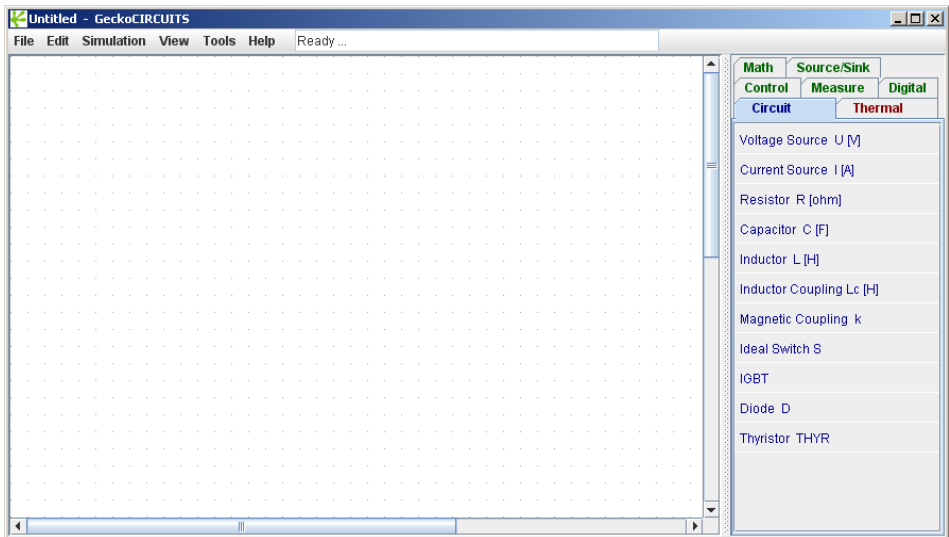# Getting Started – Buck Boost Converter

Getting Started – Buck Boost Converter

Circuit simulator GeckoCIRCUITS after starting the program. Depending on the tabs at the right side one can select components.

The power circuit components will be displayed in blue, the control components in green and thermal components in red.

Color Scheme
- Power Circuit: Blue
- Control: Green
- Thermal: Red

Getting Started – Buck Boost Converter
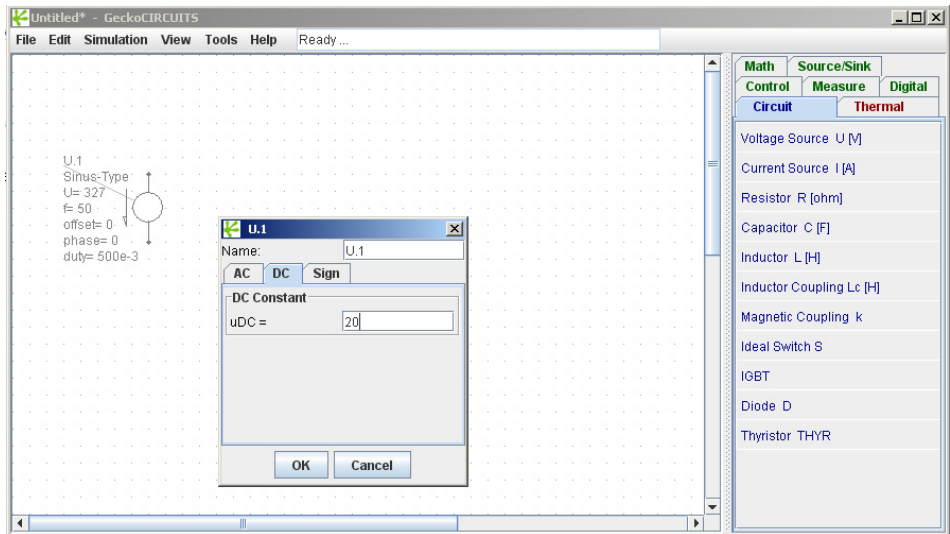
Click with the mouse (1x left button) onto Voltage Source U [V] located in the component list of the blue tab. Afterwards, move the mouse pointer into the worksheet.

The selected voltage source moves with the mouse pointer, and is in the editing mode (gray). The voltage source can be put down to its final location by clicking the mouse (1x left button). Then, the voltage source exits its editing mode (gray) and is displayed in blue.

Double-click (2x left button) with the mouse-pointer onto the component's symbol to open the parameter dialog. Sources are set to AC-sources by default. By clicking the DC-Tab of the parameter dialog, the source becomes a DC voltage source. Set the DC-value of the source to 20V.

Color Scheme
- Editing Mode: Gray

Getting Started – Buck Boost Converter
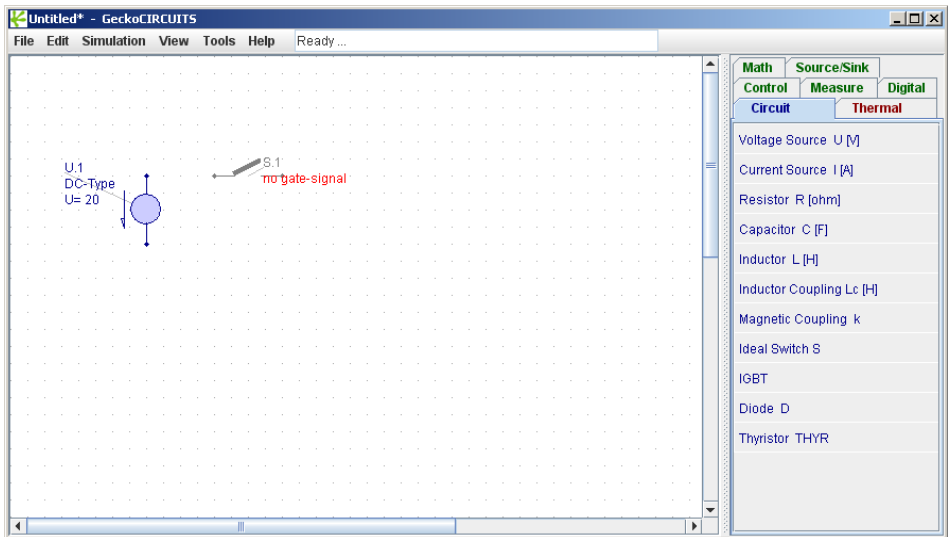
Clicking (1x left) Ideal Switch S (power circuit, blue tab) provides an ideal switch with bidirectional behaviour, ON-voltage drop (default: 0 V), ON-resistance (default: 10mΩ) and OFF-resistance (default: 10MegΩ).

