Chapter 4: **Component Based - Simple Circuit**

Block-based modeling is well suited for problems that have a well defined causality, i.e., direction of flow. An example of these types of signal-based systems is a control system. However in most cases the causality is not pre-defined, for instance a motor could also be used as a generator depending on whether or not the input signal is the current or torque. Another basic example is the AC circuit below.

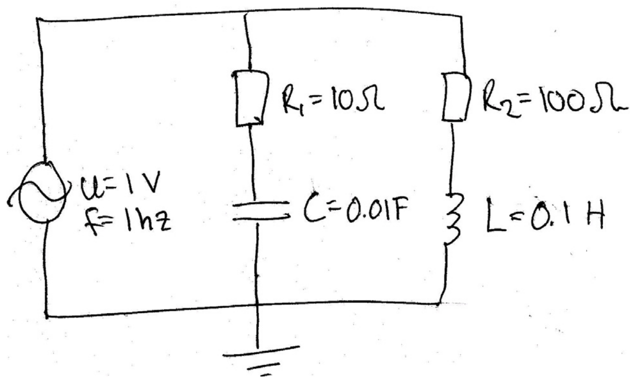

Figure 4-1: The draft schematics of an AC circuit model.

In this example the circuit above will be used to illustrate the difference between a block-based approach and a component-based approach to model the circuit.

4.1 Block-Based Circuit

We begin by creating a block-based model. Before we actually start implementing the model we have to:

- Decide on input and output signals for the system.

- Set up the system of equations.
- Derive the output as a function of the input.

In this example we want to study the current through the signal voltage as a function of the voltage. To calculate this we have three equations:

$$u(t) = R_1 i_1(t) + \frac{1}{C}\int i_1(t)dt$$

$$u(t) = R_2 i_2(t) + L\frac{di_2(t)}{dt}$$

$$i(t) = i_1(t) + i_2(t)$$

Where i is the total current through the signal voltage, i_1 and i_2 are the currents running through resistor1 and resistor2 respectively. Using the Laplace-transform on the above equations resolves i as a function of u as seen in the following equations:

$$i_1(t) = \frac{1}{R_1}\left(u(t) - \frac{1}{C}\int i_1(t)dt\right)$$

$$i_2(t) = \frac{1}{R_2}\left(U(s) - L\frac{di_2(t)}{dt}\right)$$

With these equations we can now implement the block-based model as shown below.

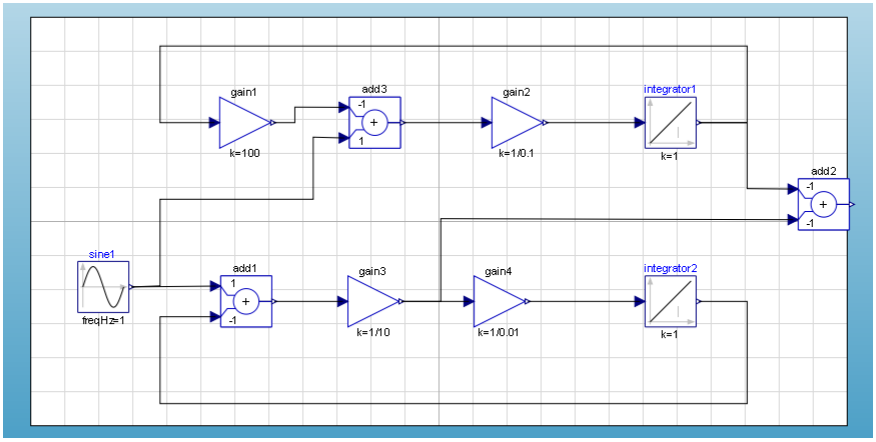

Figure 4-2: The diagram view of the IntroductoryExamples.ComponentBased.BlockCircuit model.

Create a new model, and locate the components in the library browser. All components required to implement the system with a block-based approach can be found in the following packages:

- Modelica.Blocks.Sources
- Modelica.Blocks.Math
- Modelica.Blocks.Continous.

To view the components in the Modelica.Blocks.Sources package in the library browser, expand the Modelica package, followed by Blocks and Sources, by clicking the symbol to the left of each package icon and name.

