PSIM: A Tutorial

Presentation Outline

- What is PSIM?
- Circuit Structure
- Getting started with PSIM
- Hands-on Examples

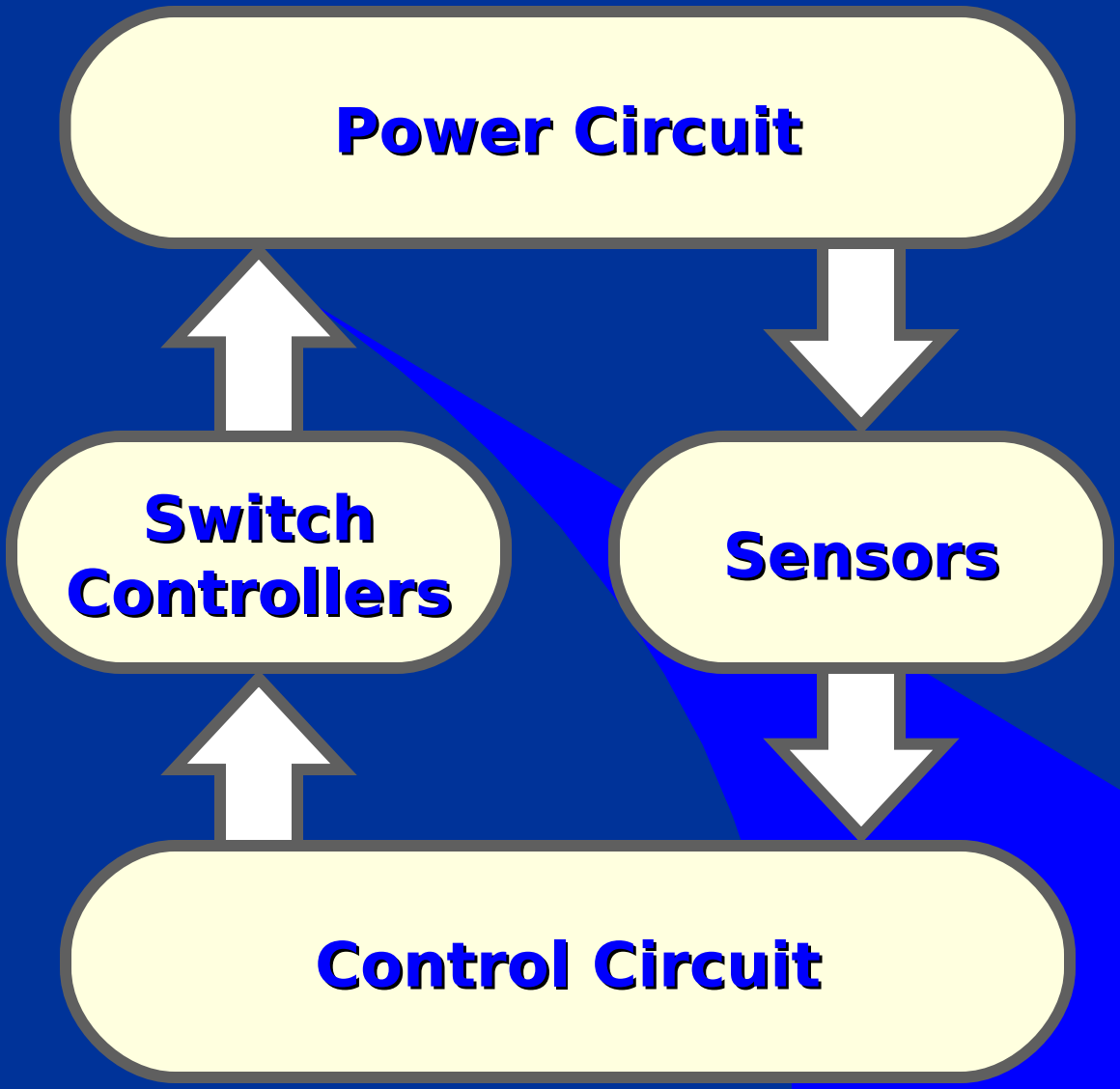
What is PSIM?

- PSIM is a simulation package specifically designed for power electronics and control circuits.
- Manufactured by Powersim Inc.

(*www.powersimtech.com*)

- It allows fast simulation and it has a friendly user interface.
- PSIM is indicated for system-level simulation, control loop design and motor drive system studies.
- The basic PSIM package consists of three programs: circuit schematic program (SIMCAD), simulator program (PSIM), and waveform display program (SIMVIEW).

Circuit Structure



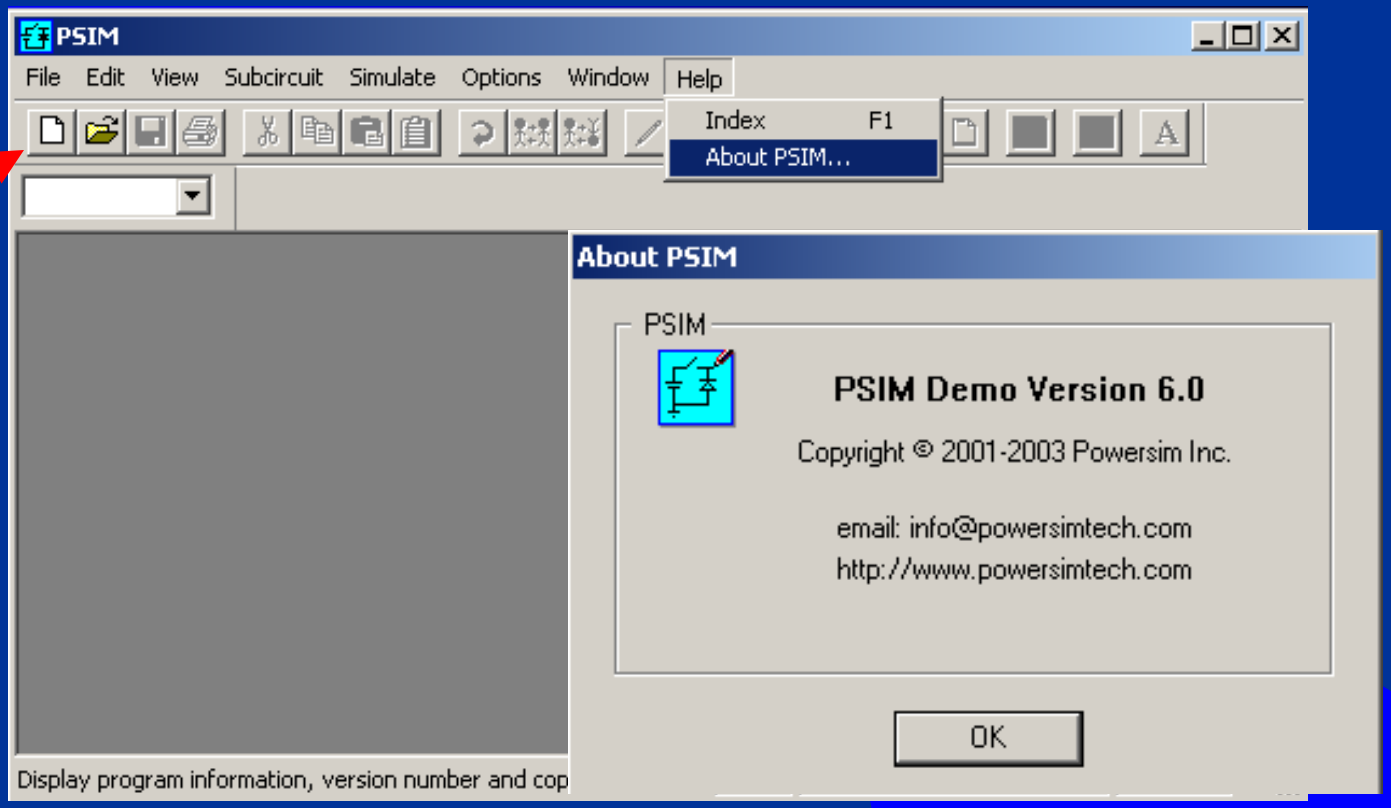
Circuit Structure

Power Circuit	Control Circuit	Switch Controllers	Sensors
➢Switching devices ➢RLC branches ➢Transformers ➢Coupled inductors	➢S-domain blocks ➢Z-domain blocks ➢Logic components ➢Non-linear components	➢On-Off controllers ➢PWM controllers ➢Alpha controllers	➢Current ➢Voltage ➢Torque ➢Speed

Getting Started with PSIM

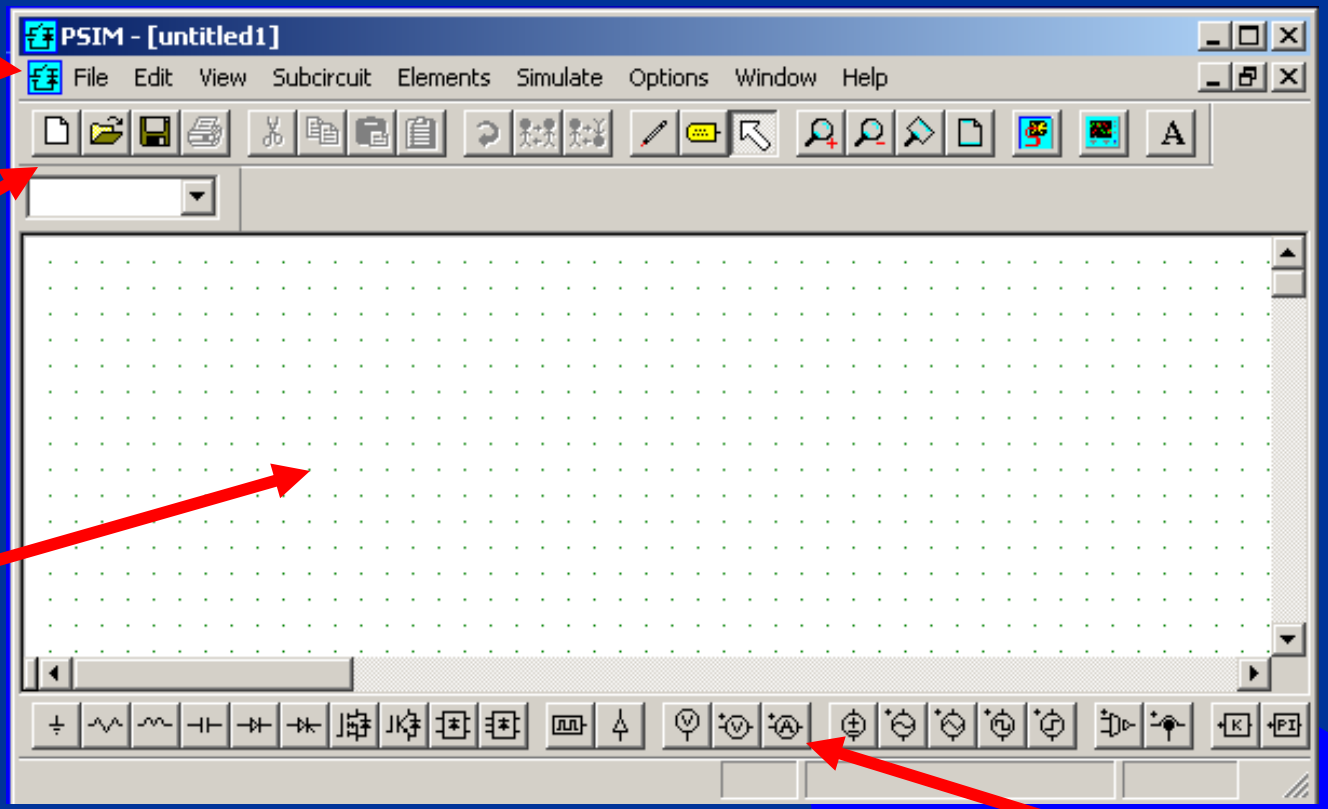
- **Start PSIM: go to *c:\PSIM6_DEMO -> PSIM***

New circuit

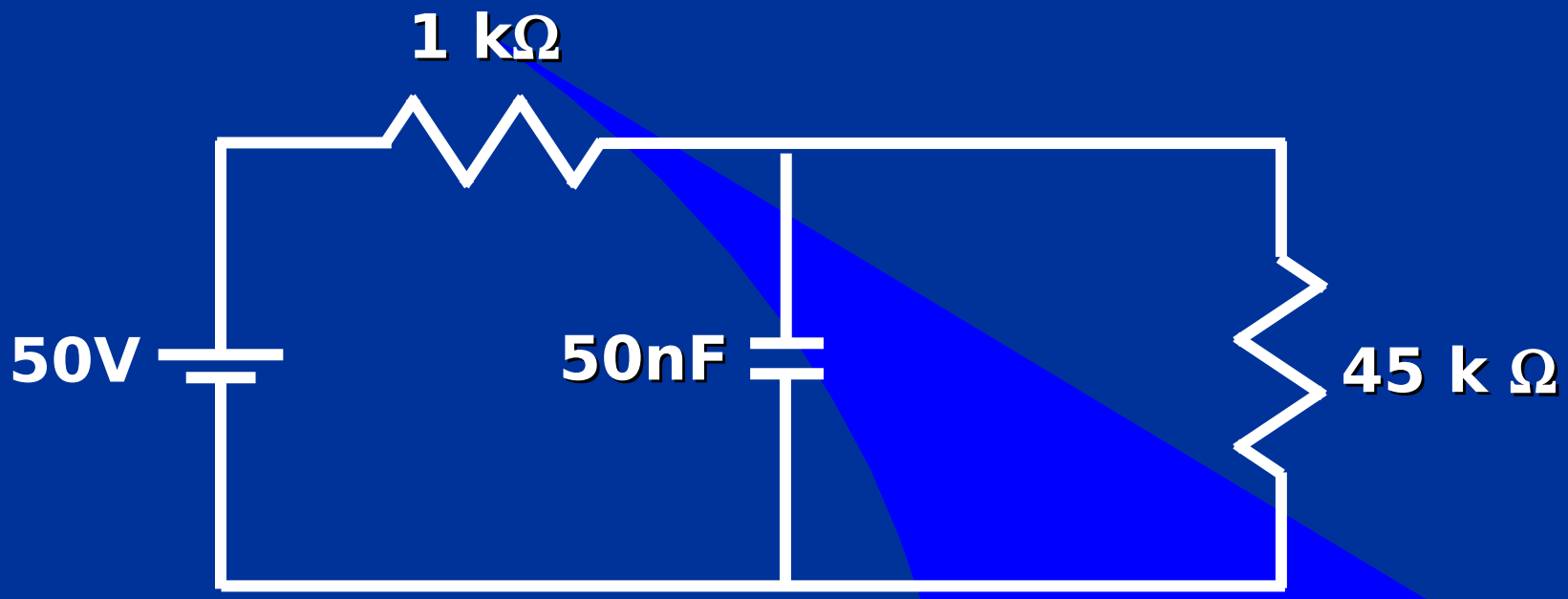


Getting Started with PSIM

- Create a new circuit

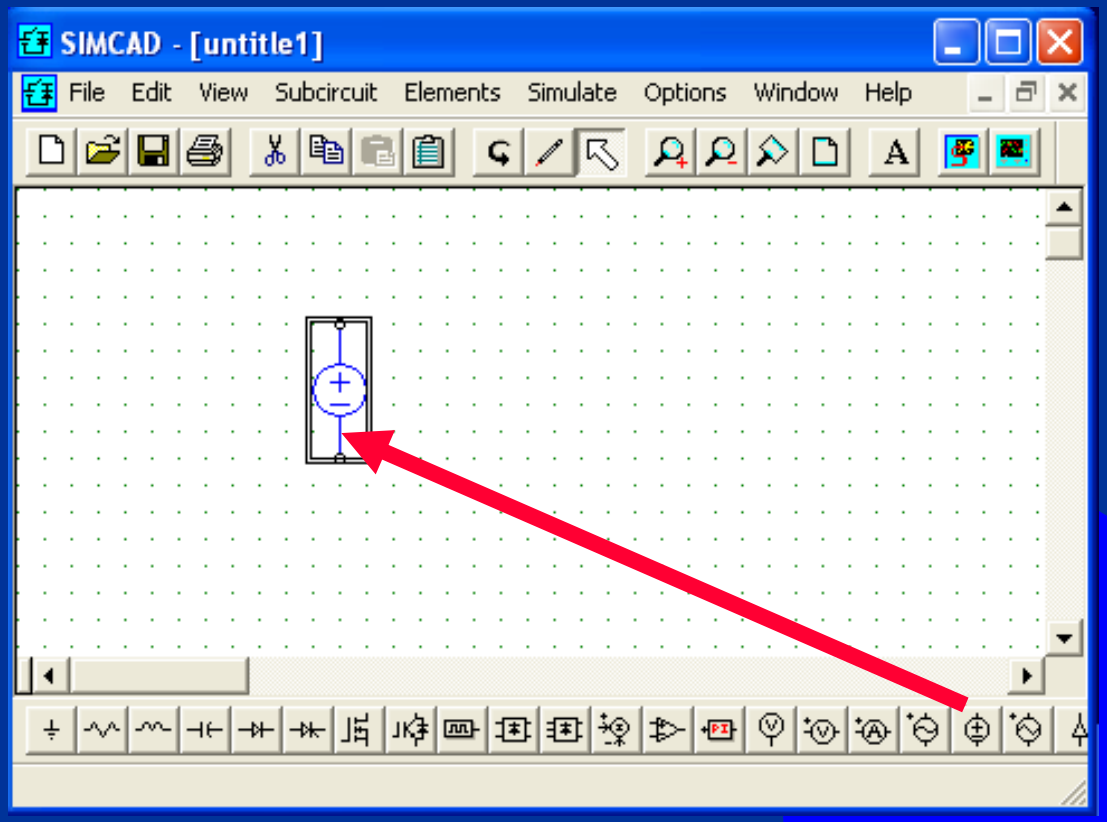


Getting Started with PSIM
Example 1 – 1st Order System

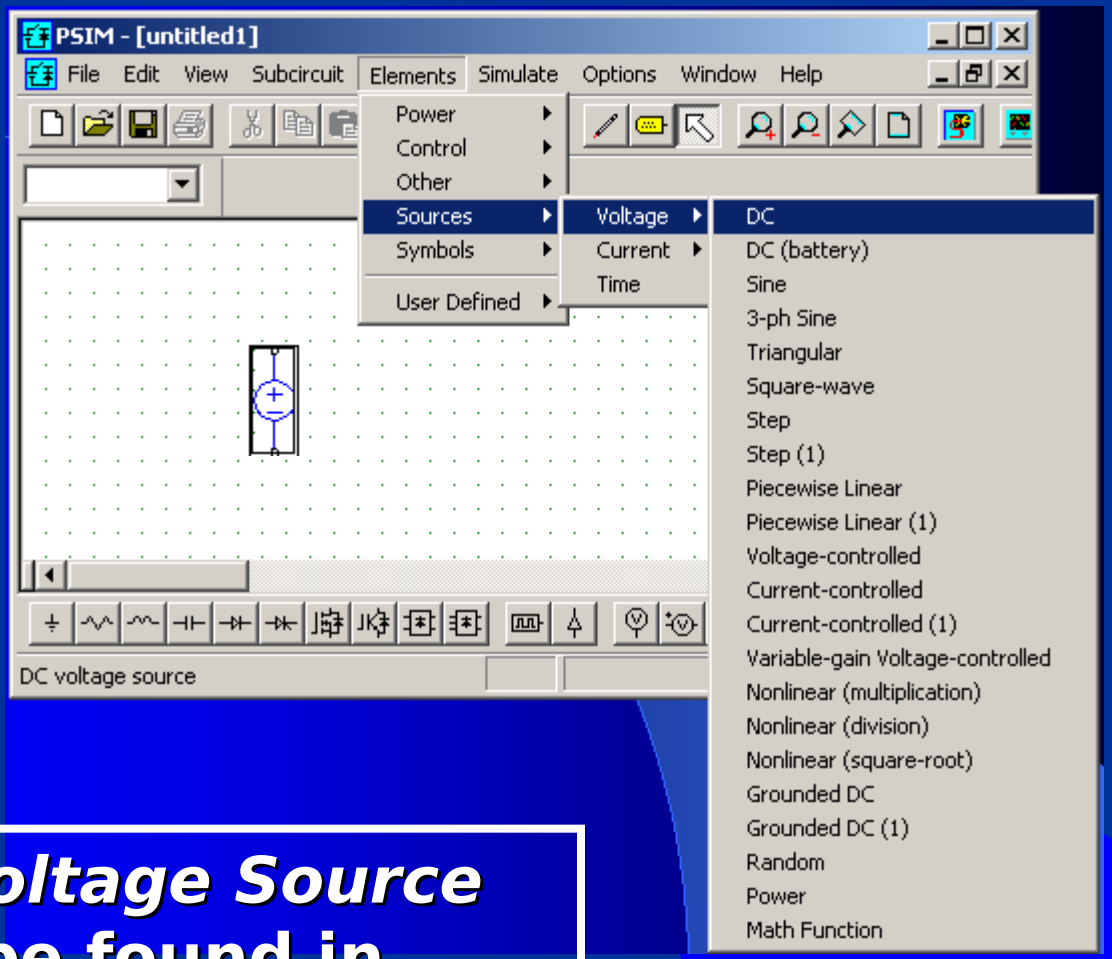


Example 1 – 1st Order System

Insert a *DC Voltage Source* from the Element Toolbar.