These parameters can be changed by the user via the component's parameter dialog. The parameter dialog can be opened by double-clicking (2x left) the component's symbol after the switch has been put down.

If power circuit components are in their editing mode (gray), they can by rotated by 90° with each mouse-click (1x right).

The ideal switch (default-name: S.1) is put down with one mouse-click (1x left), and exits its editing mode.
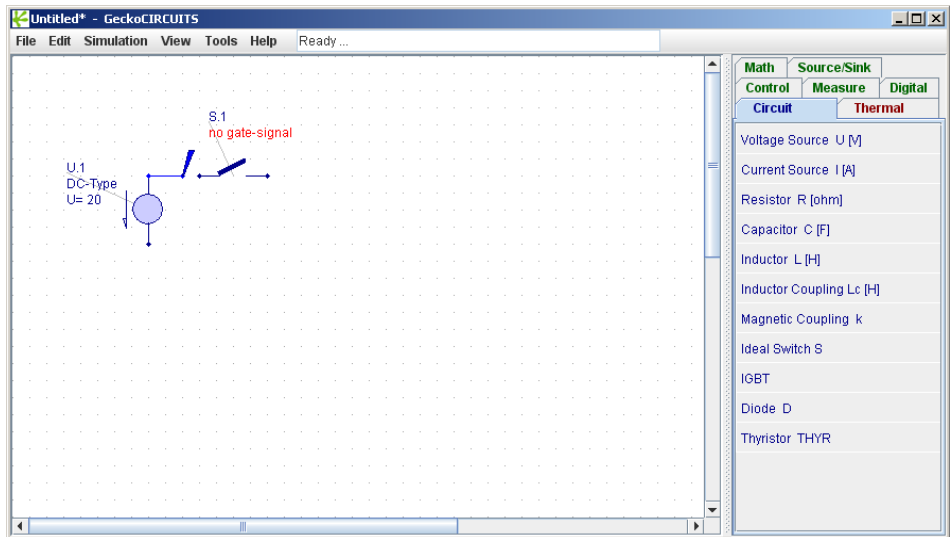
Ideal Switch in GeckoCIRCUITS
- Bidirectional
- U_on = 0 V
- r_on = 10m Ω

Rotate Component
- Power circuit component
- Editing mode (gray)
- Mouse-Click (1x right)

Getting Started – Buck Boost Converter

If the blue tab (power circuit) is active with no component in editing mode, a blue pen for drawing connections can be activated by a mouse-click (1x right). There is a node at start- and end-point of each connection where other connections or input/output-ports of components can be attached.

Blue connections can only connect (blue) power circuit components. A second mouse-click (1x right) deactivates the drawing pen.

Get Diode.

Clicking (1x left) Diode D in the blue tab provides a diode with ON-voltage drop (default: 0.6V), ON-resistance (default: 10mΩ) and OFF-resistance (default: 10MegΩ). These parameters can be modified in the tab Characteristic of the diode's parameter dialog.

> **Draw Connections**
> - Blue Tab & Mouse-Click (1x right)
> - Blue Pen for Drawing Connections
> - Blue connections can only connect blue component nodes

Getting Started – Buck Boost Converter
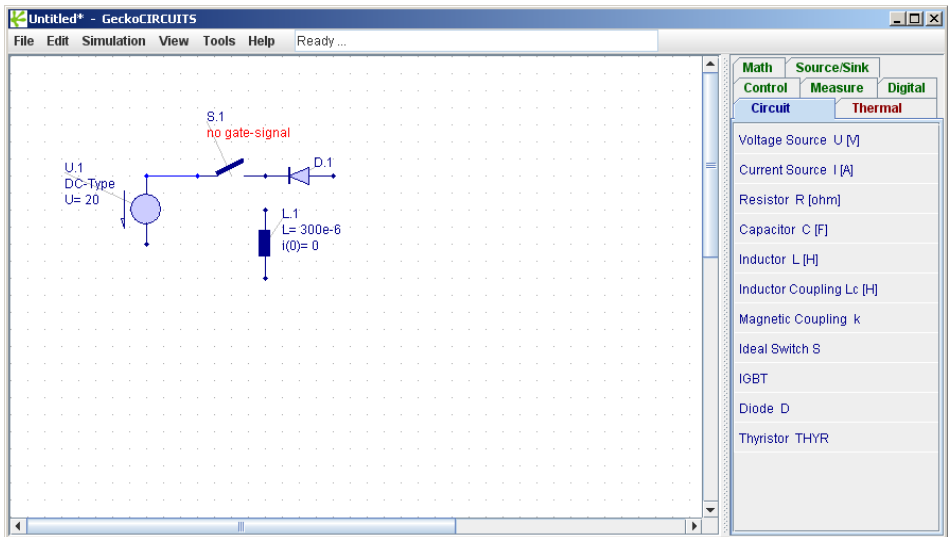
Now select Inductor L [H] from the blue tab. If you want to couple inductors magnetically (e.g. modelling transformers) you have to employ the Inductor Coupling Lc [H] instead.