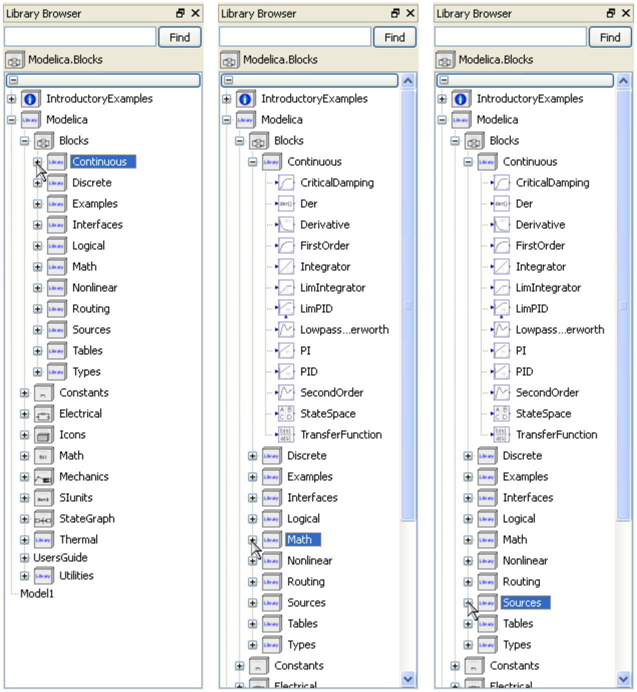

Figure 4-3: Expanding the Continuous, Math, and Sources packages within Modelica.Blocks.

Place the components in the diagram view of your model by dragging them from the library browser and dropping them in the view. Complete the model by connecting the components.

Switch to Simulation Center and simulate the model for 10 seconds. The output current is the result of add2. The signals i_1 and i_2 are from gain3 and integrator1 respectively. The picture below shows the resulting current.

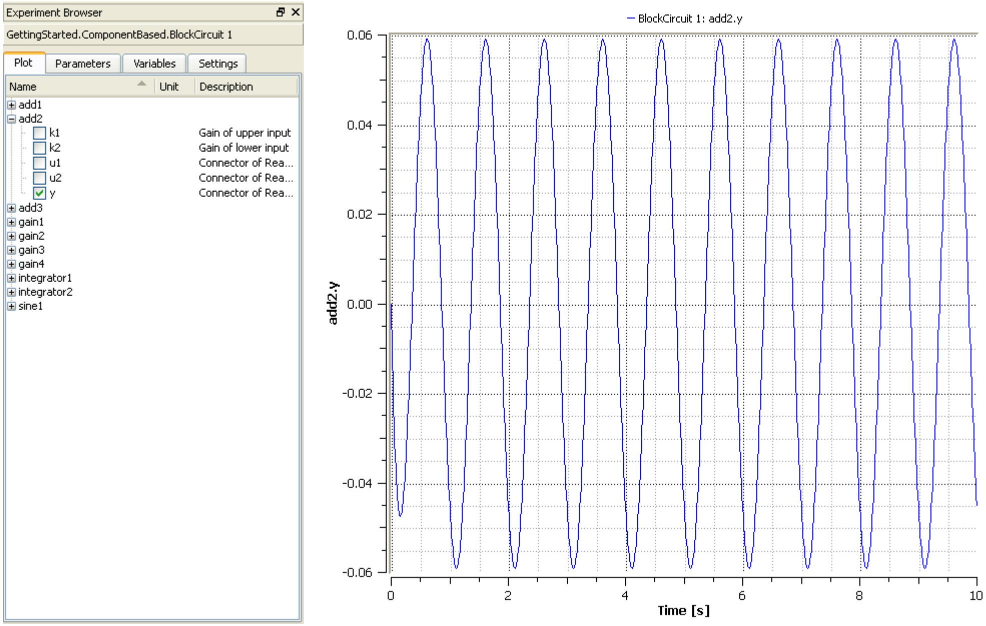

Figure 4-4: Plotting add2.y for the IntroductoryExamples.ComponentBased.BlockCircuit model with default parameters values.