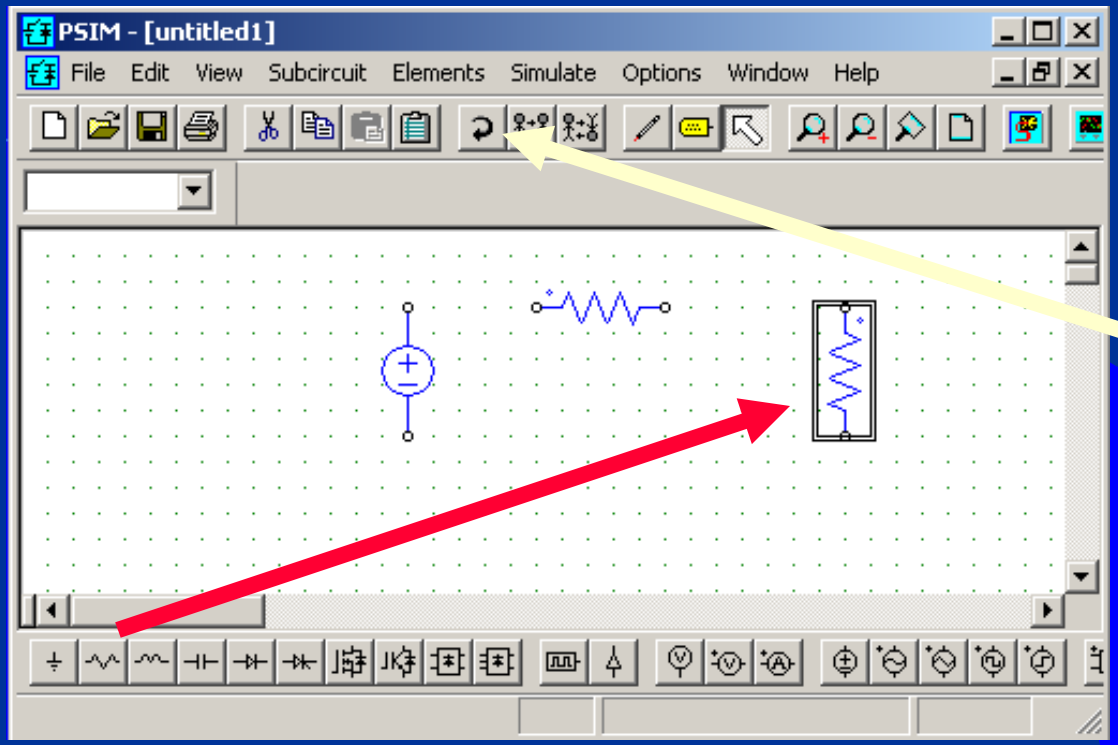
Example 1 – 1st Order System



The *DC Voltage Source* can also be found in *Elements > Sources > Voltage > DC*

Example 1 – 1st Order System

Add two *Resistors* to the circuit.

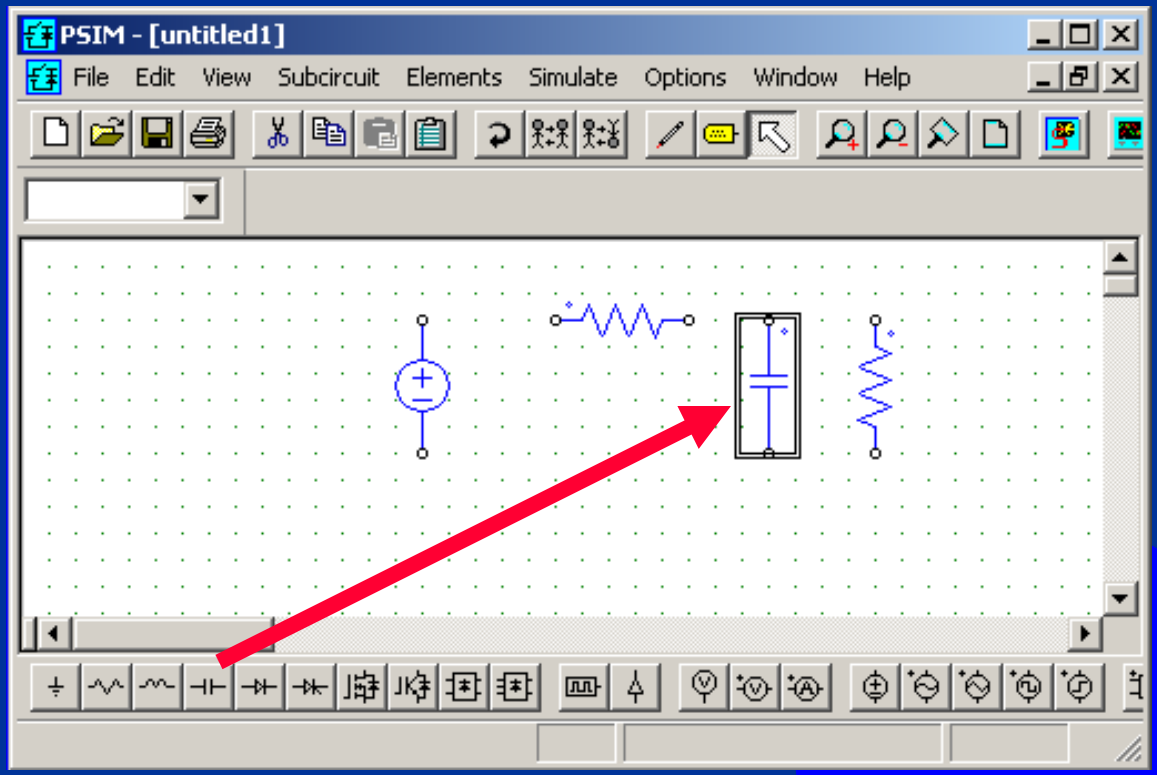


To rotate an element click with the right button…

… or use the icon *Rotate the Selection*.

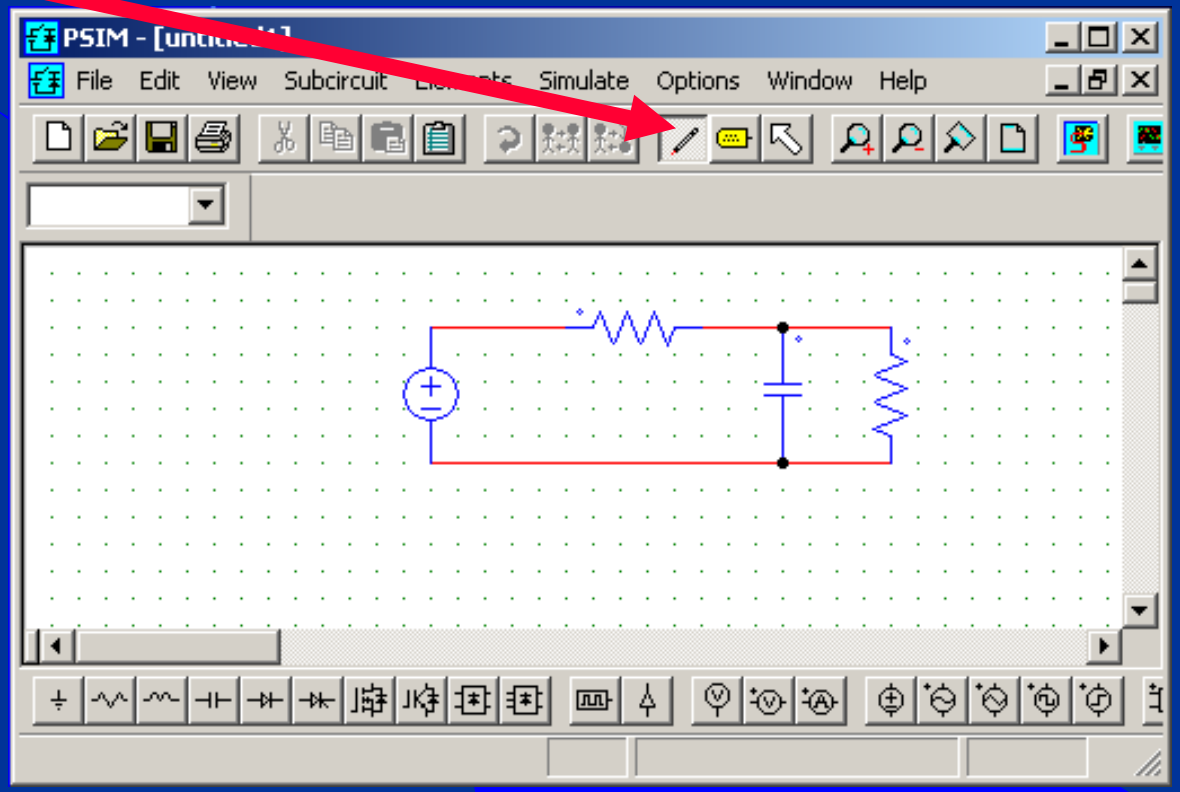
Example 1 – 1st Order System

Add a *Capacitor* to the circuit.



Example 1 – 1st Order System

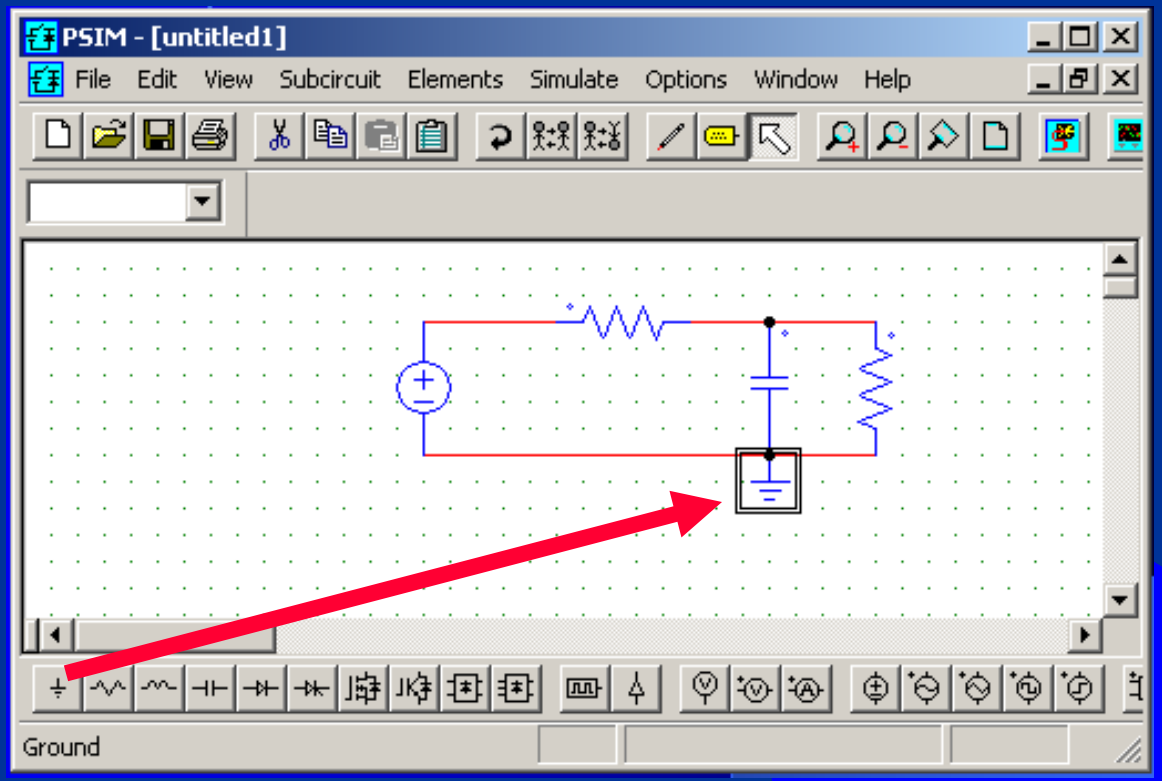
To connect the elements use the *Wire* tool.



Left-click on the circuit and drag the line with the mouse.

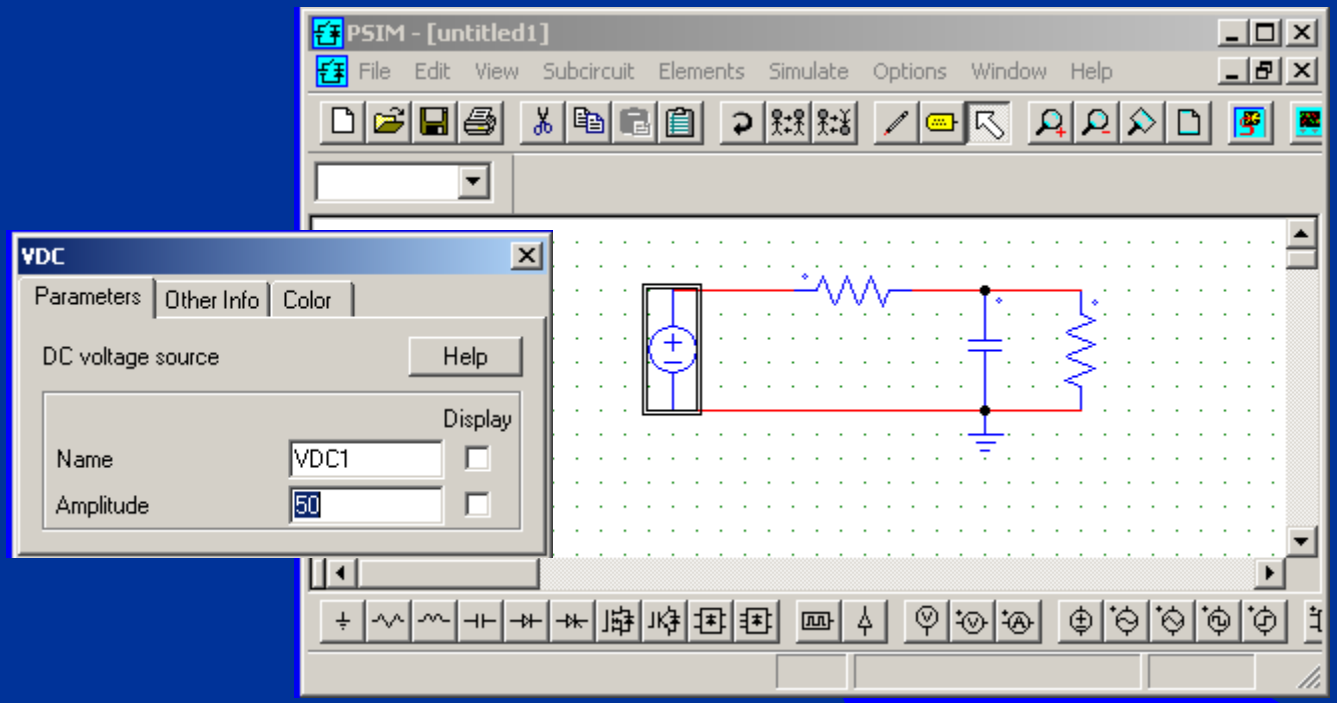
Example 1 – 1st Order System

Insert a *Ground* element.



Example 1 – 1st Order System

Set all the parameters values.

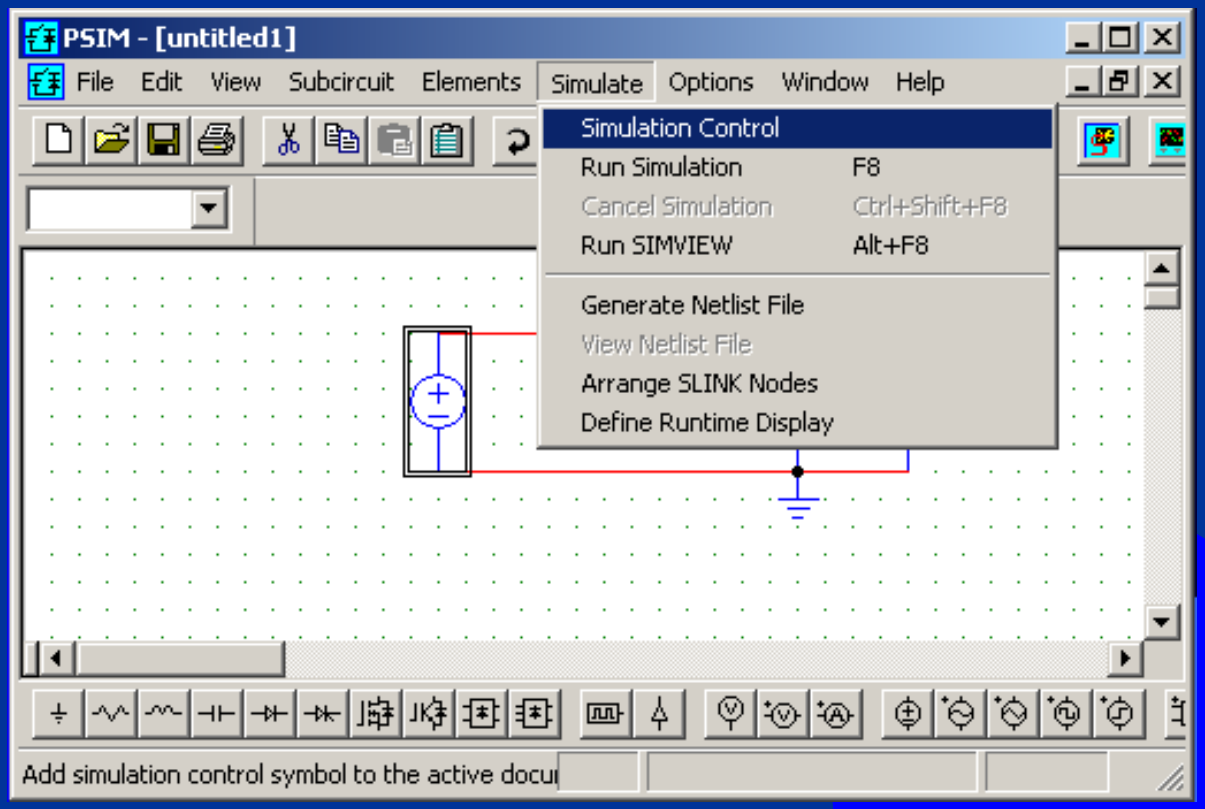


Double-click on the element to set its parameters.

Just close the window to set the new value.

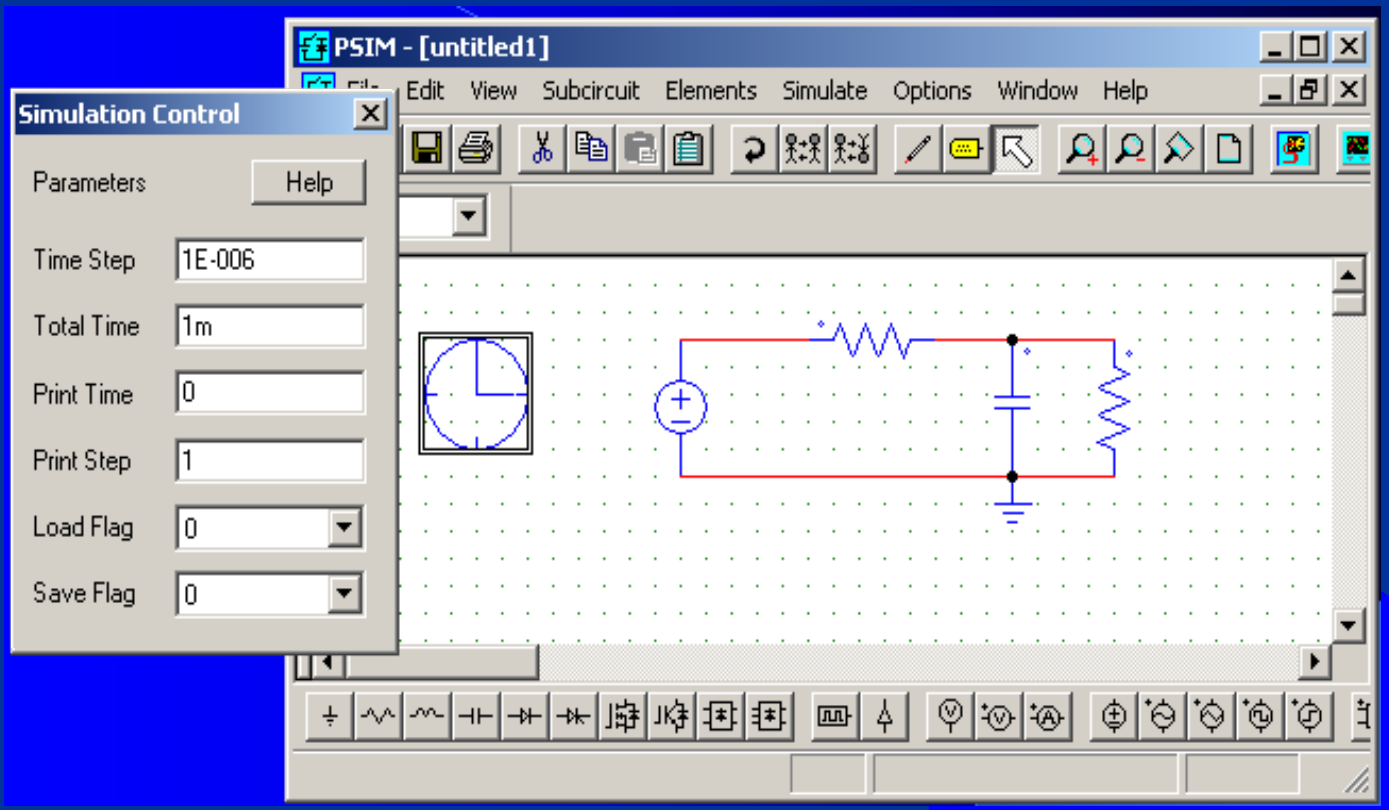
Example 1 – 1st Order System

Set the simulation parameters: Insert a *Simulation Control* block.