The component Magnetic Coupling k would provide the coupling. The two components Inductor L [H] and Inductor Coupling Lc [H] are equivalent, but using Inductor L [H] might improve simulation speed.

Rotate the inductor by 90° via mouse-click (1x right) in editing mode (gray). Put down the inductor by mouse-click (1x left). The editing mode is then exited automatically and the inductor symbol changes its color from gray to blue.

Inductor vs. Inductor Coupling
Inductor L gives higher simulation speed, but for magnetic coupling Inductor Coupling Lc has to be employed

Getting Started – Buck Boost Converter
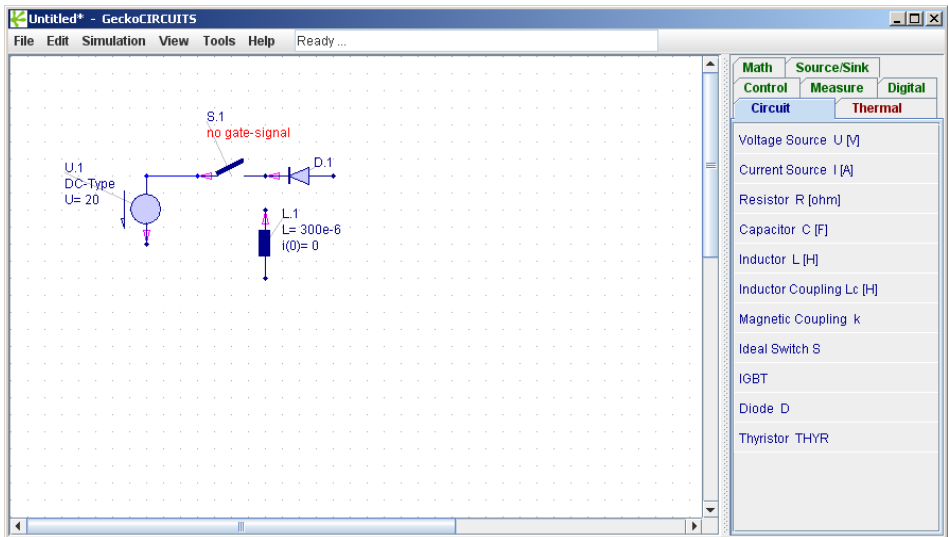
Visualize the flow direction in power circuit components via submenu View >> Flow_Direction.

This is especially of advantage for current measurement and for setting initial conditions of inductors (initial current) and capacitors (initial voltage).

Mouse-click (1x left) the inductor to bring it into its editing mode (gray). Then, rotate the inductor by 180° via two mouse-clicks (2x right). Put the inductor down by one mouse-click (1x left) which makes the inductor exit its editing mode (changing from gray to blue again).
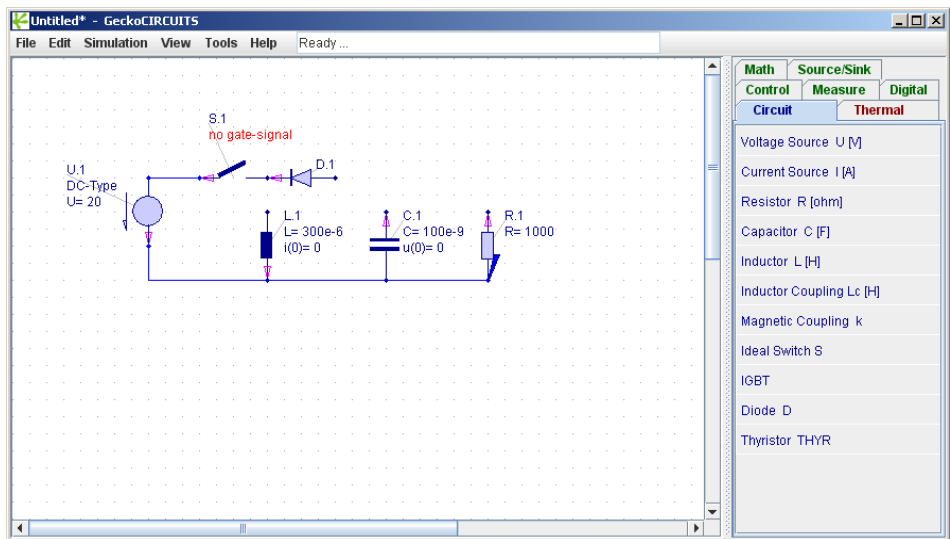
Visualize flow direction
- Menu View >> Flow_Direction
- Current measurement
- Initial conditions of L, C

180°-Rotation
- Mouse-click 1x left: Entering editing mode (gray)
- Mouse-click 1x right: Rotation 90°
- Mouse-click 1x right: Rotation 90°
- Mouse-click 1x left: Component put down (changes to blue)

Getting Started – Buck Boost Converter

Select a capacitor and a load resistor.

