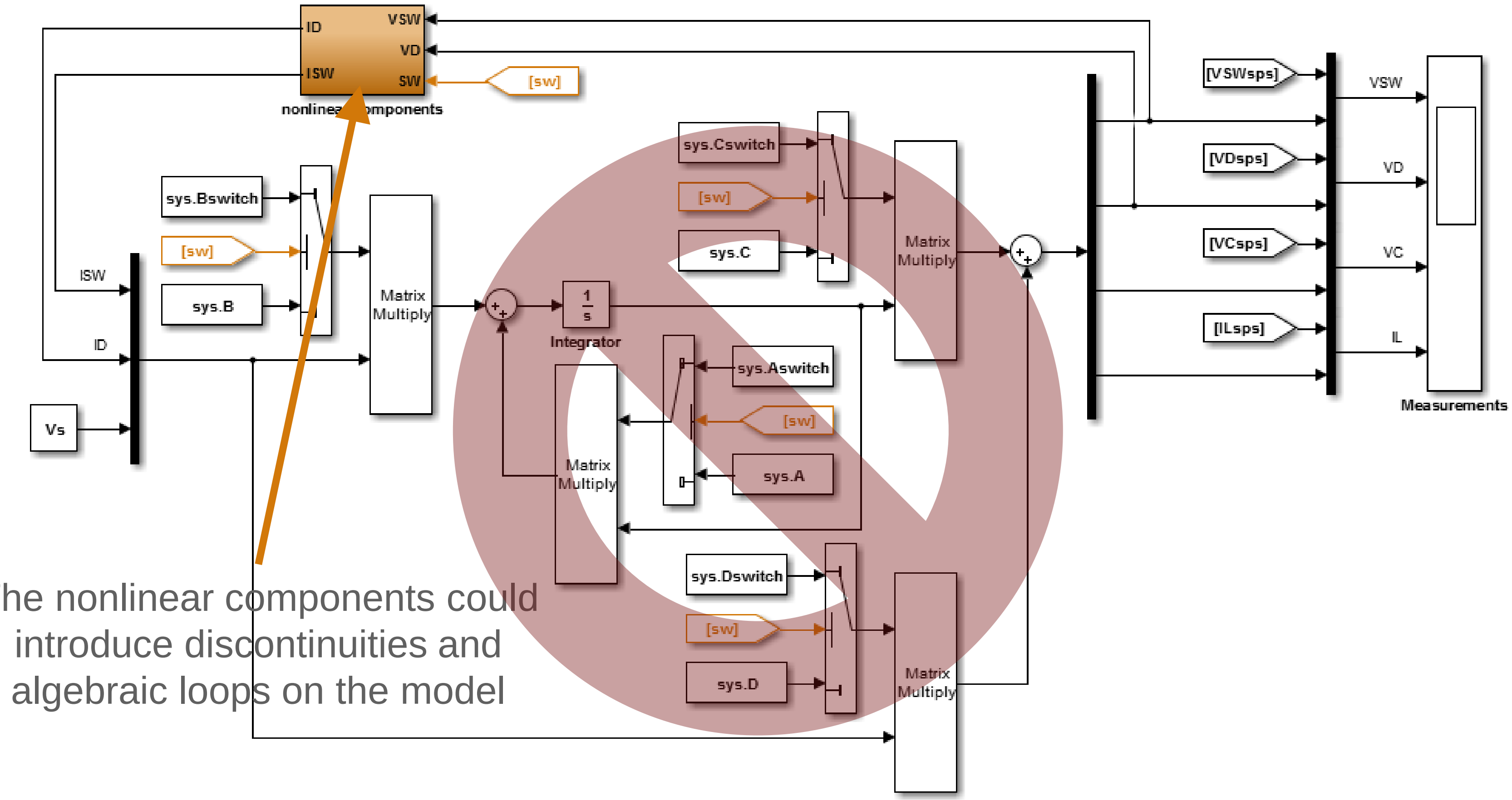


Both the switch and the diode are nonlinear elements and must be placed in the feedback path of the state-space model

```
>> rlc_diode_sps
```

How does SimPowerSystems work?

Introduce a diode to mitigate flyback



The nonlinear components could introduce discontinuities and algebraic loops on the model

```
>> rlc_diode_sps_sl
```

How does SimPowerSystems work?

Introduce a diode to mitigate flyback