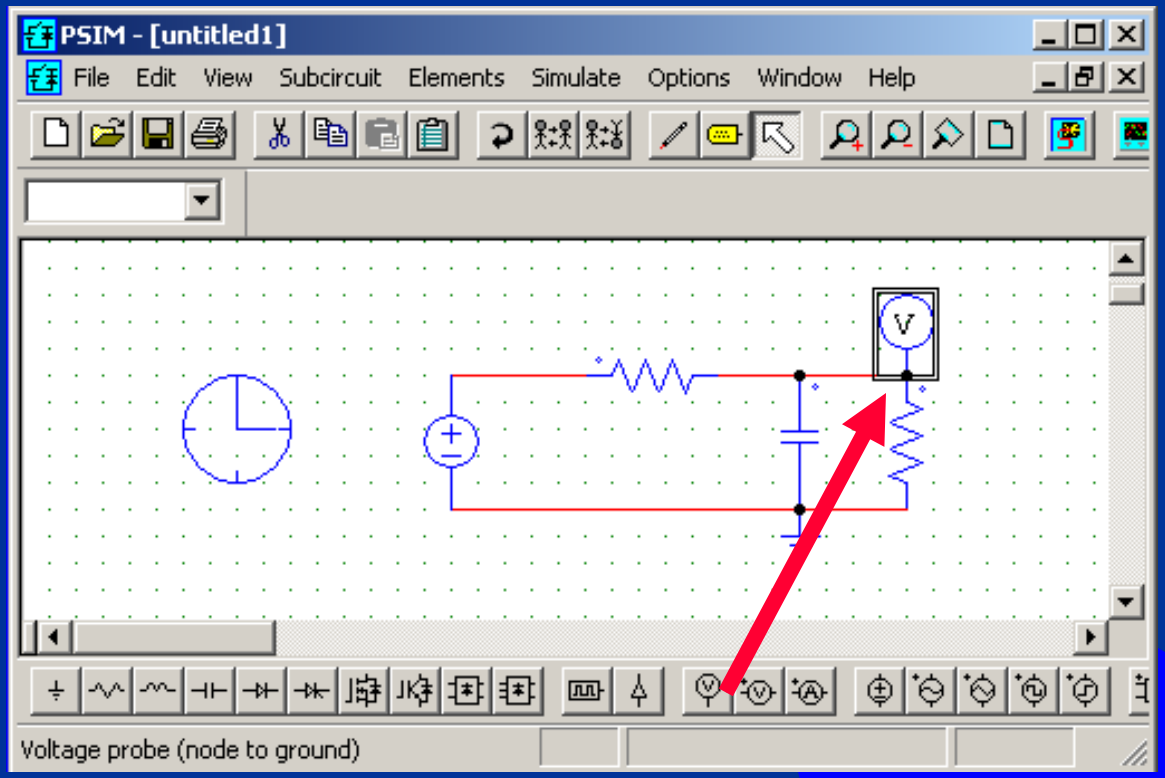
Example 1 – 1st Order System

Set the simulation parameters: *Time Step* and *Total Time*.



Example 1 – 1st Order System

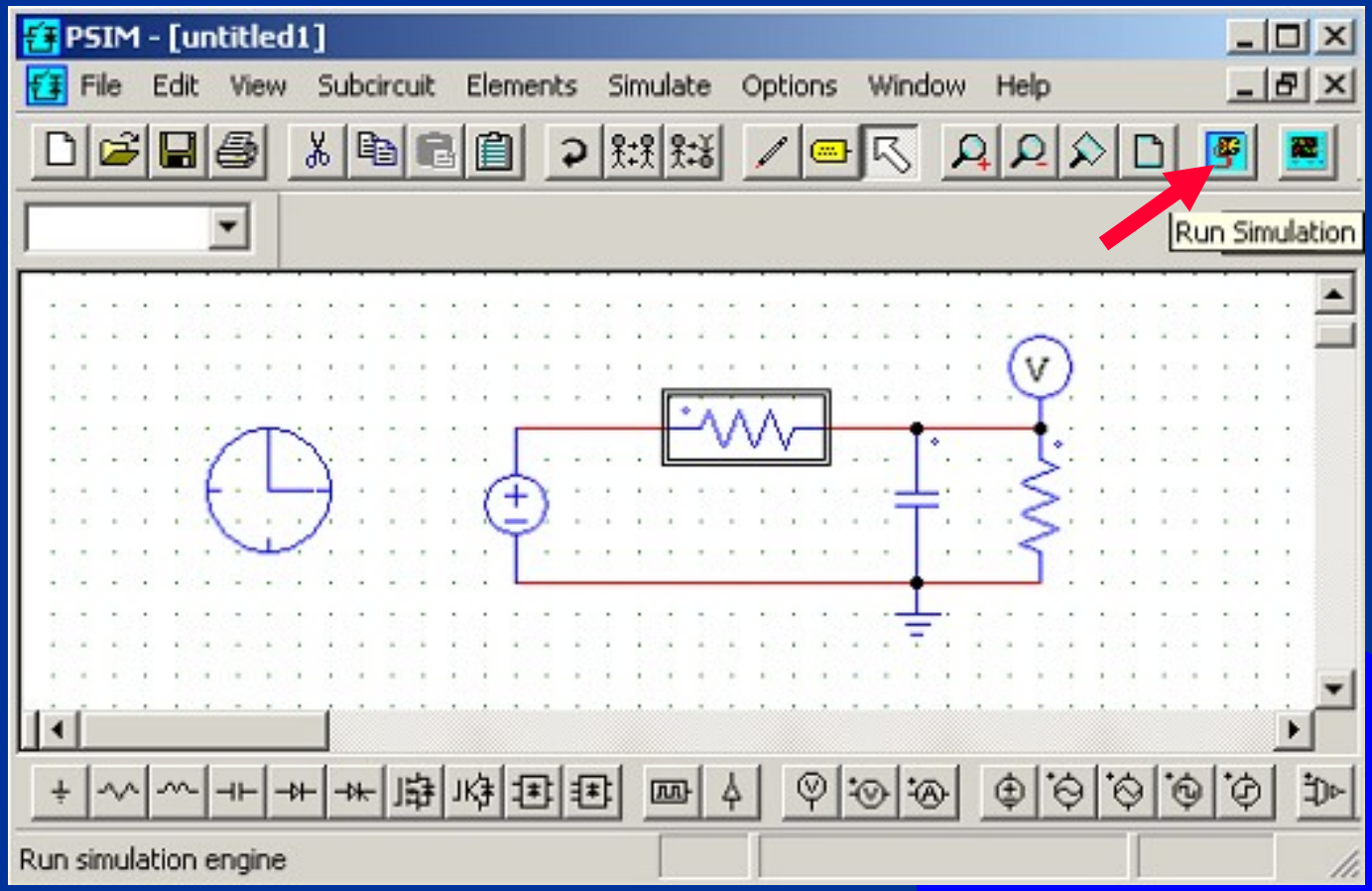
Insert a *Voltage Probe* (*node to ground*).



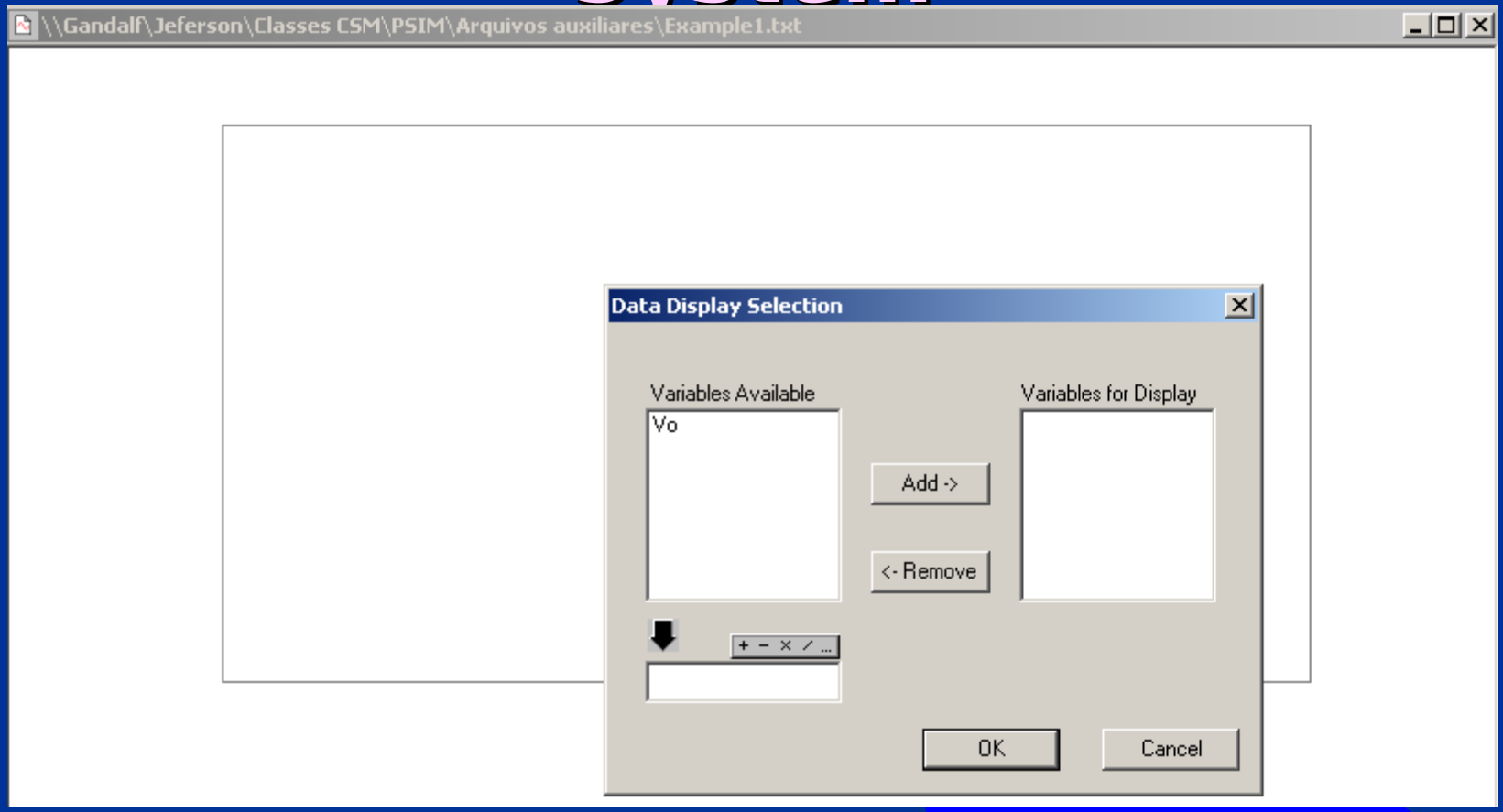
Double-click on the voltage probe to change its name to *Vo*.

Example 1 – 1st Order System

Start the simulation



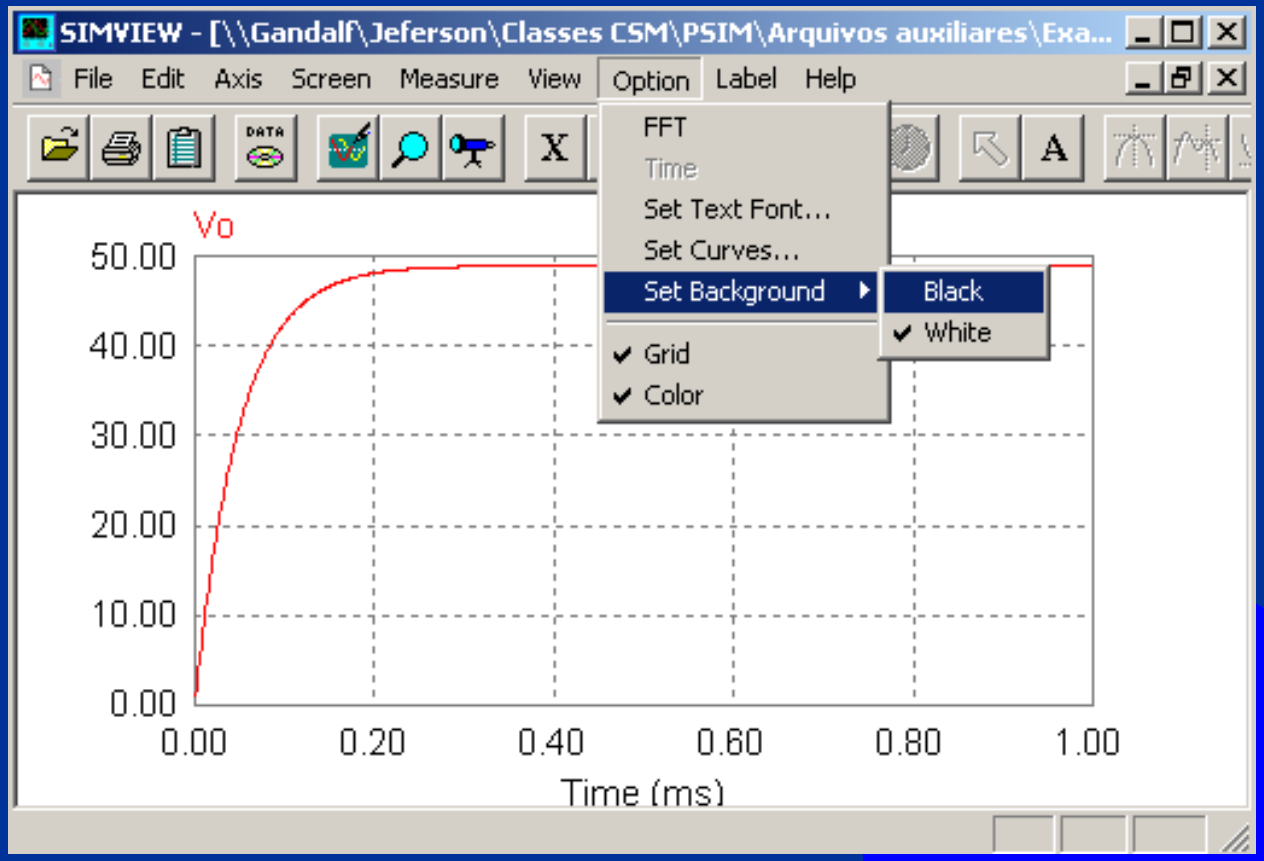
Example 1 – 1st Order System



Select the variable *Vo*.

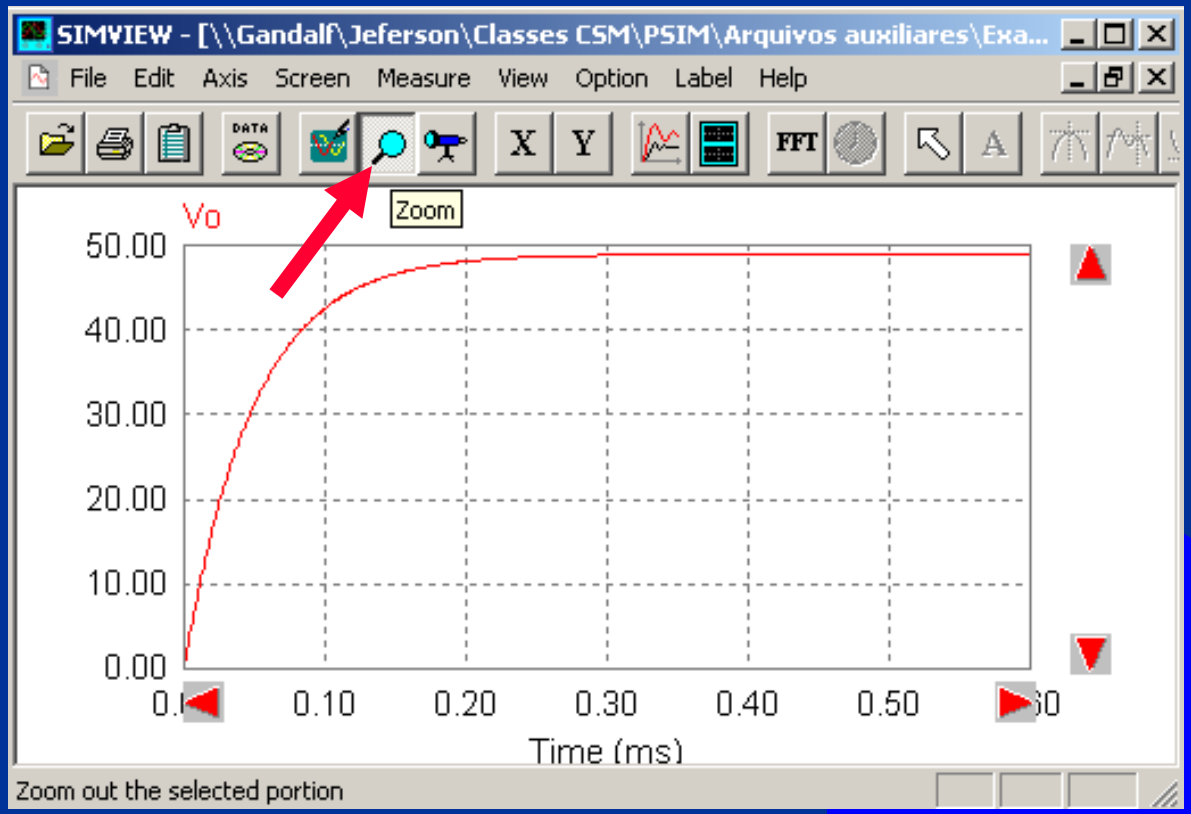
Example 1 – 1st Order System

Set the colors.



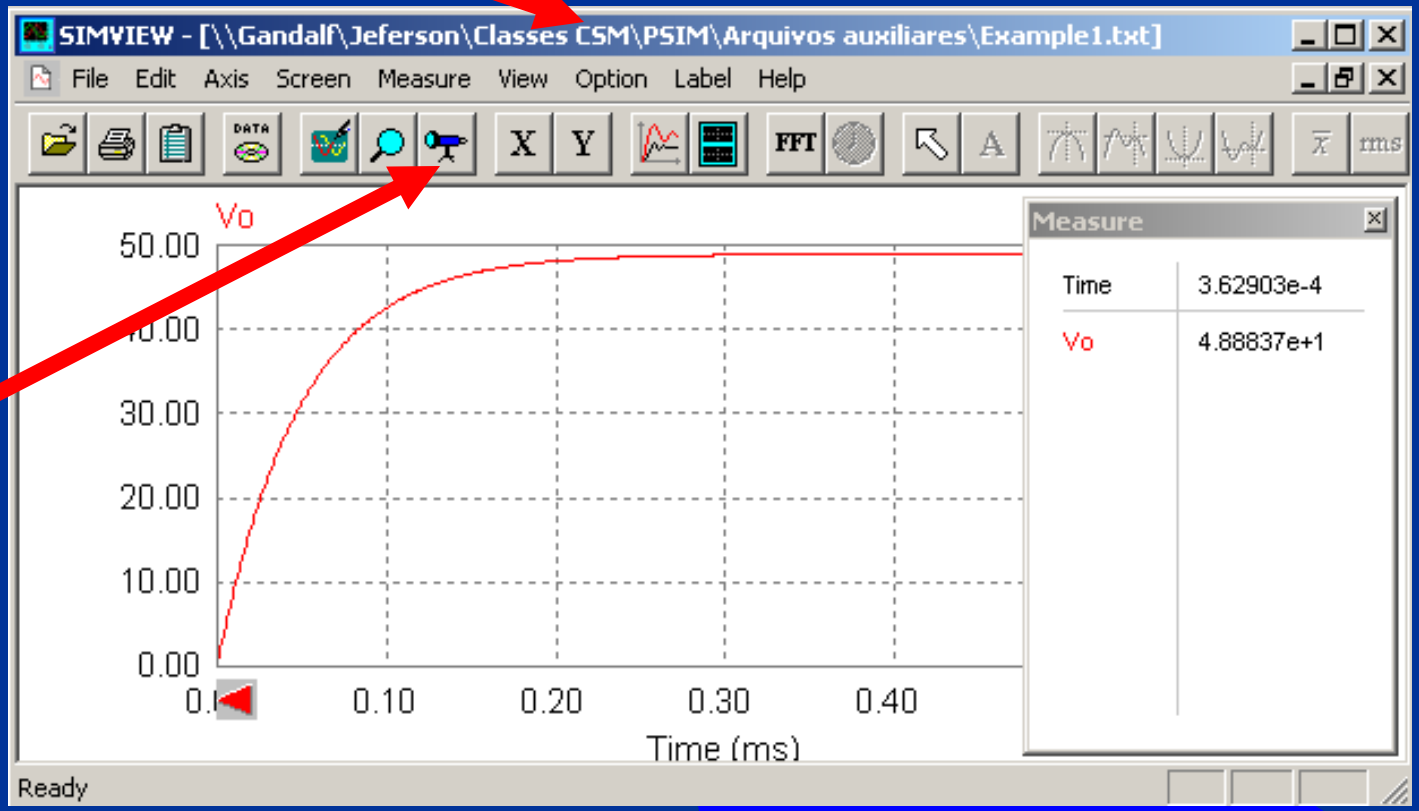
Example 1 – 1st Order System

Use the *Zoom* tool and buttons to select a specific area you want to see.