A mouse-click (1x right) activates the drawing pen for drawing connections. Here, the blue tab for power circuit components has to be active in order to get the blue pen. Only the blue pen can realize (blue) connections for power circuit components.
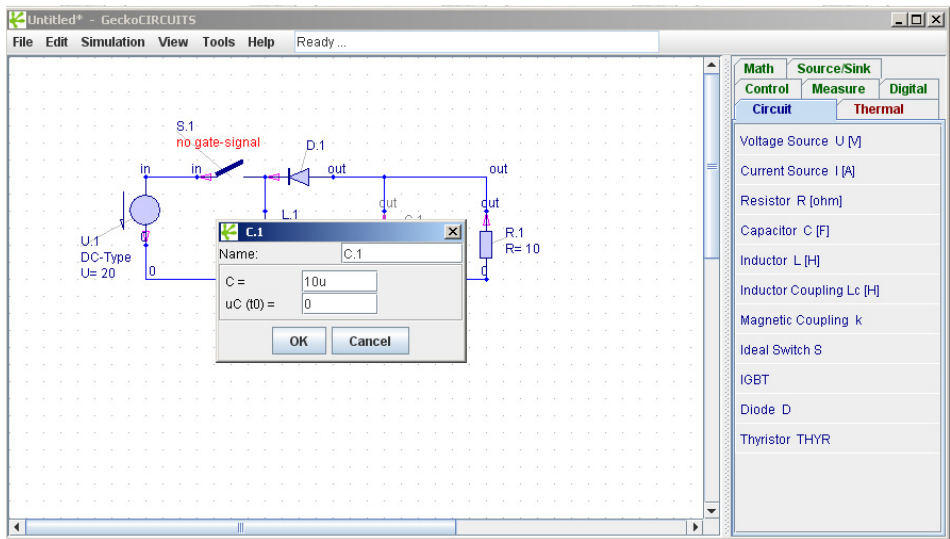
Connections can be changed into editing mode (gray) by one mouse-click (1x left). Connections cannot be rotated but they can be deleted and copied like components (see menu Edit).

Connections in the editing mode
- Deleting
- Copying

Getting Started – Buck Boost Converter

If you double-click connections or input/output-ports of components, a parameter dialog will open and you can define a node-name. Node-names are important for e.g. voltage measurement (see later).

Double-click symbols of R and C to open parameter dialogs for changing component values. Instead of typing 10e-6 or 0.00001 you can alternatively write 10u (also valid abbreviations: p, n, u, m, k).

You can also define an initial voltage of the capacitor. This is of advantage e.g. in case of boost-converters, if you would like to omit the simulation of pre-loading.
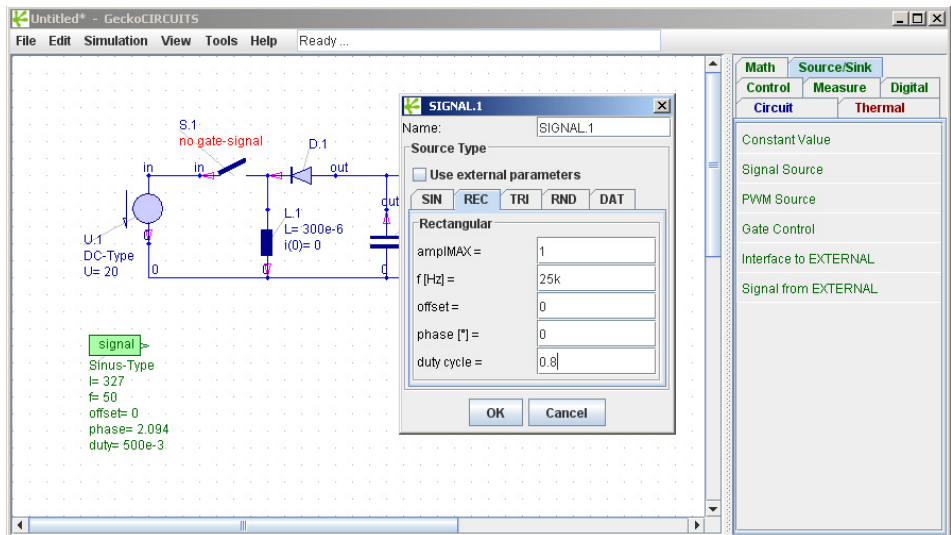
**Connections &
Input/Output-Ports of Components**
Double-click nodes to define node-labels

Simplified input of values
Instead of typing 10e-6 or 0.000001 just write 10u

Getting Started – Buck Boost Converter

For modelling the control circuit you have to activate one of the green tabs, e.g. Source/Sink.

By mouse-clicking (1x left) of Signal Source, moving the mouse-pointer into the worksheet, and putting the selected component at its location (mouse-click 1x left to exit the editing mode), you get a general signal-source. Open the parameter dialog via double-clicking.

By selecting the tab REC the signal-source will provide a rectangular signal.

**Signal-Source**

Getting Started – Buck Boost Converter
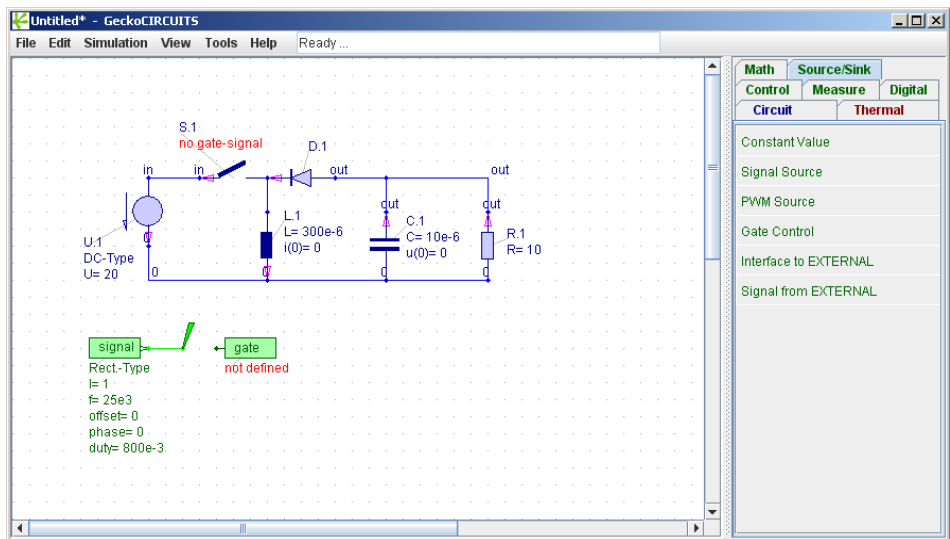
Get the control block Gate_Control from the tab Source/Sink in order to be able to control active switches in the power circuit. This is the only way to control active switches.