4.2 Component-based circuit

Naturally, implementing a component-based model of the system shown in figure 4-1 requires only drag-and-drop as well as connecting the components and setting parameters. This leaves us with a model that looks just like the drawing with which we started with.

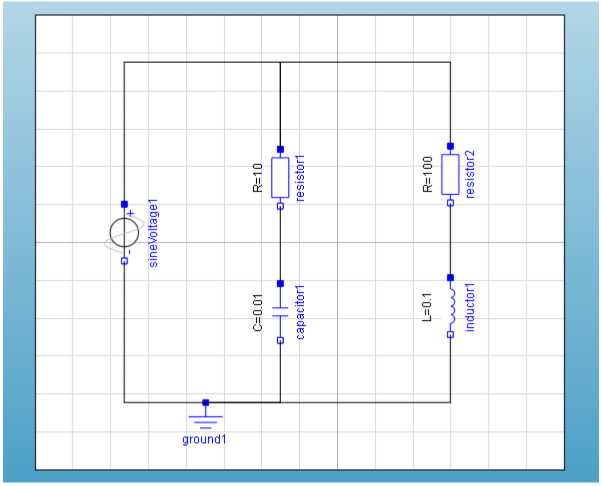

Figure 4-5: The diagram view of the IntroductoryExamples.ComponentBased.ElectricCircuit model.

If you would like to build the model yourself, the sine voltage component is located in the Modelica.Electrical.Analog.Sources package, and the rest of the components in the Modelica.Electrical.Analog.Basic package. Note that some of the parameter values differs from the default, so in order to obtain the same simulation results you will have to change these as well.

Now we can simulate and plot the resulting current through the signal voltage, and as expected it looks just like the result plotted from the block model.

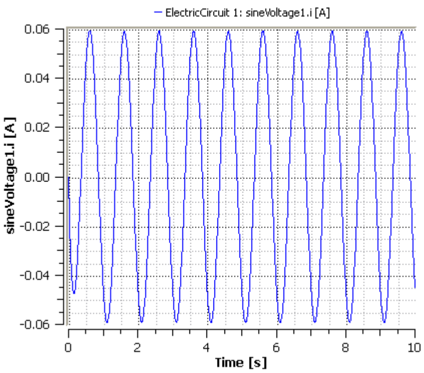

Figure 4-6: Plotting the current going through the source, for the

IntroductoryExamples.ComponentBased.ElectricCircuit model with default parameters values.

We will end this chapter by adding a second capacitor to the model as shown below. The capacitor component is located in the Modelica.Electrical.Analog package.

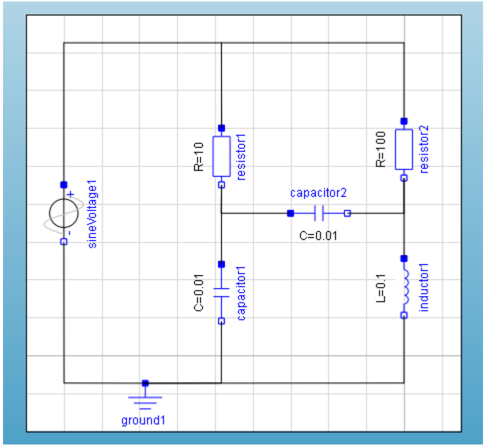

Figure 4-7: The diagram view of the of IntroductoryExamples.ComponentBased.ElectricCircuit2 model.

After simulation we compare the resulting currents with one another.

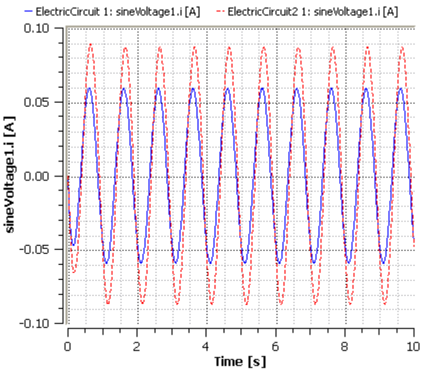

Figure 4-8: Comparison between the two currents going through the source in the ElectricCircuit and ElectricCircuit2 models.

4.2.1 Exercise

Develop a block-based model for the second circuit.