Example 1 – 1st Order System

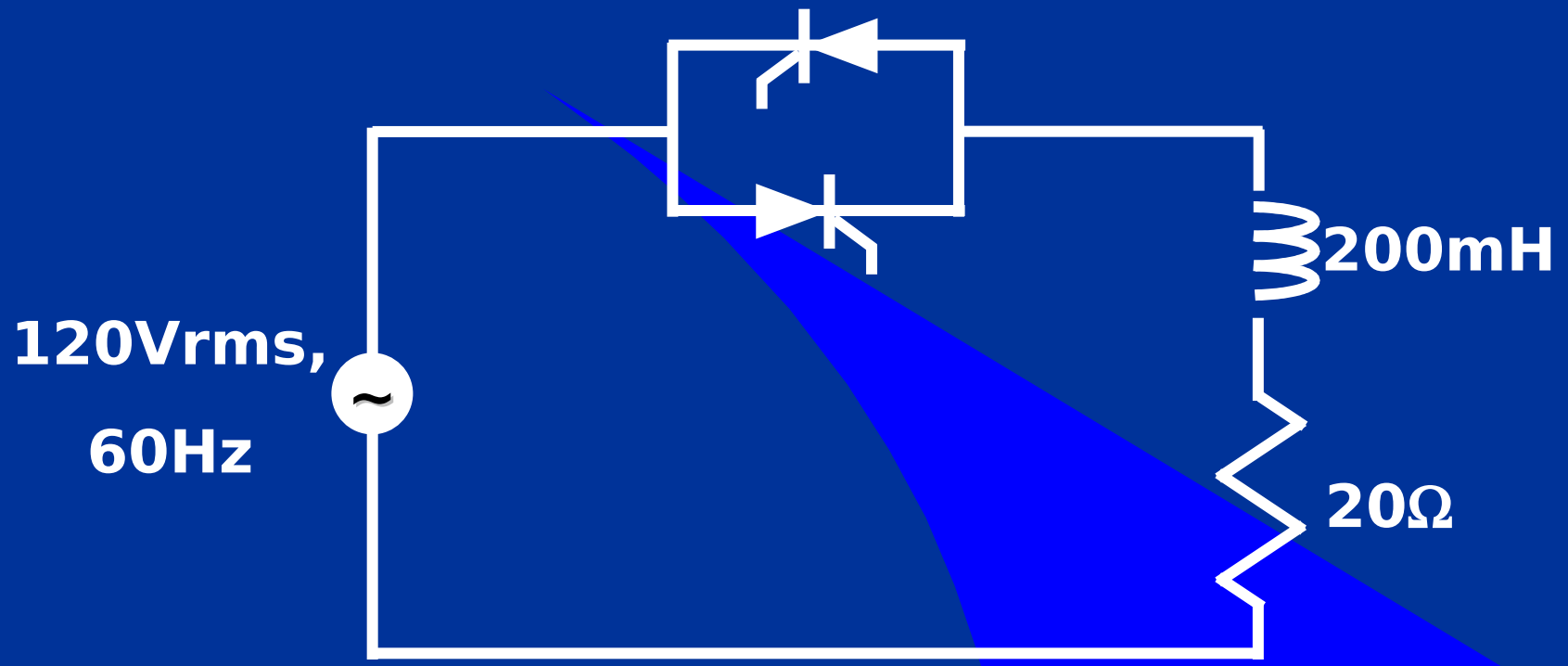
Output file: *.txt



***Measure* tool.**

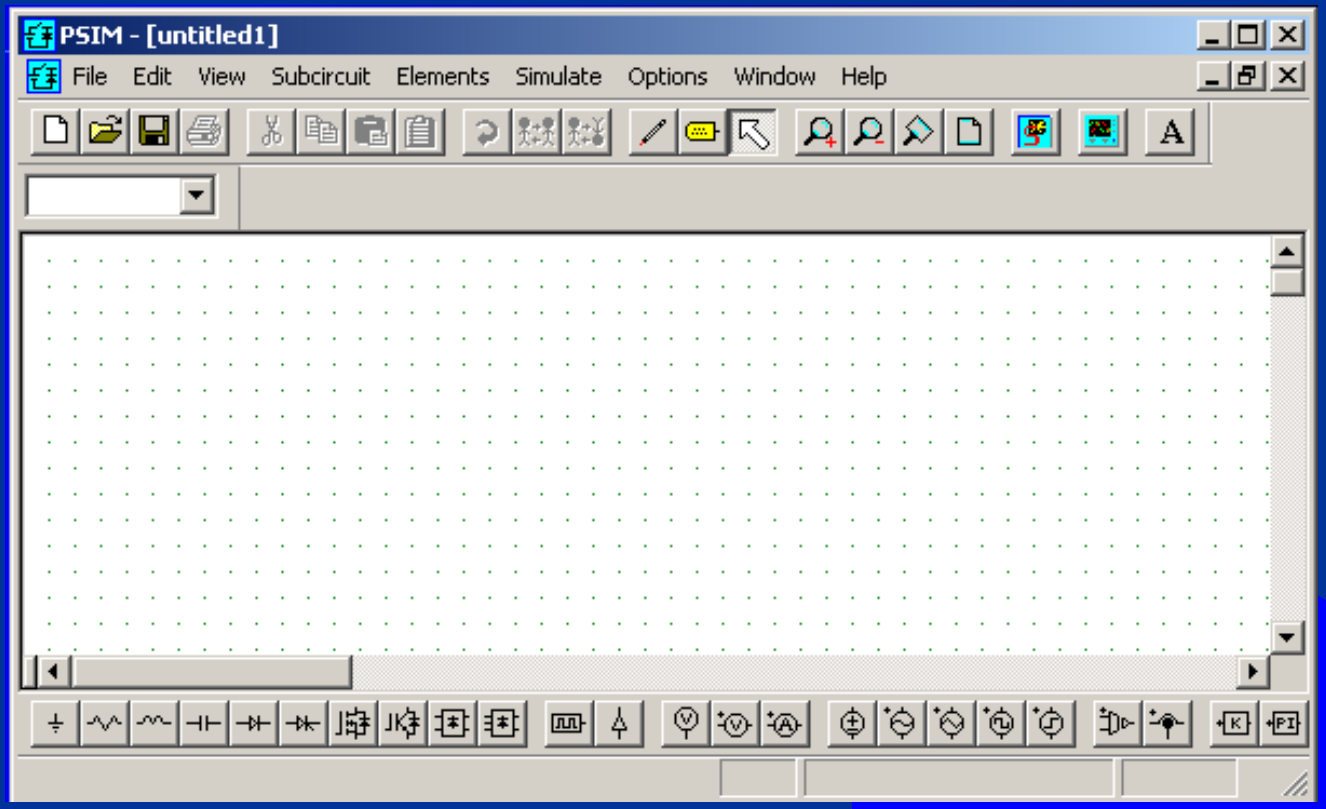
What is the expected steady-state output voltage?

Example 2: Voltage Controller



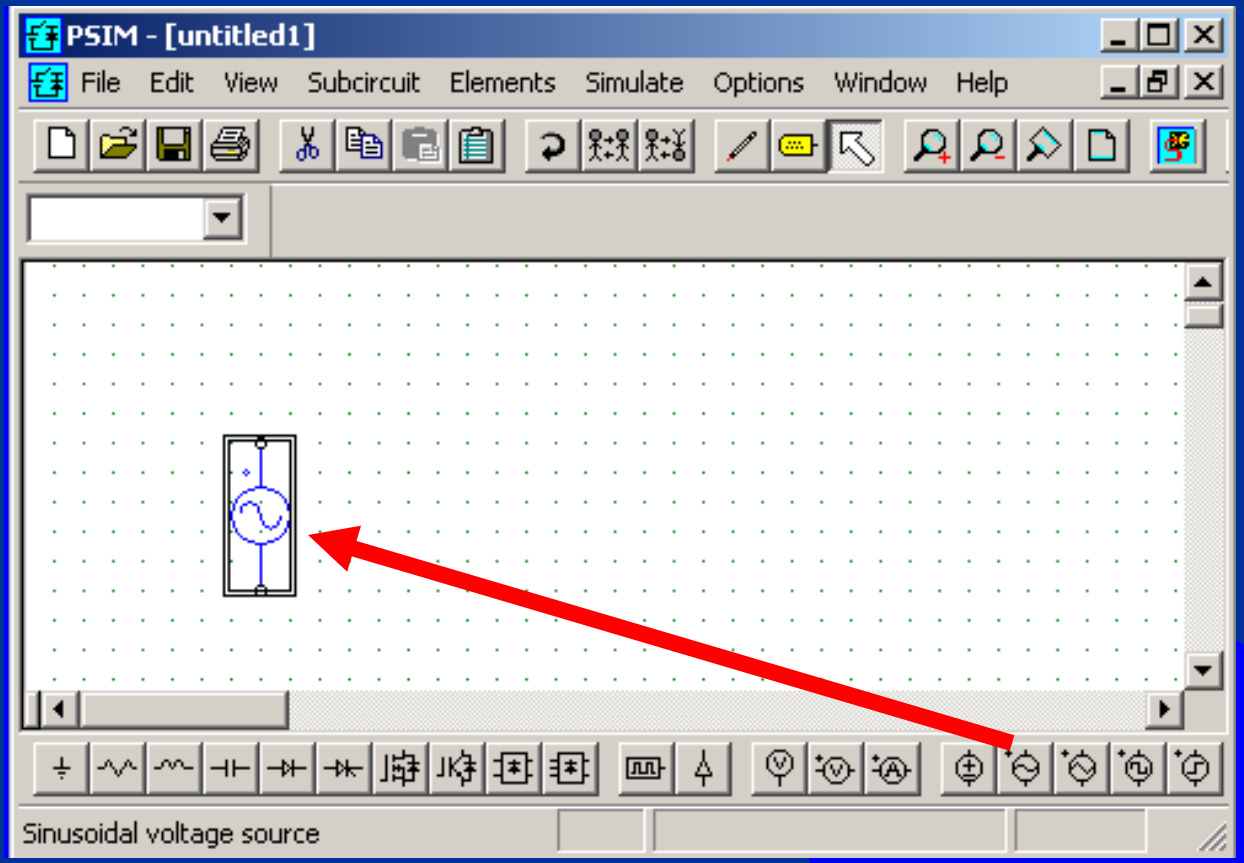
Example 2: Voltage Controller

Create a new circuit.



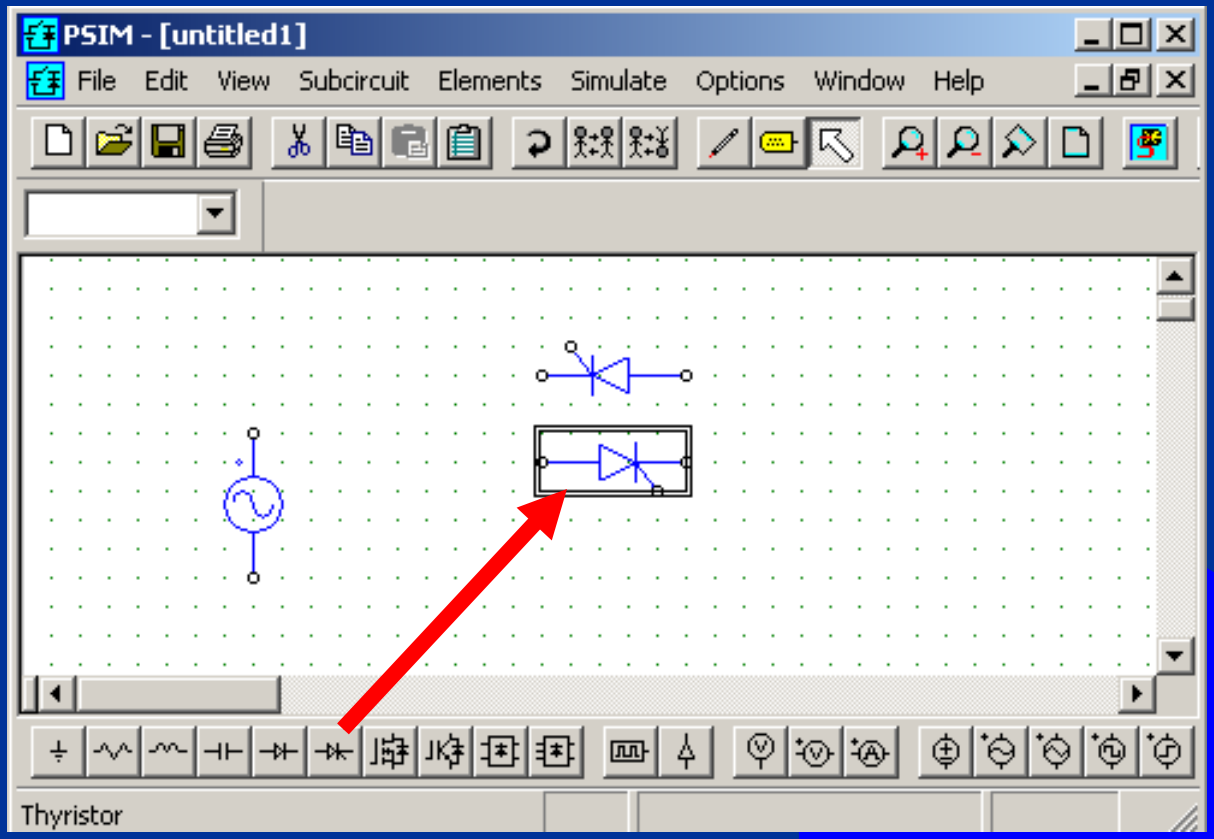
Example 2: Voltage Controller

Insert a *Sinusoidal Voltage Source*.



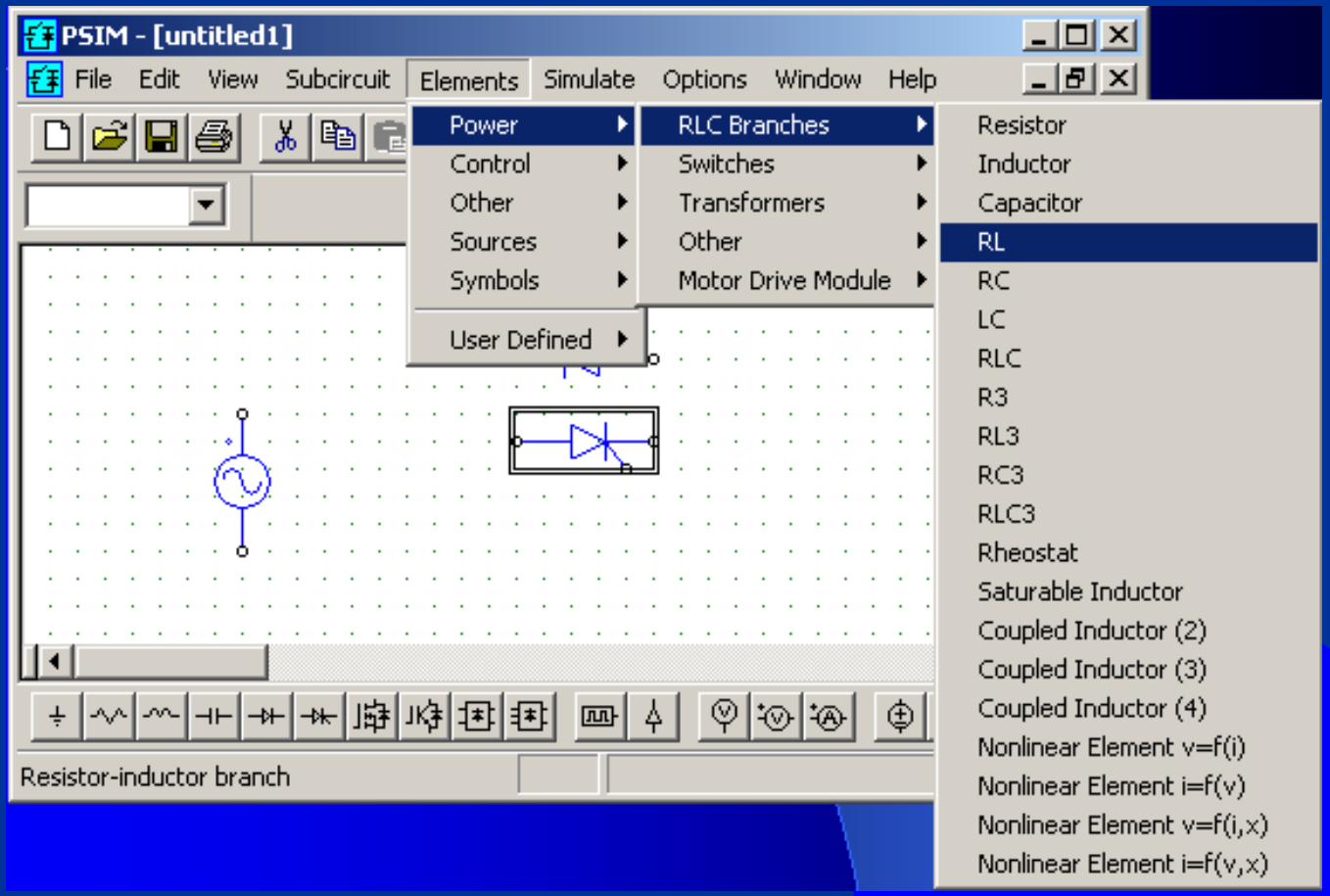
Example 2: Voltage Controller

Add two *Thyristors* to the circuit.



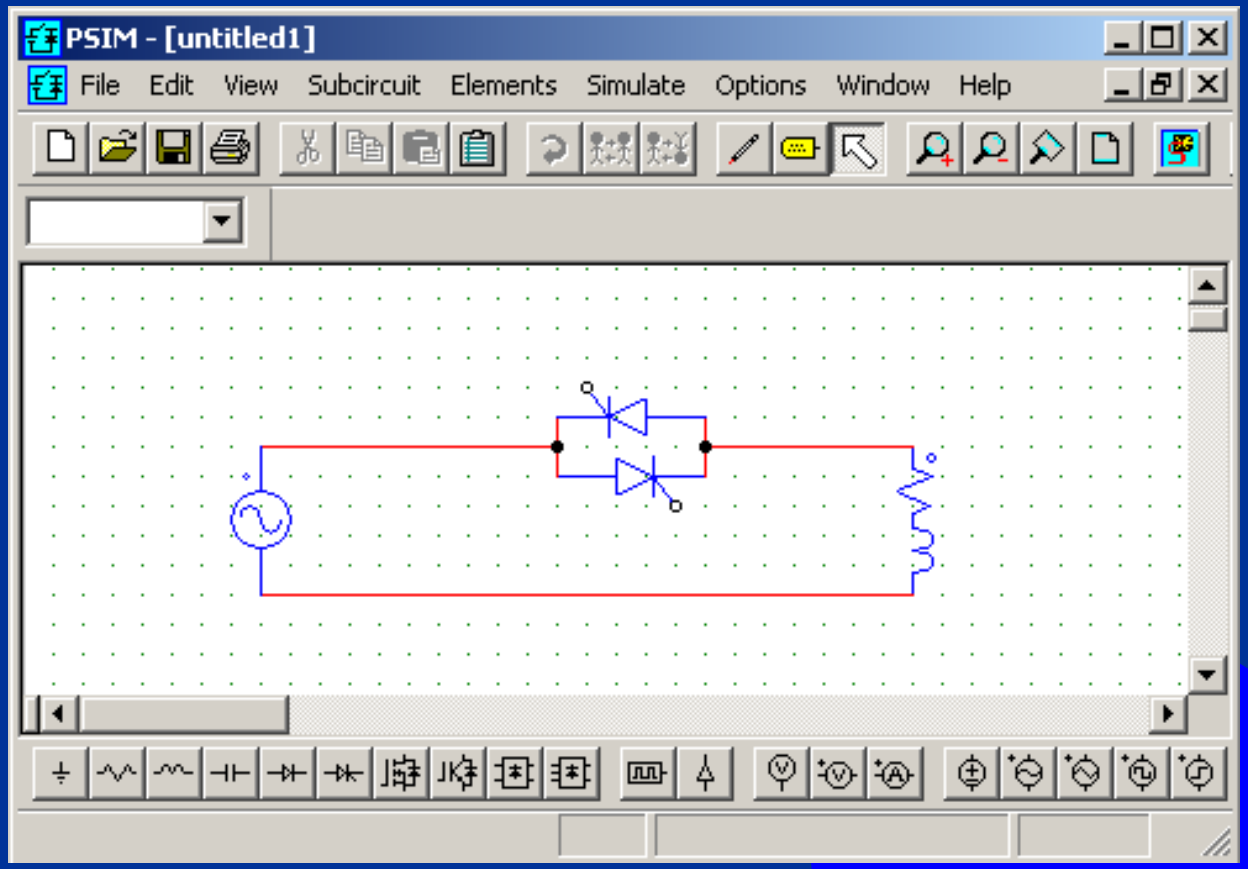
Example 2: Voltage Controller

Insert a *R-L Branch*.



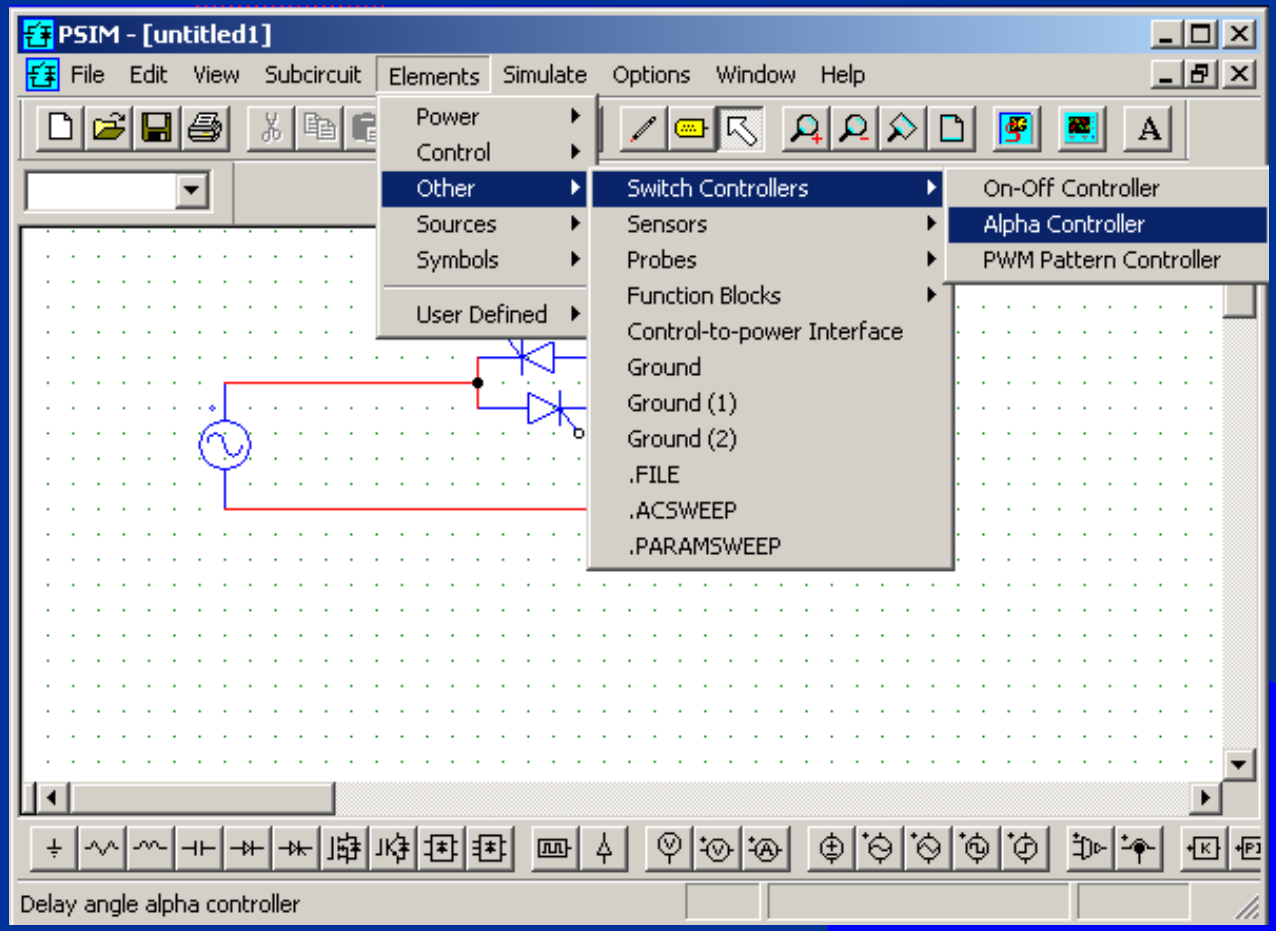
Example 2: Voltage Controller

Connect all the elements.