Because the green tab is active, you can get the green drawing pen by one mouse-click (1x right). With the green pen only connections between green control-blocks can be drawn. Deactivate the green pen by one second mouse-click (1x right).

Control active power switches via the green Gate-Control block

Getting Started – Buck Boost Converter
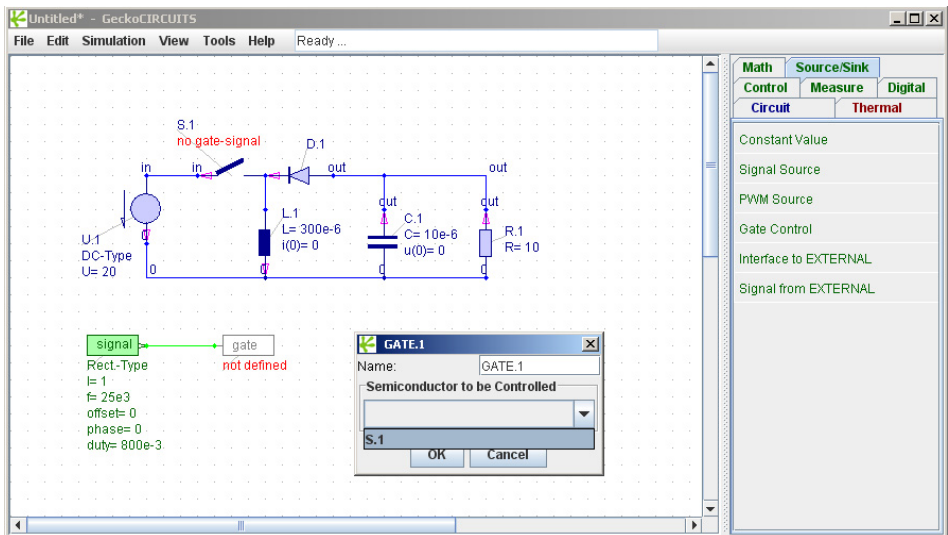
Double-click the Gate Control_ block to open its parameter dialog. Here, you can select a certain active power switch to be controlled by this block.

After successful selection, the red text not defined of Gate Block changes to the name of the selected power switch: >>_S.1. The red text no gate-signal of the selected power switch changes to the name of the controlling block: GATE.1 >>.

Gate-Control block

Getting Started – Buck Boost Converter
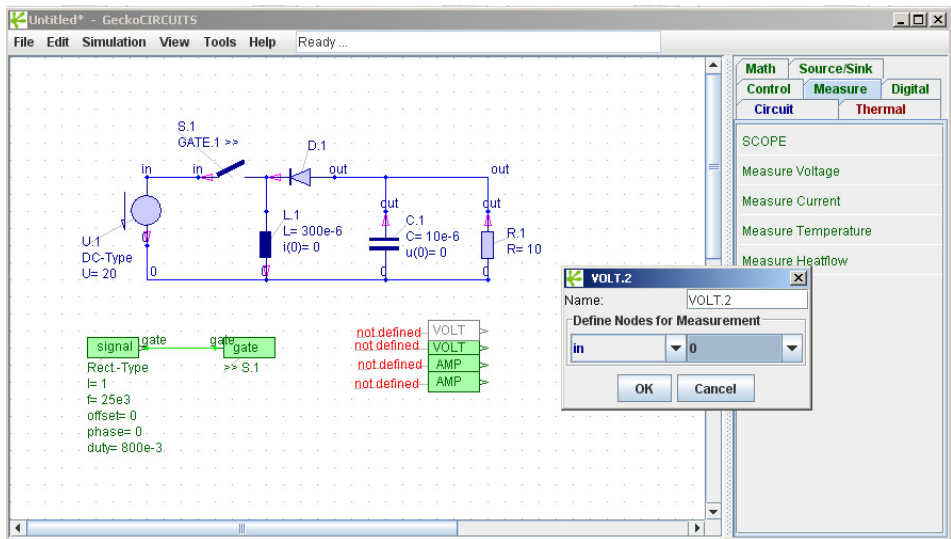
To measure currents and voltages you need to employ the control blocks Measure Voltage and Measure Current in the green tab Measure. If you double-click the voltage measurement block, the according parameter dialog allows the selection of two nodes, if you already have defined node-names. If there are no node-names defined, you cannot select and measure voltages.

Double-clicking of the current measurement block opens the according parameter dialog. Here, all power circuit components are listed and one can be selected.

Measurement
Measure all currents and voltages of the power circuit (blue) via green measurement blocks AMP and VOLT

Getting Started – Buck Boost Converter
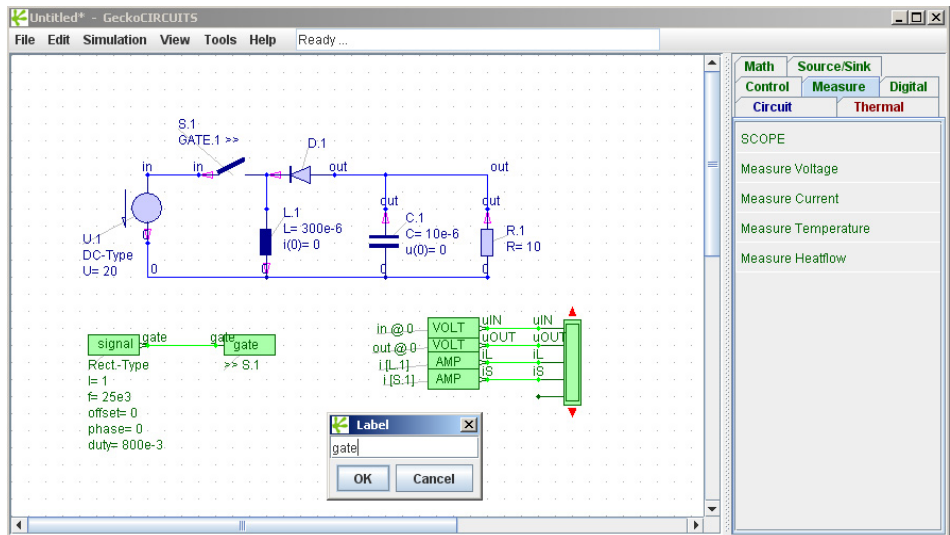
Use the signal block SCOPE of the green tab Measure for visualization of the simulated time-behavior.

The number of input-ports of the SCOPE can be modified by clicking one of the red triangles (at top and bottom of the SCOPE-symbol). If the input-ports have names, these names are used to label the displayed curves.

Nodes are also connected if they have identical node-names (e.g. the green node-name gate in screenshot above). Instead of drawing a (green) connection from the signal-block output port to the SCOPE input port, you can simply name the according SCOPE input port.

SCOPE
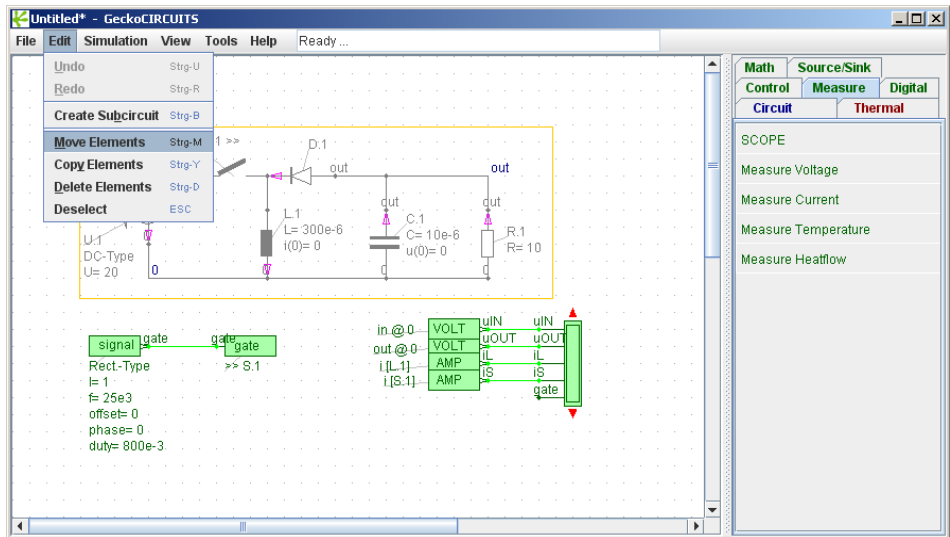Use SCOPE for visualization of simulated time-behavior

Naming of SCOPE-curves
Node-names of the input-ports of the SCOPE are used to name the displayed curves

Connections
Use equal node names for creating connections alternatively

Getting Started – Buck Boost Converter


Move the Topology.

If you click with the mouse into the worksheet (1x left), and then drag the mouse pointer (keep left mouse-button pressed while moving), you can define a yellow rectangle. All components internal of this rectangle change into editing mode (gray) if you release the mouse button.

Employing the yellow selection rectangle is an easy way to work on a component group efficiently, e.g. moving components via the menu Edit_>>_Move_Elements, or copying and deleting whole component groups.

Yellow Selection Rectangle
Put component group into editing mode

Getting Started – Buck Boost Converter
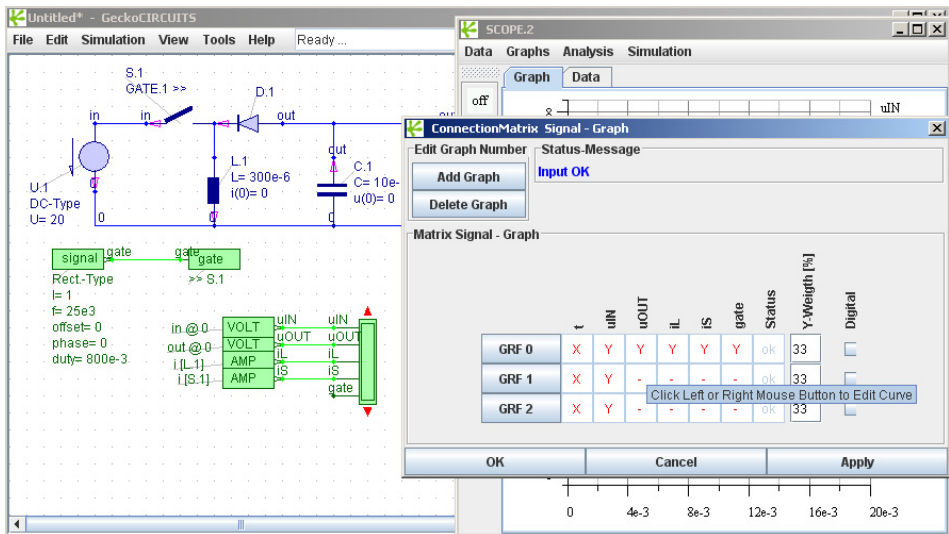
Double-click the SCOPE-block to open a scope-window. All signals at the SCOPE input ports can be displayed.