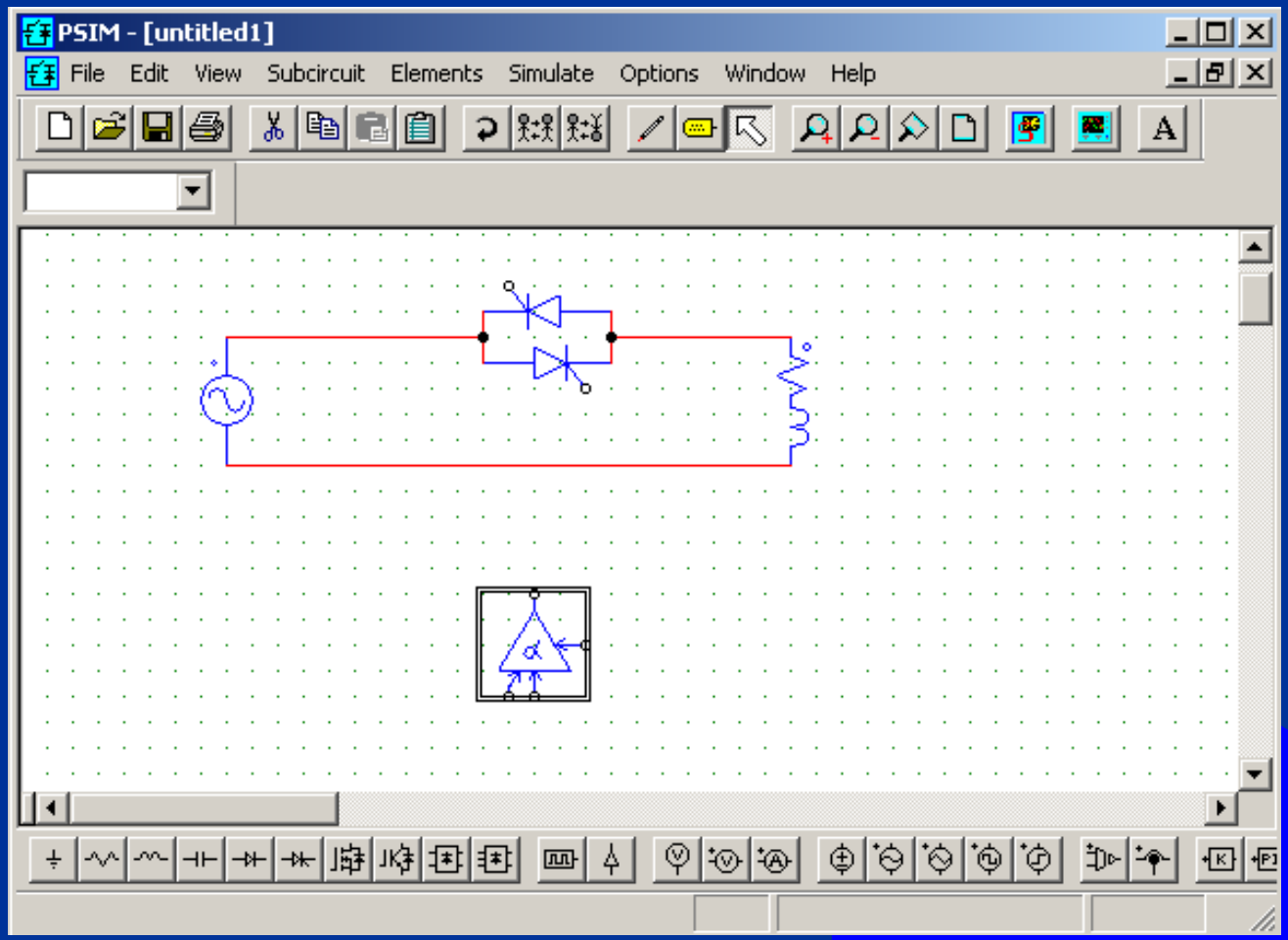


Example 2: Voltage Controller

Add an *Alpha Controller* to the circuit.



Example 2: Voltage Controller



Example 2: Voltage Controller

Double-click on the block and click on *Help* to understand this block.

PSIM

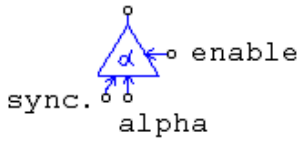
File Edit Bookmark Options Help

Contents Index Back Print

Description:

Alpha Controller — alpha controller

Image:



Parameters:

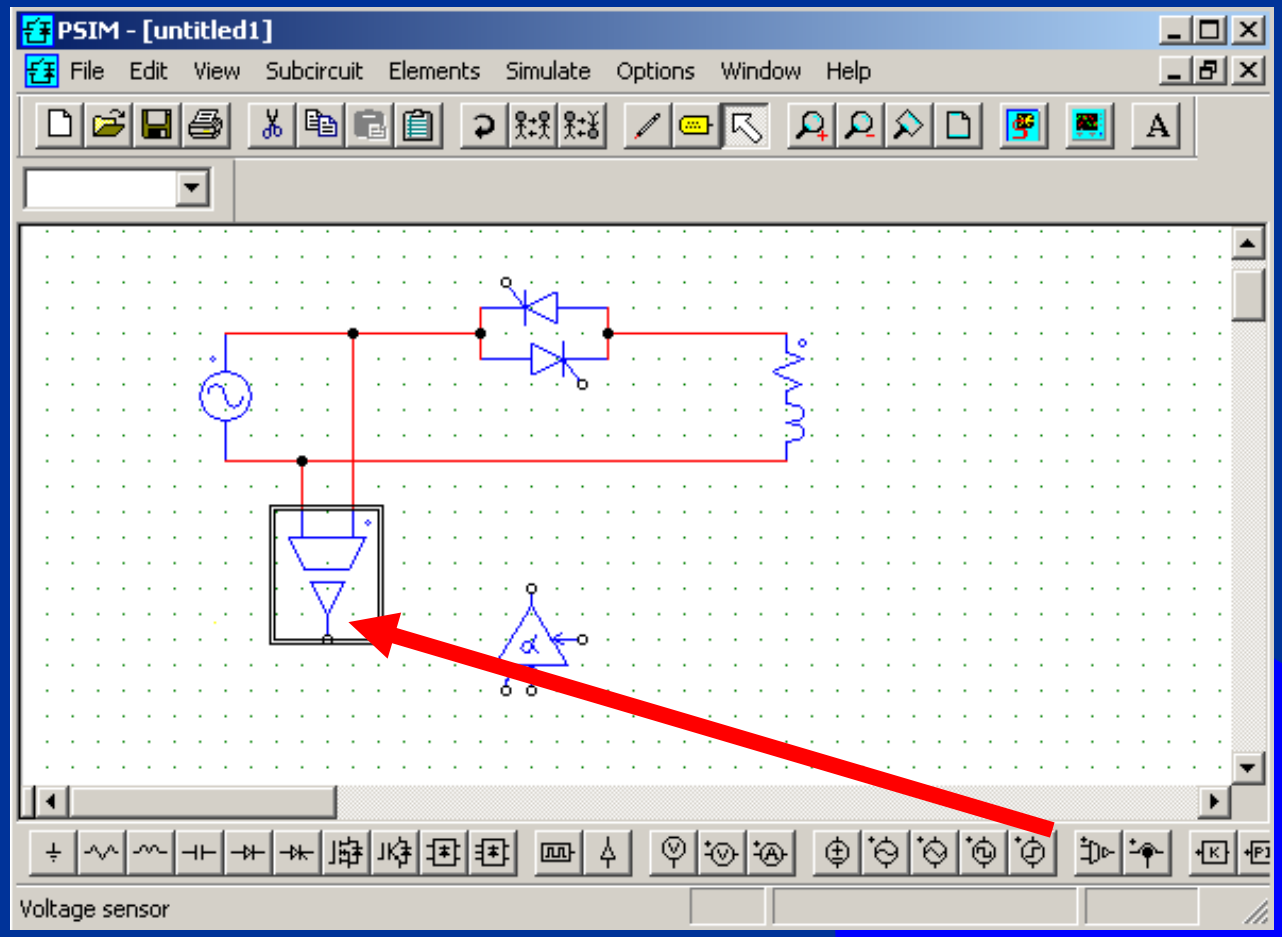
Frequency	Operating frequency of the controlled switch or switch module, in Hz
Pulse Width	On-time pulse width of the gating signal, in deg.

The alpha controller is used for the delay angle control of thyristor switches or bridges. There are three input for the controller:

- alpha value, in degree (at the center bottom)
- synchronization signal (at the left bottom)
- enable/disable signal (at the middle right)

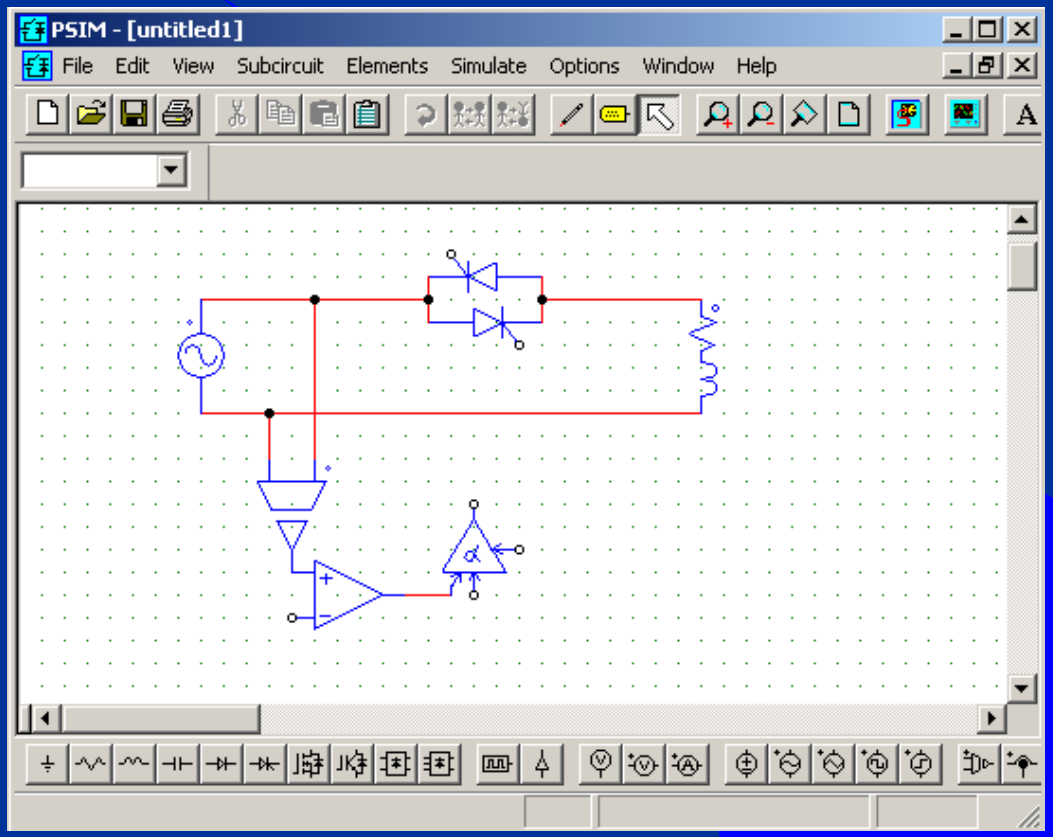
Example 2: Voltage Controller

Add a *Voltage Sensor* to the circuit to synchronize the gating signal.



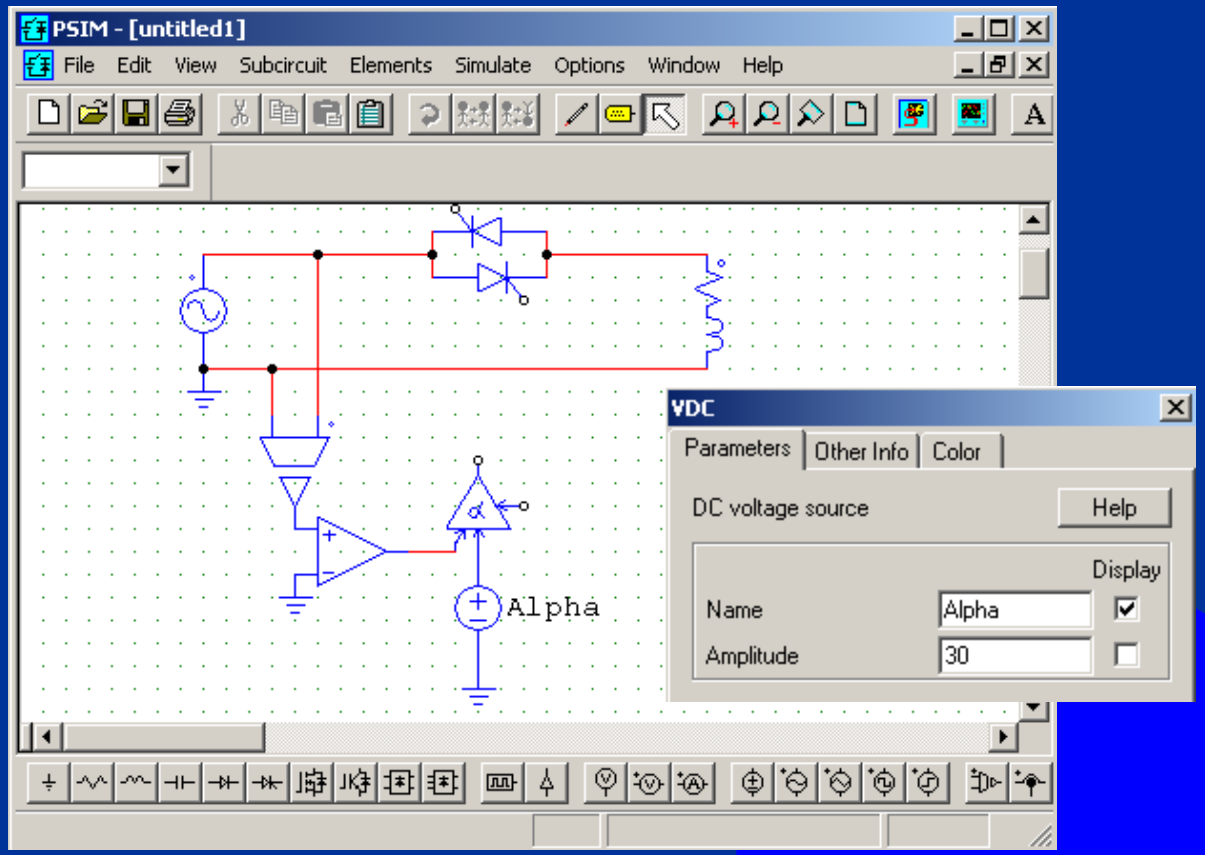
Example 2: Voltage Controller

Insert a *Comparator* to detect the zero crossing (from *Elements* > *Control* > *Comparator* or from the Element toolbar)



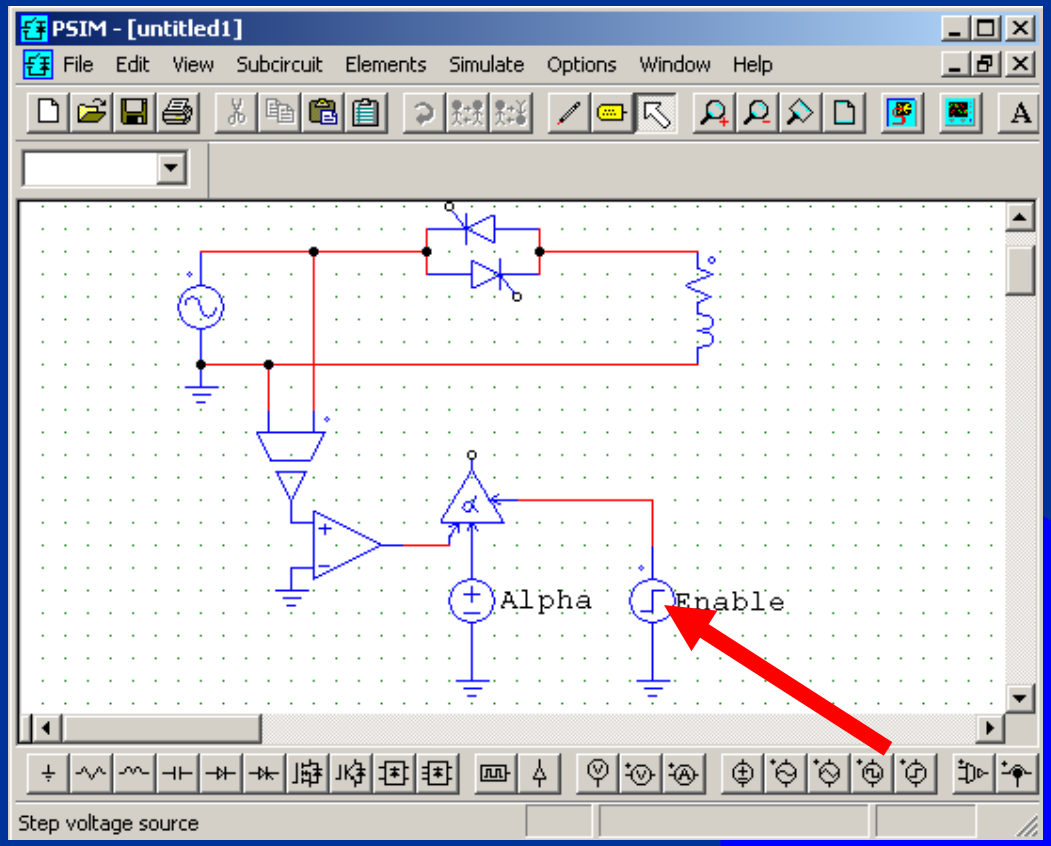
Example 2: Voltage Controller

Add a *Ground* to the circuit. Insert a *DC Voltage Source*. Change its name to *Alpha* and display it.



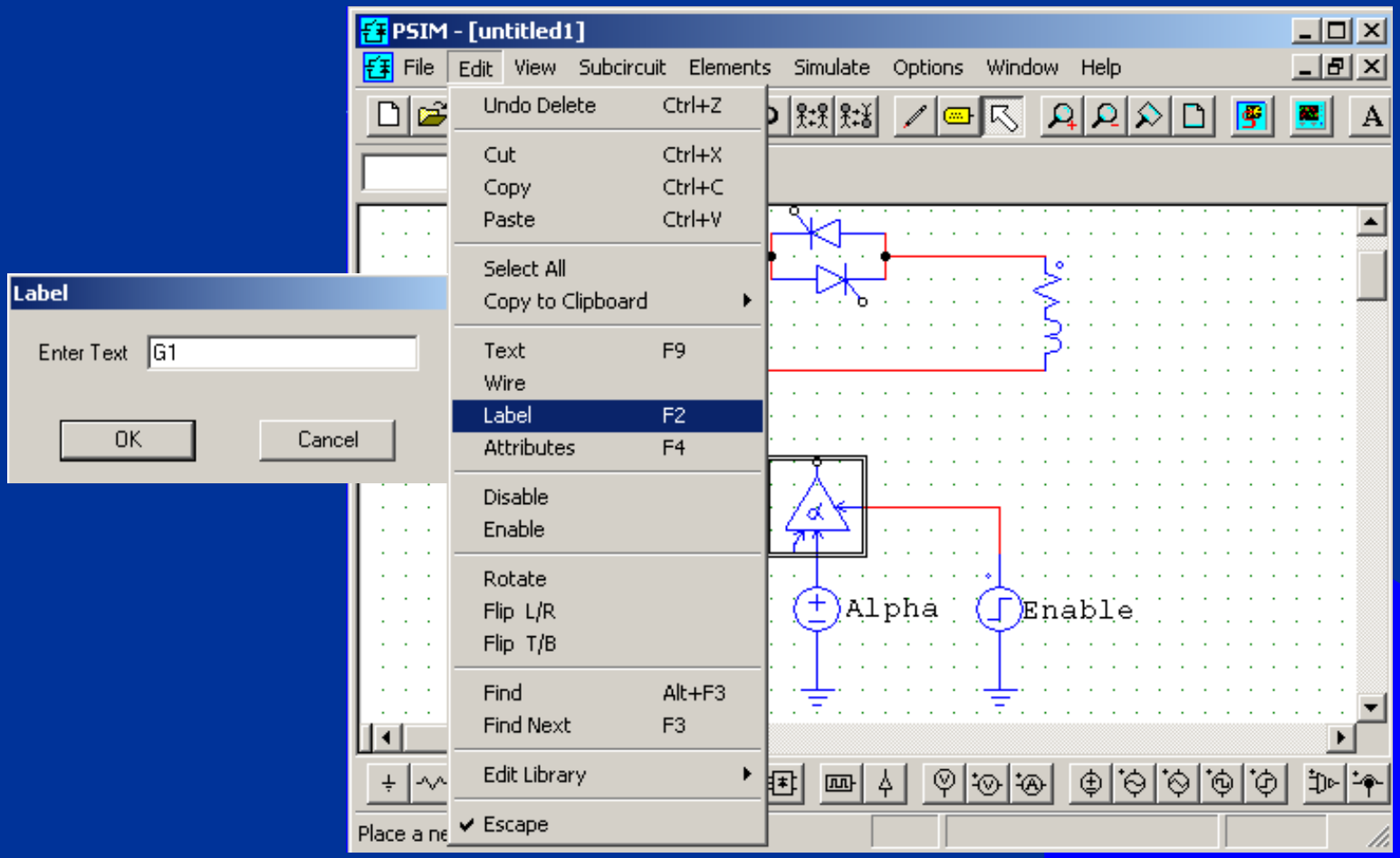
Example 2: Voltage Controller

Insert a *Step Voltage Source*. Change its name to *Enable* and display it.