Open the dialog ConnectionMatrix via the scope-menu Graphs >> Signal-Graph, where the number of displayed graphs can be set (via buttons Add Graph and Delete Graph). All SCOPE input signals can be attached to each graph via the matrix settings in this dialog.

Click button Add Graph twice to create two more graphs in this scope-window. In the matrix there are now three graphs, furthermore three signals with entry 'X' plus five signals with entry 'Y' (uIN, uOUT, iL, iS, gate). By mouse-clicking (1x right) these matrix-entries can be changed quickly (active 'Y', inactive '-').

Graphs >> ConnectionMatrix
Easy and convenient definition of displayed graphs and curves
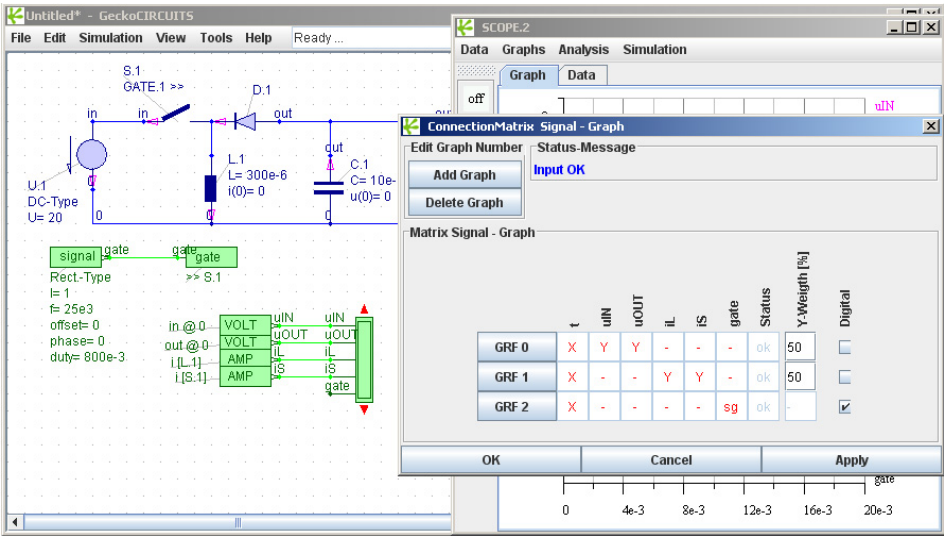
Add/Delete Graph
Add or delete graphs quickly via button

Activate/Deactivate Matrix-Entries
by one mouse-click (1x right)

Getting Started – Buck Boost Converter

If you click (1x left) the matrix-entry 'Y', a dialog for editing the curve properties will open. There, you can define color, line style and/or symbol points of the curve. Optionally, you can change the properties of the x- and y-axis by clicking the graph buttons (e.g. GRF 1).

Set the top graph to display two voltage curves uIN and uOUT, and the second graph to display two current curves iL and iS. The third graph has to be set as Digital (see according checkbox). This is very helpful if a number of digital signals should be displayed which is a popular option with many modern measurement devices.

After all properties and parameters have been set, the three graphs (including the third one which has been set to Digital) are displayed. The curve-names (defined by the node-names at the SCOPE input ports) are shown in the colors selected by the user.
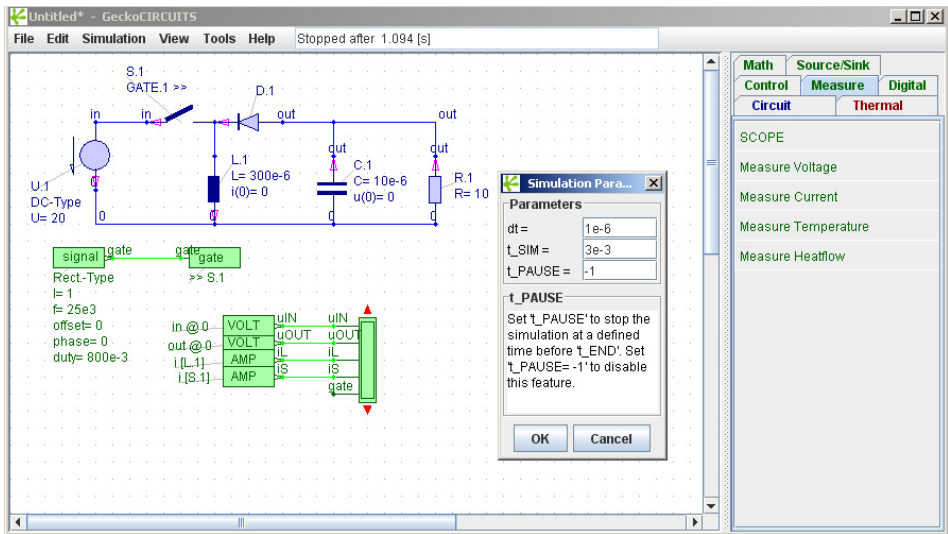
Matrix-Entry 'Y'
Mouse-click (1x left) to start dialog for single curve properties (line-style, color)

Digital Signals
Select checkbox in Connection Matrix

Getting Started – Buck Boost Converter

Open the dialog Simulation Parameters via menu Simulation >>_Parameter for defining the constant numerical step-width (dt = 1e-6) and the duration of the simulation (t_SIM = 3e-3).

Optionally you can stop the simulation at a defined time by setting t_PAUSE different from ‚-1'.

E.g. t_PAUSE = 0.001 would stop the simulation after one third of its total duration. Then, the user could change parameters like load resistor and proceed via menu Simulation_>>_Continue in order to investigate a load-change.

For the numerical step-width dt (defined in the dialog Simulation >> Parameter) you should select a value that is significantly lower than the smallest time-constant of the system.
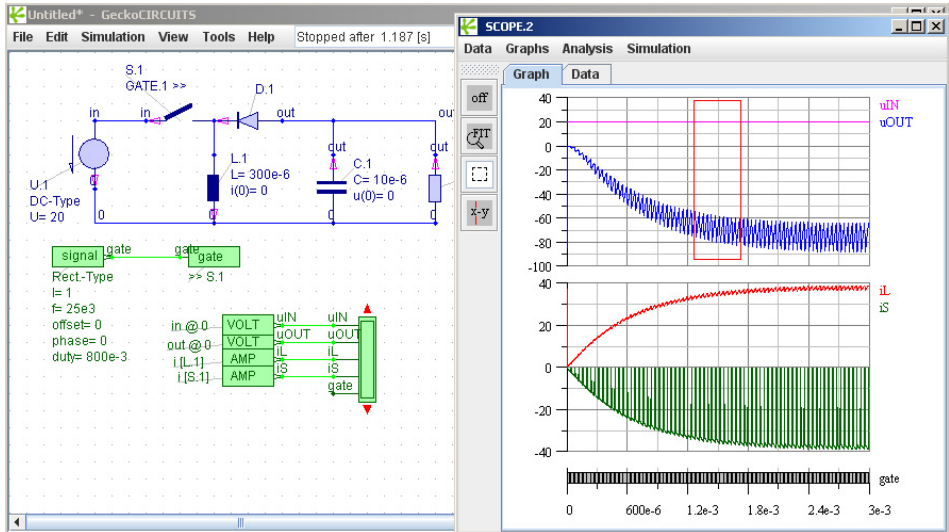
In case of this DC-DC converter the smallest time to consider is defined by the switching frequency as Ts = 1/fs = 1/25kHz = 40us. Therefore, the maximum value of dt should be around 40us/100 = 400ns.

Start the simulation via submenu Simulation >> Init & Start.

Menu Simulation >> Parameter
Dialog for numerical step-width and simulation time

Getting Started – Buck Boost Converter

Click the Zoom-Symbol (dotted rectangle, third symbol from top at the menu left-hand side in the scope-window) top at the menu left-hand side in the scope-window).
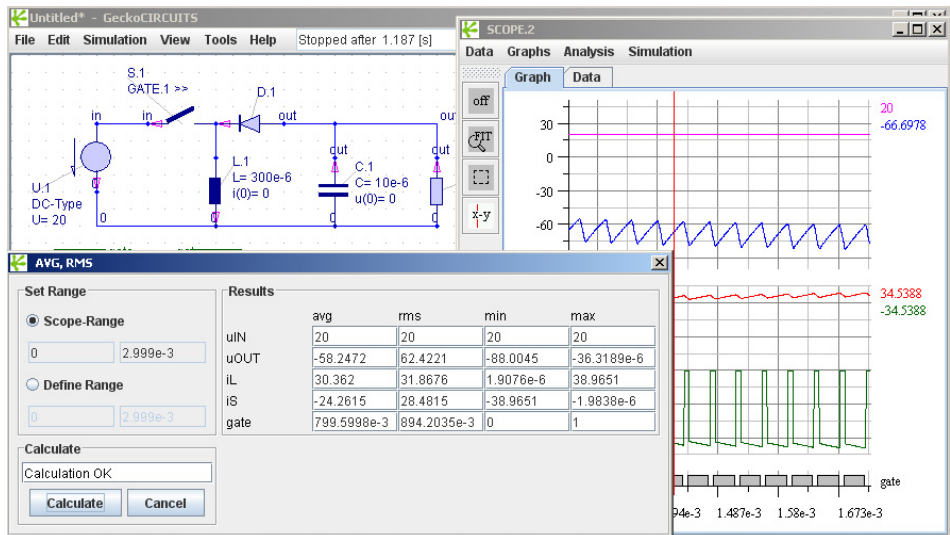
Draw a red rectangle to define the zoom-region by dragging the mouse pointer on the graph. The zoomed curves are auto-scaled.

By clicking the Slider-Symbols (fourth symbol from top at the menu left-hand side) you activate the time-slider to show values of the curves.

Zoom-Button in Scope-Window

Time-Slider in Scope-Window

Getting Started – Buck Boost Converter

Use the scope-menu Analysis >> Calc. AVG, RMS to calculate important curve properties like avg- and rms-value.

Proceed with the simulation via scope-menu Simulation >>_Continue. Before proceeding, parameters can be modified. If, e.g., the load resistor is changed, a load-step-response can be simulated.

If you want to save simulation-data in form of an ASCII-file (scope-menu Data >> Write Data to File), activate data-saving before starting the simulation via scope-menu Data_>> Activate Data Saving.

Activate Data Saving in Scope-Menu before simulation
- Save simulation results as ASCII-file
- Data-saving to disk will slow simulation

Getting Started – Buck Boost Converter

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