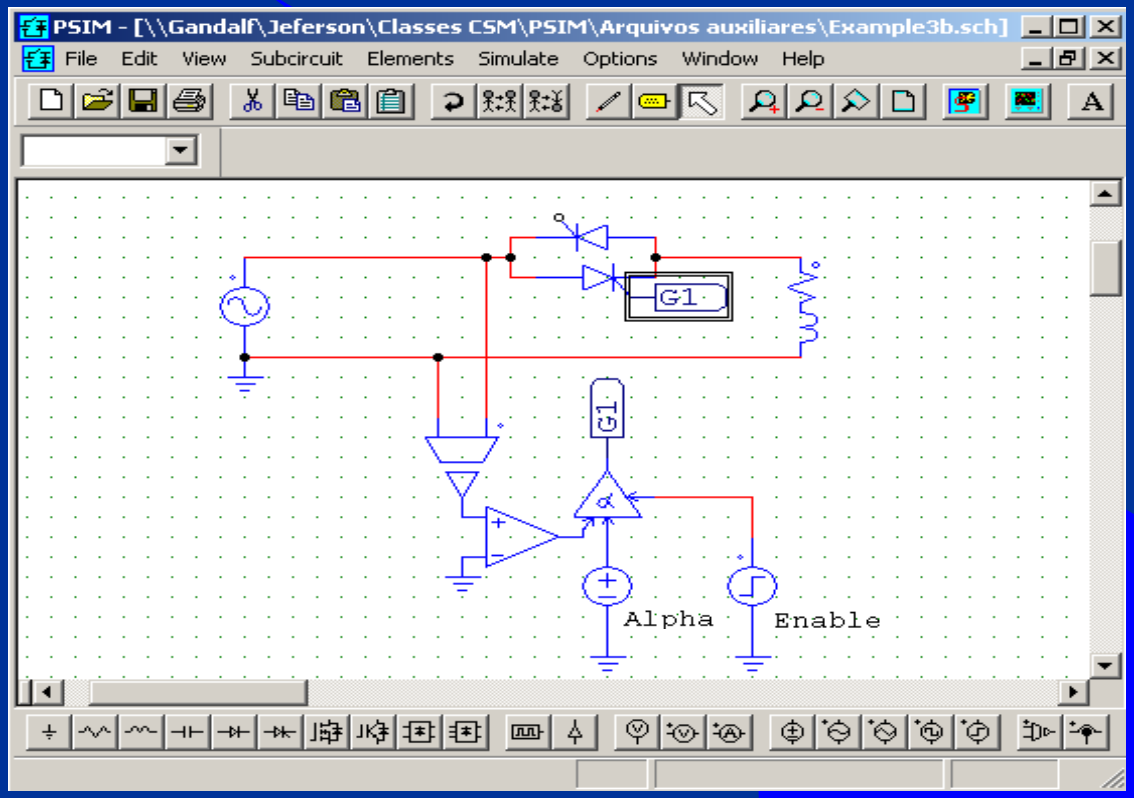
Example 2: Voltage Controller

Using *Labels* to make connections: insert a *Label* and name it *G1*.



Example 2: Voltage Controller

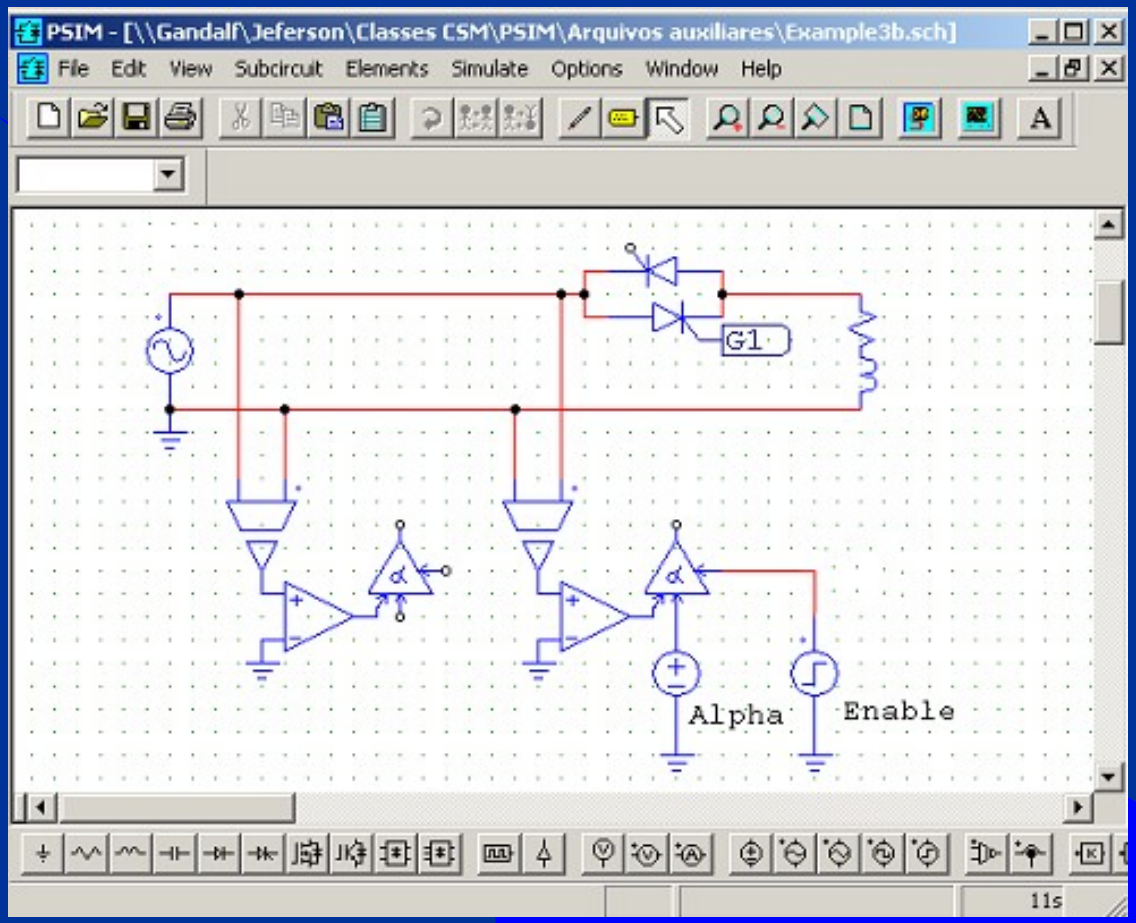
Connect the *Label* to the output of the *Alpha Controller* block. Insert another *Label*, name it *G1* and connect it to the gate port of *Thyristor* 1.



Example 2: Voltage Controller

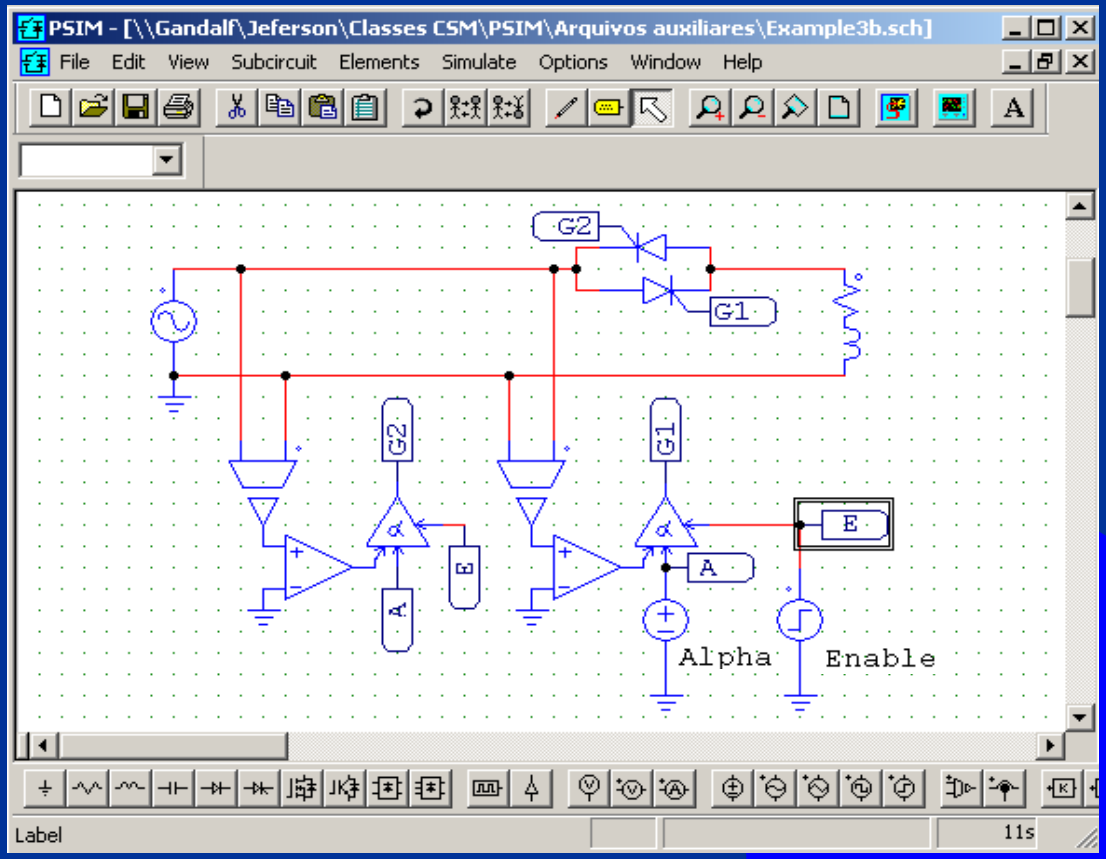
Create the alpha controller for the other *Thyristor*.

Insert a *Voltage Sensor, a Comparator* and an *Alpha Controller* block.



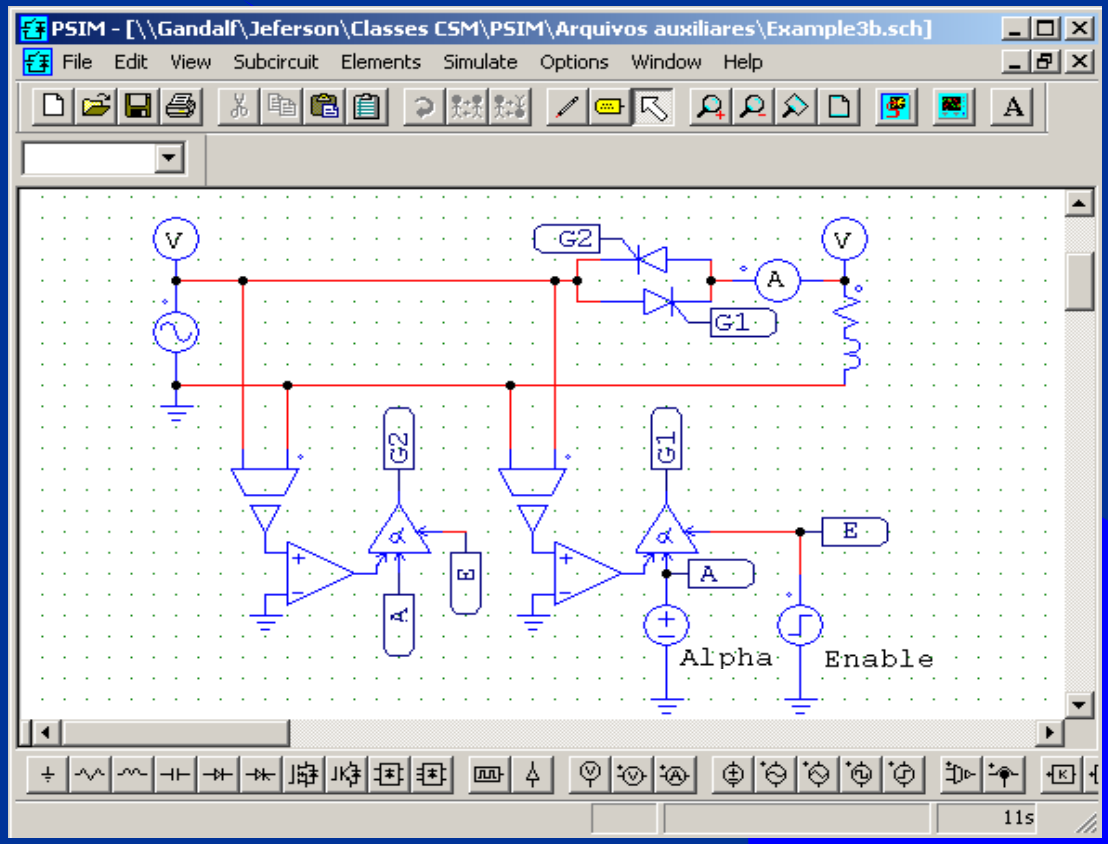
Example 2: Voltage Controller

Use *Labels* for the *Enable* signal (*E*), *Alpha* signal (*A*) and *Gate* signal for *Thyristor* 2 (*G2*).



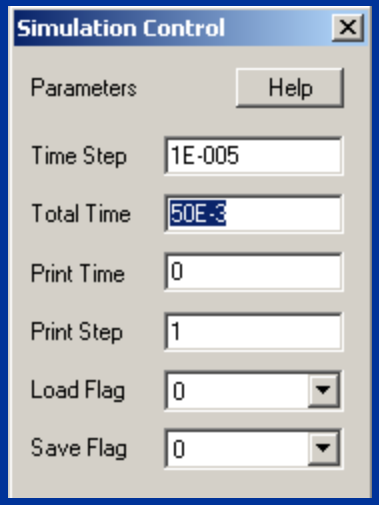
Example 2: Voltage Controller

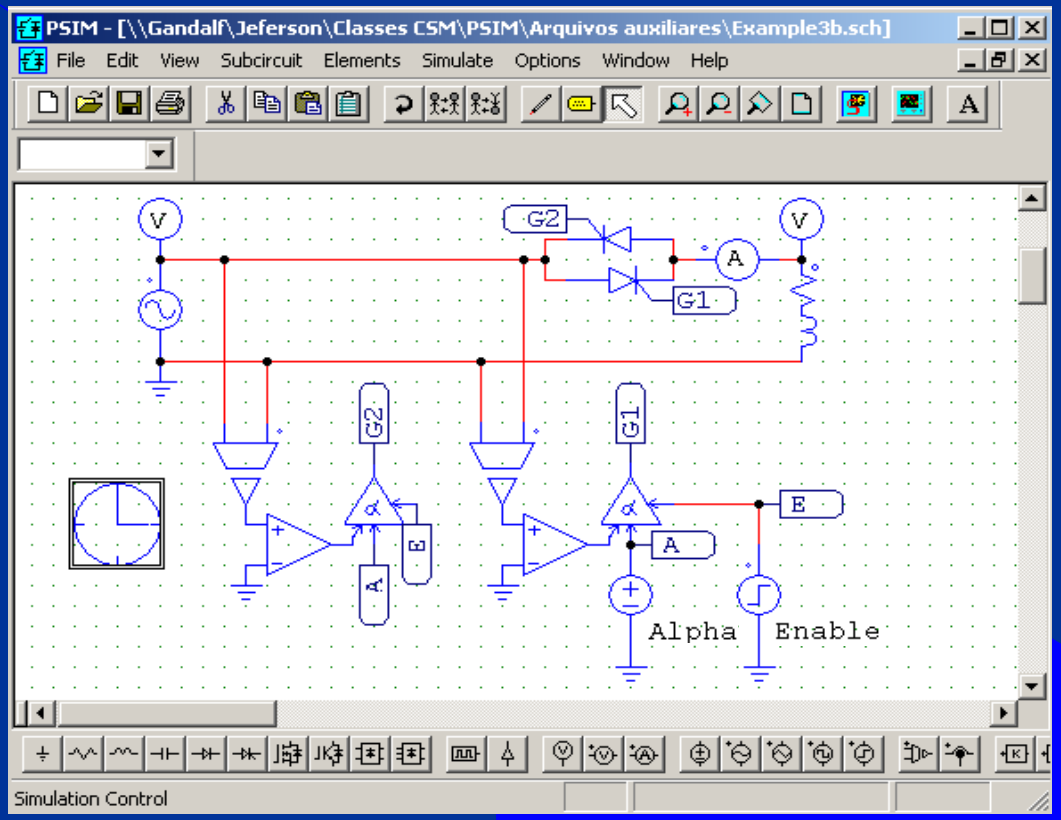
Insert an input *Voltage Probe* (*Vi*), an output *Voltage Probe* (*Vo*) and an output *Current Probe* (*Io*).



Example 2: Voltage Controller

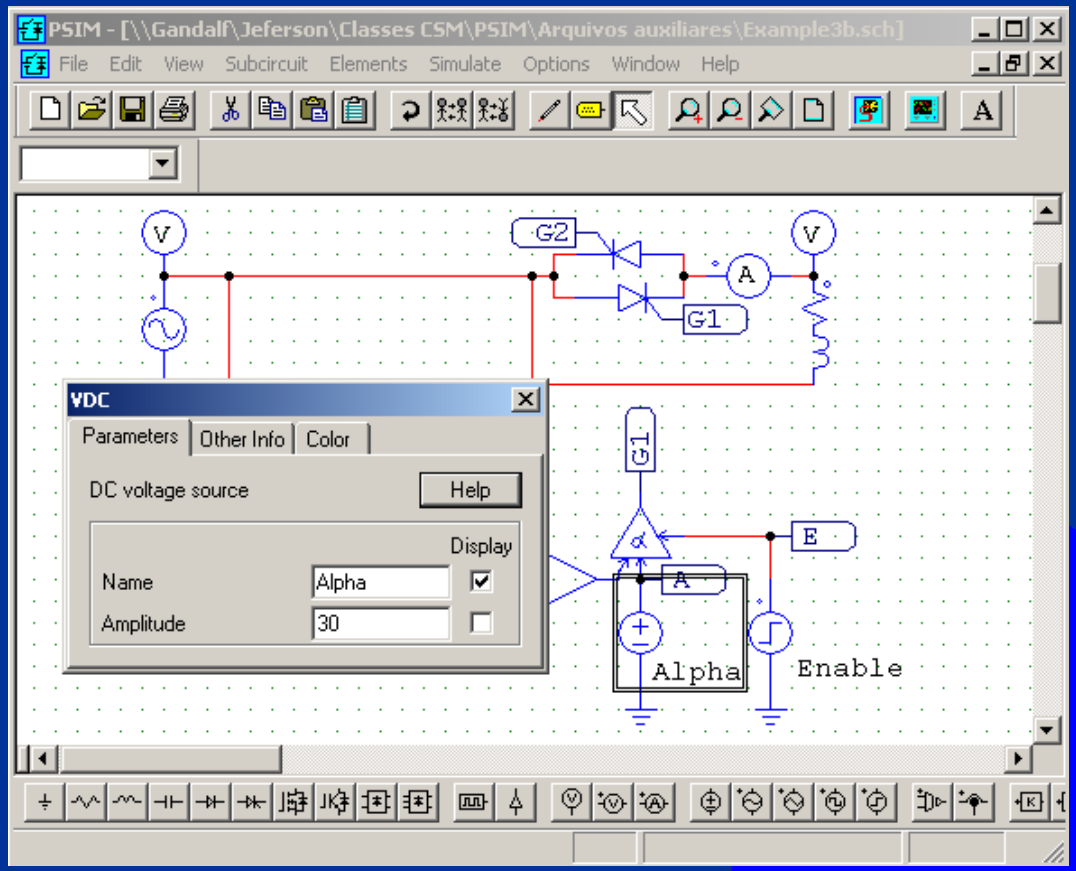
Insert a *Simulation Control* block. Set the simulation time to 50 mili-seconds





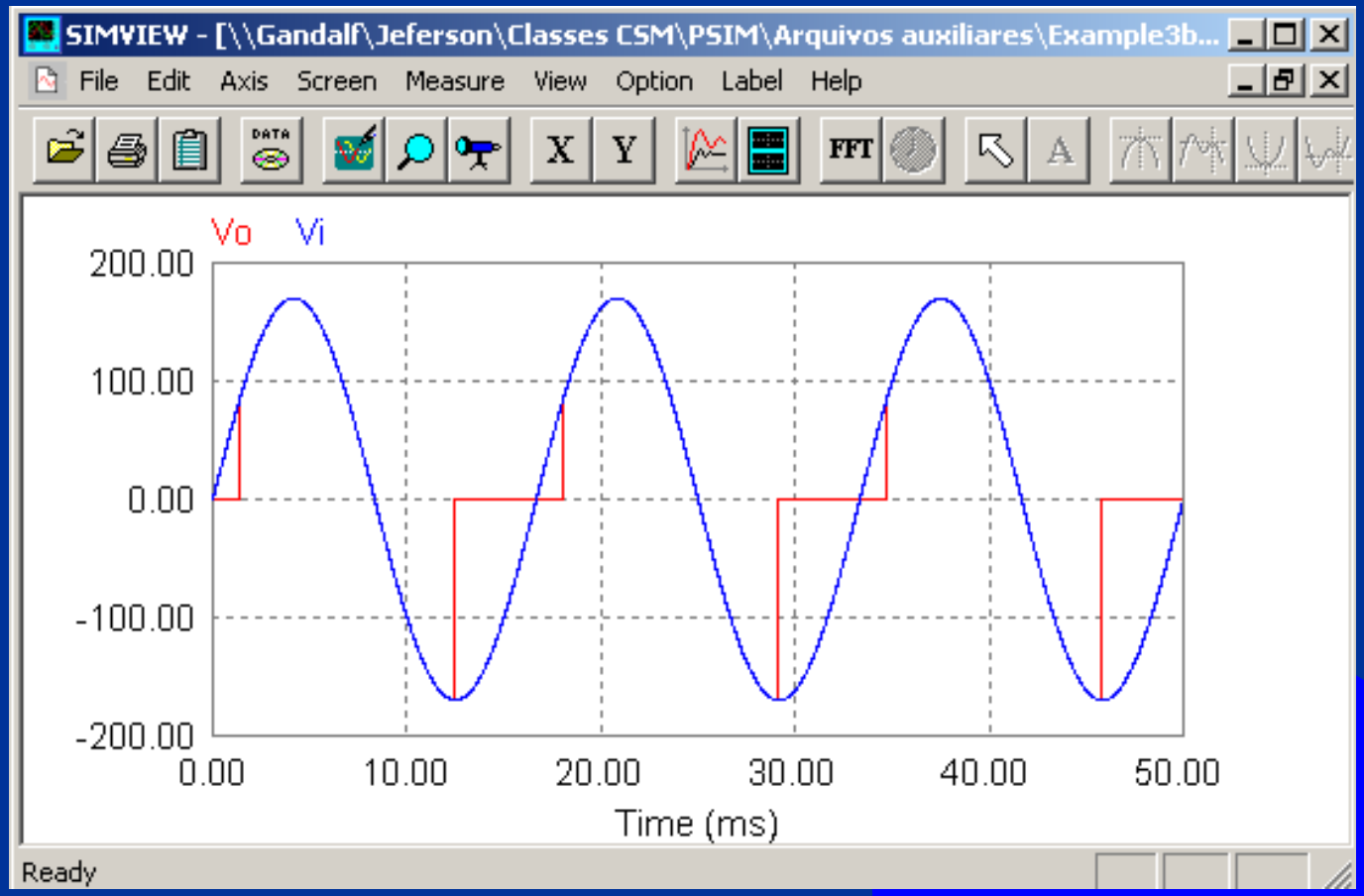
Example 2: Voltage Controller

Set all the parameters values. Set the *Alpha* angle to 30º.



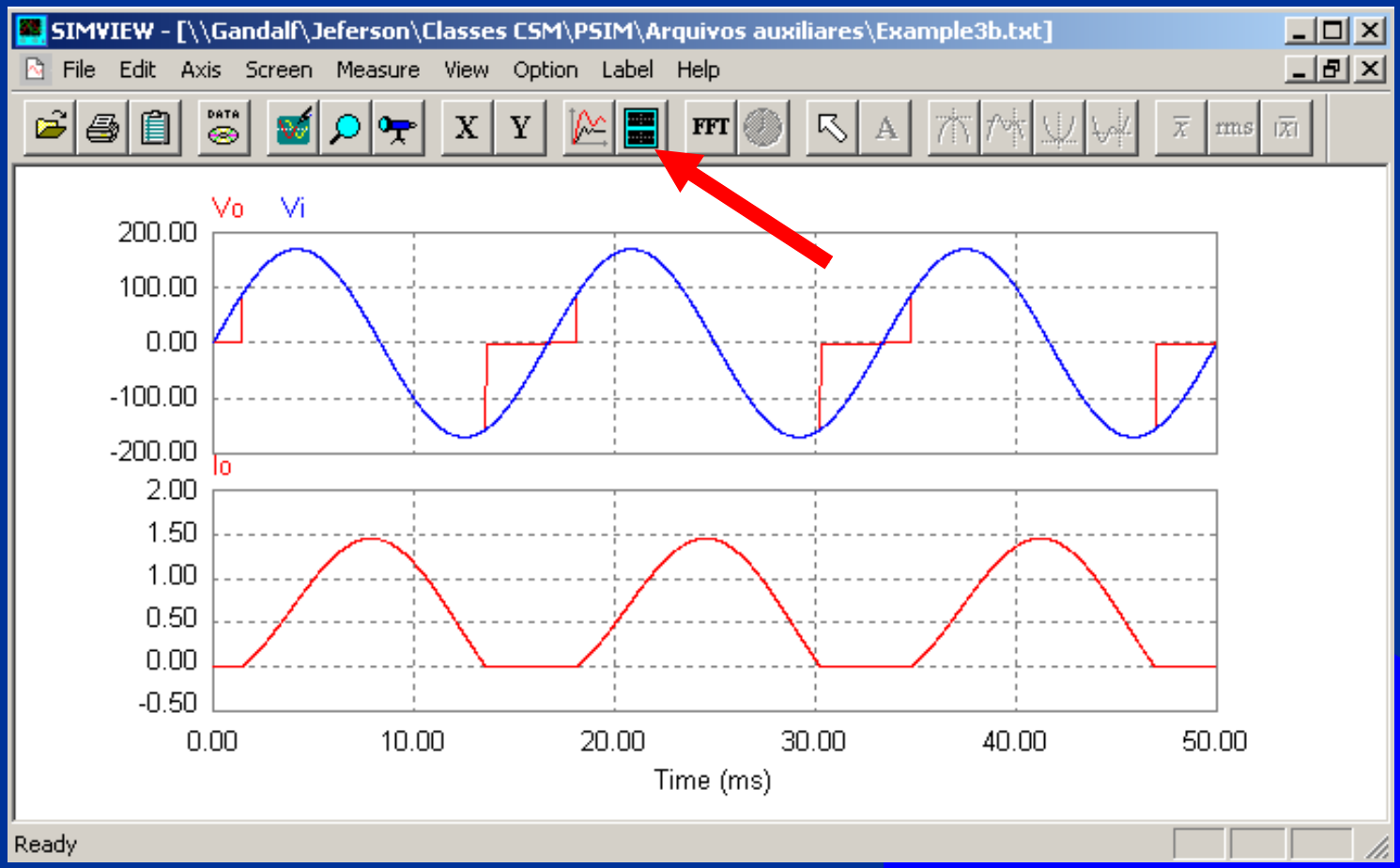
Example 2: Voltage Controller

Run the Simulation. Plot *Vi* and *Vo*.



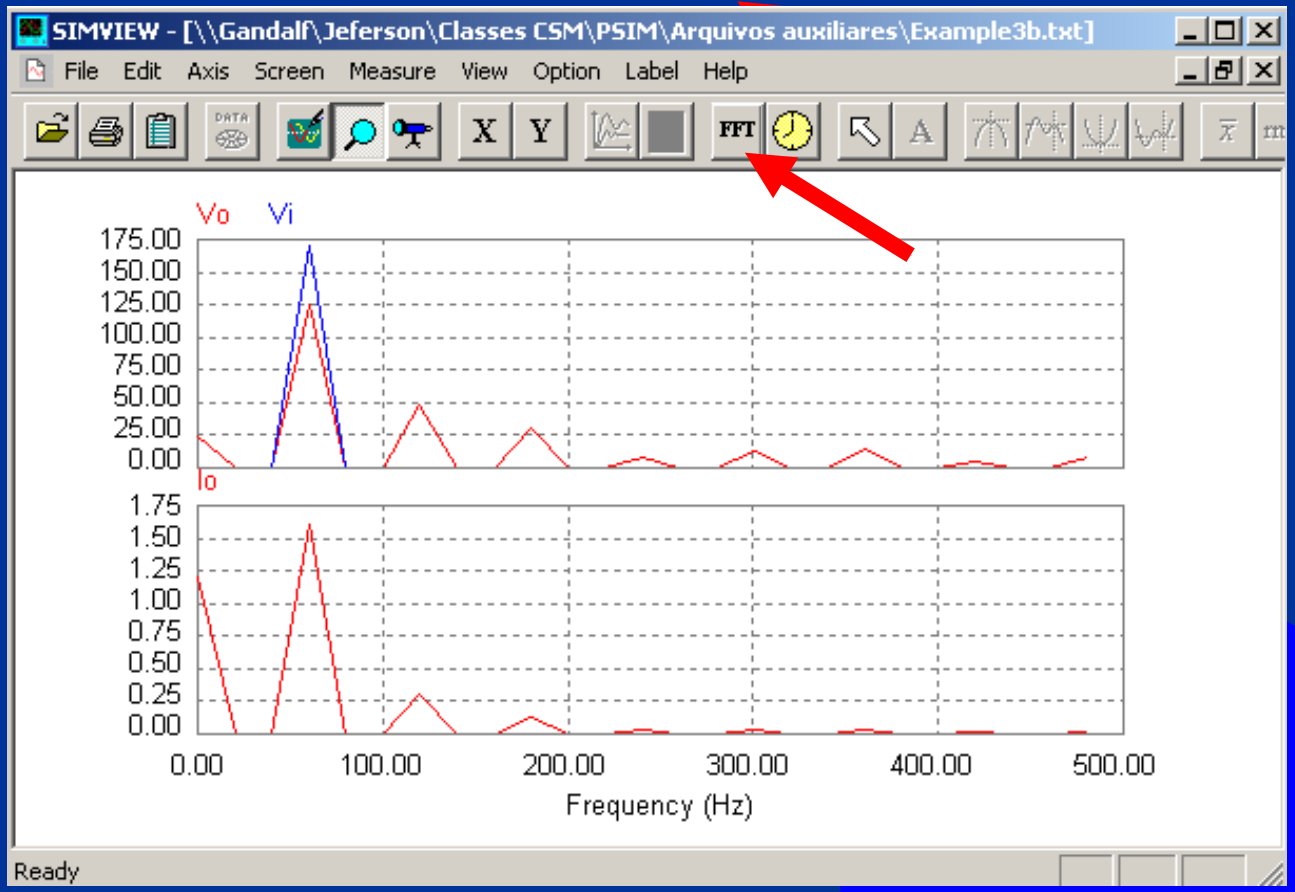
Example 2: Voltage Controller

Add a new *Screen* and plot *Io*.



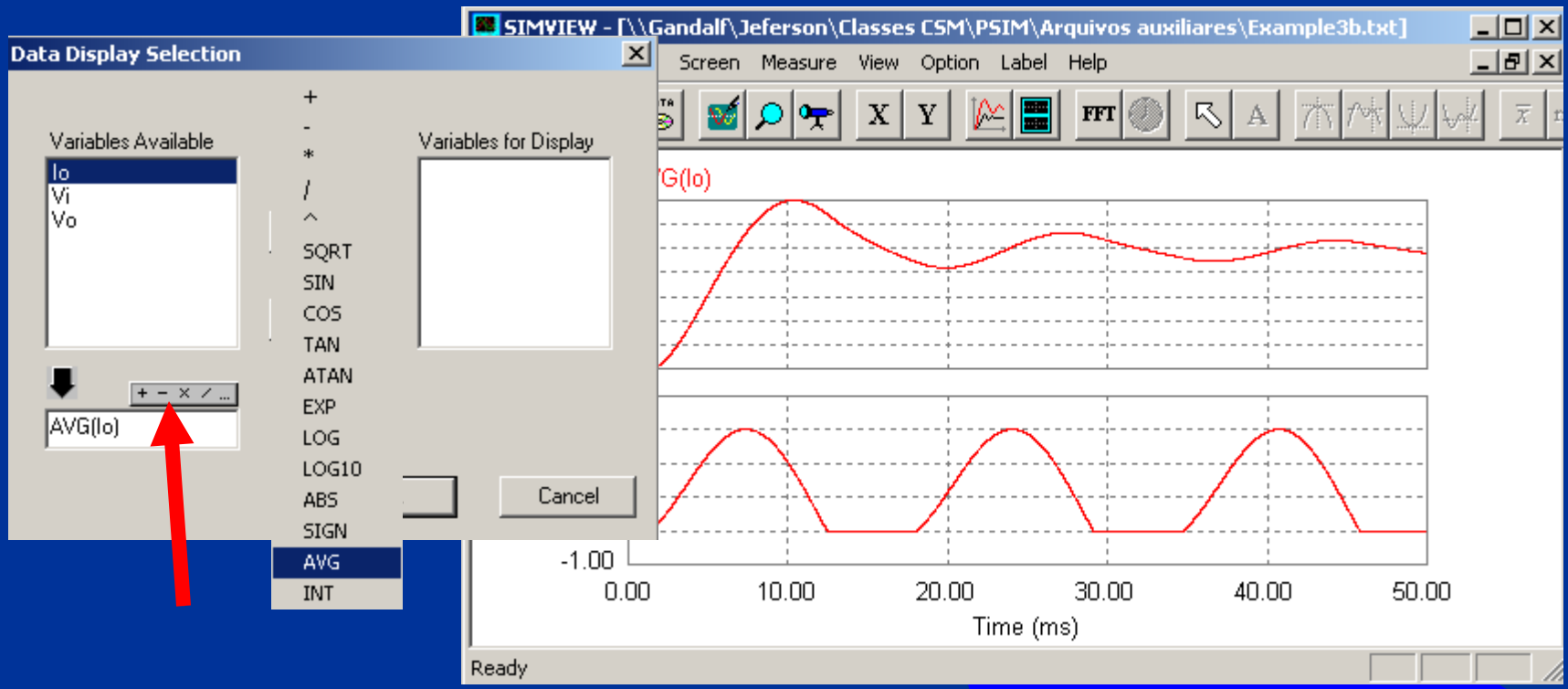
Example 2: Voltage Controller

Other tools: *FFT* and *AVG*.



Example 2: Voltage Controller

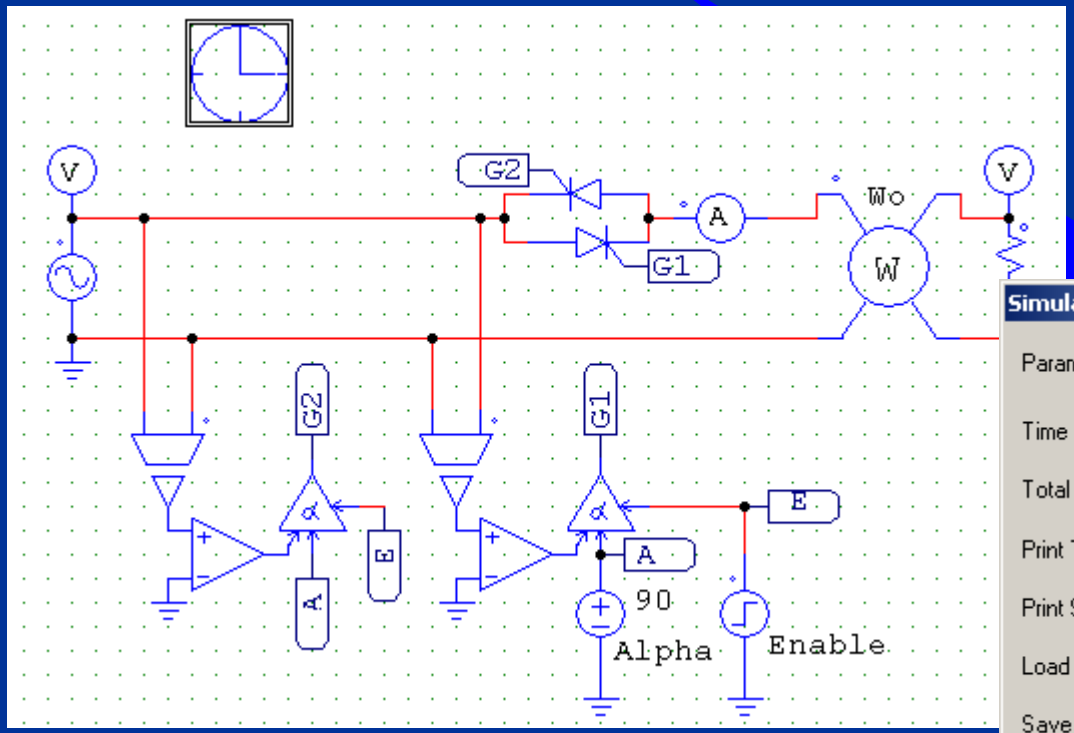
Other tools: *FFT* and *AVG*.



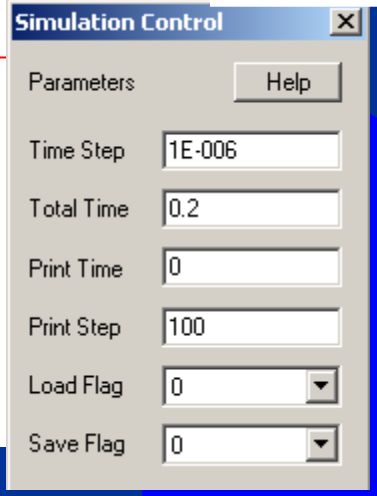
Run the circuit for *Alpha* equals to 60° and 90°.

Example 2: Voltage Controller

Additional measurements: load power, RMS current and power factor. (Example 5-2; Hart; pg 170)



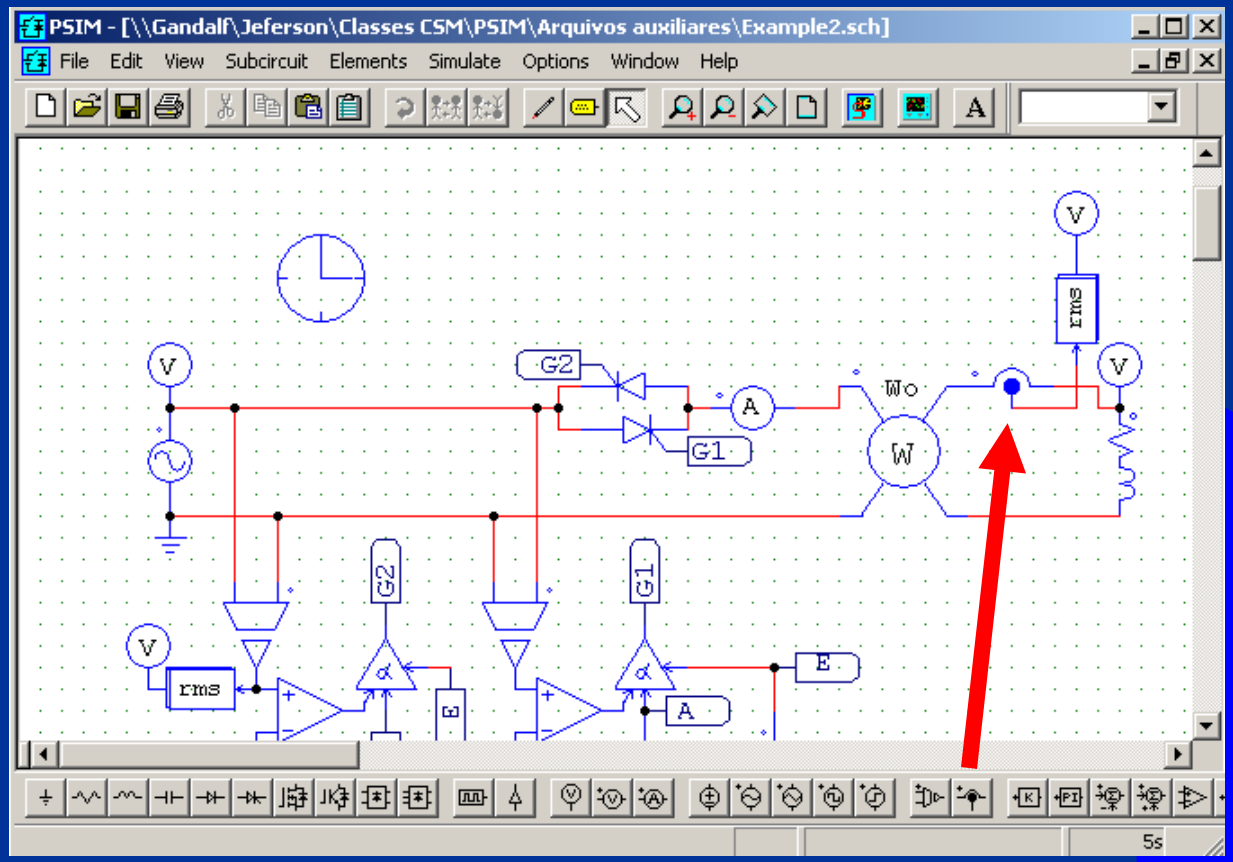
Add a *Watt Metter* from *Elements > Other > Probes > Watt Metter*



Change the *Time Step, Total Time* and *Print Step*

Example 2: Voltage Controller

Additional measurements: load power, RMS current and power factor.



Add a *Current Sensor* and two *RMS* blocks from *Elements > Control > Computational Blocks > RMS*

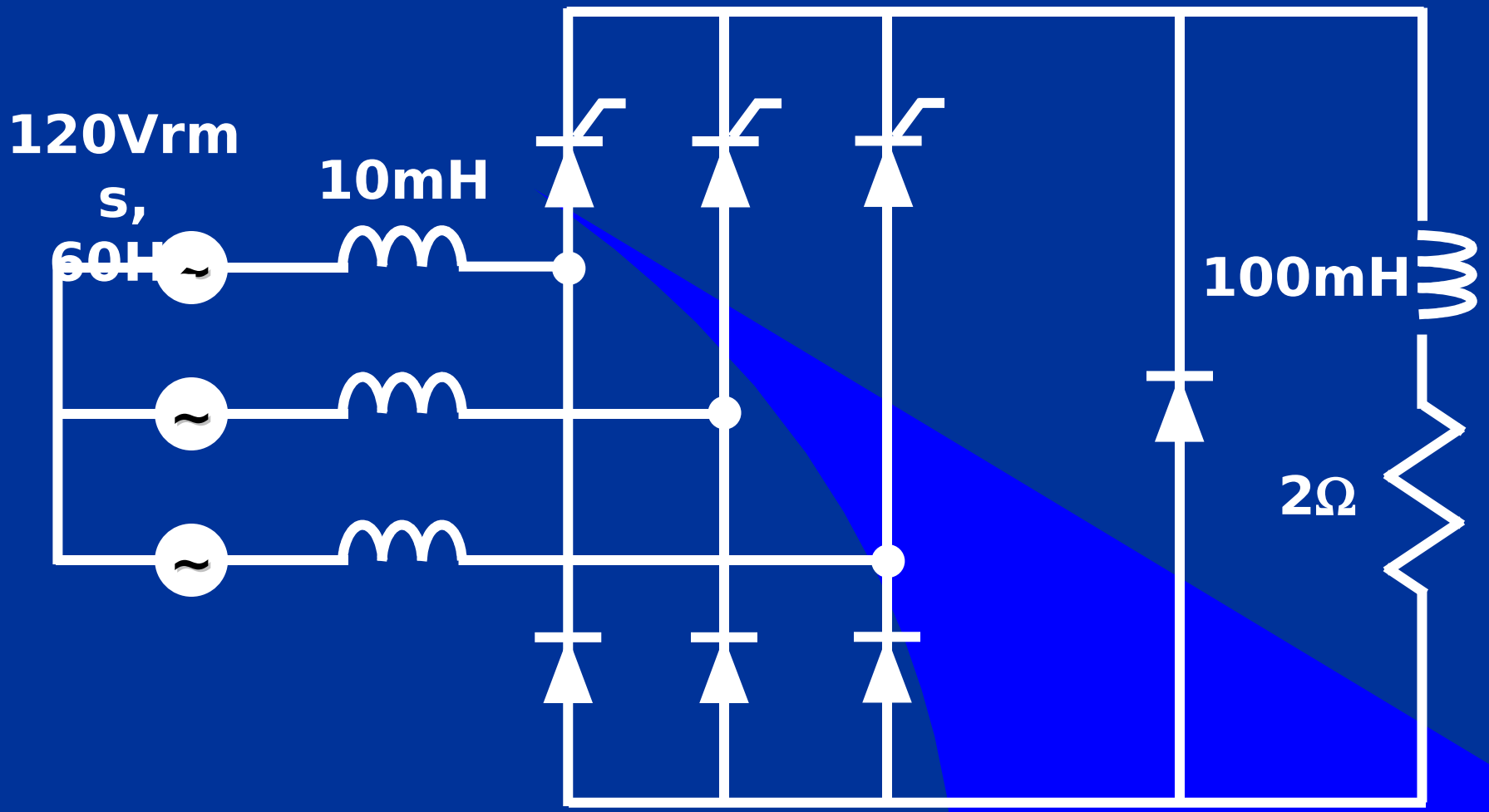
Add *Voltage Probes* to measure the RMS values

Example 2: Voltage Controller

Additional measurements: load power, RMS current and power factor.

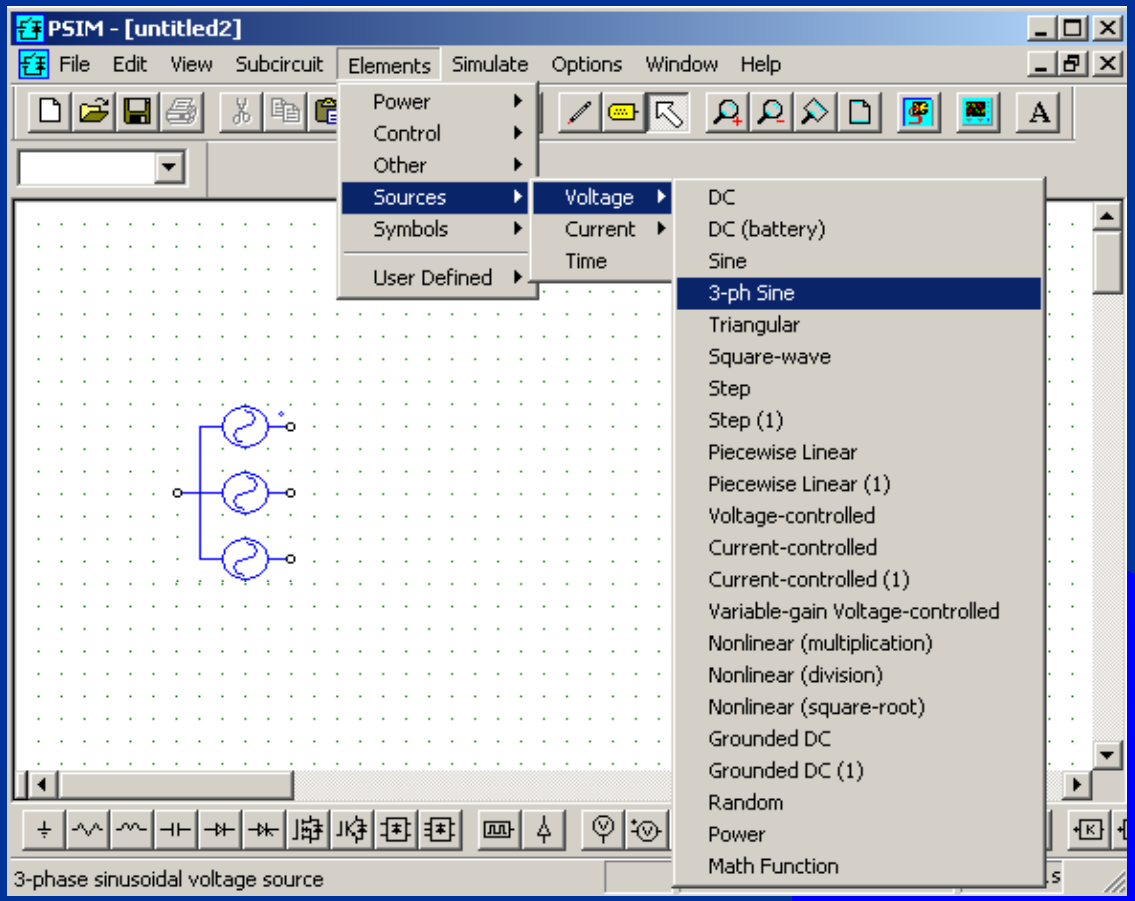
$$PF = \frac{P}{S} = \frac{P}{V_{i,rms} \cdot I_{i,rms}} = \frac{147}{120 \cdot 2.71} \cong 0.45$$

Example 3: Semiconverter



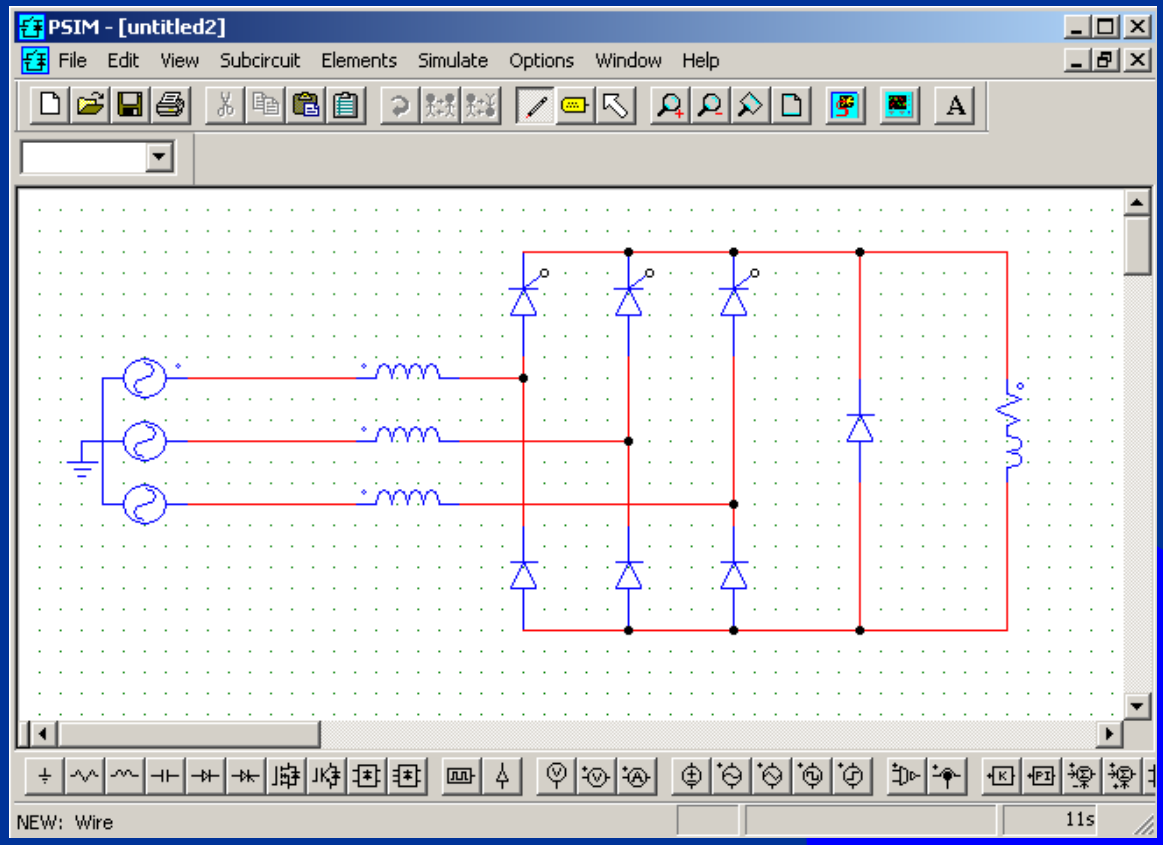
Example 3: Semiconverter

Create a new circuit. Insert a *Three-Phase Voltage Source*.



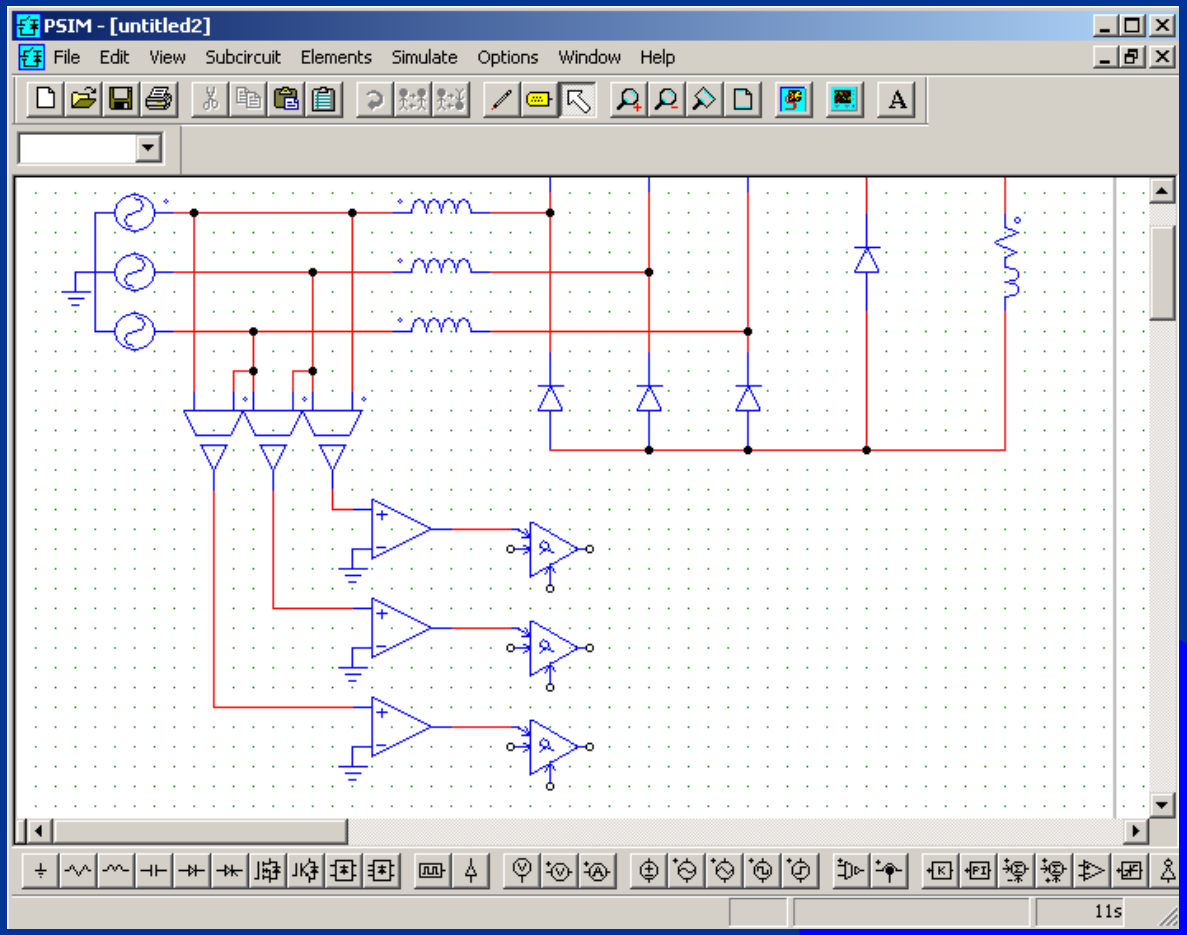
Example 3: Semiconverter

Insert all the other power elements and connect them.



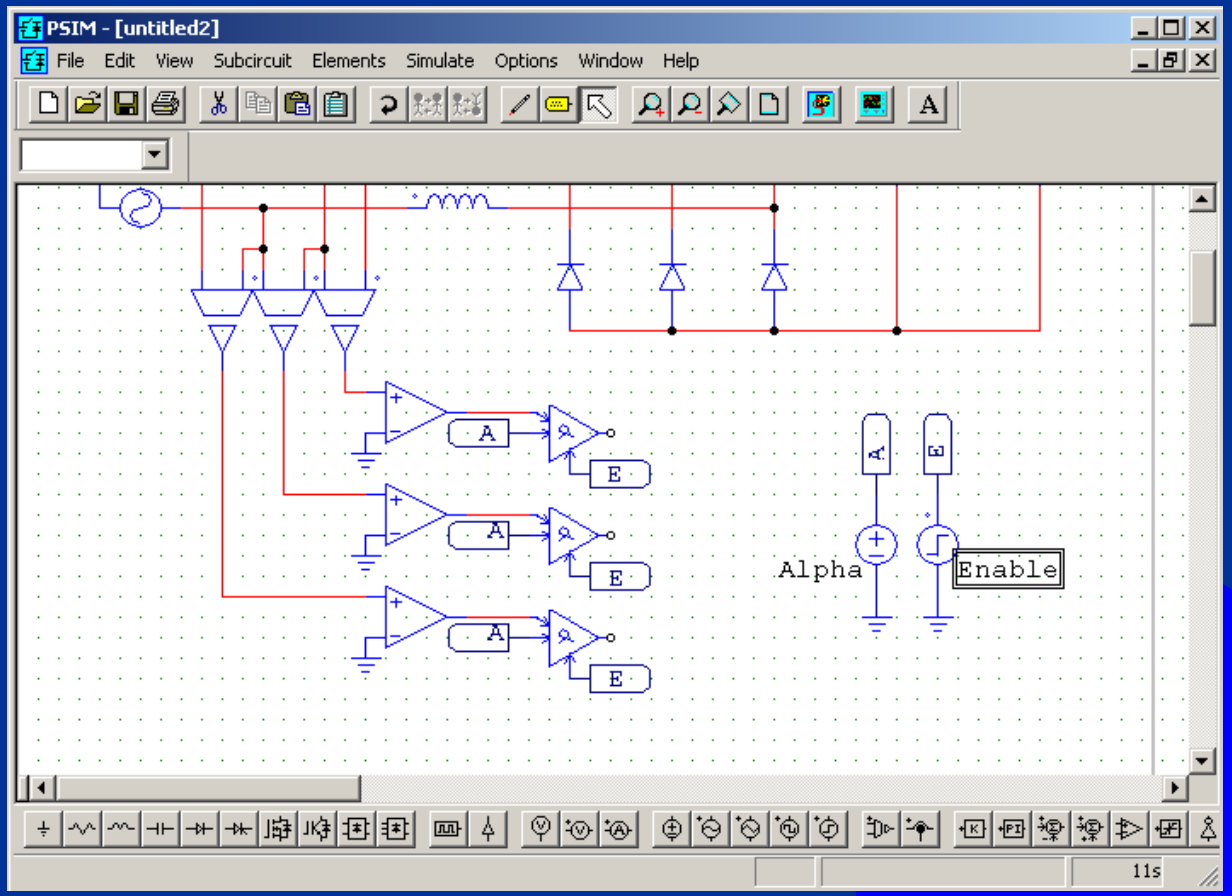
Example 3: Semiconverter

Insert and connect the *Alpha Controllers*.



Example 3: Semiconverter

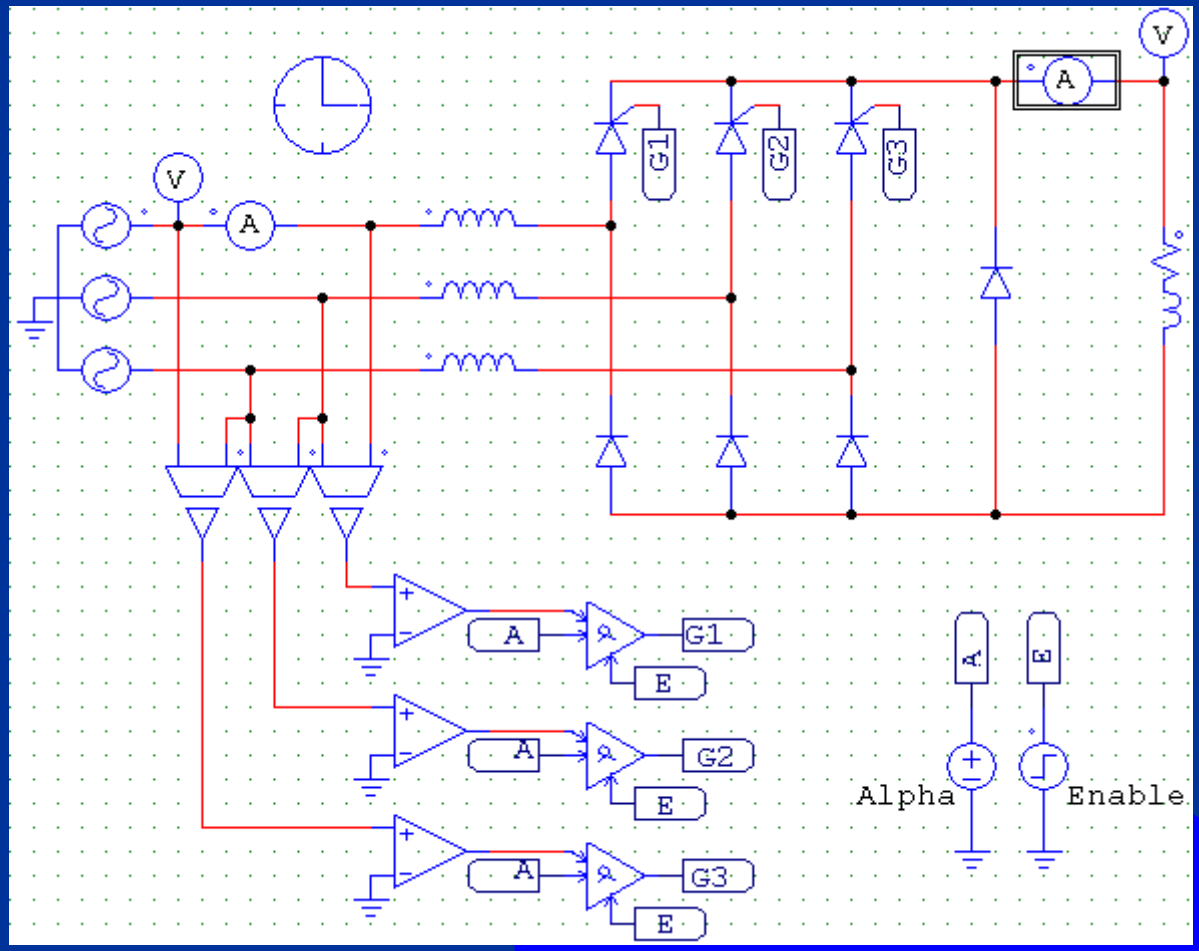
Insert the *Sources* for the angle *Alpha* and for the *Enable* signal.



Example 3: Semiconverter

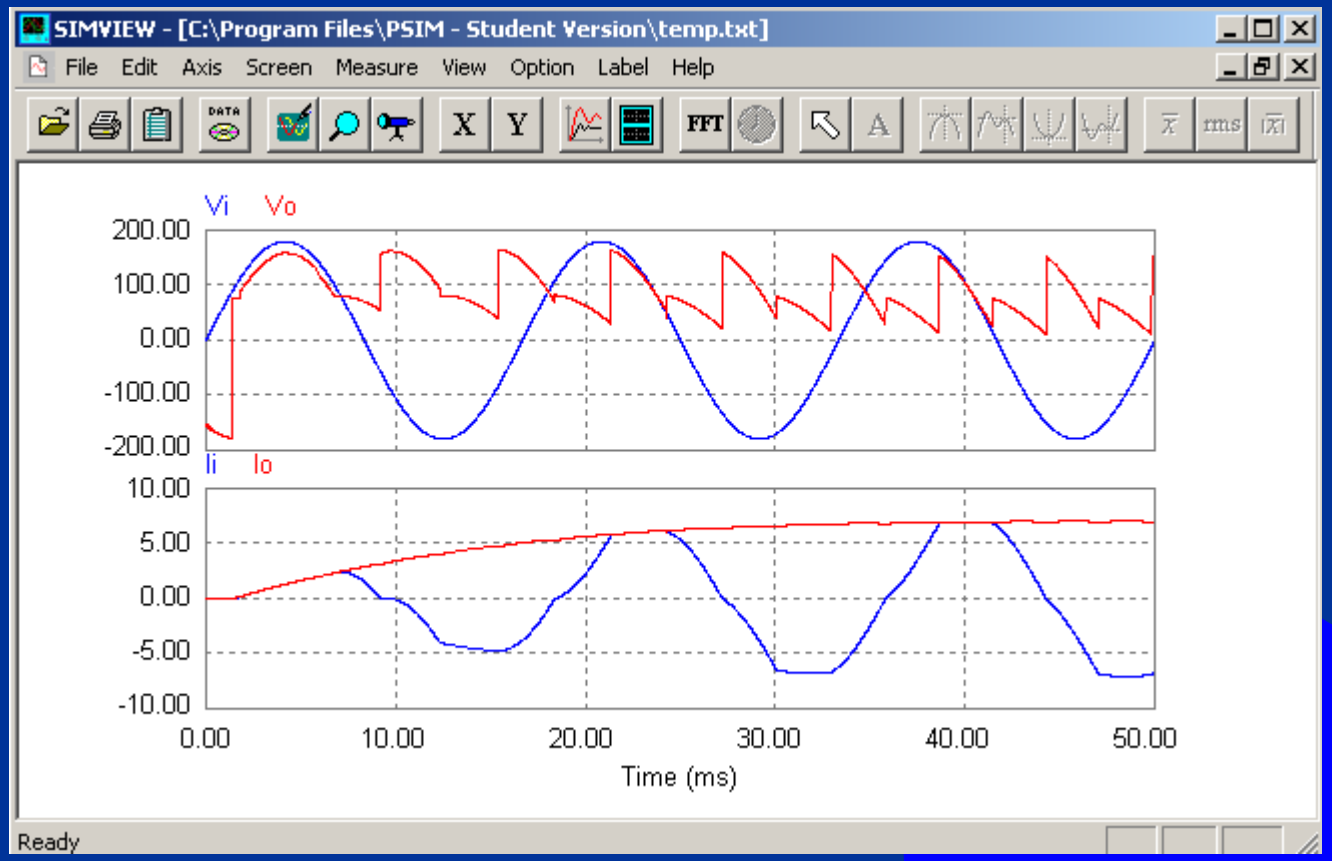
Connect the Gate signals, insert a *Simulation Control* (50 ms) and set all the parameters.

Insert an input *Voltage Probe*, an output *Voltage Probe*, an input *Current Probe* and an output *Current Probe*.



Example 3: Semiconverter

Run the circuit for *Alpha* equals to 30, 60 and 90 degrees. Check the results.



Example 3: Semiconverter

Exercise:

Implement the additional measurements for this circuit: THD, load power, RMS current and power factor.

See Ex. 5.9; Rashid; pg 156